ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

VOL. XL. No. 17.

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A HEAVY FREIGHT TRAIN was hauled from De Witt, near Syracuse, to West Albany, on the New York Central & Hudson River R. R., last week. The train consisted of 81 loaded grain cars, and its total weight was 3,478 tons. The total amount of grain was about 80,000 bushels. The distance hauled was 140 miles, which was made in 12 hours and 55 minutes. The train was hauled by locomotive No. 786, a Mogul, with 123,000 lbs. on the drivers, 20 × 28 cylinders and 57-in. driving wheels.

A VERY HEAVY PASSENGER TRAFFIC was carried by the Chicago surface and elevated railways on the day of the Peace Jubilee parade, Oct. 19. The railways had made special rates for the week, and the city was crowded with visitors who came to see the President and the parade. As no surface cars were allowed within the limits of the parade from 9 a. m. to 3 p. m., all the traffic centered on the elevated loop. The trains ran at intervals of five to ten seconds, and took nearly 40 minutes to make the circuit, instead of the usual time of 14 minutes. The cars were packed to the gates, and policemen had to be stationed at the entrance to the stations, to keep the people from overcrowding the stairways and platforms. The street and elevated railways carried about 1½ million passengers, from which it is estimated that 700,000 people were carried to the scene of the parade and back again. The traffic was apportioned as follows:

West Chicago Street Ry.	450,000
Chicago City Ry.	440,000
North Chicago Street Ry	250,000
Other surface lines	30,000
Metropolitan Elevated Ry.	162,165
South Side Elevated Ry.	129,415
Lake St. Elevated Ry.	77,184
Total number of passengers	1,538,764

CHEAP RAILWAY TRAVELING is to be made a specialty in Switzerland by means of tickets good for two weeks to twelve months, during which periods the holders can travel as much as they like on the entire railway system. The tickets are not transferable, and no baggage is carried free. They are available on the lake steamers, a second-class ticket being good for first-class accommodations on these steamers. The rates are as follows:

	Class First.	Class Second.	Class Third.
15 days	$11.58	$8.11	$5.79
30 days	19.30	13.51	9.65
3 months	46.32	32.81	23.16
6 months	73.34	52.11	36.67
12 months	115.80	81.06	57.90

GROOVED RAILS are proposed for Chicago's street railways, according to an ordinance recently introduced in the Council. In view of the condition of the streets, however, and the city's neglect to clean or repair them, the grooved rails would effect little or no improvement and would be of little benefit to the public. When the city undertakes to maintain its streets in good condition then it will be reasonable to consider the improvement of the railway tracks.

CONTRACTS for the equipment of the Third Avenue (New York) conduit lines have been awarded. Electrical apparatus to the extent of $4,500,000, it is understood, will go to the Westinghouse Electric & Mfg. Co., Pittsburg, Pa. The underground construction, estimated at $1,500,000, will be done by the National Conduit & Cable Co.; 15,000 tons of 110-lb. rails fall to the lot of the Johnson Co., and the castings, such as yokes, handholes, etc., to the Pennsylvania Steel Co.

THE EXTENSION OF CUBAN RAILWAYS, so as to provide a trunk line running the length of the island, is to be recommended by the Secretary of War, according to Washington items. He will also recommend that this work be undertaken by the government as a military necessity, and that Congress appropriate the funds necessary.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred on the Rock Island R. R., near Fort Worth, Tex., on Oct. 22. From newspaper reports it appears that a freight train broke in two at the top of a steep grade and before the rear portion could be stopped it collided with the front section, wrecking several cars in one of which were 10 men stealing a ride. It is said that five were instantly killed and three mortally injured.

A LOCOMOTIVE BOILER BLEW UP near Budsboro, Pa., on Oct. 17, killing four men. The engine which was drawing a freight train on the Wilmington & Northern R. R. had just taken water at Joanna and the explosion was a severe one, totally destroying the locomotive.

AN EXPRESS TRAIN RAN 20 MILES with a dead engineer at the throttle on the Erie R. R. on Oct. 24. The train was drawn by a double-cab engine, and soon after leaving Binghamton it was noticed that the usual crossing signals were not given and that the train was running at an unusual speed. When the whistle was not blown for Susquehanna, 23 miles from Binghamton, the fireman went forward to the engineer's cab and found the engineer dead with his skull crushed. It is thought that he must have been struck by a swinging water crane just east of Binghamton.

THE BURSTING OF SEVERAL BOILER TUBES on the torpedo-boat "Davis," which was undergoing an official trial at Astoria, Ore., on Oct. 20, scalded three men to death and injured four others so severely that they died later. It is understood that some derangement of the automatic water gage permitted the water to get low in the boiler. Although there were 40 men on board only those in the boiler room were killed. The "Davis" was one of two torpedo-boats recently built by Wolff & Zwicker, of Portland, Ore., for the United States Government.

RECENT FLOODS IN JAPAN are reported to have caused great loss of life and to have done an immense amount of damage. A report received on Oct. 20, via Vancouver, B. C., states that in the valley of the Feng River 250 towns are under water and 2,000 persons were drowned; also that 1,000 persons suffered a like fate along the Ishikari River.

THE NEW YORK CIVIL SERVICE COMMISSION gives notice that open competitive examinations will be held at its office on the dates given for the following positions: Nov. 14, Examiner to the Municipal Civil Service Commission; Nov. 15, Supervising Engineer. In the latter case candidates must have knowledge as to the construction, management and repairs of marine and stationary engines, and hold licenses for both; they must also have knowledge of the installation of steam heating, ventilation, boilers, plumbing and drainage. The candidate for Examiner will be examined in arithmetic, grammar and composition, general intelligence, special qualifications and experience.

THE AWARDS OF PLANS FOR THE UNIVERSITY of California have been announced as the result of the preliminary competition. Out of about 100 sets of plans the following have been chosen to enter the final competition: Barboud Baubain, Paris; E. Benard, Paris; F. Blunschli, Zurich; D. Dexpradelles and Stephen Codman, Boston; Rudolph Dick, Vienna; J. H. Freedlander, New York; Howard & Eichmuller, Paris; Howard & Cauldwell, New York; Howells, Stokes & Hornbostel, New York; Lord, Hewlett & Hull, New York; Whitney Warren, New York. Successful competitors in the preliminary competition will have six months in which to perfect their plans for the final competition, and a sum of at least $20,000 will be devoted to premiums for the best plans. These premiums will be awarded to at least five of the competitors.

A NATIONAL PHYSICAL LABORATORY is proposed in England, and the committee appointed by the Treasury, in August of last year, has submitted its report. The committee, consisting of Lord Rayleigh (chairman), Sir Courtenay Boyle, Sir Andrew Noble, Sir John Wolfe Barry, W. C. Roberts-Austen, Robert Chalmers, Prof. A. W. Rucker, Alexander Siemens and Prof. T. E. Thorpe, was directed to consider and report upon the desirability of establishing a national physical laboratory for the testing and verification of instruments for physical investigation; for the construction and preservation of standards of measurements, and for the systematic determination of physical constants and numerical data useful for scientific and industrial purposes, and to report whether the work of such an institution, if established, could be associated with any testing or standardizing work already performed wholly or partly at the public cost.

This committee investigated the subject very thoroughly, visiting the various government physical laboratories of the Continent. As a result, the committee proposes that the Kew Observatory be enlarged by the addition of new buildings where the desired work can be conducted. It is further suggested that the institution be controlled by a governing board appointed by the Royal Society and by the principal commercial organizations.

THE PARIS EXPOSITION MANAGEMENT has granted 26,000 sq. ft. additional space for American exhibitors, making the present total 203,000 sq. ft.

THE EXTENSION OF THE PARCEL-POST SYSTEM in the United States is favored by the managers of the Philadelphia Commercial Museum. They contend that such an extension of privilege is necessary in the export trade to enable manufacturers to send samples to possible foreign buyers. Their competitors in England, Germany, France and Belgium can do this, and doubtless secure in this way considerable business. Objection is made that manufacturers would get into the habit of sending samples abroad and thus divert the trade from customary channels and build up a system of direct business which will not be satisfactory to either manufacturer or buyer, owing to a disarrangement of credits. The second objection is that the extension of the parcel-post might encourage the direct importation of European goods of small bulk, to the detriment of accredited importing agents, or of American manufacturers in similar lines. The Museum Managers think that as to the first objection, if the line of goods is of sufficient importance to warrant pushing in foreign markets, the manufacturer would arrange his own agencies. As to the second objection, they believe the danger is overestimated. It is always objectionable to deal out of established channels; and it is possible to make this parcel traffic subject to such tariff regulations as would prevent any great derangement of trade. Representative manufacturing firms believe that the extension of privilege in sending samples abroad would more than outweigh any damage from possible European competition.

EXPORTS OF AMERICAN IRON TO GERMANY are exercising German trade papers. In 1895 Germany took raw iron and steel and manufactured goods and machinery to the value of about 4,500,000 marks; in 1897 these imports into Germany exceeded three times this amount. In 1895 the import of American machinery amounted to 2,761 tons, valued at 1,600,000 marks; in 1896, 5,213 tons, worth 3,000,000 marks; in 1897, 9,593 tons, worth 5,500,000 marks, and Germany has taken in the first seven months of 1898 12,570 tons of machinery from the United States.

AMERICAN WATER PIPE IN GLASGOW is troubling Scotch makers of cast-iron pipe. The order for 1,000 tons of pipe has been given to R. D. Wood & Co., of Philadelphia, in the face of determined opposition. In the first letting the American firm offered to do the work for about $24,825, against $28,205 as the next lowest Scotch bid. The fact that the American pipe was 12 ft. long, instead of the 9 ft. usual in England, was made the grounds for a new letting. R. D. Wood & Co. reduced its bid about $366 and the Scotch firm reduced its offer $3,410; but the American bid was still the lowest, and it was then proposed to give the order to the home firm because it had a testing machine which could be used. Some members of the City Council objected to this unfairness, and an amendment was adopted giving the Scotch firm the small pipe. This offer was refused by the firm at the price named, and the American corporation received the whole contract. "Engineering" says that the Scotch makers have probably not heard the last of American pipe.

THE KLONDIKE GOLD REGION has produced over $8,000,000 of gold this season, of which the Seattle assay office has taken about $4,400,000 and the San Francisco mint about $3,800,000. It is estimated that dust amounting to $500,000 was sent to Denver, Helena and Philadelphia.

A NEW AND SHORTER CHANNEL FOR YUKON-bound vessels has been found by Mr. John F. Pratt, in charge of the U. S. Coast and Geodetic Expedition, working in these waters. The new channel saves 400 or 500 miles of distance, and will carry 8 ft. of water over the bar at low water, instead of 2 ft., as at the old Aphoon entrance. Vessels of moderate draft can now pass directly into the mouth of the Yukon and proceed over 400 miles up the river before transferring passengers and loads to smaller vessels.

THE LARGEST LOCOMOTIVE EVER BUILT.

The Union R. R. Co., of Pittsburg, Pa., has recently received from the Pittsburg Locomotive & Car Works some consolidation locomotives which, so far as we can find, are the heaviest and most powerful locomotives ever constructed. The weight on the drivers (208,000 lbs.) is greater than any locomotive of which we can find a record. The Mexican Central double-boiler locomotives designed by Mr. F. W. Johnstone, have 200,000 lbs. on two separate driving-wheel bases, and have the same total weight (230,000 lbs.) as the Union R. R. locomotive. The tank locomotives which run through the St. Clair tunnel, have 195,000 lbs. on ten driving wheels, and no truck wheels. The 12-wheel locomotives of the Great Northern Ry. (illustrated and described in our issue of April 17, 1898), have a total weight of 212,750 lbs., of which only 172,000 lbs. is on the driving wheels. The cylinders of this new locomotive are 23 × 32 ins., as compared with 21 × 34 ins. for the Great Northern locomotive, and its total boiler heating surface is 3,322 sq. ft., as compared with 3,280 sq. ft. for the Great Northern.

It will be seen, therefore, that this new locomotive not only has greater weight on its drivers than any other locomotive thus far built; but it exceeds also in cylinder power and in the steam producing capacity of its boiler, the huge machines of the Great Northern, which when they were built were generally agreed to be, on the whole, the most powerful locomotives ever constructed.

It is therefore entitled, until some new leviathan claims the precedence, to the distinction of being the largest locomotive in the world.

Our readers will of course be interested to know the class of work which these huge machines are to do. The Union R. R. Co., on which they are run, forms a part of the system operated in connection with the various works of the Carnegie Steel Co., and very heavy trains of iron ore, coke and mill and furnace products have to be moved over it. About four miles of this line has a grade of 70 ft. per mile, and one stretch of about 2,000 ft. from the yard at the Edgar Thomson works up across the main line of the Pennsylvania R. R., and reaching to the foot of the 70-ft. hill, has a grade of 2.4%. The road is laid with 80-lb. steel rails, and now extends from Munhall to North Bessemer, Pa., about 12 miles.

The accompanying half-tone view is reproduced from a photograph of one of these locomotives, and its great size is well shown by comparison with the small tank locomotive beside it. The principal characteristics of its design are, perhaps, best expressed in the remarks of Mr. D. A. Wightman, General Manager of the Pittsburg Locomotive Works, to whose courtesy we are indebted for the photograph from which our illustration is prepared, that the engine is "big all over." In other words, its great weight has been obtained by making all details of generous size and putting on metal liberally where it will do its part in taking strains, and there has been no loading with cast iron merely for the sake of adding weight.

Great pains has been taken to take care of the enormous strains which are thrown on the cylinder castings at the front end. The cylinder castings are of the half-saddle type, with unusual thickness and great longitudinal depth. The frames are 4½ ins. wide cut from rolled steel slabs made by the Carnegie Steel Co., and weigh when finished, 17,160 lbs. per pair. At the front end a steel plate 1⅜ ins. thick, and of the same width as the bottom of the saddle extends across from frame to frame, and is securely bolted to the lower frames. The cylinders are fastened to this plate, as well as to the frame. Heavy bolts pass through the top frame bars in front of and behind the saddle and form additional transverse ties. The longitudinal strains usually transmitted to the cylinders through the frames are largely absorbed by the use of a casting extended from the bumper beam well up to the saddle, and securely bolted to the top and bottom front frames. This casting also acts as a guide for the bolster pin of the truck. This method of relieving cylinders of longitudinal stress was introduced by the Pittsburg Locomotive Works nearly two years ago, and has proven, in practical use on a large number of locomotives, to be of great value in reducing the breakage of saddle castings.

The locomotives are now in daily use, steaming well, are not extravagant in the use of fuel and water, and appear to have ample grate surface for the work required of them.

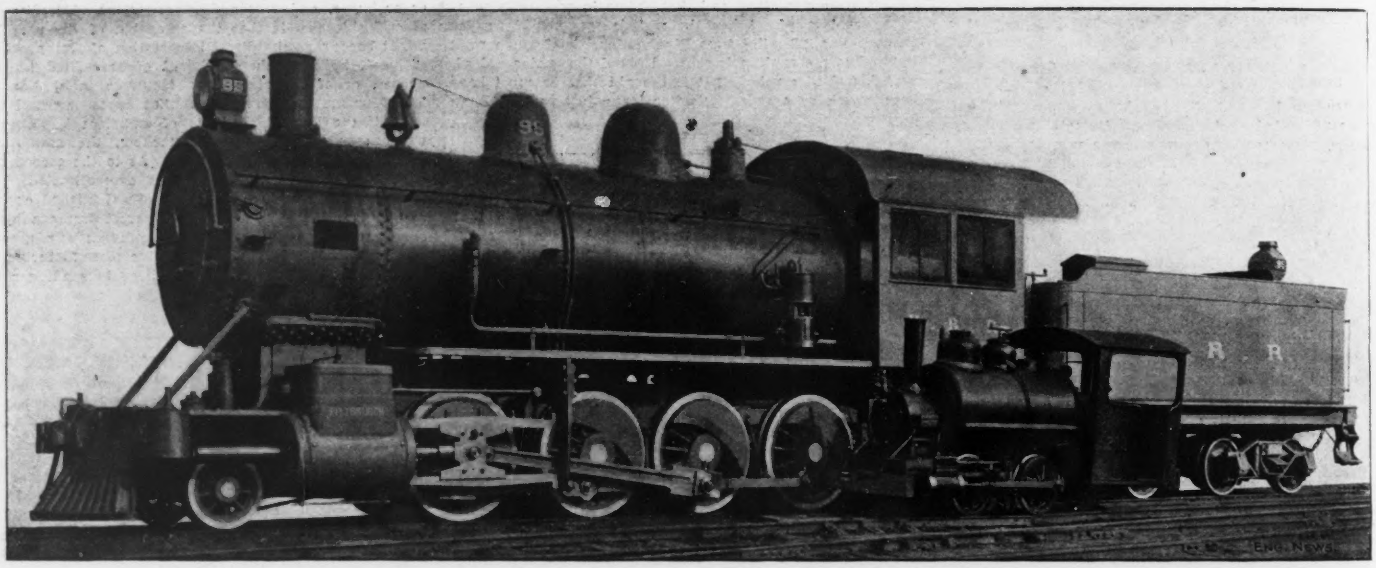
We give below in our standard form the principal dimensions of this locomotive. We would call especial attention to the fact that the load on each driving wheel reaches 26,000 lbs., which is a larger wheel load than has ever been adopted in any locomotive, so far as we are aware. The single driver passenger locomotive of the Philadelphia & Reading R. R. has 24,000 lbs. on each driver. It will also be noticed that the total driving wheel load of 104 tons is concentrated on a wheel base of 15 ft. 7 ins., giving an average load per foot of nearly 7 tons. The mere fact that such a locomotive as this is built and running is one which designers of railway bridge floors will do well to bear in mind in considering provision for future traffic requirements.

On another page of this issue we have noted the recent feat on the New York Central R. R. of hauling a train carrying 80,000 bushels of grain a distance of 140 miles with a single mogul locomotive, having a weight of 123,000 lbs. on its drivers. Let us see what train load this huge machine of the Union R. R. Co. could haul if working under the same conditions as the New York Central locomotive. If we take the hauling power as proportionate to the weight on the drivers, we have:

123,000 : 208,000 : : 80,000 : 135,000.

That is to say, this machine on such a track as the New York Central, from Syracuse to Albany, could haul a paying load of 135,000 bushels of grain, or a net weight of 3,375 tons, an amount equal to the cargo of a fair-sized Lake steamer.

We do not mean to say, of course, that the hauling of such huge trains would be practicable or economical with present rolling stock and railways. We do believe, however, that such powerful machines as this point the way toward future possibilities, if not probabilities, in the economical movement of bulk freights by rail; and the advocates of ship canals and barge canals for internal transportation will do well to bear the fact in mind.



THE LARGEST LOCOMOTIVE IN THE WORLD.
Built for the Union R. R. Co,, Pittsburg, Pa., by the Pittsburg Locomotive & Car Works.
Geo. E. McCague, General Manager Union R. R. Co.; D. A. Wightman, General Manager Pittsburg Locomotive Works.

Dimensions of Consolidation Locomotive for the Union Ry., Pittsburg, Pa.; Built by the Pittsburg Locomotive & Car Works.

Running Gear:
Driving wheels (8), diameter ....54 ins.
Truck wheels (2), diameter ....30 "
Tender wheels (8), diameter ....33 "
Driving wheel centers ....Steeled cast iron, and cast steel for main drivers.
Journals, driving axles ....9 × 12 ins.
Wheelbase: Driving ....15 ft. 7 ins.
Total engine ....24 ft.
Engine and tender ....54 ft. 9½ ins.
Length over all: Engine ....39 ft. 8¾ ins.
Engine and tender ....65 " 3½ "
Weight in Working Order:
On driving wheels, 208,000 lbs.; truck wheels 22,000 lbs.
Engine, total ....230,000 "
Tender, loaded ....104,000 "
Water in tank (full) .... 37,500 "
Coal on tender (full) ....10 tons.
Total engine and tender, ...334,000 lbs.
Cylinders:
Diameter and stroke ....23 × 32 ins.
Diameter of piston rod, ...4½"
Connecting rod, length between centers ....9 ft. 10½"
Valve Gear:
Ports, steam ...20 × 1⅝ ins.; ports, exhaust...20 × 3¼ ins.
Bridges, width, ...1½ "
Slide valves, style,..Balanced; maximum travel....6 "
" " inside lap..0 ins.; Outside lap..........1 in.
" " lead (full forward gear)..............1-16-in.
Boiler—Type ....Straight barrel, sloping back end.
Diam. barrel, inside smallest ring ....80 ins.
Dome, diameter ....32 "
Thickness,bar'l plates, ⅞-in.; smokebox tube sheets, ⅝-in.
Horz. seams..Butt joint, double welded, sextuple riveted.
Circumferential seams ....Double riveted.
Height from rail to center line ....9 ft. 3⅜ ins.
Length of smokebox ....68⅝ "
Form of spark arresting device....Netting, 2 × 2-in. mesh.
Injectors ....Two No. 11.
Working steam pressure. ....200 lbs.
Firebox ....Above frames.
Length, inside........10 ft.; width, inside....3 ft. 4¼ ins.
Depth at front.....76¾ ins.; depth at back....69 7-16 "
Thickness, sides and back ....⅜-in.
Thickness, crown plate, 7-16-in.; tube plate..........½-in.
Crown stays, diameter ....1⅛ ins.
Grate bars ....Cast iron; rocking.
Is firebrick arch used?..........Yes; supported on studs
Water spaces, width all around ....4 ins.
Tubes.—Knobbled charcoal iron; No. 355
Diameter, outside..2¼ ins.; length over tube plates, 15 ft.

