ENGINEERING NEWS AND AMERICAN RAILWAY JOURNAL.

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THE REPORT ON THE CHICAGO DRAINAGE CANAL made by the Special Canal Commission appointed by Governor Tanner, is generally regarded as being favorable to the opening of the canal. The population of the Sanitary District is estimated at 1,800,000, which will, under the law, require a flow of 360,000 cu. ft. of water per minute, and the commission concludes that the channel will have the necessary capacity when the obstructions now existing are removed from the channel and the Chicago River. The question as to whether the restriction to a current velocity of 1¼ miles per hour should be considered, has been abandoned, the commission having found that it had no legal right to consider it, since the law specifically allows a current not exceeding three miles per hour. The report, however, states that so far the Drainage Board has failed to meet the requirements of the law in providing means for excluding solid matter (garbage, dead animals, etc.), from the canal. The report is a preliminary one, but states that the commission will make its final report to the governor, recommending that water be turned into the canal, as soon as the Drainage Board is ready to turn over the channel unobstructed for the full and free flow of the requisite amount of water. Mr. Isham Randolph, Chief Engineer of the canal, has submitted a statement of dates for the completion of unfinished work, ranging from Dec. 1 to Dec. 25, with the exception of March 1 for the Chicago Terminal Transfer R. R. bridge, and "a few months" for widening the river at the 18th St. bridge by the U. S. Government. The bridge superstructures and much of the other work can be done after water has been let into the canal, and will not affect the capacity of flow.

THE CAPACITY OF THE CHICAGO RIVER has been reported on by Mr. Thos. T. Johnston, Consulting Engineer to the Drainage Board, in connection with the dispute referred to editorially in our issue of Nov. 9. He refers to the thorough examination and tests of flow made by him in 1892, when Assistant Chief Engineer. At that time the river channel was in much worse condition than it is at present, but carried from 300,000 to 520,000 cu. ft. per minute. He finds that under the improved conditions the river will have a capacity for the flow of 300,000 cu. ft. with less velocity than then existed, which was from ¾ mile per hour in open channel to 1¼ to 2 miles at the bridges. He believes a velocity of more than 1¼ miles per hour could be allowed with safety, and points out that the Illinois & Michigan Canal, 90 ft. wide and 9 ft. deep, has a velocity of 1 mile per hour, which does not impede navigation. A properly managed boat could be handled safely at the bridges with such a current.

THE CHICAGO RIVER BY-PASS described in our issue of Feb. 16, has been partly completed, and the short independent section, under the shore arm of the Adams St. drawbridge, has been opened. This section is 300 ft. long and 50 ft. wide. The longer section, 800 ft. in length, including new cylinder piers for the west abutment of the Van Buren St. bascule bridge, is still unfinished.

STEEP GRADES FOR CABLE RAILWAYS will be required when the Chicago River tunnels are lowered in order to allow of deepening the river, and the railway companies are said to claim that the grades will be dangerous. The approaches will not be lengthened, but the grades will be changed as follows: Van Buren St., from 5.40% at present to 6.32% on the west side, and 10 to 11% on the east side; Washington St., 6.33 to 7.87% on the west side, and 7.58 to 9.33% on the east side; La Salle St., 6.44% on the north side instead of 4.83 to 5.09%, 5.89% on the south side instead of 4.32 to 4.95%, as at present. The Van Buren St. tunnel has racks for ratchet brakes on the approach grades. The city authorities deny that there will be any danger, as the 16% grade at the Van Buren St. tunnel has been in operation for some years, while steeper grades are operated by cable railways in other cities, as follows: Cincinnati, 16% on the Sycamore St. line beyond Liberty St.; Kansas City, 18½% from the Union Station; San Francisco, 18 to 21½ and 25½% on the Sacramento St. line. At Seattle, Wash., also, the grades are very heavy.

THE ROCK RIVER CANAL project is being promoted by the Rock River Improvement Association, the intent being to canalize the river between Rockford and Sterling, and thus make it an extension of the Hennepin Canal. The cost of the work is estimated at $1,000,000. Mr. W. L. Eaton, of Rockford, Ill., is President, and Mr. Harry Washburn, of Sterling, Ill., is Secretary of the Association.

THE SLACK-WATER IMPROVEMENT of the Allegheny River, as reported upon by Major Charles F. Powell to the War Department, contemplates, for the whole project, 54 dams and locks with an estimated total cost of $13,704,391. There are now three dams and locks on the lower part of the river, affording slack-water navigation to Natrona, 24.2 miles from the mouth of the river. The surveys extend to Oil City, 134.7 miles from the mouth. It is roughly estimated that an annual tonnage of 924,000 tons could be accommodated by a slack-water navigation.

THE CALIFORNIA WATER AND FOREST ASSOciation is the name adopted at San Francisco on Nov. 15, by a number of men who met to discuss the water and allied interests of the State. This meeting had been preceded by one or two others, devoted chiefly to a consideration of the storage of flood waters, as a measure designed to prevent damages and to conserve the water for use in irrigation and otherwise. The convention adopted a number of resolutions, which with a detailed account of the proceedings were given in San Francisco "Chronicle" of Nov. 16. The resolutions included a declaration for Federal construction of storage reservoirs to prevent floods, and aid both navigation and irrigation; for other reservoirs to aid irrigation enterprises; and for the preservation and reforestation of the forest lands of the country; for a national commission to settle interstate water questions. These resolutions applied to the whole country, or at least the States immediately concerned. Other resolutions, limited to California, demand a State Engineer, a revision of irrigation laws, better protection to capital invested in irrigation and other water supply enterprises; and legislation to provide works for controlling the flood waters of the Sacramento, San Joaquin rivers, and, later, their tributaries.

FURTHER ACTION ON THE RAMAPO WATER CONtract has been postponed for 90 days from Nov. 22 by the Board of Public Improvements of New York city. This action was taken at the request of the Merchants' Association, in order that it might make a careful investigation of the whole water supply situation, including the contract in question. Mr. Wm. F. King is president of the Merchants' Association, which has its offices in the New York Life Building.

A 9,000,000,000-GALLON STORAGE RESERVOIR on the Cross river branch of the Croton River has been recommended to the Board of Public Improvements of New York city, by Mr. William Dalton, Water Commissioner. This action is only one of a number of steps necessary before construction can be started.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred on the Chicago, St. Paul, Minneapolis & Omaha R. R., at Humboldt, S. Dak., Nov. 19. A construction train backed into a hand-car bearing 35 laborers, wrecking the caboose of the construction train and the flat car next to it, which was also loaded with laborers. Six men were killed and four seriously injured.

TO ABOLISH THE 133 GRADE CROSSINGS in Cleveland, O., will cost about $10,000,000, according to the estimates of City Engineer Ritchie, says the Cleveland "Leader." Of this amount the railway companies would be expected to pay $6,500,000, and Mr. Ritchie figures that the actual annual cost to the railways of operating the 133 crossing is $145,635; to this he adds an average of one accident to each crossing per year, costing the railway $5,000; and thus makes a total of $810,635 per year. As 5% on $6,500,000 is only $325,000, he figures a saving of about $500,000 annually by doing away with the crossings.

FURTHER TIME TO EQUIP THEIR CARS with automatic couplers and power brakes has been asked by a large number of railways and the Interstate Commerce Commission has set the public hearing of these applicants for Dec. 6. The extension of time requested is one year or until Jan. 1, 1901.

A LONG AND HIGH STEEL VIADUCT will be the principal feature of the cut-off between Boone and Ogden, Ia., which is now being built by the Chicago & Northwestern Ry., under the name of the Boone County Ry. This cut-off is a double-track line, 7¼ miles long, and three miles shorter than the present line. The earthwork, which is now about completed, was very heavy, and required the handling of 575,000 cu. yds. of material, 90% of this amount being concentrated within four miles. The double track steel viaduct across the Des Moines River will be 2,685 ft. long, and 185 ft. high above low water. It will consist of 45-ft. and 75-ft. plate-girder deck spans, and a 300-ft. truss span across the channel. The foundation work is now in progress, but the contract for the steel work has not yet been let. Winston Bros., of Minneapolis, Minn., had the contract for the grading; and Widell & Co., of Mankato, Minn., had the contract for masonry. For the above particulars we are indebted to Mr W. C. Armstrong, Resident Engineer.

AN ENGINE-RUN OF 5 MILES IN 3 MINUTES, or at the rate of 100 miles per hour, was made on Nov. 23, by a new engine, No. 601, on the Lake Shore & Michigan Southern R. R. This engine hauled 8 passenger and baggage cars; the train left Buffalo 59 m. late and ran into Cleveland 2 m. ahead of time; thus making up 61 m. lost time in 185 miles. Only three station stops were made, and the engine slowed down seven times for crossings. The run of 5 miles, between Perry and Painesville, was made in 3 m.

THE ENGLISH DESTROYER "VIPER," built by the Parsons Steam Turbine Co., made 32 knots on her trial trip, with "three-quarter power," the contract called for 30 knots, but 35 knots was expected. The "Viper" is 215 ft. long, 21 ft. beam, 12 ft. deep, 320 tons displacement, 10,000 HP., guaranteed screw revolution about 1,000 per minute. She has four screw-shafts, operated by two engines, and on each shaft are two propellers. The engines are high and low pressure; and to each low-pressure shaft is coupled a small reversing turbine, expected to give a backward speed of 15½ knots. Mr. Parsons, according to report, believes that he can increase the speed by reducing the diameter of the screws and changing the pitch.

THE BATTLESHIP "KENTUCKY" made her official trial trip on Nov. 24, from Cape Ann to Boone island, off Boston. Her contract speed is 16 knots and she made 16,877 knots against a heavy sea, according to unofficial reports. The course was 66 miles long, divided into five sections. Her fastest speed on any section was 17.254 knots.

THE NAVAL PROGRAM proposed by the Board of Rear Admirals, is now approved by Secretary Long, and is recommended to Congress. It includes 18 new warships estimated to cost about $26,000,000, exclusive of guns and armor. With minor changes the proposed naval increase is the same as already published, but is summarized as follows: Three sheathed and coppered armored cruisers of 13,000 tons displacement, carrying the heaviest armor and most powerful guns of their class; highest possible speed, and to cost $4,500,000 each, exclusive of armor and guns. Three sheated and coppered protected cruisers of about 8,000 tons displacement each; with the highest possible speed and great radius of action; to carry the most powerful ordnance of their class and to cost $3,000,000 each, without armor or guns. Twelve sheathed and coppered sea-going light draft gunboats of about 900 tons displacement each; to have highest speed compatible with good cruising qualities and great radius of action and most powerful guns of their class; to cost $275,000 each, exclusive of armament.

THE CONTRACT FOR THE WOODEN DRY-DOCK at League Island, Philadelphia, was awarded, on Nov. 23, to the Atlantic, Pacific & Gulf Co., of New York city. The contract provides, however, that if Congress so orders, stone and concrete can be substituted for the wooden construction now properly out of favor for such government purposes. The work on the Portsmouth, N. H., stone and concrete dry-dock has been started.

TWO NEW ANTWERP DOCKS, each covering an area of 62 acres, are to be built by the joint action of the Belgian government and the city of Antwerp. These will increase the water area of the harbor 25%, and the dockage space 27%. The improvement is badly needed, as the limited facilities in the present harbor have caused much of the commerce to desert Antwerp for Rotterdam.

A NEW CANADIAN STEAMSHIP LINE has been established between Montreal and Liverpool. The contract is between the Canadian and British governments and Elder, Dempster & Co., of Liverpool, for a weekly mail service for two years from Nov. 11, 1899.

EXPERIMENTAL DETERMINATION OF DRAW-BRIDGE REACTIONS.

By Malverd A. Howe,* M. Am. Soc. C. E.

Given the loading and the corresponding reactions, it is a very simple matter to determine the true stresses in the members of any framed structure, either by algebraic methods or by graphics. The dead load is easily determined with sufficient accuracy from structures previously built, and the live load is usually specified, but the corresponding reactions must be determined by the computer in some manner which leads to approximately correct results.

The proper process to follow in computing the reactions for draw-bridges of the type shown in the accompanying illustration has not been definitely decided upon by bridge engineers, and at the present time two or three methods are in common use. The final stresses do not differ seriously when found by these different methods, but it is quite unsatisfactory not to know which method leads to results most nearly correct. The well-known bridge engineer, Mr. J. A. L. Waddell says in "De Pontibus:"

> Candidly, the author has very little faith in even the approximate correctness of the ordinary methods of computing live-load stresses in draw-spans; nor has be much more in the super-refined methods involving the principles of least work or stretching of the different truss members, or the principle of the Three Moments with varying moments of inertia.

In order to shed a little light upon this important question and to determine, if possible, a reliable method for computing draw-bridge reactions, a steel model constructed upon a scale of 1 in. to the foot was built in the Rose Polytechnic Institute shops for experimentally determining the reactions of different loads by weighing them. The bridge selected as a copy was erected in 1898 by one of the best bridge companies in the country, and, as stated above, the linear dimensions of the model are nearly one-twelfth those of the large bridge. The sectional areas of the members are approximately one-fifty-third those of the bridge used as a copy. The dimensions, areas, etc., for each member of the model are given in Table I., which also contains the general dimensions of the large bridge.

As the object of the investigation was to obtain results which could be applied to structures as actually built, the model was not made an "ideal structure," but follows very closely in detail the large bridge. The top chord is continuous from hip to hip, and the bottom chord is broken at the center support only. Where eye-bars are found in the large bridge, similar construction is found in the model, the heads of the eye-bars being forged from the bar and not welded on. The floor and lateral diagonals are omitted in the model.

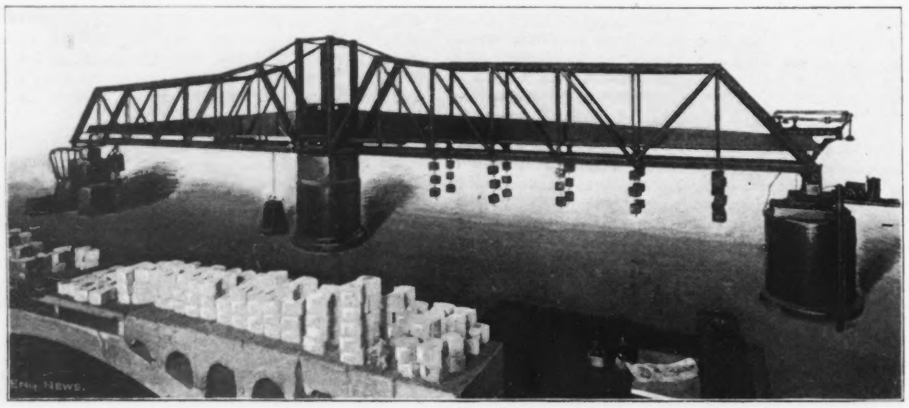

FIG. 1.—VIEW OF MODEL DRAWBRIDGE TESTED AT THE ROSE POLYTECHNIC INSTITUTE, TO DETERMINE END REACTIONS FOR DIFFERENT CONDITIONS OF LOADING.

The supports of the model are clearly shown in Fig. 1. The reactions were weighed upon specially constructed scales with agate bearings reading to 1-100th of a pound. The loading was applied at the bottom chord pins by means of individual five-pound weights (Fig. 1). The center pins rest in semicircular holes in cast-iron uprights, which are a part of a cast-iron bed-plate anchored to the center pier. These supports are in the longitudinal axes of the trusses. The ends of the model were supported by means of adjusting screws placed in the longitudinal axis of the structure, which were directly supported by the scales or the masonry piers.

The methods employed in weighing the reactions are best described by dividing them into series in the order in which they were tried. The method of procedure was essentially the same throughout in the following respects: The scales were balanced under a load of about 50 lbs., induced by raising the ends of the model with the adjusting screws. Then a load of 50 lbs. was placed upon the panel-point considered in one arm of the model and the scales balanced. The difference between the readings before and after the application of the load was taken to be the actual reaction for 50 lbs. An additional 50 lbs. was then added, and the scales balanced, and so on until a load of 200 lbs. had been applied, when the loading was removed by 50-lb. increments. This gave seven determinations of the reactions for a load of 50 lbs.

Series No. 1.—The center pins of the model merely rested in the semicircular holes mentioned above, being kept in place by the weight of the model, which is approximately 500 lbs., and the ends were supported by the adjusting screws upon the platforms of the scales. It was assumed that, if the scales were at all times balanced, or the pointer on the weighing beam was kept at the same point, the end pins and the center pins would remain in the same relative positions to each other and the model would fulfil the condition of rest-

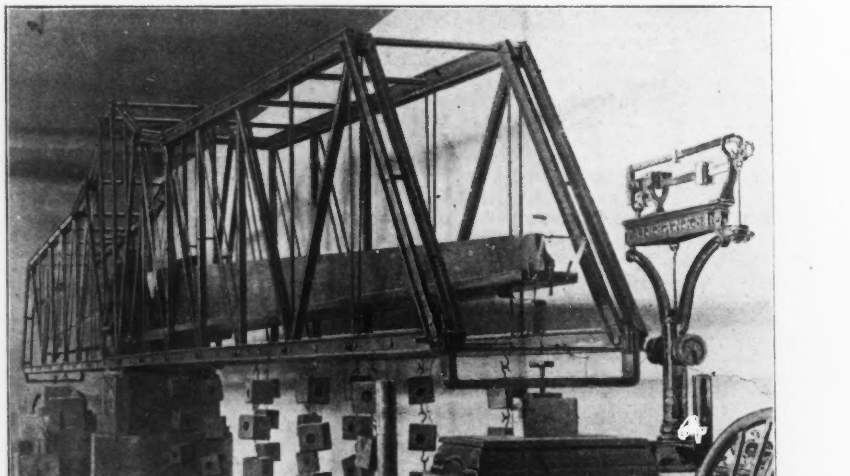

FIG. 2.—VIEW SHOWING ARRANGEMENT OF SCALES, ELECTRIC CONTACTS, ETC., OF MODEL DRAWBRIDGE.

TABLE I.—Showing Comparative Dimensions of Actual Structure and Its Model Tested at the Rose Polytechnic Institute. (Fig. 3.)

Piece.	Make-up.	Model: Area, sq.in.	Model: Length in ins.	Bridge: Area, sq.ins.	Bridge: Approx. length, in ft.
A a	Two 1½-in. channels..	0.702	36.234	40.0	36.3
b c	" 1-in. " ..	0.432	36.234	23.5	36.3
d e	" 1-in. " ..	0.432	37.802	26.5	36.3
f g	" ¾-in. eye bars...	0.203	38.600	19.8	38.8
h i	" ¾-in. " ...	0.204	39.408	18.0	39.6
j k	" ½-in. - " ...	0.194	42.720	24.0	42.8
l m	" 1½-in. channels..	0.702	42.720	43.8	42.8
e f	" 1-in. " ..	0.432	30.000	19.8	30.1
g b	" 1-in. " ..	0.432	31.000	23.5	31.1
i j	" 1-in. " ..	0.432	32.000	29.0	32.1
m T	" 1½-in. " ..	0.702	45.000	39.2	45.0
K a L b	" 1½-in. " ..	0.702	46.000	20.6	46.1
M e	" 1½-in. " ..	0.702	23.000	38.2	23.1
N g	" 1½-in. " ..	0.702	23.000	38.2	23.1
O l	" 1½-in. " ..	0.702	23.000	23.2	23.1
P k Q l	" 1½-in. " ..	0.702	46.000	29.0	46.3
B c C d	" 1½-in. " ..	0.702	46.040	34.3	46.2
D f	" 1½-in. " ..	0.702	23.020	37.9	23.1
E h	" 1½-in. " ..	0.702	23.020	37.9	23.1
F l	" 1½-in. " ..	0.702	23.344	29.3	23.4
g m	" ½-in. eye bars...	0.191	24.798	31.5	24.8
H T	" ½-in. " ...	0.191	16.000	30.0	16.0

Remarks: Span of model, 161 + 16 + 161 ins.; span of large bridge, 162 + 16 + 162 ft. Trusses of model 16 ins. center to center; trusses of large bridge, 16 ft. center to center.

†Professor of Civil Engineering, Rose Polytechnic Institute, 2008 North 10th St., Terre Haute, Ind.

TABLES II. to VIII.—Showing Results of Experiments Made to Determine Drawbridge Reactions Under Different Conditions of Loading.

Table II.

Load of 100 lbs. on panel, No.	No. of experiments combined.	Reaction: Loaded arm.	Reaction: Unl'ded arm.
1	7	+ 66.3	— 19.64
2	7	+ 53.1	— 18.42
3	7	+ 41.2	— 16.08
4	7	+ 29.1	— 13.80
5	7	+ 18.8	— 9.85
6	7	+ 9.0	— 5.48

Table III.

Load of 100 lbs. on panel, No.	Reaction: Loaded arm.	Reaction: Unl'd'd arm.
1	+ 66.3	— 23.0
1—2, inclu.	+ 54.0	— 17.7
1—3, "	+ 43.2	— 14.2
1—4, "	+ 30.5	— 12.6
1—5, "	+ 19.6	— 8.9

Table IV.

Load of 100 lbs. each panel.	Reaction: Loaded arm.	Reaction: Unloaded arm.
1	+ 66.9	— 19.7
1—2, inc.	+ 55.4	— 16.2
1—3, "	+ 43.2	— 14.0
1—4, "	+ 30.4	— 12.9
1—5, "	+ 21.9	— 6.8

Table V.

Load, 100 lbs. on panel.	No. of experiments cmbnd.	Reaction: North arm.	Reaction: South arm.
1	4	+ 70.91	+ 70.61
2	5	+ 59.17	+ 58.97

Table VI.

Load, 100 lbs. on panel.	No. of experiments combined.	Reaction for load'd arm.	Load, 100 lbs. on panel.	No. of experiments combined.	Reaction for load'd arm.
1	6	+ 85.2	4	5	+ 39.3
2	6	+ 72.1	5	5	+ 24.8
3	5	+ 55.8	6	5	+ 12.5

Table VII.

Load, 100 lbs. on panel.	North arm: No. of results combined.	North arm: React'n for loaded arm.*	North arm: No. of results combined.	North arm: React'n for loaded arm.†	South arm: No. of results combined.	South arm: React'n for loaded arm.†
1	39	+ 83.8	4	+ 84.0	10	+ 85.9
2	10	+ 69.8	13	+ 67.8	16	+ 71.6
3	10	+ 51.8	4	+ 50 2	10	+ 52.4
4	10	+ 36.5	4	+ 35.5	10	+ 35.9
5	10	+ 22.4	6	+ 22.6	10	+ 23.6
6	35	+ 10.0	8	+ 10.4	10	+ 9.9

*Howe. †Kidder.

Table VIII.

