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IMPORTANT MUNICIPAL IMPROVEMENTS were authorized in a number of cities throughout the country on Nov. 7. Philadelphia voted to issue $12,000,000 for improving its water-works, by a vote 115,000 to 24,000. Most of the money, it is expected, will be used to construct filtration plants. Denver voted several million dollars to buy or construct municipal water-works. Rapid transit in New York city seems to have been given something of an impetus by a vote throughout the state in favor of a constitutional amendment separating city and county debts in cities and counties whose boundaries are identical. If the amendment was carried it will greatly increase the debt limit of New York city and make it much easier to issue bonds for the construction of an underground railway system.

STORAGE BATTERIES having an aggregate of 10,000 HP. are to be used by the Third Avenue R. R., of New York city, in connection with the electric equipment which has recently been put into operation upon its lines. The batteries will be located in two substations, and will probably be added to later. The Electric Storage Battery Co., of New York city, has the contract to furnish the batteries.

ELECTRIC RAILWAYS for the suburban districts of London, England, are proposed by the County Council, the lines to be built, owned and operated by the city authorities. The underground conduit system is recommended for busy streets, and for the lines in the neighborhood of the Greenwich Observatory, so as to prevent stray currents from affecting the astronomical and meteorological instruments. For other roads the overhead system is proposed. Prof. A. B. W. Kennedy has made a report on this matter, and is to act as expert adviser to the council, receiving a commission of 4% on the cost of the experimental lines, and also on the cost of such lines as the council may obtain government authority to construct. Professor Kennedy estimates the cost at $75,000 per mile of single-track for the conduit system, and $60,000 for the overhead system.

EXTRA COMPENSATION FOR CITY ENGINEERS in Wisconsin, when they have performed extra services, has just been held legal by the Supreme Court of that state. The suit involved the city and city engineer of Madison, Wis. The council agreed to pay the city engineer, Mr. McClellan Dodge, $5,000 extra compensation for designing and superintending the construction of sewerage and sewage disposal works. A citizen contested the validity of the agreement, claiming that the sewerage work was a part of the regular duties of the city engineer. The Circuit, as well as the Supreme Court, upheld the agreement, only two of the Judges of the latter court dissenting.

THE MOST SERIOUS RAILWAY accident of the week occurred in the yards of the Lehigh Valley R. R., at Jersey City, on Oct. 28. The driver of a freight engine mistook a signal because of the heavy fog prevailing at the time and backed up suddenly, probably fatally crushing three brakemen who were standing between cars expecting to uncouple them.

THE FALL OF A BUILDING at 139 Lake St., Chicago, on Nov. 1, was caused either by a flour-dust explosion, or by structural weakness combined with overloading. The building was six stories high, and collapsed without warning, crushing three adjacent buildings, and three or four men were killed. It was occupied as a feed mill, and grain and seeds were stored on the upper floors. Some of the witnesses assert that there was the sound and shock of an explosion before the building fell, while others assert that there was no such evidence. The owner and architect admit that it was originally intended to erect a two-story structure and a permit for this was obtained from the Building Department. Afterwards the owner decided to make it six stories high, and had the architect change the plans accordingly, but no second permit was obtained.

THE FAILURE OF A WATER TANK at Breese, Ill., is reported as having occurred on Oct. 30. It is said that the tank was erected about ten years ago, for fire protection. It appears that the tank was of wood.

MUNICIPAL OWNERSHIP OF A TELEPHONE SYSTEM is proposed at Logansport, Ind. A special committee recently reported in favor of negotiating with the Mutual Co. for the purchase of the system owned by that company, and it is stated that the council adopted the report and is now carrying out the recommendation.

ACETYLENE LIGHTING IN A CITY OF 12,000 INhabitants is being tested in Tata-Tovaros, Hungary, says "Le Genie Civil." A central station has been established and a provisional installation already supplies a system of about 5 miles of pipe and furnishes gas to 158 street lamps and 250 burners in houses. The whole generating plant is installed in a building 26 by 13 ft. in plan, located about midway between the two portions of the town and 656 ft. from the nearest house. In this station building are two groups of apparatus connected by pipes, controlled by valves, so that they can be used either singly or together. The gas is produced in four generators by the fall of the carbide into water; and the normal pressure is 160 to 200 mm. of mercury, and it cannot exceed 700 mm. Each generator can produce 106 cu. ft. of gas per hour, with a maximum temperature of 30° C., or 86° Fahrenheit. The gas for each group, on leaving the generators, passes by a 3-way valve into a coiled-cooler, and then into the chemical purifier. This latter is a double cylindrical vessel of lead, and in it the ammonia and sulphuric acid are absorbed as in the ordinary coal-gas plant. The gas finally passes into two gasometers, of 106 cu. ft. capacity each; and on leaving these the gas passes through drying cylinders containing carburet of calcium, which by contact with the water liberates additional acetylene gas. The gas finally reaches a counter and a pressure regulator and enters the main distribution pipe. The generating plant requires the services of only 2 men. The pipe-system is laid as for ordinary gas lighting, and no especial precautions were taken to insure the tightness of the joints. The total cost of installation was $30,000, of which $8,000 was expended for the central station and $19,000 for the pipe-system. The company operating the plant has a monopoly for 40 years, and the city pays $1,200 annually for the street lamps, not less than 158 in number, and they must each burn 1,800 hours in the year and have 20 c. p. For the purpose of estimating these figures the price of the gas was fixed at 2.60 francs per cu. m., or about $15 per 1,000 cu. ft.; the carbide of calcium must be brought from France or Switzerland, and the production cost, at the central station, was figured at 2.50 francs per cu. m.

THE SALE OF ILLUMINATING GAS containing more than 20% of carbonic oxide, corresponding roughly to a mixture of equal parts of coal and carburetted water-gas, should be prohibited, according to a recent English blue book.

A NEW ARTIFICIAL PAVING STONE is made in Germany, as follows: Coal tar is mixed with sulphur and warmed thoroughly, and chlorate of lime is added to the semi-liquid mass. After cooling this product is broken fine and is mixed with ground glass, or blast-furnace slag, and the blocks are then subjected to a pressure of 200 atmospheres. The specific weight of the compressed block is 2.2, and the resistance to crushing is claimed to be about 2,000 lbs. per sq. in. No statement of cost is made.

PEAT PAPER PULP MANUFACTURE in Canada is to be tested by a company now being formed in Montreal, according to a news item from that city. Mr. Charles Lionais, a civil engineer, is mentioned among the chief promoters. The peat would be disintegrated and bleached by an alkali solution and converted into paper stock by "a simple process" not described.

COKE FROM ILLINOIS COAL and other western coals has not hitherto been satisfactory, the coals not being adapted to the ordinary coking process, so that western smelting works, etc., have had to obtain their coke from Eastern States. Successful experiments with the Hemingway hot-blast system of coking have, however, been made at Chicago, with several kinds of western sulphurous coals, and the coke has been tested for smelting and other purposes with very satisfactory results, the sulphur content being greatly reduced in the process. The percentage of the coke produced to the original charge of coal is said to be even higher than under the ordinary process. The Connellsville coke is said to average 66%, while the Hemingway coke is from 75 to 80%. A temperature of about 3,000° F. is maintained in the oven, and it is claimed that under this intense heat the hydrocarbons are absorbed by the coke instead of being volatilized and driven off, as is the case with lower temperatures and comparatively slow combustion. The process occupies 6 to 12 hours, according to the grade of coal. The coke is of good cellular construction, and has a crushing strength equal to that of 48-hour Connellsville coke. The process is operated by the Universal Fuel Co., 81 South Clark St., Chicago, which has four ovens at 34th St., on the south branch of the Chicago River. President, L. Z. Leiter; Vice-President, Joseph Leiter; General Manager, W. E. Rothermel; Consulting Engineer, Joseph Hemingway. Analyses of coke made from coals from Danville, Ill., and Lucas, Ia., as furnished us by the company, are given below. The analyses were made by Robert W. Hunt & Co., of Chicago:

	Illinois.		Iowa	
	Coal.	Coke.	Coal.	Coke.
Moisture	1.36	2.22	3.85	0.55
Volatile matter	29.29	.....	34.16	.....
Fixed carbon	59.81	84.21	46.44	77.52
Ash	9.54	13.57	15.55	21.73
Sulphur	1,876	0.52	2.658	0.644

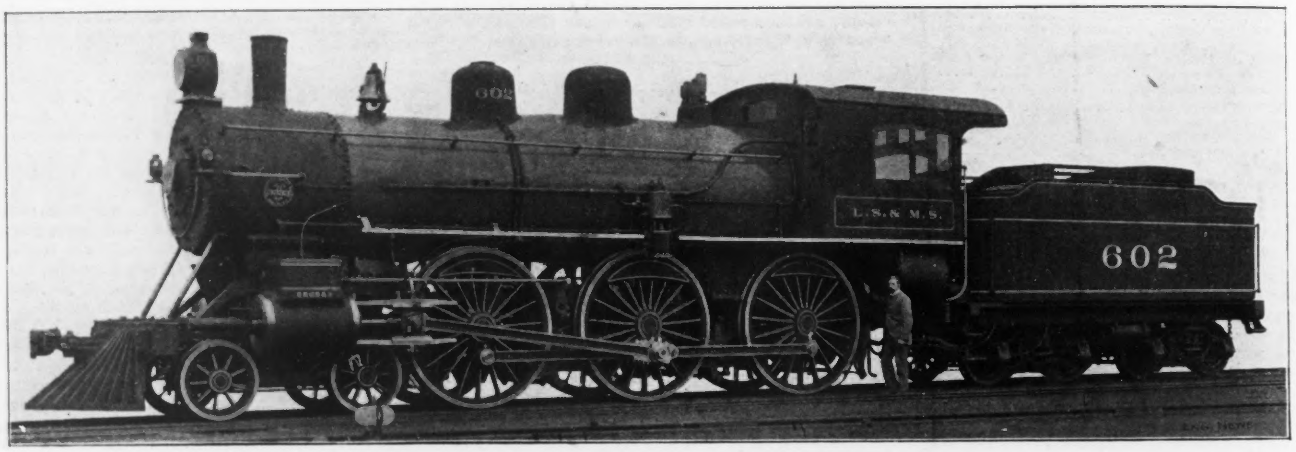
THE BLAST FURNACE AS A POWER PRODUCER is the subject of an article in "Feilden's Magazine" (London), for October, where the Thwaite-Gardner system, invented by B. H. Thwaite, is described. The average composition of furnace gas is given as: nitrogen 57.7%, carbon dioxide 7.8%, carbon monoxide 30.7%, hydrogen 3.3% and marsh gas .5%. The thermal value of the different combustible gases per cubic foot measured at 60° F., when the products of combustion are considered as not lower than 212° F., is: carbon monoxide, 319 B. T. U.'s, hydrogen, 228 B. T. U.'s and marsh gas, 908 B. T. U.'s. The blast furnace gas then has a value of about 120 B. T. U.'s per cu. ft., and, when employed to drive gas engines, will give from 60 to 70 lbs. per sq. in. mean pressure in the cylinder, and not over 100 cu. ft. will be required horse-power hour. Where coke is the fuel employed, there are given off from 170,000 to 180,000 cu. ft. of gases for each ton of coke consumed. Thus, a furnace producing 600 tons of pig iron per week and using one ton of coke per ton of iron would deliver about 600,000 cu. ft. of gases per hour. Allowing one-third of this for heating the blast by combustion in fire-brick hot-blast stoves, there is left 400,000 cu. ft. for power purposes, which would produce, if used in gas engines, 3,500 to 4,000 HP., of which 300 HP. would be needed for supplying the blast and other purposes, leaving the remainder for other use. It will be seen that 1 HP. hr. is delivered for each 1½ to 1¾ lbs. of coke charged into the blast furnace. When the iron market is overstocked, the blast-furnaces need not be blown out, which is costly and involves a rapid deterioration of the furnace, but may be profitably maintained in operation for the purpose of producing power. Plants of this description have already been installed in England, Scotland, Germany and France. In England and in Scotland the power is being used in electric lighting; in France for electric lighting and traction, and in Germany, for the production of calcic carbide.

THE BRITISH ASSOCIATION SCREW GAGE COMmittee was appointed in 1882 to determine a gage for the small screws used in telegraphic and electric appliances, clockwork, etc. In 1883-84 it proposed a system of threads, since known as the British Association screw threads, and practically the same as that proposed by Prof. Thury, of Switzerland. In 1895 complaint was made that the screws thus made were not reliable and interchangeable, and a committee was again appointed, with Sir W. H. Preece as chairman. This committee now commends gages and tools made by the Pratt & Whitney Co., of Hartford, Conn., as much more nearly accurate than any submitted by English firms. But these gages are for the British Association screws, and a test shows that "with the best appliances in the most experienced hands," the tools fail to produce even single specimens of first-rate accuracy. It is suggested that as the American, or flat-ended, form of thread, is now entirely employed by the French Admiralty, and is rapidly establishing itself in Germany, that it might also be better adapted to screws of small size than the British system in use. The American thread was limited by the Zurich conference to screws exceeding 6 mm. diameter; but the committee thinks that the same system of manufacture would apply to the smaller screws; and one of the committee has used such small screws and found them perfectly satisfactory. The committee of 1899 asks that it be continued and instructed to consider the modification of the British Association form of thread.

THE HEAVIEST PASSENGER LOCOMOTIVE EVER BUILT; L. S. & M. S. RY.

That this is the day of large and powerful locomotives is a fact that must be patent to everybody who is in touch with railway service, or who reads the technical papers, and the reasons for this have been fully presented in our columns. Within recent months we have published descriptions of several locomotives of exceptional size and power, reaching a temporary climax two weeks ago with the heaviest engine thus far built. We have described the largest freight engines of the twelve-wheel and consolidation types, and this week we describe and illustrate the largest passenger engines of the ten-wheel type, which are conspicuously in advance of all predecessors of this type in weight and dimensions. It is worth noting also, that eleven of these engines have been built for the Lake Shore & Michigan Southern Ry., which road has long had the reputation of adhering to light engines for its passenger service, although within the past year some passenger and freight engines of much greater power than those formerly used have been added to the equipment, as noted in our issue of April 27. These engines, however, were in no way remarkable as to size and weight, when cast-steel equalizers are journaled in castings projecting below the frames, and two other castings hold the outer ends of the end springs. Short slings have hooked upper ends resting upon the ends of the driving springs, while the lower ends have pin bearings in the end castings and the ends of the equalizers. The frame is of rather peculiar construction, with a top and bottom member embracing the cylinder saddle, the top members being brought down to the cross brace behind the bumper beam.

The cylinders are of large dimensions, though the stroke is 2 ins. less than in the latest ten-wheel freight engines above referred to. The piston rod is extended through the front cylinder cover, and the valve rod has a bushed guide in the guide yoke. The connecting and coupling rods are all of I-section, and the latter have solid ends. The main crank pin is 6½ × 6 ins.; main coupling pin, 7¼ × 4½ ins.; main pin wheel-fit, 7⅝ ins. The eccentrics are on the middle or main driving axle, which is hollow, and the eccentric rods are quite short, the links being only about 4 ft. 4 ins. forward of the axle. The Allen-Richardson balanced slide valves are used, instead of the piston valves which the builders are introducing on many of their engines. Sight-feed Nathan lubricators are used.



TEN-WHEEL PASSENGER LOCOMOTIVE; LAKE SHORE & MICHIGAN SOUTHERN RY.
W. H. Marshall, Supt. of Motive Power; Brooks Locomotive Works, Builders.

compared with similar engines on other roads. The new engines are designed to haul trains of 14 cars, including sleepers, at high speeds, even up to 60 miles an hour when necessary. The accompanying table gives a comparison of these new engines with other large engines of the same type.

The new engines are designed for fast and heavy passenger service, and will use bituminous coal as fuel. The driving wheels are of exceptional size for an engine with six coupled wheels. They have cast-steel centers, and all have flanged tires. This is in accordance with the latest practice, the use of blind tires on ten-wheel engines being less general now than formerly, except on roads having very sharp curves. The distance back to back of flanges is 52¾ ins. for the main drivers, and 53¼ ins. for the front and back drivers, while the truck wheels are 53⅜ ins. back to back. The driving springs are all placed beneath the boxes, the straps being seated in saddles carried by horse-shoe yokes. Each yoke consists of two curved bars, the tops resting on the driving box, and the lower ends having the saddle pins. Two

The boiler is of the extended wagon-top type, carrying a working pressure of 210 lbs. The dome is short and is placed on the wagon top, with the sandbox on the throat sheet and a special dome just in front of the cab for the whistle and the Ashton safety valves. An extension smokebox is used, with a steel tapering "boot-leg" stack. The firebox is very long, placed over the frames, the mud-ring being almost directly above the top bar of the frame. The side sheets and crown sheet are curved, and the latter is supported by radial stays. Expansion and contraction are provided for by sliding surfaces between large castings attached to the firebox and the frames, the castings being connected by a vertical link. The bottom of the firebox is inclined, and there is a double ashpan, with a hopper on each side of the trailing axle. The firebox has a firebrick arch, supported on water-tubes opening into the water spaces.

The tender has a frame built up of steel channels, and is mounted on diamond frame trucks with triple elliptic springs. It is 21 ft. 2 ins. long over the bumper beams, and the horseshoe tank is 19 ft. 6 ins. long, 9 ft. 10 ins. wide and 4 ft. 6 ins. high (exclusive of the collar).

The engines were designed by Mr. W. H. Marshall, M. Am. Soc. M. E., Superintendent of Motive Power of the L. S. & M. S. Ry. They were built by the Brooks Locomotive Works, of Dunkirk, N. Y., to whom we are indebted for photographs and other information. The general dimensions are given below in our standard form:

Dimensions of Ten-Wheel Passenger Locomotive, Lake Shore & Michigan Southern Ry.

Running Gear:
- Driving wheels (6) ....6 ft. 8 ins.
- Truck wheels (4) ....3 ft.
- Tender wheels (8) ....[illegible]
- Driving wheel centers ....Cast steel.
- Engine truck........................Swing center.
- Journals, driving axles, 9×12 ins; truck axles, 6 × 12 ins.

Wheelbase: Driving..16 ft. 6 ins.; truck........................[illegible]
- Total engine, 27 ft. 4 ins.; engine and tendr 55 ft. 2½ ins.
- Engine truck-pin to c. leading driv. wheel....7 ft. 10 "
- Wheels having blind tires ....None.

Weight in Working Order:
- On driving wheels ....133,000 lbs.
- On truck wheels ....38,600 "
- Engine total ....171,600 "
- Tender, loaded ....112,000 "

Cylinders: Number ....Two.
- Diameter and stroke ....20 × 28 ins.
- Crosshead and guides..Alligator crosshead; 2-bar guides.
- Connecting rod, length between centers......11 ft. 6 ins.
- Side rod ....Solid ends.

Valve Gear: Type ....Stephenson link.
- Ports, steam.....1⅝×19 ins; Ports, exhaust...2¾×19 ins.
- Bridges, width ....1⅝"
- Slide valves, balanced; maximum travel.........6.2 "
- " inside clearance ....⅛-in.
- " outside lap ....1⅛ ins.
- " lead (variable), full gear, 1-16-in. negative.

Boiler: Type ....Extended wagon-top.
- Barrel, diameter inside smallest ring.........5 ft. 6 ins.
- " " at throat ....6 " 2⅞"
- Dome, diameter ....2 " 6 "
- Thickness, barrel plates ....⅝, 11-16 and ¾-in.
- Thickness, smokebox tube plate ....¾-in.
- Horizontal seams ....Sextuple riveted.
- Circumferential seams ....Double riveted.
- Joints ....Butt, with inside and outside welt.
- Height from rail to center line...............9 ft. 2 ins.
- Length of smokebox, including extension......5 " 9 "
- Spark arresting device ....Netting in smokebox.
- Injectors (2) ....Nathan.
- Working steam pressure ....210 lbs.

Firebox: Type ....Above frames.
- Length inside...10 ft. 1 in.; width inside......3 ft. 5 ins.
- Depth at front,..6 " 6 ins.; depth at back.....5 " 3½"
- Thickness,side plates,⅜-in.; back plates..........⅜-in.
- Thickness, crn plate.⅜-in.; tube plate ....⅝-in.
- Crown stays ....Radial.
- Grate bars ....Cast-iron; rocking.
- Is firebrick arch used?............Yes, on water tubes.
- Mud ring, width, front & sides, 4 ins.; at back..3½ ins.

Tubes: Charcoal iron; No 345
- Thickness...No. 12 B.W.G.; diameter outside......2 ins.
- Length over tube plates........................15 ft. ¼-in.

Table of Dimensions of Heavy Ten-Wheel Passenger Locomotives.

Railway	L. S. & M. S.	Grand Trunk.	N. Y. Central.	Den. & R. Grande.	Southern.	Atch., T. & S. F.	Fitchburg.	Balt. & Ohio.
Builder	Brooks.	Schenectady.	Schenectady.	Brooks.	Richmond.	Dickson.	Baldwin.	Baldwin.
Driving wheels	6 ft. 8 ins.	6 ft. 0 ins.	5 ft. 10 ins.	5 ft. 3 ins.	6 ft. 0 ins.	6 ft. 1 in.	6 ft. 6 ins.	6 ft. 6 ins.
Wheelbase, driving	16 " 6 "	15 " 8 "	14 " 8 "	13 " 0 "	14 " 7 "	15 " 0 "	14 " 6 "	13 " 8 "
Wheelbase, total	27 " 4 "	26 " 11 "	26 " 0 "	23 " 7 "	26 " 1 "	25 " 2 ins.	26 " 3 "	24 " 6 "
Weight on drivers	133,000 lbs.	125,000 lbs.	126,000 lbs.	124,000 lbs.	121,250 lbs.	125,300 lbs.	111,000 lbs.	113,000 lbs.
" total engine	171,600 "	166,000 "	164,000 "	160,000 "	158,000 "	156,800 "	150,000 "	147,000 "
" eng. & tendr	283,600 "	268,000 "	......	272,000 "	245,500 "	249,200 "	244,000 "	229,000 "
Compound or simple	Simple.	Simple.	Simple.	Simple.	Simple.	Simple.	4-cyl. compound.	Simple.
Cylinders	20 × 28 ins.	20 × 26 ins.	20 × 28 ins.	21 × 26 ins.	21 × 28 ins.	19½ × 28 ins.	15 and 25 × 26 ins.	21 × 26 ins.
Boiler, diameter	5 ft. 6 ins.	5 ft. 0 ins.	5 ft. 6 ins.	5 ft. 8 ins.	5 ft. 1 in.	4 ft. 11 ins.	5 ft. 0 ins.	5 ft. 0 ins.
Boiler pressure	210 lbs.	200 lbs.	200 lbs.	210 lbs.	200 lbs.	180 lbs.	200 lbs.	190 lbs.
Firebox	10′ 1″ × 3′ 5″	10′ 7″ × 3′ 4″	9 ft. × 3 ft. 4 ins.	10′ 1″ × 3′ 5″	10 ft. × 3 ft. 6 ins.	7′ 4″ × 3′ 9″	10 ft. × 3 ft. 5 ins.	10 ft. × 3 ft. 5 ins.
Tubes, number	345	291	360	326	295	264	328	231
" diameter	2 ins.	2 ins.	2 ins.	2 ins.	2¾ ins.	2⅞ ins.	2 ins.	2¼ ins.
" length	15 ft. 0¼ ins.	15 ft.	14 ft. 4 ins.	13 ft. 4 ins.	14 ft. 5 ins.	14 ft. 10 ins.	15 ft. 1 in.	14 ft. 7½ ins.
Heat. surf., tubes	2,694 sq. ft.	2,270 sq. ft.	2,686 sq. ft.	2,257 sq. ft.	2,217 sq. ft.	1,796 sq. ft.	2,576 sq. ft.	1,970 sq. ft.
Heat. surf., total	2,917 "	2,470 "	2,886 "	2,422 "	2,410 "	1,960 "	2,748 "	2,194 "
Grate area	33.6 "	33.4 "	30.2 "	33.6 "	35 "	25 "	34.5 "	34.3 "
Water in tank	5,000 gallons.	4,500 gallons.	4,500 gallons.	5,500 gallons.	4,500 gallons.	4,650 gallons.	4,500 gallons.	[illegible],000 gallons.
Coal on tender	19,000 lbs.	20,000 lbs.	20,000 lbs.	16,000 lbs.	14,000 lbs.	16,000 lbs.	......	7,244 lbs.
Date in Eng. News	Present issue.	July 28, 1898.	......	......	June 16, 1898.	March 3, 1898.	......	Sept. 30, 1897.