Heating Surface and Grate Area.

Heating surface, tubes (exterior area)	3,116.5 sq. ft.
" " firebox	205.5 "
" " total	3,322.0 "
Grate area	33.5 "
Ratio of total heating surface to grate area	99 to 1
Miscellaneous.—Exhaust nozzle. Single; diameter	5¾ ins.
Exhaust nozzle below center line of boiler	5⅝ "
Smokestack, diameter at top, 18 ins.; diam. at base,	17 "
" height above smokebox	2 ft. 9 "
" height of top above rail	15 " 6 "
Total tractive force (builder's figures)	53,892 lbs.
Total adhesive tractive power at ¼ weight on driving wheels	52,000 "

Note.—The locomotive is equipped with pneumatic track sander; Westinghouse American brakes; sight-feed lubricator; metallic packing on piston-rod and valve stems; two 3-in. open-pop safety valves and one 3-in. muffler. The tender frame is of steel channels, and the tender has rigid bolster trucks with elliptic springs.

THE NEW 50-FT. FURNITURE CARS OF THE CHICAGO ROCK ISLAND & PACIFIC RY.

(With two-page plate.)

A furniture car is nothing but a box car of exceptional size, intended particularly for light bulky freight, such as furniture or carriages, but it has come to be a very troublesome part of the equipment of a railway as far as the transportation department is concerned, owing to the fact that it is very frequently used in regular freight service. When a shipper has once sent a "carload" in a furniture car, he is apt to object when future shipments have to be made in the ordinary cars of less capacity. For this reason the furniture car is one of the important features in the large-car question, which was discussed at some length in our issue of March 12, 1896. We do not intend now to take up this question again, but the above remarks will serve as an introduction to a description of some enormous cars, which are exceptionally large even for furniture cars, and which are certainly among the largest freight cars ever built. In fact, there are probably many roads, especially in the eastern states, which could not handle the cars on account of the limitations of their tunnels.

These cars are 54 ft. 6½ ins. long over the couplers, 52 ft. 3 ins. long over the deadwoods, 9 ft. 10 ins. wide over the roof, and 14 ft. 1¾ ins. high from the rails to the running board. They are somewhat peculiar in appearance, as may be seen from Fig. 1, the huge box being set as low as possible, so that the bottoms of the sills project 2 ins. below the tops of the wheel treads. To allow of this, the outer intermediate sills are not extended over the trucks.

From the general plans given in Fig. 2, it will be seen that the underframe consists of two end sills and eight longitudinal sills, the frame being trussed by four 1½-in. truss rods. The rods have 1¾-in. upset threaded ends, and are set up by hollow turnbuckles. All the rods pass through the end sills, and the two inner rods also extend through the deadwoods. The transoms, to which the truss rod struts are attached, are 5 × 9 ins., 7 ft. 11¼ ins. c. to c. The outer intermediate sills do not extend from end to end of the car, but are fitted to cross pieces 4 ft. 5⅛ ins. back from the body bolsters, thus leaving a space for the wheels and allowing the frame to be dropped below the tops of the wheels, as above noted. The end sills are 13¼ ins. deep and taper in width from 9 ins. at the middle to 4¾ ins. at the ends. Upon the sills is laid the flooring of transverse planks 1¾ × 6 ins., tongued and grooved.

The side frames have posts 6 × 2 ins. and braces 8 × 2 ins., fitted to malleable iron castings, and ¾-in. vertical rods extend through the plates and sills, these rods being let into the posts. The side plates are 6½ × 3½ ins. The end frames have posts and braces 6 × 3 ins. and 8 × 3 ins., with 3½-in. end plates, 6 ins. deep at the ends and 13 ins. at the middle. The corner posts are 7½ × 3 × 2 ins., and are tied to the side posts by ½-in. rods. Between the two posts are two rows of girths or belt rails, 4 × 3⅞ ins. in the ends and 4 × 2⅞ ins. in the sides. The outside sheathing is of vertical planks ⅞ × 4 ins., while the inside sheathing is of ⅞-in. planks placed horizontally. This inside sheathing is carried up to the upper girth on the sides and to the plates at the ends. On it are marked the heights for full capacity loads of wheat, corn, rye, barley and oats. The roof is supported by wooden carlines 3 ft. 2⅛ ins. apart, these carlines being 1⅞ ins. thick, 3½ ins. deep at the ends and 10 ins. at the middle. It has two layers of planking, between which is the asphalt roofing of the Drake & Weirs Co., Cleveland, O.

Fig. 3 shows the draft rigging, which is fitted between the center sills, these sills being strengthened by angle irons 4 × 4 ins., bolted under them and under the end sill. On the front of the end sill is a deadwood 4 × 11¾ ins., 3 ft. 1½ ins. long, faced by a ¾-in. iron plate and to the bottom of the deadwood is bolted the foot iron for the brake shaft. The Janney car couplers are used.

In accordance with the best modern practice in car construction, the body bolster is entirely of metal, as shown in Fig. 4. The top member is a plate ¾ × 10 ins., the ends of which are bent to form stirrups for the side sills. The lower member is a plate 1 × 10 ins. The top plate has a camber of about 1¾ ins., and the truss depth between the plates at the center is 12⅝ ins. Between the plates are three malleable iron fillers, supporting truss-rod struts, bolster filling pieces, truck columns, spring plank seats and saddles, side bearings, etc. As an example of these castings we show in Fig. 6 the malleable iron poling pockets which are fitted to the corners of the cars, on the sills. All these fittings were supplied by the National Malleable Castings Co., of Toledo, O.

The cars are fitted with the Westinghouse brake, the reservoir and cylinder being placed below and between the two intermediate sills, near the middle of the car. The brakeshoes are hung outside the wheels, and the arrangement of the brake rigging is very similar to that of the Illinois Central R. R. 80,000-lb. coal car, illustrated in our issue of June 16, 1898. The Bettendorf metal brake beam is used, supplied by the Cloud Steel Truck Co., of Chicago.

These huge cars are quite new, 100 of them having been built during the present year by the Michigan-Peninsular Car Co., of Detroit, Mich.

FIG. 1.—VIEW OF 50-FT. FURNITURE CAR; CHICAGO, ROCK ISLAND & PACIFIC RY.
Michigan-Peninsular Car Co., Builders.

the sills and two of the truss rods, while underneath the bolster are secured the steel center plate and malleable iron side bearings. All the parts are put together with ⅞-in. bolts.

The truck, Fig. 5, is of interest in that it is of the swing motion type, and it is built of metal throughout, having diamond frames, steel bolster, channel iron transoms and a channel iron spring plank. The side frames have top-arch bars 1¼ × 4 ins.; bottom arch bars 1⅛ × 4 ins., and tie bars ¾ × 4 ins. The columns are of malleable iron, there being but one casting for each side frame. In the column castings are formed seats for the transoms, which are 10½-in. channels 6 ft. 3 ins. long, weighing 20 lbs. per ft. They have unequal flanges, the top flange being 3⅜ ins. and the bottom flange 2½ ins. wide. These channels are set back to back, 15⅝ ins. apart. Upon the transoms are riveted the side bearings and center plate. The bolster is only 5 ft. 4 ins. long, being entirely within the frames, and is of box section, 12 × 7¼ ins. at the ends and 12 × 10½ ins. at the middle.

The swing motion arrangement is somewhat novel. Across the top of the transoms are two square bars, having turned ends which rest in bearings riveted to the top flanges of the transom channels. From the square part of each bar hangs a stirrup or truck hanger, whose sides are ⅞ × 4 ins., the width over the sides being 15⅝ ins. In the loop of the stirrup is a malleable iron seat for the spring plank, which is only 5 ft. long, being entirely clear of the truck frames. The hangers are given a slight inclination outward from the top, and two safety hangers are provided which are riveted to the transom channels and would support the spring plank in the event of the breakage of either or both of the truck hangers. The spring plank is a 13-in. channel, with 4-in. flanges, and weighs 31¼ lbs. per ft. It is 5 ft. long, and at each end is a nest of four coiled springs upon which rests the bolster.

Malleable iron is used extensively throughout these cars, for such parts as post and brace seats, They were designed under the direction of Mr. Geo. F. Wilson, Superintendent of Motive Power and Equipment of the C., R. I. & P. Ry., to whom, as well as to the builders we are indebted for information. The following is a list of the leading dimension and particulars of these cars:

Dimensions of Furniture Cars; C., R. I. & P. Ry.

Length over draw bars	54 ft. 6½ ins.
" over deadwood face plates	52 " 3 "
" over end sills	51 " 5½ "
" inside	50 " 0 "
Width over eaves	9 " 10 "
" over sills	9 " 2½ "
" inside	8 " 8¾ "
Height, rail to under side of sill	2 " 7 "
" rail to under side of plate	12 " 5¾ "
" rail to top of running board	14 " 0¼ "
" rail to floor	3 " 6¾ "
" rail to center line of coupler	2 " 10½ "
" inside, clear	9 " 3 "
Doorways	7 ft. × 8 ft. 10¼ "
Side sills	5 × 9 "
Intermediate sills (2)	5 × 9 "
Intermediate sills (2)	4 × 9 "
Center sills (2)	5 × 9 "
End sills, (2) (section at middle)	9 × 13¼ "
Side posts	6 × 2 "
End posts	6 × 3 "
Side braces	8 × 2 "
End braces	6 × 3 "
Side plates	6½ × 3½ "
Transoms	9 × 5 "
Truss rods (4)	1½ "
Truss depth	18 "
Wheels	33 "
Journals	4¼ × 8 "
Wheelbase, truck	5 ft. 0 "
Wheelbase, total	45 " 4 "
Distance c. to c. of trucks	40 " 4 "
Capacity, rated	60,000 lbs.
Weight	40,400 "
Floor area	436.45 sq. ft.

WOOD STAVE PIPE; ITS ECONOMIC DESIGN AND USE.

At the meeting of the American Society of Civil Engineers on Oct. 19, Mr. Arthur L. Adams, M. Am. Soc. C. E., of Los Angeles, Cal., presented a paper upon the above subject, which is, without doubt, the most complete and valuable presentation of it that has ever been made in engineering literature. Mr. Adams' complete paper occupies 32 pages in the September number of the Society's "Proceedings," and is too long, therefore, for reprinting in full in these columns. We have prepared an abstract of the most important parts of the paper and present it as follows:

The first use of a stave pipe as a continuous tube was apparently the 6-ft. pen-stock built at Manchester, N. H., in 1874, by Mr. J. T. Fanning, M. Am. Soc. C. E.; this pipe is still doing service. Round bands on stave pipe under pressure were suggested in certain letters patent in 1880, and were first extensively used at Denver, Colo., in 1883. The particular type of pipe referred to in the paper is one built continuously in the trench; of staves of variable length, having radial edges and concentric faces; and which are held together by metal bands, usually circular in section and spaced on the pipe according to the internal pressure.

The essential considerations in the design of a wood-stave pipe are as follows: The staves must be thin enough to secure complete saturation and to deflect readily to the degree of curvature employed; and they must be thick enough to prevent undesirable percolation through them. The bands must be of such size that, when spaced to give the desired factor against rupture, there will be no sensible flexure in the staves and no destructive crushing of the fiber beneath the bands. The proportions between the thickness of the staves and the strength of the bands must be such that the swelling of the wood will not produce injurious strains upon an otherwise properly proportioned band.

In discussing the source of strains in these pipes the author first takes up the initial strain caused by cinching during construction; this strain is necessary to secure practical tightness when the pipe is first filled. The requisites are a degree of compression per square inch between the staves in excess of water pressure, and uniform contact between the band and all the staves. Owing to the friction between the bands and the staves, and the compressive resistance of the wood, it is not practicable to secure the necessary area of contact, under a band of curved section, by screwing up the nut at the end of the band, without inducing an objectionably high strain. In practice the band is usually vigorously pounded at all points, as the wrench is used; this practice tends to secure the proper degree of indentation without the least residual tensile strain. The strains induced in the bands by water pressure are susceptible of positive determination by familiar methods.

The additional strain induced by the swelling of the staves is less easily determined, and exists only within certain limitations of the cinching source of strain. It may be assumed that the expanding power of swelling timber, at a given stage of compression, is well within what may be called its elastic limit, and is measured by the load necessary to produce that compression under like conditions. If, then, the staves be compressed laterally by the bands beyond the elastic limit of the saturated wood, there can be no swelling of the wood; and no increased strain on the bands from that source. But if the compression is less than the corresponding swelling power of the wood, at the degree of seasoning and compression used, the timber will swell and produce an increased strain in the bands. The amount of additional band strain thus induced is, doubtless, nearly proportional to the area of contact between the staves in the straight seams; and here the special advantage of the band of curved section becames apparent. The curved band permits a permanent compressive strain on the wood sufficient to produce a decided indentation; and the swelling of the staves, if any, and the increased compression under the band, are followed by a farther yielding of the wood; and as the band strain increases the area of contact with the band is increased by the farther indentation of the stave. With flat bands the unit compressive strain under them would almost invariably be so low that no indentation would result, and swelling strains to the full expanding power of the wood would be added to the band strains arising from other sources.

Mr. Adams then takes up the equation deduced for obtaining the permanent and temporary strains in the band. The symbols used are as follows:

R = internal radius of pipe.
r = radius of band section.
t = thickness of stave, in inches.
f = spacing of the bands between centers, inches.
S = tensile strain in the band, in pounds.
s = safe tensile strength in band, in pounds.
E = permanent sustaining power of the staves, in pounds per lineal inch of band.
E′ = temporary sustaining power of the staves, as above.
E″ = permanent swelling force of the wood, lbs. per sq.in.
E‴ = temporary swelling power of the wood, lbs. per sq.in.
P = water pressure, pounds per sq. in.
e = safe bearing power of the wood, lbs. per lin.in. band.
X = additional strain induced by band cinching, lbs.

The least band strain induced by water pressure = P R f. The permanent band strain induced by swelling of staves = f t E″. The least permanent strain in the bands of a tight pipe =

$$(X + P R f + f t E''), < R E.$$

Assuming $X = \frac{3}{2} t f P$ and substituting, we have as the least permanent value of S for a tight pipe when $P < E''$,

$$S = [P f (R + \frac{3}{2} t) + E'' t f], < (R + t) E. \quad (1)$$

If $P > E''$, this becomes

$$S = [(R + \frac{3}{2} t) P f], < (R + t) E, \quad (2)$$

which is the equation generally used for computing band strains for all pressures.

The least temporary band strain induced on first filling a tight pipe =

$$(X + P R f + E''' t f), < (R + t) E'.$$

Assuming as before, $X = \frac{3}{2} t f P$, and substituting, we have as the temporary value of S when $P < E'''$:

$$S = [P f (R + \frac{3}{2} t) + E''' t f], < (R + t) E'. \quad (3)$$

If $P > E'''$, the equation becomes the same as (2).

From the foregoing the following equations, convenient for application, are deduced:

When $P < E''$,

$$f = \frac{s}{(R + \frac{3}{2} t) P + E'' t}, \text{ when } s < (R + t) e. \quad (A)$$

$$f = \frac{(R + t) e}{(R + \frac{3}{2} t) P + E'' t}, \text{ when } s > (R + t) e. \quad (B)$$

When $P > E''$,

$$f = \frac{s}{(R + \frac{3}{2} t) P}, \text{ when } s < (R + t) e. \quad (C)$$

$$f = \frac{(R + t) e}{(R + \frac{3}{2} t) P}, \text{ when } s > (R + t) e. \quad (D)$$

Inasmuch as stave pipe has never been used under heads where the value of P is greater than E″, and it has not as great economic value under such heavy pressures as under lighter pressures, formulas (C) and (D) have no great practical value.

The only experiments upon the sustaining and swelling power of staves known to the author are those made on Oregon "yellow fir" by Mr. D. C. Henny, M. Am. Soc. C. E.* The results are repeated in this paper in tabular form and commented upon, but the conclusions are as follows: So far as they go, these experiments demonstrate (1) That with a proper degree of compression, an ultimate permanent pressure of between 900 and 1,000 lbs. per square inch of contact with the band may be resisted by the staves. This result may be conservatively assumed to obtain in the use of all prevailing sizes of bands and of staves without regard to the character of the grain. (2) That the ultimate swelling power of the wood may be taken at from 90 to 100 lbs. per square inch of stave contact in straight seams; a result which may be affected by the spacing of the bands, since a light flexure in the stave would tend to release the strain instead of transmitting it to the bands. (3) That for water pressures exceeding, say, 94 lbs., per sq. in., and probably considerably less, hard cinching, rather than the swelling of the wood, must be relied upon to maintain a tight pipe. (4) That the yielding qualities of the wood renders hard cinching not seriously objectionable in its effect upon final band strains, with the usual factors of safety in the band, and when working reasonably close to the limit of ultimate compressive resistance of the stave.

*The Astoria Water-Works; Transactions, Vol. xxxvi., p. 18.

One of the most important points to be determined from this discussion is the maximum value of e, which can be used with entire safety in designing a pressure pipe. While pressures as high as 1,100 lbs. per sq. in. have been successfully used under favorable conditions, this is not conservative enough for entirely safe construction. With thorough compression of the bands into the staves, well-seasoned lumber, skilled construction and no water-hammer, 800 lbs. per sq. in. is considered by the author as a maximum; and if there is any considerable fluctuations of pressure, or doubtful constructive skill, a much lower figure should be used.

In view of what has been said, the following values are assigned for use in the formulas here given:

E = 240 lbs. for ¼-in. bands, when the fiber is fully compressed (960 lbs. per sq. in.).
E′ = say, 500 lbs., in the absence of any experiment.
E″ = 95 lbs. for 12-in. band spacing; assumed at 100 lbs. for all spacing.
E‴ = 120 lbs. for 12-in. spacing; assumed at 125 lbs. for all spacings.
e = equivalent of 800 lbs. per sq. in. of band contact, or less.

Before using any formula for band-spacing it is necessary to fix upon the size and form of section of the most economical and best band. Bands less than ⅜-in. diameter have torsional weakness and are difficult to upset. An oval form permits an increase in the value of e and costs but little more than round bands; the heavier band costs less per pound than light sections; the use of upset rods or rolled threads is always economical, and the heavier the band the fewer to be handled and the better for resisting corrosion. These are all general considerations influencing the selection.

Economy in the use of steel requires the selection of a band of such sectional area that if possible $s < (R + t) e$; otherwise it is necessary to use closer spacing, or more steel, than the pressure requires to secure a low value for e. By substituting for s and e, in the above equation, their proper values corresponding to bands of various standard sizes the limitations of the economic use of each may be ascertained, thus:

$$R + t = \frac{s}{e}.$$

The following table gives the minimum sizes of pipe to which specified bands are applicable without exceeding values of 650 lbs. and 750 lbs. for e:

Diameter of band.	s = ¼ ultimate st'gth, lbs.	Band pressure per sq.in., lbs.	e band pressure per lin.in., lbs.	Least external radius of pipe, ins.	Band pressure per sq.in., lbs.	e band pressure per lin.in., lbs.	Least external radius of pipe, ins.
⅜-in....	1,650	650	122	13.5	750	140	11.8
7/16-in...	2,250	650	142	15.8	750	164	13.7
½-in....	2,950	650	163	18.1	750	187	15.7
9/16-in...	3,725	650	183	20.4	750	211	17.6
⅝-in....	4,600	650	203	22.6	750	234	19.6
¾-in....	6,600	650	244	27.0	750	281	23.5

A factor greater than 4 must, therefore, be used in the steel in designing pipes of smaller diameter, if round bands are used, and the specified values of e are not exceeded. Bands of oval section give a greater bearing surface with the same degree of indentation, and permit the use of less steel for given values of e in small diameters of pipe. For this reason oval bands have been introduced and used by the Excelsior Wooden Pipe Co., of San Francisco, on a number of pipe lines.

The greatest band strains consistent with specified values of e for pipes of small diameter, are given as follows:

Int'rnl diameter.	External radius.	S = assumed working strain on band.	Factor of safety in band.	S = assumed working strain in band, lbs.	Factor of safety in band.
e = 122 lbs,	= 650 lbs. per	sq.in.		e = 140 = 750 lbs.	pr sq.in.
12 ins.	7.1 ins.	866 lbs.	7.6	994	6.1
16 "	9.2 "	1,122 "	5.9	1,288	5.1
20 "	11.2 "	1,366 "	4.8	1.568	4.2
24 "	13.5 "	1,650 "	4.0	.....	...

The staves used must be thick enough to prevent percolation, to resist undue flexure under the band spacing adapted, to prevent cracking or crushing of quarter-sawed staves under the cinching operation, and to afford the rigidity necessary to support the weight of the pipe and back-filling without distortion. If the size of band and band-spacing are determined in accordance with foregoing principles a maximum spacing of 12 ins. will make safe against flexure staves of the thickness generally used. The practice of running staves from 2 × 6 ins., 2 × 8 ins. and 3 × 8 ins. stock nearly meets the economic requirements of pipes designed as here set forth. These requirements would be better met, however, if 1½ × 4 ins. were used for the smallest diameters; and if the odd size, 2½ × 8 ins. were used for certain pipes of intermediate sizes between those for which 2 × 6 ins. and 3 × 8 ins. are used. The following relation between pipe diameters and size of stock is the result of careful study, the staves in each case being run as thick as the stock will permit:

Pipe diameter.	Stock sizes.	Pipe diameter	Stock sizes.
10 to 14 ins.	1½ × 4 ins.	50 to 58 ins.	2½ × 8 ins.
16 " 48 "	2 × 6 "	60 " 72 "	3 × 8 "

By assigning to e the conservative value of $\frac{650}{r}$, the author submits the following table of pipe diameters, with corresponding stave thicknesses and bands. Should it be desired to use some other value for e, the needed modification can be easily made:

Economic Proportions for Pipe Design.