Load, 100 lbs. on panel.	No. of results combnd.	React'n for loaded arm.	Reactions as found by computation: Continuous girder method.	Partially continuous method.	Pul method.
1	53	+ 84.3	+ 82.2	+ 82.7	+ 83.6
2	39	+ 69.8	+ 64.9	+ 65.7	+ 67.9
3	24	+ 51.8	+ 48.4	+ 49.6	+ 52.4
4	24	+ 36.1	+ 33.2	+ 34.5	+ 36.4
5	26	+ 22.9	+ 19.8	+ 21.0	+ 21.9
6	53	+ 10.0	+ 8.6	+ 9.3	+ 9.7

ing upon "level supports." Each panel in turn in the first arm was loaded in the manner outlined above and the reactions weighed, and results obtained as tabulated in Table II. The results being reduced to loading of 100 lbs.

Series No. 2.—Following the above experiments 50 lbs. were placed upon panel No. 1, then upon panels Nos. 1 and 2, etc., until one arm was loaded for five panels. The results obtained are given in Table III. This loading was now removed in the inverse order in which it was applied. Table IV. contains the results obtained.

Series No. 3.—Balanced loading on panels No. 1 and 2 respectively were next tried, with the results given in Table V. Checking the reactions, as weighed, under the assumption of equal moments over the center supports they were found to be very consistent, indicating that the two arms of the model behaved in practically the same manner. Nevertheless the results differed so radically from those by computation that their accuracy was questioned, and it was decided to determine if the model fulfilled the condition of "level supports."

Series No. 4.—The scales were removed from the south arm of the model and the end anchored down to the masonry. At the north end two metal rods were driven into the ground and their tops connected by a piece of wood, tightly clamped to each. Upon this was placed a machinist's surface gage, with the pointer touching the U-piece containing the adjusting screw. The breaking of this contact was indicated by an electric bell.

The first rough trial of this arrangement at once indicated that the end pins did not retain their original positions in the previous experiments, but that they were lower after the loading had been applied.

Carefully conducted experiments under the above conditions gave the results shown in Table VI. These are seen to be considerably larger than

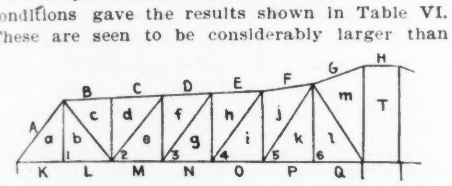

Fig. 3.—Diagram of Half-Span of Model Drawbridge.

those found in previous experiments. This difference was so marked that the possibility presented itself that with unbalanced loads the center pier might tip slightly and thereby increase the reactions for the loaded arm.

Series No. 5.—To eliminate the effect of any tipping, a wooden beam was placed in the longitudinal axis of the model, and supported upon the center pins in the axes of the trusses (see Fig. 1), and securely clamped down to the cast-iron bedplate. This practically fastened the center pins in place.

Electric contacts were provided at each end of the beam and the model, at the intersection of the longitudinal axis and the center lines of the end pins of the model. An ordinary telegrapher's relay was employed to determine contact. One end of the model was anchored down to the masonry and the other supported upon the platform of the scales. The scales were balanced as in previous experiments and the end pins kept in their original positions relative to the wooden beam by the adjusting screws and the electric contacts. By this method it was possible to be reasonably certain that the model behaved as if upon "level supports." Great care had to be exercised in making the experiments, as very slight disturbances would open and close the electric contacts. (Fig. 2.)

The passage of an electric car, some two hundred feet away, was sufficient to rapidly open and close the contacts, and it was possible even to tell in which direction the car was going by noticing which relay "talked" first. A few hundred pounds placed upon the pavement near the center pier was noted by the relays.

In order to see if the beam might be tipped from some movement of the center pins (since the pins were clamped the possibility of their movement seemed very slight), the mirror, scale and telescope method was resorted to, and it was found that the pressure of the finger upon the metal bar clamping the pins was sufficient to tip the wooden beam—so, finally, the wooden beam was supported upon the cast-iron bed-plate quite independent of the model, and the center pins clamped in place. With this arrangement the final experiments were made, the number being sufficient to make the final means reliable.

In order to eliminate any personal equation, a number of experiments were made by Mr. Kidder, a member of the senior class. The writer's experiments were confined to loads upon the north arm of the model, but Mr. Kidder's included both arms. Table VII. shows these results for each arm, while Table VIII. gives the general means of all of the results, as well as the reactions, computed by the three different methods in common use.

The computed reactions were obtained by means of the following formulas.

Model considered as a continuous girder of two equal spans—(moment of inertia constant):

$$\text{Reaction for loaded arm} = \frac{4 - 5\,k + k^3}{4}\,P.$$

Model considered as a partially continuous girder of two equal arms—(moment of inertia constant):

$$\text{Reaction for loaded arm} = \frac{1}{4 + 6\,n}\,[4 - 5\,k + k^3 + 6\,n\,(1 - k)]\,P.$$

Model considered as an elastic framed structure (pul method):

$$\text{Reaction for loaded arm} = \frac{\Sigma\,\text{pul} + P\,(1 - k)\,\Sigma\,\dfrac{u^2\,l}{a}}{\Sigma\,\dfrac{u^2}{a}}$$

From Table VIII. it is quite evident that the pul method gives results in closer agreement with those obtained by experiment than either of the others, although the model is but partially articulated, which condition is assumed for framed structures when the members are not assumed to be rigid. In bridges as now designed it is quite probable that the lack of articulation in the joints for some pieces and the continuous stringers carried by floor beams rivetted to the verticals, affect the magnitudes of the stresses in the members to an amount which cannot be readily determined by any known method. Now since the effects of these two conditions cannot be determined, and since their effect is probably to decrease rather than increase the direct stresses in the members, they can be neglected in computing stresses in framed structures and the pul method used for the determination of reactions, since this method leads to correct results when the structure is articulated and elastic.

For large draw-spans any of the three formulas given above will lead to final results not seriously different, so that the pul method need only be used in the final design. For framed structures of widely different sections and depths the pul method is probably the only correct method which is now known for determining the proper reactions.

TECHNICAL EDUCATION IN GERMANY.*

In 25 years Germany has increased her manufacturing capacity ten-fold, so that it equals that of England; her shipping has increased twenty-fold, so that as regards steamships at least, Germany is now the second in the world. German sugar rules the world's markets; German chemists have revolutionized the dyeing industries; Germany supplies most of the electrical plants in Europe, in Central America, and in the East; in iron and steel industries she is pressing close upon the heels of England. Germany, in fine, has attained the position of a first-class commercial and industrial power, and aspires to universal supremacy. Side by side with this marvellous progress has gone on the development of her system of technical education, in the wider as well as the narrower sense.

The lowest grade of school which gives technical training is the so-called Fortbildungsschule, i. e., a school for supplementing the work of the elementary schools. This school is the point at which the general and technical systems overlap. These schools vary according to locality and prevailing industries. A boy leaves the elementary school (what we should call the public school), and becomes an apprentice. While an apprentice, he must attend the Fortbildungsschule at least up to his eighteenth year. But he does not attend to learn a trade. These schools do not teach trades either wholly or in part. Their object is (1) to supplement and continue the general instruction of the elementary school, and (2) to give elementary technical instruction, such as drawing or the like, bearing on the various trades represented by the pupils in attendance. A typical curriculum is that of the school at Nurnberg, the technical division of which includes in its lower course: German language, composition, elementary economics, physics and chemistry (technical), elementary physiology and hygiene, arithmetic and mensuration, together with drawing (freehand and linear), to which special importance is attached. In its more advanced course, book-keeping, commercial correspondence, higher commercial and technical arithmetic and technical drawing, are prominent subjects. The school has also a more elementary course of general learning with the merest beginnings of technical instruction in business correspondence, etc. To illustrate the variation in the technical part of the course, it may be noted that in this school, wood-workers, metal-workers, lithographers and painters, have special and extensive courses of drawing; waiters and barbers take French instead of drawing; bakers and butchers are very properly relieved of drawing. The general subjects are the same for all. Instruction is given evenings, mornings and Sundays, to suit the hours of the apprentices and laborers, for whom the Fortbildungsschule practically exists. In Hamburg, for example, last year, out of 3,042 pupils, 2,424 were apprentices or helpers; 486 were schoolboys taking special subjects such as drawing. No less than 40 trades are represented in the Hamburg schools, and the technical part of the curriculum is correspondingly elastic. I have described this part of the system somewhat fully because it seems to have most bearing on the movement here.

Next above the Fortbildungsschule, we come to a numerous class of schools. The whole class is denoted by the terms Höhere Industrieschulen, and Technische Fachschulen, i. e., technical schools of a grade higher than the elementary. I might explain parenthetically that, though these are called "higher" schools, curiously enough the next grade above them is known as the "technical high school." Coming back now to these so-called "higher" schools, we note as the divisions of them, first, the Baugewerkschulen and Technica. As an example of the former may be cited the Baugewerkschule, or school for the building trades, at Hamburg, attended by bricklayers, stone masons and carpenters only—the total number last year being 45 in summer and 256 in winter. This school is under the direction of an architect, and the curriculum forms part of the course for architects. As an example of a Technicum, may be mentioned that at Mittweida (in Saxony) for the training of men as mechanical and electrical engineers, and also as foremen in electrical workshops, etc.

Secondly, we have in this class Gewerbeschulen (schools for artisans). As an example of them may be mentioned the Kunstgewerbeschule (a school for the more artistic trades), at Hamburg, attended by carvers, sculptors, engravers, painters, cabinetmakers and decorators.

Third, we have technical schools for single trades, e. g., the school for tanners at Freiberg, schools for watchmakers, gardeners, etc.

Fourth, there are still in this class of "higher" schools, the commercial schools. It is worth noting that French and English form part of the curriculum in these schools, and that the pupils consist almost altogether of those actually engaged in business. Thus, at Hamburg, of the 174 pupils in attendance last year only four were not engaged in business.

We come now to the schools of highest grade, among which are the Technische Hochschulen (or technical high schools), known also as Polytechnica, which take rank with the universities, and train men as engineers, architects, chemists, physicists, etc. Of these academies, which correspond in general to the School of Practical Science with us, Germany possesses nine. In this highest grade we have also such institutions as the famous Berg-Academie, or mining academy, in Freiberg, and the Forst-Academien, or schools of forestry, at Neustadt-Eherswald, Aschaffenberg, etc. The latter are mentioned on account of the interest which the subject of forestry should have for us. In addition to all these, there are the universities, 21 in number, which are intimately connected through their scientific departments with the highest interests of trade.

An idea of the general diffusion of technical education may be gained from the statistics regarding Saxony, with its 4,000,000 inhabitants. It possesses:

112	Fortbildungsschulen with	10,000 pupils
39	Höhere Industrieschulen with	10,000 "
44	Commercial " "	4,800 "
11	Agricultural " "	700 "
25	Technical Schools for women and girls with	4,000 "

The city of Hamburg alone, with a population of about 700,000, has 17 technical schools with almost 5,000 pupils.

Having thus outlined the technical educational system of Germany, let us now inquire as to its special features. The system covers the whole field of industry and commerce. It distinguishes clearly between the general and the technical. No attempt is made to put a veneer of

*Extract from the Convocation Address of President Jas. Loudon, at the University of Toronto, Oct. 2, 1899.

technical training on a defective general training. It distinguishes between the training of the director, the foreman and the operative. In all grades it concentrates effort on the underlying principles of art and science and their application. The general result is a thoroughly trained body of workmen under scientific leadership.

We have seen that Germany is rapidly overtaking Great Britain in the industrial race. What is the secret of this remarkable achievement? It does not seem to be due wholly to the training of the rank and file of the workmen, for it is well known that, notwithstanding educational disadvantages, the British workman has, in many respects, no superior in the workshop. We must seek the cause primarily in the extent to which the highest teachings of science have been turned to account. Here, as elsewhere, success has depended upon leadership combined, of course, with effective practical training all along the line. As an illustration of German methods, take the fact that German chemical experts, trained in the universities and polytechnica, have revolutionized the sugar industry, the dyeing industry, and the manufacture of chemicals. In one factory alone, the Badische Anilin u.-Soda Fabrik at Ludwigshafen, over 100 chemical experts are engaged in special researches with a view to discovering new processes or new products. So also in electrical works we find that experts in physics are employed in research work. Of chemical experts the number just mentioned is greater than that of those employed in the same line of work in the whole of England, a fact which goes to show that it is evidently the British manufacturer who above all needs enlightenment. The British manufacturer, though a very estimable citizen, reminds one, in his attitude towards scientific knowledge, of the Parisians of a hundred years ago, who beheaded Lavoisier amid cries of "nous n'avons plus besoin de savants." It is impossible to insist too strongly on this feature of the German industrial system. I fear that the belief in this country is too common that the short road to industrial prosperity lies through the adoption of an extensive system of elementary technical training. I should like to state emphatically here my conviction that no diffusion of technical training will in itself be effective if we do not take care to maintain the higher and the highest kind of scientific instruction, and if our manufacturers do not utilize this expert knowledge.

THE SEAGOING STEAM AND SAIL TONNAGE of the world is given in the annual report of Mr. Chamberlain, Commissioner of Navigation. The summary is as follows, as taken from the Bureau Veritas:

Seagoing Steam Tonnage.

Country.	1873-74. Tonnage.	1898-99 Tonnage.	Increase 1873-74 to 1898-99. Per C't.
Great Britain	2,624,431	10,993,111	311
United States	483,040	810,800	68
France	316,765	952,682	200
Germany	204,894	1,625,521	693
Spain	138,675	520,847	275
Italy	85,045	420,880	395
Holland	72,753	363,200	399
Russia	67,522	358,415	430
Norway	41,602	628,493	1,410
Japan	......	439,509	...
All others	293,466	1,773,674	504
Total	4,328,193	18,887,132	336
Atlantic coast	165,280	227,731	38
Pacific coast	20,451	131,953	545

Seagoing Sail Tonuage.

Country.	1873-74.	1898-99.	Ratio of Decrease from 1874. to 1899.
Great Britain	5,320,089	2,910,555	0.45
United States	2,132,838	1,285,859	.40
Germany	893,952	535,937	.40
France	768,059	279,412	.64
Norway	1,137,777	1,144,482	...
Italy	1,126,032	463,767	.59
All others	2,807,689	2,073,757	.26
Total	14,185,836	8,693,769	.40

The interesting points in this statement are—that natural causes have reduced the sail tonnage 40% since 1873; and while tho steam tonnage has increased in this period 336%, the steam tonnage of the United States has only increased 68%. In the above list only seagoing steam vessels over 100 gross tons are taken into account. The figures following the words Atlantic and Pacific coast refer to ships bearing the American flag only. The progress of Japan is a lesson to ourselves; as it began with six steamers of 3,459 gross tons aggregate in 1873, and it now holds the seventh place; while the United States holds fourth place; where we had the second place in 1873. In steamers of "100 tons net and upward," we have 551, against 5,453 for England; 900 for Germany and 526 for France. England still has 7,706 sailing vessels over 50 tons net, against 3,497 for the United States and 2,306 for Norway. In 1899 15,324 steam vessels of the merchant marine of the world had an aggregate tonnage of 12,935,904 net tons, against 12,856 sailing vessels of 6,795,782 net tons.

NOTES BY RAIL.

Chicago & Northwestern Ry.

This system now comprises 5,077 miles, an increase of only 6 miles for the year ending with June, 1899, but several extensions are now in progress. While the extensions have been small, a considerable amount of work has been done in double tracking, about 176 miles of second track having been laid, bringing the total length of double track up to 625 miles, which includes a considerable portion of its three principal main lines from Chicago to Omaha, to St. Paul and to Milwaukee. The track elevation work done during the year ending May 31 cost $990,727.

The main tracks are laid with 80-lb. and 90-lb. rails, having square joints with channeled bridge plates, but the rails are not bolted to the plates, and there is a very decided clicking of the joints under traffic. The square joints are not in universal favor on this road, the objection being that they are more noticeable and more noisy than broken joints, unless the track is kept up to a higher degree of perfection than is usual in these days. The rails also batter more quickly, and it takes more time to lay rails with square than with broken joints. In laying rails, less expansion spacing is given with heavy than with light rails, as it is found by experience that the heavy rails expand less even in hot summer weather. Slopes are being trimmed and sown to grass, in order to consolidate them and prevent washing and sliding, as well as to improve the appearance, a point to which more attention is now paid in this country than formerly. A great deal of ballasting has been done this year, clean coarse gravel being used, and dressed to a neat and even shoulder. On some parts of the Ashland Division the ballast is carried out level with the rail for 5½ ft. on each side. Sags have also been raised, in some places as much as 9 ft. Parts of this division cross swampy ground, where the track can be seen to rise and fall, and the telegraph poles to sway to and fro as the trains pass.

Near Chicago, the Hall automatic block signal is extensively used, while the Sanborn train-order signal (Eng. News, May 25, 1899), is the standard device for the entire C. & N. W. Ry. system. Bridge floors are not provided with inside guard rails, but have only outside guard timbers. The Chicago passenger terminal is to be considerably enlarged by the addition of a tract of land formerly occupied by a grain elevator which was burned some time ago. This will give a water front as well as additional yard room.

Illinois Central R. R.

This road lays its rails with square-supported joints. On the line entering Chicago it is using stone ballast, consisting of coarse broken stone to a little above the bottoms of the ties, and covered with fine crushed limestone. Hall automatic block signals are used from the Chicago terminal to Kensington, and are to be installed for a considerable distance south of that point. Ordinary semaphore signals are used at the interlocking plants at junctions and crossings. The second track has been extended 22 miles, and the work of reducing grades south of Jackson, Miss. (to a maximum of 0.38% against southbound traffic), and between Memphis and Fulton, on the Louisville Division, will probably be completed this year. The new extension from Fort Dodge to Council Bluffs, Ia., 130 miles, will also be completed about the same time. The expenditures for the year ending June 30, 1899, include $685,000 for reducing grades, $242,470 for raising the grade of the tracks in Chicago and elsewhere, $193,788 for new second main track, and $10,367 for widening roadway. The rails are of 11 different weights, ranging from 50 to 100 lbs. per yd., but 2,554 miles out of a total of 3,678 miles are laid with 60 and 75-lb. rails. Of the 763 locomotives now in service, 392 have been built since 1890, while three were built in 1854-56, and 67 between 1867 and 1880.

Erie R. R.

The track elevation at Jersey City, described in our issue of Aug. 18, 1898, is practically completed, as far as the line connecting with the old Bergen tunnel is concerned, but the new passenger line (which is to be at a higher elevation on the same right of way, so as to pass through an open cut above the old tunnel), has not yet been built. The foundations have been put in, however, ready for the erection of the superstructure whenever the open cut above the tunnel is completed. One rather striking feature of the track of this road is that all main line turnouts are fitted with derailing switches connected up to the main switches. For rail renewals, 80 and 90-lb. sections are used, 22,410 tons of such rails having been laid during the year ending June 30, 1899. The expenditures for additions and betterments amounted to $659,915, and included the track elevation at Jersey City, the renewal of grade crossings at Buffalo, the reduction of grades, new side tracks and yard extensions, and the removal of several street and county road crossings.

This road has introduced the Atlantic type of engine for its fast passenger trains, the engines being Vauclain four-cylinder compounds, built by the Baldwin Locomotive Works; driving wheels, 6 ft. 4 ins.; cylinders, 13 × 26 ins. and 22 × 26 ins.; Wootten fireboxes, 8 × 8 ft.; weight, 151,000 lbs., with 84,290 lbs. on the driving wheels, 36,545 lbs. on the truck, and 30,175 lbs. on the trailing wheels. Many of the older consolidation engines, carrying a low boiler pressure, have been converted into high-pressure engines with new cylinders, new boilers and Wootten fireboxes. This increases their capacity and enables them to burn a much cheaper grade of coal. About 2,500 coal cars have had their sides raised to increase the carrying capacity. At Jersey City a turntable operated by electricity has been put in. In passing through the iron region on this line, one cannot but be struck by the extensive use of steel cars for ore and coal traffic, though the Erie R. R. has as yet only a few of these cars.

New York, Chicago & St. Louis R. R.

This road, commonly known as the "Nickel Plate Route," has not in the past been very popular with the traveling public. Of late years, however, great improvements have been made in the equipment and the service, and the road now forms one of the most comfortable routes between Chicago and New York. The through trains are run over the Delaware, Lackawanna & Western R. R., but there are through cars also by the West Shore R. R., to New York, and the Fitchburg R. R. to Boston. New 65-lb. rails are being laid, and wooden trestles are being replaced by steel bridges and trestles and by earth embankments. A new interlocking plant has been put in at Lockwood, Ill.

Many of the engines are old-fashioned and light, but are still kept in good condition for service, rigid economy having for a long time been a necessity on this road. With the improved conditions of train service, however, and the increase of traffic, it will probably be found necessary to introduce more modern and powerful equipment, in order to obtain the economies in transportation which result from the hauling of heavy trains. The tenders have the initials on the side and the number on the back painted on boards which are bolted to the collar. This is much cheaper than lettering on the tank, and the work can be done at any time in the paint shop, instead of keeping the tender out of service while being lettered. The result is not unsightly, but it might be even better to omit lettering altogether, as is done on the tenders of the Boston & Albany R. R. A similar number board is bolted to the front of the smokebox. A peculiarity of this road is that it is all main line, 512½ miles, with no branches.

Delaware, Lackawanna & Western R. R.

This old conservative road, which has for so long been regarded as distinctly behind the times in many respects, in spite of its good financial reputation, has had a thorough shaking-up this year, by the introduction of western men and western ideas. Mr. Samuel Sloan, the President for many years past, has been succeeded by Mr. Wm. H. Truesdale, Vice-President of the Chicago, Rock Island & Pacific Ry., who has taken with him several officers from this road, including the Chief Engineer, Mr. W. K. McFarlin, M. Am. Soc. C. E., and the Superintendent of Motive Power, Mr. John W. FitzGibbon. The line is double track, and new rails are being laid, with six-bolt splice bars and 16 to 17 ties per rail. The ballast is partly of broken stone, not of the best quality, but clean as compared with ordinary gravel ballast. The line is a great coal road, passing through the heart of the Pennsylvania coal fields. The enormous extent and volume of the culm banks which disfigure the country, suggests the desirability of utilizing the material. Some of it can be utilized as fuel under proper conditions, and it is possible that it might make as good ballast as cinders, which are comparatively free from dust when once laid and wetted down. In such case, it would be preferable to gravel, and would be much cheaper for many roads, since it could be obtained for the mere cost of loading and hauling. Considerable work has been done in renewing bridges with heavier structures, in preparation for heavier rolling stock, and an interlocking plant has been put in at the crossing of the Erie Ry., at Binghamton, N. Y. The terminals at Hoboken, N. J., are to be rearranged and rebuilt.