Heating Surface and Grate Area:
Heating surface, tubes (interior area) ....2,694 sq. ft.
" " firebox and arch tubes..... 223 "
" " total ....2,917 "
Grate area .... 33.6 "
Miscellaneous:
Exhaust nozzle (single, permanent), diameter ..5⅛ ins.
Exhaust nozzle, distance below center line boiler..7 "
Smokestack, diameter at top 16⅝ ins.; at base..15 "
" height above smokebox ....2 ft. 10½"
" height of top above rail........15 " 3 "
Capacity of tender tank ....5,000 gals.
Capacity of coal space ....19,000 lbs.
Brake fittings { American.......................For drivers.
{ Westinghouse..Tender and train service.

EXPERIMENTS ON THE FILTRATION OF CRUDE SEWAGE THROUGH COKE, AT LONDON, ENGLAND.

Some interesting experiments on the filtration of crude sewage through coke are in progress at the Crossness outfall of the London sewerage system. The most notable features of the tests have been the rapid rate of filtration, the large size of the particles of filtering material, and a combination of a relatively high chemical with a low bacterial efficiency. For a proper appreciation of the methods and results, it should be known that their aim is to throw light on the best means of producing an effluent which may be discharged into the Thames without creating a nuisance. The chemical precipitation works, put in operation at Barking and Crossness in 1890-2, remove about 80% of the suspended matter from the sewage, and 17% of the dissolved putrescible matter, whereas the experimental coke filter beds have removed practically all of the suspended matter and 51.3% of the dissolved putrescible organic matter. Besides these advantages over chemical precipitation, coke filtration requires no chemicals, produces no sludge for final disposal, and gives an effluent which is not only unobjectionable in smell, but does not injure the fish. The small reduction in bacteria, considering the chemical nature of the effluent and the character and uses of the stream into which the effluent goes, is probably far more advantageous than otherwise; that is, these bacteria simply carry on the process of nitrifying the organic matter after the sewage reaches the river, instead of completing the process in the beds. By this means the area of filter beds required is lessened, and no harm results. Quite likely more disease germs are discharged into the Thames than would be the case if the bacterial purification were higher, but from the information at hand it does not appear that this is a matter of much consequence, the water being too brackish to drink at this point in the river.

The experiments in question are being carried on for the London County Council, by Prof. Frank Clowes, Chief Chemist to the Council, and Dr. A. C. Houston, the latter having charge of the bacteriological work. The work was begun in May, 1898, and the results obtained for some ten months are embodied in a report submitted to the Main Drainage Committee of the County Council, and recently published for that body. (See New Publications, in the Supplement to this issue.)

Three filter beds were used in the experiments, each having an area of 240 sq. ft., or 0.0055 acres. One of these beds was used for a secondary filtration, but all were filled with gas-works coke about the size of a walnut. The coke, after long soaking, was found to absorb water up to 15% of its weight. The coke beds had an initial sewage capacity (absorption and interstitial storage combined) of 50% of the space occupied by the coke and interstitial air. One primary tank was filled with coke to the depth of 4 ft., and the other primary and the secondary tank were filled to a depth of 6 ft. A fourth bed, 13 ft. deep, was installed about the close of the period covered by this report, but all the results discussed are from the other beds, unless otherwise stated. All the tanks had brick bottoms and sides, and were underdrained by "a series of parallel loose-jointed stoneware" pipes.

Before the sewage reaches the beds it has had a rough screening, and has been freed from coarse sand and heavy mineral road detritus. It has also passed through pumps. The sewage is distributed over the surface of the beds by means of troughs. The outlets to the beds are closed meanwhile, and when the beds are filled to the surface of the coke the sewage is shut off. The sewage remains in contact with the beds about three hours, after which it is slowly drained off by gravity. About seven minutes are taken for filling, and one hour for emptying the 4-ft. bed. The primary beds stand empty for about eight hours "in order that the surface of the coke fragments may become aerated." The secondary bed has only seven hours' aeration. This bed receives the sewage from the 6-ft. primary bed. Twice a week each bed is raked to a depth of several inches. This has prevented all appearance of clogging. Holes dug occasionally to the bottom of the beds have always shown the coke to be perfectly sweet, with only a slight earthy odor. The beds are not filled on Sundays, and have rested on occasional holidays or for repairs to the pumps. In addition, the 4-ft. bed, which was put in operation before it was fully "matured," was given a fortnight's rest in June and July, 1898, after having been dosed twice daily. Subsequently one filling a day until November, and then two doses each day, gave satisfactory results. Up to February 18, 1899, a total of 1,017,000 U. S. gallons had been treated on the 4-ft. bed. The report does not state clearly whether this was for the period covered by the anaylses, May 9, 1898, to Feb. 18, 1899, or for the period beginning on April 22 and ending on Feb. 18. The latter, however, seems to be the period. During this time the bed was idle 14 days consecutively, 12 scattering days, and every Sunday. Making no allowances for stoppages, the average daily rate of filtration from April 22 to Feb. 18, was about 610,000 U. S. gallons per day. The rates given in the report appear to be the actual daily rates of application, instead of the averages for the total number of days in any stated period. The analyses do not cover the operations of the 4-ft. bed for its first three weeks of service, when it was getting into shape for work. For the balance of the period, this bed removed an average of 52.7% of the putrescible oxidizable matter. The actual amount of sewage applied to this bed daily when in service, appears to have been about 665,000 U. S. gallons for single, and 1,330,000 gallons for double dosing.

The 6-ft. primary bed was started on Sept. 1, and received about 2,220,000 U. S. gallons per day. With the exception of Sundays, holidays, and possibly three or four days for repairs to the pumps, this bed was in continuous service, removing 49.9% of the total dissolved organic matter. The secondary bed, of the same material and thickness, receiving the effluent from the first 6-ft. bed, removed only 19.3% in addition. The daily amounts given were applied to the 6-ft. bed in two doses, and to the 4-ft. bed part of the time in two and the balance in one dose per day. The report indicates that after the close of the ten months which it covers, single dosing was begun at the reduced rates of 440,000 U. S. gallons a day for the 4-ft., and 805,000 for the 6-ft. filter. The reason for this reduction is not given, and can be explained only by assuming that it was desired to learn whether the degree of purification would be increased materially by a lower rate, since the report states the beds had been working satisfactorily at the higher rates. The report also states that on June 21, 1899, a 13-ft. filter had been working satisfactorily for about nine weeks, and had "given a purification approximately equal to that effected by the 4-ft. bed," with indications that it might be expected to handle sewage at the rate of at least 4,200,000 gallons per day.

Examinations of air drawn from the bottom of both the 6-ft. and the 13-ft. bed indicated that the aeration of the coke, between fillings, extends to the bottom of the beds.

The information thus far given is from Prof. Clowe's section of the report. Dr. Houston contributes an interesting study of the bacterial phases of the subject, beginning with a brief historical review of the biological treatment of sewage, and including an account of the bacteriological methods followed by him in these tests, as well as a discussion of the bacterial contents of the sewage and effluent, quantitatively and qualitatively. As but little bacterial improvement was wrought by the coke beds, and the tests were being continued at the time of the report, this feature of the experiments will not be discussed here. It may be added, however, that the effluents from the coke beds appear to be quite as good, bacterially, as those from the chemical precipitation tanks at the Barking and Crossness outfalls of the London sewerage system, and that Dr. Houston's report is a valuable contribution to the bacteriology of sewage.

A number of diagrams showing the chemical and bacterial results are appended to the reports of Drs. Clowes and Houston, together with photomicrographs and drawings of some of the bacterial cultures.

In conclusion, perhaps it should be pointed out that some of the advantages claimed for such coarse-grained filtering material are its greater sewage capacity per volume of coke to each filling and the increased speed with which the beds may be drained, and their complete drainage. The effluent seems to be discharged from the beds at a time when there still remain sufficient oxygen and food supplies to maintain almost the original number of bacteria, although the organic matter is so far reduced, both in kind and quantity, as to render its further transformation an easy and seemingly speedy process, especially as the effluent itself is rich in bacterial life.

EARLY RAILWAY CONSTRUCTION IN THE UNITED STATES.

An interesting review of early railway construction in the United States forms a part of the introduction of "Poor's Manual" of railroads for 1899, which has just been published. This review, which we assume to have been prepared by Mr. John P. Meany, the Managing Editor of the manual, covers the development of the country's railway system from its beginning, in 1828, until about 1880, but is chiefly interesting for its records of railway construction and operation previous to 1860. Among the more important tabular matter are statistics showing the mileage and termini of each railway in each state of the United States in 1840; showing the mileage and earnings of railways in the United States in 1851, and showing the name, length, termini and date of construction of the first line of railway built in each state of the Union. While these matters of early railway history are familiar in a general way to most engineers, it is not easy to find exact information concerning them for reference when it is wanted, and we believe that our readers will be interested in having at hand the following facts, which we abstract from the manual:

The railway system of the United States had its birth in 1828, when the Baltimore & Ohio R. R. was begun. In 1835, seven years later there were in operation in the United States 1,098 miles of railway, of which nearly all was in the states bordering the Atlantic. The Camden & Amboy R. R. connecting Philadelphia with New York harbor was completed in 1837. In 1840 there was in New England a well defined system of railways, and by the end of 1841 there was a complete through line from Boston to Albany. The construction had by this time begun to extend toward the interior. The line from Albany to Lake Erie at Buffalo, N. Y., was completed in December, 1842, and in the same year the Philadelphia & Reading R. R. was extended west to the coal fields of Pennsylvania. At the end of 1848 connection was established between Boston and New York by the New York & New Haven R. R., and two years later, in 1851, the Hudson R. R. had been completed from New York to Albany, and the Erie R. R., built from the Hudson River to Lake Erie. Up to 1851 canal tolls were imposed by the state of New York on all freight moved by railway from Albany to Lake Erie for the benefit of the canals owned by the state, but as they could not be imposed on the Erie R. R., completed in this year, they were removed from the other lines. In the 19 years, 1830 to 1848, there were constructed 5,996 miles of railway in the United States of which only 419 miles were in the Western States. During the 12 years from 1849 to 1860, there were added 24,639 miles of line, making a total at the end of the latter year of 30,635 miles, an increase over 1848 of over 400%, and an annual average of 2,000 miles as compared with 316 miles for the first period.

After Lake Erie was reached, the next great step was the extension of the northern system of railways to Chicago by the completion, in 1853, of the Cleveland & Toledo R.R. (now a part of the Lake Shore & Michigan Southern). The Michigan Central and Michigan Southern, extending from Lake Erie to Chicago, were opened in 1852, ten years after the opening of the main line of the New York Central from Albany to Buffalo. The construction of the Pennsylvania R. R. was begun in 1847, and was opened for business in 1854. This line was extended to Chicago by the Pittsburg, Fort Wayne & Chicago, which was completed in 1858.

In the preceding sketch we have briefly recapitulated the works first undertaken, and have traced the progress westward of the great trunk lines based upon Boston, New York, Philadelphia, and Baltimore. Some progress had, however, been made in the Valley of the Mississippi before either of those lines had reached that valley or Lake Erie. The first line of railway undertaken in the great interior basin of the country was the Mad River & Lake Erie of Ohio, afterwards a part of the Cincinnati, Sandusky & Cleveland Ry., which line was purchased in November, 1890, by the Cleveland, Cincinnati, Chicago & St. Louis Ry. Co. Its construction from Sandusky to Dayton, 154 miles, was begun in 1835, a portion of it being opened in 1838. In connection with the Little Miami, which was opened from Cincinnati to Springfield in 1846, it formed (in 1848) a part of the first through line from Lake Erie to the Ohio. A second line between the lakes and river was formed by the Little Miami and the Cleveland, Columbus & Cincinnati, which was completed between Cleveland and Columbus, 135 miles, in 1851. The Cleveland & Pittsburg, forming the third line, was opened in 1852. These roads opened up the greater part of the state of Ohio to transportation by railways, and supplemented the trunk lines westward, so soon as the intermediate links could be put in. This was accomplished by the completion of the line of railroad from Buffalo to Toledo, the last link of which, between Cleveland and Toledo, was opened in 1853. Of the lines running east and west through that state, the first to be constructed was the Central Ohio, which was opened from Wheeling to Columbus, 137 miles, in 1854. The Marietta & Cincinnati R. R. was begun in the spring of 1851, and six years later was completed from Marietta, on the Ohio River, to Loveland, 173 miles; entrance into Cincinnati, six miles beyond Loveland, being made over the tracks of the Little Maimi R. R. In 1857, the same year that the Marietta & Cincinnati was completed, the Baltimore & Ohio reached the Ohio River at Parkersburg, by the construction of its Parkersburg branch; and two years later a branch of the Marietta & Cincinnati was built to meet the latter line, thus forming a through line from Baltimore and Washington to Cincinnati. In 1858 the Pittsburg, Fort Wayne & Chicago R. R. Co. opened its important line from Pittsburg to Chicago, a distance of 468 miles, completing the second great trunk line from New York to Chicago.

As in Ohio there were no railways of importance constructed in the other Western States of the Union previous to 1849. In Indiana the Madison & Indianapolis (now a part of the Jefferson, Madison & Indianapolis), one of the roads first constructed in the West, was opened in 1847. This line was originally begun by the state, and 26 miles of it were opened in 1841. It was transferred to a private corporation in 1843, and completed between Madison and Indianapolis in 1847. The first line running east and west through the state, made up of the Indiana Central, and the Indianapolis & Terre Haute, was opened in 1853. The next line, having a similar direction, was the Ohio & Mississippi, opened in 1857. The New Albany and Salem, now the Louisville, New Albany & Chicago, the first line connecting Lake Michigan and the Ohio, and lying wholly in Indiana, was opened in 1854.

In Illinois the first line undertaken was the Sangamon & Morgan, a portion of which was opened as a state work in 1839. This road now forms a part of the Wabash line. The second line opened in Illinois was the Galena & Chicago Union, which was commenced in 1849, and opened for a distance of 10 miles in June, 1850. The railway first opened in this state from Lake Michigan to the Mississippi River was the Chicago & Rock Island, in February, 1854. This connection marked a very important extension of the railway system of the country. The second line to the Mississippi, made up of the Galena & Chicago and the Illinois Central, was opened early in 1855. The Chicago & Alton was opened in 1855; the Chicago, Burlington & Quincy to the Mississippi River in 1856; the Milwaukee & St. Paul in 1858, and the Western Union in 1862. Both of the latter now form part of the Chicago, Milwaukee & St. Paul system. The Chicago branch of the Illinois Central was opened from Chicago to Cairo in 1856. At this time the Illinois Central, with its 700 miles of road, was considered the most stupendous undertaking in the world.

The next important extension westward was the Hannibal & St. Joseph, which carried the railway system to the Missouri River in 1859. Of the lines constructed through Central and Southern Illinois, the Terre Haute & Alton was opened in 1854, and the Ohio & Mississippi in 1857. From St. Louis westward, the Pacific Railroad of Missouri, the beginning of the present Missouri Pacific system, was completed to Sedalia, 189 miles, in 1861—before the outbreak of the war.

The railways whose progress has been here sketched formed at this date, geographically and commercially, one system, of which the Baltimore & Ohio R. R. and its connecting lines may be said to constitute the southern boundary or member. South of Baltimore there was no important commercial city upon the Atlantic Coast, and the trade of all the interior north of a line with the lower Ohio naturally sought eastern outlets through the railways that had been opened. In consequence, the railway development of the Southern States during the earlier periods was slow and of local importance only.

Several railways were constructed at an early day in Virginia, the more important of which were those now forming the line traversing the state from north to south, and made up of the Richmond, Fredericksburg & Potomac, completed from Richmond to Fredericksburg in 1837, and to the Potomac in 1841; the Richmond & Petersburg, opened in 1838; and the Petersburg & Roanoke, in 1843. But the great line of Virginia, prior to the Civil War, was the railway traversing the state diagonally from Alexandria to the boundary line of Tennessee, 382 miles, made up of the Orange & Alexandria and the Virginia & Tennessee railways. The former of these roads was opened in 1859, and the latter in 1856. At the boundary this line connected with the East Tennessee & Virginia, extending to Knoxville, Tenn., which was opened in 1858. From Knoxville this line was extended to Dalton, on the line of the Western & Atlantic R. R., by the East Tennessee & Georgia R. R., opened in 1856.

From Weldon the Virginia system was extended to Wilmington, N. C., by the opening of the Wilmington & Weldon R. R., in 1840. It was not till 1853 that a connection was formed with the system of South Carolina by the opening of the Wilmington & Manchester R. R. The South Carolina R. R., as before remarked, was opened to Augusta, Ga., in 1833. From Augusta, the Georgia R. R. was opened to Atlanta in 1839. The Central R. R. of the same state was opened from Savannah to Macon in 1840. From Atlanta the railway systems of South Carolina and Georgia were extended to the Tennessee River at Chattanooga, Tenn., by the completion of the Western & Atlantic R. R. of Georgia, a state work, in 1850. From Atlanta a line of railway was opened to Montgomery, Ala., in 1853, and from Montgomery to Mobile, in the same state, in 1862.

From Chattanooga to Nashville the Nashville & Chattanooga was opened in 1854, and the Memphis & Charleston in 1857. The Mobile & Ohio R. R. was opened to Columbus, on the Mississippi River, near the mouth of the Ohio River, in 1859. The line from New Orleans, made up of the New Orleans, Jackson & Great Northern, and the Mississippi Central, was opened to a connection with the Mobile & Obio at Jackson, Tenn., the same year. The Louisville & Nashville was opened to a connection with the roads last named in 1861, and with Nashville in 1859.

The following statement gives the terminal points of the first railway or section of railway built in each state in the Union, with its length and date of opening:

Groups of states.	Termini of first section opened — From	To	Length in Miles.	Opening year.
N. England:				
Me.	Bangor	Oldtown	11.0	1836
N. H.	Nashua	Mass. state line	5.2	1838
Vt.	White River	Betbel	25.0	1848
Mass.	Boston	Lowell	26.7	1835
R. I.	Providence	Stonington, Ct.	50.0	1837
Conn.	Hartford	New Haven,	36.2	1839
Middle:				
N. Y.	Albany	Schenectady	16.1	1831
N. J.	Bordentown	Highstowu	14.0	1832
Pa.	Port Carbon	Tuscarora	9.2	1830
Del.	Newcastle	Frenchtown	16.2	1832
Md.	Baltimore	Ellicott's Mills.	15.0	1830
D. C.	Washington	Md. state line	4.0	1835
Central Northern:				
Ohio	Sandusky	Green Spring	22.5	1838
Micb.	Toledo, O.	Adrian, Micb.	33.0	1836
Ind.	Madison	Vernon	22.0	1842
Ill.	Jacksonville	Meredosia	24.0	1839
Wis.	Milwaukee	Waukesha	21.5	1851
South Atlantic:				
Va.	Richmond	Chstrfld Mines.	12.0	1831
W. Va.	Harpers Ferry, W.Va.	Winchester, Va.	32.0	1836
N. C.	Petersburg, Va	Blakely, N. C.	63.0	1833
S. C.	Charleston	West	7.0	1830
Ga.	Savannah	West	9.0	1837
Fla.	St. Joseph	Lake Wimico	8.0	1836
Gulf & Miss. Valley:				
Ala.	Tuscumbia	Decatur	45.5	1834
Miss.	Vicksburg	Jackson	14.0	1841
Tenn.	Nashville	Murfreesboro'.	30.0	1851
Ky.	Lexington	Frankfort	29.0	1835
La.	New Orleans	L.Pontchartrain	5.0	1831
Southwestern:				
Mo.	St Louis	West	6.00	1852
Ark.	Memphis	West	5.0	1857
Tex.	Harrisburg	Richmond	32.0	1854
Kan.	Kansas City	Lawrence	40.0	1864
Colo.	Sheridan, Kan.	Kit Carson	87.0	1870
N. Mex.	Colo. state line	South	8.3	1878
Ind. T.	Seneca	Vinita	35.5	1870
Okla.	Arkansas City, Kan.	Ponca	25.0	1886
Northwestern:				
Iowa	Davenport	Muscatine	3[illegible]	1855
Minn.	St. Paul.	St. Anthony	1[illegible]	1862
Neb.	Omaha	West	4[illegible]	1864
N. Dak.	Fargo	Bismarck	19[illegible]	1872
S. Dak.	Big Sioux River	Yankton	6[illegible]	1873
Wyo.	Denver, Colo.	Cheyenne	10[illegible]	1870
Mont.	Ogden, Utah.	Blackfoot	16[illegible]	1869
Pacific:				
Cal.	Sacramento.	Folsom	22[illegible]	1856
Wash.	Lower Cascade	Upper Cascade.	6[illegible]	1862
Ore.	Portland	Albany	80	1870
Nev.	Truckee, Cal.	Reno	35	1868
Ariz.	Yuma.	Adonde	30	1879
Utah	Evanston, Wyo.	Echo	36	1869
Idaho	Brigham, Utah	Franklin	61	1874

THE 3,000-TON CONCRETE BLOCKS AND ROLLING CAISSONS AT THE BRUGES SHIP CANAL, BELGIUM.

In our issue of Dec. 22, 1898, was illustrated and described the ship canal now under construction for the restoration to the city of Bruges of its old-time commercial prestige. In building the breakwater for protecting the entrance to

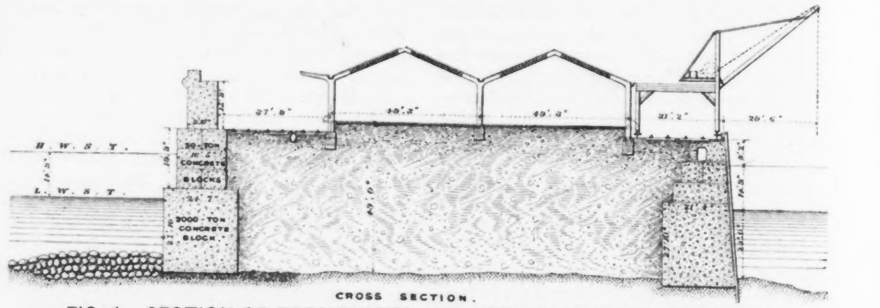


FIG. 1.—SECTION OF BREAKWATER AND QUAY AT ZEEBRUGGE HARBOR.

this canal, monoliths of concrete, weighing from 2,500 to 3,000 tons are being employed, and in a paper on this canal, read before the Institution of Civil Engineers, Mr. L. V. Vernon-Harcourt, M. Inst. C. E., describes the method of making these blocks. The following abstract is taken from this paper:

The curved breakwater will have a total length of 4,984 ft., and will extend to a depth of $4\frac{1}{2}$ fathoms at a point 930 yds. from low-water mark. The wide part of the breakwater, over a length of 3,918 ft., will consist of a concrete-block quay wall on the harbor side and a concrete-block sea wall on the sea side. The width at the level of the quay will be 177 ft., including a sea parapet 10 ft. thick, and the space between the walls will be filled.

The lower part of the sea wall is made of huge concrete blocks built up in metal caissons 82 ft.

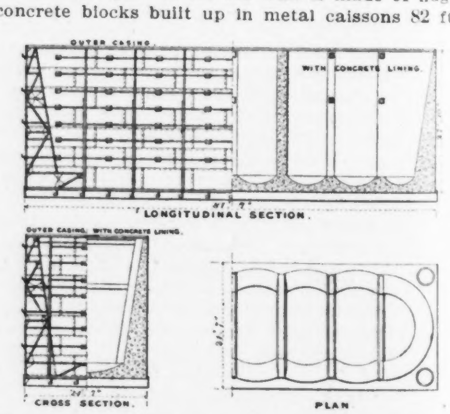


Fig. 2.—Details of Caisson for 3,000-ton Concrete Block in Breakwater Foundation.

long, 24 3-5 ft. wide and varying in height from 23 to 30 ft., according to position. The tops of these blocks are intended to project $3\frac{1}{4}$ ft. above low water of spring tides. Somewhat similar blocks, but with a batter on the outer face, are being built up for the base of the inner quay wall. The caissons for these blocks are erected in the dry in the inner basin above the lock. These caissons have a cutting edge around the bottom and are strengthened at the base by a series of lattice girders, and at the sides by triangular lattice stays extending up the whole height of the caisson. They are then partly filled with concrete over the bottom and around the sides, leaving sufficient buoyancy to float with their tops projecting 3¼ ft. out of the water. The concrete employed is 1 part Portland cement to 2¾ parts of sand and 4¼ parts of small porphyry rock.