Nominal diameter, ins.	Staves. Stock sizes, ins.	Staves. Thickness of finished, ins.	Economic sizes of bands, ins.	s = permanent band strain, lbs.	Factor of safety in band.	e = max'm value = $\frac{650}{r}$ lbs.
10	1½ × 4	1 1/16	5/16 × 7/16	1,255	5.26	207
12	1½ × 4	1⅛	5/16 × 7/16	1,475	4.47	207
14	1½ × 4	1 3/16	5/16 × 7/16	1,650	4.0	...
16	2 × 6	1 7/32	5/16 × 7/16	1,650	4.0	...
18	2 × 6	1⅜	5/16 × 7/16	1,650	4.0	...
20	2 × 6	1⅜	5/16 × 7/16	1,650	4.0	...
			O			
22	2 × 6	1⅜	⅜	1,508	4.4	122
24	2 × 6	1⅜	⅜	1,650	4.0	...
27	2 × 6	1 7/16	⅜	1,650	4.0	...
30	2 × 6	1½	½	2,673	4.4	162
36	2 × 6	1 9/16	½	2,950	4.0	...
42	2 × 6	1⅝	½	2,950	4.0	...
48	2 × 6	1 11/16	½	2,950	4.0	...
54	2½ × 8	2⅛	⅝	4,600	4.0	...
60	3 × 8	2¼	⅝	4,600	4.0	...
66	3 × 8	2 9/16	¾	6,600	4.0	...
72	3 × 8	2⅝	¾	6,600	4.0	...

The author then tabulates the features and strains in about 15 existing pipe lines; and this, while interesting, is omitted here to take up some of the construction details in accepted practice.

In making connection between the butts of connecting staves it is the prevailing practice to snugly insert a No. 12 or No. 14 steel plate, about 1½ ins. wide and slightly larger than the width of the stave used; this plate extends slightly less than half its width into each stave. The use of a bead on the stave edge is not vital to the success of the pipe, but it has some strong points in its favor. By the use of a slight bead the compression due to cinching is at first concentrated on the bead, and a uniformly tight seam is secured without the necessity for hard compression through the entire contact area—as is the case without the bead. The bead adds nothing to the cost of the pipe.

Coupling shoes of various types have been devised, and these are of two classes; those which engage the two ends in the same transverse plane, as Figs. 1, 2 and 3; and those in which the ends are not engaged in the same transverse plane, as in Fig. 4. Figs. 2 and 3 are forged shoes; Fig. 4 is cast, and Fig. 1 is malleable cast iron, and is the shoe largely used by the Excelsior Wooden Pipe Co. The author says that, when properly proportioned, Fig. 1 admirably meets all the requirements for a successful connection. Fig. 2 is considerably used on the Pacific Coast, and is forged from a rolled section. But the length of the shoe in the rear of the nuts is wholly insufficient to afford the proper degree of bearing surface on the stave to safely resist the pressure; and the bending strain at X, due to the depressing of the end of the shoe into the stave, can only be resisted by the use of a much heavier section than the tensile strains alone require. The fault lies in the use of low connecting ribs.

The forged shoe, Fig. 3, is employed on the work of the Pioneer Power Co., of Ogden, Utah. While generally well calculated to economically resist imposed strains, it necessitates the use of a welded loop, and the shoe is expensive as compared to others. The author suggests that its form could be improved, and it could be more cheaply made of cast or malleable iron, without sacrifice in other respects. The type, Fig. 4, introduces a cross-strain, or tendency to rotate about an axis vertical to the center of the shoe. Attempts to resist this tendency to rotate are generally found insufficient, and hard cinching usually results in breaking the tail-pieces or rotating the shoe and bending the bolts. The author recommends Fig. 1 as most nearly meeting requirements.

In discussing the economy of wood stave pipe he contrasts it with steel riveted and cast-iron pipe, confined to a pressure range not exceeding 100 lbs. per sq. in., which may be assumed as the

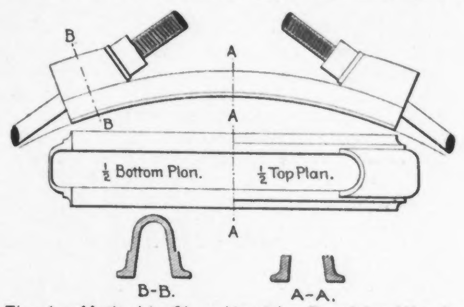


Fig. 1.—Malleable Shoe Used by Excelsior Wooden Pipe Co.

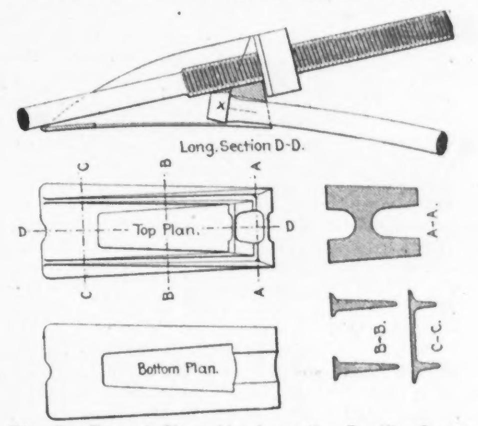


Fig. 2.—Forged Shoe Used on the Pacific Coast.

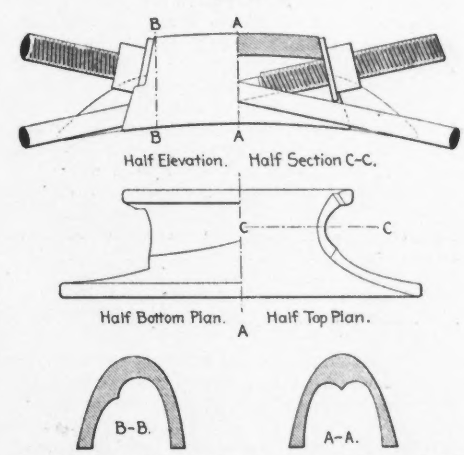


Fig. 4.—Cast Shoe Used on Los Angeles Outfall Sewer.

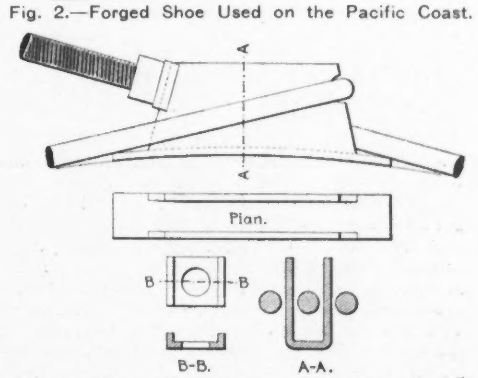


Fig. 3.—Forged Shoe Used on Pioneer Power Co.'s Pipe Line.

COUPLING SHOES FOR WOOD STAVE PIPE.

practical limit of stave pipe construction. In order of merit, with reference to the three most important qualifications, he classifies them as follows:

	Cost.	Life.	Capacity.
1.	Stave.	Cast iron.	Stave.
2.	Steel riveted.	Stave.	Cast iron.
3.	Cast iron.	Steel riveted.	Steel riveted.

In placing steel pipe last in duration the author is influenced by the following considerations: The sheet metal is of less thickness than the diameter of the stave pipe bands; the same degree of care in protecting the metal can be exercised in both cases; the properly proportioned steel pipe does not eventually fail by bursting, but by the formation of rust-holes and the attendant leakage; or, the life of the steel pipe is measured by the life of its weakest point. The life of the stave pipe is determined by the life of the bands; and this is fixed by the reduction of the entire band until its ultimate strength is exceeded by the strain; say, to less than one-fourth of its original section. Stave pipe has done service in America for from 20 to 50 years in many cases, without failure from the decay of staves when proper requirements are absorbed. But steel pipe, under favorable conditions, has also done excellent service for many years.

As to carrying capacity, there are as yet but few experimental determinations in the case of stave pipe. But the experiments discussed in the Transactions of the American Society of Civil Engineers, Vol. XXXI., p. 144, Vol. XXXVI., p. 26, and for May, 1898, and reviewed at considerable length in Mr. Adams' paper, give startling results. Clean cast iron would seem to have about 90% of the carrying capacity of stave pipe; and if seriously tuberculated, the proportion is only two-thirds that of stave pipe. The steel pipe, when clean, discharges from 93%, in a 12-in. pipe, to 68% in a 6-in. pipe of the amount expected from stave pipes of the same size. If the steel pipe is tuberculated, by from 10 to 15 years' use, these discharges may fall to 74% and 54%, respectively.

The cost of any pipe is affected by market quotations on materials, freight rates, wages, geographical location, etc. But the author submits a table of comparative cost based on the following conditions: It is assumed that the wood pipe is designed in accordance with the formulas given; the steel pipe is supposed to be double-riveted on the straight seams, and single-riveted on the round, as ordinarily built, and to be coated with asphalt. The mill price for sheet steel is taken at from 1.60 cts. for No. 14 plate to 1.25 cts. for thicknesses over No. 8. The cast-iron pipe is proportioned for thickness by the Warren Foundry formula, and the price assumed per ton is $19 at Chicago, and $26 at San Francisco, as the lowest quoted. Comparative tables are given for both Chicago and San Francisco, but the latter only is here given:

Comparative Cost per ft. of Wooden, Steel and Cast-Iron Pipe at San Francisco. (Including laying, but not hauling.)

Nominal diameter.	Stave. Head, ft. 25.	Stave. 50.	Stave. 100.	Stave. 200.	Steel riveted. B. W. G., No. 14.	No. 12.	No. 10.	No. 8.	No. 6.	¼-in.	5/16-in.	⅜-in.	Cast iron. Head, ft. 25.	Cast iron. 50.	Cast iron. 100.	Cast iron. 200.
12 ins.	$0.37	$0.45	$0.61	$0.94	$0.45	$0.52	$0.60	.....	.....	.....	.....	.....	$0.94	$0.99	$1.09	$1.31
18 "	.58	.71	.96	1.47	...	.77	.88	$1.04	$1.30	.....	.....	.....	1.65	1.73	1.89	2.21
24 "	.76	.96	1.35	2.12	...	...	1.01	1.35	1.67	$1.97	$2.51	.....	2.50	2.62	2.86	3.37
30 "	.83	1.03	1.43	2.23	...	...	...	1.64	2.04	2.45	3.10	$3.79	3.52	3.70	4.07	4.81
36 "	1.02	1.20	1.83	2.90	...	...	...	1.80	2.44	2.92	3.67	4.49	4.60	4.87	5.40	6.50
42 "	1.23	1.58	2.28	3.69	...	...	...	2.27	2.80	3.37	4.24	5.12	5.87	6.25	6.97	8.43
48 "	1.34	1.73	2.51	4.07	...	...	...	...	3.14	3.80	4.78	5.78	7.33	7.80	8.73	10.64
54 "	1.94	2.45	3.49	5.52	...	...	...	...	3.55	4.32	5.37	6.47	8.86	9.47	10.69	13.15
60 "	2.44	3.09	4.39	7.00	...	...	...	...	...	4.87	5.95	7.24	10.73	11.54	13.14	16.33
66 "	2.79	3.57	5.14	8.26	...	...	...	...	...	5.43	6.54	7.81	12.70	13.69	15.45	18.92
72 "	3.22	4.15	6.04	9.78	...	...	...	...	...	5.90	7.09	8.50	15.12	16.05	17.78	21.53

These figures are supposed to include only the common principal items of expense, with no profit to the contractor. They are, therefore, perhaps in every case somewhat below probable cost, and are intended for use by way of comparison only. But a contract of actual quotations for particular cases would in almost every instance show a greater advantage from the use of the stave pipe than the table indicates, which assumes the most favorable conditions for the steel-riveted and cast pipe.

At the meeting of the American Society of Civil Engineers on Oct. 19, the presentation of the above paper was followed by a discussion which was opened by the Secretary, reading a letter from Mr. H. B. Patten, M. Am. Soc. C. E., City Engineer of Cheyenne, Wyo. This gave the experience of the City of Cheyenne, where in 1889, several thousand feet of 24 and 30-in. stave pipes for water mains were buried. These were only partially filled at times, and when removed 7 or 8 years later were found in bad condition. Grass roots had to a considerable extent forced their way between seams, and the staves were rotted principally on top, where the pipe was subjected to alternate wetting and drying. The pipes were also distorted, and in one place the section had changed from circular to elliptical with a vertical axis of 26 ins. and a horizontal axis of 34 ins. This reduced the section area and restricted the flow. The grass roots and other growths inside also interfered with the flow.

Mr. J. F. O'Rourke called attention to the fact that in a 6-ft. stave pipe under a pressure of 100 lbs. per sq. in., the maximum pressure set by the author, the pressure would be about the same as the pressure allowed on a steel pipe of ¼-in. thickness. It would, therefore, be necessary to have as much metal in the bands as would be necessary to make a steel pipe. This being so, he was quite certain that cast iron could be bought cheaper than stave pipe.

The chairman, Mr. James Owen, asked if the statements of the author regarding greater durability and capacity of a given size of stave pipe compared with the same size of other kinds did not seem contrary to general experience and opinion. Mr. Rudolph Hering, in considering these points, remarked that the question was one needing longer experience before it could be finally answered. The paper presented by Mr. Adams was based on more experience than appeared on the surface, and he for one considered the statements of durability quite true. He had seen stave pipes which had been in the ground 30 years, and were still as good as when put down. On the other hand, he had also seen wrought iron pipes that had been buried some time, and then exposed and subjected to weather supposed to be sufficient to cause considerable oxidization that, were barely rusted. Stave pipes should not be painted inside since the water cannot permeate the wood and keep it thoroughly wet, a feature which is necessary if rotting is to be prevented. To insure this saturation of the staves it is necessary to have the water in the pipes always under pressure. Regarding the form of band used for holding the stave pipe, experience had shown that the round or elliptical sections served best since the same section in this way exposed less surface to the weather, and there was, therefore, less likelihood of corrosion. Great care in the manufacture and placing of bands was necessary owing to the strains that they must stand.

Some wrought iron pipes which he had seen while in San Francisco, in which there was little or no uncombined carbon, seemed to stand the weather better than ordinary wrought iron pipes. These pipes were made according to specifications prepared by the Superintendent of the Spring Valley Water Co., of San Francisco.

Regarding capacity, he saw no reason why a wooden pipe properly made should not be better than a riveted steel or iron pipe. Of course, it was possible for a growth of some sort to accumulate which would materially restrict the flow. In response to a question from the chair, Mr. Hering stated that he had never heard of any chemical action between the bands and the staves.

Mr. G. W. Tillson pointed out that the rapid action of the weather upon pipes when alternately wet and dried was fully understood by the author, who expressly states that the staves must in every case be thin enough to become soaked. To show how rapidly wood rotted, unless continually saturated, he mentioned a case in Omaha where a substantial wooden sidewalk was badly rotted inside of four months, the walk being covered with ordinary earth taken from a foundation excavation. Cedar block pavement in the same city, notwithstanding the interstices were filled with gravel and tar, decayed inside of two years.

The chairman asked what were the possibilities of wooden pipes for water pipes in small towns.

Mr. J. R. O'Rourke mentioned an experience in taking up some old wooden water pipe, on Broadway, N. Y., which had been buried by the Manhattan Water Co. This pipe had been in the ground over 100 years. It was damp and water-soaked, but was not rotted, and was still serviceable. Another instance that had come under his observation occurred at the corner of Gold St. and Maiden Lane, in New York city. At this point while tearing down a building over 100 years old, they encountered oak mud sills 56 ft. long and 6 ins. thick. These timbers were just above the water line, and were in very good condition. Just above them were timbers 24 × 10 ins. which were 18 ins. above the ground water level. These timbers were perfectly sound, and not in the least decayed.

From his observation the principal difficulty with stave pipes would be the corrosion of the bands. The thickness of staves could, in his estimation, be much greater than the limits given by the author, and experience with some 3-in. yellow pine caissons, which he had recently used in connection with some foundation work, convinced him that water, even under moderate pressure, would permeate staves of considerable thickness.

Mr. J. C. Meem described a 4-ft. stave sewer which the Department of Sewers of Brooklyn had designed, but which had never been built. This was composed of 1¼-in. staves with strap bands placed every 2 ft. Outside of this the plans called for a casing of 6 ins. of concrete on top and 8 ins. on the sides and bottom. In section the whole resembled an inverted letter U. The object of this design was to preserve the roundness of the pipe and assist the clamp bands to hold the whole together.

Mr. F. W. Skinner spoke briefly of the cheapness of small wooden pipes, and described the process of boring logs, employed at a factory he had visited. The core cut out in forming large pipes was in turn bored to form a smaller pipe, thus making the cost very small, as there was little waste.

NEW FREIGHT LOCOMOTIVES FOR THE BALTIMORE & OHIO SOUTHWESTERN RY.

The introduction of heavier and more powerful locomotives for freight service, in order to ensure the greater economy in cost of transportation, which is now one of the principal aims of railway operation, as recently pointed out in our columns, is now being practiced by the Baltimore & Ohio Southwestern Ry., following the example of a number of other railways. This road has recently added to its equipment ten consolidation freight engines for service on the Ohio Division, between Cincinnati, O., and Parkersburg, W. Va. There are some rather heavy grades on this division, and it is expected that with the new engines the train load will be increased nearly 40%.

The locomotives are all alike, except that eight are simple engines and the other two are Vauclain four-cylinder compound engines. The simple engines have cylinders 21 × 28 ins., and carry a boiler pressure of 190 lbs. The compound engines have cylinders 15½ × 28 ins. and 26 × 28 ins., and carry a boiler pressure of 200 lbs. The piston heads are of cast iron, fitted with the Dunbar packing. The firebox is intended for bituminous coal, and has a brick arch, supported on studs, while the crown sheet is supported by radial stays. The grates are of cast iron, of the railway company's standard pattern. The equipment includes the Leach pneumatic double sanding jet, Sellers 10½-in. injectors, and a pneumatic bell ringer.

The engines were built by the Baldwin Locomotive Works, of Philadelphia, Pa., from designs prepared by Mr. J. G. Neuffer, General Master Mechanic of the B. & O. S.-W. Ry. The principal dimensions, etc., are as follows:

Consolidation Freight Locomotives; Baltimore & Ohio Southwestern Ry.

Running Gear:	
Driving wheels, 8, diameter	4 ft. 8 ins.
Truck wheels, 2, diameter	2 " 9 "
Journals, driving axles	8 × 12 "
Journals, truck axles	5 × 9½ "
Wheelbase: Driving	15 ft. 3 "
Total engine	23 " 6 "
Engine and tender	53 " 5 "
Truck-pin to c. of leading driving wheel	8 " 3 "
Weight in Working Order:	
On driving wheels	137,000 lbs.
Engine, total	152,000 "
Tender, loaded	98,000 "
Cylinders:	
Compound engines, (4)	15½ × 28 ins. and 26 × 28 ins.
Simple engines (2)	21 × 28 "
Valve Gear.—Type	Stephenson link.
Slide valves, style	Richardson balanced.
Boiler:	
Diameter barrel, inside smallest ring	5 ft. 6 ins.
Height from rail to center line	8 " 4 "
Injectors	Sellers.
Working steam pressure, simple engines	190 lbs.
Working steam pressure, compound engines	200 "
Firebox.—Type	Radial stayed.
Length, inside	9 ft. 5 ins.
Width, inside	3 " 5 "
Crown stays, radial diameter	1⅛ "
Grate bars	Cast iron.
Fire-brick arch	Supported on studs.
Stay bolts, diameter....1-in.; pitch	4 ins.
Tubes.—Number	236
Diameter, outside	2¼ ins.
Length over tube plates	14 ft.
Heating Surface and Grate Area:	
Heating surface, tubes (interior area)	2,054.34 sq. ft.
" firebox	185.00 "
" total	2,239.34 "
Grate area	32.46 "
Miscellaneous:	
Smokestack, height of top above rail	14 ft. 7 ins.
Capacity of tender tank	5,000 gallons
Capacity of coal space	10 tons.
Brake fittings	Westinghouse-American.

TIME TESTS OF TIMBER IN COMPRESSION ENDWISE.*

By J. B. Johnson, M. Am. Soc. C. E.†

Some 6 tests were made on dry long-leaf pine blocks, 1½ ins. square and 3 ins. long, all cut from the same 2-in. plank. Sticks were first cut out 2 ins. square and 48 ins. long, and these were dressed down to 1½ ins. square, and then cut into 16 pieces each 3 ins. long, by a power cross-cut saw.

Alternate specimens were then tested in compression endwise in the ordinary manner in a Riehle testing machine, and the crushing strength determined. The intervening specimens were then loaded with certain percentages of the average two adjacent specimens, and this load left on till failure occurred, and the time noted. The load was made constant by using a geared Riehle 30,000-lb. testing machine, and mounting the specimen upon a nest of helical car springs which would deform about an inch under the maximum load upon the specimen. The time tests began by putting 95% of the breaking load on the specimen, then 90%, 85%, and so on.

The lowest time load was 65% of the breaking load. There were a number of time tests for each period, and the averages were taken, they plotted into a very smooth time curve, from which the following table is taken:

Crush'g load impos'd	90%	80%	75%	70%	65%
Time required to produce failure	10 min.	16 hrs.	36 hrs.	72 hrs.	200 hrs.