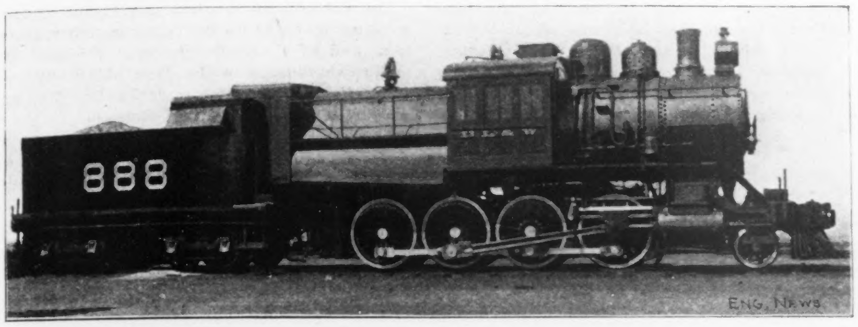

FIG. 1.—CONSOLIDATION LOCOMOTIVE; DELAWARE, LACKAWANNA & WESTERN R. R.
John W. FitzGibbons, Superintendent of Motive Power.

Some of the engines look curiously old-fashioned, having cabs of varnished wood, and having an unusual amount of brasswork and colored striping, bright brass feed pumps, etc. Some of the express engines even have filagree work around the top of the smokestack, as on the smokestacks of western river steamers. In Fig. 1, however, is shown a thoroughly modern-looking consolidation freight engine, designed for burning anthracite coal of "buckwheat" size. It was built this year at the company's shops at Scranton, Pa., under the direction of Mr. FitzGibbon. The road has also added 15 twelve-wheel engines to its freight equipment, these latter engines having been built by the Brooks Locomotive Works, of Dunkirk, N. Y. The leading dimensions of the consolidation and twelve-wheel engines are as follows:

	Consolidation.	12-wheel.
Driving wheels	4 ft. 9 ins.	4 ft. 6 ins.
Truck wheels	2 " 7 "	2 " 6 "
Wheelbase, driving..	15 " 6 "	15 " 0 "
Wheelbase, total	23 "11½"	25 " 9 "
Weight on drivers...	175,500 lbs.	166,000 lbs.
Total	197,650 "	205,000 "
Tender, loaded ..	101,000 "	106,000 "
Cylinders	22 × 30 ins.	21 × 32 ins.
Valves	Slide.	Piston.
Ports: Steam	1½ × 20 ins.	2½ × 25 ins.
Exhaust	3 × 20 "	110 sq. ins.
Boiler, diameter	6 ft. 2 ins.	6 ft. 6 ins.
Working pressure ...	200 lbs.	200 lbs.
Firebox, length	10 ft. 6 ins.	10 ft. 3 ins.
Width	9 " 0 "	8 " 1 "
Tubes, number	413	410
Diameter	2 ins.	2 ins.
Length	13 ft.	13 ft. 10¼ ins.
Heating surface, tubes	2,791 sq. ft.	2,950 sq. ft.
Firebox	211 "	218 "
Total	3,002 "	3,168 "
Grate area	95 "	82.4 "
Water on tender.....	5,000 galls.	5,000 galls.
Coal on tender......	......	10 tons.

As already noted, through trains between Chicago and New York are operated over this road and its western connection, the N. Y., C. & St. L. R. R. The service is good, and the trains keep time with rather exceptional regularity.

Michigan Central R. R.

The main line of this road passes mainly through a flat and level country, and has 233.6 miles of double track between Chicago and Suspension Bridge, 496.25 miles. The entire system aggregates 1,643.5 miles of road, with 254.5 miles of double track. There are some very long tangents; one 54 miles in length, on the St. Clair Division, and another 50 miles in length on the Canada Southern Division. On this latter division (east of the Detroit River), work is in progress for widening the roadbed for double tracking. A considerable amount of new 80-lb. rail is now being laid, partly with six-bolt, three-tie joints, and partly with a base-support joint which has been extensively introduced by Mr. A. Torrey, M. Am. Soc. C. E., Chief Engineer. This latter, shown in Fig. 2, has four-bolt angle bars, and a short piece of inverted rail under the joint. The flanges of the angle bars do not touch the ties, but are made ½-in. thick, and flat on top to receive the nuts of the U-bolts, which support the riveted rail. Some joints have three bolts and others only two, and it is not yet proved whether the middle bolt is necessary. The inverted rail, or "crop-end," is 10 or 11 ins. long, and slightly cambered, so that at its ends there is a clearance of about 1-16-in. from the base of the track rails. The Long truss joint is also in use to some extent. The ballast is mainly of gravel and is unpleasantly dusty in dry weather, but stone is used near Chicago.

Tie-plates are put on the ties before the latter are laid in the track. They are set in position by the Ware tie-plate gage and driven into the wood by wooden mauls. The new ties are piled in triangular piles of 12 ties each alongside the track, and when piled in this way theft can be at once detected. A peculiar form of spring rail frog which is used to a limited extent is the Jordan frog, in which the rails form their own springs, assisted by one spring in front of the point. One of these frogs, made with 80-lb. rails, is shown in Fig. 3. Both wing rails lie normally against the frog point and the pressure of the wheel flanges springs the rails out so as to form a flangeway. The movement of the rails is limited by guides and stops riveted to a steel base plate, to which the frog point is riveted, this plate being 4 ft. 6 ins. long, 2 ft. wide and ½-in. thick. Metal cattleguards are used, and the bridges have the Jordan guard, consisting of three lines of steel rails laid between and parallel with the track rails. The Hall automatic block signal is used on a considerable portion of the line between Chicago and Detroit. In addition to the block signals, the operator at each station displays the number of each train passing, so that an engineman can see what train is ahead of him and how long since it passed. A box, triangular in plan, projects from the side of the station, and in either side are set figures on slides showing the eastbound and westbound trains, thus: "X, 8.47" or "16, 3.20." The figures are illuminated at night by a lamp within the box.

The curves are well lined, and ride easily, owing to the use of easement curves, laid out on the method devised by Mr. A. Torrey, the Chief Engineer. Distant signals are set for the outlying switches of yards, and at many turnouts the side track has the cut-out or derail invented by Mr. A. G. Dailey, Superintendent of Tracks, which is operated automatically from the switchstand. This is one of the few roads using ¼, ½ and ¾-mile posts. The station grounds are well kept, and have lawns and flower beds, as described in our issue of Sept. 21 (p. 190). This undoubtedly adds to the favorable reputation which the road possesses. At some of the large stations (which are usually on the street level) gates are closed across the tracks, so that loungers and trespassers cannot enter, and all persons going to and from the trains must use the proper entrances and exits. The improvements now in progress include new culverts with concrete side walls, these walls being made long enough for a double track bank. The openings are spanned by plate girders, on which are I-beams 12 ins. c. to c., with ⅜-in. deck plates and 6 to 12 ins. of ballast under the ties.

For the heavy passenger service, large ten-wheel engines are employed, but compounds are not in favor, the pioneer two-cylinder compound built by the Schenectady Locomotive Works in 1889 being the only one in service. Formerly the front driving wheels had plain or blind tires, but wear on the rails has been reduced since flanged tires have been used on the front pair and blind tires on the second or main pair of driving wheels. The ten-wheel engines run through from Michigan City to Detroit, 210 miles, with passenger and fast freight trains. The passenger engines also make the through run between Windsor and Montrose, on the Canada Southern Division, 223 miles. Freight trains change engines, and run from Windsor to St. Thomas, 111 miles, and St. Thomas to Montrose, 112 miles.

New York Central R. R.

The four-track line between Buffalo and Albany is rather disappointing as an example of ideal track, and is not always as good or as easy riding as might be expected, while the clicking of the rail joints is very perceptible. The rails are laid with broken, six-bolt three-tie joints, and tie-plates are used only on the middle tie at joints. On the freight tracks, the rails seem to have sustained very severe wear, the wear extending down upon the tops of the angle bars which are cut and worn bright. This may be due in part to the slight outward flare of the rail head in the section adopted by this road. Many of these rails are also badly gouged and marked by the wheels. The track and roadway are not specially attractive in appearance, with the dingy and not very well dressed gravel ballast, and the black asphalt paint which is used for bridges, signal bridges, tell-tale posts, etc. The stations and tool houses are well painted, but many of the stations are insignificant, hardly more than sheds, while there is little attempt at beautifying or trimming up station grounds. Ballasting is being done with Rodgers ballast distributing cars. At Albany, work is in progress on the new union station, the elevation of the tracks, and the reconstruction of the bridge over the Hudson River, the old structure being kept in use while the new spans are being built.

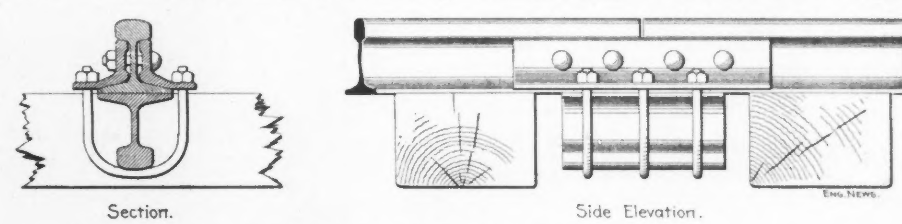

FIG. 2.—RAIL JOINT OF THE MICHIGAN CENTRAL R. R.
A. Torrey, M. Am. Soc. C. E., Chief Engineer.

Spare rails are carried on cast-iron posts with brackets, and the rails and posts are painted with black asphalt paint. There are long stretches of Page woven wire fencing, with Jones gates at intervals, and there is also a considerable amount of dry stone fencing. Wooden slat cattleguards are used. Besides the regular semaphore block signals, which are usually mounted on iron lattice bridges spanning the tracks, there are clumsy-looking semaphores with red blades (some of iron with vertical slots) which when lowered are concealed in the wide head of the post. The posts are painted black, rendering them very inconspicuous. Where block signals are placed on posts, the posts are painted cream color. The old signals above mentioned were erected some years ago to protect switches, and, in some cases, to protect trains standing at stations. They are being replaced by regular block signals as interlocking is put in. Enginemen regard them as distant signals, and pass them under control until they have ascertained that the track is clear.

Boston & Albany R. R.

This road, which will probably soon he leased to the New York Central R. R., has a double track main line between Albany and Boston, 202 miles, which is remarkably uniform in construction. It has an excellent track, laid throughout with 95-lb. rails, and though these are of a rather shallow section, they make a very easy riding track. They have broken, supported (one-tie) joints, spliced with short angle bars and four bolts, the bars having holes instead of slots for the spikes, so as to ensure their always being firmly held to the tie to prevent creeping. At the middle of each rail also a creeper plate is bolted to the outside of the web, this plate being a short piece of angle bar spiked to the tie. The inside splice bars are grooved, to hold the rectangular heads of the bolts. Large ties are used, 15 to a rail length, with metal tie-plates on every tie. Bolted rigid frogs are used, with short guard rails having widely-flaring ends. The ballast is of gravel, trimmed to a good surface and shoulder, and has been sprinkled with oil for two years so that it is practically free from dust. This adds greatly to the comfort of the passengers and the reputation of the road. Mr. E. A. Haskell, Division Roadmaster, informs us that after two years' experience he is able to say that weeds do not grow in ballast that has been oiled. The so-called "swamp-pine," however, is an exception; this will grow in anything, and the oil seems to have no effect upon it. Wire fencing is used almost exclusively. No inside guard rails are used on the bridges, but only outside guard timbers of hard pine, 10 × 12 ins., bolted to the ends of the ties, and 2 ft. 6 ins. from the track rails. In some cases a flaring approach floor is built, having a rail set to bring derailed wheels within the line of the guard timbers. The road is well kept, and of attractive appearance throughout its entire length. It has handsome stone stations (that at Worcester having a trainshed), and the grounds are very nicely kept. Even the section houses are designed with some regard to artistic effect, but their color, in two shades of dark green, is rather somber.

This road was one of the pioneers in adopting automatic block signals, and has both the Hall enclosed disk signal and the Union exposed revolving disk signal. The latter is set parallel with the track when at the "clear position," thus giving practically a negative indication, which is not considered good modern practice. The semaphore arms at junction and interlocking points are all numbered, and are painted black and white instead of red and white on the running face. Mr. Geo. W. Blodgett, the Electrical Engineer, who has charge of signals, states that the Union signals are so placed that the engineman observes the change from clear to danger when he enters the block. Should it fail to change (which very rarely happens) it is regarded as a danger signal, and the train proceeds under control. With semaphore signals, full-sized blades are used only for main line or high speed routes. All others are for switching movements. As to the use of white for the running face of the signal, Mr. Blodgett thinks it absurd to adopt red as a standard for danger signals, and then run by that same color merely because the position is different. The color of the blade serves merely to make it conspicuous, and he sees no good reason for using red. Some other roads use yellow for the running face.

While most railways are now using ten-wheel engines for fast heavy passenger service, the Boston & Albany R. R. prefers the eight-wheel type, double-heading westbound trains on the mountain division. Ten-wheel engines are used to some extent. The length of run of the through passenger engines is 100 miles and return, the average weight of train being about 325 tons. West-bound trains are run as double-headers between Chester and Washington, 13 miles, on a grade of 1.7%. The freight trains weigh about 1,000 tons, and are hauled by consolidation engines, the westbound trains being double-headed between Chester and Washington. The eight-wheel engines are very large and powerful. For freight service consolidation engines are employed. A large number of the passenger cars have the turtle-back style of roof, with a number of adjustable ventilators, instead of the ordinary monitor roof with side deck lights.

FIG. 3.—JORDAN SPRING RAIL FROG; MICHIGAN CENTRAL R. R.

The leading dimensions of the large eight-wheel engines for fast and heavy passenger trains are as follows:

Driving wheels,	6 ft. 3 ins.
Cylinders	20 × 26 "
Weight on drivers	87,000 lbs.
Weight, total	137,000 "
Boiler, diameter	5 ft. 4 ins.
Boiler, pressure	190 lbs.
Firebox	9 ft. × 3 ft. 4⅜ "
Tubes, ...342; diameter......2 ins.; length	13 ft.
Heating surface	2,492.00 sq. ft.
Grate area	30.33 "
Coal on tender	7 tons.
Water in tank.	5,200 gallons.

Boston, Mass.

Two notable union stations, one of which is the largest in the world, have replaced the seven or eight terminal stations which formerly existed in this city. Both stations have accommodation for cabs and carriages inside the building, and there is no yelling and touting of cabmen, such as greets passengers arriving at the Grand Central Station in New York. The arrangement of the waiting-room of the South Union Station (Eng. News, Jan. 14, 1897), is worthy of notice in connection with the criticisms of waiting-room design made in our issues of Jan. 12 and June 1, 1899. The room is very long, with one side forming the street front of the building, but there are no doors opening direct to the street, and the windows are set high up in the wall. Along this side of the room are rows of high-backed wooden seats, set with their ends to the wall, so that persons occupying them are not disturbed by drafts or by persons going to and from the trains. The opposite side of the room is kept clear, unobstructed by seats, and in the wall are numerous ticket windows. Doorways in this side of the room give access to the main platform. In one end of the room, also, there is an entrance upon one of the broad passageways through the building from the interior of the trainshed to the street.

The subway for electric cars is one of the most striking features of the local transportation system, and to a visitor who sees Tremont St. now and remembers it in the days before the subway, the difference is very remarkable. The subway was built by the city and is leased to the street railway company. It is well built and well lighted, and has neat and attractive buildings over the entrances to the stations. The noise of the trolleys is rather obtrusive, and there are great crowds at the stations during the rush hours. There is a continual procession of gayly-colored cars covered with signs, but in spite of the endless variety and combination of routes, there seems to be comparatively little confusion and comparatively few mistakes.

The new bridge over the Charles River is practically completed, and is severely plain in appearance, having a series of plate girder spans on masonry piers. Upon it is built the structure of the Boston Elevated Ry., which also has plate girder spans. This structure is painted in various colors, evidently to test the qualities of different grades of paint. The bridge has handsome masonry approaches, with which the plate girder elevated structure does not harmonize.

Boston & Maine R. R.

This road now has a system aggregating 1,715 miles, of which only 386 miles are owned, the balance being leased. The system includes a large majority of the railway mileage of Vermont, New Hampshire, and Maine, with a considerable mileage in Massachusetts, its lines extending west to the Connecticut River. The Portland & Rochester R. R. (already controlled) has recently been acquired, and will give a third direct line between Boston and Portland. The B. & M. R. R. system has been formed within recent years by the acquisition of a great number of small independent lines, and under these conditions it is not surprising that the 2,876 miles of track include a great variety of methods of construction, with a considerable portion of light track. Considerable expenditures have had to be made to put these lines in good condition. The standard track consists of 75-lb. rails of the so-called Am. Soc. C. E. section, with Weber or four-bolt angle bar joints.

FIG. 4.—SNOW FENCES IN CUTS; BOSTON & MAINE R. R.

A peculiar style of snow fence is used on some parts of the White Mountain and Concord divisions, consisting of permanent board fences built diagonally along the slopes of the cuts, as shown in Fig. 4. They are about 90 ft. apart, alternating on opposite sides of the track, and are placed at right angles to the direction of the prevailing winds which tend to fill the cuts with snow. The plan is said to serve admirably in preventing snow from drifting across the tracks. It is thought, however, that the portable fence shown in Fig. 5 would serve the same purpose equally well, and the latter would have the advantage of not being objectionable in appearance, like the permanent fence. For particulars of these fences we are indebted to Mr. A. C. Stickney, Division Roadmaster. About 400 miles of track having gravel ballast have been sprinkled with oil, at a cost of about \$100 per mile of single track, using 2,000 gallons per mile. No weeds have so far grown up where the oil has been applied. This, in conjunction with coke fuel in the engines, conduces greatly to the comfort of the passengers.

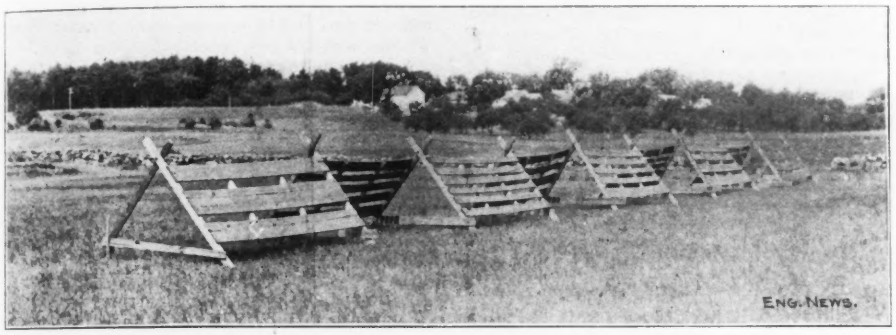

FIG. 5.—PORTABLE SNOW FENCES; BOSTON & MAINE R. R.

The automatic block signal system is used on some parts of the line, and includes the Union disk signal, and the old form of Hall signal, having a small semaphore blade (instead of the present disk), working in a large "banjo" box with a glass front. An old style of signal still in use at some junctions consists of a tall pole with an endless chain passing over sheaves on cross arms at top and bottom. On each chain are two balls, made of canvas, and these are operated by the switchmen, one ball being raised while the other is lowered, to indicate for which track the switch is set. Granite mile posts are used in many places.

At Portland the railway has a very handsome station, with large trainshed, and at Boston it is the principal user of the north Union Station. At Concord are extensive locomotive and car shops, built in 1898. The railway has a very heavy tourist traffic in connection with the various summer resorts along the coast and in the mountains, and it has also a heavy freight traffic with the large manufacturing centers, such as Concord, Nashua, Manchester, Lowell and Lawrence. It has also an extensive suburban traffic around Boston.

The motive power equipment includes a number of odd and old-fashioned engines, as well as many fine new engines. Large ten-wheel locomotives are used to haul passenger trains of 10 and 12 cars. The use of coke fuel has already been referred to, and was described in our issue of Sept. 7. The car platforms are fitted with Wood's folding gates, which are closed across the top of the steps when the train is running. These are made by the R. Bliss Mfg. Co., of Pawtucket, R. I.

Maine Central R. R.

This road is practically controlled by the Boston & Maine R. R., the two together forming a complete system, while the President of the B. & M. R. R. (Mr. Lucius Tuttle) has recently been elected President also of the M. C. R. R. The main line is laid principally with 75-lb. rails of the so-called Am. Soc. C. E. section, the rails having square, suspended joints, spliced with four-bolt angle bars. There are still some places laid with 67-lb. rails, 4½ ins. high, but all these will be replaced next season with the 75-lb. rails. The gravel ballast is extremely dusty. The slopes are in many places well covered with grass.

The frog guard rails are of rather peculiar design, as shown in Fig. 6. The web and flange are cut away for a few inches at each end, and the head is bent downwards and then at right angles, so as to pass under the track rail. The end is formed into a clamp which takes hold of the base of the track rail. The rail is 9 ft. long, the center length of 3 ft. being straight, with a flangeway of 1¾ ins. The ends flare out to give a clearance spacing of 4 ins. between the guard and track rails. For particulars of this guard rail design we are indebted to Mr. H. A. Toward, Division Roadmaster.

Portland & Rumford Falls R. R. and Rumford Falls & Rangeley Lakes R. R.

These two roads form a standard gage line to the industrial center of Rumford Falls, Me., with its water power plant, pulp mills, etc., and thence through the forest to the hunting, fishing and pleasure resorts of the Rangeley Lake District. The P. & R. F. Ry. leaves the Maine Central R. R. at Danville, and just below Rumford Falls the other line begins, avoiding the steep grade of the terminal spur. On this latter line there is a grade of 1.85%, six miles long. The maximum grade is 2½%, and the minimum curvature is 10°. It is proposed to extend the line north to Megantic, to connect with the Canadian Pacific Ry. and the Quebec Central Ry. Two routes were surveyed last winter by a snowshoe party under the direction of Mr. R. B. Stratton, Chief Engineer.

The track is largely laid with 56-lb. rails, 7 years old, and on the older track these have square joints, which is common practice in New England. In all new work and renewals, however, broken joints are used, spliced with four-bolt angle bars.

At the terminal at Bemis, on Lake Mooselucmeguntic, is a conveyor plant for loading logs upon the cars.

Mount Washington Ry.