As soon as the sea lock is completed and the total number of caissons built and lined with concrete the water will be admitted through the lock from the entrance channel and the caissons floated in the inner basin. The floating blocks will then be towed, one by one and in calm weather, to their proper site, and when moored in position they will be sunk by removing wooden plugs from holes left in the sides for this purpose. They will settle either on the natural bottom or on a levelling bed made by dumping small rubble stone. The filling of each block with concrete will be accomplished by the aid of a Titan crane running on the finished portion of the work. This crane will handle closed skips, each holding about 6½ cu. yds. The same crane will lay the 50-ton concrete blocks, which will raise the level of the sea and the quay walls to 23 ft. above low water and 8 1-5 ft. above high water of spring tides. The sea-wall parapet will be 10 ft. thick at the base and 28 ft. above high water, and will be made by depositing concrete in forms resting on the 50-ton blocks. The sea-wall foundation will finally be protected against scour by an apron of rubble stone extending 50 ft. out from the face of the blocks.

These 3,000-ton blocks, says Mr. Vernon-Harcourt, are the largest ever made. The next in weight and size are those used in the approach to the port of Bilboa, in Spain. But these blocks are only 42 2-5 ft. long by 23 ft. wide and 23 ft. high, and they weigh 1,400 tons.

Another novel feature in this canal is the employment of rolling gates, worked by electricity, for a commercial lock. Rolling caissons have been used for closing graving docks, and instead of ordinary gates at the locks of naval dockyards, where they must only be moved occasionally; but it is a new departure to resort to rolling caissons for a lock that must be opened and closed near the time of high water. The rapidity and facility of motion expected from the employment of electric power caused the engineers of the Bruges Canal to adopt the system. The advantages of these rolling caissons are that the lock-chambers can be made longer, in proportion to the length of the whole lock, than with gates; the sills need not be raised above the floor of the lock; and, in this case, the caissons will serve the purpose of flood-tide and ebb-tide

this work is calculated to occupy only 2⅔ minutes. Hand apparatus will be supplied so that in case of a breakdown in the electric power three men can draw the caisson in or out in 15 minutes. Each caisson will travel on four pairs of wheels, 3¼ ft. diameter, arranged two and two near each extremity. These wheels run on rails laid in a recess in the floor. Meeting-faces are formed on both sides of the caisson so as to operate at both sides, and there is a play of 1⅜ ft. between the meeting-faces and the sides of the caisson to allow the escape of water along the sides of the faces when the caisson is being moved. As the

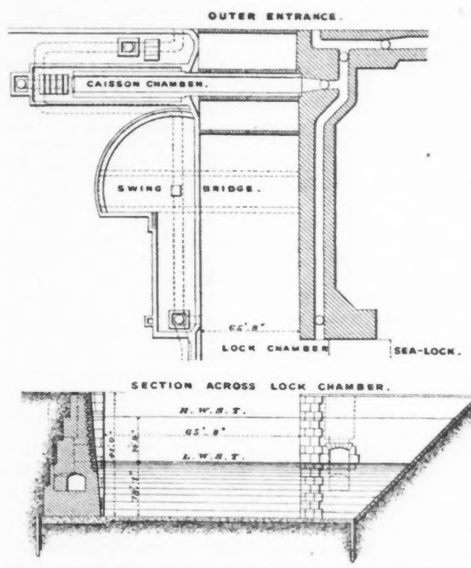


Fig. 3.—Rolling Caisson for Closing Entrance to Tidal Lock.

caisson will be thus able to retain a head of water on either side, each caisson serves as a flood-tide or an ebb-tide gate. The wheels and rails under the caisson are accessible for repairs by means of a chamber in the caisson encircling each set of four wheels, 7½ ft. wide and stretching clear across the caisson. Into this chamber compressed air can be forced, the water driven out and access gained by a 2⅓-ft. shaft provided with an air lock. A third shaft in the caisson enables the water-tight air chamber to be inspected and repaired. To keep the sills and floor of the lock clear of sediment five sluiceways are

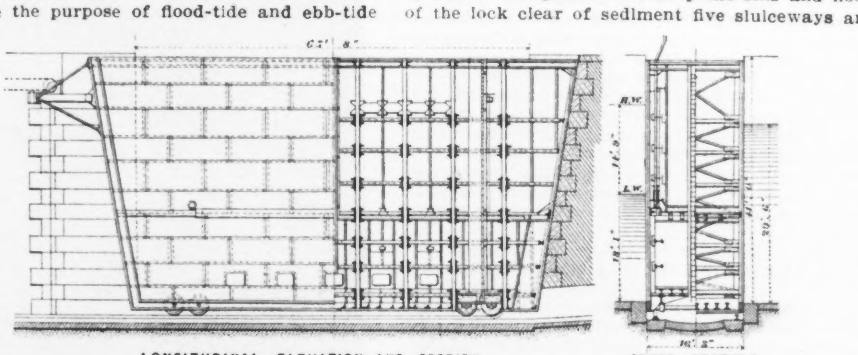


FIG. 4.—DETAILS OF ROLLING CAISSON.

gates in place of two pairs of reverse gates at each end of the lock. While caissons are sometimes used as bridges, in this case it has been deemed expedient to provide movable bridges over the lock, distinct from the caissons; this is probably owing to the delay that would arise from lowering the roadway before the caissons could be rolled back.

The caissons closing the sea-lock are 14¾ ft. wide, 41⅔ ft. high and 80⅓ ft. long at the top, and 68 ft. long at the bottom. They weigh 200 tons as designed, and with 279 tons of ballast, the total weight is 479 tons, or 50 tons in excess of the 429 tons of water displaced. The stability of the caisson is thus insured while it is being moved. The power to be applied in opening and closing the opening has been so proportioned to the resistance to be overcome that

formed through the caisson near the bottom 3¼ ft. wide and 2⅛ ft. high.

The sea-lock will be closed at each end by a steel rolling caisson, leaving an available space of 840 ft. between them for locking vessels. Sluiceways, controlled by cylindrical sluice-gates, will be formed in the side walls and serve for filling and emptying the lock-chamber. The outlets will be so arranged that the water can be used for scouring out the caisson chamber.

A CIRCULAR STEEL LIGHT-TOWER AT STURGEON BAY CANAL, WISCONSIN.

(With two-page plate.)

The total length of the coast line of the United States is about 6,600 miles, of which about 1,500 miles is washed by the waters of the Great Lakes. To protect the shipping that skirts these miles of ocean coast line or approaches from foreign shores requires an extensive system of light-houses, light-ships and beacons. But the same is equally true of the shores and harbors of the Great Lakes, where the amount of shipping at risk is greater even than on the Atlantic coast.

The entire system of light and signals is maintained by the Light-House Board, one of the most efficient bureaus of the United States Treasury Department. Through the courtesy of Major R. L. Hoxie, Engineer Corps, U. S. A., and Engineer-Secretary of this Board, we are enabled to present herewith a description of a type of light-tower recently installed at the entrance of Sturgeon Bay Canal, Lake Michigan, Wisconsin.

While there is nothing absolutely unique in the structure, either from the standpoint of size or difficulty of construction, it is representative of a new type of light-house favored by the Department because of its simplicity, small cost and lasting qualities.

Fig. 1 shows the tower as it appeared shortly after completion, and affords a clear idea of its general construction. Briefly, the structure consists of a cylindrical steel plate tower, 91 ft. high (to the focal plane of the light), resting on a monolithic concrete foundation, and braced against lateral strains by buttresses or inverted brackets, and surmounted by an enlarged portion for the convenience of the look-out who watches for approaching vessels and keeps an eye on the large lamp just above his head. The figure shows four heavy steel guys attached to the top of the tower and anchored to the foundation, and held away from the tower by suitable struts. This arrangement was altered later, and the guy ropes are now arranged as shown in Fig. 2, in which they are seen to run off at an angle of about 60° to the horizontal to 6 ft. concrete cube anchorages on the edge. These rope guys are provided with turnbuckles for adjustment.

In erecting the tower an excavation (Fig. 3), 25 ft. square and 8 ft. deep, was made; the bolts for the central cast-iron bed plate and the 16 bolts for the buttresses were suspended in place, and the excavation was then filled in with concrete. These bolts are 7½ and 8 ft. 5 ins. long, respectively, and 1½ and 2 ins. in diameter. They were placed and anchored as shown in Fig. 2.

Starting from the central or newel casting, which has a diameter of 9 ft. 5 ins., and is made in 8 segments, an inner tube of ½-in. steel and 24 ins. diameter, and an outer tube 8 ft. in diameter, were built up. The plates for the outside shell are 12½ × 5 ft. 6¾ ins. and ½-in. thick. The eight buttress braces, Fig. 4, are made of 4 × 4 × ⅝-in. angles, ¾-in. webs, and ⅝ × 3-in. latticing.

In the space between the inner and the outer tubes the spiral stairway, the details of which are shown in Fig. 4, winds around six times between the ground and the floor of the watch-room. Each step has a rise of 8 ins. and a tread of 18 ins. at the outside, and is a single casting bolted to the inner tube.

In continuation of the lines formed by the base brackets, and placed in each case just under the winding stairway, are 40 small truss braces 6 ft. long and 2 ft. deep, made up of 4 × 3 × ½-in. angles, and 2½ × ½-in. diagonals, as shown in Fig. 4.

As already stated, the main cylinder terminates in a circular room called the watch-room, 11 ft. 5 ins. in diameter and 7 ft. in clear height, from which four porthole windows 11¾ ins. in diameter look out. Above this, with a narrow surrounding balcony, is the large lantern, shown in Figs. 5 and 6. According to the Light-House Board classification, this is of the Third Order. It is 8 ft. 9½ ins. in diameter. Inside of this is the large oil lamp glass central portion 6 ft. high and 8 ft. 7¼ ins. in diamter. Inside of this is the large oil lamp flashing alternately red and white, and visible under favorable conditions at a distance of 18½ miles. The mechanism for causing the flashing is operated by a heavy-weight which hangs in the small inner tube.

The tower was built by John P. McGuire, of Cleveland, O., according to plans furnished by the Light-House Board.

LARGE ATLANTIC CARGO STEAMERS.*

By Mr. G. B. Hunter.†

Since 1891, and more especially since 1894, there has been a great increase in the size of cargo steamers employed in the Atlantic carrying trades.

Of merchant steamers (both for cargo and passengers) 6,000 tons gross register and over, according to a return of Lloyd's Registry, there were building in March, 1895, 10 vessels, and in March, 1899, 54. Among the largest cargo, or partly cargo, steamers now building are the "Saxonia" and "Ivernia," of about 13,200 tons gross register, for the Cunard Co., by the Clydebank Shipbuilding Co. and Messrs. C. S. Swan & Hunter, Ltd., respectively. Of merchant steamers, 10,000 tons gross register, and over (cargo and passengers), there are now building in British yards 18 vessels, including the "Oceanic," about 17,000 tons; in German shipyards, 9; and in French shipyards, 2 vessels.

Instead of singling out an existing steamer for description I will discuss some leading features of what I consider a typical American freight steamer of the present or early future, for carrying large cargoes across the Atlantic economically and safely, on a moderate draft. With docks, harbors and markets as they are, and will be, such a vessel may be designed to carry not less than 12,000 tons dead weight, with cubic capacity for 20,000 tons of cargo at 40 ft. per ton, and 1,000 tons of fuel. This would require dimensions approximately as follows: Length, between perpendiculars, 500 ft.; breadth, 60 ft.; depth molded, 36 ft. to main deck; 44 ft. to shelter deck. The draft of water loaded would be about 27 ft. 6 ins. I have aimed at dealing with a pure cargo steamer, not suited only for one regular line of trading, safe in Atlantic weather, and able to run very economically.

The development of the Atlantic cargo steamship will be on ship-shape lines, and not in the way of fantastic patent ships. There should not be more than three completed decks, including a shelter deck; with a partial fourth deck in forehold only. The shelter deck is practically necessary for the American trade. The space covered by the shelter deck must necessarily be exempt from measurement for tonnage dues, except when used for freight or cattle. It is reasonable and necessary that it should be so treated, because it is not required for heavy cargoes, and adds greatly to the surplus buoyancy and freeboard, and to the safety of the ship and crew; while the expense of paying tonnage dues on this space, when not carrying freight in it, would be practically prohibitive.

The specifications should not be allowed to include any items that will not earn 20% per annum on their cost, to cover insurance, depreciation, interest and profit. The steel decks need not be sheathed with wood, neither should wood sheathing be fitted on the double bottom. I may pass over the question of cargo-discharging appliances, beyond saying there is no need for a donkey boiler, and there should be not less than 12 to 15 steam winches of the best description. It is a question for consideration whether there should be any masts and sails or not.

As regards strength, experience has shown that with good work, Lloyd's scantling for large steamers, with some little additions, have proved sufficient for Atlantic weather. The largest ships we have built have proved perfectly strong enough, after three or four years' work.

Of course it is necessary to pay special attention to the strengthening of deck and side openings, and to any places such as the ends of bridge deck house and the corners of hatchways, where there is a sudden termination of a rigid superstructure, or concentration of stresses. The number of rivets, spacing and size, also require special attention.

Very few Atlantic cargo steamers have sufficient water ballast. From some of the Continental ports considerable quantities of outward cargo can usually still be shipped. From British ports, our somewhat one-side free trade, together with the McKinley tariff, has so diminished exports to the United States that except to a certain extent by some special lines, there is no outward cargo, or scarcely any to be carried. It is necessary, therefore, to make the outward passage in ballast—that is to say, water ballast. The 500-ft. 12,000-ton dead-weight steamer should have not less than 4,000 to 4,500 tons of water ballast, of which 1,700 tons can be carried in the double bottom tanks, 2,000 tons in two "deep tanks," one aft and one forward, at about the quarter length, midway between the engine and boiler space and the stem and stern, and 800 tons in "'tween deck" tanks between the main or upper, and first lower tanks.

The question of propelling machinery and speed are not at the present moment very difficult, with an exception that may be referred to further on. Large steamers are more easy and economical to drive than small ones. When they run in a regular line in turn with smaller steamers it is desirable for them to be fast enough to make up on the voyage for the longer time they take in port to load and discharge than the smaller steamers. In the Atlantic larger power is required than for Eastern trades. It is understood that one at least of the great lines trading to the East is carrying cargo at only 9 knots. With head winds, steamers of similar power to that in the Atlantic would be reduced sometimes to about 6 knots.

The point of difficulty I have referred to is the question of shafting, and particularly of the propeller shafts. It is recorded in "Lloyd's List" that 173 steamships were disabled in 1898, mostly in the Atlantic, through fracture of shafting. It is stated that 53 similar accidents occurred in April, May and June of this year. This can only be regarded as highly unsatisfactory. The causes usually assigned for these accidents are—the practice of steaming outwards from Europe to American ports in ballast—and generally with very insufficient ballast—the lightness of steel ships; and the reduction of their draft in ballast trim, due to their floors and their lower lines, forward and aft, having been made so much fuller than formerly. I do not consider those causes entirely sufficient to account for the remarkable increase in the number of shafting casualties that has occurred during the last two years. They undoubtedly have much to do with the trouble, but some of them have been in operation for many years. I think it may be taken as established that the diameters of shafting, and particularly of propeller shafts, as required by the rules of the Registry Associations and the Board of Trade, have been, and are still, insufficient. The Committee of Lloyd's Register have already increased their requirements for propeller shafts about 16%, and it is believed that they have under consideration the question of a further increase. Greater attention is being paid to the protection of propeller shafts from corrosion and from sudden diminution of strength at the outer end of the brass liners. These improvements will tend to diminish shafting casualties, but they will probably not be found sufficient to prevent them. It may be necessary to go back to the practice of having an outer bearing for the tail-end of the shafts. For reasons which I need not enter into, I do not go to the length of recommending this. Failing this, I should, in large single-screw vessels for Atlantic service, recommend increasing the strength of propeller shafts 100% above the present rules. No doubt exception will be taken to this recommendation. It is not made without due consideration.

There is reason to believe that during the last three or four years not only has the practice of running steamships across the Atlantic in ballast increased, but the captains and engineers, having grown bolder and more accustomed to it, have been less careful to slow their machinery down to half-speed in bad weather when the vessel is pitching and racing badly. With the old compound engines, governors were used, and were at least of some use, and in very bad weather the engines had to be slowed or the machinery would have been shaken to pieces. With three-crank triple engines, governors are less effective and are now seldom used, and the main engines are not so severely tried by running through heavy seas as with two cranks. But the propellers and propeller shafts bear practically the same strains with triple engines as with compound. The shafting is smaller in diameter, as compared with the power of the machinery and the size of the ships, than under the old rules and formulas for compound engines. But the bending strains on the tail-end shafts when the propellers are only partly immersed and the blade strikes the sea, are as great, if not greater, in new steamers, than they used to be in the old compound steamers.

Considering the enormous and incalculable strains brought on the propeller shafts, with the vessel pitching and the engines "racing," there is no reason for surprise that propeller blades and shafting are frequently broken at sea. Unless it is made impossible to run the engines more than half revolutions when in "racing" weather, it may be doubted whether an increase of even 100 per cent. above the present rules would be sufficient to prevent fractures.

For large steamers carrying 10,000 or 12,000 tons of valuable cargo, the ship and cargo being valued at, perhaps, £300,000, duplicate engines and screws should be provided. In addition to the immense advantage of having an additional propeller in the event of one breaking down, the advantage of being able to use smaller screws when running in ballast is very considerable, and in a bad weather passage will often shorten the voyage. It may be taken that twin engines increase the first cost, and usually increase the space occupied, and in fine weather are less efficient by about 5%. Yet these disadvantages, together with, in most cases, a slight increase in the cost of working, are more than outweighed by the increased safety from breakdown and disablement at sea. In ships of about 500 ft. long or more it may be said that twin engines are also necessary for handling the steamers in confined spaces.

It would be interesting to know the experience of other builders, but our own experience has been that the cost of building with the ordinary appliances is considerably greater per ton in very large ships than in smaller ships. The cost per ton diminishes as the ships increase in size up to 5,500 or 6,000 tons dead weight, but gradually increases from 6,000 tons dead weight upwards. This increase is partly due to the larger ships being usually built on an improved and less simple specification, but is also largely due to the greater expense of handling the increased weight of frames, beams, and other parts of the vessels, and the increased height to which the weights have to be lifted while building. The expenses of shoring and keeping very heavy ships in shape are also considerably greater even than in proportion to the increased size of the ships.

The increased cost of handling the materials for big ships finally determined my firm to provide steam or electrical power, not only for hoisting the materials, but for transporting them and placing them in position. In considering the structural arrangements necessary for supporting overhead cranes, the advantages to be gained by protecting the workmen in our uncertain climate from the weather, appeared so great that we determined to provide not only lifting appliances, but a complete shelter over the shipbuilding berths for the larger class of steamers we were building. We now, therefore, have covered-in sheds 500 ft. long, with glass roofs and with closed-in sides from about 14 ft. above the ground upwards, over two of our building slips. In each of these, two electric traveling cranes are provided on rails running the full length, and with jibs revolving below the cranes, so that any part of the ships building can be reached. One of the shed roofs is also used to support an outside cantilever crane commanding a space of 500 ft. in length by 65 ft. in breadth, on which a third steamer can be built.

It has been found that the work can be carried on much more quickly and economically under those sheds than under the old conditions. It has also been found, contrary to the prophecies that were uttered, that the ships under the sheds are more comfortable to work at than the ships built outside. The temperature under the sheds is higher in winter and lower in summer than outside, and though they are open at the ends and at the bottom, there has been no complaint of drafts. It has been found that there is, together with a saving in the cost of staging and increased safety, a saving in the cost of shoring and fairing the vessels, as the columns supporting the roofs are freely used as abutments for the shores, which are consequently much lighter and more handy to use than if required to reach from the ground.

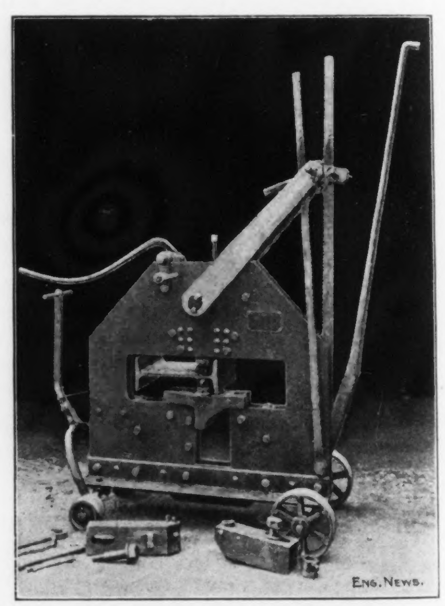
The one disadvantage (which was foreseen) is that although the roof and most of the sides is of glass, there is a slight diminution of light, which has to be met by the increased use of electric lighting.

*Condensed from a paper read before the Institution of Naval Architects.

†Of the shipbuilding firm of C. S. Swan & Hunter, Wallsend, England.

A PORTABLE HAND-POWER PUNCHING MACHINE.

The hand-punching machine, shown herewith, is intended for use in places where a power-punch is not available, and is well fitted for this work, as it is light and easily portable. The frame is made by riveting and bolting together two steel plates, which take the place of the cast-iron construction common in this class of machines. The piece to be operated upon is introduced into the central open-



A Portable Hand-Punching Machine.
Built by Henry Pels & Co., at the "Berlin Erfurt" Machine Works, Berlin, Germany.

ing, where, if it is a flat sheet or the web of an I-beam that is to be operated on, it is supported by a saddle, as shown in the cut. When it is desired to punch holes in the flange, the saddle is removed and the I-beam is placed in a vertical position, and the upper flange is supported upon the ends of the two shoes, which are provided for that purpose. The latter are to be seen in the picture lying in front of the machine. Each is provided with a slot at the outer end, through which a bolt is passed to secure the shoe to the frame and prevent it from tipping up. The bolts are screwed into nuts held between the plates of the frame. The bar holding the punch slides up and down in guides riveted between the frame plates. It may be raised and lowered easily and quickly by means of the curved lever, and thus may be adjusted and set down upon the work preparatory to applying force sufficient for punching. The latter force is secured by means of the heavy double lever or crank. The arms of the latter are keyed to a short heavy shaft passing through the frame and carrying, between the plates of the latter, an eccentric. The eccentric lies directly over the head of the punch bar, and, by introducing a wedge between the former and the latter, it may be made to bear down upon the bar. The outer end of the crank is provided with two ratchet devices, which operate in connection with the two serrated vertical bars. One of the latter is fastened at its lower end directly to the frame, and serves to hold the crank down to any position to which it may be brought, while the lower end of the other bar is attached to the long hand lever, by means of which it may be given a reciprocating motion. It will be seen that by pumping the hand lever up and down the punch will be slowly forced through the plate. A machine of this description weighing 2,200 lbs. will safely exert a punching force of 320,000 lbs., and may be used to punch a 2-in. hole in a ¾-in. plate. The width of the opening is about 3 ft.

The above machine, as well as other slightly differing types designed for cutting off, is manufactured in various sizes by Henry Pels & Co., at the "Berlin-Erfurt" Machine Works, Berlin, Germany. The firm is represented in the United States by Arthur Koppel, 68 Broad St., New York city.

INSUFFICIENT PROVISION FOR COUNTERSTRESSES IN RAILWAY BRIDGES.*

By Henry S. Prichard, M. Am. Soc. C. E.†

Many specifications for railroad bridges do not make sufficient provision for counterstresses. The term counterstresses must be understood, in what follows, to apply, not only to the stresses in the counters, but to all stresses from the action of the combined dead and live loads (including the effect of shock, sudden application, etc.), which are of a reverse character to the stresses from dead load alone.

In a good modern specification the unit stresses allowed are so low that, except for the counterstresses, a bridge designed and built in accordance therewith could reasonably be expected to be able to carry without serious injury a live load at least twice as great as the live load specified.

In view of the great increase which has been and is now taking place in the weights of locomotives and trains, not to mention other pertinent considerations, the wisdom of requiring this seeming surplus of strength will hardly be questioned, yet, as regards counterstresses, many otherwise good specifications make no such provision for increased loads.

This defect is probably due in most cases to the failure of the authors of the specifications to realize that a provision for possible increase in loading, which is adequate for all other stresses, may be entirely inadequate for counterstresses.

To assist in the consideration of this subject, the relations between loads and stresses are stated as follows:

Calling L the live-load stress, D the dead-load stress, A the sectional area, and S the stress per square inch, then for counterstresses $S = \frac{L - D}{A}$; for stresses other than counterstresses $S = \frac{L + D}{A}$.

From these equations the following propositions are evident:

For stresses other than counterstresses, if the live load is doubled, the stress per square inch cannot be more than doubled, so that if for the original live load the stress per square inch was less than half the safe stress, the stress per square inch would still be within safe limits if the load was doubled.

For counterstresses any increase in the live load must make a greater proportional increase in the stress per square inch. If the live-load stress is but slightly larger than the dead-load stress, than even a small increase in the live load may make a very large increase in the intensity of the counterstresses, while if the live load is slightly smaller than the dead load, a small increase in the live load may require counters where none were required under the original live load.