These tests were made in April and May, 1898, the material having been stored in my testing laboratory for four years and kept in the laboratory during these tests. To make such a series entirely free from moisture effects, due to changes in the hygrometric condtions of the atmosphere, all the specimens should be shellaced as soon as cut out, to hold them to a constant moisture condition. This was not done in this series of tests, and hence the above results must be accepted as approximate only.

A YACHT WITH CARBONIC ACID GAS as the motive power is being built at the ship yard of Capt. Louis N. Towne, at College Point, Long Island, N. Y. Its dimensions are: Length, 70 ft.; beam, 7 ft.; draft, 4½ ft. Compressed carbonic acid of 2,000 lbs. pressure per sq. in. will be used in a three-cylinder engine 10 × 10 ins. It is expected that the yacht will develop extraordinary speed.

*Abstract of a paper read before Section D, Mechanical Science and Engineering, of the American Association for the Advancement of Science, Boston meeting, August, 1898.
†Professor of Civil Engineering, Washington University, St. Louis, Mo.

A TRAIN-ORDER ANNUNCIATOR FOR LOCOMOTIVE CABS.

One of the frequent sources for railway accidents is forgetfulness or carelessness on the part of enginemen in regard to making stops at the meeting points called for by their orders. Several devices have been invented to jog the memory of the enginemen, including a train-order board with pegs to be inserted opposite the names of the

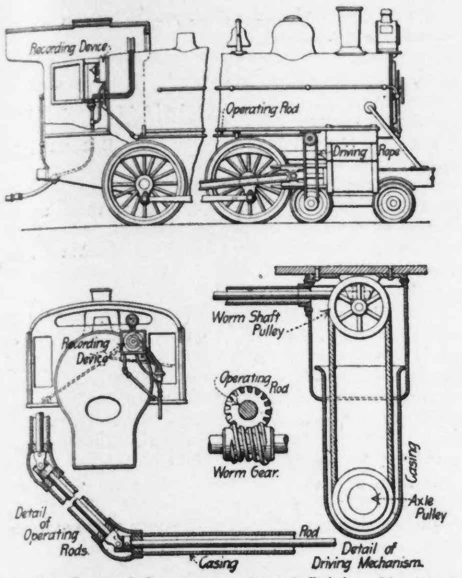


Fig. 1.—General Arrangement and Driving Mechanism of Train-Order Signal and Brake Setting Device.

Harry De Wallace, Inventor.

meeting points, which was described in our columns some time ago.

The device which we illustrate and describe in the present article is a step beyond other devices intended for the same general purpose, in that it automatically warns the engineman by sight and sound that he is approaching a meeting point, crossing, "slow" point, etc., while it would stop the train if he should carelessly or wilfully neglect to stop at the required places. It will at the same time show his position on the road, which is an additional safeguard in dark and stormy weather.

The recording apparatus is contained in a metal box about 10 × 10 ins., and 6 ins. deep, fitted with train-order dials, an air valve and a signal whistle. This is mounted on the boiler head or in any convenient part of the cab, as shown in Fig. 1. The mechanism is driven by rods with universal couplings, which rods are in turn driven by a bevel gear operated by a rope running around pulleys on the worm shaft and the end of one of the truck axles. The rods and driving gear are enclosed in suitable casings, as shown by Fig. 1.

A general view of the recording device in the cab is shown in Fig. 2. On the face of the box are two concentric dials, 8 and 6 ins. diameter, each graduated for 100 miles. These dials are set far enough apart to allow the hand or pointer to travel between them. The pointer is set at zero at the beginning of each run, and as the engine moves forward or backward this will show the distance traveled. On the face of the smaller dial are a number of triggers fitted with lugs which may be made to engage with the notches made in the edge of the dial at all the mile marks. In Fig. 2, the only trigger set is that at mile mark 76. When set in this position they will be released by an inclined lug on the pointer as it reaches them, the lug lifting up the trigger so as to free it from the notch, when the spring returns the trigger to its normal position. There are 15 of these triggers, allowing for that number of train orders, and they are pivoted at the center so that they may be set for any required distance or any required meeting point named in the orders.

A specially-prepared schedule card for the division on which the engine is running is attached to a holder on the box, the card being printed for westbound trains on one side and for eastbound **trains on the other side. This is shown at the right in Fig. 2, the card being for the Fergus Falls** Division of the Great Northern Ry., on which this device has been in use. On this card are marked the stations, sidings, crossings and other desired points on the run, together with the distance from the starting point, and the telegraph calls. The distance given is approximately one mile short of the near switch at the station or siding. Thus, if the train order requires the engineman to meet a train at Elk River, which is 40½ miles from St. Paul, the card shows 39 miles, so that the apparatus, being set for the latter distance, will give its warning at a suitable distance ahead of the meeting point.

The engineman will pull back one of the triggers convenient to that mileage and hook it in the 39-mile notch of the upper dial, where it will remain until the hand rotates and points to 39 miles, and in passing under the trigger releases it. Instantly the signal mechanism is set in motion and the signal whistle is blown by the air pressure, reminding the engineman that at a point about one mile distant, there is a siding, and that he has an appointment to meet, pass or clear for another train, or to do something else, as the case may be. If there are other triggers set for other orders at the same time, they will remain in their respective positions until the hand travels around to the mileage for which they are set. After the signal begins to sound, if the engineman hears it and is attending to his duty, he will release the signal by pulling out the button shown in the center of the dial, and also pushing in the one shown at the lower right-hand corner of the case, and prepare to make his stop (if a stop is necessary). But if he does not so release the device, showing thereby that he is attending to his duty, the signal will continue to sound while the train runs a quarter of a mile, and then the air will be automatically released from the train pipe and the train stopped before it reaches the station or point for which the trigger was set. The opposing train being similarly equipped, and the engineman being in the same condition, and affected in the same manner, his train in that emergency would also be stopped before it reached the station from the other side. If they are reminded by the signal and release it, then they will not forget their orders in the short distance they have to travel from the point of signal to the designated point. A train using this device cannot pass a point for which the apparatus is set unless it is released in the manner described.

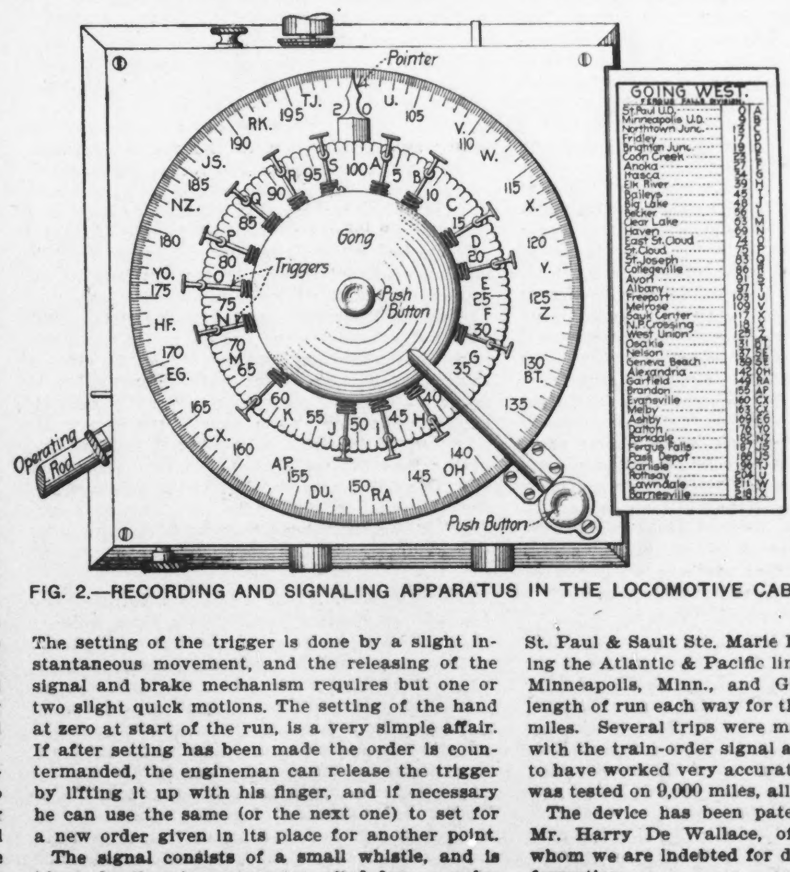


FIG. 2.—RECORDING AND SIGNALING APPARATUS IN THE LOCOMOTIVE CAB.

The setting of the trigger is done by a slight instantaneous movement, and the releasing of the signal and brake mechanism requires but one or two slight quick motions. The setting of the hand at zero at start of the run, is a very simple affair. If after setting has been made the order is countermanded, the engineman can release the trigger by lifting it up with his finger, and if necessary he can use the same (or the next one) to set for a new order given in its place for another point.

The signal consists of a small whistle, and is blown by the air pressure supplied from a valve located within the case, which is connected directly with the train pipe. It begins to blow upon the release of a trigger, and blows till the brakes are set, when it stops, unless the engineman releases it sooner. A bell or gong may be used instead.

The device requires no change or attention when the engine is reversed and run backward. Switching may be carried on for an indefinite length of time and space without alteration. The distance will be measured, the signal operated and the brakes set with the same facility and accuracy, whether the locomotive is going ahead, or backing up. Of course, when the engine backs up as in switching, the mileage is deducted. The backward distance may be added to the forward measurement, however, if desired. At night, or in stormy or foggy weather, the engineer can ascertain his whereabouts by looking at the face of the machine. If he has difficulty in finding any place on the road, he can set the device for the distance, and it will locate it exactly and inform him of his approach to it. In snow-plow work, the engineman can always tell his position when every other landmark is obscured.

As already noted, the mileage on the card is from one to two miles less than the exact distance to each station, according to whether it is level or down grade approaching the point named. This is done so that the automatic stopping of a train will occur at a safe distance from the desired point. The letters on the card are intended to be used by the dispatcher, and inserted after the names of the stations in his orders, as a check, to prevent his giving the wrong station for a meeting point. The same letters appear on the dials; a different letter is given to each five mile space.

The inventor has recently added to the signal combination, what he calls a "disorder signal." The purpose of this is to notify the engineman in case the train-order signal, or its connections, get out of order, or for any reason fail to do their work. It will also give a warning when any of its own parts become out of order. This makes the invention very reliable. If the engineman should learn to rely implicitly upon the contrivance, and it should fail without his notice, this latter attachment would let him know it at once. If it signals "out of order," he will not rely upon it or use it again until repaired or replaced.

Some time ago the inventor made a 7,000-mile test, with a full-sized working model, on the Great Northern Ry., running west from St. Paul, as far as Portland, Ore. In this long test, the device was attached to one of the large Brooks passenger locomotives in regular service, hauling the heavy and fast Pacific Coast train, and the machine is said to have clearly demonstrated the correctness of its principles, its practicability and usefulness. In July he placed an improved machine on one of the fine new Schenectady engines owned by the Minneapolis, St. Paul & Sault Ste. Marie Ry., and used in hauling the Atlantic & Pacific limited express between Minneapolis, Minn., and Gladstone, Mich. The length of run each way for this locomotive was 356 miles. Several trips were made over this distance with the train-order signal attached, and it is said to have worked very accurately. In all, the device **was tested on 9,000 miles, all on long and fast runs.**

The device has been patented by its inventor, Mr. Harry De Wallace, of St. Paul, Minn., to whom we are indebted for drawings and other information.

ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

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

GEO. H. FROST, ... President
D. McN. STAUFFER, ... Vice-President
CHARLES WHITING BAKER, Secretary and Managing Editor.
F. P. BURT, ... Treasurer and Business Manager

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

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CHAS. W. REINHARDT, ... Chief Draftsman.

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

Publication Office, 220 Broadway, New York.
Chicago Office, 1636 Monadnock Block.
Boston Office, 299 Devonshire St.

SUBSCRIPTION RATES: United States, Canada and Mexico, One Year, $5.00; *6 months,* $2 50; *2 months,* $1.00. *To all other countries in the Postal Union: Regular Edition, One Year,* $7.60 (*31 shillings*); *Thin Paper Edition, One Year,* $6.31 (*26 shillings*). *SINGLE COPIES of any number in current year,* 15 *cents.*

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The decision of the Supreme Court of the United States that the Joint Traffic Association is an infringement of the Anti-Trust law and of the pooling clause of the Interstate Commerce law, is almost unquestionably a sound one. The question before the Court was simply whether the legislative department of the government had power to prohibit contracts in restraint of competition on the part of common carriers. It was not the Court's business to inquire whether such prohibition was wise, or good public policy. That was the duty of the legislative department of the government, and judges have no authority to usurp the functions of lawmakers.

We have heretofore expressed the opinion that the attempts to keep competition alive by legislation are unwise, and will eventually defeat their own end by fostering the consolidation of competing companies. Nevertheless, if the lawmakers decide to try this method of combating the abuses and evils to which monopolies give rise, the courts have no warrant for interference. Further, it is to be borne in mind that all this law or any law can do is to prohibit actual contracts or agreements in restraint of competition. It cannot compel any person or corporation to compete with its rivals if it does not choose so to do. Any railway company or all railway companies are at liberty to discharge their soliciting agents if they choose, and if all railway companies were to take this step, it would probably do more for the maintenance of rates and the prevention of rate-wars than all that has been accomplished by traffic associations in the past decade.

What appears on its face to be another example of failure on the part of laymen to appreciate the length of time required to make plans and estimates for important engineering works has recently occurred at Philadelphia. Some weeks ago the Select Council passed a resolution calling upon the Chief of the Bureau of Water, Mr. John C. Trautwine, Jr., Assoc. Am. Soc. C. E., to prepare plans for a 90,000,000-gallon reservoir for West Philadelphia, and submit them at the next stated meeting of the council. The plans not being presented as soon as called for, a resolution was passed on Oct. 20 by the Select Council, 31 to 0, and by the Common Council, 54 to 25, which is such a gem of its kind that we reproduce it, as follows:

Whereas, The Select Council five weeks ago passed a resolution calling on the Department of Public Works, Bureau of Water, to have prepared by Council's next stated meeting the plans and specifications for the reservoir authorized to be built in West Philadelphia, on George's Hill; and

Whereas, The said resolution has since been passed by Common Council and forwarded to the Bureau of Water, in the Department of Public Works, for the instruction of the chief of the same; and

Whereas, The said chief of the Bureau of Water has failed either to provide the plans and specifications or to make any report to Councils for his failure to do so, or to give some date at which said plans will be ready, and has therefore treated contumaciously the resolutions of these Councils;

Therefore, Be it resolved by the Select and Common Councils of the city of Philadelphia that the Director of Public Works be informed of the failure and neglect of the chief of the Bureau of Water to comply with the resolution of these Councils and his failure to respect its request; and be it further

Resolved, That the said Director of Public Works be asked to order and direct the chief of the Bureau of Water to provide the plans at the earliest possible date, and not later than the first regular meeting of Councils in November. (Nov. 11—Ed.).

During the discussion on this subject, in and out of councils, one councilman urged that plans for a 380,000,000-gallon reservoir, the Queen Lane, had been prepared in four weeks, and therefore one week was sufficient to prepare plans for a 90,000,000-gallon reservoir. It was also urged that the request for plans was made last summer, but Mr. Thompson, the Director of Public Works, is reported as having said in a newspaper interview that the Park Commission did not approve the site of the reservoir until Sept. 28.

Philadelphia councilmen might learn something from the experience in New York state, where engineers were given only two weeks in which to prepare estimates on many millions dollars of canal work, with results only too well known. But it is unnecessary to go outside of Philadelphia for examples of the folly of haste in or inadequate studies of engineering work, for, if the Philadelphia "Times" of Oct. 22 is right, the Queen Lane reservoir, mentioned above as having been designed in four weeks, and the Roxborough reservoir, both show the evil effects of deficient preliminary investigations. Mr. Trautwine has had the difficult task of making these very reservoirs tight, and naturally wishes to profit by the lessons they teach.

In the opening sentence of this note we said "what appears on its face to be another example," etc. We used these words because there is reason to believe the resolution quoted above was really prompted quite as much, if not more, by a desire to harass Mr. Trautwine than anything else, on account of his sturdy attempts to present the water supply situation to the people of Philadelphia in its true light. His recent report showing that a proper meter system would save money enough to go far towards paying the cost of a filtration plant was a bitter pill for the advocates of giving some big corporation a contract for furnishing a filtered supply. Some members of the council remarked, when the report came out, that he was not instructed to present the meter question, but to report plans and estimates for filtration, as though any engineer could do such a thing until he knew what water consumption to figure on, or could conscientiously put in an estimate for filtration on the basis of the vast water waste in Philadelphia without pointing out the saving that the meter system would effect. In view of all the facts in the case the public is less likely to be impressed with the "contumaciousness" of Mr. Trautwine than with the ignorance and pugnacity of some Philadelphia councilmen.

The train-order signal which is illustrated and described on another page of this issue, appears to us to be a device worth careful examination by those responsible for the safe movement of railway trains on all roads where the block system is not in use and the trains are governed by telegraphic orders. Every railway man familiar with the movement of trains under this system knows that the point where failure is most frequent is the forgetfulness of engineers. Under the modern system of giving train orders by a standard code and in duplicate, errors by train dispatchers or telegraph operators have become comparatively rare, and when a head collision occurs, it is most frequently because the engineer runs past the point at which his orders required him to stop.

The device in question is a simple automatic appliance for giving warning to the engineer whenever he approaches a meeting point and compelling him to heed the warning by applying the brakes if he does not respond after a suitable time.

While the device is of great value on roads which have no fixed signals, it is also applicable in connection with the block system to give an audible warning to the engineer of his approach to signals, and seems to us superior in many respects to the numerous class of inventions in which a track instrument is used in connection with an attachment on the locomotive to sound a whistle or apply the brakes when the train passes a home signal at danger. The objection to these appliances, as we have before pointed out, is the complications they introduce into the signaling system, the liability of the track instruments to breakage, and the fact that if an engineer is so derelict in his duty as to disregard a home signal at danger, he will probably run up to it at such speed that a brake setting device at that point will operate too late to avoid a smash-up.

The instrument which we describe in this issue, however, requires no track instruments whatever, and is wholly independent of any signaling system. It is simply a mechanical memory which acts as a check on the fallible memory of the engine runner; and when the latter fails, stands ready to "jog the elbow" of the man who may otherwise in a lapse of absent-mindedness carry on a trainload of passengerts to a fatal wreck.

We are aware that it is sometimes claimed that automatic warnings of all classes give no real gain in safety. It is said that there is more chance that they will become out of order and fail to operate than there is that the vigilance of the human operator will relax. In our opinion, however, this is a fallacy. The history of mechanical progress shows countless instances where automatic mechanism has been substituted for the human hand and brain, with a gain in precision, accuracy and unvarying reliability in practically every instance. Besides this, in the present case, the inventor has followed the cardinal rule of safe signaling operations, and has so designed his instrument that it automatically gives warning in case it becomes deranged from any cause.

Another objection frequently brought against instruments of this class, is that the men could not be made to systematically use them; that they would consider their provision a reflection upon their own fidelity and vigilance. Some prejudice of this sort might be encountered at first; but we believe most engineers would welcome such an aid in carrying their heavy responsibilities, and would make faithful use of it. The relief from the nervous strain and fear that a moment of forgetfulness may come would be a welcome boon to them, and would be shared, we are sure, by many higher railway officials, who often lay down to sleep at night with a prayer that some unseen mentor may give a timely warning to any one of those under them who forgets his duty at the critical moment.

THE MODERN NAVAL ENGINEER.

The bill for the permanent settlement of the "line and staff" controversy between the line and engineer officers of our navy, which was brought forward at the last session of Congress, will doubtless be again taken up at the approaching session, and will receive, it is to be hoped, the consideration which is its due. Meanwhile it is of interest to note that the eminently unsatisfactory position of the engineer officer in the British Navy is arousing attention in that country, and the "Naval and Military Record" has vigorously taken up the subject, which it deems of the utmost importance to the efficiency of the navy. While the methods of training engineer officers for service in the two navies radically differ, the results of the two are very similar, in depriving the engineer of executive authority over his own subordinates, and in often compelling him to report to officers very much his junior in years and grade.