This small, but somewhat celebrated, railway was the pioneer of the now numerous rack-rail mountain-climbing railways built for tourist traffic. Mr. Sylvester Marsh invented the ladder rack and projected this railway in 1858. Construction was commenced in May, 1866, and completed in July, 1869, at a cost of about \$150,000. The late Mr. Walter Aiken was also prominently interested in this project. It is 3 miles long, attaining an elevation of 3,700 ft. in this distance, and the summit being 6,293 ft. above sea level. The average grade is 25%, and the maximum grade, 30%. The line is not built entirely on a solid roadbed, like the Pikes Peak Ry. (Eng. News, April 6, 1899), but has a considerable length of trestling, with a maximum height of 30 ft. While the line was under construction, a German engineer, Mr. Riggenbach, sent engineers over to examine it and procure drawings of its construction. From this information the Rigi Ry., in Switzerland, was designed, and in Europe the ladder-rack system is commonly, but erroneously known as the Riggenbach system. The facts in this case were given at some length in our issue of Aug. 14, 1886.

The track of the Mt. Washington Ry. consists of very light T-rails, spiked to thin longitudinal timbers resting on thin ties carried by stringers. These stringers rest upon heavy timber caps or sills, which rest upon the ground or upon blocking on the rocks, where the line follows the surface of the ground, and which form the caps of the framed bents of the trestles. The gage is 4 ft. 7½ ins., and between the track rails is a third longitudinal carrying the rack. This consists of two angle bars, set back to back, about 4 ins. apart, with round bars riveted between them, forming the teeth of the rack, with a pitch of 4 ins.

The railway is reached by a six-mile branch of the Boston & Maine R. R., on which there are a number of Fisher joints which rattle in an extremely noisy manner, not calculated to soothe the nerves of timid travelers. The time of the ascent is about 1½ hours for the three miles. It may be noted that a rack railway on the Marsh system, but of standard gage and with ordinary track construction, was built some years ago up Green Mountain, near Bar Harbor, Me. This was described in our issue of Jan. 22, 1887, but it has now been dismantled and abandoned, its engines having been transferred to the Mount Washington Ry. after a fire had destroyed the engine-house and engines of the latter. The new engine-house is rectangular, with three or four parallel tracks, and the engines are carried to and from it by a transfer table which normally forms part of the main track. Each train consists of an engine, one long four-wheel passenger car (with ratchet brakes), and a little four-wheel car for baggage. The engine is in the middle, and always pushes the passenger car up.

The first engines had vertical boilers, but were not very successful. The earlier engines of the present type were wood-burners, with huge mushroom-topped smokestacks. The present engines burn coal, and have diamond stacks. The boilers are inclined upon the frames so as to be practically horizontal on the average grade. There are four carrying wheels (which run loose on the axles), but no adhesion driving wheels. Each engine has four cylinders, 8 × 12 ins., set back to back, just forward of the cab, and driving two shafts at opposite ends of the frame. On each shaft is a steel pinion with 12 teeth, keyed to the cog wheel shaft. The cog wheels have 19 teeth, 4 ins. pitch. For each revolution of the cog wheel (which advances the engine 6 ft. 4 ins.), the pinion shaft makes 5⅓ revolutions. In descending, the cylinders are used as air brakes, on the Le Chatelier system, taking in air from the atmosphere by a special inlet and not from the smokebox. A fine stream of water is admitted to lubricate the cylinders, and the steam thus generated escapes through the pet cocks. All the engines have been built by the Manchester Locomotive Works, of Manchester, N. H., and their general dimensions are as follows:

Carrying wheels	2 ft.
Weight	12 tons.
Wheelbase	10 ft. 2⅝ ins.
Cylinders (4)	8 × 12 "
Boiler, diameter	4 ft. 0¾ "
Boiler pressure	140 lbs.
Firebox	2 ft. 10 ins. × 3 ft. 2¾ ins.
Tubes, No. 230; diameter	1¾ "
Tubes, length	5 ft.
Heating surface	540 sq. ft.
Grate area	9 "
Water in tank	500 gallons.
Coal in bunker	1½ tons.
Gearing:	
Engine pinion, diam.. 6 ins.; teeth..12; pitch..	1.57 ins.
Spur wheel diam.....32 " ; " ..64; " ..	1.57 "
Cog wheel, diam.....24 " ; " ..19; " ..	4.00 "

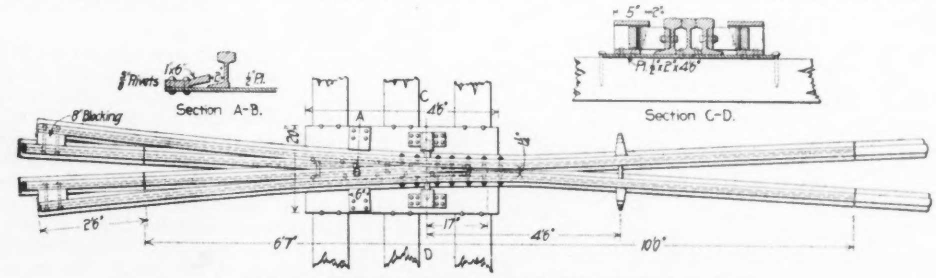

FIG. 6.—FROG GUARD-RAIL; MAINE CENTRAL R. R.

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

We bespeak the attention of our readers in the State of New York to the letter of Mr. E. C. Eckle, Assistant State Geologist, which is published elsewhere in this issue, and which asks the aid of engineers in furnishing the Survey with such records of deep borings as they may have made or have information about. The purpose for which this information is required is the compilation of a geological map including the territory named in the letter. The superficial formations of this territory have been studied by the Survey as far as possible, but it has been found necessary in order to determine the limits of these formations in many places to depend upon borings, as the drift covering or the spread of the cities conceal the outcrops. Unfortunately the Geological Survey of the state is not given a financial support which will enable it to conduct independent borings, and it therefore calls upon those who have made such subsurface studies to aid it by making known the information which they possess. There is without question a vast quantity of information of great value to geological study available in the various deep borings which have been made on and about Manhattan Island in connection with the building and engineering work which is being conducted there yearly, and we believe that those who possess this information will be glad to give geologists the benefit of it when once they understand the use to which it will be put. As we pointed out in our issue of July 13, 1899, such co-operation between engineer and geologist as is asked here is certain to be of mutual advantage. The engineer is often quite as much interested as, and many times far more vitally concerned in the geology of specific localities than is the geologist himself. Moreover, with the growth of the study of what may be called economic geology by our various State Geological Surveys, a vast amount of information directly concerning engineers is being made public annually. In illustration of this we may refer to the very valuable report on building and ornamental stones, with complete tables of tests, which has recently been issued by the Wisconsin State Geological Survey. The bulletins of the New York State Survey on the stone, iron, salt, gypsum and clay industries are other instances of similar work which is being furnished to the engineer gratis through the work of the geological surveys being conducted by the various State Governments. The engineer owes it as a mark of appreciation of this work which benefits him so much to do what he can to extend the available geological information of every locality where his work may give him possession of pertinent and useful data.

For 84 years the bones of Robert Fulton, the active promoter of steam navigation in the early years of this century in America, France and England, and one of the foremost engineers of his time, have lain, neglected and absolutely forgotten, in the Livingston family vault in Trinity churchyard, in New York city. While his memory is honored and his name will always occupy a prominent position on the roll of America's great men, very few indeed are even aware of his last resting place; and for the movement now being made to remedy this almost shameful neglect the American people owe a debt of gratitude to the Council of the American Society of Mechanical Engineers. At the Washington meeting in May last it was decided to take action in this matter; and the efforts of the committee then appointed have been heartily seconded by the Trinity Corporation, which has already set aside a suitable and conspicuous site for a proposed monument. It is desired that this monument shall be a handsome and fitting one; and not only the members of this particular society but all engineers and all Americans, proud of Fulton and of his epoch-making work, should contribute towards this end. It should be a privilege to honor his memory in the one practical way possible; and it would be better for this purpose that the subscriptions be individually small but come from many sources. While his name is known over the civilized world, it is the people of the United States that directly benefit by his inventive talent; and every steamboat on our rivers and steam vessel on our lakes and shores is but an evolution of the ideas that emanated from the brain of Fulton. He suggested armor-clads and submarine torpedoes in naval warfare long before the navies of the world were ready to utilize his suggestions; and any failure that followed his first efforts in establishing steam navigation on our rivers is due to the then poverty of our manufacturing facilities rather than to anything lacking in his general designs. Others, however, have followed in the path he pointed out, and, more fortunate in their environment, have made all that his name stands for, famous throughout the world.

We call the attention of our readers to the proposed Fulton Memorial, believing that there are many who would gladly join in this movement for fitly marking his tomb. While the project originated with that one of the American engineering societies most closely connected with the field in which Fulton worked, the cause is one appealing to every American engineer; and it appeals all the more strongly for being a long-deferred payment of a just debt. Remittances should be sent to Prof. F. R. Hutton, Treasurer Fulton Memorial Fund, 12 West 31st St., New York City.

COMPARISON OF SUSPENSION CABLE SPECIFICATIONS OF BROOKLYN AND NEW EAST RIVER BRIDGES.

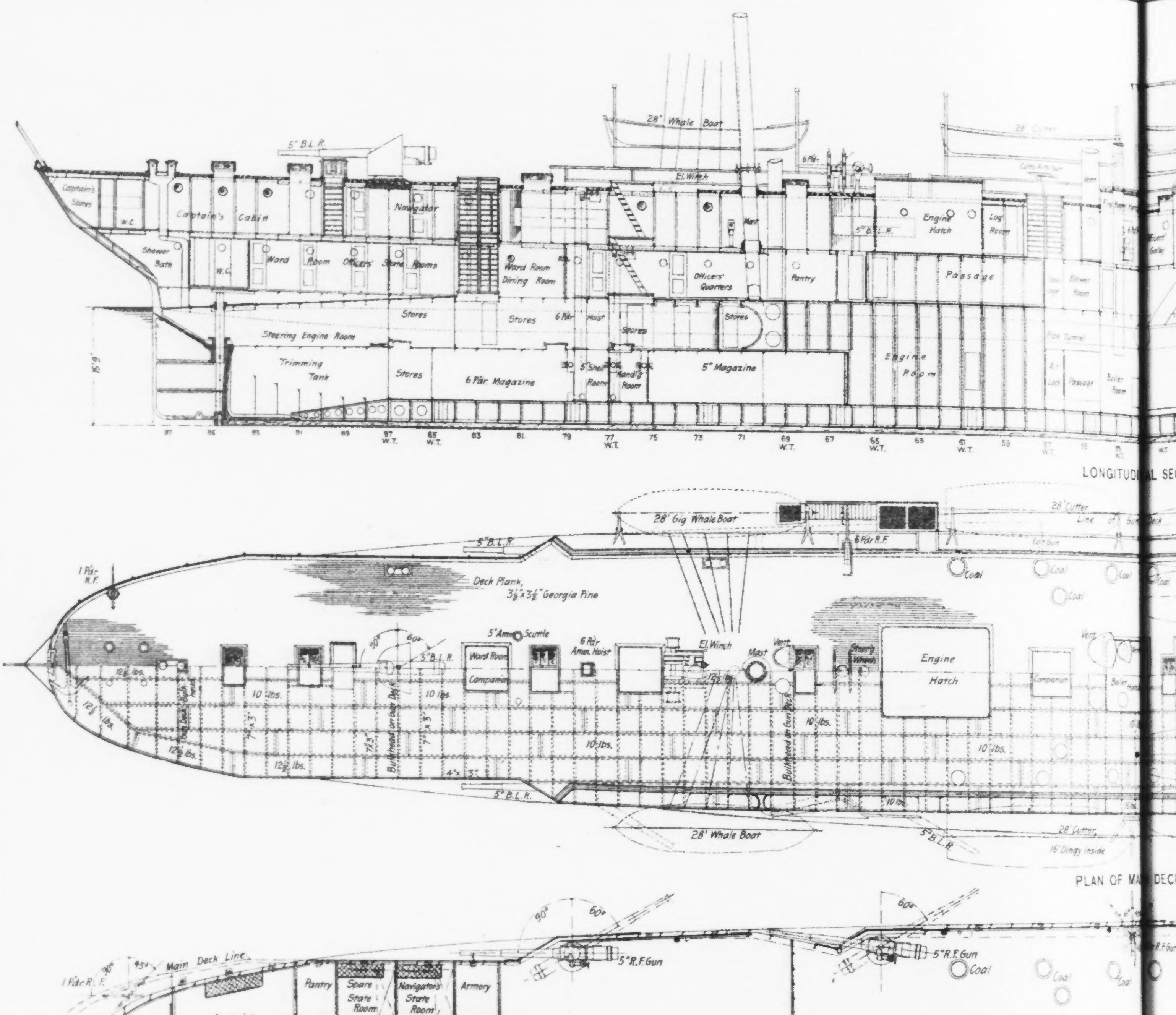
On Dec. 7 the commission having the work in charge will receive bids for constructing the steel wire suspension cables for the New East River Bridge, at New York city. The specifications on which these bids will be made were published nearly in full in our last issue, and we presume that they have received at least a cursory perusal by the majority of our readers. A few of these perhaps will also have recalled that it was in constructing the nearby Brooklyn Bridge that the first specification for steel wire cable was employed. The bids for the cable wire for the Brooklyn Bridge were called for on Dec. 1, 1876, on specifications drawn up by W. A. Roebling, the Chief Engineer of the work, and almost exactly 23 years have, therefore, elapsed between these first steel wire cable specifications and the latest ones which we published in our last issue. In 23 years marvelous progress has been made in the costs of steel making and bridge building. In 1876 the adoption of a specification requiring steel instead of iron was a novelty. It was decided upon only after exhaustive experiments to determine the qualities of the material which was available and was promulgated with considerable perturbation and uncertainty by the engineer. To-day the only question which is likely to arise regarding such a specification will be respecting the minor details of its requirements. The change is a significant one, and it becomes more interesting when we compare the two specifications in detail.

As a preliminary to such a comparison it is interesting first to contrast the new bridge being built across the East River with the older Brooklyn Bridge in some of their more general features. A little study shows that the new bridge differs from the older structure principally in the following features: (1) The towers carrying the main cables are of steel framework instead of masonry; (2) the two shore spans are carried entirely independent of the main cables by placing an intermediate steel framework tower between the main cable towers and the abutments on each side; (3) the inclined stays from the towers to the roadway which were employed in the older bridge are omitted in the new structure; (4) the stiffening trusses and other framework are of high-class steel with riveted connections instead of wrought iron with pin connections. Bridge engineers will recognize these changes as being generally along the line of improvement and economy in construction.

Referring now to the suspension system, a comparison of the two bridges shows the new structure to have a main span of 1,600 ft., as compared with 1,595.5 ft. in the older bridge. The number of main suspension cables is the same, or four, but the diameter of the cables in the new bridge will be 17½ ins., or 2 ins. greater than the diameter of the present Brooklyn Bridge cables. In both bridges twisted wire rope suspenders carry the roadway and stiffening trusses. The resemblance between these general features of the suspension systems of the two bridges will be observed, and it adds a further point of interest to the comparison of the cable construction in detail, which follows:

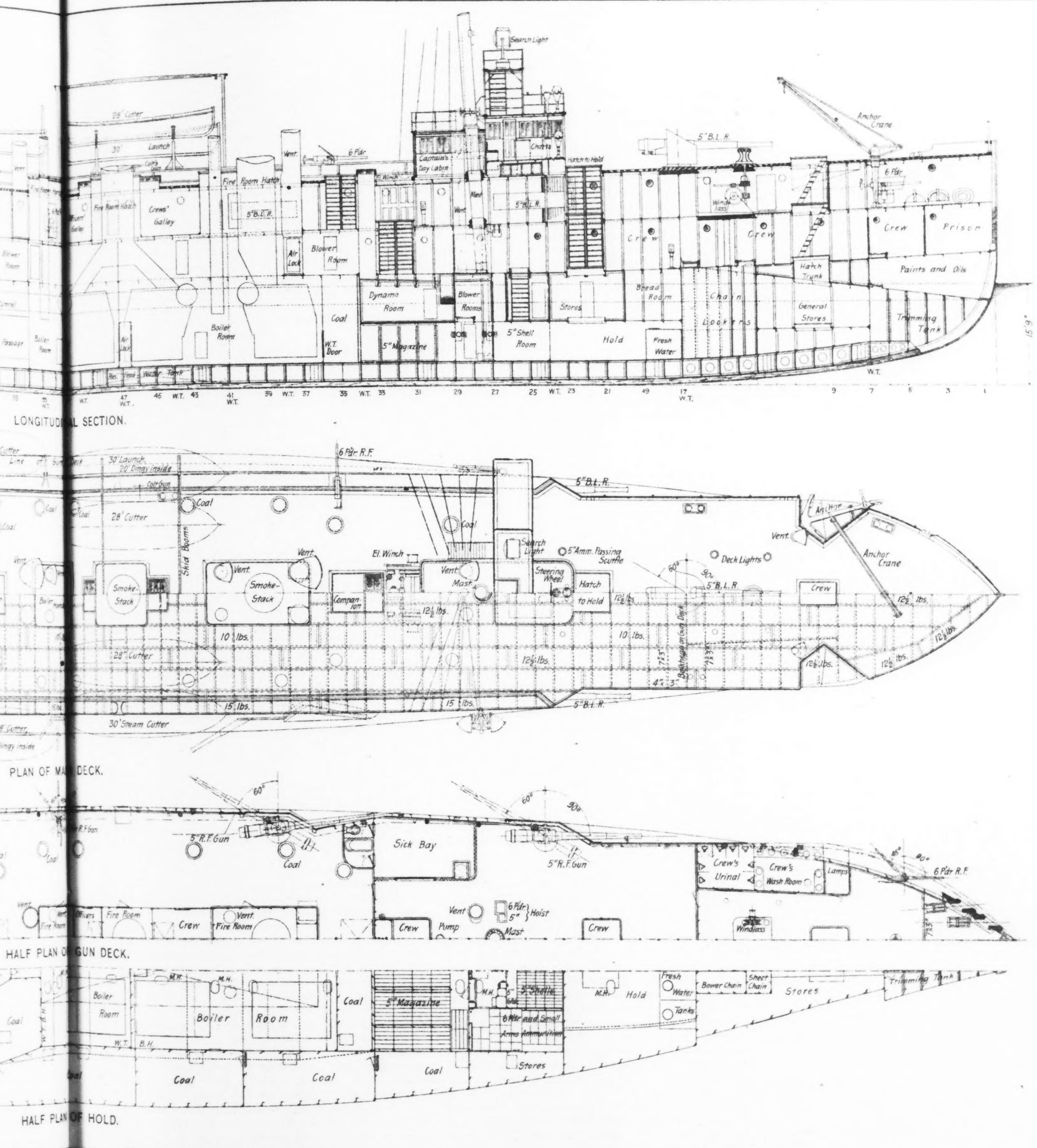
Material.—Previous to the construction of the Brooklyn Bridge the material used for wire cables had been charcoal iron. The Niagara suspension bridge, built in 1855, had cables of No. 9 B. W. G. iron wire, and the same diameter and kind of wire was employed in the Covington & Cincinnati suspension bridge, built in 1857. In the latter structure, however, the cable wires were laid parallel instead of being twisted into a rope, as at Niagara. The reasons which urged the change from the iron wire formerly employed to the steel wire adopted for the Brooklyn Bridge were carefully stated by Col. Roebling in his specifications for the cable wire of this structure. It seems a little amusing in the light of our present knowledge of steel and iron to think that the engineer felt called upon thus to justify his choice of the stronger material in asking for bids from wire manufacturers, but the action was fully warranted by the conditions at that time. Steel-making in 1876 was a different art from what it now is, and structural work of wrought steel was for the most part beyond the reach of the engineer.

As illustrating the general attitude of engineers toward steel at that time, it is interesting to notice that Col. Roebling, after nearly six years of experimenting with steel wire of foreign as well as American production, had decided that neither open hearth nor Bessemer steel could be made which would come up to the requirements he thought it necessary to demand for the cable wire of his great bridge. As originally drawn, his specifications excluded steel made by these processes, and carefully stipulated that crucible cast steel should alone be used. A more mature consideration of this stipulation when the specification came up for final consideration before the Board



"DENVER" CLASS SHEATHED, PROTEC

Rear Admiral Philip Hichborn, Chief Constructor, U. S. N.



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N. Rear Admiral Geo. W. Melville, Engineer-in-Chief, U. S. N.

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of Trustees led the engineer, however, so far to modify it that bids could be made by all kinds of steel wire makers. The requirements otherwise were left unaltered. It is interesting to notice that the wisdom of this more liberal course was soon proven, and in his report for the year 1876 Col. Roebling was enabled to say, in speaking of the subject, that:

> It soon became manifest, from samples received, that both open hearth and Bessemer steels could be so manipulated as to meet the requirements in every respect; giving a uniformity equal to and even superior to any brand of cast steel, and this could be done not only in a few specimen rings, but in many tons at a time.

Col. Roebling could appreciate the significance of this fact, both as an engineer and as a manufacturer of wire, and it is with something of a touch of enthusiasm that he refers to it in his report. The fact that the less expensive steel processes could be depended upon to produce high quality steel wire was not the only gratifying development of the competition for the wire contract for the great bridge. It was supposed at the time the specifications were drawn that such wire as was called for could not be made without being hardened and tempered, and these finishing processes were required by the specifications. The final tests, however, showed that untempered wire could be made which would satisfy all the requirements stipulated.

These special developments of the competition for making the cable wire for the Brooklyn Bridge are a little aside from the main question set down for consideration here, but they serve particularly well to show the uncertainty under which the engineer labored then in all knowledge relating to the properties and safe use of steel. The same uncertainty is manifested in the fact that the only criteria established by the specification for the quality of the steel for cable wire, were the physical tests for strength, and elasticity and ductility. Besides defining these physical requirements the specifications contained merely the following explanatory stipulation:

> The rods of which the wire is made must be of a superior quality of steel, suitable for wire purposes. It is not implied that the highest price of steel shall be used, such as is required for fine cutlery, springs, or the like, but it is only a superior steel rod, which will make a wire that comes up to the standard here laid down. * * * * Owing to the uncertain character of steel, and the percentage of rejection that usually attends the finished product, notwithstanding all the care and amount of selection it may have undergone in the various stages of its manufacture, it is absolutely necessary that every ring should undergo a test when finished.

The specifications for the new bridge, published in our last issue, not only say what the strength and toughness of the steel stall be, but they prescribe with certainty the nature of the raw material, the processes of manufacture, and the chemical composition of the finished product, which are deemed best suited to the engineer's purpose. Compared with these concise and definite stipulations, the almost helplessly vague instructions to manufacturers given in these first specifications which we quote from, speak a whole volume for what has been done in perfecting the engineer's knowledge of his most important manufactured structural material.