If the counterstresses in a bridge are obtained by simply subtracting the dead-load stresses from the reversed stresses for the specified live load, and the members subject thereto are proportioned by the specified stress per square inch, which is the way prescribed in many specifications, and a common practice among bridge designers, then such members will have a less factor of safety as regards increase in the live load than the other members of the bridge, and the trusses may in some panels have no proper provision whatever for any increase in the live load.

The absence of a regular provision for counterstresses does not necessarily result in immediate failure if the bridge is subjected to a load sufficient to produce counterstresses, as the stiffness of the chords and floor system, and the fact that the load is generally but a few moments in the critical position which would produce the counterstresses may save a bridge from seemingly impending failure.

A case in point, brought to the author's attention about a year ago, is that of a 300-ft. span. This span, for an unknown period, had been carrying loads which, for want of counters, would temporarily buckle the main diagonals whenever a loaded train crossed the bridge.

As this bridge is of a common type, and has no special features or unusual stiffness in the chords and floor system tending to supply the place of counters, it is fair to suppose that most bridges would possess some capacity for sustaining loads if some of the counters necessary to a proper design were omitted. It is to be feared, however, that loads so carried produce dangerous strains in the chords and floor system which may in time cause failure. Ability to carry loads when there is not proper provision for the counterstresses, like the ability to resist stress after the elastic limit has been exceeded, is a very desirable property in a bridge, and may, in an emergency, save it from disastrous failure, but it should not be relied on for sustaining the traffic, either present or prospective.

As a bridge designed in accordance with recognized good practice would be considered fairly safe as regards all stresses other than counterstresses, under increasing traffic up to a point where the live load was about double that originally specified, to be consistent, proper provision should be made for the counterstresses produced by a live load of at least double that originally specified. If the stresses are obtained from double the live load, the stress per square inch in members not subject to counterstresses will vary from something less than twice the specified stress per square inch in some members to nearly or quite twice the specified stress in others. Hence, it would seem to be consistent, after obtaining the counterstresses from double the specified live load, to allow nearly double the specified stress in proportioning.

All the previous references to live-load stresses are intended to be references to the live stresses, with the effect of shock, sudden application, etc., included. The author's present practice in determining what members of a bridge are liable to counterstresses, and in proportioning them, is to add to the nominal live-load stresses (that is, the live-load stresses with the effect of shock, sudden application, etc., neglected), 125%, to combine the stresses thus increased with the dead-load stresses, and to use double the specified stress per square inch in determining the sectional area required.

Fortunately, even when the specifications require no provision for counterstresses beyond what would be produced by the specified live load, most bridge designers will make some provision, which, however, will differ greatly according to individual judgment. If the designers are contractors competing for work on a lump-sum basis, under specifications deficient as regards counterstresses, any provision they may make toward remedying such deficiency is a self-imposed handicap.

For bridges with parallel chords resting on two supports this handicap generally is not great, because for most cases only a few members will have counterstresses, even when the live load is doubled, and these stresses are mostly quite small; but for bridges with inclined chords, which for long and moderately long spans are now very frequently used, the case is quite different, because the inclination of the chords decreases the dead-load stresses and increases the reverse live-load stresses in the web members, thus increasing the counterstresses. It is frequently customary to start the inclination of the chord at a sufficient distance from the center of the truss to avoid the use of counters in the portions of the truss having an inclined chord, and to make the inclination as great as the avoidance of counters and the maintenance of the required headroom will admit. As there is generally considerable economy in making the inclination of the chords as steep as possible, there is a decided advantage, from the commercial point of view of the aforesaid competing contractors, in making no provision for counterstresses in excess of the specifications.

The chief danger to be apprehended from specifications which do not make adequate provision for counterstresses lies, not in their use by those who from self-interest wilfully omit unspecified provisions which they believe to be essential to good design, but in their use by those who either fail to realize that the specifications are inadequate, or underestimate the extent of their inadequacy.

The same causes which lead engineers to write specifications which do not make sufficient provision for counterstresses may lead them to design bridges which are defective in this regard.

It is believed that what has been presented shows that provision should be made for counterstresses from some increase in the live load, perhaps more, perhaps less, than the increase advocated, and that whatever provision is decided on should in all cases be definitely and clearly stated in the specifications.

Discussion.

Henry B. Seaman.—The difficulty mentioned by the author arises from undue refinement in bridge design. The use of wheel concentrations implies that we are designing for some precise loading of the present time, while, as Mr. Prichard intimates, our designs should be an approximate provision for future conditions. The use of wheel concentrations practically submits the loading to the criticism of men who are not engineers, but who, nevertheless, exercise sufficient authority to restrict the loading. This condition would be avoided, to some extent, if a satisfactory equivalent load could be adopted.

The method suggested, of doubling the load, will avoid the difficulty described, though it seems to be rather an extreme measure. Fifteen years ago bridges were designed for 25,000-lb. concentrations, and to-day the actual concentrations in some instances reach nearly 50,000 lbs.; but this does not mean that they will reach 100,000 lbs. in the future. The larger part of the present increase took place between 1885 and 1890, and the increase since the latter date has been comparatively slight, though its adoption has been more general. The weights of locomotives having been increased about as much as the present gage and car clearance will permit, any future increase will arise from a change of the distribution rather than from any material increase of concentration, and there seems to be no possibility of doubling the loads for which the heaviest bridges are now designed.

Henry S. Jacoby.—The subject of counter-bracing does not usually receive the attention it deserves in the design of bridge trusses. Sometimes the only rule followed is to put a counter in a panel on each side of those in which theory requires their insertion for the specified dead and live loads, without regard to the effect of impact or the future increase of loads. In some cases this may be sufficient, but in other cases the provision is wholly inadequate. This rule is certainly not a rational one.

The specifications recommended in the paper is in accordance with the best practice, known to the writer, for the design of counters. The increase of 100% in the live-load stresses, besides the addition for impact, is not simply to provide for the gradual increase of the live load until it may reach that figure before the life of the bridge expires, but to provide for occasional loads of unusual magnitude, so as to avoid the necessity of shoring up bridges for such requirements, except those which may be nearing the end of their service.

As pointed out, the need for a better provision for counterstresses is greater in trusses with curved chords than for those with parallel horizontal chords. It seems that some account should also be taken of the stresses due to the overturning moment of the wind, for a reversal of stress due to insufficiently counter-bracing caused by the wind in conjunction with the live load may be just as serious in its results as if it were caused entirely by the live load.

Under the usual specifications, the stress due to the wind may be neglected in the design of any member unless its magnitude exceeds a given percentage of the dead plus live-load stresses, its character being the same. When, however, the character of the wind and live-load stresses is different from that of the dead-load stress it may require but a relatively small amount of the wind stress to cause a reversal of stress, and this fact often escapes notice on account of the too prevalent custom of failing to compute any minimum stresses.

Again, the addition of a counter-brace in a panel may, in turn, not only modify the magnitude of the minimum stress in an adjacent vertical, but may actually change the character of that stress, and thereby affect its design to a greater or less extent.

*Abstract of a paper read before the American Society of Civil Engineers, on Sept. 20, 1899.

†New Jersey Steel and Iron Co., Trenton, N. J.

AN X-SHAPED CONCRETE BRIDGE was built in 1898 at Le Mans, France, across the River Sarthe. This peculiar plan was necessitated by the location of two electric railways which cross each other at the middle of the bridge. One street, occupied since 1888 by one of the lines, was not wide enough for two lines without interfering too much with ordinary traffic. Hence, the novel plan was adopted and the bridge was built of concrete with a metal skeleton. The remarkable feature about the structure is the low cost of construction. The floor area was 5,382 sq. ft., and the total cost was $6,600, or about $1.04 per sq. ft. The cost of other concrete bridges in the same neighborhood had ranged from $4.80 to $7.70 per sq. ft. About 21 tons of old rails and over 80 tons of cement were used, according to the "Revue Tecnique" for Feb. 10, 1899.

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The Supreme Court of Indiana has just rendered a decision in a water pollution case that does little credit to its intelligence or to the abilities of the attorneys who represented the parties who sought relief, so far as can be judged from the abstracts of the opinion which have reached us. The offender was the city of Valparaiso, Ind., a place which had a population of 5,090 by the last census. It appears that the city has been discharging sewage into a swamp, the waters of which reach Salt Creek, and that it proposed to extend the outlet sewer to the creek. Riparian owners from two to ten miles below the city brought suit to restrain the extension of the sewer and also the continuance of the discharge of sewage into the swamp, claiming that the present discharge is a nuisance and a damage to their property, which would be increased by the proposed extension. The Circuit Court granted an injunction against the proposed new outlet, but its decision has been reversed by the Supreme Court. The higher court holds that the creek is the only natural outlet for the sewage of the city, and as some of the complainants live ten miles down the stream asks, "if the city is required to go so far to recompense the effect of its sewage, where may it stop short of the sea?" This alleged impossibility of finding any other practicable outlet, the court holds, renders invalid the argument for the complainants that the latter are damaged in their general property rights, as well as their riparian rights through bad odors and deposits on adjacent lands during floods. The possibility of purifying the sewage before discharging it into the stream does not seem to have occurred to the court or to the counsel for the complainants. As a matter of fact, Indiana, like some of the other Western States, is either very backward in sanitary matters or else most fortunate in not having to face some of the serious problems which confront other states. Ohio, for instance, has made its State Board of Health the guardian of the purity of its natural waters and a number of its cities have established sewage purification plants, while many others have schemes for such works under execution or consideration. Indiana, so far as we can learn, has no adequate legislation designed to protect its natural waters, has not yet built a single municipal sewage purification plant and, worse yet, has scarcely taken the subject into serious consideration. Perhaps this seeming backwardness on the part of the Hoosier State is really due to lack of urgent need for action in these directions, but such an explanation seems very doubtful. Possibly, too, the court decision under review would have been of a different tenor if the complainants had sued for damages, rather than prohibition of the further discharge of sewage into the stream. This charitable view does not seem probable in the light of the opinion itself, for the Judge alluded to the contention of the complainants that their property was being taken for public uses without compensation, but seemed to waive it aside on the ground already mentioned, that only an outlet sewer of prohibitory length would alleviate the nuisance and damage. Furthermore, he said,

> the construction of sewers and outlets is sanctioned by the law, and what the law grants will not constitute a nuisance, per se, either public or private.

The building of new blast furnaces, which, in our issue of Oct. 19, we said would in the course of time put a check to the advance in prices of iron and steel, is now under way to an extent which has not been equalled since the "boom" of twenty years ago. The "Iron Age" of Nov. 2 mentions no less than 19 furnaces which are either now in course of construction or will be at an early date. The names of the owners and the locations of the furnaces are as follows:

Ohio Steel Co., Youngstown, O.	2
National Steel Co., Youngstown, O.	1
" " " Mingo, O.	1
" " " Newcastle, Pa.	1
Jones & Laughlins, Pittsburg	3
Carnegie Steel Co., Rankin, Pa.	2
" " " Duquesne, Pa.	2
Illinois Steel Co., South Chicago	2
National Tube Co., Benwood, W. Va.	1
Am. Steel & Wire Co., Cleveland, O.	2
Sharon Steel Co., Sharon, Pa.	1
Republic Iron & Steel Co., Birmingham, Ala.	1

The "Iron Age" says the aggregate capacity of these 19 furnaces cannot be less than 2,600,000 tons per annum. This we should judge an extremely low estimate, as it is only 375 tons per day per furnace, whereas some of the furnaces are stated to be of 600 tons daily capacity. But few of these furnaces will be in blast before July 1, 1900, and most of them not until some time in 1901. Besides the above list of furnaces, the erection of which is assured, many others are in contemplation, among them four or five to be built by the Lackawanna Iron & Steel Co., at Buffalo. A vast amount of work is being done in the improvement of the machinery at existing furnaces, to enable them to increase their product. It is quite evident that by the end of next year the producing capacity of the active blast furnaces of the country will be fully 20% in advance of the present rate of production of pig iron.

THE CANAL PROBLEM IN NEW YORK: A NEW SOLUTION.

Two weeks ago we discussed the revolution in railway transportation, which has come about through the introduction of heavy locomotives and the hauling of heavy trains, and declared that in view of what is now being accomplished in the cheapening of bulk freights by rail, it can no longer be contended that river or canal waterways can furnish effective competition to railways.

Our presentation of this question was reviewed editorially by the New York "Journal of Commerce" in its issue of Oct. 31, with especial reference to the current problem regarding the disposition which New York should make of its canals. The "Journal of Commerce" is probably the ablest daily newspaper devoted to commercial matters in this country. Its editorial is so fair a discussion of the question, and presents so well the position assumed by the most intelligent defenders of the canal, that we have deemed it worth reprinting in full as follows:

RAIL VERSUS WATER TRANSPORTATION.

A writer in the "Engineering News" undertakes to show that the railway can carry freight at less cost than any inland waterway, river or canal, and that, therefore the attempts to revive water transportation in the face of rail competition can achieve at best only a temporary success. He bases this opinion on some very interesting calculations of the cost of moving long-haul freight in 2,000-ton train loads. Including locomotive expenses, car rentals and train expenses, stations, station service and signaling, maintenance of way and structures, with interest on cost of road, and adding 50 per cent. for empty car movement, he figures out a total cost per train mile of [illegible] for a 2,000-ton train load. In other words, it is, according to this estimate, possible to move bulk freight by rail on low grade roads, if a large traffic can be secured, at a cost of 1 mill per ton-mile, this cost including, in addition to the ordinary expenses of operation and maintenance the interest on the cost of the railway and its rolling stock. It is the contention of this writer that were the necessary volume of traffic assured, there are not a few railways which are prepared to move freight at this minimum figure. In the item of terminal charges, water transportation is shown to be under no more favorable conditions than that by rail, and local circumstances are likely to determine whether one or the other will have a larger expense under this head. It is contended that terminals for railways are, in general, cheaper than those for waterways, because water front improvements are of necessity expensive, both in first cost and cost of development, while rail freight can be delivered wherever a spur track can be run. It need hardly be pointed out that this argument is not applicable to a port situated as is New York, where it is equally necessary for the railroads, as for the canal, to have water front terminals, and where, as a matter of fact, the railroads have robbed the canal of water front privileges which legitimately belong to it.

Interesting, and apparently accurate, as are the data of the costs of freight transportation by rail which this writer supplies, he has only partially made out his contention that the system of water transportation is doomed. He makes an admission of this kind himself in conceding that the Canadian canal system is one of the competitive factors with which the New York railroads have to deal. He assumes that the new Canadian water routes to the seaboard are superior to any waterway which New York is in any way likely to build, a conclusion which, however true, is on the whole destructive of his main argument. It may be admitted, however, that the competition of the railroads seeking freight for Gulf ports, as well as those which terminate at the ports on Chesapeake Bay, will compel the railways reaching New York to keep their rates down in order to maintain their traffic. It is quite true that it is this competition, and not that of any canal, which the New York Central is preparing to meet with its new locomotives capable of hauling 2,400-ton train loads. The remark is also just that if New York would retain its position in the export trade it must concentrate its energies upon the question of reducing the cost of handling freight at its terminals, so that it may bear competition with the cost at the terminals built on cheap land at Newport News and New Orleans and other competitive Atlantic and Gulf ports. But the fact remains that in spite of the competition among themselves, the railroads are engaged in a combined effort to bring freight rates up to a standard of ten years ago. The shipper may thus very naturally make something of the argument, of which the writer from whom we have quoted thinks so little, that the waterways should be kept open in order that their competition may keep railway charges down to a reasonable figure. Under existing conditions it is decidedly premature to assume that the influence which the Erie Canal has exerted in the past as a regulator of railway traffic exists no longer.

It would be equally imprudent to adopt, as a panacea for all excessive charges on the part of the railways, the right of the government to fix and regulate railway rates. It is quite true that the principle has been fully established in court decisions that such rates should not be in excess of what is necessary to pay the operating expenses and a fair return on the capital invested. But it is also true that courts will naturally incline to give a very liberal interpretation to the latter requirement, and that there is a good deal of capital invested in railroads which can hardly be said to be entitled to a return at all. That is to say, if the public interest is to be accepted as the final test of what is due to the railroad investor, he must take his chances with other prudent or imprudent speculators in the public necessities. In the article before us we have the supposition of a railway moving one 2,000-ton train over its line, one way every day, for 300 days in the year. Thus, leaving an ample margin for interruption of traffic by Sundays, holidays, accidents, etc., such a train movement in only one direction would represent the carriage of 600,000 tons of freight per annum. It is apparent that a double-track railway operated for freight traffic only has almost unlimited capacity for the movement of freight; that is, that the limit is set by the available rolling stock and the capacity of the terminals, and not by any limit to the movement of trains on the road itself. A traffic of 10,000,000 tons per annum, as-

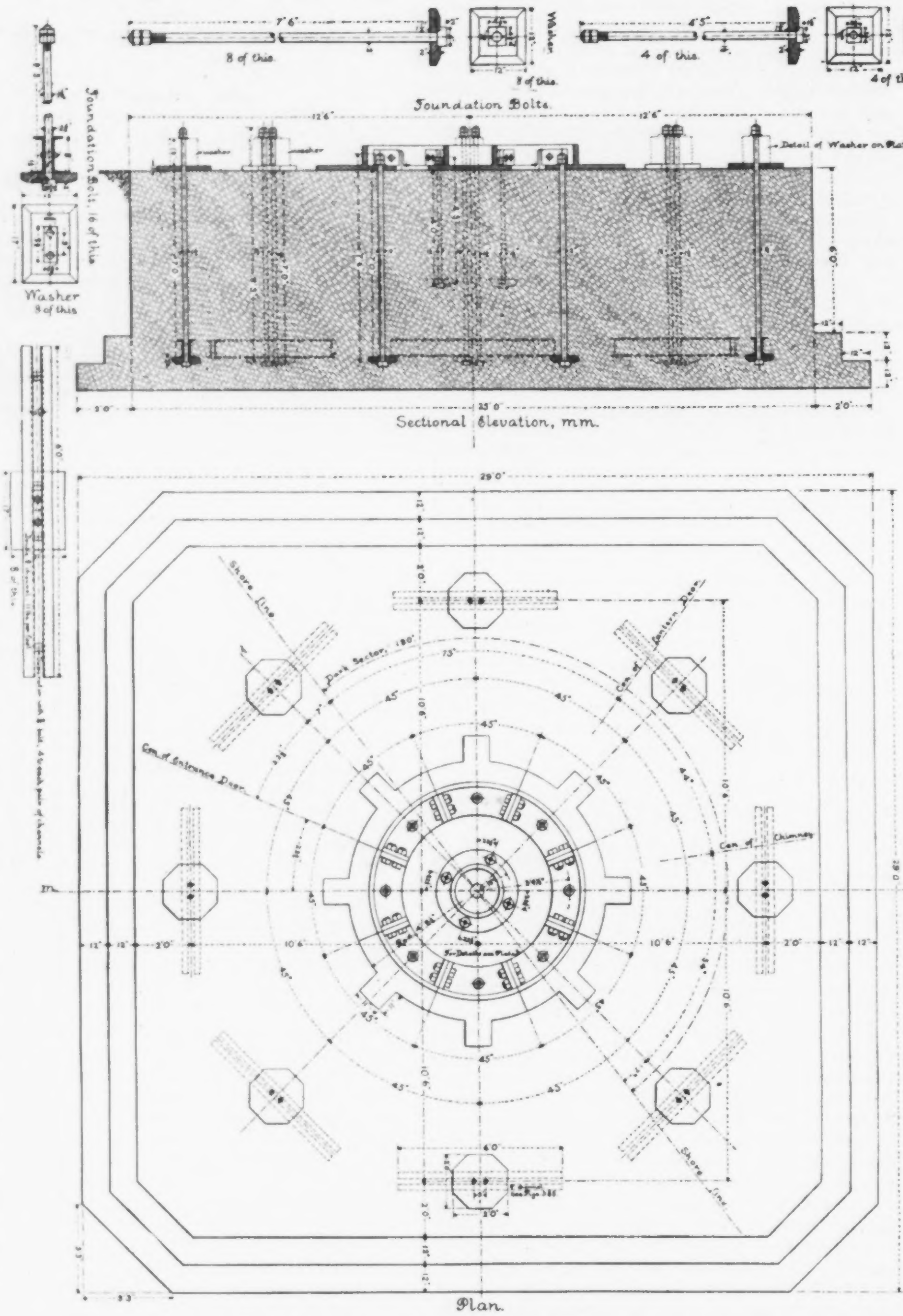


FIG. 3.—DETAILS OF CONCRETE FOUNDATION AND METHOD OF ANCHORING BOLTS.

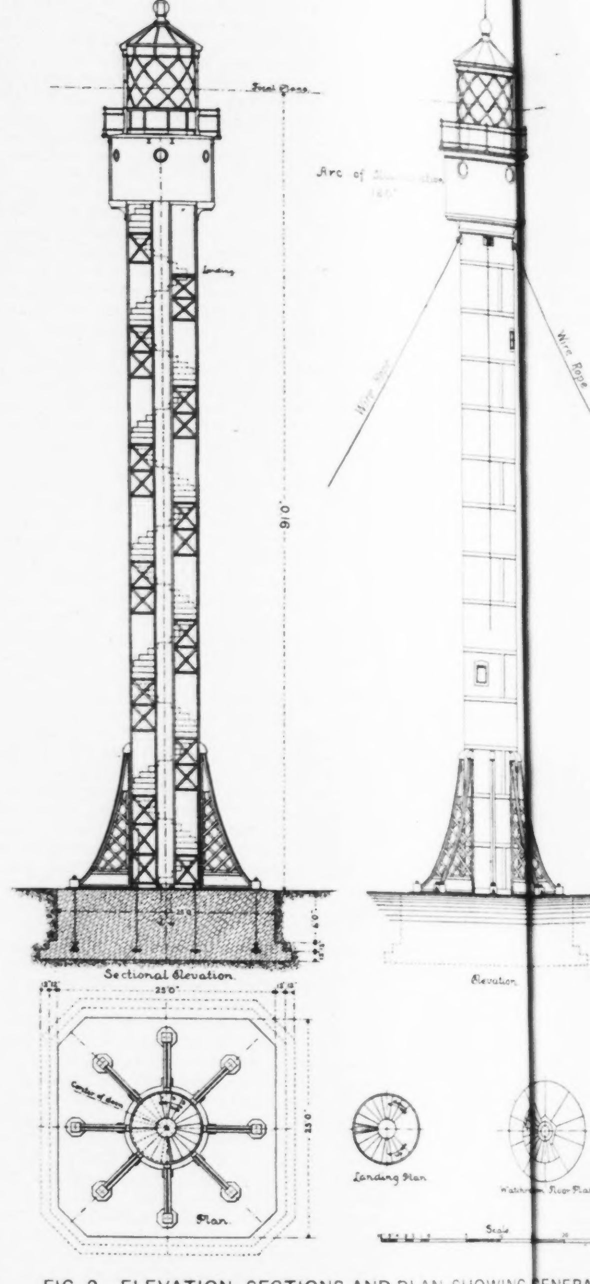


FIG. 2.—ELEVATION, SECTIONS AND PLAN, SHOWING GENERA

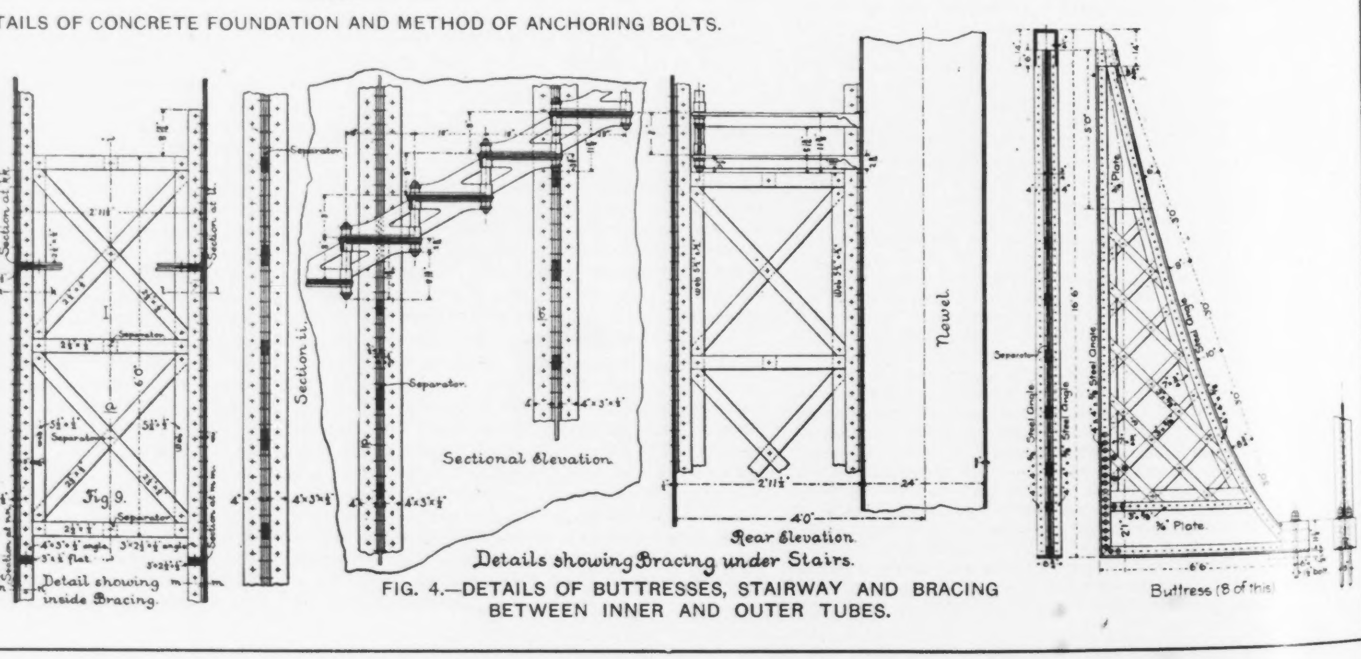
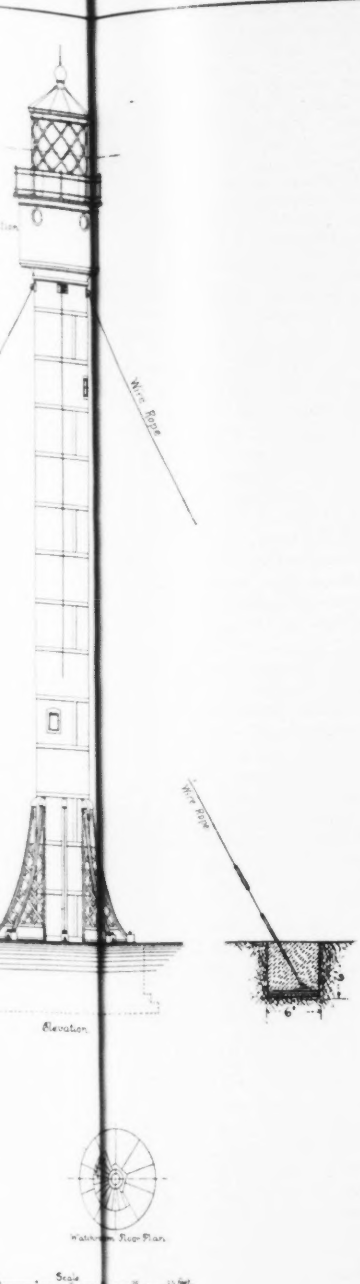


FIG. 4.—DETAILS OF BUTTRESSES, STAIRWAY AND BRACING BETWEEN INNER AND OUTER TUBES.