In the British Navy the future engineer officer

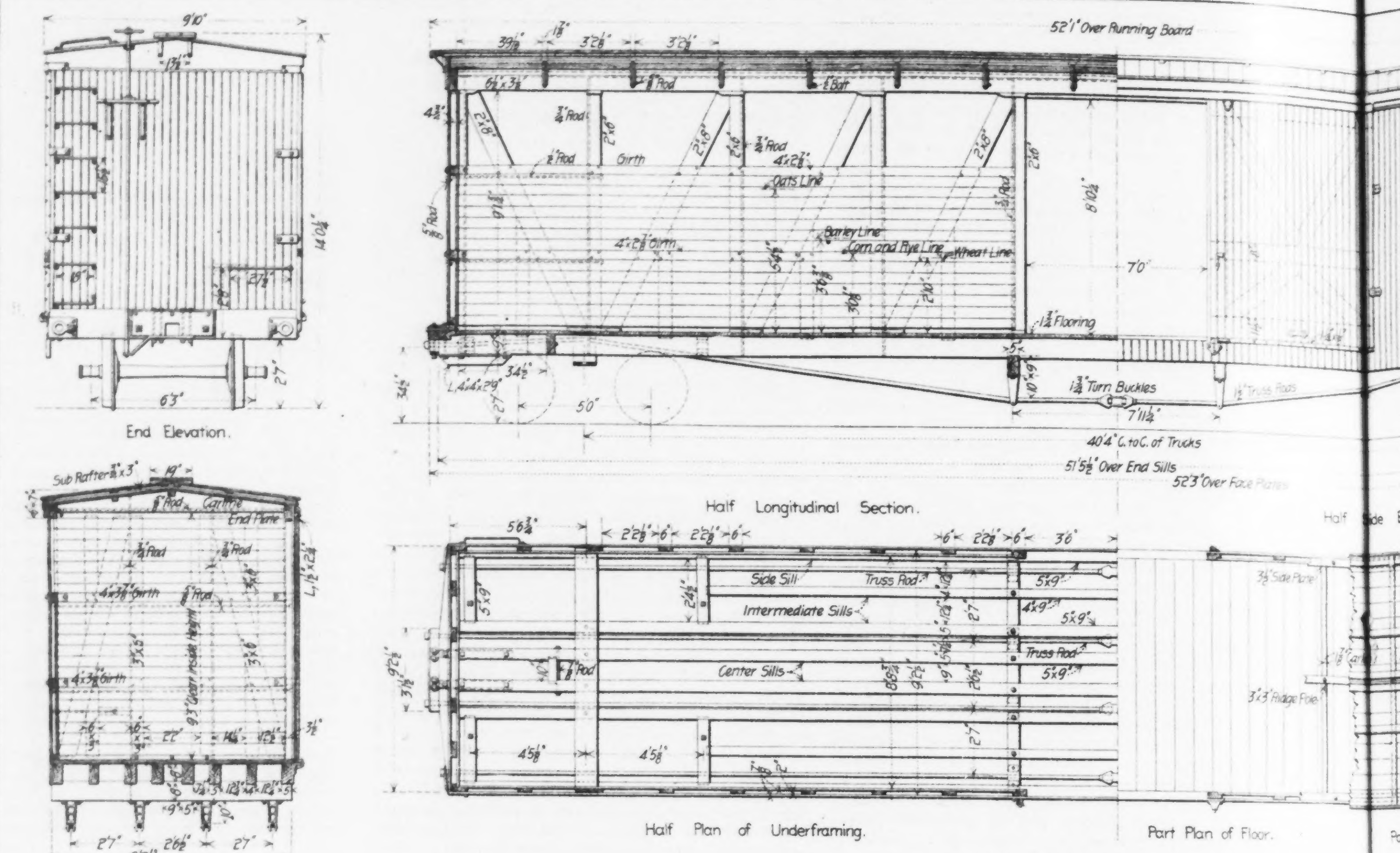


FIG. 2. ELEVATION, SECTIONS AND PLAN OF CAR.

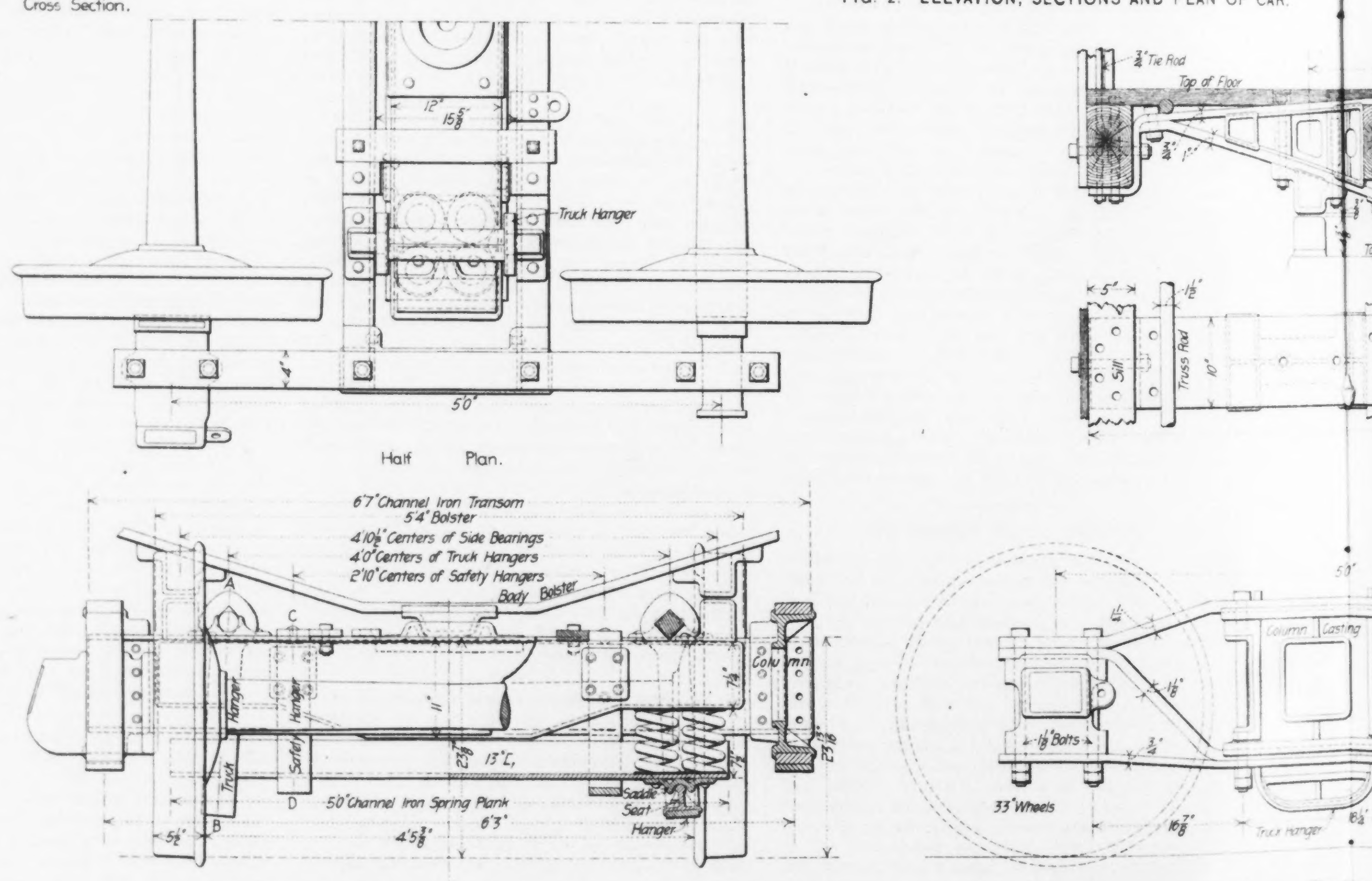
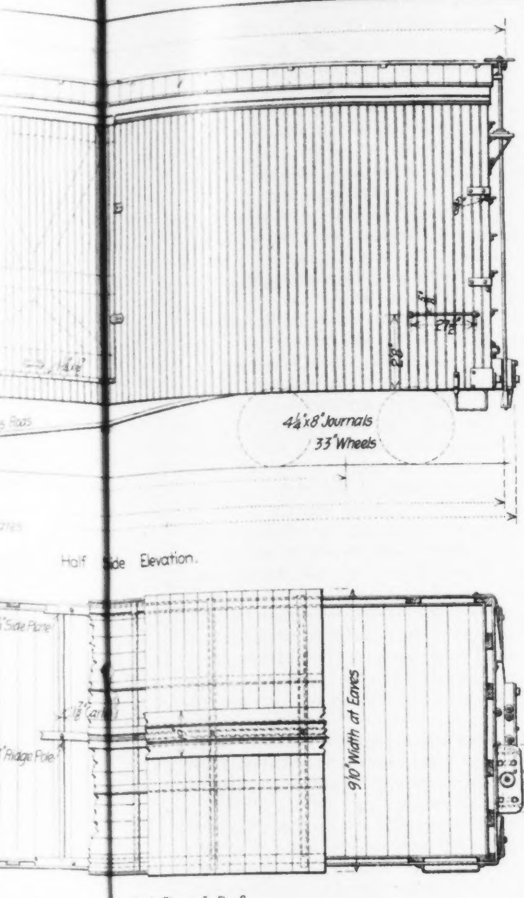


FIG. 5. TRUCK DETA

50-FT. FURNITURE CAR OF 60,000 LBS. CAPACITY

Geo. F. Wilson, Superintendent of Motive Power and Equipment.



OF CAR.

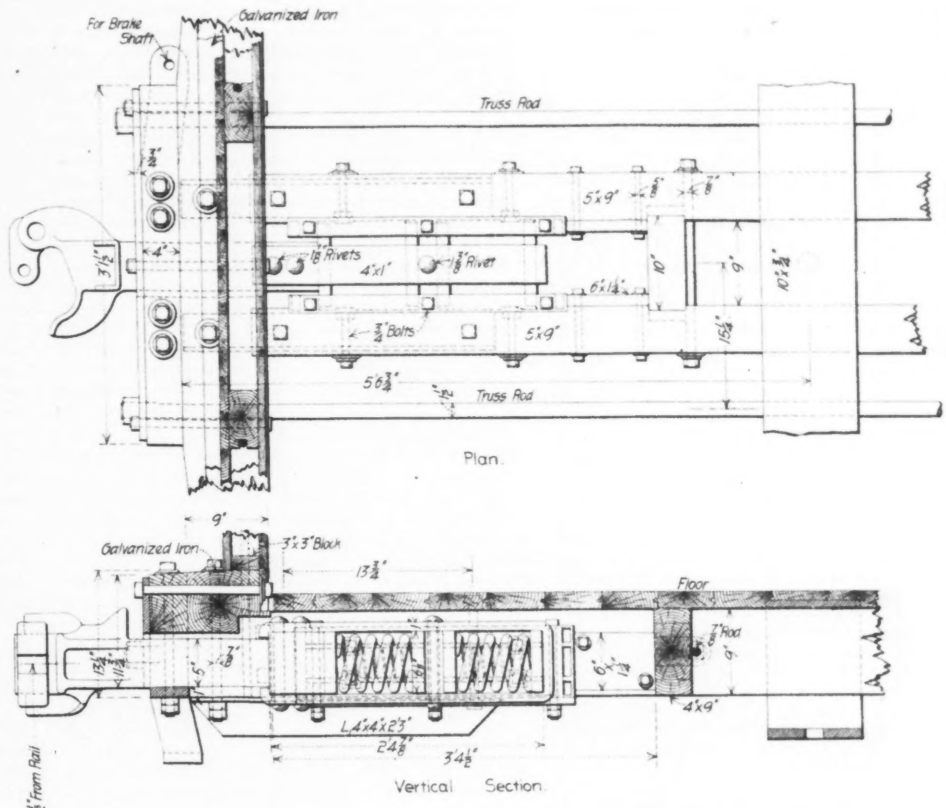
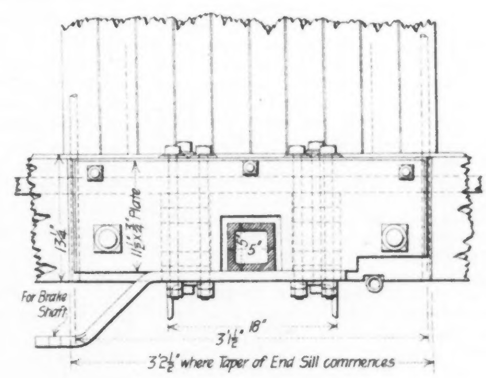


FIG. 3.
DRAFT RIGGING.



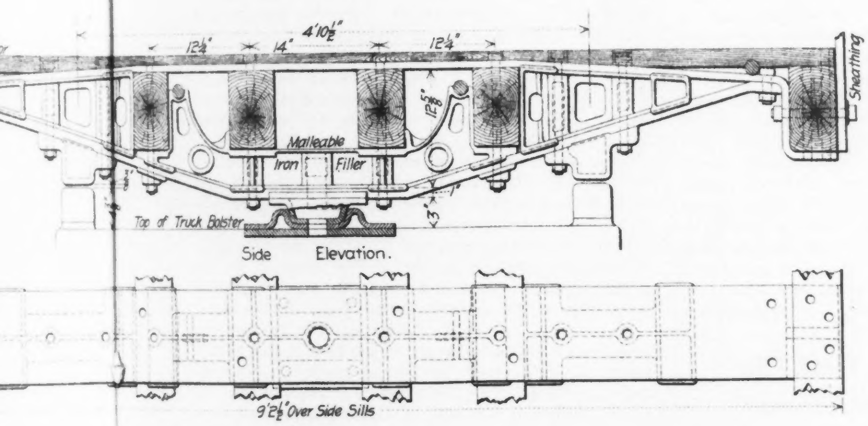


FIG. 4. METAL BODY BOLSTER.

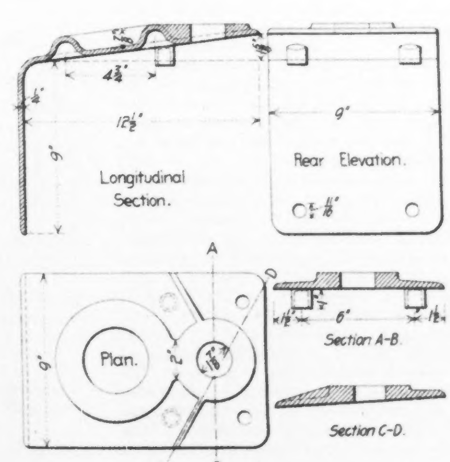
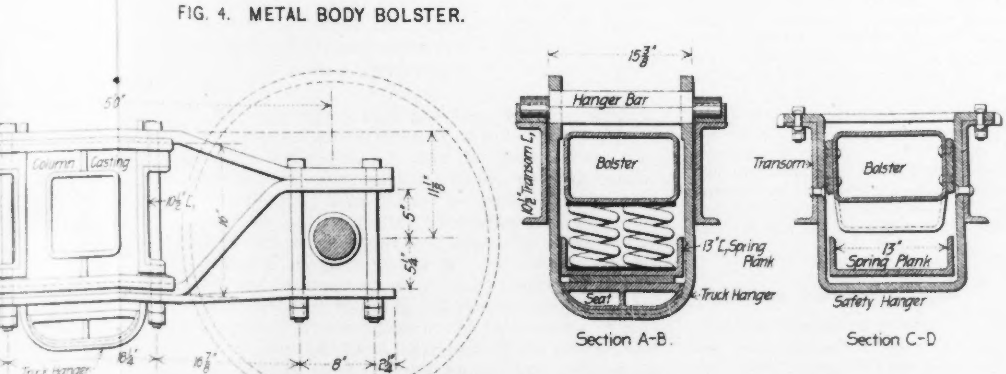


FIG. 6. MALLEABLE IRON CORNER POCKET.



G. 5. TRUCK DETAILS.

LBS. CAPACITY; CHICAGO, ROCK ISLAND & PACIFIC RY.

pment.

Michigan-Peninsular Car Co., Builders.

has no such engineering education at the hands of the Government as is given in this country. Instead he goes from civil life directly to the engine-room, and receives his only training there. He is promoted from time to time as he succeeds in picking up the practical part of his business. There is no preliminary technical course, of any high order, at least; and while the system may produce very good mechanics, it is not calculated to provide that thorough and scientific, as well as practical, knowledge that is now an absolute necessity to efficient service in responsible positions in the engineers' division. As a direct result of this method, the English engineer officer in the navy is regarded as not quite up to the standard of the "English gentleman"; he receives considerably less pay than line officers of the same relative grade, and the same length of service; the position is unpopular among the brighter class of young men, and the opportunities for reaching a high rank in the staff grade are so few that out of 845 engineer officers now serving in the English navy only 14 have reached the relative grade of Captain. As a contrast, there are 65 Admirals and 185 Captains among 1,676 line officers. The "Record" charges this condition to the stupidity and old-fashioned prejudices of the English Admiralty, and practically claims that the ruling line of conduct of this board is based upon a navy now obsolete. The English engineer officers are very modest in their demands for reform, and only ask that they be given executive command over their subordinates and be relieved from the present necessity of reporting the most trivial offences to some line officer.

Our English contemporary seems to think that some concession of this kind would be sufficient, and it regards as a "foolish experiment" the amalgamation of the two classes of officers, which is now proposed in the United States Navy. But the "Record" suggests no way of otherwise avoiding the inevitable conflict of authority between the line and staff officers which occurs under prevailing conditions in the navy. It is well enough to suggest that the executive power of engineer officers should be confined to the engine and boiler rooms; but in a modern warship the engineering department covers a great number of auxiliary engines and mechanical appliances which also require engineers to manage and supervise them. To carry out the suggestion of the "Record," these auxiliary engines, etc., would have to be taken away from the engineer department and placed under the charge of line officers, who, to properly perform the duty thus imposed upon them, should also be trained engineers. Under this view of the case it would be very "foolish" indeed to make any distinction in grade and authority between the two classes of officers; and the interests of the service would be best advanced by making all officers line engineers. This is exactly the amalgamation proposed in the United States Navy and condemned by the "Record."

The fact is that the proposed change in personnel in the U. S. Navy is not the result of an attempt to adjust absurd differences, as to relative rank and dignity, between the line and the staff, but is the direct outcome of a radical change in the methods of conducting naval warfare. Under modern conditions, the engineer officer of thirty years ago is almost as obsolete as the sailing-master in the proper performance of duty on a warship.

The objection which has been brought against the proposed amalgamation of the steam engineer officers and the line, is that the duties of the former are technical, and those of the latter are executive, and that men cannot be expected to become proficient in both fields. This argument, however, overlooks the fact that line officers in all the junior grades at the present day are really doing technical and engineering work, quite as much as the commissioned officers in the steam engineering department. The training of the two classes of officers is identical for a large part of the course, and the special work of the young line officers in ordnance manufacture, in torpedo work, in the handling of explosives, is as truly engineering work as the work of the young engineer officers on steam engine and boilers. It is a well-known fact that many line officers who have resigned from the navy have won distinction in the engineering field. Many of the latest and best appliances employed on our warships are the invention of naval officers. They have improved the apparatus for loading 12-in. guns and for handling water-tight bulkhead doors; they have devised range-finders and have applied compressed air to the handling of turrets.

Line officers are now in charge of the electric plant, and in the daily performance of their duty are constantly handling machinery. It only requires a slight extension of their present technical training to fit them for command in the engine-room.

On the other hand, the reason which formerly existed for making the engineer officers a class apart no longer exists. The lieutenant may be as well fitted for future positions of greater responsibility by command in the engine-room as in the turret, by the study of thermodynamics as of ballistics. He must be a competent engineer, if he is to obtain success in either case.

Diplomacy, the knowledge of men and the world, the ability to command and to successfully deal with emergencies of every kind, are all essentials in the make-up of the naval officer of high rank. But these qualities come with time and experience, and are not the direct results of academic training. As the officer gravitates toward a position of command, he will be relieved by younger men of active service in connection with the mechanism of the ship, no matter where located; but he would always possess that invaluable condition in all positions of command—a personal and intimate acquaintance with the duties of his most important subordinates and the possibilities of his ship as a fighting machine.

The successful conduct of our late war by the naval arm of the service is largely due to the thorough training of our naval officers, and their methods and their success have wrung praise from unwilling naval authorities. But the handling of the engines of the "Oregon," in her unprecedented sea-voyage, and the serving of the guns at Manila and Santiago, were alike the work of engineers, and the results reached were alike due to mechanical means; under these conditions there seems to be no good reason why any distinction should be made in pay or position between the officers who did the one piece of engineering work and those who did the other. The evolution in naval warfare has made engineering knowledge the essential, all-important requisite in the naval officer. Every warship must now have its practical mechanics, electricians and trained assistants of all kinds, and men of this class now form the bulk of the crew. But just as the old naval commander was a sailor in command of sailors, it now requires an engineer of a high degree of training to properly direct his mechanical assistants and to handle a ship in which practically every movement is controlled by intricate mechanism.

LETTERS TO THE EDITOR.

Relative Corrosion of Iron and Steel.

Sir: In your issue of Oct. 20 I note a query regarding the relative rate of corrosion of iron and steel and a request for discussion from anyone having experience with the two metals. I would call your attention to a discussion of the subject by me to a paper by Prof. A. H. Sabin in Trans. Am. Soc. C. E., Vol. XXXVI., December, 1896.

Since that was written I have had another examination made of the plates after two years' exposure, with the same general result.

My observation of these plates would not support the statement of your correspondent that steel is much more subject to corrosion than iron, but rather the contrary, that iron was the more susceptible of the two metals.

Yours truly,
L. M. Hastings,
City Engineer.

Cambridge, Mass, Oct. 21, 1898.

[In the discussion referred to, Mr. Hastings tells how he practically tested the effect of water and soil upon uncoated and protected plates of steel, wrought iron and cast iron, and gives the results. Taking the uncoated plates alone, we find those of steel and wrought iron were 6 to 10 ins. square and 5-16-in. thick; the cast iron was about 1 in. thick. These plates were carefully weighed and placed in the water in the pump conduit. This water was a mixture of brook and pond water, fairly soft and containing comparatively little acid. After one year's immersion the plates were examined on Oct. 8, 1896. The two uncoated wrought-iron plates were badly tuberculated and rusted and one of them was "the worst in the lot." The two uncoated steel plates were rusty and tuberculated but "not so badly as iron." The uncoated cast-iron plates were badly rusted and tuberculated. The percentages in increase of weight due to corrosion were as follows: For the two wrought-iron plates, 1.5 and 3.1%; the two steel plates, 1.1 and 2.1%; the two cast-iron plates, 1.0 and 0.96%. The wrought-iron plates buried in sand and in clay also showed greater increase in weight than steel plates similarly placed. Mr. Hastings concludes that, subjected to the action of water, unprotected plate iron was effected the most; steel plate to a less degree, and the cast iron least of all.—Ed.]