Size and Arrangement of Wires.—The size of wire first determined upon for the Brooklyn Bridge cables was No. 8 B. W. G., or 0.165-in. in diameter, but the successful bidder for supplying the wire, having decided to make it of crucible cast steel, and the tests having shown his material to have a certain strength of 12,000 lbs. per sq. in. in excess of that required by the specifications, it was decided to increase the size of the wire used to No. 7 B. W. G., or 0.18-in. in diameter. This change gave a slightly smaller breaking strength, but greater ductility, and reduced the number of wires required to make each of the 19 strands from 332 to 282, thus reducing the time required to manufacture the cable about one-sixth. The total number of wires used in each cable was 6,300, which were laid parallel to each other. Compared with these numbers and dimensions the cables of the new bridge will consist of 37 strands of 281 wires of No. 8 B. W. G., 0.165-in. each, making a total number of 10,397 wires in the whole cable. These wires will be made of open hearth acid steel. The changes made, it will be seen, have been a decrease in the size of the wires, and a very large increase in their number, and in the number of strands in which they are laid up. The total increase in the diameter of the cables is 2 ins.

Physical Qualities.—The specifications for the cable wire for the Brooklyn Bridge called for a breaking strength of 160,000 lbs. per sq. in. As furnished by the manufacturer, the breaking strength actually averaged 170,000 lbs. per. sq. in. for No. 7 gage wire. In the specifications for the new bridge the breaking strength required of No. 8 gage wire is 200,000 lbs. per sq. in. The elastic limit set for the cable wire of the Brooklyn Bridge was 0.47 of the breaking strength, but this property is not specified for the cable wire of the new bridge. The Brooklyn Bridge wire specifications for ductility and stretch required: (1) An elongation in 50 ft. of 2%, with a reduction of diameter at point of fracture to 0.15-in.; (2) an elongation in 5 ft., of 3½%, and (3) the coiling without fracture of 1 ft. of wire continuously and closely around an iron bar ½-in. in diameter. The corresponding requirements in the specifications for the new bridge call for an elongation of 2½% in 5 ft. and of 5% in 8 ins. No requirements are specified for reduction of area at fracture, but it is required that the wire shall be capable of being coiled without showing fracture around a rod of its own diameter. In both the specifications the wire is required to be drawn straight and free from any tendency to coil, and must not be straightened by machine. In the specifications for the new bridge it is required that the wire shall not be made in lengths of less than 4,000 ft., and the Brooklyn Bridge specifications required that no single coil of wire should weigh less than 50 lbs., and that the coils should average 60 lbs., with a running weight of 1 lb. per 14 ft. for No. 8, and 1 lb. per 11 ft. for No. 7. As delivered the lengths of single wires ran from 600 ft. to 800 ft. for the No. 7 wire, which was the size used except for two strands of one cable. The smaller wire was delivered in lengths of from 800 ft. to 1,000 ft.

The last figures given throw an interesting side light on the progress which has been made in the wire drawer's art. Their significance to the engineer obviously extends further. The longer the length of single wire employed the fewer, of course, are the splices necessary. For example, a rough calculation shows that using wires averaging 4,000 ft. long there will be required about 780 spices in each cable for the new bridge. With wires 800 ft. long, such as were used in the Brooklyn Bridge cables, the number of splices would be increased to 3,900, about, in each cable. There was no such number of splices as this in the Brooklyn Bridge cables, of course, for they contained only 6,300 wires, as compared with 10,397 wires in the cables of the new bridge, and because, also, their length was less. The specifications for the new bridge require a strength for each splice of at least 95% of the strength of the wire itself. It is worth notice here also that the right and left sleeve nut splice developed by the engineers of the Brooklyn Bridge is singled out in the specifications for the new bridge as being the only one known to its engineers as being certainly capable of developing the required percentage of strength.

Protection from Oxidation.—In wires suspended over a salt water stream, and subjected both during and after erection to the salt ocean air, the question of preventing oxidation is an important one, and it was carefully considered in building both the Brooklyn Bridge and the new structure now under way. The Brooklyn Bridge engineers seem to have been particularly impressed with the seriousness of this question, and were contented in ensuring their cable wire against rust only with having it thoroughly galvanized. In the new bridge the specifications require simply that the wires shall be drawn bright, and as soon as drawn be immersed in boiling linseed oil. This is the only protection specified up to the time when the wires in each strand are being bound with their temporary bands, when they are to be filled with as much approved "cable shield" as they will hold. In the final gathering together of the strands into the completed cables another filling of cable shield will be applied.

In the Brooklyn Bridge the final gathering and clamping together of the separate parallel wires into a single compact cable was accomplished by wrapping them with a coil of steel wire running continuously from one end of the cable to the other, except at such points at the anchorages and towers where wrapping was impossible. This wire wrapping is painted, and forms the only weather protection for the cables. In the new bridge a series of screw clamps placed at the suspender connections, or about 20 ft. apart horizontally, with intermediate bands of steel wire every 5 ft., serve to bring the separate wires into the final cylindrical cable form and to retain them there. For weather protection dependence is placed upon a removable armor of steel plates fitting closely to and encasing the cable.

In comparing the leading features of the two specifications for the Brooklyn Bridge and the New East River Bridge cables, as has been done here, no attempt has been made at comparative technical criticism. Such a treatment is practically impossible, owing to the vastly different conditions and considerations which influenced the engineers of the two structures. We believe, however, that the brief comparison which has been made is important in one particular at least. It will be very curious indeed, we think, if the engineer who reads it with a fair mind does not conclude with an increased admiration of the work which was accomplished by the engineers of the Brooklyn Bridge.

LETTERS TO THE EDITOR.

Records of Deep Borings Wanted by the New York State Geological Survey.

Sir: Much information which would be of value to the State Geological Survey is contained in records of borings made for wells, bridge foundations, etc. Many such borings have been made, but it is difficult to ascertain where records of them can be obtained. As such information would be especially useful at present to the Survey, I wish to ask the aid of your readers in obtaining as much as possible. The area from which records are desired includes Westchester and New York counties, Western Long Island, the Harlem and East Rivers, and the adjoining waters. A complete record would include a location of the boring, the approximate elevation, at the ground surface at that point, and notes on the materials passed through at different depths; but even incomplete records might contain information of much scientific interest. Copies of records, or information concerning the place where the original records can be found, if forwarded either to the State Geologist, Dr. F. J. H. Merrill, Albany, N. Y., or to me, will be gratefully received, acknowledged and properly credited when used.

Very respectfully, E. C. Eckel, C. E.
429 West 162d St., New York city, Nov. 13, 1899.

The Balancing and Adjustment of Compass Survey Notes—Correction.

Sir: In my letter on the above subject, published in your last issue, there occurs the statement (or misstatement) that "the total error in latitude may be represented by ΣL, and the total error in departure by ΣD, the expressions ΣL and D standing, respectively, for the algebraic sum of the errors in latitude and the algebraic sum of the errors in departure." This should read: "The total error in latitude is equal to ΣL, and the total error in departure to ΣD, the expressions ΣL and ΣD standing, respectively, for the algebraic sum of the latitudes and the algebraic sum of the departures." It is obvious that ΣL and ΣD are formed not by adding the errors, which are unknown, but by adding the latitudes and the departures, which are given.

Antonio Llano.
International Correspondence Schools, Scranton, Pa., Nov. 27, 1899.

Sir: In your issue of Nov. 23, in the contribution entitled "The Balancing and Adjustment of Compass-Survey Notes," you will find a slight error in equation (2). It is written

$$d_c = -\frac{\Sigma L}{\Sigma C} C;$$

whereas it should be

$$d_c = -\frac{\Sigma D}{\Sigma C} C.$$

I think myself, that this subject has been overlooked in every text-book that I ever read on "Compass-Surveying," and the method presented by Mr. Llano is very simple and convenient. Yours respectfully,

John Wm. Ash.
Thayer School of Civil Engineering, Hanover, N. H., Nov. 25, 1899.

The Automatic Stopping of Trains at Grade Crossings.

Sir: Your esteemed paper of Nov. 16, on p. 327, is an illustrated article entitled "Automatic Signaling and Stopping of Trains at Grade Crossings." We quote from this article. "In one of the tests, a St. L., P. & N. Ry. train of six cars was run at the crossing at a speed of 40 miles an hour, when the signals were set against it in consequence of another train standing on the intersecting line. By means of the track instrument the brakes were automatically set as the engine passed the semaphore signal, 1,200 ft. from the crossing and the train stopped 300 ft. from the crossing. It was pointed out, however, that had the brakes failed to work the train would have gone over the crossing at a speed of probably ten miles an hour."

We ask if you will not kindly give us your formula for arriving at this result. We confess that it is a problem in mathematics which we cannot solve. If it takes the full power of the train brakes to stop the train in 900 ft. and they fail to work, what agency would intervene to reduce the speed of this train to 10 miles an hour in only 300 ft. greater distance? We are willing to learn and will esteem it a great favor if you will enlighten us on your method of solving this problem. Yours truly,

Rowell-Potter Safety Stop Co.
B. C. Rowell, Gen. Mgr.

Chicago, Ill., Nov. 20, 1899.

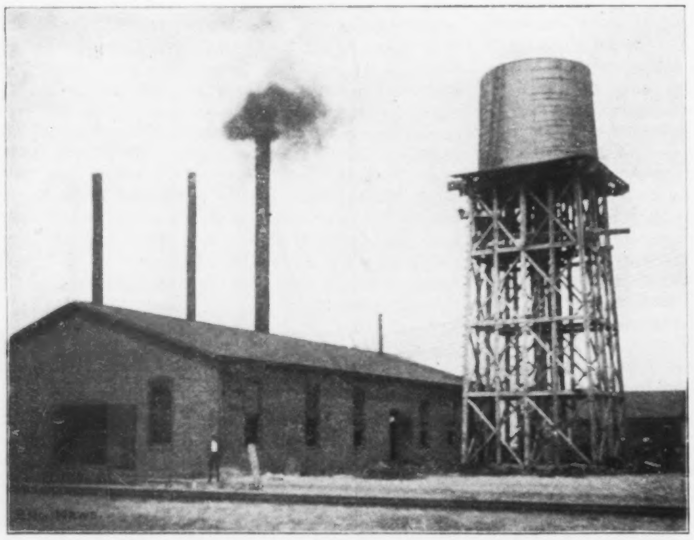
(The statement was made to us by a railway official, and should, perhaps, have been put more clearly. It undoubtedly referred to a partial failure of the brakes, or to a failure on some of the cars, which conditions sometimes occur in service. The important point, however, regardless of any defective wording of the criticism, is that with the safety stop dependence must be placed upon the efficiency of the brakes. If they are defective, the safety-stop may not succeed in stopping the train before it reaches the crossing. The safety-stop is an excellent device under certain conditions, but whether it is well adapted to replace derails for the protection of trains at railway grade crossings is a question for railway officers to decide. —Ed.)

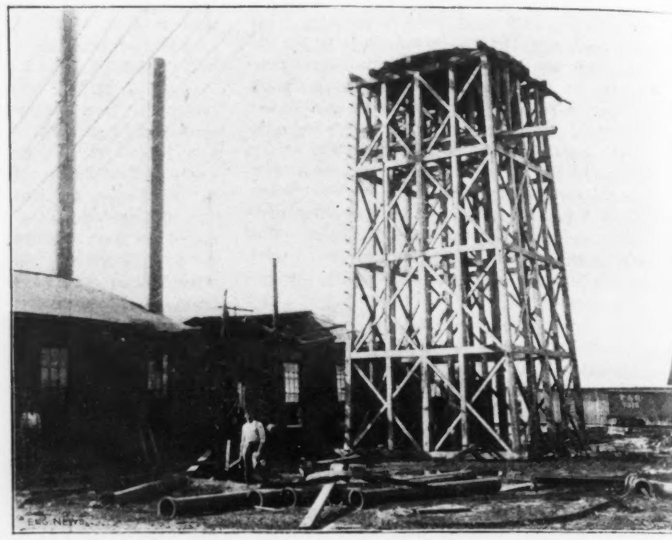
The Failure of the Wooden Water Tank of the Ocean City, N. J., Water Co.

Sir: The accompanying illustrations show the results of the bursting of an elevated wooden tank belonging to the Ocean City Water Co., which supplies water to the city of Ocean City, N. J. This tank had a capacity of 50,000 gallons, and it was located on a timber framework tower 50 ft. high and situated close by the general power house of the Ocean City Electric Light Co. The tank was built about 1893, and was made of 2½-in. cedar staves, hooped with iron hoops. The evidence is that the top hoop burst first and then the others gave way in order toward the bottom. The tank was full at the time of the accident, and the staves and about one-third of the water, weighing about 70 tons, fell upon the roof of the power house. The roof was supported by a plain timber truss made of 8 x 8-in. heart pine and covered with corrugated iron. As the roof collapsed under the weight of the tank, it smashed things generally, breaking the steam pipes and disabling the entire plant. A steam pipe was put up at once connecting the large pumps, so that the city had water five hours after the accident happened, by direct pumping. Piping was also put up to the auxiliary Westinghouse engine the following day, and the consumers were without light but one night. This is the first time the consumers have been without light for five hours at any one time since the plant was built in 1893, and the first time that pressure has been off the water mains. The most remarkable part of the accident was that only one man was injured, and he not seriously. The men in the company's employ worked night and day and were untiring in their efforts to have the plant running as soon as possible. Special mention for their work is due to Mr. William Gibb, Superintendent Water and Sewer Plant; Mr. H. M. Kalbach, Electrician Electric Light Co.; Mr. Charles Watson, Chief Engineer, and Mr. Sylvester Sawyer, Fireman, of the power plant. The estimated cost of the damage done was about $3,000.

Very truly yours, Harvey Y. Lake,
General Manager, Ocean City Water Co.

Ocean City, N. J., Nov. 17, 1899.





VIEWS SHOWING POWER PLANT OF THE OCEAN CITY WATER CO. BEFORE AND AFTER COLLAPSE OF 50,000-GALLON WATER TANK.

PRESIDENTIAL ADDRESS BEFORE THE INSTITUTION OF CIVIL ENGINEERS.*

By Sir Douglas Fox.

The Institution of Civil Engineers came into existence in a small way in A. D. 1818, and was incorporated by Royal Charter in June, 1828. Thomas Telford, the first President, was elected to this chair in March, 1820. The century which has so nearly run its course, and which is notable above any of its predecessors for progress in many directions, has thus witnessed the rise of a profession, having scientific principles as the basis, and their practical application to the service and use of man as the superstructure, of its work, and its present attainment to a high rank both intellectually and socially, with its establishment amongst the learned professions.

It has been the effort of the Institution, from the commencement, to inculcate among its members a high tone of professional etiquette and of commercial morality. The by-laws have recently been strengthened by giving the Council a greater power of initiative in disciplinary cases, fortunately very rare. Questions of most serious importance, both practical and semi-judicial, are entrusted to civil engineers. British engineers have, however, generally been too much occupied to be able to enter into the political arena—a course which has led to foreign and American engineers holding the highest positions in the government of their countries. But, as engineers in charge of the design and construction of public works and machinery, as arbitrators in matters involving most serious interests, as expert witnesses on many intricate and difficult subjects, our members make their influence felt throughout the Empire. The civil engineer is more and more appealed to as a man of honor and common sense, as well as of science and skill.

Only a few years since, Great Britain, the birthplace of the electric telegraph, of railways and of ocean steamships, was the workshop of the world and the educator of all the nations in mechanical science. This was the time when European nations sought our aid; but the well-matured and State-aided scientific education of the Continent had changed all that, and we have now much to learn from foreign engineers, notably from those of France, Germany, Italy and Switzerland, as well as from our cousins in America.

It was in an early year of the century that William Murdoch exhibited in a practical form the lighting of rooms and streets by coal gas. A leading philosopher of the day sounded the note of prejudice and depre[ciation], which has so often since that time heralded the intro[duc]tion of great inventions. He trusted that "no one would rely upon so foolish and unlucky a thing as gas," and anticipated that its inventor would soon be asking for the dome of St. Paul's as a gasholder. He little thought that, within the century, gasholders would be erected greatly exceeding in diameter and cubical contents that noble building. Peckston, an engineer, writing in 1841, stated that about 1837 the sale of gas in London, Westminster, and Southwark required the production of 1,460 million cubic feet of gas; and, in the same work, demonstrated the comparative economy of gas and other means of lighting in tables based on the price of gas at 9s. per thousand, tallow candles 8d. per lb., wax candles 2s. 6d. per lb., and sperm oil at 9s. per gallon.

Gas is at the present day being sold by the South Metropolitan at 2s. 2d (56 cents) per M., and the best petroleum lamp oil is sold at about 5d. per gallon. According to the latest available returns issued by the Board of Trade in November, 1898, the sale of gas, by both companies and local authorities throughout the United Kingdom, in the year 1897, aggregated 122,219,000,000 cu. ft., involving the carbonization of 12,000,000 tons of coal, consumed by 3,000,000 consumers scattered over 25,000 miles of gas mains, involving a total capital expenditure of £78,000,000. Of the total sale of gas above stated, so much as 33,495,810,000 cu. ft., or over 25%, was sold within the metropolis, as included under the County Council. It is interesting to note that gas making in horizontal retorts, purifying by lime, storing in holders, and distributing by mains of cast iron with wrought-iron service pipes, are in operation now, with very much the same plant—although improved in detail—as was in use in 1840.

In spite of the charms of its younger sister, electricity, coal gas still holds its own, and in consequence of the rivalry between the two systems of lighting, improvements in both are rapidly being made. The introduction of the mantle system, at one time so very near failure, has proved to be a great step towards a more powerful light; and the mantle, used under forced draft, results in a gas light of intense power and of very low cost, which is proving to be no mean competitor with the electric light, and promises to restore gas to its former position as an illuminant. At the same time, gas is more and more asserting itself as a most useful, if not the most important, agent for cooking and heating, and were it to be generally adopted it would go a very long way towards solving the great problem of London fogs.

The motor car, which bids fair to revolutionize the traffic of our roads and streets, had its prototype in a quaint vehicle, built by Trevithick and exhibited in 1802, which attracted dense crowds of people, and in one of its trials, attained the then unheard-of speed of twelve miles an hour. The first Act for a "Surrey Iron Railway" was passed in 1801, and it was in 1804 that the first locomotive engine "drew carriages containing ten tons of bar iron for a distance of nine miles at the rate of five miles per hour," the forerunner of those machines which have now invaded almost every part of the world, even to the very gates of Pekin.

When the century opened, our first President, Thomas Telford, was about midway in his great career, busy with the Ellesmere Canal, a work of national importance extending to a length of 125 miles, and with the Caledonian Canal, well known to us all, which was opened for traffic in 1823. It was as early as 1803 that he commenced the 1,000 miles of road and some 1,200 bridges, which he carried out for the Commissioners of Highland

*Considerably condensed from the original.

Roads and Bridges; whilst the Holyhead Road, laid out about 1815, and the Menai Suspension Bridge, opened in 1826, are crowning monuments of his genius. There had been two previous attempts to tunnel under the Thames, but the problem was only solved when, in 1829, Brunel commenced the Thames Tunnel, and carried it through successfully by means of a shield, opening it to the public in 1843. It is a remarkable fact that British engineers have designed and supervised nearly all the subsequent subaqueous works which have marked the century, notably the Severn, Mersey, Blackwall, and Sarnia tunnels, and the London Bridge, the Waterloo & City, and the Glasgow subways.

Another engineer, who was about at the height of his fame when the century opened, was John Rennie, whose noblest work, that of Waterloo Bridge, was begun in 1809, whilst the remarkable iron bridge at Southwark was commenced in 1815 and opened in 1819. The Bell Rock Lighthouse engaged his attention from 1806 to 1811. His designs for London Bridge were, subsequently to his death, carried out by his sons, Sir John and George Rennie.

One of the most unsatisfactory features in the history of British civil engineering has been the slow progress made in this country, with the introduction of electricity for its three great applications of lighting, traction, and transmission of power. Hampered by restrictive legislation, opposed by vested interests, and encumbered by the by-laws and regulations of official bodies without number, the electricians, who form so important a branch of our profession, have been unable to do justice to their skill. A few railways, especially designed for city traffic, and a comparatively insignificant length of electrical street tramways, have struggled into existence. Some rather better progress has been made with lighting in the chief towns, but it is discouraging to compare the present position of electrical industries with that of similar undertakings in the United States, Germany, Switzerland, Japan, and even in our own Colonies. No powers have yet been obtained for the transmission of energy to a distance, whilst the electrical tramway, hailed as a boon by the inhabitants of almost every town abroad, is still quite exceptional here, and the extension of the system seems doomed to still encounter serious delay. The Metropolitan and Metropolitan District Railway companies of London have only now commenced the experiment upon a question which has been long since practically decided in the United States, that of the electrical haulage of heavy trains, combined with rapid acceleration on starting. Upon this latter important point our American cousins have arrived at the limit of actual safety to passengers.

The century has witnessed a complete revolution in the sanitary engineering of towns and villages, followed by a notable decrease in the death-rate and an improvement in the public health. Thus within the last few years means have been devised, not only to consume and render innocuous the solid products of sewage and of the dust-heaps, but to utilize them as fuel for the electrical installations of towns and other purposes.

Whilst Glasgow, Manchester, Liverpool, Birmingham, and other cities have taken steps to improve their supply of water, inaugurating vast works for this purpose, notably those at Rhayader, now in active progress under the able supervision of our vice-president, Mr. James Mansergh, the metropolis and its suburbs are in this respect in a most unsatisfactory condition, the available sources being often quite insufficient to provide that constant supply which is of such importance to the health of the population.

The telephonic service of this country is at present much behind that of other nations. Metallic returns, possibly automatic exchanges, and far more numerous trunk lines, are called for; and it is to be hoped that, ere long, the telephone and telegraphic wires, with gas, water, and hydraulic mains, will be relegated to proper subways, admitting of easy inspection and repair, and thus reducing to a minimum the present constant interference with street surfaces.

A commencement has been made in the metropolis with improved electric railways running through specially designed tunnels, but this development is not by any means keeping pace with the increase of the population and of the traffic, it having been found difficult to raise capital for such undertakings. One of the most serious difficulties of the situation is the insufficiency of accommodation at the various termini of the trunk railways in London. The Americans have, in their latest terminus in Boston, introduced the important innovation of an underground circular railway for suburban purposes, round which local trains can run, giving a three-minute service, without shunting of locomotives, or any delay beyond a one-minute stop, as at an ordinary wayside station. The increasing unpunctuality of trains on our main lines is becoming a very serious question, in spite of constant enlargements of stations and widening of the railways themselves.

There is still much activity in railway construction in this country. Some 300 miles of new works are under contract, in addition to widening; and improvements in detail are also proceeding apace. Amongst other things, these are shown in the introduction of long runs at high speed without stops, in the increased weight and width of trains, and improved arrangements of rolling stock for the comfort and safety of passengers, such as corridor trains, dining, lunching, and breakfast cars, and sleeping carriages. The main railways are rapidly being provided with separate lines for express and ordinary traffic, and, where these are not continuous, considerable lengths of relief sidings are found necessary. The tendency is towards more space everywhere. Tunnels have been increased from 24 ft. to 27 ft. in width, and a distance of 9 ft. 6 ins. is now required between main and auxiliary running lines. The interlocking, with tight-fitting plungers, of points with the signals; and the introduction of locking bars to prevent any movement of points or signals whilst a vehicle of any sort is standing thereon; the establishment of catch-points, catch-sidings, and runaway points, have all tended to reduce the chance of accident.