N, SHOWING GENERAL CONSTRUCTION.

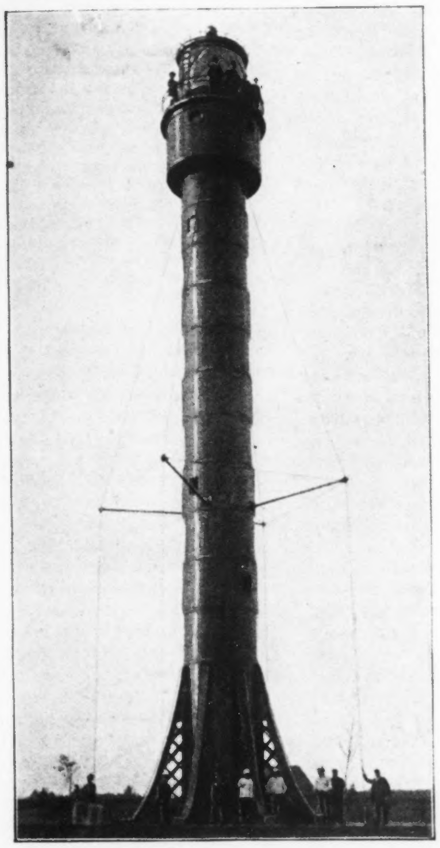


FIG. 1.—PERSPECTIVE VIEW OF TOWER, SHOWING METHOD OF BRACING GUYS, FIRST USED.

FIG. 6.—VIEW OF "THIRD ORDER" LANTERN.

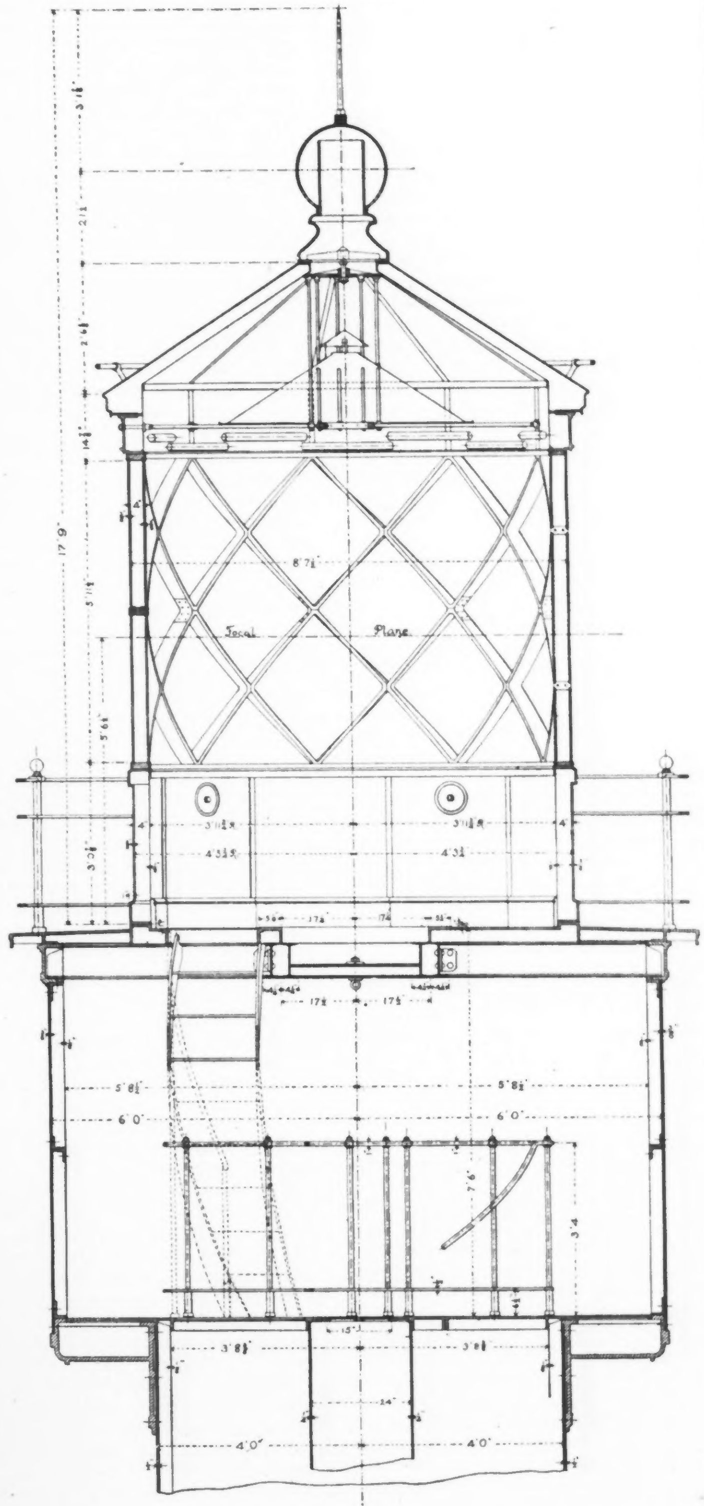


FIG. 5.—SECTIONAL ELEVATION OF LANTERN AND WATCH ROOM.

LIGHT TOWER AT STURGEON BAY CANAL, LAKE MICHIGAN, WIS

Built by the Light-House Board, U. S. A.

John P. McGuire, Cleveland, O., Contractor.

...ming the traffic to be three-fourths in one direction, ...ans only a movement of a dozen 2,000-ton loaded cars ...er the road in one direction daily for 300 days in the ...ar. Now, apply such a standard to the capacity of the ...x roads between this city and Chicago, and it will be ...und that the business of construction has been over-...ne three-fold. There is no system of the direct or indi-...ct exercise of government control, under which the ...perfluous lines equally with those that are necessary ...ould not be entitled to impose their share of expense ...n the conveyance of freight between these two points. ...n short, without attempting to dispute the conclusion ...hat a thoroughly equipped freight railroad can move ...reight at a total expense of not more than 1 mill per ...on-mile, it must be held that in order to insure the con-...inuance of actual competitive conditions the canal is ...orth preserving.

To sum up in brief compass our esteemed contemporary's position: it admits our claims as to the low cost of moving freight by rail, and as to the legal right of the state to fix or limit rail rates. It holds, however, that the state in fixing rates must allow the railway to charge rates high enough to pay an income on the "water" in the capitalization and also upon the money invested in unnecessary parallel railway lines, and this, it apparently thinks, would bring the rates higher than those charged by the canals.

Our reply to this is, first, that the courts have held that railways are not entitled to charge rates high enough to pay dividends on stocks representing no actual investment, and, secondly, that the development of local traffic has finally justified the existence of many lines which were originally projected merely to parallel an existing railway. This local traffic is properly chargeable with a large proportion of the interest and maintenance of way charges in any case.

Let us turn, however, directly to the practical problems before the State of New York. Our contemporary argues—and it fairly represents the position of many prominent business men who have appeared before the State Commerce and State Canal commissions—that the Erie Canal is still an important influence in the regulation of freight rates, and that it should be maintained merely for the potential competition which it offers to the railways.

As we look at it, however, even the potential competition of the canal is about at an end. The Erie Canal traffic last year amounted to 2,338,020 tons. The traffic of the New York Central and Erie railways amounted to 45,950,000 tons. Suppose the railways had made a high rate for the carriage of bulk freights last year, how much of their traffic would have been transferred to the canals? Very little indeed, for the reason that there are no boats to carry it. The building of new boats has almost ceased. Last year just four were registered. In the preceding year the number was 16. In 1896 only 12 were built, and in 1895, 27. Now a canal without boats can hardly be called a potential competitor; but unless new boats are built to replace the old hulks that are now well-nigh past their days of usefulness, the canal might as well be non-existent so far as its effect on rail rates is concerned.

What inducement have the boatmen to build new vessels? Are they not absolutely at the mercy of the railways? The latter can if they like lower rates to a point below the actual cost to the boatman and still make a profit. Under these circumstances there is no reason to expect the boatmen to invest money in new boats.

We have said that the Erie Canal carried 2,338,020 tons last year; but it carried it only because the railways did not deem it worth while to carry it themselves. A general impression exists that the traffic still left to the Erie Canal is principally the movement of grain from the Lakes to tidewater. The fact is, however, that the canal has lost nearly all this traffic. It carried only 10,000 tons of through wheat last year, and the only grain of which any considerable amount is still carried on the canal is corn, of which 337,500 tons were carried through. Lumber, wood-pulp, ice, stone, lime and coal, now constitute about two-thirds of the traffic of the canals; and the local shipments on them now exceed in volume the through traffic.

The importance of these facts to our present discussion is this: The railways are not troubling themselves to capture the present traffic carried by the canals, because it is too small in volume and offers too little profit to make it worth while. If, however, the state should further improve the canals as has been proposed, and a tendency should develop to divert back to the canal some of the traffic it has lost, the railways would be heard from at once. Rates would be put at a point which would drive the boatmen out of the business.

This competition, it may be said, is just what the shipper desires; but the trouble is it would not last. After the boatmen were permanently defeated, the railways could put their rates back where they were before, and the shippers could whistle.

These are a few of the reasons why we believe it to be unwise for New York to expend further money on the maintenance of its canals, and that the best plan for keeping down railway rates to a reasonable figure is through direct action by the government rather than by trying to keep alive an independent competitor. We are well aware, however, that state regulation of railway rates is not likely to be adopted in the East without a severe struggle. The railways do not care a pin what the state does with its canals; but their influence would be strongly exerted against state regulation of their rates. In the East, too, a large proportion of the business community still looks upon state regulation of railway rates as a radical "populistic" experiment. Suppose, therefore, that we accept for the moment the position of our contemporary and of the majority of New York's commercial leaders, that the State, for the preservation of its commerce, ought to maintain an independent transportation line from the Lakes to tidewater. Let us see from this standpoint what the State's action should be.

At present, the general concensus of published opinion is that New York should spend $15,000,000 more to complete the so-called "nine-million dollar improvement" upon its canals. The Erie Canal could then, according to the estimate of the State Canal Commission, carry traffic at a total cost to the boatmen of one mill per ton-mile, which includes nothing, of course, for the interest upon the state's investment or its annual expenditure upon the maintenance of this waterway.

Now suppose we test the possibilities in a radically different course of action. Suppose the state were to build upon the banks of the Erie Canal a double-track railway for freight traffic only, extending from the Buffalo terminus eastward to a point in the Mohawk Valley near Schenectady. Here it would leave the canal and diverge to the south, following the general course of the West Shore R. R., and finally terminating at the head of deep-water navigation on the Hudson River in the vicinity of Kingston. Here could be built on cheap lands a system of freight terminals, in which loaded cars would discharge directly into the holds of ocean steamships lying alongside. The total length of such a railway would be about 380 miles. For all but 70 miles of this distance it would utilize the canal right of way and towpath and grading would be trifling in amount. An estimate of $40,000 per mile, therefore, would seem to be an ample one for the entire cost of constructing such a railway in a first-class manner, or a total for the whole line of $15,200,000. As we have said above, the estimate made by the State Canal Commission of the cost of completing the "$9,000,000" improvement in the New York state canals is $15,000,000. In other words, for about the same sum as that required to complete repairs on her obsolete barge canals, New York could build a double track railway from Lake Erie to deep-water navigation in the Hudson, which could handle traffic more cheaply than any canal, and which could carry on business the year round.

The above estimate does not include the cost of terminals; but these could be built at no greater cost than will be required to be expended upon canal terminals if the canal is to attract any such volume of traffic as its defenders claim.

Again, the State of New York is paying from $800,000 to $1,000,000 a year to keep its canals in repair and pay lock tenders and other employees required in their operation. Esimating the cost of maintenance of way on the proposed railway at $2,000 per mile per annum, we have a total of $760,000. In other words, what New York annually expends on its canals would suffice to permanently maintain the proposed railroad in operating condition.

If, then, the State of New York is prepared to raise the minimum further sum which the friends of the canals admit to be necessary to place the canals in anything like decent shape, and if she is willing to continue the present annual tax for canal maintenance and operation, she can by a wiser expenditure of these sums obtain and keep open to traffic a state railway line which can haul freight from the Lake steamer to the ocean steamer at less cost than any possible canal.

That such a line would be of vastly greater benefit to the merchants and shippers of the state and to its commercial interests generally than could result from any canal, seems beyond question. The canal, even in its best estate, is admittedly limited to the cheapest class of bulk freights; the railway can move all classes. Canal movement is too slow to satisfy the needs of present day commerce, even in the movement of bulk freights; and the railways have diverted traffic from the canal, even at higher freight tariffs, upon this ground alone. Finally, as has been already pointed out, the canal is abandoned for nearly half the year, while the railway does business the year round.

It may be objected that the terminal point proposed is too remote from New York city; but if this port is to successfully compete with its rivals in the handling of full cargoes in the export trade, it must see to it that its terminal charges are lowered. To effect this, some location must be chosen for the transfer from car to steamer remote enough from New York to find cheap lands.

In all the talk regarding a ship canal from the ocean to the Lakes, the fact seems to be overlooked that the Hudson River forms a natural ship canal, navigable for ocean steamers, extending from the coast inward over 100 miles, and one which has never been utilized.

If the cheapest possible route from the Northwest to Europe through the port of New York is desired, this deep waterway and that furnished by the Great Lakes should be connected by the shortest possible length of low-grade railway.

Again it may be said that such a terminal as that proposed would not supply berth freights to the steamers which dock at New York. This could be effected, however, by a lighterage service, and probably at a cost no greater than that which now attends the delivery of berth freights. Freight of all classes from the West for coastwise points could also be shipped here and could proceed over deep water for the rest of its journey. Rail transportation is, as we have stated, cheaper than any water navigation in contracted channels; but it is as yet more expensive than deep water transportation on the ocean or the Great Lakes.

It may be asked how such a railway could be operated, in order to secure the desired benefits. It should be possible to effect this either directly by state officials, as the canals are now operated, or by leasing it for short periods of years under restrictions which would ensure good service to shippers and low rates of freight. As the lessee would have to furnish only the rolling stock and would have no fixed charges to pay, it would be possible to secure active competition for the lease.

It will, of course, be understood that the above estimate of the cost of the road is merely a rough approximation, based on general considerations merely. On the other hand, we venture to believe it nearer the mark by a long shot than the "estimate" with which New York set out on the work of deepening its canals four years ago, and we are by no means sure that it is not as much to be relied upon as the $15,000,000 estimate for canal work with which we have compared it. At any rate, its accuracy can readily be tested by the Commission charged with the duty of advising the state as to the disposition which it should make of its canals.

We are well aware that there are some legal obstacles in the way of such a plan as that we have outlined; but there are none that cannot be overcome, and more easily, we think, than the taxpayers of the state can be induced to vote $15,000,000 more bonds for the canals. It is also true that this is not the only course open to secure an independent rail line. It is possible, though hardly probable, that the New York Central company might consent to sell the West Shore road to the state; or on the other hand it might agree to substantial guarantees in the matter of low freight rates on condition that the plans above proposed were not put into effect.

Finally, we will repeat, that the shortest way out, and the way that will some time be adopted, is the acceptance of the railway's monopoly and of the policy of state regulation. Before we reach this stage, however, it may be decided to have a longer trial of state competition. If so, by all means let the state adopt the best possible agent. That the canal has been defeated in competition by the railway is everywhere acknowledged. People are at last awakening to the fact that this is due not so much to the wicked machinations of railway corporation managers as to the fact that the railway is a better machine for the carriage of goods than any artificial waterway. If the taxpayers' money is to be spent to further competition therefore, by all means let it be spent for a transportation system as good as the best, and not wasted in a misguided effort to rejuvenate an obsolete system, more costly in construction, more expensive in maintenance and less efficient and economical in operation than the railway lines with which it must compete.

LETTERS TO THE EDITOR.

Gravel vs. Broken-Stone Concrete.

Sir: The issue of Engineering News for Sept. 28, 1899 contained some extracts from my "Treatise on Masonry Construction," among which was one claiming that concrete made with broken stone was stronger than that made with gravel. A well-known engineer has written me, mildly suggesting that possibly there was something wrong in my data. He said that he had known of gravel being preferred on the supposition that it made the stronger concrete; and said further that he thought the opinion was based upon experiments,but of this he was not sure. This is a matter of some moment to the engineering profession, and, therefore, I present the matter with the hope that any of your readers who have experimental data on this subject will make it public.

In the same mail with the letter as above I received the annual report of tests made with the U. S. testing machine at the Watertown (Mass.) Arsenal—"Tests of Metals, etc., 1897-98." This volume contains the report of some experiments which throw light upon this question. Pages 649-50 contain the crushing strength of five 1-ft. cubes, composed of "Portland cement 1, sand 1, broken trap 3," crushed when 7 days old, the average being 2,556 lbs. per sq. in. The average for four similar cubes using gravel instead of broken stone is 1,763 lbs. per. sq. in. In this case the broken-stone concrete was 40% stronger than the gravel concrete. Seven of the broken-trap concrete cubes, tested at an average of 71 days, had a strength of 4,514 lbs. per sq. in., while four cubes of gravel concrete tested at an average of 64 days had a strength of 3,794 lbs. per sq. in. It will be noticed that the ages for the two kinds of concrete were not the same in this case, but the difference can not be material. Again the broken-stone concrete was the stronger—in this case about 20%. As was to be expected, the broken-stone concrete is proportionately stronger at early ages than when older, since a part of the resistance to crushing is due to internal friction, and this is a greater proportion of the strength at an early than at a later age.

Again the hope is expressed that any one having data on this subject will make them public.

Ira O. Baker.
University of Illinois, Champaign, Nov. 1, 1899.

Concerning Roof Truss Design.

Sir: In your issue of Aug. 17 there is printed a letter from W. W. Brush, 427 Nostrand Ave., Brooklyn, regarding joints in timber roof trusses. Mr. Brush criticises

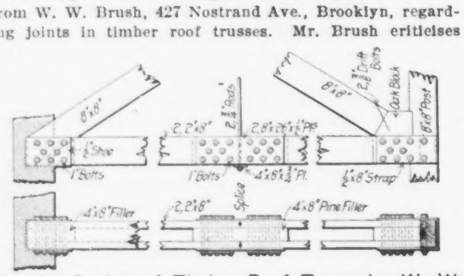


Fig. 1.—Design of Timber Roof Truss, by W. W. Brush.

the design given by Mr. Aus in the issue of Engineering News for Aug. 3, 1899, and submits a design for which he claims superior merit. It would seem to me that the design offered by Mr. Brush is much inferior to that of Mr. Aus, my reason for thinking so being as follows: I enclose a drawing (Fig. 1) of the main tension joint as given by Mr. Brush, the scale being taken from his drawing.

Mr. Brush calculates that the only reduction in area of the main members is due to the two bolt holes lying on a vertical line. He makes no allowance for another bolt hole in the center, but 2 ins. from that line. While this may be allowed in steel, the small shearing strength of timber prevents the carrying of the strain around a bolt hole. The practical result of boring a third hole in the position mentioned is to reduce the effective area for tension by the amount cut away. This would give a reduction of 1 × 4 × 1,300 = 5,200 or about 15% of the effective tensile strength given by Mr. Brush.

However, the defect in the joint does not lie so much in this error as it does in the insufficient allowance for shearing strength along the grain. Mr. Brush seems to have neglected this entirely, although he gives 130 lbs. as the unit shear parallel to the fiber. The tendency of the strain is to pull out three strips of timber at the lines of

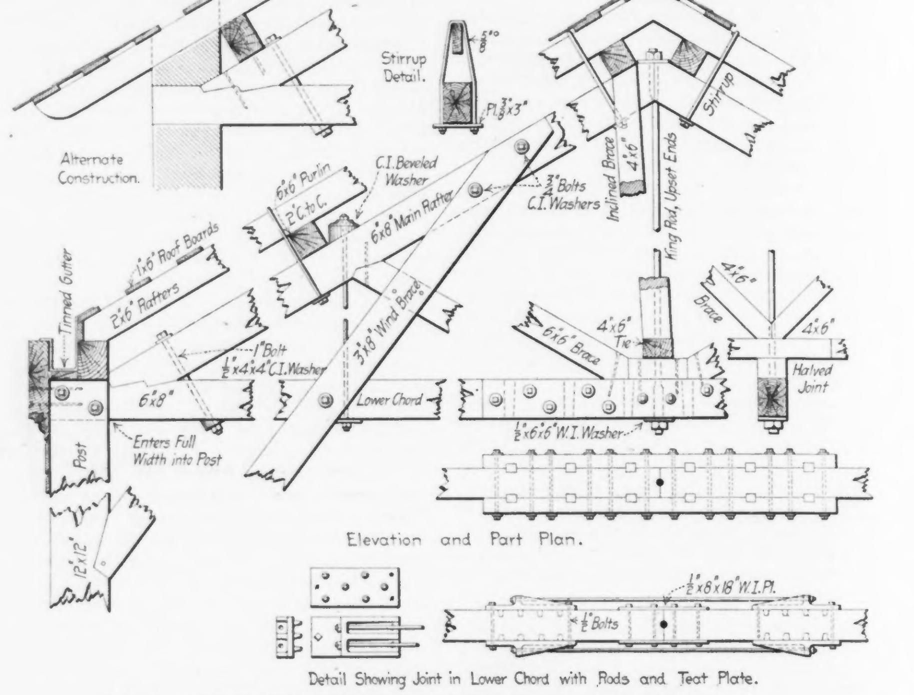


FIG. 2.—DESIGN FOR TIMBER ROOF TRUSS, BY J. D. GALLOWAY.

the bolts. This would give an area for shear of (11 + 9 + 11) ins. × 2 × 4 ins. = 248 sq. ins., which, at 130 lbs. unit shear, gives a strength of 32,240 lbs. as the total shearing strength. Thus the theoretical shearing strength is about the same as the available strength for tension as given by Mr. Brush.

The above calculation is based upon the assumption that all the bolts are in bearing at one time. My experience leads me to say that one would be in luck to have half those bolts bear at once. The result is obtained in iron work by upsetting rivets, but here that is impossible. If all the bolts reached a bearing it would be only through the failure of some parts of the timber.