Conditions in Havana.

Sir: In fulfilment of the half promise which I made you before leaving for Cuba I now send a few lines from this city. In the first place, all friends of humanity will be glad to know that, largely due to the enormous quantities of food supplies shipped to this port from the United States and Mexico since the raising of the blockade, the evidences of intense misery and starvation have almost disappeared from Havana and its environs. I think any one revisiting Havana, a stranger to the events of the last four years, would be simply struck with the less degree of animation and movement in the streets and the greater number of beggars as compared with his previous recollection.

The streets of the city and the adjoining suburbs of Cerro and Jesus del Monte are about in their normal condition of cleanliness—or filth. The copious rains which are still falling (2.40 ins. were reported in five hours the other evening) are performing the work of the street cleaning department with considerable success, so that Havana at present is as clean as ever, be that saying much or little.

Outside of the city, to the west and south, through the region bounded by the springs of Vento, Mariel, Guanajay, Marianao and the Playa, which is included in the "zone of cultivation," no signs of want and starvation exist. A large part of this territory is under cultivation, and herds of horned cattle and pigs are to be seen. The people look in as good condition as to health and clothing as ever, and demonstrate to a remarkable degree their powers of rapid recuperation. The unfortunate victims of a previous cruel regime are at rest, and the survivors are regaining health and hope. No doubt by looking for them cases of still living victims might be found in a condition worse than death, but it would be necessary to go off the beaten track to find them. I believe that the worst and most permanent effects of past privation will be found in the broken nerves and lowered vitality of the formerly well-to-do inhabitants of Havana and other large Cuban cities. As you know, a large and strong commission, appointed by the President, among whom is Col. Waring, of New York, are now sitting in Havana, and much and radical improvement may be expected if their recommendations shall be carried out. The duties of the commission, as you will recollect, embrace not only the arranging for the landing and encampment of the incoming American troops, but the sanitation of Havana as well.

Speaking broadly and ignoring numerous exceptions, it may be said that the great body of the Spanish population of Havana are desirous of annexation to the United States as giving security to their commercial operations and enhanced value to their real estate. An exception may exist on the part of merchants, especially retail merchants, who are carrying large stocks and dread the competition of American rivals with large capital and low prices. Among the Cubans I should say that the most enlightened and truly patriotic also desire annexation, realizing the difficulty of erecting an independent nation upon a territory somewhat less in extent than the State of New York, and with a total population of at the outside one and a half millions, of which one-third are negroes, and perhaps one-third of the remainder Spaniards or Spanish sympathizers. Among those Cubans who are still dreaming of independence—a noble though unrealizable dream—I think very few are to be found outside of the insurgents still in the field, who do not ardently desire an American protectorate until perfect order and tranquility are established. Does not this really involve a permanent protectorate?

As to business opportunities and private enterprises of all kinds, the whole subject may be disposed of at once by stating that nothing can be safely undertaken until the Spanish troops have been withdrawn, the Cuban troops disbanded, American garrisons established and a stable order of things set up, so that titles can be secured, franchises awarded and business carried on upon business principles. It is the object of the various commissionsnow in Havana to forward these desirable conditions, and it is to be hoped that their efforts will be promptly sustained by our Government. E. S. G.

Hotel Pasaje, Havana, Cuba, Oct. 21, 1898.

AUTOMATIC COUPLERS FOR AIR BRAKE HOSE.

The general introduction of air-brakes and automatic couplers on railway equipment has naturally been followed by attempts to couple automatically the air-brake hose at the same time that the cars themselves are coupled. While various forms of apparatus have been devised for this purpose, but little practical success has been obtained, partly on account of the cost and complication of the apparatus, but mainly, it seems to us, for the reason that the conditions of operation are not such as to demand automatic action. Automatic car couplers were introduced largely to eliminate the danger to life and limb incident to coupling moving cars by hand, but the brake hose cannot be coupled until the cars are already coupled, and are very rarely connected up while the cars are in motion in the yard. There would be somewhat greater safety and a certain saving in time (particularly in uncoupling), but not enough probably to warrant the expense of applying and maintaining an apparatus which would require to be inspected almost as frequently as the ordinary hose coupling, in order to ensure that it is in proper condition and properly coupled. The claims made, however, include a minimum cost of maintenance and a large saving in hose.

It will probably surprise many of our readers to know that automatic hose couplers are in regular every-day service, though to a limited extent, and we are indebted to Mr. N. F. Niederlander, President of the American Brake Co., St. Louis, Mo., for particulars of the coupler which is manufactured by that company for the Automatic Air & Steam Coupler Co., of St. Louis.

This device, shown in Fig. 1, is attached to the underside of the car coupler by a bracket, to which is bolted a slotted hanger which supports the coupling spring, and also an arm carrying a chain which supports the coupling head. A short length of hose attached to the existing train-pipe fitting connects by means of a union nut with a pipe which enters the coupling head directly back of the registering rubber gasket. The coupling spring being free in the slotted hanger, and the short hose and chain being flexible, full and free movement is allowed to meet the variations in height of cars and the positions of couplers on curves. The flaring guides or wings on the back of the coupling head, and the projecting end of the coupling spring guide the heads into proper position for coupling under any conditions. The gaskets are so placed on the face of the coupling heads that neither is touched by the opposite member until the coupling is made. This protection of the gaskets is effected by means of an incline groove and strip on the face of the coupling heads, which parts interlock when the gaskets are in position to register. Provision is made to couple with the ordinary hand hose coupling by means of the union nut at the lower end of the short hose. In uncoupling, when the car couplers are released the brake coupler heads will readily separate as the cars are pulled apart.

Fig. 1 shows only the air-brake, and air-signal pipes fitted to the coupling head. The steam pipe fittings are separate and can be readily attached and detached. For freight service the brake hose attachment only need be used. This apparatus has been used on the Wabash R. R. and the Atlanta & West Point R. R. It has been in use for over three years on a passenger train equipped with the brake and signal coupling, and for about a year on two passenger trains equipped with the brake and steam coupling. Several freight cars have also been equipped with the air coupling above. Mr. George C. Smith, President and General Manager of the Atlanta & West Point R. R. and the Western Ry. of Alabama, informs us that the automatic coupling for air and steam hose on passenger cars, and for air hose on freight cars, which has been in use for more than a year, has shown very satisfactory results. This road has two passenger trains equipped with the apparatus, and last spring it was applied to 50 freight cars.

Another apparatus for the same purpose, which has as yet been tried only to a very limited extent, is the Walter automatic air-coupler, invented by Mr. Wm. J. Pugh, of Muscatine, Ia. In this apparatus, shown in Fig. 2, the coupling head is suspended from, but not rigidly attached to the drawbar, the thrust in coupling being taken up by a telescopic strut behind the coupler. A short vertical piece of hose connects the train pipe with the opening on the outer side of the coupling head. In this device, as in the one already described, the gaskets of the joint between the two heads are not forced into contact until the openings register, or coincide with one another. The patents on this latter device are owned by the Walter Automatic Air Coupler Co., 605 First National Bank Building, Chicago, Ill.

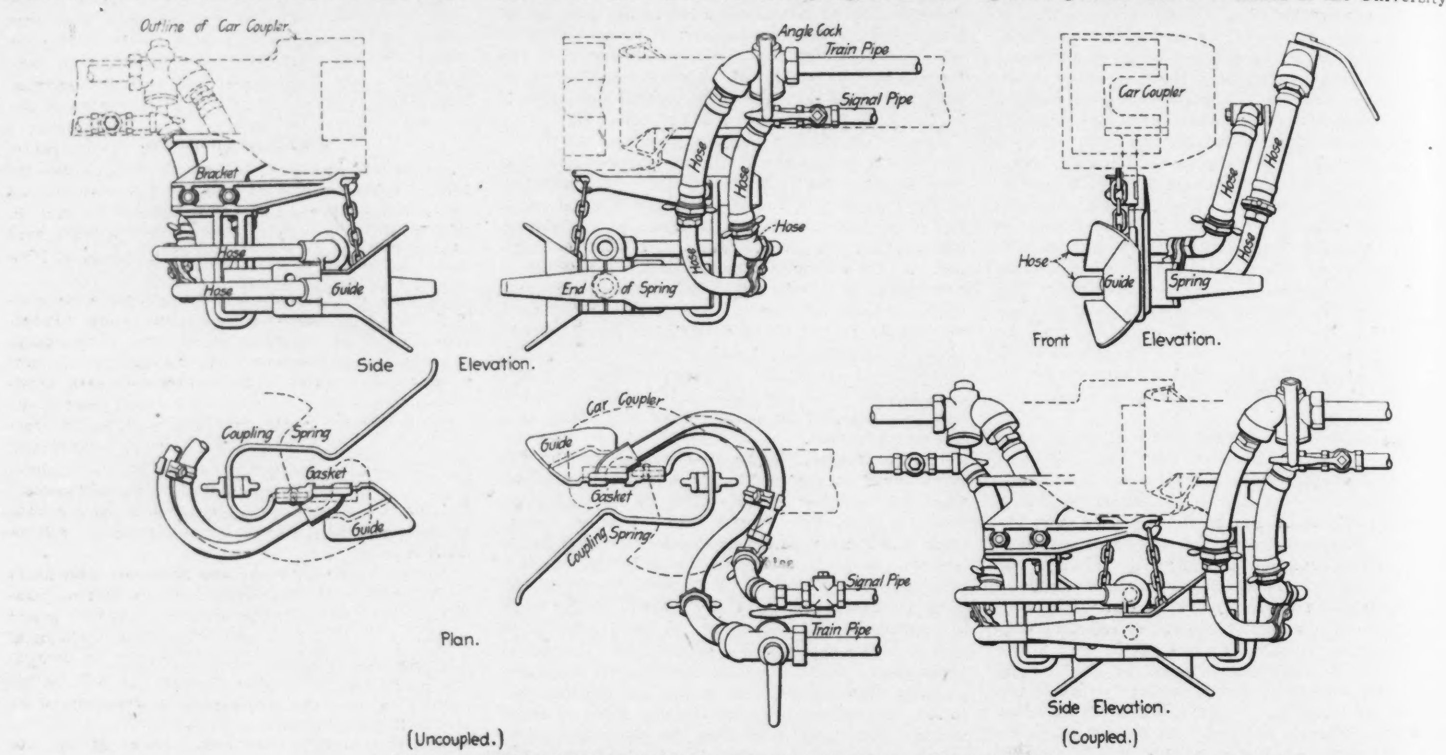


FIG. 1.—AUTOMATIC COUPLER FOR AIR BRAKE AND SIGNAL PIPES.
Automatic Air & Steam Coupler Co.; St. Louis, Mo.

A NEW METHOD OF PUMPING BY COMPRESSED AIR.

The accompanying illustration shows in an elementary way the principle of pumping water or other liquids, or semi-liquids, which has been adopted in several different forms of pumping apparatus that are now being put on the market by the Pneumatic Engineering Co., 100 Broadway, New York city. They are made under patents issued to Elmo G. Harris, Professor of Civil Engineering in the School of Mines of the University of Missouri, Rolla, Mo., who is well known as a writer on compressed air, especially in its relation to pumping.

Hitherto in the application of compressed air to the elevation of liquids confined in tanks a large part of the applied power was lost on account of the necessity of allowing the tank full of compressed air to escape into the atmosphere before the tank could be again filled with water.

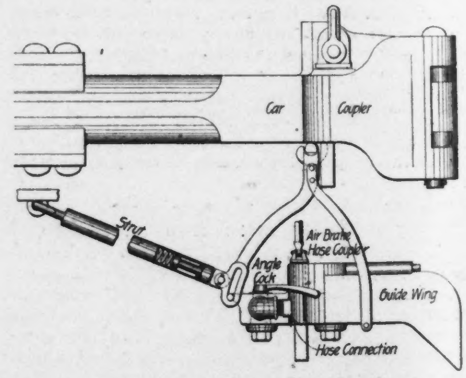


Fig. 2.—Automatic Coupler for Air Brake Pipes.
Walter Automatic Air Coupler Co., Chicago, Ill.

This loss is avoided in Prof. Harris's system by utilizing the stored energy of the compressed air, which would in the older systems be thrown away, to assist in doing the work of the air compressor. The figure shows how this is accomplished. There are two tanks which are alternately filled and emptied. When one tank is full air is admitted directly from the compressor until the water has all been discharged, then an automatic switch valve is turned so as to allow the compressed air remaining in the tank to pass to the suction side of the compressor. When the switch is set as in the figure the air is drawn out of the right hand tank and forced into the left

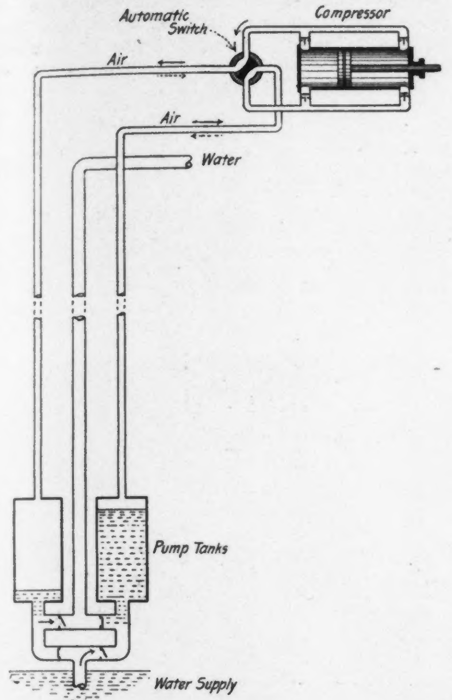


Diagram Illustrating Method of Pumping Water by Compressed Air,
Prof. Elmo G. Harris, Inventor.
Pneumatic Engineering Co., 100 Broadway, New York, Manufacturers.

hand tank. The charge of air in the system is so adjusted that when one is emptied the other is just filled. At that moment the switch will reverse the pipe conditions so that action in the tanks will be reversed. Several proposed practical applications of the system are described in a small pamphlet issued by the company, and to which we would refer any of our readers desiring further information.

THE MANUFACTURE OF SILK in the United States, says the Treasury Bureau of Statistics, amounted in 1860 to $6,607,771 in value; in 1870 it was $12,210,662; in 1880, $41,033,045, and in 1890, $87,293,454. It is now estimated that the silk production of the United States amounts to about $150,000,000 per annum in value. Meanwhile the importation of manufactured silks has rapidly fallen: from $38,686,374 in value in 1890, to $25,523,110 in 1898. The raw silk is imported; the amount in the fiscal year ending June 30, 1898, being 10,315,161 lbs., valued at $31,446,800, as compared with $18,918,283 in the previous year. This large increase is partly due to the fact that a number of cotton factories in New England and the Middle States have recently substituted silk manufacturing machinery in place of cotton. Our manufacturers are now exporting silk goods. In 1878 these exports amounted in value to only $19,032; in 1898 the silk exports were valued at $297,074. That there is room for growth in this export business, however, is made evident by the English export of silk manufactures, which amounted to about $5,690,805 in 1897; though this value was $13,321,220 in 1888. German exports have also decreased from $45,000,000 in 1889 to $26,000,000 in 1897. France still heads the list of silk manufacturing countries, and holds its own with a value of $52,283,700 for the silk manufactures exported in 1897. While our manufactures, in 1860, supplied only 15% of the silk goods used in the United States, to-day they furnish 85% of the consumption.

FAST TIME TO AUSTRALIA from New York has been made by the "Fort Salisbury," of the American and Australian Line. This ship, of 4,404 tons register, sailed from New York on Aug. 26 and arrived at Adelaide on Oct. 15; this is 50 days, or the shortest trip yet made between these ports. This line now sends a steamer every third week.

12 NEW STEAMSHIPS are under construction for the Hamburg-American Line, costing about $20,000,000. They are intended for transatlantic service and will ply between Hamburg and New York, Philadelphia and Baltimore. The largest of these vessels is being constructed by the Vulcan Company at Stettin for passenger service between New York and Hamburg. She will be 687 ft. long, 67 ft. beam and 45 ft. depth of hold, with 16,000 tons. Her engines will have 34,000-HP., giving an estimated speed of 24 knots. It is expected to complete the "Deutschland," for such is the name of this enormous vessel, in time for the Paris exposition in 1900.

THE NICARAGUA CANAL CONCESSION expires on Oct. 20, 1899, according to the late decision of a commission of Nicaraguan lawyers convened by President Zelaya. The concession was originally ratified by the Nicaraguan Congress on April 20, 1887, and granted to the Maritime Canal Co. of Nicaragua. But an official act of the Government of Nicaragua declared that the ten years within which the company obligated itself to complete the interoceanic canal commenced on Oct. 20, 1889. This act was signed and officially agreed to by the Minister of Public Works of Nicaragua, and by John Hall, official agent in Nicaragua of the Maritime Canal Co., in the presence of Mr. Mizner, then U. S. Minister to Nicaragua.

THE DEEPENING OF CERTAIN NAVIGABLE creeks on Long Island seems likely to be required of New York city by an act of the last legislature of the State of New York. This act provides that where any city or village diverts fresh water streams from any tide water creek or estuary which were previously navigable for boats of 20 tons burden and by the diversion are rendered unnavigable for that class of boats the city or village in question must dredge the creek or estuary. The constitutionality of the act, known as the Wallace bill (Chap. 469, Laws of 1898) has just been affirmed by Justice Johnson of the Supreme Court, in session at Jamaica, N. Y. The case in which the decision was rendered appears to involve some creeks in the town of Hempstead. It is yet to be established by the court, we presume, whether navigation has been actually affected by diversion for the Brooklyn water supply, which supply is now a part of that of Greater New York.

THE HENNEPIN CANAL is progressing, and the Illinois River division is said to be practically completed, all the locks and dams having been built. On the eastern division the line of the canal has been definitely located from the Illinois River to the feeder junction, 28 miles. The land for the first 24 miles has been condemned and paid for and enclosed by a barbed wire fence. All masonry on the eastern eight miles and the earthwork on the canal trunk and highway bridges is complete. Contracts have been let for the construction of miles 9 to 24 inclusive. Lock foundations 8 to 21 inclusive, and all work on the culverts of this section are complete. All earthwork on miles 9 to 16 is finished with the exception of approaches to locks and highway bridges and filling behind lock walls and the concrete masonry of locks 8 to 18. Highway bridges 1, 2, 3, 4 and 10, including approaches, have been completed. On the western section the route from the feeder junction to the Mississippi River is approved. Nearly four miles of canal trunk are completed, together with locks 36 and 37 and Girard lock, north and south dams, and railway and highway bridges. The right of way has been located from feeder junction to Rock River. The land for the main line of the western section, in Bureau county, will soon be condemned. The location of the feeder line along the Sterling route has been approved. All the right of way for the feeder except one piece of land (which has been condemned), has been secured. Proposals have been opened for constructing earthworks along the first eight miles of the feeder.

THE PATENT LITIGATION concerning the use of aluminum in the manufacture of steel, which has been in the courts nearly four years, has been decided in favor of the United States Mills Co., complainants, against the Carnegie Steel Co., Limited. The Carnegie Co. appealed from the decision of the lower court, which enjoined it from using the patent, and now that the Court of Appeals has upheld that finding it is said that the Carnegie Co. has taken a license under the patent and made settlement for past infringement.

A NEW ABRADING MATERIAL equal to emery in hardness, according to the claims of Mr. Floryanowicz, the Russian inventor, is made from fire-clay. The clay is thoroughly washed, mixed in a pasty mass, dried and then burned at a temperature of about 2300° F. The described result is a uniformly hard product with a hardness of 8 to 9 on the Mohr scale; this is equal to that of emery. The burned clay is crushed and used for making wheels, etc.

A CIRCULAR SAW FOR CUTTING STONE is being employed in the construction of the buildings for the Paris Exposition. It consists of a steel disk over 6 ft. in diameter, which has about 200 diamonds set in its rim. The saw is mounted upon a suitable shaft, and driven by steam power at about 300 revolutions per minute, for hard stone, at which rate about one foot per minute can be cut. For soft stone steel teeth are used, with diamonds every fifth tooth, and the rate of advance is about 3 ft. per minute. It is estimated that the stone is cut in this way at from ⅕ to 1-10th the cost of hand labor.

NOTES FROM THE ENGINEERING SCHOOLS.

Colorado State Agricultural College, Fort Collins, Colo.—A new mechanical engineering laboratory, 40 × 60 ft., costing $3,000, is now being erected. Funds for its completion have been subscribed by citizens of Fort Collins.

Lehigh University.—Two changes have been made in the instructors of the mechanical engineering department. Instructors Barry H. Jones and L. O. Danse resigned at the close of last term, and their places have been filled by Lucien N. Sullivan, of the Sheffield Scientific School, and John C. Peck, of the Rose Polytechnic Institute.

Dr. C. B. Dudley, of Altoona, Pa., recently delivered a lecture on "What a Chemist Does on a Railroad." Lectures announced in the course in the near future are by John C. Trautwine, Jr., Chief of Water Department of Philadelphia, on "The Water Works of Philadelphia," by Mr. R. W. Hunt, of Chicago, on "The Iron Manufacture in Sweden," and by Mr. Geo. S. Morison, of New York, on "Masonry."