The increase of the capital cost of main lines of railways in this country is becoming every day more serious, and indirectly affects the power of Great Britain to hold her own in the markets of the world. I am not, however, prepared to say that the Board of Trade regulations, to which some of this cost is due, are in themselves unreasonable, ensuring as they do the protection of the public from manifold dangers. Taking a fairly representative section of one of the main lines, outside the metropolis, and constructed in recent years, as an example, the percentages of the cost of about £40,000 per mile work out somewhat as follows:

	Per cent.
Land and compensation	10
Fencing	1½
Earthworks	24
Tunnels	12
Viaducts	8
Bridges for roads	9
Accommodation works	2
Culverts and drainage	5
Permanent way, including ballast, main line	11½
Sidings	3
Junctions and signals	1
Stations, including buildings—roadside only	6½
Contingencies, including parliamentary, administration, legal and engineering expenses	6
Maintenance	½
	100

From this abstract it will be seen that for country lines the value of land does not form so important a factor in the total cost as is generally understood. The necessity for very easy gradients and flat curves, in order to admit of high speeds, involves heavy earthworks, viaducts and tunnels, and expensive, well-ballasted permanent way, whilst stations and sidings have to be extensive to accommodate the traffic.

The increased weight of locomotives and tenders, and the high speeds attained, not infrequently seventy miles per hour, have led to the gradual increase of the weight of rails from 56 lbs. or 60 lbs., which were for many years very common standards, to 84 lbs., 90 lbs., and, in some cases for tunnels, to 100 lbs. per lineal yard. It is, however, considerably doubtful whether the economic maximum has not been attained, as already complaints are heard of rigid roads, and injury to tires and springs. The amount expended upon the drainage of both cuttings and embankments has been very wisely increased, and a closer study of natural surroundings has led to the flattening of slopes and consequent diminution of slips, telling favorably upon the cost of maintenance. Efforts are being made to reduce the first cost of secondary or light railways, chiefly by steepening gradients and sharpening curves, but in some cases by reducing the gage. Whether the enhanced cost of working and maintenance will counterbalance the seeming advantage remains to be proved by the test of lengthy experiment under ordinary traffic conditions. Far more economy will result from omitting fencing except where absolutely necessary; from reducing the width of formation of the earthworks; from substituting level crossings without lodges or gates for public and private bridges; from reducing the weight of rail, and the depth and width of ballast; from modifying the station arrangements, and doing away with raised platforms and complicated signalling; and from arranging for lighter locomotives and reduced speeds.

The question of gage has been a very vexed and difficult one. As we all know, the standard gage of 4 ft. 8½ ins. is an empirical one, growing out of the gage of the old tramways or plateways of the collieries, which were the forefathers of the railway system, and which were themselves based on the average gage of road vehicles. Then came the battle with the gage of 7 ft. ½-in., resulting, after serious expenditure, in the triumph of the more moderate dimension and of uniformity of gage. It seems remarkable that this question of uniformity of gage for the railways of any country should, after the battle of the gages in England, and the full discussion of the subject in this Institution in connection with India, again come to the front, and form one of the most important topics for our Conference this summer. It is well known that great variety of gage at one time existed, both in the United States and in Canada. Attempts were made to overcome the serious drawbacks of handling and transhipment, where the gages only differed by a few inches, by the adoption of "compromise" cars, with wide treads on their tires. The tendency there, however, of late years has been to adhere to the standard of 4 ft. 8½ ins., to which the railways of Canada have also been made to conform by the removal of the 5-ft. 6-in. and 3-ft. 6-in. gages. In India and in the Argentine, we have the painful spectacle of trunk lines of 5-ft. 6-in. gage, surrounded by auxiliary or competing systems on the meter gage, with certain special lines lately introduced in India on the 2-ft. 6-in. gage. At the Cape of Good Hope the standard is 3 ft. 6 ins., the same as that adopted for the Soudan railways, destined some day to connect with them; whilst, most unfortunately, the Uganda Railway, which will join up with this system, is being constructed on the meter gage, thus differing only by 2⅝ ins., but nevertheless involving all the drawbacks of transhipment and isolation. At the same time a large expenditure is being incurred in Mashonaland to widen a narrower gage railway, some 200 miles in length, to the standard gage of 3 ft. 6 ins. In Australia a multiplicity of gages exists, owing to independent action on the part of the several Colonies.

Since the removal from the Great Western system of the 7-ft. ½-in. gage, the standard gage had, until within the last few years, been maintained in England for passenger lines, except in the special case of the Festiniog Railway and one or two other short lines. Of late, however, certain railways have been sanctioned by Parliament on narrow gages, and the Light Railway Commissioners have admitted no fewer than five varying gages, from 4 ft. 8½ ins. down to 2 ft. The Railway Section of our recent Conference, which was largely attended, expressed a very strong opinion as to the serious drawbacks which must accrue from this. There is a false impression in the public mind that gage has a dominating influence over the first cost of a railway. Now that, by the use of the bogie truck, sharp curves can be readily introduced upon the standard gage, the economy resulting from reduction of gage is less than ever.

British engineers have two chief bodies of competitors to reckon with, the engineers of the great and growing empire of Germany, and those of the United States, who have been thoroughly trained in theory and practice, and are proving their ability and courage by the vast works they originate and carry out. German and other continental engineers are greatly assisted in many ways by paternal governments, whose officers they generally are, and who lay down valuable regulations, and in many instances establish standards of quality and design. American engineers are encouraged by the vast demands of a comparatively new country, in which nature exists on a magnificent scale, only equalled by Switzerland and India, and of a rapidly rising civilization, calling loudly for the most recent improvements in locomotion, in building, in lighting, in telephonic and telegraphic communication.

An important matter demanding careful consideration by civil engineers, if not by the Institution itself, is whether competition in the world's race could be facilitated by the establishment, upon sufficient authority, of standard specifications for such materials as steel and cement, and the introduction of standard types for bridge-work, roofing, and other structures, frequently occurring in practice, and for locomotives and rolling stock. Care must be taken not to stereotype the details of design so thoroughly as to throw difficulties in the way of improvements; but the experience with the Atbara Bridge shows how important it is, when early delivery is a necessity, to be prepared with type designs, based upon ordinary merchant sections of steel. This, however, is already carried out by British engineers engaged upon railway extension in the Colonies, India, and elsewhere abroad. It is hardly practicable in thickly settled countries, where local circumstances involve variation in almost every span. In the case of the Liverpool Overhead Railway every effort was made to duplicate as far as possible, yet, for some 660 spans, over 1,000 drawings were found to be necessary.

The question of the adoption of the metric system has been ably dealt with by others. I therefore only desire to record my opinion that it of the utmost importance to the engineers and traders of this Empire that this simple and effective mode of measurement, already in force in almost every other civilized nation, should be introduced here. Having had occasion for many years to work under both systems, I can bear testimony to the great saving of time and of labor effected by the use of the metrical weights and measures, and to the ease with which the system is acquired, even by those trained to use our antiquated and complicated standards. I am strongly of opinion that the two great Anglo-Saxon nations, Great Britain and the United States, must fall into line with the rest of the world in this matter, and it would be a notable and interesting mark of our entry into a new century if, as has already been suggested to our Government, the metric system could be made compulsory as from A. D. 1900. One great obstacle to British designs and manufactures finding their way upon equal terms through the continent of Europe, and into the vast empire of China, Japan, and elsewhere, would thus be removed, and engineers throughout the world would be thinking and designing upon a basis of like dimensions.

The present and probable size of ships is a question of great importance to engineers. Provision has already to be made in dock entrances for a length of 600 ft., with a beam width of 64 ft. and a draft of 30 ft. 3 ins., but these dimensions show a tendency to steady increase, a demand having already arisen for accommodation in dry-docks for a length of 800 ft. and a draft of 32 ft. 6 ins. The use of concrete for dry-docks and entrances is becoming more general, and, combined with this, entrances are being made rectangular in section, the invert being practically level.

Very remarkable results have been obtained in dealing with river bars, such as that of the Mersey, by the use of sand pump dredgers, which, from their simplicity and the position of the intake pipe, can operate in a sea which would be quite unsafe for bucket dredgers. Hydraulic engineers have been giving close study to wave effects under different circumstances, and improvement has in consequence taken place in the design of walls exposed to their influence.

Under the head of machinery the question of competition with other nations is of serious import. As careful trial is being made by several of our leading firms of foreign and American machinery, our manufacturers need to give special attention to all labor-saving appliances. Much has been said lately as to the introduction of locomotives of American manufacture into this country. It has been shown that the efficiency of a locomotive is greatly affected by the "construction gage." Unfortunately, as has been pointed out by Mr. Webb, this is limited in Great Britain to about 9 ft. by 13 ft., whilst in the United States locomotive engineers may go up to 10 ft. 6 ins. by 15 ft. This enables them to introduce much larger boilers, increasing both economy and power. When our transatlantic brethren have to compete under the British restrictions, there should be no reason why our English and Scotch manufacturers should not hold their own.

There is no department of engineering which has benefited more by the inventive genius of the century than that of mining. Improved methods of sinking deep shafts, tubbing backwater, and winding at high speeds from great depths, have enabled much coal to be opened up. Electricity has been impressed into the service with most beneficial results, not only of economy, but of safety and improved sanitation; and is now largely used for underground haulage, for lighting, for pumping at the face, and in the shape of telephones for communication. In dealing with gold and other ores, chemistry, electrolysis, and mechanical engineering have combined to reduce cost and waste. Every effort is still necessary on the part of our mining engineers to face the competition and the labor-saving appliances, not only of Belgium and Germany, but still more of the United States. It is surely to be regretted that it has been found necessary to obtain so large a portion of the mining machinery for our Colonies from our transatlantic cousins.

The progress of late years in all the details of shipbuilding, both for war and for commerce, has been most remarkable. Not only has the introduction of mild steel, as already mentioned, given to the naval architect the same advantages which have accrued to the bridge designer, but great improvements have been introduced in detail; and this, combined with the adoption of the twin screw and triple expansion, has led to remarkable results. Continuous speeds up to 23 knots per hour have been attained by passenger steamers, with much higher results by "destroyers." The capacity of cargo vessels is now being raised to 25,000 tons at 40 cu. ft. per ton measurement, and 12,200 tons of dead weight. Special designs have been introduced for carrying oil in bulk, and for the cattle trade; the latter vessels having pens to carry 800 head, whilst steamers with insulated holds of capacity for 100,000 frozen sheep have been constructed.

The problems now opening up to the civil engineer are of surpassing importance. Trunk railways through Russia, China, Persia, Africa; irrigation works to supply the wants of growing populations; harbors large enough to receive the vessels of the future; central installations to furnish lighting, power, traction, and heating to whole counties; the extension of the telephonic communication —with and without wires; the abolition of the smoke and smell of cities; the replacement of horses by mechanical power in the streets; the increase of the speed of trains to 100 miles per hour; the erection of buildings of great height, where land is valuable; the utilization of waste products, especially the refuse of cities; the improvement of the water supply; the reclamation of land; the profitable working of deep seams of coal.

These are but some of the branches in which engineering progress in the twentieth century may be expected to develop. They will call with increasing force for engineers sanguine for the future, educated upon a basis of sound scientific attainment, trained in experimental research, and qualified by practical experience.

It will be essential for our successors to maintain a high standard of professional loyalty and cohesion, a strong sympathy between chief and assistant, an absolute integrity as regards the interests of clients, and rigid impartiality in the administration of contracts, or the settlement of disputes. Our aim as a profession must ever be to leave behind us works of efficiency and stability, combined with economy of first cost and maintenance, and, at the same time, structures which shall as far as possible conform to true æsthetic taste and feeling. I am one of those who believe that destiny, whether it be of a nation or of an individual, depends upon character. Most earnestly, then, must we strive to hand down from generation to generation the tradition that to be a civil engineer implies the possession of high qualities, not only in intellect, but of character and heart.

CONCRETE-STEEL DUST FLUE CONSTRUCTION; ARKANSAS VALLEY SMELTING CO., LEADVILLE, COLO.

A novel use of concrete-steel construction is exhibited at the works of the Arkansas Valley Smelting Co., at Leadville, Colo., where the dust flue conveying the smoke and gases from the roasting furnaces to the chimney is built of concrete, with an embedded metal skeleton. The flue is U-shaped in plan, with one leg of the U shorter than the other. The sulphurous gases from the

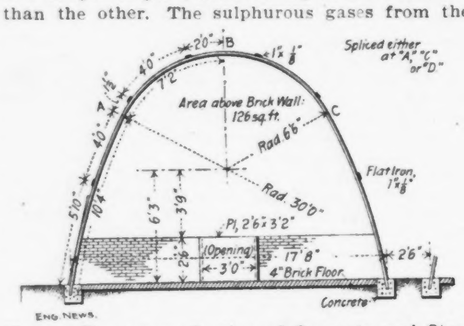


Fig. 1.—Transverse Section of Concrete and Steel Skeleton Dust Flue; Arkansas Valley Smelting Co., Leadville, Colo.
E. H. Messiter, Chief Engineer.

roasting furnaces enter the short leg of the U from a tunnel below; pass around the loop, being somewhat cooled, and depositing in the passage the valuable dust which it contained; and, finally, pass out of the chimney into which the long leg of the U enters. Brick riffle walls placed at intervals across the bottom of the flue aid in collecting the dust. The flue was designed by Mr. E. H. Messiter, the Engineer of the company.

The construction of the flue is quite clearly shown by Figs. 1 and 2. Fig. 1 is a cross-section showing the main arch members, which are simply iron channel hoops bent to an arch and having their ends set in a concrete base wall. Between the base walls is a concrete floor resting directly on the ground. The channel iron arches are connected longitudinally by flat iron members connected to the channels by clinched staples. Fig. 2 shows this connection, and also shows the arrangement of the lathing of expanded metal, which was fastened to the inside of the main flat and channel iron skeleton. The expanded metal lathing and main skeleton were finally embedded in mortar composed of 1 part German Portland cement to 3 parts sand, to make a wall 2¼ ins. thick, except at the crown, where a furnace slag concrete was employed. The inside of the wall was given a wash of neat cement paste. In one side of the wall a space was left for an iron plate door. The various other details of the construction are clearly shown by the drawings. Mr. Messiter, the engineer, states that the iron skeleton was erected by day labor, and the plastering was done by ordinary plasterers. He also states that the flue is very rigid and that the cost of the work was quite reasonable.

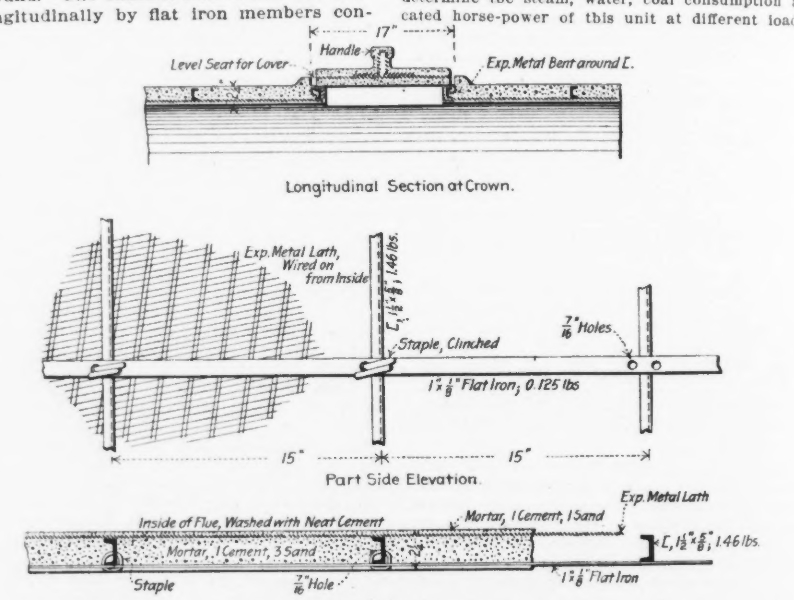


FIG. 2.—STRUCTURAL DETAILS OF CONCRETE AND STEEL SKELETON DUST FLUE.

TEST OF A 300-KILOWATT DIRECT-CONNECTED RAILWAY UNIT AT DIFFERENT LOADS.*

By Edward J. Willis, Assoc. M. Am. Inst. E. E.†

In 1896 the writer designed and there was installed under his supervision a steam installation of two 300-K.W. direct-connected railway units for the Richmond Traction Co. On March 30, 1897, as superintendent of that road, he had opportunity to test the steam, water, coal consumption and electrical output of one of these units at different loads and it is this data which is listed below.

Description of Units.—Boilers—One 300-HP. Campbell & Zell water-tube boiler with 3,000 sq. ft. submerged heating surface.

Engine—16×30×42 Hoover, Owens & Rentschler horizontal tandem compound condensing engine, double eccentric, 100 revs. per min.

Generator—300-K-W., 6-pole, steel frame, General Electric railway generator.

Piping—The piping is practically what is known as standard, being an 8-in. spring from boiler to 14-in. steam-header and 6-in. spring from steam-header to throttle. A short 14-in. exhaust pipe exhausts through a Hartford heater into a Deane jet condenser.

Method of Making Test.—A large water rheostat was provided, capable of handling the full output of the generator, and a Weston ammeter and voltmeter were placed upon the circuit of the generator. By this means the output of the generator could be fixed, maintained and measured at any desired point. The system of piping permitted the feed pump and condenser to be operated by a separate boiler, so that all the steam generated by the boiler passed through the engine. All valves were tested and made tight. A Worthington hot-water meter was thoroughly overhauled before the test and was accurately tested before and after the run. The water and steam consumptions are those given by this meter. The coal fired during the test was Pocahontas run of mine, giving probably 13,000 B. T. U. Draft at grate during run, ⅝-in.. Indicator cards were taken as nearly every 15 minutes as possible off both ends of each cylinder, and also simultaneous readings of coal, water, electric output and the other items mentioned in the table. The object was to determine the steam, water, coal consumption and indicated horse-power of this unit at different loads. The load was as follows: For 1 hour at 200 amperes, the next hour at 300 amperes, the next hour at 400 amperes, the next hour at 500 amperes, and it was intended to place the load the next hour at 600 amperes, but under such steady load the machine became too warm and instead the load was continued for two hours at 500 amperes.

Remarks.—It is regretted that the point of load could not be carried higher, but it is to be remembered that railway generators are usually designed for fluctuating loads

*From a paper presented before the American Institute of Electrical Engineers.
†Superintendent Richmond Traction Co., Richmond, Va.

and that such steady loading as given in this test is likely to cause considerable heating. It is further unfortunate for the sake of accuracy that on account of the need of a generator for the operation of the road, the duration of each test could not have been made greater, since the determination of coal and water consumption for such short periods of time are almost always attended with unavoidable inaccuracies. The water rheostat was composed of two sheets of boiler plate 5 × 6 ft. each. By means of soda the conductivity of the liquid was brought to the desired point. With light loads and before the water commenced boiling completely, there was some fluctuating in amperage, but after the water got to boiling thoroughly, the load could be maintained perfectly steady. At 500 amperes there was about 15 sq. ft. of each plate submerged. The water evaporated by the boiling was replaced by a hose connection and the water level in the rheostat tank thereby maintained constant. The writer would state that in his experience with rheostats of any size, if a steady load is required, it is better to let the water come to a boil and the plates remain steady, replacing the evaporated water with a running connection, than to attempt the continual raising and lowering of the plates.

This test was made to confirm the writer's opinion that it was advisable with railway units carrying fluctuating loads to install a double eccentric under-sized engine, and that better running economy could thereby be obtained than by the installation of the usual larger and more expensive engine. It will be noticed that the engine gave its best steam economy at about 400 amperes, and as the average load on this engine is lower than this, the wisdom of the installation for this plant of so small an engine for the 300-K-W. units is plainly shown.

Calculated Results of Tests.

	Amperes.			
Load	200.	300.	400.	500.
Power: Indicated HP.	216	299	373	469
Electrical HP.	146	220	293	369
Kilo-watts	110	164	219	275
Evaporation, lbs.:				
Water per lb. of coal (actual)	10.05	10.8	8.94	8.57
From and at 212° F.	10.71	10.75	9.53	9.18
Coal consumed, pr I. HP. hr., lbs.	1.45	1.43	1.54	1.66
Per electric HP., lbs.	2.18	1.94	1.96	2.11
Per K-W. hour, lbs.	2.90	2.60	2.63	2.83
Steam, lbs.: Per I. HP. hr.	14.8	15.3	13.8	14.25
Per electric HP. hour	21.9	21.9	17.53	18.1
Per K-W. hour	29.1	28.1	23.46	24.3
Efficiencies: I. HP., per E. HP.	1.48	1.36	1.27	1.27
Electric HP. per I. HP.	.68	.74	.79	.79
I. HP. per K-W.	1.96	1.82	1.70	1.70

THE COAST AND GEODETIC SURVEY STEAMER "Pathfinder" has been sent from San Francisco to Hawaii, where she is to survey and chart the channels and harbors. She will also make surveys for the landing of the proposed Pacific cable, and also select sites for the possible connection of some of the islands by the Marconi wireles telegraphic system.

TESTS OF MARCONI'S WIRELESS TELEGRAPHY on the vessels "Massachusetts" and "New York" have been completed and reported upon by the inspecting board, composed of Lieut.-Comdr. J. T. Newton, Lieut. J. B. Blish, and Lieut. F. K. Hill, as follows:

We respectfully submit the following findings as the result of our investigation of the Marconi system of wireless telegraphy:

(1) It is well adapted for use in squadron signaling under conditions of rain, fog, darkness and motion of ship. The wind, rain, fog and other conditions of weather do not affect the transmission through space, but dampness may reduce the range, rapidity and accuracy by impairing the insulation of the aerial wire and the instruments. Darkness has no effect. We have no data as to the effects of rolling and pitching, but excessive vibration at high speed apparently produced no bad effect on the instruments, and we believe the working of the system will be very little affected by the motion of the ship.

(2) The accuracy is good within the working ranges. Cipher and important signals may be repeated back to the sending station, if necessary to secure absolute accuracy.

(3) When the ships are close together (less than 400 yards) adjustments (easily made) of the instruments are necessary.

(4) The greatest distance that messages were exchanged with the station of Navesink was 16½ miles. This distance was exceeded considerably during the yacht races, when a more efficient set of instruments was installed there.