Now, as to the practical working of such a joint. Two pieces of timber, 2 × 8 ins. in section, have bored through them eight holes 1 in. in diameter, and all the holes are concentrated within 12 ins. of the end of the sticks. It would require a careful workman to do this without splitting the timber. Then, when the truss is up and the load on, the bolts bear on each hole in each piece with a force of about one ton. If the joint did not then fail, what would be the condition of the timber after a year or two in the dry air surrounding a roof truss, where it would naturally shrink and split?

The design is bad all through. The assumptions as to strength do not hold, especially in shear, where the timber must be prevented from splitting before the strength can be developed. No account is taken of changes in the wood due to time and dryness and an accuracy in workmanship, which does not exist, is assumed.

It is almost always necessary to calculate a piece of timber, subjected to tension, as being most liable to fail, at the points where joints occur, by shearing along the grain. To prevent failure, the timber must be seized, not at the end, but at some point distant from the end, where the timber will remain in the condition it was when erected. The design of Mr. Aus, if properly calculated, seems to attain this end.

In order that this criticism may not be wholly destructive, I enclose details of two forms of joints, Fig 2, which, if properly proportioned, form good joints.

Very truly yours, J. D. Galloway.
San Francisco, Cal., Aug. 24, 1899.

RECENT PROGRESS IN SIGNALING.*

By H. M. Sperry.†

Great progress has been made in the practice of signaling, and the present year has been a most active one in signal construction. The signal departments of our railways are growing, and a number of new signal departments have been created on railroads heretofore without them.

In March, 1897, the author read a paper before the Railway Signaling Club entitled "Some Signal Problems," in which an effort was made to sum up some of the questions that were thought to be of interest to signal engineers. Some of these problems are much nearer solution than they were in 1897. A green light is now pretty generally conceded to be the proper one for the clear indication; opinion differs, however, as to the proper color for the distant signal. The New York, New Haven & Hartford R. R. has made a strong effort to establish yellow as the proper light for distant signals. After a serious accident on the line in 1898, they decided to use green for the clear indication, and all signals on the system were changed early this year by substituting double-light semaphore castings for the single light; their standard now being: Red for stop, green for clear and yellow for caution. A number of roads are anticipating a change by putting up double-light semaphore castings in connection with all new work.

There has been little or no change in the practice in regard to derails, except a tendency to make the distance greater between the derail and the fouling point, in order to provide for the increasing speed of trains. In many of the arguments against the use of derails, reference is made to the fact that they are but little used in Great Britain; overlooking, however, the English method of protecting junctions and crossings by means of block signals. This is clearly set forth by C. E. Streeton in a treatise on "Safe Railway Working" as follows:

> Junction block working should always be adopted and then strictly carried out. No two trains should ever be allowed to approach a junction at one and the same time, either upon converging or crossing lines, otherwise the required certain interval of space is actually reduced to nothing more than the thickness of the junction signalpost.

It would be very awkward to carry out this system in this country, especially on lines that are without block signals, and even in Great Britain it is frequently a cause for delay, and a modification of this method of block working is permitted and trains are allowed to approach the junction after notification that the junction is blocked, and this in some cases has led to accident. There can be no question that the derail has proved its efficiency in this country; we must either continue its use or find a method that will give the same measure of safety.

Improvements have been made in switch and lock movements by increasing their stroke. They are not recommended, however, by the American Railway Association. For facing switches in main lines, an improvement in facing-point locks is still to be desired, so as to make it

*Abstract of a paper to be presented at the annual meeting of the Railway Signaling Club, at Boston, Nov. 14.
†Signal Engineer and Eastern Agent of the Union Switch & Signal Co.

impossible to lock a switch in the wrong position. Some effort has been made in this direction in Great Britain, but it is the exception in this country. Some of our most progressve lines are now specifying bolt locks on all facing main line switches, whether they be operated by switch and lock movements or locked by facing-point locks. This is a step in the right direction, as a bolt operated by the signal connection is a most efficient check on the proper operation of the switch.

The question of better construction has received considerable attention, and many lines have abandoned the use of wooden foundations, substituting cast iron or concrete. As the average life of a wooden foundation does not seem to exceed five years, the increased expense in the use of iron or concrete is more than justified, when the expense of renewing wooden foundations of a plant in service is considered.

There have been some serious failures of pipe connections, and a number of railways are now specifying longer pipe couplings, plugs, and either larger rivets, or four in place of two. As a change of this kind not only means a change in the pipe coupling, but in all jaw and other connections, it is to be hoped that our signal engineers will agree upon a reform of reinforced coupling that can be used by all. The importance of this subject should not be overlooked, as it is a most important detail in signal construction.

The boxing of interlocking connections is being largely done away with, except at points in close proximity to stations, etc., where unboxed connections might lead to accidents by people tripping over them. Signal wires are now successfully run under ground in small pipes filled with oil.

For large installations, such as terminal stations, power plants are rapidly increasing in favor, and this year marks the completion at Boston of the largest plant in the world. The first power plant in Great Britain (taking the place of two mechanical plants) has also been put in successful operation.

In automatic signaling, the semaphore is rapidly displacing the disk largely due to the fact that it is now possible to operate a semaphore by electric motor.

There is still a field in signaling that has been little touched upon, and that is signals for electric railways. Numerous accidents on these lines have called attention for the necessity of block signals. The problem, however, is not an easy one to solve, as, on account of the use of electricity for motive power, the operation of automatic signals by track circuits is made impossible. This is a rich field for the inventor. Grade crossings of electric and steam lines are easily cared for by interlocking, and as these crossings are frequently more dangerous than the crossing of two steam railways, proper signals should always be installed.

AUTOMATIC SIGNALS; NORMAL SAFETY OR NORMAL DANGER.*

By. A. J. Wilson.†

Automatic signals have been in service in this country, to a greater or lesser extent, for nearly 30 years; the first application being put in service on the Eastern Ry. (now a part of the Boston & Maine) and the New York & Harlem R. R. in 1871 by Thos. S. Hall, of Connecticut. This system was operated on the open-circuit plan, but to guard against the possibility of a signal failing to show danger on account of a broken wire, or other derangement of the apparatus, two signals were used. At the entrance to each block was located a home signal, and a caution, or, as it was called, a "safety" signal, about 500 ft. in advance of the home signal.

The normal position of the home was "clear," and the safety signal "caution," and when a train passed the home, putting it in the "danger" position, another circuit was completed, clearing the safety signal, thereby showing to the engineer that the system was in operation, and that he was protected in the rear. This system was also operated on the Boston & Albany R. R., Boston & Lowell R. R., and the Old Colony R. R. Some time after this system was introduced, the circuits were changed to operate the signals on a closed circuit, and the safety signal done away with.

All automatic signals at this time, and until 1891, were operated on the normal clear principle; the batteries being in constant use, except when the block was occupied, and as there are several hours per day on most roads, when trains are few, there is necessarily a large waste in battery material.

With automatic signals, operated on the normal danger plan, the battery is in use only while the signal is clear for an approaching train. The saving in material and labor, on this account, will amount to a considerable sum per annum, and is worthy of consideration.

On one road running from Boston there are a number of signals operated on both the "normal clear" and "normal danger" plan, which gives a very good chance to make comparisons of the cost of maintenance. On the normal clear, the signal batteries have to be renewed every eight or ten weeks, while on the normal danger only once in from 12 to 18 months, with practically the same service.

Let us see what is the saving per cell from the above, taking the present price of gravity battery material:

Zincs, 4 lb., 35 cts.	35 cts.
Vitriol, 4 lb., 24 cts.	24 "
Glass jars, broken, 1 in 20, at 20 cts. each	01 "

Coppers we will leave out, allowing old material to pay for new coppers, and we have a total of 60 cts. But zincs will usually last to put in twice, so we will deduct one-half of the cost of these, leaving a total of 42½ cts. per cell per year, and if renewed every ten weeks, there will be 5.2 renewals per year, or a cost per cell for material of only $2.20 per year.

With the same service, operated on the normal danger plan, we have, cost per cell—60 cts., using the zinc but once, renewed every 12 months, or once a year. A total of 60 cts. against $2.20 on the normal safety; or with 1,000 cells in use, a saving of $1,610 per year, without taking any account of labor, and it is clear that one man can take care of many more batteries on the latter plan.

It has been claimed that the "normal danger" system is more expensive to construct; that there are more chances for trouble; that it is more difficult to maintain, and that certain combinations could occur which might prevent a danger signal from being shown with a train in the block, etc.

It will cost perhaps $25 more to construct a signal on the normal danger plan; this signal will require say 15 cells of battery to operate, which, with a saving of $1.60 per cell per year, will pay the exact cost of construction in about one year, after that the saving is clear gain. The second objection is true, so far as the extra contact is concerned, but in spite of this, records show that there is a difference in favor of the normal danger. The objections to it, from a maintainer's standpoint, are best answered by the maintainers themselves, and I have yet to hear the first man, who has had experience with both, object to the normal danger system.

*A paper to be presented at the annual meeting of the Railway Signaling Club, at Boston, Mass., Nov. 14.
†Assistant General Manager of the Hall Signal Co.

THE UNITED STATES AS A COMPETITOR FOR THE WORLD'S IRON AND STEEL TRADE.

In a recent paper before the Institution of Civil Engineers, Messrs. Jeremiah and Archibald Head, the well-known English metallurgical experts, describe the Lake Superior iron ore mines with especial reference to their influence upon the position of the United States as a competitor in the international market for iron and steel The authors say that many British iron masters believe that American competition in the export trade in iron and steel is carried on at a loss, "and will never attain serious dimensions." To satisfy themselves upon this question the authors undertook the investigation described in their paper covering the Lake Superior iron ore deposits, the methods of mining in use, the facilities for shipping them by lake and by rail, with the methods of handling in detail. All this is quite familiar to American engineers, and we need not take space to print it. The final summing up of the paper, however, entitled "The Future of the American Iron and Steel Trade," is of much interest, as showing the conclusions reached by such able expert representatives of foreign competitors as the authors of this paper upon the question before us.

The authors will conclude with a few remarks as to the influence of these abundant, excellent and cheap ores, upon the supply of iron and steel to the markets of the world: The following is approximately the price of producing 1 ton of Bessemer pig-iron at Pittsburg and at Middlesborough, England, on Jan. 1, 1899:

Pittsburg.

	£	s.	d.
1.66 tons of ore at 12s. 8d	1	1	1
16 cwts. of coke at 7s.	0	5	7
12 cwts. of limestone at 3s.	0	1	9½
Labor.	0	2	0
Repairs	0	1	0
Other items	0	1	0
Total	1	12	5½
	($7.87.)		

Middlesborough.

	£	s.	d.
1.95 tons of ore at 15s. 2d.	1	9	7
20.5 cwts. of coke at 15s. 6d.	0	15	10½
9 cwts. of limestone at 3s. 9d.	0	1	8½
Labor	0	3	0
Repairs	0	1	0
Other items	0	1	0
Total	2	12	2
	($12.68.)		

From these figures it appears that Bessemer pig-iron can be produced at Pittsburg under present conditions for almost £1 per ton less than at Middlesborough. This advantage is principally due to the Lake Superior ore and the Pennsylvania fuel supply. It will readily be seen that by the time the pig-iron has been converted into ingots, and further into finished steel, the advantages has been increased in proportion to the loss in conversion, and by reason of the lower cost of the fuel required in the later processes.

Selling Prices, December, 1898.

	Pittsburg, U.S.A.			Middlesborough, England.			Pittsbg lower by		
	£	s.	d.	£	s.	d.	£	s.	d.
Steel rails (heavy), per ton	4	2	9	4	12	6	0	9	9
Steel ship-plates, per ton	5	10	9	6	15	0	1	4	3
Steel billets and blooms	3	2	6	4	5	0	1	2	6

The figures seem to show that the present low prices of American steel are justified, if only by the cheapness of the pig-iron from which it is made; and that the competition now felt in England and in neutral markets is likely to continue, and can only be met by lower costs on the part of English producers in all available directions.

Pittsburg has been mentioned as the principal ore-smelting point, although there are others,notably Youngstown in Ohio. Pittsburg is 150 miles from Lake Erie. As only about 1.66 tons of Bessemer ore are required to make 1 ton of Bessemer pig-iron, and in the best practice only about 16 cwt. of coke, it is clearly better that the blast furnaces should be situated near the ore rather than near the fuel center. This, however, involves other considerations of a somewhat complex character, such as the direction and distance of the center of consumption. Authorities in the United States are fairly agreed that the south shore Erie ports are the best smelting and distributing centers for pig-iron and steel, as well as the best receiving centers for the ore. The distance from Pittsburg to Baltimore is about 300 miles, and the cost of railway transport and loading there of iron and steel goods in quantity would probably not exceed 4s. 2d per ton. From Detroit to Liverpool—by lake as far as Buffalo; by rail 400 miles to New York, and by steamer to Liverpool—the through rate for charcoal pig-iron, in 2,000-ton to 3,000-ton contracts, but taken in lots to suit ocean steamers, is at present only 13s. per ton. Efforts are being made to improve the route from Lake Erie ports to New York by way of the Erie Canal, and it seems likely that this route, which avoids railways altogether, will increase greatly in importance.

As regards pig-iron, rails, and other steel goods, statistics showing recent imports from America to England have already been given. But naturally their competition will always be felt in distant and neutral markets more seriously than in those of the United Kingdom. Considerable consignments have already been made to Canada, South Africa, India, Japan, Mexico, South America and Australia, and they are likely to obtain a large share of what may in future be required in the development of Chinese railways and other undertakings; especially if, as seems probable, the Atlantic and Pacific oceans are united by a maritime canal.

The authors are inclined to the view that Lake Superior iron ores are likely to have a considerable and permanent effect in cheapening iron and steel and all goods made therefrom throughout the markets of the world; and that they will tend to encourage the production of such goods, and especially of ocean-going ships and engines at United States ports to a hitherto unprecedented extent.

SPECIFICATIONS FOR CONCRETE SIDEWALKS AND DRIVEWAYS.

The following specifications for concrete sidewalk construction were employed recently in laying some 9,000 sq. ft. of walk around the grounds of the University of Kansas, and have also been employed to some extent by the city of Lawrence, Kan., where the University is located. Some of these walks, we are informed by Prof. Frank O. Marvin, M. Am. Soc. C. E., who drew up the specifications, have been down for over two years, and have stood well without any defects showing. The price for sidewalk flagging was 18 cts. per sq. ft., and that for driveway flagging 36 cts. per sq. ft. In our issue of March 4, 1897, we described briefly the method of constructing similar walks employed at San Francisco, Cal., and in the succeeding issue of June 24, 1897, a specification for cement sidewalks, written by Mr. A. J. McPherson, was published. Prof. Marvin's specifications are in abstract as follows:

A foundation of cinders shall be laid on the subgrade. The contractor shall level this off and bring it to an even surface and the proper grade. The cinders shall have a depth of 8 ins., except where otherwise directed, after having been thoroughly wetted and consolidated by ramming. Just before laying any concrete on the cinders the latter must be thoroughly moistened. There will be two grades of artificial stone flagging, "sidewalk flagging" and "driveway flagging" as defined below.

Sidewalk flagging shall consist of a bottom course of concrete 3 ins. thick,composed of 1 part of cement, 1 part of sand and 4 parts of crushed flint; and a top wearing course, ½-in thick, composed of 1 part of cement to 1 part of sand. The above proportions shall be by volume.

For the bottom course the cement and sand shall first be mixed dry until the whole is of an even color, then slowly moistened by sprinkling and the entire mass thoroughly and continuously stirred and mixed. The crushed flint, which must have been previously wetted, shall then be added in proper proportion and the whole mass again mixed until the ingredients are thoroughly incorporated. Only a sufficient amount of water shall be used to make a stiff concrete. This concrete shall be immediately placed on the cinder foundation, which must be previously wetted and shall be well rammed until all interstices are filled with cement. Especial care must be taken to have the concrete well rammed and consolidated along the outer edges.

Immediately after the bottom course is finished and before the cement has had time to set, the top course shall be added. For this the cement and sand shall first be mixed dry till an even color is shown, then slowly moistened by sprinkling, and thoroughly mixed to form a smooth and thin mortar. This shall be evenly spread on the bottom course and brought to a smooth and even surface and to the proper grade. This top course shall be disturbed as little as possible by additional troweling after the first setting takes place.

The pavement shall be cut or separated by the trowel into individual blocks, containing about 30 sq. ft. of surface, or in such manner as may be directed by the engineer. The edges of blocks where showing on the surface must be worked to true lines without any raggedness and the outside edges shall conform to all lines and curves and be neatly rounded. The surface of each block shall be a true plane, except where otherwise ordered by the engineer.

Across all roadways, where directed by the engineer, the excavation shall be 20 ins. below grade. On the 8-in. course of cinders, laid as above described, shall be placed an additional foundation course of concrete, 6 ins. thick, consisting of 1 part of cement, 2 parts of sand and 5 parts of local limestone, broken so that the largest piece shall in all its dimensions pass through a 2-in. ring. The sand and cement shall first be mixed dry, then sprinkled with water and mixed to form a stiff mortar. The broken stone shall be free from all dust and dirt, and be thoroughly wetted before being mixed with the mortar. The mass shall be quickly placed on the wetted cinders and be well rammed until the mortar begins to flush to the surface. This foundation shall remain undisturbed for at least 24 hours before the pavement is laid thereon and shall be protected from the sun's rays until the pavement is laid. This pavement shall consist of two courses of like materials and composition as the course for sidewalk flagging, except that the bottom course shall be 5 ins. thick and the top course 1 in. thick. The top course shall be grooved lengthwise of the walk with grooves ¼-in. deep and 6 ins. apart, and the whole cut into blocks as hereinbefore provided. This driveway flogging shall be 1 ft. wider than the sidewalk, each edge being beveled or chamfered for a width of 6 ins.

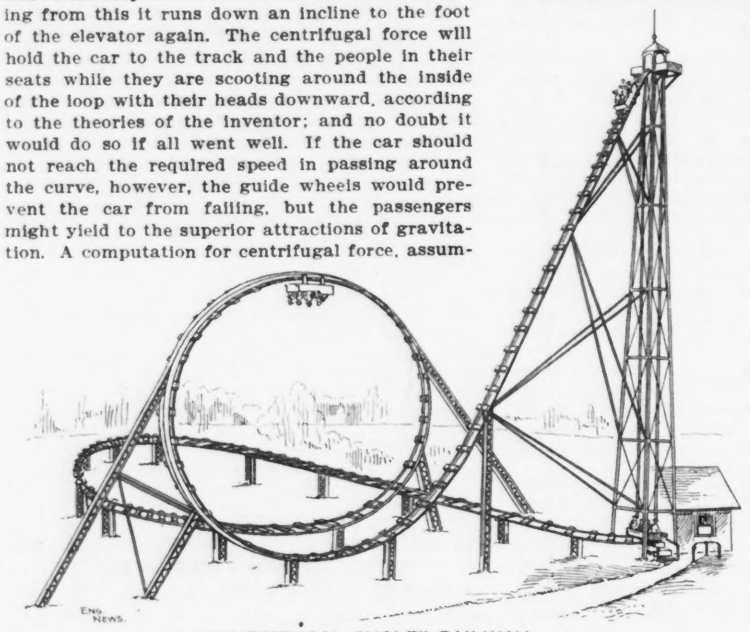
As fast as any part of the pavement is completed, it must be kept covered and continuously moist by sprinkling for a period of at least 6 days, and it must be suitably barricaded to prevent its use during this time. The retempering of any cement or mortar that has once set and its use in the walks will not be permitted. All cement brought upon the work must be protected from the weather. All sand used shall be clean, sharp and coarse Kaw River sand, free from all earthy or vegetable matters, and shall be screened if so required by the engineer. The crushed "Joplin flint" shall consist of irregular sharp edged pieces of varying sizes, with no dimension larger than ¾-in., and it shall be free from dust or dirt. The broken stone shall be sound limestone, broken so as to pass through a 2-in. ring.

The cement used shall be a slow-setting Portland of the best quality and capable of withstanding a tensile stress of at least 400 lbs. per sq. in. after having been one day in air and six days in water. It shall be of such fineness that not more than 10% will be retained on a standard sieve of 100 meshes per lin. in., and shall develop no unsoundness under either cold or hot water tests.

A "CENTRIFUGAL" RAILWAY FOR PLEASURE RESORTS.

A number of ingenious inventors have reaped more or less fame and fortune in recent years by the design of various sorts of "amusement railways," as they may be called, for use at pleasure resorts. A scheme which falls in this class was brought to our attention some time ago by a thin brick-colored pamphlet issued by the "Monorail" Railway Co.,* of Toledo, O., and we have thought it worth while reproducing one of these sketches for the amusement of our readers. The scheme is the outgrowth of the "monorail" railway system of "Captain" Lina Beecher, which we believe was actually put into use on a small scale in some farming community in the West. Like most of the so-called monorail systems, this inventor used three rails, a central carrying rail, and guide rails on each side, with wheels running on their under surface. These side wheels were claimed to be advantageous in holding the car on the track and preventing derailments at high speeds.

The application of this track to a "centrifugal cycle railway," as it is termed, is shown in the sketch. An elevator takes the car with its passengers to the top of a very steep "toboggan slide." The car plunges down this and acquires such velocity as to run up and around the inner side of the loop of the verticle circle, and on emerging from this it runs down an incline to the foot of the elevator again. The centrifugal force will hold the car to the track and the people in their seats while they are scooting around the inside of the loop with their heads downward, according to the theories of the inventor; and no doubt it would do so if all went well. If the car should not reach the required speed in passing around the curve, however, the guide wheels would prevent the car from falling, but the passengers might yield to the superior attractions of gravitation. A computation for centrifugal force, assuming the loop to be 40 ft. in diameter, shows that the car would have to reach a velocity of at least 20 miles per hour at the top of the loop to keep its passengers from falling. Add to this the velocity it would acquire in running down the other side of the loop, dropping a vertical distance of 40 ft., and the speed at which it would strike the sharp curve on the level stretch would probably furnish another instalment of "amusement" to the passengers. Very likely the apparatus might be so arranged that the trip could be made without very great risk; but he would be a sanguine man who would build one and take the chance that the public would pay for the "amusement" of riding over it and under it; and so far as we can ascertain none have been actually constructed.



A "CENTRIFUGAL CYCLE" RAILWAY.

It is of interest to note that the idea of this "centrifugal railway" is not wholly new. Something of the sort was suggested in the very early days of railways, and it is our impression that one was actually constructed and was illustrated in one of the technical periodicals of that day. The reasons why the system did not attain popularity may be readily imagined.

*The address given is 233 Spitzer Building, Toledo, O.

TEST OF A MECHANICAL FILTER AT EAST PROVIDENCE, R. I.

In our issue of July 13, 1899, there appeared an article by Mr. Edmund B. Weston, M. Am. Soc. C. E., of Providence, R. I., on a test, made under his direction, of a mechanical filter plant at East Providence, R. I. An article by Mr. Weston on the same subject, giving more details, but not covering quite so long a period, was read before the American Society of Civil Engineers on Nov. 1. An abstract of the discussion is given below.

The filter tested was recently installed for the East Providence Water Co. by the New York Filter Manufacturing Co. It is of the Jewell gravity type, designed for a capacity of 500,000 gallons a day, when working at the daily rate of 125,000 gallons an acre.

The discussion was opened by Mr. Geo. W. Fuller, Assoc. M. Am. Soc. C. E., of New York city. Mr. Fuller first pointed out that the water treated was very soft, and that comparatively little data is available on the treatment of soft water by mechanical filtration. From another source than the paper the speaker had learned that nesslerized ammonia was used as a color standard. This was unfortunate, because, as shown by Mr. Desmond FitzGerald, M. Am. Soc. C. E., in the report of the Boston Water Board for 18[illegible], this standard is a variable one, giving, in this case, too high figures for the raw and too low ones for the filtered water, and thus exaggerating the percentage of color removed, which was given in the paper as 83%.

A somewhat similar criticism was made regarding the alkalinity tests, and several other objections were raised to the analytical methods employed.

The speaker suggested that an unnecessary amount of alum was used at times, the rate throughout the greater part of the test being one grain per gallon, without regard to whether the color was 0.3 or 1 part. It is desirable to know the maximum color at the time of minimum alkalinity, as the amount of coagulant required to remove color increases with the color, while the amount of sulphate of alumina that can be used without going through the filter in an undecomposed state decreases with the alkalinity.

The bacterial results obtained were certainly high, but this would be expected when so much high grade coagulant was used, the 1 grain per gallon in this case being equivalent to 1.3 grains of ordinary commercial sulphate of alumina. The possibility that some of the bacteria in the effluent were due to growths in the sand seemed unlikely in the case of a mechanical filter, where the sand is subjected to daily washing, with reversed flow of water and stirring by the agitator rake.