During the past summer the testing laboratory in connection with the civil engineering department has been entirely remodeled. The equipment has been increased by the addition of new machines for torsion and compression tests, while the appliances for testing cement have been made very complete. A comprehensive series of tests on roofing slates has been recently completed, and the result published in pamphlet form under the title "The Slate Regions of Pennsylvania." During the present year researches on methods of testing cement by flexure and impact will be undertaken.

Cornell University.—A new chemical laboratory building 65 × 130 ft., three stories and a subbasement, is now being erected. It will stand to the north of Morse Hall, the present chemical building, and will be connected with it by bridges from the first and second stories. It will be devoted chiefly to assaying and to research work in inorganic chemistry.

Trinity College, Hartford, Conn.—It is announced that a course in gas engineering will be established next year.

Washington and Lee University, Lexington, Va.—A course of electrical engineering has been established, with Mr. Robert E. Hutton as instructor. Mr. Hutton is the manager of the Lexington Light & Power Co., and is a graduate of Johns Hopkins University.

THE MELTING POINT OF CAST IRON.*

By R. Moldenke,† E. M., Ph. D.

In the rapid development of the art of founding one point seems to have escaped general research, not because it was not recognized, but because the proper appliances were lacking. This is the question of melting and casting temperature, a question all foundrymen deal with daily, and which for some branches of the art means either a successful cast or an utter failure.

The question of whether silicon affects the condition of the carbon contents of a casting or not is coming up again, as it does periodically, analyses by the dozen being quoted to substantiate statements made on either side, and yet we see only an occasional statement that the temperature conditions were as nearly the same as possible. What proof is there of this? The writer has taken the temperature of a ladle of iron which to the eye seemed as hot as melted steel, and yet another ladle full of iron of a different composition, which was dull red, contained the hotter metal of the two. Again from the same tap differences in temperature were found running nearly 200°F. The castings made with the two extremes in this case, though of the same silicon contents, differed widely in the proportion of graphite to combined carbon for the same thickness of section.

No wonder we are told that the silicons do not play so important a part. In one of the determinations described later on, a piece of cast iron was placed side by side with some ferro-chrome, both being under the same cupola conditions. The comparatively thick piece of cast iron heated quickly and melted before the thin piece of ferro-chrome was thoroughly red hot. Thus it will be seen that the eye

*A paper read before the Pittsburg Foundrymen's Association, Oct. 24.

†48th St. and A. V. Ry., Pittsburg, Pa.

is a most inaccurate instrument for measuring high temperatures.

Those who cast heavy work know the danger of pouring either too hot or too cold, many are the devices made use of to test the heat of a ladle full of melted iron. Since these methods are empirical at best, how will we know at least approximately the temperature of our melt? Only by a device capable of withstanding such a severe usage. In looking about for such an instrument the attention of the writer was naturally directed to the latest and admittedly the best form of pyrometer for very high temperatures, the Le Chatelier. This consists essentially of two pieces of wire of a slightly varying composition, a heating of the junction of which produces a current of electricity proportioned to the degrees of heat applied. The amount of this

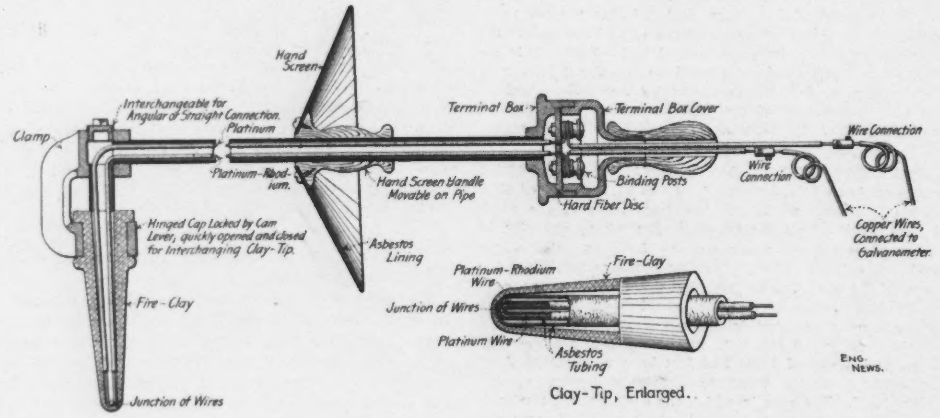


FIG. 1.—SECTION OF LE CHATELIER PYROMETER AS MODIFIED FOR MEASURING TEMPERATURE OF MOLTEN IRON.

current is measured by a suitably calibrated galvanometer, and thus we can read off the heat at any convenient distance rapidly and with a surprising degree of accuracy.

A New Pyrometer.

Unfortunately, this wonderful instrument, one wire of which is of platinum, the other of an alloy of platinum and 10% of the rare metal rhodium, cannot be immersed directly in the melted iron—there would soon be an end to this expensive thermo-couple. The long porcelain tube which protects it when used in kilns is worse than useless in a ladle full of metal, and so at the suggestion of the writer the Pittsburg representative, the Vulcan Mfg. Co., set about remedying the matter and devising some protective cover which would allow experiments of this kind to be carried out readily. The outcome, while not having the advantage as yet of an extended period of trial, was, nevertheless so happy a solution that it is presented to-night for the first time and to the Pittsburg Foundrymen's Association with the hope that much of value may be learned with it, not only in our daily work, but also in connection with the many intricate problems still before us which await solution at the hands of those willing to give their time and energy to such an exacting study.

Fig. 1 shows a section through the instrument. The platinum wire will be noticed running from the terminal box through an iron pipe ending at the inner side of the point of the clay tip. Here is the button made by the fusion to the other wire of platinum and rhodium alloy which runs back, parallel to the platinum wire, to the terminal box. Both wires are covered with asbestos to insulate them from each other and from the iron frame as well as to serve as a protection in case the tip breaks while in the molten iron. The interchangeable connection holding the clay tip allows it to point out straight for use in small ladles or in experimenting, or it may come down at right angles for taking temperatures in large ladles full of metal. A third form, not completed in time for illustration purposes, has a ball and socket joint which allows the tip to stand out at any angle. A movable shield lined with asbestos protects the hand.

Fig. 2 shows two of the styles of the pyrometer, and Fig. 3 the method of using the angular form. In the terminal box are placed the connections which allow wires of any convenient length to run through the handle and connect with the galvanometer. The galvanometer itself is a "D'Arsonval," specially gotten up and calibrated for industrial purposes. The original form with the reflecting mirror, and capable of reading to one-half degree at these high temperatures, was found too cumbersome and delicate for factory use.

The sensitiveness of the couple, even though protected by a refractory material, is such that plunging it cold into the melted iron the correct reading is obtained in 1¾ minutes. When heated up to redness beforehand, however, this time is reduced to not many seconds.

It would be beyond the scope of this paper to show the many uses to which such an instrument can be put in the steel and iron trade. On the question of annealing alone it will pay for itself in a short time, and when its capabilities in foundry practice come to be investigated and generally understood, one more safeguard will be added to those already helping us to increase the efficiency of our plants.

Test of the Melting Point of Various Irons.

The material experimented with was gathered for several years, some of it being furnished by Mr. Jos. Seaman, Mr. Thomas D. West and Mr. J. E. McDonald, members of this Association, and the especially interesting alloys by Mr. R. McDonald, of the Crescent Steel Co.

There were 48 pig irons, embracing both foundry and Bessemer brands as well as softeners, made with coke and with charcoal, both cold and warm blast. Seven of the 15 cast irons were of the shape seen in Fig. 4, being melted right from the tip. The balance were of the sand and chill rolls made by Mr. West in his recent experiments. Two steels and nine alloys of chromium, tungsten and manganese with iron, complete the list of 73 specimens.

The melting was done in an assay furnace converted for the time into a cupola. A jet of steam entering the stack in the side near the top induced the blast, the air being drawn in all around the bottom. In this form it is really the "Herberz" cupola of European fame and excellent for small diameters. A hole was broken into the wall just below the charging door, which must be kept closed when not used. This hole allows the introduction of the pieces of pig iron, etc. After heaping up enough coke to last for some time, the piece of pig iron (of full section and about 5 ins. long), was driven into the bed, surrounded by incandescent coke and the opening closed with a tile. After it was red hot the tile was removed, the pyrometer inserted and pushed against the center of the pig where the borings were taken for the analysis. The temperature as registered by the pyrometer rose rapidly, then more slowly, remaining stationary while the iron melted slowly. Then, as the point finally became uncovered, the temperature jumped up, going above 2,000° F. In this way the results noted in the accompanying table were obtained.

It took much patience, a loss of a few samples, and a number of broken tips to accomplish all this, but on the whole the results given are as good as could be gotten under the conditions prevailing. The coke burning up

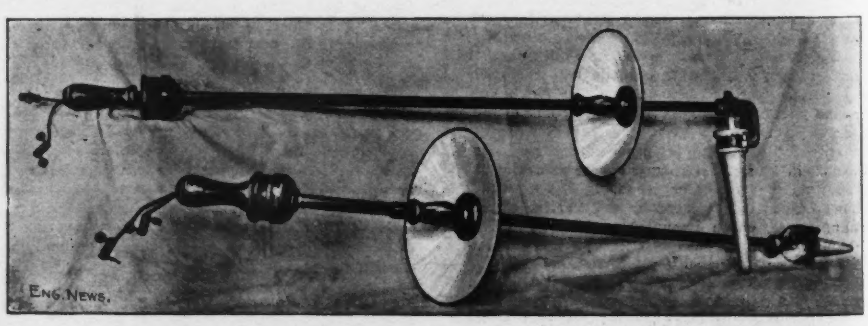


FIG. 2.—PERSPECTIVE VIEWS OF "ANGLE" AND "STRAIGHT" PYROMETERS.

would let the iron drop a little, and a failure to adjust the pyrometer to suit (the opening being closed by a piece of sheet iron, to prevent undue cooling by air drawn in), meant a break in the tip, which, while not affecting the results, caused subsequent delay and trouble.

The following general observations were made: The white irons held their shape, the iron running from the sides and bottom freely, leaving smooth surfaces. The gray irons became soft, dropped in lumps, leaving a ragged surface. Ferro-manganese samples became soft and mushy, exhibiting a consistency of putty before finally running down. Ferro-tungsten behaved most marked. As it melted it acted like white iron, but instead of chilling quickly it ran through the coke, coming down the spout in thin streams like white hot quicksilver, only setting after collecting in a pool in the pan of sand.

The cupola was fluxed heavily with fluor spar to take care of the ash, for it was a case of a furnace full of incandescent coke and only one piece of iron in it. The accompanying tables give the results:

TABLE I.—Melting Points of Various Pig Irons.

No.	Melting point. deg. F.	Combined carbon.	Graphite.	Silicon.	Manganese.	Phosphorus.	Sulphur.
1.	2,030	3.98	....	0.14	0.10	0.220	0.037
2.	2,040	3.90	....	.28	.11	.216	.044
3.	2,040	3.74	0.14	.38	.16	.172	.022
4.	2,070	3.70	...	.26	.09	.198	.033
5.	2,100	3.52	.54	.47	.20	.200	.036
6.	2,040	3.48	...	.36	.09	.240	.040
7.	2,055	3.22	.68	.71	.09	.142	.038
8.	2,010	3.21	.20	.45	.18	.198	.037
9.	2,110	2.28	1.14	.42	.13	.185	.026
10.	2,140	2.27	1.80	.45	1.10	1.465	.032
11.	2,150	2.23	1.58	.42	.16	.415	.045
12.	2,170	1.96	1.90	.75	.63	.097	.028
13.	2,170	1.93	1.69	.52	.16	.760	.036
14.	2,170	1.87	1.85	.56	.46	.713	.027
15.	2,150	1.84	1.95	.56	.34	.175	.022
16.	2,190	1.72	2.17	1.88	.54	.446	.028
17.	2,200	1.69	2.40	1.81	.49	1.602	.060
18.	2,230	1.54	2.08	2.02	.39	.632	.062
19.	2,190	1.49	2.26	2.54	.50	.349	.038
20.	2,210	1.48	2.30	1.41	1.39	.168	.033
21.	2,190	1.47	2.63	.89	.48	.164	.037
22.	2,190	1.36	2.41	1.65	.32	.160	.038
23.	2,210	1.31	2.70	1.25	.76	.170	.022
24.	2,210	1.31	2.40	1.69	.46	.085	.030
25.	2,230	1.24	2.68	.65	.26	.201	.020
26.	2,230	1.23	2.70	1.20	.37	.299	.022
27.	2,230	1.12	2.66	1.13	.24	.089	.027
28.	2,200	.90	3.07	1.09	.33	.176	.014
29.	2,230	.87	3.10	1.34	.42	.158	.030
30.	2,210	.84	3.07	2.58	.47	2.124	.051
31.	2,260	.83	3.26	1.97	.59	.210	.018
32.	2,230	.80	3.22	1.30	.59	.172	.042
33.	2,250	.80	3.16	1.29	.50	.218	.020
34.	2,250	.80	2.89	2.21	.25	.411	.041
53.	2,250	.67	3.60	1.32	.20	.205	.020
36.	2,240	.59	3.15	1.50	.61	.094	.032
37.	2,230	.47	2.84	2.19	.65	1.518	.042
38.	2,250	.38	3.43	2.44	.57	.422	.048
39.	2,250	.35	3.44	2.07	.28	.448	.039
40.	2,260	.35	3.70	3.29	.82	.501	.038
41.	2,260	.24	3.48	2.54	.30	.060	.020
42.	2,280	.13	3.43	2.40	.90	.082	.032
	Softeners, Ferro-silicons, and Silico Spiegel.						
43.	2,190	3.38	.37	12.30	16.98	....	....
44.	2,040	1.82	.47	12.01	1.38	....	....
45.	2,090	2.17	.72	10.96	1.34	....	....
46.	2,155	1.35	1.60	9.40	.32	....	....
47.	2,145	1.57	1.36	8.93	.39	....	....
48.	2,170	1.77	1.80	4.96	.39	....	....

The tables of the pig and cast irons have been arranged according to their combined carbon contents, for it is evident that with few exceptions the melting points increase as the combined carbon goes down, this being the case independent of the amount of graphite present. One could hardly expect anything else for that matter, gray cast iron being really a steel with a lot of mechanically mixed graphite, and white iron a combination of carbon with iron. Alloys melt at a lower temperature than any of their constituents, and so also white iron, really an alloy of carbon or some carbides of iron with iron, should melt sooner than the purer iron in the gray variety.

The fact, however, that steel melts at a much higher temperature than the grayest of irons in the table, shows that there are other considerations not to be overlooked in studying the molecular physics of cast iron. The principal reason for this lowering of temperature is the supposed solution of the graphite in the iron before actual melting takes place. To what extent this occurs and under what circumstances is not known, but may account for the difference in the melting points of steel and gray iron.

Again, in melting steel in the cupola commercially, an absorption of carbon from the fuel takes place, the melting point is doubtless lowered a little, and the results obtained are tangible, even though care must be taken to get the whole of the charge down before pouring. In the air furnace the steel absorbs carbon by contact with the pig iron charged and melts off, the wasting of wrought iron or steel poking bars used for rabbling giving evidence of this occurrence.

The writer is especially pleased to see the full corrobora-

TABLE II.—Melting Points of Various Cast Irons.

No.	Melting Point.	Com. Carbon.	Graphite.	Silicon.	Manganese.	Phosphorus.	Sulphur.	Remarks.
49	2000°F.	4.67	.03	.57	.22	.266	.044	Cast into chill roll (Mr. West).
50	1990	4.20	.20	.63	.33	.254	.040	" " "
51	2010	4.08	......	.89	.06	.287	.040	" dry sand.
52	2000	3.90	.16	.75	.66	.240	.030	" chill roll (Mr. West).
53	2030	3.62	......	.72	.14	.193	.026	" dry sand.
54	2030	3.48	......	.47	.09	.190	.032	" "
55	2040	3.40	......	.42	.07	.196	.029	" "
56	2170	1.63	2.27	1.46	.50	.092	.032	" "
57	2210	1.60	3.16	.59	.25	.271	.048	No. 48 in sand rolls (Mr. West).
58	2250	1.57	2.90	.66	.31	.237	.040	No. 49 " " "
59	2240	1.22	1.66	1.69	.47	.274	.037	Cast into dry sand.
60	2250	1.20	2.90	.75	.66	.248	.030	No. 51 in sand rolls (Mr. West).
61	2260	.17	3.57	2.09	.43	.272	.042	Cast into green sand.
62	2080	1.95	1.28	11.64	.98	......	......	Remelted ferro-silicon No. 5, cast into chill roll (Mr. West).
63	2080	1.81	1.36	11.70	1.00	......	......	Remelted ferro-silicon No. 5, cast into sand roll (Mr. West).

tion of Mr. West's elaborate experiments with the melting of white and gray irons. The contrast is remarkably sharp, and on the whole it shows us that science and practice go hand in hand admirably, no matter what the field may be. Whatever theories may develop regarding the melting of iron, whatever the effect of high or low phosphorus, silicon, manganese and sulphur may be shown to

Fig. 3.—Testing Temperature of a Ladle of Molten Iron With Angle Pyrometer.

be on the melting point of an iron eventually (the present series of irons not being well enough adapted for this phase of the question), the results here given are, it is hoped, of sufficient value to stimulate further research of practical value to the founders of cast iron.

BOOK REVIEWS.

PURIFICATION OF THE OHIO RIVER WATER AT LOUISVILLE, KY. Report to the President and Directors of the Louisville Water Co., by George W. Fuller, Chief Chemist and Bacteriologist to the Louisville Water Co.; formerly Biologist in Charge of the Lawrence Experiment Station, State Board of Health of Massachusetts; Member of the American Chemical Society, etc. Published under agreement with the directors. New York: D. Van Nostrand Co. Cloth; 4to.; pp. 461; many tables and eight full-page plates. Price, $10.

For the past three years the attention of a large number of those interested in water purification has been directed to certain investigations of the subject at Louisville, commonly referred to as the Louisville experiments. At the start it was generally understood that these investigations would be limited to mechanical filtration and that the results would be available to the public within a year or less. But both the scope and length of the investigation was extended. Certain so-called electrical methods of water purification and of producing coagulation were included, together with more detailed studies of sedimentation, and the final report was not presented to the company by Mr. Fuller until two years after he assumed charge of the tests. Another year elapsed before the report, advance sheets of which have just been received by us, was off the press. More than one city has postponed the adoption of a much-needed system of water purification, largely to await the result of the Louisville experiments. The report now before us is a monumental piece of work, which does great credit to the Louisville Water Co. and its officials, to Mr. Fuller and his assistants, and to the several companies and gentlemen who met the expense of installing and operating the test plants. At the beginning of this review we wish to caution our readers that while this report marks an era in the development of water purification in some respects more notable than the special report on "The Purification of Sewage and Water," published by the Massachusetts State Board of Health in 1890, the Louisville studies, like those at Lawrence, were confined to the waters of one river and mostly to one general method of purification. It is true that the Ohio River at Louisville is in many respects typical of a large class of water supplies in the West and South, as is the Merrimac at Lawrence of many water supplies in the North and East. But it should be constantly kept in mind that there are variations in each class, due to local conditions, especially in the Southern and Western waters, which demand special investigations for each source of supply if the highest efficiency and economy of purification are to be obtained.

TABLE III.—Tests of the Melting Point of the Same Irons Cast in Sand and Cast in Chills.

No.	Combined Carbon.	Graphite.	Fracture.	Melting Point.	
57	1.60	3.16	Gray	2210°F	same ladle.
49	4.67	.03	White	2000	
58	1.57	2.90	Gray	2250	same ladle.
50	4.20	.20	White	1990	
60	1.20	2.90	Gray	2250	same ladle.
52	3.90	.16	White	2000	

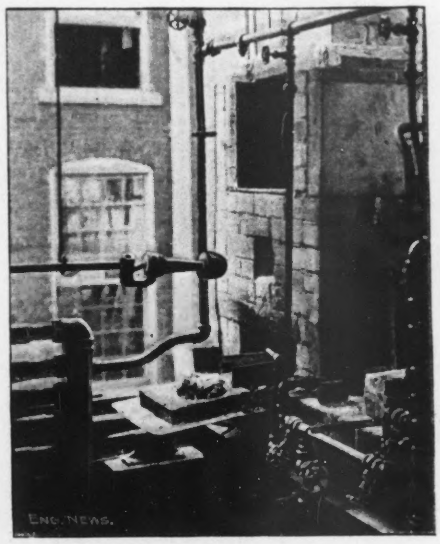


Fig. 4.—Experimental Cupola Showing Piece of Cast-Iron to be Melted, on the Tip of the Pyrometer, Before Thrusting it Into the Furnace.

Perhaps it should be stated, although most of our readers must know it, that the problems presented in the purification of the Ohio River water are the removal of suspended matter, in the most widely varying quantities, and also the removal of bacteria, some of which are of sewage origin. The water is not well suited for boiler purposes, and while the removal of mud improves it in this respect, some of the methods proposed add to the corroding and incrusting qualities of the water, necessitating a careful study of this phase of the subject.