(5) The best location of the instruments would be below, well protected, in easy communication with the commanding officer.

(6) The spark of a sending coil or of a considerable leak due to faulty insulation of the sending wire would be sufficient to ignite an inflammable mixture of gas or other easily lighted matter, but with the direct lead (through air space, if possible) and the high insulation necessary for good work, no danger of fire need be apprehended.

(7) When two transmitters are sending at the same time, all the receiving wires within range receive the impulses from transmitters, and the tapes, although unreadable, show unmistakably that such double sending is taking place.

(8) In every case, under a great variety of conditions, the attempted interference was complete. Mr. Marconi, although he stated to the board, before these attempts were made, that he could prevent interference, never explained how nor made any attempts to demonstrate that it could be done.

(9) Range of signaling: Between large ships (heights of masts 130 to 140 ft. above the quarter deck), the range is at least 35 miles at sea and 16½ miles or less when tall buildings of steel frames interfere. Between a large ship (height of mast, 140 ft.) and a torpedo-boat (height of mast 45 ft), across open water, signals can be read up to 7 miles on the torpedo boat, and 8½ miles on the ship. Communication might be interrupted altogether when tall buildings of iron framing intervened.

(10) The rapidity is not greater than 12 words per minute for skilled operators.

(11) The shock from the sending coil of wire may be quite severe and even dangerous to a person with a weak heart. No fatal accidents have been recorded.

(12) The liability to accident from lightning has not been ascertained.

(13) The sending apparatus and wire would injuriously affect the compass if placed near it. The exact distance is not known and should be determined.

(14) The system is adapted for use on all vessels of the navy, including torpedo boats and small vessels, as patrols, scouts and dispatch boats, but it is impracticable in a small boat.

(15) For landing parties the only feasible method of use would be to erect a pole on shore and then communicate with the ship.

(16) The system could be adapted to the telegraphic determination of differences of longitude in surveying.

The board respectfully recommends that the system be given a trial in the navy.

A LOCOMOTIVE CABLE-LAYER was employed, on Nov. 22, in relaying the telegraph cable connecting Randall's and Ward's Islands with the Bronx district. The distance across Bronx Kills was 600 ft., and the new cable weighed about 3 tons. The method pursued was as follows: The cable was stretched across Randall's Island in the line of the crossing and 1,000 ft. of 1½-in. rope was attached to it and led to a powerful freight locomotive, stationed on the track running across St. Ann Ave., and this rope was passed over a snatch-block, placed on the line. When all was ready the locomotive moved off and the cable was pulled across in 11 m. 33 s.; though the strain on the rope was considerable as the cable pushed through the muddy rived bed.

ABUTMENT PROTECTIONS for the Niagara Falls steel arch bridge have recently been completed. In the great ice-jam last winter, the ice gathered about the abutments in such quantities as to endanger them seriously, and the owners of the bridge were forced to blast away the mass with dynamite. The new protections are designed to obviate the recurrence of this danger. The abutment skewbacks of the bridge are four in number. They are located in pairs very close to the water's edge, and the members of each pair are about 68 ft. 9 ins. apart. In order to protect them the International Traction Co., which controls the bridge, has built walls between the abutments and the river. The wall on the Canadian side is laid on a concrete foundation, placed about 4 ft. below the normal water line. Its width at the foundation is 9 ft. and at the top 3 ft., and it is 24 ft. high. Its length, including the wing on the upper side is 150 ft. The wing has an angle of 30° to the face. The wall is made of concrete with embedded rubble stones. The Portland cement concrete was built in a form, and into the concrete were rammed stones of various sizes, the largest having a volume of about 1½ cu. ft. The wall has a concrete face, front and back, and its object is to serve as a fender and also to prevent the ice from squeezing into the iron work of the arch, as it did last winter. The back of the wall is to be filled in with earth and rock. The wall on the New York side was carried down to bed rock, the main part being built about 8 ft. below the normal water mark. It rests on red sandstone and Medina stone. The foundation is concrete laid under water. Everything below water was laid with Portland cement mortar, 2 to 1, with 4 parts of stone and the proportions above water were 3 to 1 to 5. The main part of the wall on the New York side is 70 ft. long, with a wing 50 ft. long on the up-stream side. The bottom of the wall is 10 ft. wide, and the top 3 ft. wide, and it is 24 ft. high. The work was done by the International Traction Co. under the personal supervision of its engineer, Mr. Walter McCulloh. It is also stated that some parts of the iron work of the bridge are being strengthened.

THE ENLARGEMENT OF THE CARNEGIE STEEL Co.'s Works, now in progress, includes 14 new basic open-hearth steel furnaces, with a capacity of 1,500 to 2,000 tons of open-hearth steel per day; and a new blooming mill to break down ingots. Two more furnaces will also be added to two Corrie furnaces bought from the Fownes Bros. several years ago; they will each be 106 ft. high and 24 ft. diameter at the bosh, with a capacity of 700 tons of metal per day each. As an index of the increasing prices, it is reported that the Federal Steel Co. has bought 500,000 tons of Biwabik ore at $3 per ton at upper lake ports, with $1.25 carrying charge, or $4.25 per ton at lower lake ports. Last year's prices on ore were $1.60 per ton at upper lake ports, and $2.20 at Cleveland, Erie or Ashtabula; and this is still the price on all 1899 delivery, for which contracts were made in the fall of 1898, at an advance of 20 cts. per ton over previous prices. The above $4.25 is on 1900 delivery, and it looks as if the ore men were trying to get square.

THE TOTAL VALUE OF MINERAL PRODUCTS of the United States, for 1880-1898, is given by the U. S. Geological Survey, along with a tabular statement of the amount of each product, for the years 1889-1898 inclusive. As showing the growth in these industries, it is sufficient to give the values for a few years in this series, as follows:

	1880.	1890.	1898.
Metallic products	$190,039,865	$305,735,670	$343,400,907
Non-metallic "	173,279,135	312,776,503	353,419,765
Unspecified	6,000,000	1,000,000	1,000,000
Totals	$369,319,000	$619,512,173	$697,820,720

The metallic products include pig-iron, silver, gold, copper, lead, zinc, etc. The non-metallic include coal, stone, petroleum, natural gas, cement, phosphate rock, limestone, clay, etc.

THE OROYA RAILROAD FEVER OF PERU.

By Albert S. Ashmead, M. D.

The following account of Peruvian Verrugas will be interesting to engineers going to South America:

Peruvian, or Andes Verrugas, exist endemically in some valleys of the Andes. It is special to Peru, Ecuador and Bolivia, where probably the Incas have known it. Its principal habitat is the valleys of Huarochiri, Yanyos and Cauto. Tschudi gave, in 1843, a description of it, a paragraph of which is here reproduced:

In many of the valleys of the road running from the coast to the mountains, especially in the Valley of Surco, there are certain springs from which the Indians never drink water. When a stranger approaches them to quench his thirst they cry to him: "It is the water of Verruga!" They do not permit even their horses or mules to refresh themselves from these springs, the waters of which they suppose have the effect to produce that malady. As the existence of this disease is not known in any other country, there is apparent reason for believing that it has its origin in some local circumstances.

It is well to add here that Peruvian Verrugas attacks not only men, but sheep, mules and horses. It is attributed solely to water by the natives, but as people who dreaded water, and, therefore, did not use it, still got the disease, there must be another mode of infection. Men are said to have contracted it by working in ores sent from mines in places where Verrugas exists.

The symptoms are as follows: Malaise, shiverings, fever, pains in muscles, bones and joints. If the patient does not die, weeks or months afterwards, he gets an eruption, copious or scanty, of one or ten papules; later on a few more; sometimes on the body, or legs or arms. These do not suppurate like little boils, but gradually disappear; one or two becoming fungous; that is, they project more and more above the level of the skin; they lose their skin covering, and are then red and raw, and bleed easily. They vary from the size of a pea to that of the palm of the hand, projecting above the surrounding level a quarter of an inch or more. Often a ligature is applied about the base to stop the oozing of blood and hasten their fall. As a rule they leave no scar. Naturally the patient presents an anemic appearance, even if he does not suffer from hemorrhages. Once he gets well, he is well for good; there appear no sequelæ. No treatment seems effective, or is agreed upon excepting warmth, in the hope of hastening the coming out of the eruption. The natives give a "ptisan" (tea) of maize, and a plant called cat's-nail.

D Ernesto Odriozola has given an interesting account of this disease, which first attracted general medical attention by the ravages it caused among the workmen, who, in 1871, were engaged in constructing the railroad line between Lima and Oroya, in Peru. At first the disease was thought to be malaria, which was already of frequent occurrence in the district; then it came to be looked upon as the pyrexial stage of a disease which showed itself as larger or smaller reddish nodules or new growths (wart-like) on the mucous membranes, skin and subjacent tissues. These lesions were known as Verrugas (warts), and the proof that a pyrexial (fever) stage occurred exactly similar to the fever which had wrought so much havoc among the railroad men, was furnished by a medical student at Lima, named Daniel Carrion, who heroically inoculated himself with some of the lesions, and died six weeks later. In his case the disease passed through all the stages characteristic of the Oroya fever, and for the future it was universally held that this fever was a pyrexial stage of the disease known as Verruga peruana.

Treatment of the disease with quinine is unsatisfactory, in spite of the resemblance to malaria which it presents. Nor does mercury have any effect upon it, even in those cases where it occurs in a child born of an infected (syphilitic) mother. It should be remembered that the disease is inoculable in animals as well as human beings. Probably as good treatment as any would be an anti-grippe treatment, for the pyrexial stage, 3-grain doses of phenacetin and 5-grain doses of salicylate of soda 4 times a day, with sweating medicines besides. In the warty, or Verrugas stage, which comes on 6 weeks to 2 months after the fever stage is aborted, the best treatment would be to apply chromic acid to the warts, 10 grains to an ounce of water, to be cautiously painted over the bleeding sore with a camel's hair brush once or twice a day, until the oozing ceased. Supporting measures and iron are necessary to overcome the anemia.

Those who do not drink unboiled water will not contract Peruvian Verrugas.

DESIGNS FOR THE "DENVER" CLASS, SHEATHED PROTECTED CRUISERS, U. S. NAVY.*

By Philip Hichborn, Chief Constructor, U. S. N.

(With two-page plate.)

The act of Congress, approved March 3, 1899, provided for three sheathed sea-going battleships of about 13,500 tons trial displacement, at a cost for hull and machinery not to exceed $3,600,000 each; for three sheathed armored cruisers of about 12,000 tons trial displacement, at a cost for hull and machinery not to exceed $4,000,000 each, and for "six protected cruisers of about 2,500 tons trial displacement, to be sheathed and coppered, and to have the highest speed compatible with good cruising qualities, great radius of action, and to carry the most powerful ordnance suited to vessels of their class, and to cost, exclusive of armament, not exceeding $1,141,800 each." The act further provided that "in no case shall a contract be made for the construction of the hull of any vessel authorized by this act until a contract has been made for the armor of such vessel." The limiting price for the armor of these vessels was fixed by the same act at $300 per ton, and the effort to make contracts within this limit was unsuccessful. The designs for the battleships and armored cruisers have proceeded slowly on this account, and will not be submitted for the Navy Department's action for some time to come. I am unable, therefore, to present these designs for this year's proceedings.

The question of armor not being involved in the case of the smaller cruisers, the designs for these vessels were completed and bids invited for their construction under the usual conditions, allowing bidders to submit proposals on the plans and specifications issued by the Department, or on their own plans and specifications, based upon certain requirements outlined in the Department's circular issued about Aug. 1 for the information of shipbuilders. (The bids for these cruisers were received Nov. 1, and were published in our issue of Nov. 9, 1899.—Ed.)

The chief characteristics of the design for these cruisers were settled and approved by the Department before the final preparation of the general plans. These characteristics show the vessels to be about the size of the "Raleigh" and "Cincinnati," which, though they have been classed as 19-knot vessels, with more than double the horse-power of the present designs, have never been able, owing to certain well-known conditions, to maintain a speed even approximating to the rated 19 knots for any length of time. The "Raleigh," when with Dewey's squadron, was only able to steam, with difficulty, at a speed of 9 knots, using three-fifths of the boiler power. The coal supply of these vessels was also limited, and the coal consumption was a serious question when making passage between distant ports.

In the new designs a liberal allowance has been assigned to all the principal weights, and there has been no attempt to secure "fancy" results either on paper or on trial. They have been designed for hard service, and the offensive and defensive properties, suitable speed, durability, habitability, etc., were carefully considered in determining their characteristics. Owing to the nature of the service which they were likely to perform, independence of coaling and repair stations, as far as possible, was believed to be an important consideration.

In view of the fact that the vessels were to be sheathed and coppered, and that the machinery was to be liberally proportioned, a speed of 16½ knots, as representing the capacity of the vessel at all times, was considered sufficient, and easily places the ships in the class with our earlier vessels making 19 or 20 knots on a forced trial with clean bottoms.

The coal supply is represented by a bunker capacity of 700 tons: sufficient to give them a radius of action at full speed of nearly 2,500 knots, and at the most economical rate of steaming—probably in the neighborhood of 10 knots per hour—they will be able to steam about 7,000 knots without re-coaling. This would cover a continuous trip from San Francisco to Manila.

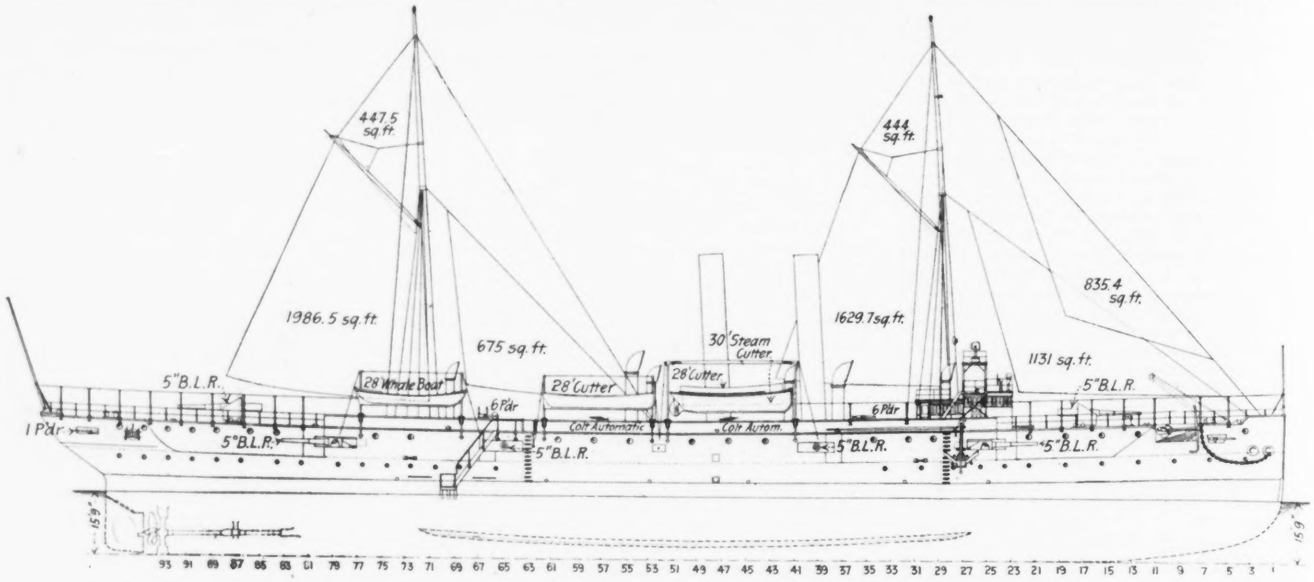
Careful consideration has been given to the strength of the vessels, and the scantlings are unusually heavy. The frames are spaced 36 ins. throughout the length of the vessel. The inner bottom will be 204 ft. in length, divided into 29 compartments. Between the inner bottom and the protective deck there will be 67 water-tight compartments, and above the protected deck 39, making a total of 135 compartments in the vessel. They will have three complete steel decks. There will be three longitudinals on each side of the water-tight 34-in. vertical keel, in addition to the bilge stringer and side stringer. The protective deck will be water-tight and ½-in. in thickness throughout. In addition there will be 2 ins. of nickel steel 8 ft. in width on each slope, for a length of 105 ft. in the wake of the machinery. Forward and abaft this on the slope the ½-in. plating will be doubled. The ram bow has been entirely omitted, it being considered unnecessary for this class of vessels. Being sheathed, the stem, stern-post, shaft struts, and rudder will be of manganese bronze. The wood sheathing will be of Georgia pine, fitted in a single thickness of 4 ins., secured by composition bolts tapped through the plating, and with nut and washer on the inside. The copper sheathing will be of 28 to 32-ounce material.

Over the protective deck and along the water-line a coffer-dam 27 ins. in width and about 4 ft. in depth will be fitted; the top of the coffer-dam being about 2½ ft. above the normal, or 15 ft. 9 in. water-line. Fireproofed corn-pith cellulose will be used as obturating material. This will be packed to a density of 8 lbs. per cu. ft., the total capacity of the coffer-dam at this rate being about 24 tons.

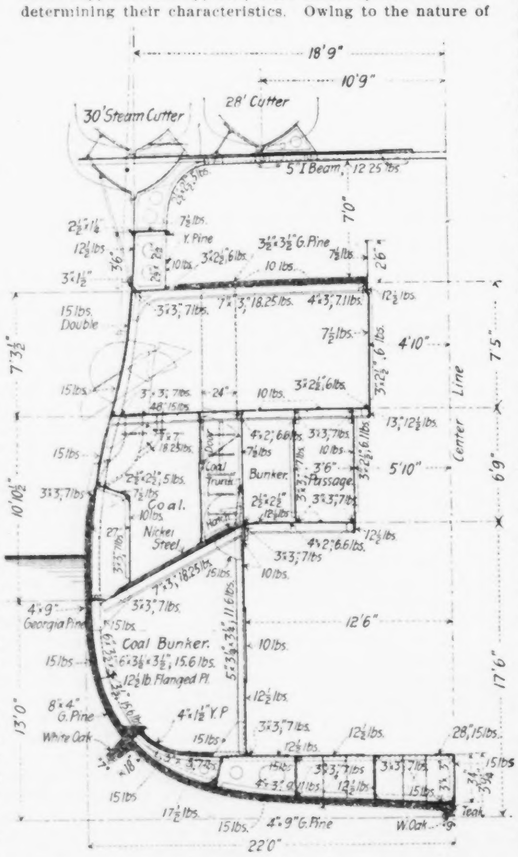
The main deck will be the only one planked with wood, and this wood, together with all other wood used in the construction of the vessel, except outside sheathing and that used for special purposes, such as electric wire moldings, will be treated with an approved fireproofing process before being worked into the ship. Careful attention has been given to reducing the amount of woodwork in the ship to the minimum. Stateroom bulkheads and the like will be of corrugated metal.

As previously stated, a liberal allowance has been made for machinery weights, the engine-room weights per indicated horse-power being about 10% heavier than is the case with the "Raleigh" or "Detroit" classes. The total machinery weight is somewhat reduced, proportionately, by the use of water-tube boilers and high pressures. The ventilation of machinery spaces will be thorough, and not subject to the criticism to which the "Raleigh" and "Cincinnati" were exposed.

The armament of each of the vessels will consist of a main battery of ten 5-in. guns of 50 calibers length, and a secondary battery of eight 6-pdrs., two 1-pdrs., four Colt's automatic guns, and one 3-in. field gun. Eight of the 5-in. guns will be mounted on the gun deck in recessed ports; the forward pair having a range from directly forward to 60° abaft the beam, and the second pair from 83° forward to 60° abaft the beam, the four after guns being similarly placed as regards stern fire. The two remaining 5-in. guns will be mounted behind shields on the main deck, one forward and one aft. Four 6-pdrs. will be mounted on



GENERAL ELEVATION OF "DENVER" CLASS SHEATHED PROTECTED CRUISER, U. S. NAVY.
Rear Admiral Philip Hichborn, Chief Constructor, U. S. N.



Half Transverse Section Through Engine Room and Bunkers; "Denver" Class Sheathed Protected Cruiser U. S. N.

*Abstract of a paper read at the seventh general meeting of the Society of Naval Architects and Marine Engineers, held in New York, Nov. 16 and 17, 1899.

the gun deck, two forward and two about amidships, and the other four 6-pdrs. will be located on the main deck. The two 1-pdr. guns will be mounted aft on the gun deck, and the Colt machine guns on top of the hammock berthing amidships. The plating around the gun ports of the gun-deck battery will be thickened up with nickel steel to 1½ ins. The shields of the 5-in. guns on the main deck will be of 2-in. nickel steel.

The ammunition supply will be unusually large, and will include 250 rounds for each of the 5-in. guns, and 500 rounds for each of the 6-pdrs. The use of smokeless powder is contemplated for all ammunition, and special appliances will be fitted for keeping the temperature of the magazines to a minimum. The nature of these appliances will depend somewhat on the results of experience with the battleships now building.

Each vessel will be fitted with a distilling plant, ice machine, refrigerating rooms, electric ammunition hoists, winches and blowers, two search-lights, electrical signaling and other outfits. Storerooms for various purposes will be ample and commodious. The electric generating plant will consist of four units, each with a rated output of 300 amperes at 80 volts.

The complete deck over the battery adds greatly to the efficiency of the design. The complement of crew assigned to each vessel is 263, including 27 marines. These can be readily accommodated. In fact, 450 men could be berthed without discomfort, and the vessel can, therefore, be used to advantage in transporting relief crews to foreign stations, or for other similar service.

Dimensions and particulars of the design, including weights and other data, including machinery, are given in the accompanying table, and plates are appended showing the general arrangement of the vessels.

So much has been published about the cruisers built for the Brazilian government, and purchased by us just prior to the outbreak of hostilities with Spain, that I cannot refrain from presenting a few facts—principally because the published statements have been used for the purpose of making unfavorable comparisons with our new designs. One of these publications, for instance, in a prominent scientific paper, contained cuts of the vessels, with certain particulars headed, respectively, "The 3,500-ton protected cruiser 'New Orleans'" and "The proposed 3,500-ton semi-protected cruiser 'Denver' and class." It takes but a glance to discover the first gross error in this comparison, for those familiar with the facts—the "New Orleans" having left the New York Yard a short time ago, in ordinary full-load condition, displacing over 4,000 tons. Under exactly similar conditions, the "Denver" and class will displace only 3,500 tons, and at this displacement the actual weight of ammunition carried and the actual weight of stores aboard will be greater than in the case of the "New Orleans" at 4,000 tons. Moreover, the coal will be practically the same, for the "Denver" will stow and carry 700 tons readily on 3,500 tons displacement, while the most that has ever been in the "New Orleans'" bunkers as far as is known—and certainly what was in her bunkers when displacing the 4,000 tons referred to above—was less than 750 tons.