The paper contains no statement regarding the amount of water used in washing the filter, which is an important matter. The 17 minutes allowed for coagulation was a short period.

The item of $2.15 per 1,000,000 gallons of water filtered as operating expenses should be increased, Mr. Fuller thought, by the cost of the wash water, and the speaker also believed it would seem only fair to charge something against the filter plant for labor, even if the force at the pumping station has not been increased since the filter was put in use.

Mr. E. Sherman Gould, M. Am. Soc. C. E., of Yonkers, N. Y., thought that the concensus of opinion was in favor of slow sand filtration, but he had noted statements in several recent reports to the effect that equal results could be obtained from either slow sand or mechanical filtration.

Dr. C. Gilman Currier, Assoc. Am. Soc. C. E., of New York city, stated that although he favored slow sand, rather than mechanical filtration, he believed good results could be obtained from the latter system. Its chief danger was negligence on the part of the operators.

RECENT FIRE TESTS OF FIREPROOFING BY THE BRITISH FIRE PREVENTION COMMITTEE.

In our issues of June 8 and July 28 we described the earlier tests conducted by the British Fire Prevention Committee upon fireproof floors, casements, ceilings and partitions. This same committee has recently published the details of a comparative fire test of two different constructions of fireproof doors. The results of these tests are of unusual interest, for while American building laws generally prescribe such doors, and while they are extensively employed in most American cities, there is very little definitely known regarding their comparative fire-resisting qualities. The

..o doors tested by the British committee were a ..oden door covered with tinned steel much simi... to the well-known underwriters' fireproof shut... employed in this country, and an all-iron ...med and panelled door. Both of these doors ...e subjected to test under identically the same ...ditions.

..riefly described, the test consisted of submit... these doors to a fierce fire for one hour, ..dually increasing to a temperature of 2,000° F., suddenly followed by the application of a ...eam of water for five minutes, and consequent ...pid cooling. The door-openings were about 3 ft. 9 ins. by 7 ft. 3 ins., and the doors were hung to open inwards, towards the fire.

The testing-chamber was built of stock brick, laid with lime mortar, and measured 10 by 10 ft. internally, with the ceiling 8 ft. 6 ins. above the pavement of the chamber. This ceiling was formed of solid wooden beams grouted with fire-clay; and the hut was roofed in with galvanized iron. The fuel used was gas, admitted through two mixing chambers of fire-brick, each 10 by 3 ft., and located under the chamber floor. A 14-in. brick wall, with two openings, each 3 ft. 9 ins. by 7 ft. 3 ins., was built across the chamber, 15 ins. back of the main wall, forming a passage, and these two openings were each arched over with two half-brick rings. There were draft-holes in the east and west walls, and also observation holes covered by movable iron-sheathed wooden shutters. Two Roberts-Austen pyrometers were used for recording temperatures; with four observations made inside and two outside of the doors.

The armored wooden door was obtained in the open market. It was 4 ft. 3 ins. wide by 7 ft. 6 ins. high; fixed close to the wall by the maker and overclapped 3 ins. on each side. This door was 2 ins. thick; made of ⅞-in. pine boards, planed, tongued-and-grooved, and nailed together, diagonally, with wrought-iron nails, clinched on the other side. These boards were completely covered inside and out with tinned steel plates, No. 26 standard wire gage, with welted joints and screwed in the joints. The screws were 6 ins. apart, penetrated three-quarters of the thickness of the door, and the screw-heads were entirely covered by the welted joints. All fittings were of malleable iron. The hinge-straps were 3 ft. 6 ins. long, 3½ ins. wide, ⅝-in. thick, and they were secured to the door by four ½-in. bolts; they were hung on two 7-in. wrought-iron gudgeons, with cast-iron blocks built into the wall, with a 1-in. turned pin 4 ins. long. There were two latches, 1 ft. 9 ins. from top and bottom, connected by a 1¼-in. by 3-16-in. iron bar, with a strong iron lever handle on each side of the door. The catches, ¾-in. thick, were built into the wall.

The wrought-iron door and frame were also obtained in the open market. The frame was made of angle-iron 2½-in. by ⅜-in., and a wrought-iron stop was carried all around the frame and secured with iron screws. The door was ¼-in. wrought-iron plate; and on the inside, forming panels, were 3-in. by ¼-in. wrought-iron stiles, screwed to the iron plate. This door fitted closely into the frame and was hung with wrought-iron pivots. A 6-in. rim-lock was screwed on the outside.

The test was made on June 14, one week after the doors were hung. The gas was gradually turned on and fired at 5 p. m.; and at 6 p. m. the temperature ranged from 1,800° to 1,970° F. on the fire-side of the doors, and stood at 1,100° and 1,175° F. outside of the doors in the 16-in. chamber referred to.

The record for the wooden door was as follows: Commencing at 5 p. m., in 1 minute smoke was coming very slightly through the door; in 3 mins., smoke came through the plate joints; in 5 mins., flames came slightly between top of door and arch; in 7 mins., spurts of flame came through joints of plating on the fire-side; in 8 mins., much resin and smoke came through the joints on outside; in 10 mins., the door was burning freely on the fire-side, and some of the joints had opened; in 13 mins. the flame was coming freely over the top of the door; in 19 mins. the top of the door opened inwards to about 1½ ins., and flame issued to end of test; in 20 mins. the door had bent inwards 2 ins.; in 24 mins. flames commenced to come fiercely over top of door; and in 26 mins. the door was considerably bulged on fire-side, and was burning fiercely all over. At 5.40 p. m. the gap at the top of the door was 3½ ins. wide, and flames were coming from this gap 2 ft. down the sides; at 5.50 spurts of flame came through in two jets near the center of the door, and the top gap was 5 ins.; the door was burning and the plates were red-hot about half-way down on the outside. At 5.59 p. m., flames were coming freely through the door at the fastenings and the top-gap was 5 ins., as it had been at 5.50 p. m.

The iron-door test showed that the door was quite hot at 5.1 p. m., and at 5.10 it twisted very slightly and bulged about ½-in. at the top corner, with smoke coming through between the door and frame. At 5.13 the door was buckled about ½-in., and at 5.20 momentary spurts of flame came from between the door and frame at the top on the lock side. The door was red-hot at 5.24, and at 5.26 the buckling had increased to about 1 in. at the same top corner. At 5.30 this gap was about 1½ ins., and the flame came through freely; at 5.35 the gap was 2 ins., diminishing to nothing 2 ft. down; at 5.40 the door was buckling at the bottom, on the lock side, and the top gap was about 3 ins. wide, with flames coming fiercely through both openings. At 5.49 the door was bright red-hot all over; the top gap was about 3½ ins. wide, and extended down to the lock. At 5.53 the top gap was about 4 ins. wide, and at 5.59 it was about the same. The gas was shut off at 6 p. m., and from 6.1 to 6.6 p. m., a jet of water was alternately applied to both doors, outside and inside.

An examination then showed the following results: For the armored wooden door all the woodwork was reduced to charcoal, and had fallen to pieces inside the steel casing. The tin was melted off the plates, and some of the plates were forced out of position and the welted edges opened. The casing was considerably bulged on the fire-side, and also on the outside, so that, at the center, the distance between the inner and outer casing was 9½ ins. The top of the door had inclined 6 ins. towards the fire, and the bottom 1 in. in the same direction.

The iron-framed and panelled door had buckled and warped, as had also the rebated frame, in which it was hung. The door had bent towards the fire 4⅛ ins. at the top corner on the lock side; and the rebated frame had bulged to the extent of 2⅞ ins. from a vertical straight line.

Since writing the above we have received the details of three other tests conducted by the committee, one being a test of luxfer prism casements, one being a test of a skylight, and the third being a test of the Columbian fireproof floor. We give the essential features of these tests below.

Luxfer Prism Casements.—The purpose of this test was to show the effect of fire and water upon electro-glazed squares of plate glass fixed in teak casements. The standard testing chamber described above was employed. Upon a dwarf wall three teak rebated casements were fixed, reaching from the top of the wall to the ceiling of the chamber. The joints where the casements abutted against one another were covered by teak fillets, and similar fillets were fixed where the casements abutted against the walls and ceiling of the chamber. The casements were glazed with copper electro-glazed sheets of plate glass 4 × 4 ins. × 3-16-in., framed with a brass border and fixed to the rebated teak frames by teak beads. Each casement showed glazing measuring 3 × 4 ft. There were 108 prisms in each casement, or 324 in all.

The duration of the test was to be 45 mins., during which time the temperature was to be gradually raised to 1,300° F. Water was to be turned on the outside of the casement for a period of 2 mins. at the expiration of 20 mins., and at the expiration of 45 mins. water was to be applied to the inside for the same length of time. In the actual test, however, the temperature reached 1,600° F., and as only one casement was left standing at the expiration of the first water test and of the fire test, the outside application of water only was made on this casement. The results of the test are summarized by the committee as follows:

In five minutes the glass in north casement commenced bulging inwards, smoke issuing between timber ceiling and top edge of teak casement; in 15 mins., teak casement was alight on outside, but glass not displaced; in 20 mins. (after the application of water), the glass was cracked, but not displaced; the glass in north casement showed further bulging inwards; in 30 mins. the glass in center casement commenced bulging partly inwards and partly outwards; in 35 mins. the glass in north casement fell inwards; in 36 mins. the glass in center casement fell inwards; in 38 mins. the glass squares in south casement along the two top rows began to soften and bend outwards; the remainder of this casement remained in position till the end of test.

Wire Glass Skylights.—The object of this test was to determine the effect of fire and water upon wire glass skylights. Each skylight, of which there were two, was glazed with rolled plate wire glass ¼-in. thick, with teak skylight bars 4 × 3 ins., and teak cover fillets on top. Each skylight showed glazing 2½ ft. × 4 ft. 7½ ins. In one minute after heat was applied the glass began to crack, and in three minutes smoke come through the joints around the frame and brickwork. In 15 mins., on the application of water from the top, the glass bulged inwards some 2 ins., but did not let the fire through; the water being retained in the hollow formed in the south skylight and gradually boiling away, and that in the north skylight slowly filtering away through two small holes in the glass. On the expiration of the full 30 mins., the glass was intact, except for the cracks and the fire did not pass through it. The wire glass used was made by Pilkington Bros., of London.

Columbian Floor.—The standard construction of this floor was described in Engineering News, Jan. 7, 1897. The test lasted 2½ hrs., the temperature being gradually increased from 500° F. to about 2,300° F., and a stream of water being applied to the underside of the floor for 2½ mins. at the end. The test resulted in taking off some of the plaster and producing some slight cracks in the beam protection. The concrete forming the floor was not injured.

A SIGHT-FEED GRAPHITE LUBRICATOR FOR GAS ENGINES.

Because of the high temperatures met with in gas engine cylinders, their lubrication has always been a difficult matter. The oil introduced is practically all burned away at each explosion, and, owing to the high pressures at the beginning of the stroke, it has not been possible to apply the oil lubricators at a point where the best use could be made of the oil.

The fact that graphite is unaffected by heat recommends it for use in such cases, and some atten-

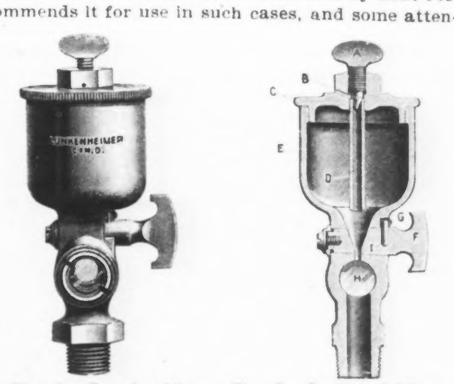


Fig. 1.—Exterior View. Fig. 2.—Sectional View.
A GRAPHITE CYLINDER LUBRICATOR.
The Lunkenheimer Co., Cincinnati, O., Manufacturers.

tion has been bestowed on the problem of properly feeding it into the cylinder. The lubricator shown herewith is said to accomplish this satisfactorily. The cup is attached directly to the air suction pipe of the engine, as close to the vaporizer as possible. At each suction stroke of the engine a current of air is drawn through the passage B, through the cock F and past the sight feed H. The amount used is determined by the relative adjustment of the throttling screw A and the stop-cock. When the latter has been turned off it can be accurately brought back to its former adjustment, as it is made to stop against the screw point G.

The manufacturers state that they have found that about one-twentieth of an ounce of graphite per HP.-hour for a run of 10 hrs. will give good results. After the graphite has been forced into the surface of the metal by the movement of the piston, the amount of oil used may be reduced to one-third.

For the cuts illustrating this article and the details given therein we are indebted to the manufacturers of the device, The Lunkenheimer Co., of Cincinnati, O.

SWITCH DETAILS OF THE BOSTON TERMINAL YARDS

The tracks in the extensive yards of the new terminal of the Boston Terminal Co., at Boston, Mass., are laid with 2,500 tons of 6-in., 100-lb. rails of the standard section of the New York, New Haven & Hartford R. R., rolled by the Lackawanna Iron & Steel Co., of Scranton, Pa. The ties are of yellow pine, 7 × 10 ins., and on all curves the rails are laid on Goldie steel tie-plates furnished by Dilworth & Porter, of Pittsburg, Pa. The whole yard is covered with 12 ins. of good gravel ballast. The track system is of interest in that it includes no less than 15 miles of track (of which 4 miles are in the trainshed), with 252 switches, 37 double slip switches and 283 frogs. The frogs are of the clamp type, with wooden foot guards. The switches and frogs were all manufactured by the Ramapo Iron Works, of Hillburn, N. Y., from the 100-lb. rails, and all slip switches, ordinary switches and movable frogs, as well as the signals, are operated by the Westinghouse electro-pneumatic interlocking system, installed by the Union Switch & Signal Co., of Swissvale, Pa.

One of the interesting features of the yard is the use of the slip switches. Two intersecting double-track lines form an elongated X in the middle of the yard, and these cross all the approach tracks. At each intersection between the diagonal tracks and the approach tracks is placed a double slip switch, thus giving an almost illimitable variety of combinations for connecting any of the main tracks with any of the 28 station tracks.

In Fig. 1 is shown the construction of one of these slip switches, which is of a very substantial character. The switch rails are 13 ft. long, with head-rods and three tie-rods, while the movable frogs have point rails 10 ft. 10 ins. long, with a head-rod and one tie-rod. The head-rods and tie-rods are all flat bars ¾ × 2½ ins., with T-heads riveted to the webs of the rails. On every tie is a steel plate ⅜ × 7 ins., extending the full width of the switch, and having riser plates 1-16 to ⅜-in. in thickness riveted to it. In addition there are slide plates for all moving switch and frog rails, and rail braces for the stock rails, where required. The stock and switch rails are also connected so as to permanently retain their relative positions, without any spreading or creeping. This arrangement makes the entire switch a single piece of work, with all its parts maintained permanently in their proper relation to one another. All cutting of the ties, with consequent disturbance or distortion of the switch, is entirely prevented by the use of the through bed plates.

A special feature of the construction of all the ordinary and split switches and movable-point frogs in the yard, is the use of a splice trough at the heel joint of each movable rail. This is a trough or channel 10 ins. long and 3 ins. deep, made of ⅜-in. steel and placed between the angle bars of adjacent rails, or between the web of the outer stock rail and the splice bar of the heel joint. The width of the trough varies to suit the angle between the rails, and in each side are two 1 1-16-in. holes for the bolts. The use of this device ensures the switch being placed with the correct spread at the heel for which it is planed, though in general practice the distance is often made a little too wide. The trough, being bolted to both the switch rail and the stock rail, maintains the parts in their proper relation, and prevents the switch rail from creeping or being driven ahead, which movement would result in defective alinement and gage. This device was invented and patented by Mr. E. H. Bryant, Division Roadmaster of the New York, New Haven & Hartford R. R., of South Boston, Mass.

If these heavy switch rails were bolted up tight at the heel-joint spice, they would not move freely. Two of the bolt holes in the rail are, therefore, reamed out to a diameter of 1⅜ ins., and a heavy 1-in. gas pipe thimble is put over the bolt through the rail, the thimble being of sufficient length to take the pressure on the angle bar and prevent pinching the rail tight at this point. This is shown in Fig. 2. The arrangement allows the switch to work freely, and yet leave no loose nuts.

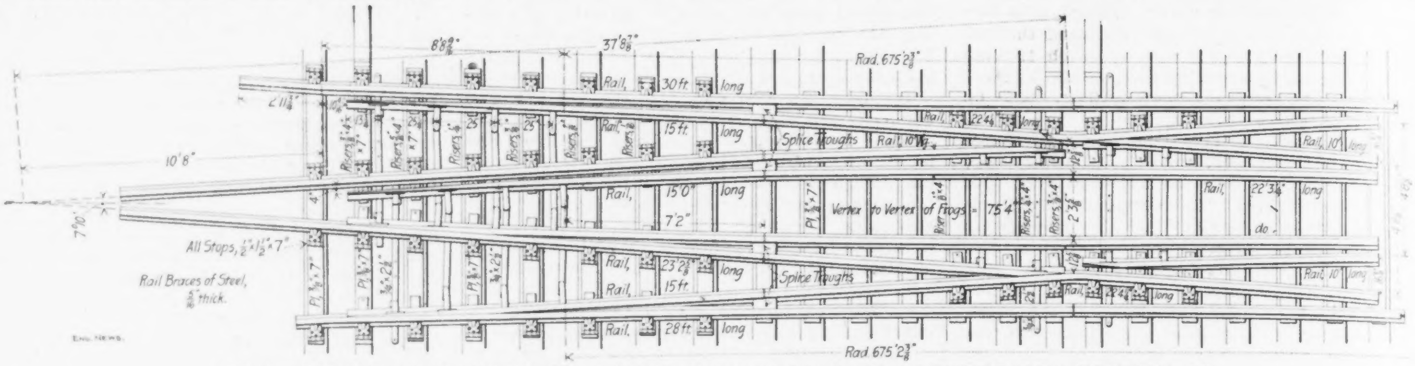


FIG. 1.—DOUBLE SPLIT SWITCH WITH 100-LB. RAILS, IN THE YARD OF THE BOSTON TERMINAL CO.
Ramapo Iron Works, Makers.

PAPERS PRESENTED AT THE MEETING OF THE IRON AND STEEL INSTITUTE OF GREAT BRITAIN.

The following are abstracts of a number of papers relating to metallurgical processes and machinery which were presented at the meeting of the Iron and Steel Institute of Great Britain, which was held at Manchester, on Aug. 15 to 18, inclusive, but whose special character or great length prevent their publication in these columns in full:

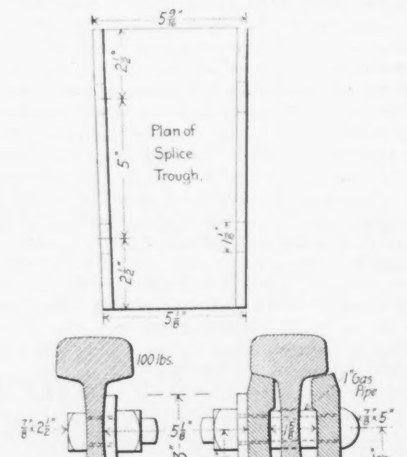


Fig. 2.—Splice Trough for Heel Joints of Switches and Movable Frogs.
E. H. Bryant, Inventor.

A New Casting Machine for Blast Furnaces.

By Richard Hanbury Wainford.

Several casting machines have recently been brought out but up to the present, particularly in this country, they have not been generally adopted. The reason for this is that in each of these schemes the iron so cast has suffered in fracture. This deterioration, in point of texture is due to: (1) The chilling of the iron through conduction in the mold; (2) the vibration to which the iron is subjected whilst solidifying; (3) the rapid cooling of the iron in water. The present machine aims to overcome these objections and consists of, briefly, a 15-ton ladle, a central inclined ladle-track, narrow-gage railways (placed on either side of the ladle-track) upon which is traveled a controlling vessel which is attached to the ladle. These narrow-gage railways are placed horizontal, and on the outer side of them a line of 40 molds is also placed horizontally, and underneath each line of molds is run the wagon lines on which stand wagons to receive the contents of the molds.

The full ladle is brought to the lower end of the inclined ladle-track. The controlling vessel is then attached to it, and both are hauled by means of a wire rope, along the line of molds; at the same time the operator gradually tilts the ladle. The idea of the inclined plane is to avoid splashing of the molten metal, as by its use the lip of the ladle is kept low down and in constant position with regard to the controlling vessel. After the metal has remained in the molds a short period, the molds are tilted over in pairs, and their contents delivered to the wagons.

The molds are constructed in a light, corrugated form, and are placed in semicircular casings, leaving a cavity or space between the molds and the casings, in which is placed suitable non-conducting material. The corrugated form of the mold gives strength with lightness; and the question of lightness, combined with the non-conducting material, constitutes one of the chief points devised to avoid the chilling effect, and therefore preserves the texture in the iron. The molds are made detachable, and by releasing the bolts at each end of the casing may be readily taken out and replaced. The casings holding the molds are fitted at each end with trunnions, upon which they are revolved when required to be discharged. A locking gear is provided, and the spaces between the molds close automatically during the operation of casting. By these several means a continuous cast is obtained. the molds are held perfectly still while the metal is solidifying, thus avoiding mechanical action during that period, and by insulating the molds the chilling effect is also avoided.

The Solution Theory of Carburised Iron.

By A. Stansfield.

As defined by the author, the solution theory of carburised iron affirms that this substance is, when fluid, a solution of carbon in iron, and that under certain conditions the solidified mass also forms a solid solution. It further affirms that these liquid and solid solutions obey the ordinary laws of solution, which have been fully studied in the case of aqueous, saline and organic solutions. The purpose of the paper is to embody in an accessible form the main features of this theory.

India as a Center for Steel Manufacture.

By Maj. Reginald Henry Mahon.

This paper points out the growing demand for steel and iron in India, and the availability of the Indian ore, coal and limestone deposits for establishing works with which to supply this demand. In conclusion the author says:

The conditions, then, which appear to offer the greatest prospects of success are the establishment of a steelwork on a large scale, capable of undertaking the whole or a large part of the requirements of India, both as to rails, sections and plates, to be situated either on the Hooghly below Calcutta, or on the Mutlah River at or below Port Canning. Given these conditions, and given that the steel company absorbed the profits from the mining of the minerals to the final out-turn, and carried out the scheme with a sufficient capital and with honest, unselfish supervision, there is no doubt that remunerative success awaits the enterprise.

Marking Boundaries of Mining Location.

Under Rev. St. § 2324, requiring a mining location to be distinctly marked on the ground so that the boundaries can be readily traced, in marking a claim regard must be had to the topography of the ground, and the markings be so placed that they can be readily followed from one to another, and that a person accustomed to tracing the lines of mining claims can, after reading a description of the claim in the posted notice of location, by a reasonable and bona fide effort, find all the stakes.

Ledoux vs. Forester et al., 94 Fed. Rep. (U. S.), 600.

Some Forms of Magnetic Separators.

By B. H. C. McNeill.

The paper described five different forms of magnetic separators observed by the author in operation in Sweden, and pointed out their characteristic features and fields of operation.

The Wenstroem Machine.—This is probably the simplest, and, for the particular purposes which it is intended to fulfil, the most efficient separator at present in use. Unlike most other designs, it is capable of treating ore of fairly large size, and it is not necessary that the stuff treated should be previously dried; its chief use is in such cases where the magnetic iron ore contains inclusions of rock, or where, as in open-cast-workings, portions of the containing walls of the ore body get mixed with the ore in blasting and like operations. As a general rule, it is found to be more economical to pass the whole of this material collected together over a Wenstroem machine, after the "best" of a blast has been dealt with, than to attempt further hand selection in the quarry or underground. In addition there are other uses to which this separator may be put, such as the treatment of cupola residues and foundry loam and sand; also the recovery of cast-iron shot entangled in blast-furnace slag, etc., etc.

The Monarch Separator.—This is a modification of and improvement on the original Ball & Norton machine, a class which includes the most successful machines of the eccentrically placed internal electro-magnet and the revolving drum pattern. It is necessary that the ore treated should be quite dry, and in both cases where the author was enabled to see the machine at work in Sweden the best results have been obtained upon material crushed to pass through a 1 mm. screen.

Delivik-Groendal Separator.—This machine is designed to treat those ores in which the magnetite exists in a state of intimate admixture with other and, generally, worthless materials. The material is ground very fine in a ball mill and reduced with water to a slime which is fed to the separator.

Herbele Separator.—There are two distinct types of this machine, one designed for the separation and concentration of low grade magnetic ores only, and the other for the treatment of galena blende ores where occurring with magnetic oxide of iron, also the separation of roasted spathic iron and blende, etc.; or in the treatment of a complex ore consisting of galena blende, magnetic oxide, pyrrhotine and quartz. The material is fed to the separators in the form of slime.