I do not pretend to criticise the design or construction of the "New Orleans," but she is essentially a "show" vessel, cleverly designed to that end, but not such a design as would be found emanating from the British Admiralty or from our Navy Department. Briefly stated, she was designed purely for speed and the heaviest battery the law would allow. With her extra length of about 50 ft. she will not manœuver as well as the "Denver" class; with her extra draft of about 3 ft. she is considerably handicapped for work in shallow harbors; with her heavy battery (of little advantage, considering the small amount of ammunition carried) she could not stand the weight of a flush upper deck, and even without it her top weights are such that, particularly without the waterline protection of cellulose provided for the "Denver" class, she is not nearly so well prepared to stand punishment as will be those vessels. Her powerful machinery and large battery necessitate a crew out of all proportion with the accommodations provided, and considerable objection has been filed, by those connected with the ship, in regard to the unsatisfactory provision for officers and crew, including boat capacity for very little more than half the number. Her auxiliary appliances for lighting, heating, refrigerating, etc., were, in some cases, omitted in the original design, or were meager and unsatisfactory, and have had to be added since, with increased weight.

There are different standards for comparison in cases like the one in point, and facts, even, may be distorted so as to delude the unpracticed reader. The article I have referred to, in addition to being not entirely correct, was very misleading, though probably not intentionally so; some of the original information, relative to the "New Orleans," published in the annual report of the Bureau of Construction and Repair for last year, having itself been found since to be not entirely correct.

There is also room for considerable differences of opinion in determining the elemental characteristics of a design. Personally, however, I believe our experience with the "Cincinnati" and "Raleigh" was sufficient illustration of what to expect from crowding machinery and battery into a small cruiser at the expense of cruising efficiency. I predict great usefulness for the "Denver" and class, as well as considerable popularity among sea-going officers.

Table Showing the Principal Dimensions and Particulars of the New Cruisers of the "Denver" Class for the U. S. Navy.

Hull.—	
Length on load water-line	292 ft.
Length over all	308 " 9 ins.
Beam, molded	43 " 3¼ "
Beam, extreme	44 "
Freeboard, forward	20 "
Freeboard, aft	18 " 6 ins.
Freeboard, amidships	15 " 9 "
Mean draft (with 467 tons coal and ⅔ stores)	15 " 9 "
Corresponding displacement	3,200 tons
Speed in knots, per hour	16.5
Area of midship section	615.2 sq. ft.
Area of load water plane	9,370.00 " "
Tons per inch of immersion	22.3
Armament.—	
Main battery	10 5-in. R. F. guns
Secondary battery	8 6-pdrs. 2 1-pdrs. 4 Colt's automatic
Mean height of axis of 5-in. guns, main deck, above load water-line	21 ft. 5 ins.
Mean height of axis of 5-in. guns, gun deck, above load water-line	12 " 4 "
General Schedule of Weights.—	
Hull and fittings, not including protective deck armor	1,706 tons
Protective deck armor, 2 ins.	62 "
Cellulose	24 "
Armament and ammunition	213 "
Equipment, stores and outfit	287 "
Propelling machinery with water	441 "
Coal	467 "
Total	3,200 "
Machinery.—	
Collective I. HP. of all machinery in engine-room	4,500
Corresponding number of revolutions of main engines	172
Diameter of high-pressure cylinder	18 ins.
Diameter intermediate cylinder	29 "
Diameter low-pressure cylinders (two)	35½ "
Length of stroke	30 "
Cooling surface of main condensers	6,000 sq. ft.
Cooling surface of auxiliary condensers	800 " "

The main propelling engines will be of the vertical inverted cylinder, direct-acting, triple expansion type, and will be placed in two water-tight compartments. There will be six water-tube boilers, constructed for a working pressure of 275 lbs. per sq.in. The total grate surface will be at least 300 sq. ft., and the total heating surface about 13,000 sq. ft. The boilers will be in two compartments, with two athwartship fire-rooms. There will be two smoke-pipes, the top of each 70 ft. above grates. Each vessel will carry:

One 30-ft. steam cutter; one 30-ft. launch; four 28-ft. cutters; one 28-ft. gig whaleboat; one 28-ft. whaleboat; one 20-ft. dinghy; one 16-ft. dinghy. The boats will have capacity for carrying, with ease, the entire complement of officers and crew.

STREET RAILWAYS IN FOREIGN CITIES AND THEIR FRANCHISE REQUIREMENTS.*

Basle, Switzerland.—Electric transit. All lines built, owned and operated by the city. Fare, 2 cts. for short and 4 cts. for longer distances. Passengers allowed to stand in aisles and on platforms.

Belfast, Ireland.—Horse cars. Fare, 2 cts. a mile. Standing in aisles or on platforms not allowed. Company has 14-year franchise and paid no bonus, but has to pave and repair middle of streets traversed by its lines.

Berlin, Germany.—Electric, steam and horse cars, also elevated (steam) belt-line. Fares, 2½ cts. for 2 miles and 1 ct. for every additional mile. No passengers allowed in aisles, but a designated number are allowed on each platform. Companies have to pave and repair streets through which their lines run and pay a substantial bonus to the city.

Berne, Switzerland.—Steam and compressed-air traction. Fare, 2 cts. a mile. No one is allowed to stand in the aisles. Fixed numbers are allowed on platforms. City is negotiating for purchase of the company's lines.

Brussels, Belgium.—Electric—underground and overhead trolley—horse and steam traction. Fares from 2 to 12 cts., according to distance. No one is allowed to stand in the aisles.

Buenos Ayres, Argentine.—Electric, steam and horse traction. Underground electric line being constructed. Lines owned by British companies. Fares, 10 and 20 cts. (paper.) Two postmen and one policeman allowed on front platform (free); three passengers allowed on rear platform. Companies pay 6% of gross receipts to city.

Calcutta, India.—Horse cars, but to be changed to electric cars soon. Fares, 2½ to 4½ cts. No passengers taken on after seats are occupied. Franchise runs 25 years; company pays a fixed amount per mile per annum and keeps middle of street in repair.

Cape Town, South Africa.—Electric trolley cars. Fare, 6 cts. for 3 miles. Passengers stand on front and rear platforms, but not in aisles. Cars are "double-deckers" made by the Brill Co., Philadelphia. Company has 25 years' franchise.

Christiania, Norway.—One electric line (5 miles) and one horse-car line (4 miles). Other lines under construction. City intends to buy the lines as soon as franchises expire. The city is now building a short line as a public enterprise. Fares, 2¾ cts. Fixed numbers allowed to stand on platform, but none in aisles. Companies made no direct payment for their franchises, which expire in 1924, but pay taxes on their property like other corporations. Cars are "double-deckers."

Copenhagen, Denmark.—Horse and electric traction. Fare, 2¾ cts. for any distance. When all seats are taken no more passengers are taken on, and conductors are heavily fined if they exceed the licensed number. The amalgamated company pays the city a certain percentage of gross earnings.

Cork, Ireland.—Electric lines. Fare, 2 cts. for any distance. Passengers not allowed in aisles or on platforms. Company's franchise is unlimited; it pays nothing directly, but paves the middle of the street and furnishes electric light to city at reduced rates.

Dublin, Ireland.—Electric traction. Fare, 1 ct. a mile; minimum fare, 2 cts. Cars are "double-deckers." Passengers not allowed in aisles except in rainy weather. Company pays city $2,500 a year per mile of its line for right-of-way and also has to pave between its tracks and one foot on either side. Franchise runs 40 years, with provision that city may buy the line after 20 years, paying actual market value of machinery and plant. In case of disagreement on price, the Board of Trade is to be the referee.

Edinburgh, Scotland.—Horse and cable cars. In a few months the entire system will be cable. City owns entire system, which is operated by a lessee company. Fare, 2 cts. a mile, except certain popular routes for which the fare is 2 cts., although longer than a mile. Workmen's tickets between the hours of 5 and 7 a. m. and 5 and 7 p. m. daily, and Saturdays from 1 to 3 p. m., at 2 cts. for first 2 miles and 1 ct. for each additional mile. No passengers taken on after all seats are occupied.

Florence, Italy.—Electric and horse traction. City owns the lines and leases them to private companies. Fares, 2 cts. from outskirts to center of city, and 3 cts. across city. Passengers allowed on platforms, but not in aisles. Lessee company has a 50-year franchise and guarantees the city at least $12,000 a year revenue, besides contributing $400 a year to a provident institution for street-car employees and $300 to a cabmen's society. Profits over 7% are shared by the company and the city.

Frankfort-on-the-Main, Germany.—Entire system being changed to electric traction. Fares, 2½ to 5 cts., according to distance. The city recently bought the entire system, paying $550,000 down and $75,000 annually for 17 years. There are 20 miles of lines. Fixed number allowed on platforms; no one in aisles. Considerably reduced rates given to pupils going to school or to private instructors, to swimming baths, to conservatories of music, art schools, etc. Family tickets at greatly reduced rates are issued, provided the husband's income is not over $25 a month or the wife's not over $15, and provided there is no son over 21 years of age.

Ghent, Belgium.—Electric traction. Fares, 3 cts. first-class, 2 cts. second-class. Passengers allowed in aisles and on platforms. Franchise runs 50 years from Jan. 1, 1898. Company pays city 17% of gross receipts annually, but not less than $3,860 (which amount the company deposits in advance Jan 1). Franchise provides for purchase of lines by the city and fixes minimum wages of conductors and motormen at 78 cts. a day, and of workmen at 68 cts., and a maximum day's work in summer at 14½ hours and 13½ hours in winter, with an interruption of 1½ hours for meals.

Glasgow, Scotland.—Has 37 miles horse-car service and 3 miles electric street-railway. City owns and operates entire system. Fares, 1 ct. for first half mile, 2 cts. for 2 miles, and 1 ct. for each additional mile up to 6 miles (longest route). No transfers given. No more passengers are to be taken on after seats inside and on top are taken, but this rule is not kept. Entire system is to be made electric by 1901.

Havre, France.—Trolley cars (Thomson-Houston). Fares, 3 cts. first-class, 2 cts. second-class. Passengers on front platform pay second-class fare and those on rear platform pay first-class. Transfers, 1 ct. extra. No one allowed in aisles. Franchise runs 50 years from 1893. Company pays city 2½% on its gross receipts, but not less than $3,500 a year.

Kingston, Jamaica.—Electric traction. Fare, 4 cts. within any section—city is divided into three sections. Fare through three sections is 12 cts. Three front seats in each car reserved as first-class and fare is 6 cts. instead of 4 cts. Tickets sold at reduced rates. Franchise runs 30 years. Company pays government 4% of gross earnings and maintains streets it occupies to 18 ins. on each side of tracks. Passengers allowed in aisles and on platforms. Market cars run before 9 a. m. and after 5 p. m. for country people carrying produce—fare, 3 cts.

Liverpool, England.—Electric and horse cars, also lines of omnibuses. City owns all the transit lines. Fares, 2 cts. for each "stage" or zone, and 4 cts. for entire three stages, 4 miles. Passengers allowed to stand in aisles and on platforms.

Lyons, France.—Electric, steam and horse traction. On steam lines locomotive draws trains of three long cars. Fares for first-class (cushioned seats), 4 cts.; second-class, 2 cts. Fourteen persons allowed on front platform

*From a pamphlet issued by the Royal Trust Co. Bank, of Chicago, Ill.

and same number on rear. Nobody allowed to stand in aisles. Only one door in car for both entrance and exit. Company pays $16,000 fixed annual tax and also 10% on all receipts in excess of $2,000,000. Franchise provides for purchase by city after 40 years.

Maracaibo, Venezuela.—Horse cars. Three companies. Oldest one pays 3½% a month profit on its capital. Fare, 5 cts. Rule against passengers standing is not heeded. Companies paid nothing, directly or indirectly, for their franchises, which have 5 years yet to run.

Marseilles, France.—Overhead-trolley system being installed on all lines. Uniform fare of 2 cts. Company paves between tracks and 14 ins. each side; also pays city annual fee of $19,300; and when gross receipts aggregate $1,400,000, a further fee will be paid, as follows: for the next $200,000, $7,720; for the following $200,000, $9,650; for the subsequent $200,000; $11,580; and $12,000 for every additional $200,000. Electric trains are limited to 4 cars, not exceeding 118 ft., and speed is limited to 12½ miles an hour. Franchise expires in 1950, when the State becomes owner of the company's tracks and other property located on the public domain. During the last 5 years of the concession, should it appear that the operating company fails to maintain the property in good condition, the State reserves the right to seize all the company's revenues, for the purpose of keeping up the same. The State will have the right to take all rolling stock, tools and similar property at a valuation fixed by experts, but will be under no obligation to buy more than suits its purposes or wishes. Upon the termination of the concession, should the State deem it useless to continue the operation of certain lines, the concessionaires will be required to remove their tracks and restore the streets to their original condition. The State reserves the right to purchase its concession at any time. The price, in such event, will be fixed by the net annual revenue of the 7 preceding years, including the fees paid to the city. From the total thus obtained will be deducted the net revenue of the 2 least profitable years, and the average of the 5 remaining years will stand as the amount of an annuity, to be paid to the concessionaires during each unexpired year of the revoked concession.

Mexico (City), Mexico.—Cars drawn by mules. Suburban cars are larger and are drawn to outskirts by mules and thence to their destination by small American steam dummy engines. Company is preparing to substitute electric for animal traction, but will retain the steam lines. Managers of company are Americans. Fares for city are 5 and 6 cts., according to distance. Suburban fares are 12 to 30 cts. Passengers are allowed in aisles and on rear platform, but not on front platform.

Munich, Germany.—Electric, steam and horse cars. All lines are owned by the city. Fares, 2½ to 6 cts. on horse cars, according to distance. Passengers not allowed to stand in aisles, but limited number allowed on both platforms.

Naples, Italy.—Horse cars and electric-trolley cars. Fare, 2 cts. on two back seats and 3 cts. on cushioned seats; 2 cts. to stand on front platform, 3 cts. on rear platform. Company has 50-year franchise; pays percentage of net profits to the city. Electric cars made in Schenectady, N. Y.

Paris, France.—Thirty-three lines of omnibuses drawn by two horses (with 26 to 30 places), 14 lines of omnibuses drawn by three horses (with 40 places), 3 lines of steam tramways, 23 lines of horse tramways, 4 lines of compressed air and electricity. All of the lines are controlled by one company, which has an exclusive franchise dated 1860 and expiring 1910. In 1896, the omnibus lines carried 129,000,000 passengers out of a total of 240,000,000 for all lines. Cars and omnibuses are "double-deckers." Inside fare, 6 cts. (entitles passenger to transfer ticket); fare on top and on platforms, 3 cts. Passengers not allowed in aisles.

Prague, Austria.—Electric and horse cars. Lines all owned by the city. Fare, 2 cts. Passengers allowed in aisles and on platforms.

Rheims, France.—Horse cars; but change to electric traction is in progress. Fares, 3 cts. for first class and 2 cts. for second class; 1 ct. extra for a transfer. Number of passengers on a car fixed by law. Franchise expires in 1945, and provides that from the net profits each year the company is entitled first to receive 5% upon its invested capital, while the city is entitled to 25% of any surplus above the 5%. The remaining surplus goes to the company, except that after the company has carried three millions of passengers, the city is to receive $1.15 for every additional thousand passengers carried.

St. Petersburg, Russia.—Horse cars, single track. Principal line bought by city last September, and being operated by city at a profit. The city has suits pending to obtain possession of the other lines, when electric traction will be installed. Cars are "double-deckers." Fares, 2½ and 3 cts. A dozen different lines, but no transfers. Passengers allowed in aisles and platforms. Cars slow down but seldom stop for passengers to get on or off.

Stockholm, Sweden.—Horse and steam traction. Fare, 2¾ cts. Five persons allowed on front platform, 6 on rear, and 10 inside. Company's franchise runs 40 years from 1876. Company is taxed 5% on its income.

Stuttgart, Germany.—Electric traction. Power furnished by a separate electric-lighting company. Fares, 2⅛ to 6 cts., according to distance. Cars are limited to a fixed number of passengers, but exceptions are made in case of storm, after theater, last night-car, etc. Company pays city 2½% of gross receipts.

Sydney, Australia.—Electric, steam and cable traction. All lines owned and operated by the Government of New South Wales. Fare, 2 cts. a mile. Laws against overcrowding are disregarded.

Toronto, Ont.—Electric traction. Fares, 5 cts.; after midnight, 10 cts. Tickets, 6 for 25 cts. or 25 for $1. Also tickets good from 6 to 8:30 a. m. and 5 to 6:30 p. m., 8 for 25 cts. Sunday tickets, 7 for 25 cts. School children's tickets, 10 for 25 cts. Children under 9 years (not in arms), half fare. Passengers allowed in aisles and on platforms. Company's franchise given for 20 years with a renewal of 10 years. Company pays city $800 a year for every mile of single track; also pays 8% of gross receipts up to $1,000,000 and 10% above $1,000,000. Company is also taxed on its plant, poles, etc., except track.

Victoria, B. C.—Electric-trolley cars. Fare, 5 cts. Passengers allowed to stand in aisles and on platforms. Franchise given for 50 years, for which the company pays nothing, either in the way of taxes or bonus.

Winnipeg, Man.—Electric-trolley line. Fare, 5 cts. Passengers taken on regardless of seating capacity. Franchise granted 1893 for 35 years without bonus or conditions, except that after 11 years the company must pay the city 5% of its gross earnings and pave their track (8 ft.) uniform with pavement laid by the city.

TIE-SPOTTING OR GROOVING MACHINE; FLINT & PERE MARQUETTE R. R.

When railway ties have been badly cut by the rails, the rail seat must be cut level with an adze, in order to form a proper bearing for the old or new rails, or for tie-plates, if these are to be applied to old ties. In such work the trackmen have usually to rely upon their eyes in getting a level and even seat, and while practical men are very expert, yet there is no guide to which they can work. As the ties are more or less covered with dirt and sand, and the men are hurried, the work is very often imperfectly done. If the foreman should take time enough to ensure the work being well done, he is liable to be censured for getting so small an amount of track relaid.

Mr. George M. Brown, Chief Engineer of the Flint & Pere Marquette R. R., has invented a machine for grooving the ties to the required depth, the grooves forming a gage or guide to the men in adzing the ties. This machine has been employed successfully on about 100 miles of standard gage track this year, and on 110 miles of narrow gage track which it was intended to change to standard gage last year (Eng. News, Oct. 13, 1898).

The machine, Fig. 1, is mounted between two flat cars. On the rear car is mounted an engine with a cylinder about 12 × 20 ins., taking steam from the locomotive which pushes the cars along the track. Over the front end sill of the rear car is a shaft carried in timber frames bolted to the floor. On this shaft are keyed a 20-in. and a 40-in. pulley, while journaled upon it are the side timbers of a rectangular frame which

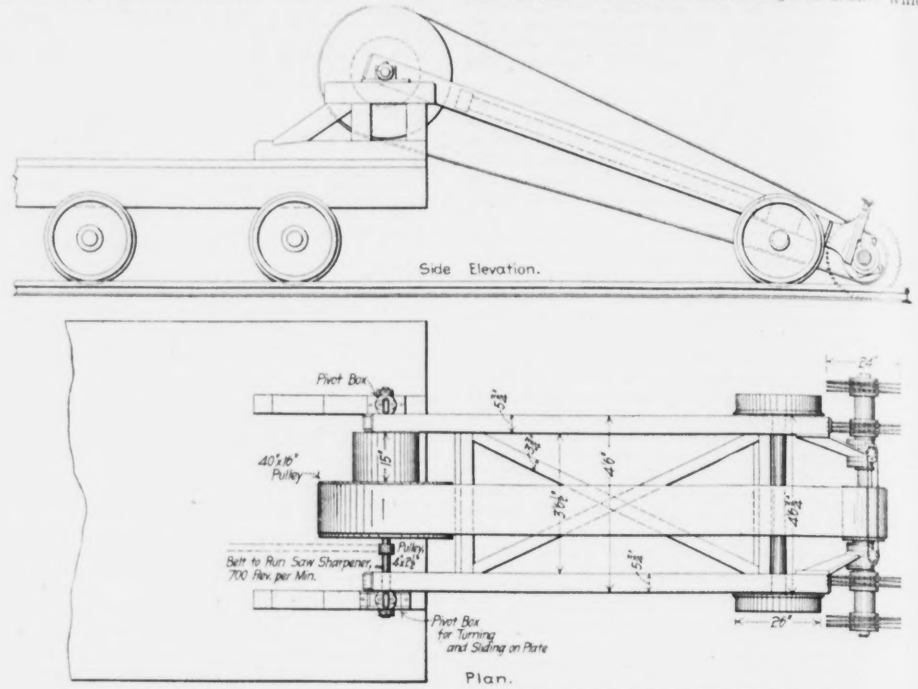


FIG. 1.—TIE-SPOTTING MACHINE; FLINT & PERE MARQUETTE R. R.
G. M. Brown, Chief Engineer, Inventor.

projects ahead of the car. The front end of this frame is supported by a pair of 26-in. wheels, the distance from the driving shaft to the axle of these wheels being about 9 ft. 9 ins. In front of the frame, and supported by iron brackets, is a shaft extending across the track and carrying four sets of four 24-in. saws. The two outer saws of each set are vertical, but the others are inclined, or set diagonally on the shaft, so as to cut out the wood between the two outer saws. The shaft is raised and lowered in guides by means of screws with sprocket wheel heads connected by a chain. These saws cut four rectangular grooves across the ties, the width being about 2½ ins., and the depth being sufficient to reach below the worn part of the rail seat. This is shown in Fig. 2. When the rails are removed, it is easy for the trackmen to adze out the intervening wood, level with the bottoms of the grooves. Part of this adzing may be done before the rails are removed.

On the rear end of the front car is a derrick frame and hoist, with chains attached to the front end of the frame carrying the saws. In this way the frame can be raised when the machine is not

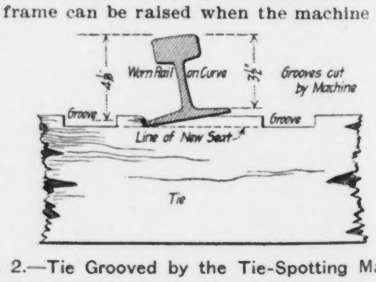


Fig. 2.—Tie Grooved by the Tie-Spotting Machine.

required to work, or in order to clear the rails at frogs, turnouts, crossings, etc. The cars are coupled together by two heavy timber beams above the floor. The saws make about 1,500 revolutions per minute, and the machine is pushed or hauled over the track at a speed of about three miles per hour, or faster for ties of soft wood. The machine was built by the Wickes Brothers' Iron Works, of Saginaw, Mich.

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