The fifth machine described is the well-known Wetherill separator, designed to treat the ores met with at the Franklin Mines in New Jersey, with which American engineers are familiar.

Iron Industry in the Territory of the Nizam of Hyderabad, Deccan.

By Shamsul Ulama Syed Ali Bilgrami.

This paper by the Secretary of the Government Public Works Department of H. H. the Nizam of Hyderabad, describes at some length the geology and mineralogy of the territory ruled over by the Indian potentate named, particularly in regard to the possible development of the iron industry. It is stated that hematitic and magnetic iron ores, and yellow and red ochres and heterite are found plentifully in connection with coal fields and limestones. The author states that the iron industry has remained in a very primitive state, and there does not remain any doubt of this statement when we read his description of the methods used in the reduction of the native ores, which is as follows:

The furnace used is 4 ft. high, and is made in two parts of almost equal height, a stout base and a chimney. The base, which is 2 ft. in diameter, is made out of clay, with admixture of sand and straw, and the chimney, which narrows at the top to about 8 ins. in diameter, is made of a better kind of clay, and is fixed on to the base and plastered over. A semicircular hole at the bottom of the base serves for the insertion of the tuyere, as well as the removal of the bloom at the end of the operation. The tuyere is a clay tube about 7 ins. in length, slightly widened in front to receive the nozzles of a pair of goatskin bellows, which conduct the blast, and are worked by hand.

The furnace is first filled with charcoal and fired through the tuyere. The bellows are then set to work, and when the furnace is well heated a charge of ore, moistened with water, is thrown in from the top. Quantities of ore and charcoal are then added from time to time, and in from three to four hours the operation is complete. The front part of the furnace is then broken, and the spongy mass of iron, which is by courtesy called a bloom, is taken out, and while hot is hammered into an irregular piece of wrought iron, which is afterwards cut up into bars. I have several of these bars in my possession, and I have been told by those competent to judge that the iron is of excellent quality. The blooms I got out weighed from 15 to 20 lbs. Four men were employed on the furnace, and could work only two charges a day.

The author concludes that nothing but capital and modern appliances are required to establish a thriving iron and steel industry in the territory named.

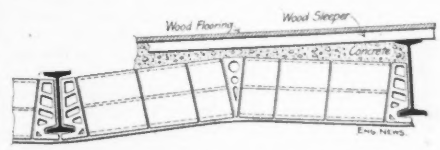
The Constitution of Steel.

By Prof. E. D. Campbell.

This paper, which was of a highly technical character, was a defense and further exposition of the author's theory that the passage of sulphide of iron through steel could not in a strict sense be regarded as true diffusion.

A NEW FORM OF HOLLOW TILE FIRE-PROOF FLOOR ARCH CONSTRUCTION.

A new form of hollow terra cotta fireproof floor arch construction, which presents several features of interest, is shown in the accompanying illustration. This arch, from its peculiar shape, has been named the serrated arch. It is the invention of Mr. Henry L. Hinton, of the Central Fireproofing Co., who presents a number of claims in its behalf. The first of these is that the new construction is as strong as a segmental arch of the same span and rise, the rise being uniformly ½-in. to the foot, or 1-24th of the span. This uniform rise is effected by giving an inclination of 2 ins. per foot of depth to the skewbacks and key and of 1 in. per foot to the parallel-arched intermediate voussoirs. By this construction a mortar joint of uniform thickness is secured without regard to the length of the span. To secure this ad-



Hollow Terra Cotta "Serrated" Floor Arch.
(Thickness, 12 ins.; span, 6 ft.; weight per sq. ft., 31.4 lbs.; safe load, 688 lbs.)

vantage in a segmental arch the batter of each voussoir has to be different. Mr. Hinton says further:

The combination of side-construction skewbacks and keys with end-construction lengtheners, as in this arch, has many advantages. A side-construction skewback can be made with a flange to protect the bottom of the beam, thus doing away with a separate block for the purpose. It can be made to fit the beam more accurately, and in pairs to encase it nicely, so it can be well covered with mortar, or flooded with liquid grout (if great perfection in the setting is required) and thus prevent corrosion. The side-construction skewback, moreover, presents an unbroken and an even flat surface to "butter" with mortar, against which the adjoining end-construction voussoir, occupying a critical place in the arch, can be well set. It is impossible, of course, that the webs of any special skewback should always conform to the line of maximum thrust, since the direction of this line varies with the span. But it will be found that the skewbacks here shown have been designed with a slope to the webs which is most efficient for the medium spans, and which is near enough for all practical purposes to the requirements of the most extreme spans to which the arch is applicable. It will be noticed, on reference to the cuts also, that the skewbacks and keys are made exceptionally heavy and the material distributed so as to present the greatest resistance where it is most needed—and yet that the arch as a whole, in medium spans, is not heavier than the side-construction arch. This is due of course to the light end-construction lengthener used in its construction. An end-construction block has its entire section available for resisting compression, as the shell and webs extend from end to end, while a side-construction block has only the horizontal webs and the upper and lower portions of the shell in direct compression, the upright webs serving only to hold these parts together and to resist diagonal strains. The latter slight advantage is amply compensated for in the end-construction block from the fact that this strain is across the grain of the material rather than with it, as in the side-construction arch block; a grain due to lamination in making hollow terra cotta blocks.

A hasty consideration might lead one to infer that a wide-span arch of this character, uniformly loaded, would be inclined to buckle between the key and either skewback. But it must be remembered, in accordance with the principle of the flat arch, that if a circular arc can be drawn inside of the middle third of an arch, uniformly loaded, it will be stable and equal to the crushing strength of its material; and as this arch has such a small rise the same rule applies. Further than that, it is assumed that the spandrels of the arch are filled with concrete, so that the depth of the arch at any point may be taken as the sum of the depths of the terra cotta and concrete of that point—as a given solid section of good, light (cinder) concrete (the concrete which is supposed to be used) may be safely taken as of the same compressive resistance as a like section of the hollow terra-cotta blocks. Of course every inch of such concrete over the top of the whole arch would add to its strength, but the best way is to design a terra-cotta arch to carry safely the desired load and depend on the concrete to carry its own weight and to meet the contingency of unforeseen shocks and eccentric loading. The flat arch acts as a brace in a building, and these arches may be depended upon to the same extent, for all practical purposes, as, owing to their slight rise, it would be almost impossible to buckle them by pressure on the ends. Although primarily intended for floors requiring great strength, such as the floors of warehouses, breweries, armories, schools, etc., these arches, being so light, it is believed, will be found applicable to a wide range of cases not requiring such strong construction.

A ceiling plastered to conform with this construction would be serrated of course, but the points could be readily rounded off if desired and the segmental effect given. A serrated ceiling, however, especially in a large room, would doubtless have a very pleasing effect, and under certain circumstances be useful in reflecting the rays of light. Its æsthetic possibilities, it is believed, will be appreciated by the architect. A serious objection to a ceiling conforming to the usual segmental arch is the difficulty of securing uniformity when dividing into rooms—as the partitions may divide an arch in a way to mar the effect. With the use of the serrated arch this difficulty, it will be seen, is more easily obviated; in fact, the ceiling may be plastered level, if the arches are not of too wide spans. In places where the plastering is thick, large-headed nails driven into the arch, leaving enough protection to be thoroughly embedded in the plastering, will insure a good bond and prevent the ceiling falling from extra weight. The average depth of concrete in levelling these arches even with the apex is always 1-48th of the span, or ¼-in. to the foot.

A RAIL-JOINT HYDRAULIC PRESS is being introduced for the purpose of driving the splice bars home to a good bearing on the rail while the bolts are being put in, thus preventing trouble from the lack of tightness in new joints. The machine has a heavy yoke straddling the rail, on the inside of which are two long jaws. One of these is stationary, held by a vertical pivot bolt, while the other is similarly attached to the head of the horizontal ram. The cylinder is formed in a rectangular block forming one end of the yoke, and on top of this is the pump, operated by a removable lever. The machine is intended especially for the deep heavy splice bars of street railway girder rails, some of which have twelve bolts, in two rows. It is also intended, however, for ordinary railway work. This "Hercules" rail-joint press is manufactured by the T. N. Motley Co., of New York, and is also sold by Elmer P. Morris, 15 Cortlandt St., New York city.

A FAST NEWSPAPER TRAIN has recently been put in service by the Great Central Ry. of England, to carry the special war edition of the London "Daily News" to Manchester and intermediate cities. The first train made the trip of 206 miles in 3 hours 26 minutes running time, or at the average speed of 60 miles an hour, exclusive of stops at Leicester, Nottingham and Sheffield. High speeds cannot be attained for some distance out from London, while near Sheffield there are heavy grades, so that speeds of 70 to 80 miles an hour are said to be necessary on some parts of the line in order to maintain such a high average speed. The train consisted of four four-wheeled baggage cars and a six-wheeled "brake van" for the conductor. The weight was probably only about 60 to 75 tons. The engine used is of the eight-wheel type, with inside cylinders and piston valves, and has a six-wheeled tender. It will be noted that the truck and tender wheels are much larger than is usual in American practice. The general dimensions are as follows:

Wheels, driving	7 ft. 0 ins.
" truck	3 " 6 "
" tender	4 " 3 "
Wheelbase, engine	22 " 2 "
" tender	13 " 0 "
" engine and tender	44 " 8 "
Weight on drivers	60,896 lbs.
" total engine	104,832 "
" engine and tender	198,912 "
Cylinders	18½×26 ins.
Boiler (straight top), diameter	4 ft. 3 "
Boiler pressure	170 lbs.
Firebox (Belpaire)	5 ft. 8½ ins. × 3 ft. 6 ins.
Tubes, No. 231; outside diameter	1¾"
Tubes, length	11 ft. 4½"
Heating surface, tubes	1,209 sq. ft.
Heating surface, total	1,318 "
Grate area	20 "
Water in tender tank	4,800 gallons.
Coal on tender	11,200 lbs.

THE BERLIN MOTOR-CARRIAGE EXPOSITION, says Consul-General F. H. Mason, included 40 different types of vehicles. The Daimler Co., of Cannstadt, Dürkopp, and Kleyer & Opel, have the chief exhibits. Mr. Mason says that these German carriages are generally heavy, and gaudy and crude in decoration. Among the novelties is the two-seated galvanic tricycle of A. Krüger, of Berlin. It carries a galvanic battery, about 2 ft. long by 18 ins. wide, arranged in cells with changeable electrodes; the negative are ordinary zinc plates, and the positive are plates of superoxide of lead impregnated with an acid salt soluble in water. With these electrodes in position, water is poured in, the acid salt is dissolved, and the consequent galvanic action develops a current that operates the motor. With cells filled for a 40-mile run, and new electrodes carried sufficient for 22 miles more, the vehicle weighs 378 lbs. But the efficiency and certainty of this galvanic battery is doubted by experts. There is also a combined electro and benzine carriage from the Pieper Co., of Liege, Belgium. The benzine motor and electric motor are both coupled to the driving shaft, and can be used together or separately. The accumulator may be either charged from an ordinary power station, or, when remote from outside electrical supply, the benzine motor can run the electric motor as a dynamo and thus recharge the accumulator. In the machine exhibited the electric motor is of 2½ HP.; the benzine motor develops 3 to 3½ HP.; the accumulator weighs 125 lbs., and in form the vehicle is a double-seated "runabout," selling at retail for $1,190. While not claimed as a perfect machine, even by the inventor, the demand exceeds the capacity of the works now making them. It is claimed to be lighter than any other electric motor-carriage, and carries all its machinery upon the running gear, below the carriage and hermetically sealed.

BOOK REVIEWS.

SMALL ENGINES AND BOILERS.—A Manual of Directions for the Construction of Engines and Boilers from 5 HP. down to Model Sizes. By Egbert P. Watson, Late Editor and Proprietor of "The Engineer." New York: Van Nostrand Co. 5½ × 8 ins.; pp. 108; 30 dimensioned drawings. $1.25.

This is a manual intended for amateurs and others having very limited shop facilities. The directions given are very plain and concise and are fully illustrated by dimensioned working drawings. Most of the machine work required can be done on a lathe with 6 ins. swing and 24 ins. between centers.

The illustrations are made by the wax process, and, as is frequently the case, with that process, a good many errors in detail in the execution of the drawings may be found.

MECHANICS APPLIED TO ENGINEERING.—By John Goodman, M. P. M. E., Professor of Engineering in the Yorkshire College, Leeds. (Victoria University.) London and New York: Longmans, Green & Co. Cloth; 5 × 7½ ins.; pp. 605; 620 illustrations. $2.

The subjects covered in this book are, in American technical schools, usually taken up separately. They are: Theoretical mechanics, theory of framed structures, including arches, theory of internal stresses, machinery and mill work, hydraulics and water motors, and dynamics of the steam engine. The matter is therefore much condensed, but is nevertheless clearly and logically written. Although it is not to be expected that the work will find a place as a text book in American engineering schools, it will prove valuable and convenient to many practical engineers, the more so, since difficult mathematics is, as far as possible, avoided. The author, however, appends a chapter in which be shows that the infinitesimal calculus, contrary to the idea apparently entertained by many, proceeds by the ordinary laws of thought and involves no mental legerdemain. The book is well illustrated with diagrams and views, and a few half-tone cuts, where the latter would be serviceable. The mechanical execution is, in general, excellent, and it is to be especially noted that the wide margins and double-leaded lines so much used by some American publishers are avoided. We recommend tbe book as a compact and concise exposition of the application of the science of mechanics to the problems of engineering.

MARINE BOILERS, Their Construction and Working, Dealing More Especially with Tubulous Boilers.—By L. E. Bertin, Chief Constructor of the French Navy. Translated and Edited by Leslie S. Robertson, Assoc. M. Inst. C. E. With a Preface by Sir William White, K. C. B., F. R. S., Director of Naval Construction to the Admiralty. London: John Murray. New York: D. Van Nostrand Co. Cloth; 8vo.; pp. 437; 250 illustrations. $7.50.

This work is a most welcome addition to the literature of marine boilers. The author, from his position as chief constructor of the French Navy, has especial qualifications for imparting information concerning the construction and performance of the modern forms of water-tube, or so-called "tubulous" marine boilers, which were adopted in the French navy and mercantile marine long before they were even tried in other countries. About one-third of the book is devoted to a discussion of the various forms of this type of boiler, including the Belleville, D'Allest, Niclausse, Normand, Du Temple, Thornycroft, Yarrow, Babcock & Wilcox, Ward, Mosher and other boilers, of French, English and American designs. Besides the illustrated descriptions of these boilers, the author discusses with great frankness their relative advantages and disadvantages, their history, and the experiments and failures which led up to their present success. The history of the Belleville boiler during its experimental stage from 1856 to 1880 is given, and the causes of its several failures between these dates are related, so that by studying them the modern designer of boilers may learn what difficulties and defects he should avoid. Many data of experiments are also given, including a very complete table of weights, performance, etc., of 20 different water-tube boilers of nine different makes. The common, or "Scotch" boiler, and the locomotive form of boiler as adapted to marine purposes are also treated of at length. The locomotive form is discussed very briefly, and it is said that "their complete disappearance is probably only a question of time." Much more space is given to the Scotch boiler, and the numerous troubles which this type of boiler has experienced since the introduction of high pressures and of forced draft are discussed at length.

The arrangement and scope of the book are shown in the following titles selected from the chapter headings: I. The Principal Laws Underlying Steam Navigation. Speed, Radius of Action, Regularity of Service. II. Classification of Boilers. Notes on the General Behavior of Boilers. III. Brief Description of Marine Engines. IV. Production of Heat from Coal. Fuel and Grates. Natural Draft. Forced Draft. Firing. V. Liquid Fuel for Marine Boilers. VI. Production of Heat. Transmission of Heat to the Water and the Steam. VII. Corrosion. Part II. Tubular Boilers. VIII. Cylindrical Boilers. IX. Locomotive Boilers. X. Remarks on the Life and Weight of Marine Boilers and Space Occupied. Part III. Tubulous Boilers. XI. Boilers with Limited Circulation, or Coil Boilers. XII. Boilers with Free Circulation. XIII. Boilers with Accelerated Circulation. XIV. Advantages and Disadvantages of Tubulous Boilers. Comparison of the Different Types. XV. Weight and Space Occupied by Tubulous Boilers. Part IV. XVI. Boiler Mountings and Other Fittings. XVII. Boiler Steam Fittings. XVIII. Feed Accessories. XIX. Accessories Relating to the Disposal of Ashes.

In regard to the name "tubulous boilers" the author says:

> A universally accepted name accurately describing them has not yet been arrived at. The name "water-tube boiler" as opposed to "fire-tube boiler" is not satisfactory, because there have been rectangular boilers with water-tubes (Martin or Cochran boiler).

It is to be regretted that the author has for this slight reason rejected the name "water-tube boiler," which has been practically universally adopted in this country and found perfectly satisfactory, and used the term "tubulous," which means the same thing as tubular. The Martin or Cochran boiler was extinct many years ago; ever since high pressures caused the abandonment of the rectangular form of marine boiler.

We note a few slight defects which may be corrected in future editions. The treatment of the dimensions of safety valves, p. 368, etc., is far from satisfactory, and the notation of the formulæ is not clearly given. It is briefly stated, on p. 407, that "there is an economy to be obtained when taking live steam direct from the boiler," but no reason is given to explain this fact, if it be a fact, which is doubtful. In the equation on the same page some of the × signs should be +.

A statement, on p. 38, to the effect that mechanical stokers have not yet met with success in marine practice, is probably out of date—a few months. They are in successful use in one of the steamers on our Great Lakes, as described in Engineering News of Oct. 5.

The style of the author is excellent, and the translation has been well done. On the whole, the work is the most important one on the subject of marine boilers that has appeared in many years.

HEAT AND HEAT ENGINES.—A Study of the Principles which Underlie the Mechanical Engineering of a Power Plant. By Frederick Remsen Hutton, E. M., Ph. D., Professor of Mechanical Engineering of Columbia University. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 8vo.; pp. 553; 198 illustrations. $5.

In his preface the author refers to his former book, "The Mechanical Engineering of Power Plants," in which the object was to make the reader familiar with steam engines, boilers and their accessories, but no attempt was made to discuss the questions of design of such apparatus. The plan and scope of the present work are well shown by the following extracts from the preface:

> It was intended that the student should ask at the end of his study of that book: What are the principles of physics and dynamics upon which these machines depend; and how do engineers proceed when called upon to design such power-house engines?
>
> This book, under the title of "Heat and Heat-Engines," has been prepared to answer these questions in part. It discusses the energy resident in fuels, and the methods of its liberation as heat for power purposes; the transfer of such heat to convenient media whereby it can be used in heat-engines; the laws and properties of such media, and the design of cylinders of the necessary volume to give a desired mechanical effect or horse-power. This point having been reached, it becomes easy and natural to go farther and discuss the air-compressor and its complement, the air-engine; and to extend this discussion to include the problem of mechanical refrigeration.
>
> This treatise tries to occupy a middle ground. It might wisely be used as a groundwork for subsequent treatment of heat-phenomena by the analytic or mathematical method after the student has become familiar with the physical facts of which the equations of thermodynamics are condensed statements. * * * This is the result of trying to treat thermodynamics without the calculus, and the result should be to turn the student to further and exhaustive research in the higher fields.
>
> Equations could not be avoided, nor the use of logarithms; but the use of the temperature-entropy diagram for the graphical representation of relations has been abundantly permitted.

Among the 23 chapter headings are the following: General Notions of Heat; Combustion; Fuels; Draft; Heating Surface; Media Used to Transfer Heat-Energy; Effects of Heat Upon Heat Carriers; Work Done by Elastic Heat Media in Cylinders of Heat-Engines; Mechanical Compression of Heat Media; Temperature-Entropy Diagrams for Heat-Engines; Thermal Analysis of Heat-Engines; Vapor Engines; Mechanical Refrigeration.

The feature of this work in which it differs from earlier text-books on heat-engines is its extensive use of the temperature-entropy diagram as a means of studying the changes which take place in the heat medium enclosed in a cylinder. In this respect the book is a valuable contribution to the literature of the steam and gas-engine. We doubt if the author has made his treatment of entropy sufficiently clear for a reader who is not in the class room, but it is probably sufficiently so for the class-room student who may be aided by the teacher by means of verbal explanations and by drill in arithmetical examples, in which the book is lacking. The author does not give a very clear definition of "entropy," but in this he is no worsa than other writers. Ha calls it a "mathematical quantity," and says of it:

> While it is of signal importance in heat-engine discussions, it is impracticable to form a defensible conception of the entropy as a property of heat media, since it does not reveal itself to tha senses nor to usual instruments of observation.

The greater portion of the book, relating to steam and other engines, air compressors, refrigerating machines and injectors, appears to he well written, and contains many examples of careful study and clear, accurate writing. Wa wish we could say as much of tha first portion of the book, relating to hoilers and furnaces, but this portion appears to have many blemishes, hoth as to style and as to precision of statement. A sample of the author's style is tha following:

> Specific Heat.—It must follow from § 9 that if heat and energy are mutually convertible, then different bodies must vary with respect to their capacity for receiving, storing and giving out this energy. In the general field of machanical acience it has heen found that the measure of stored energy in a moving organ of a machine or a frea hody is made up of the product of its mass hy the half-squara of its velocity of motion (½ M v²). In molecular or atomic motions such as those in question in heat-motion, the same conceptions are supposed to apply, the only differenca being the infinitesimal character of the atomic mass, and the probably inconceivably great velocity of the motion—whatever it may be. Hence the mind is ready to accept the ohserved fact of such great differences in the thermal capacities of different bodies, and also the differences in the same body in different states.
>
> Speaking generally, then, the quantity of heat or energy which is required to raise a unit mass of a suhstance by one heat-unit will he called its specific heat.

The words "one heat-unit" in the last sentence, of course, ahould read "one degree," the error being evidently due to a slip of the pen, but the whole paragraph, it seems to us, might be improved. It is not very clear how the differences in thermal capacities of different bodies follows from the law that heat and energy are mutually convertihle. Specific heat is a physical constant of bodies, which was known long hefore the laws of thermodynamics were thought of.

Concerning rate of combustion, on p. 95, it is stated that:

> An interesting comparison of tests recently made shows a tendency to regard 13 lbs. per hour per square foot as representing prevalent American practice for stationary boilers on land.

It would be interesting to know what authority there is for making this statement. It does not agree with figures given on the next page, on the authority of Whitham, showing that the rate of combustion in land practice, with chimney draft, rangea from 6 to 27 lbs.; nor with the results of Mr. Christie's paper, "The Study of Boiler Tests," reported in Trans. Am. Soc. M. E., Vol. XVIII., in which the range of rate of comhustion is from 5 to 45 lhs. per square foot of grate per hour.

In treating of Heating Surface, p. 153, the author states that "the practical result therefore to he sought by the engineer and designer is the proportioning of the absorbing surface," etc. But, instead of giving rules, formulæ or data, which the practical engineer might use in designing or in deciding upon the amount of heating surface which should he used in a given case, he proceeds to give several pages of theoretical treatment, which not only is of no service to the engineer, but is partly in error. Thus:

> The amount of heating surface for a given evaporation of water or ahsorption of heat will he fixed—1st, with relation to the rate of combustion to he employed, since the faster this rate the higher the temperature of the fire and the gasea.

The fact is that heating surface required for a given evaporation is not in practice fixed with any reference to rate of comhustion or to temperature of fire, hut entirely hy an empirical law, such as that 3, 4 or 5 lbs. of water may be evaporated per square foot of heating surface per hour.

A curious error in computing the velocity of gas in a chimney appears on p. 107, where the velocity in a chimney 64 ft. high is given as 64 ft. per second, being calculated from the formula $V = \sqrt{2 g H}$, without any recognition of the fact that the velocity of gas in a chimney is reduced hy varioua resistances, which the author himself mentions, in his treatment of Peclet's formula, a few pages hack.

Concerning the relative effectiveness of radiation and contact of hot gases in steam hoilers, the author says, p. 146:

> The transfer for 800° (whether Fahr. or Cent. is not stated) is over 70 times as great by radiation as by contact. This is one of the reasons for the superiority of flaming coals over short-flame fuels. Anthracite, as a short-flame fuel, requires a large furnace area, as its heat is mainly radiated from the solid carbon and not from the flame.

This statement would appear to be a copy of a statement made hy some ancient writer, and not a conclusion drawn from modern experiment. Tha fact is, tha shorter the flame arising from a bed of coal on the grate of a steam boiler, the higher, usually, is tha efficiency; and when long flaming coals, so-called, are burned so as to make the flame short, as they may be with proper appliances, the efficiency of the boiler is increased.

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