Mr. Fuller took charge of the investigations on Oct. 1, 1895. The plan then being carried out was to test certain commercial systems of water purification on a working basis, each system to be designed for a daily capacity of 250,000 gallons, which was then the unit employed by the mechanical filter companies. The proprietors of each system were to install and operate their respective plants without further expense to the Louisville Water Co. than that involved in pumping the water and in testing the results by means of a proper engineering, chemical and biological staff. Three companies entered the tests: The O. H. Jewell Filter Co., of Chicago; the Cumberland Manufacturing Co., of Boston, proprietors of the Warren Filter, and the Western Filter Co., of St. Louis. Each company installed a 250,000-gallon gravity filter and the Western Company installed in addition a pressure filter of the same capacity. Later on tests were made of electrical methods of testing water submitted by the John T. Harris Co.,of New York,and Palmer & Browrell of Louisville. There was also tested a polarite filter and accessories, submitted by Mr. John MacDougall, of Montreal, this system being known abroad as the Howatson, and as the International process. While the Western pressure filter, the electrical methods of treatment and the polarite system are described and the results given in detail, none of them were considered as at all suitable for Ohio River water and they are not included in the final summaries. The systems so included are the Warren, Jewell and Western gravity filters and independent studies made by the Louisville Water Co. on sedimentation alone, sedimentation aided by coagulation, filtration and coagulation, the best coagulant, and the electrolytical production of coagulants. An appendix contains a technical description of the methods used for the collection of samples of water, the principal features in the methods of analysis and tables for the conversion of the various unit quantities employed. The eight full-page plates show a plan of the experiment station, plans and sections of mechanical filters and typical areas of the strainer floors of the filters.

TABLE IV.—Melting Point of Iron Alloys and Steel.

No.	Melting Point.	Carbon.	Silicon.	Manganese.	Chromium.	Tungsten.	Remarks.
64	2450°F.	1.18	.21	.49	....	....	Steel.
65	2350	1.32	.29	1.27	3.40	6.21	Steel.
66	2280	......	......	....	....	39.02	Ferrotungsten.
67	2240	......	......	....	....	11.84	Ferrotungsten.
68	2255	5.02	1.65	81.40	....	....	Ferromanganese.
69	2210	6.48	.14	44.59	....	....	Ferromanganese.
70	2400	6.80	......	....	62.70	....	Ferrochrom.
71	2230	6.40	......	....	19.20	....	Ferrochrom.
72	2260	1.20	......	....	19.10	....	Ferrochrom.
73	2180	1.40	......	....	5.40	....	Ferrochrom.

The outline given above conveys an idea of the general scope of the investigations and report, but the exhaustive character of the tests, the detail in which the apparatus, methods employed and results obtained are presented and the judicial spirit shown in drawing the conclusions can be gathered only by a careful reading of the report. Each system of purification is described with a minuteness almost sufficient to serve as specifications for duplicating it. The difficulties experienced in operation and the changes made to overcome them are given. The log of the tests is presented almost in full. And, finally, all the accumulated evidence is carefully weighed and the results obtained are clearly set forth, both as relates to the efficiency and the cost of operation of each plant.

The final conclusion of the report, which relates especially to mechanical filtration, as the term is commonly understood, is as follows:

> The general method of subsidence, coagulation, and filtration is applicable to the satisfactory purification of the Ohio River at Louisville; but, as practiced by the Warren, Jewell, and Western systems during these tests, its practicability is very questionable if not inadmissible. By removing the bulk of the suspended matters from the water, large reductions could be made in the size of filter plant, amount of coagulant and cost of operation. On the basis of 25,000,000 gallons daily, these reductions when capitalized at 5% would represent about $700,000. There is no room for doubt but that for a less sum than this satisfactory provisions for subsidence as outlined herein could be provided, which would not only aid in furnishing a filtered water of better quality, but would also give the water consumers a better service in other regards.

This conclusion, when separated from the discussion leading to it, needs to be supplemented by the statement that for the Ohio River water, with its varying character and occasional vast amounts of suspended matter, the systems in question need a number of modifications, the chief of which is greatly increased facilities for sedimentation. The only other conclusions which space permits mention of here are that sulphate of alumina is the best coagulant for use at Louisville, and that it can be bought much more cheaply in its ordinary commercial form than it can be prepared electrolytically.

THE BUFFALO MEETING OF THE AMERICAN INSTITUTE OF MINING ENGINEERS.

The 75th meeting of the Institute was held in Buffalo, N. Y., beginning on Tuesday evening, Oct. 18. At the first session, held in the Public Library Building, addresses of welcome were made by the Mayor of the city and other prominent citizens, which were responded to by President Kirchhoff. Mr. F. P. Ricketts read a paper on "Slips and Explosions in the Blast Furnace," which was illustrated by lantern slides. An exhibition of stereopticon views was then given by Mr. Theodore Dwight, including several pictures taken at night and some photographs colored in the toning solution. This was followed by an informal reception.

The Wednesday morning session was devoted to the reading and discussion of a paper on "Multiple Tuyeres for Blast Furnaces" by B. F. Fackenshal. The discussion was a long one and was of much interest to blast furnace managers, many of whom were present. In the afternoon a steamboat excursion was taken on the lake. Visits were made to the Great Northern Elevator, the Union Iron Works and the Buffalo Furnace Co.

Sessions were held on Thursday morning and afternoon for the reading and discussion of papers. The morning session opened with the reading of a long list of names of members recently elected. A paper by Mr. Frank Firmstone on "Notes on the Forms Assumed by the Charge in the Blast Furnace" was presented. It had been previously printed and distributed to the members, but none of those present cared to discuss it. Mr. Bertrand S. Summers' paper on "Modern Cupola Practice, with Special Reference to the Physics of Cast Iron," which had also been printed in advance, was then taken up, and quite a long discussion followed, including written communications from absent members. The discussion showed that experts in foundry practice are still at variance in regard to what is called in the paper the "silicon fad." The ideas of the paper were strongly commended by some and as strongly condemned by others. Mr. W. R. Webster's paper on "The Relations Between the Chemical Constitution and the Physical Character of Steel" was then discussed at some length. This was followed by a brief discussion of Mr. W. H. Blauvelt's paper, "A Description of the Semet-Solvay By-Product Coke Oven Plant at Ensley, Ala." Mr. C. C. Upham then read from manuscript a paper on "The Effect of Sizing Upon the Removal of Sulphur from Coal by Washing." The Secretary, Dr. Raymond, made brief statements concerning some of the papers that had been prepared for the meeting but which there was not time to discuss, and other papers were "read by title." The morning session was rather poorly attended, but the afternoon session was only an apology for a meeting. Mr. Blue was to read his paper on "Corundum in Ontario," and as few of those present cared whether there was corundum in Ontario or not and the afternoon was a delightful one in which to make trips around the city, it was only by considerable urging of the men scattered around the hotel vestibule and parlors that an audience of about a dozen was collected to listen to the paper, which was a long one, and was read from manuscript. It is a paper that will be a credit to the "Transactions" when it it published, but is not the kind to be read in full before an audience even of mining engineers.

The Institute is to be complimented upon the progress it has made during the past ten years in the direction of a proper system of treating its professional papers at the meetings, but it is still a long way behind the practice of other societies. The papers were divided into four classes, viz., 13 papers which had been printed in advance of the meeting and mailed to members, five papers in type but not finally corrected, proof copies being furnished on application; eight papers not in print, to be presented by the authors, or in their absence by the secretary; three papers read by title only for subsequent publication and discussion. The programme of the meeting contained this interesting announcement concerning the papers: "It is impossible to say precisely at which session any given paper will be presented, much depending upon the presence of authors and other circumstances." Nothing could be better calculated to discourage attendance at the professional sessions of the meeting and to decrease the number of those attending the meeting.

Notwithstanding the lack of interest in the sessions the meetings of the Institute as a whole are fairly well attended considering the great extent of territory, the whole world in fact, over which its members were distributed. Over 160 were registered as in attendance at the Buffalo meeting, including ladies and guests. Socially the meeting was a great success, as all meetings of the Institute are. The excursions to various places in Buffalo by different small parties were numerous and full of interest. All of Friday was given up to these excursions. On Friday evening the whole party went to Niagara Falls, where a session was held in the International Hotel to listen to Mr. F. H. Davis' paper on a "New Method of Drilling Holes of Large Diameter in Rock." On Saturday excursions were made to places of interest around the Falls, including the electric power plants and various manufacturing establishments in the vicinity.

We give below brief notes concerning the papers presented at the meeting:

1. The Kytchtym Medal. By Dr. Persifor Frazer, Philadelphia.—This was a brief paper describing a souvenir medal cast at the Kytchtym Iron Works in the Eastern Urals, on the occasion of the visit of the International Geological Congress, which met in Russia last year. The medal is a fine example of medal work in cast iron, showing great perfection of detail. Analyses of the iron and of the ores from which it is made were given.

2. Modern Cupola Practice, with Special Reference to the Discussion of the Physics of Cast Iron. By Bertrand S. Summers, Chicago, Ill.—This paper was printed in condensed form in our issue of Oct. 6.

3. The Relations Between the Chemical Constitution and the Physical Character of Steel. By Wm. R. Webster, Philadelphia, Pa.—This paper is chiefly a resume of previously published papers on the subject. Mr. Webster gives tables of both of his own investigations and of those of Mr. H. H. Campbell, Prof. H. M. Howe, Mr. A. C. Cunningham and others. His concluding remarks, given below, are of timely interest:

In this practical age it will be asked, "What is the actual value of all this, and is it worth while to bother any more about it?" The answer is that already the steel-maker depends more and more every year on the very points that we have been discussing, and the engineer should know what he is doing when he uses both chemical and physical limits in his specifications. Is it to be wondered at that to-day we have specifications in which the chemical requirements do not all agree with the ultimate strengths specified? This in the ordinary home-orders may make very little difference, as it is an easy matter to investigate and make proper modifications required, but in specifications from foreign railroads or engineers at a distance, for material on export orders, it is a very different matter. There is no time to refer questions of this kind, and the inspector is sometimes forced to condemn material that he knows from experience is all right. It may give better physical tests than were called for, but not conform to the chemical requirements in the particular specifications in question, though it would meet both the physical and chemical requirements of our leading engineers and railway companies in this country. Some of these foreign specifications are so worded, and the requirements are such, that it is not safe for an American manufacturer to bid on the orders. This may be due in part to their not understanding all of the conditions under which the tests are to be made. In other cases it seems as though modifications must have been made on previous orders, either in the chemical requirements or physical tests called for, as no steel was ever made that would meet all the requirements of chemical and physical tests in some such specifications.

Many export-orders for rails call for phosphorus not over 0.6%, while the sulphur is allowed a much higher limit, or not specified at all. This low phosphorus cuts out several of our largest steel works, whose material will meet all of the physical tests called for, being low in sulphur and under 0.10% phosphorus, and giving entire satisfaction to our leading engineers and railroad companies. The foreign manufacturers of basic Bessemer steel and low-phosphorus acid Bessemer steel are working the low-phosphorus clause for all it is worth, just as our manufacturers would do under similar circumstances; but we, as engineers, want to know if there is any good reason for this distinction, which is made on account of local conditions, and if the high sulphur is not as undesirable as the phosphorus would be up to the limit of 0.10% usually allowed in this country?

This is a matter that should be thoroughly discussed and on which opinions should be secured from our leading engineers; for it of no use for the manufacturers to give their opinion unsupported by the experience of users of their rails. It is just here that the effect of the different elements plays an important part. Our manufacturers know from experience that as their phosphorus is a little higher than the limit of 0.06% referred to, they must keep the other elements inside of given limits to produce the best results in the finished rails. This is done successfully, and a rail is produced that will meet the requirements of the drop-test and give satisfaction in use. I do not wish to be understood as advocating high-phosphorus, but my position is that rails which will meet all the varying conditions in this country will meet all that is required of them when put in use in other countries. If one examines the methods of manufacture of rails in this country and those in other countries, then visits the countries where our rails are being introduced, and gets accurate information as to the service they are giving, he will be convinced that there is a great future for America in the export business in rails.

The conditions with regard to the material for bridges are about the same. Foreign specifications, in many cases, provide that only acid open-hearth steel can be used. This has already prevented our bridge builders from bidding upon thousands of tons of bridge work, although in some cases they have accepted the requirement of acid open-hearth steel, and have taken the orders. In other cases they have explained that our Government is using the basic open-hearth steel; that in the manufacture of it the works here start with an iron very much lower in phosphorus than is ordinarily used, and that the resulting steel is much more uniform. This has had a great deal of weight, and the use of basic steel has been allowed in some cases. In other cases new specifications have been adopted after investigation in accordance with the best American practice, which allows the use of either basic or acid open-hearth steel. I refer to this matter at length as it is of the greatest importance to our engineers and manufacturers, as well as to all others who wish to see our export trade developed.

The continued discussion on the physics of steel is broad enough to take up any specifications on home or export orders that may be brought forward; the uniform methods of testing and methods of manufacture and rolling that will improve the finished products. It is of the greatest importance to establish the quality of American material abroad, and to have on record all facts regarding the same, both from the engineers' side and the manufacturers', and I know of no better channel for doing this than the American Institute of Mining Engineers.

4. Slips and Explosives in the Blast Furnace. By F. B. Richards, Cleveland, O.—This paper was presented by the author at the first session on Tuesday evening, and was illustrated by lantern slides. It is of especial interest to blast furnace managers, some of whom discussed it at the session on Wednesday.

5. Multiple Tuyeres. By Dr. R. W. Raymond.—This paper also relates to blast furnace practice. It describes the Gaines tuyere, which has a horizontally elongated discharge opening, and which is claimed to have some advantages over a tuyere with a round nozzle.

6. Note on the Forms Assumed by the Charge in the Blast Furnace, as Affected by Various Methods of Filling. By Frank Firmstone, Easton, Pa.—This is a very fully illustrated paper giving the results of a long series of experiments carried on at the Glendon Iron Works to determine the method in which the stock distributes itself in the upper part of the furnace when different sizes of top and of bell and hopper and different methods of filling are used.

7. A Description of the Semet-Solvay By-product Coke Oven Plant at Ensley, Ala. By W. H. Blauvelt, Syracuse, N. Y.—This paper was presented by the author at the session on Thursday morning. It was illustrated by drawings and photographs showing the plant recently erected by the Tennessee Coal, Iron & R. R. Co. It consists of 120 ovens, and when in full operation is expected to produce from 420 to 460 tons per day, or as much as is produced by 300 beehive coke ovens. The plant will require 732 hours' labor per day, as compared with 1,020 hours for the beehive ovens. Besides the saving of labor there is the saving due to the value of the by-products, fuel gas, tar and sulphate of ammonia.

8. The Effect of Sizing Upon the Removal of Sulphur from Coal by Washing. By Chas. C. Upham, New York City.—This paper discussed the advantages of fine crushing and sizing by screens before washing to remove pyrites from coal. It was noted that the finest pyrites will float on the surface of water, and by screening before washing a large portion of this pyrites may be removed which would otherwise go with the washed coal.

9. Note on the Use of the Tri-Axial Diagram and Triangular Pyramid for Graphical Illustrations. By Prof. Henry M. Howe, New York City.—The author describes the use of the equilateral triangle diagram in plotting the total heat of fusion of silicates of lime and alumina, and its great advantage over the di-axial diagram for plotting the relation of any quality to the percentage composition of a substance composed of three constituents. He also shows that a pyramid with an equilateral triangle for a base and of a height equal to the altitude of the triangle may be used for graphically indicating the relation of any quantity which depends on four variables whose sum is constant, such as the heat of fusion of a slag composed of four constituents as silica, lime, alumina and magnesia.

10. Graphic Records of the Screening of Crushed Materials. By Prof. Courtenay De Kalb, School of Mines, Kingston, Ont.—The author has made a series of experiments on crushing ore of different kinds and screening it through sieves of different meshes, plotting the results so as to show the percentages of different sizes of the crushed material. He finds that the curves so plotted show practically identical characteristics for all the different ores, and only by varying the conditions of crushing were variations in the curves obtainable. This result was not expected.

11. Mill Practice of the Utica Mills, Calaveras Co., California. By W. J. Loring, Angels Camp, Cal.—This paper describes what is believed to be the best practice, in regard to cost, yet reached in California quartz milling.

12. A New Essay for Mercury. By Richard E. Chism, City of Mexico.—This is a new process for assaying ores containing mercury, which is accurate to 0.01%. The ore mixed with fine iron filings is heated in a small crucible over an alcohol lamp, and the vapor of mercury distilled is collected on a piece of thin, clean silver foil which covers the crucible. A silver dish containing water is placed over the foil to keep it cool.

13. The Influence of Bismuth on Brass and Its Relation to Fire Cracks. By E. S. Sperry, Bridgeport, Conn.—A brief abstract of this paper was given in our issue of Sept. 29, p. 208.

14. Experiments on the Sampling of Silver-Lead Bullion. By G. M. Roberts, Murchison Gold Fields, Western Australia.—Numerous experiments recorded in the paper lead to the conclusion that samples taken by chipping out of the top and bottom of each ingot almost always give a result lower than the actual value of the bullion. The only really accurate samples are the dip-sample from the kettles and the saw sample made by sawing through the ingot.

15. The Elimination of Impurities from Copper Mattes in the Reverberatory and the Converter. By Edward Keller, Baltimore, Md.—This is a reply by Mr. Keller to the discussion of his paper presented at the Atlantic City meeting.

16. A Modification of Bischof's Method of Determining the Fusibility of Clays, as Applied to Non-Refractory Clays, and the Resistance of Fire Clays to Fluxes. By H. O. Hofman, Boston, Mass.

17. Does the Size of Particles Have Any Influence in Determining the Resistance of Fire Clays to Heat and to Fluxes? By H. O. Hofman and B. Stoughton, Boston, Mass.—These two papers describe experiments made at the Massachusetts Institute of Technology. The query of the title of the second paper is answered in the negative. There is only a slight difference in the results obtained from mixtures made as those used in making bricks, blocks, pots, etc., and from the same mixtures ground fine, as is the usual custom in laboratory tests.

18. Notes on the Tunnel of the Melones Mining Co., California. By W. E. C. Eustis, Boston, Mass.—This paper is not yet in print. Dr. Raymond made a brief statement concerning it, and says that it shows some extraordinary records of rapid tunnel driving.

19. A New Method of Drilling Deep Holes of Large Diameter in Rock. By F. Harley Davis, New York city.—The author describes a new form of rotating rock drill, which he had invented while in Australia and had largely introduced in that country. It cuts out a core about 4 ins. in diameter, and does very rapid work in sandstone and limestone. An exhibition of the working of the drill was given in Buffalo, and its performance was highly praised. We hope to give an illustrated description of this drill in an early issue.

20. Hubnerite in Western Arizona. By William P. Blake, Tucson, Ariz.—Hubnerite is a manganiferous variety of wolframite. It compares most favorably with any wolframite as a source of tungsten, being very pure and free from sulphides and arsenides. It may prove to be of value in the manufacture of tungsten steel.

21. The Superficial Alteration of Western Australian Ore Deposits. By H. G. Hoover, Coolgardie, Western Australia.—This is a very brief paper. Its practical bearing is on the exploitation of new gold regions. Ores frequently show a transition from free milling to refractory ores, with increased depth, and disregard of this fact has brought many gold mining companies to ruin.

22. Notes on the Mines of the Frontino and Bolivia Company, Colombia, S. A. By Spencer Craigie, Mariana, Brazil.—These notes give a brief account of some gold

mines in Colombia, one of which, with a poor plant, giving only 50% extraction, nets a profit of $25,000 per month. The author says that there is probably no mining field of richer promise than that of Colombia.

23. Corundum in Ontario. By A. Blue, Toronto, Ont.—This paper was read from manuscript by its author. He gives an interesting history of the discovery of corundum of excellent quality in Ontario, and of the exploration of the whole area, which is of considerable extent, in which it is found. The deposits may prove to be of great value.

24. Mineral Lode Locations in British Colombia. By William Branden, Helena, Mont.—This paper is a brief statement of the laws of lode locations in British Columbia, which are far simpler and more satisfactory than those of the United States. From 1884 to 1892 the Mineral act was modeled after that of the United States, but was revised and greatly improved in 1891, and further amended in 1896 and 1897.

The following papers are not yet in print and were read by title:

25. The Evolution of Mine Surveying Instruments. By Dunbar D. Scott, Ironwood, Mich.

26. Note on the Operation of a Light Mineral Railroad. By James Douglas, New York city.

27. The Alluvial Deposits of a Dry Country. By T. A. Rickard, Denver, Colo.

ANNUAL CONVENTION, ASSOCIATION OF RAILWAY SUPERINTENDENTS OF BRIDGES AND BUILDINGS.

First Day's Sessions.

The eighth annual convention of the Association was held at Richmond, Va., Oct. 18, 19 and 20, 1898, the place of meeting being Murphy's Hotel. About 35 members were present at the opening session. Including the ladies and other guests, the total attendance was probably not far from twice this number. Besides a considerable amount of routine business, the convention had scheduled for consideration eleven special committee reports, and considerable other work of a technical nature, including as the principal item the discussion of the various committee reports presented at the previous year's meeting. In a number of instances this review of the previous year's work brought out valuable additional information. The list of the present year's reports was, however, shortened by the failure of two of the eleven committees to report; otherwise the programme already printed in these columns (Eng. News, Aug. 25, 1898) was carried out in full.

The first business following the opening exercises was the election of new members, 21 of whom were added to the rolls. In his address, the President called attention to the excellent work which had been done by the Association in the past, and mentioned with some pride that, taking into account the small membership and slender resources available, its technical work compared favorably with that of other societies. The reports of the Secretary and the Treasurer showed the Association to be in good financial condition, it having a surplus of $219 cash on hand with all debts paid. The total receipts during the past year were $1,357. After some further routine business, the convention proceeded to the consideration of the special committee reports. It being the custom of the Association simply to read these reports at the first day's sessions and reserve their discussion for the second day's proceedings, they will be considered in connection with the discussions presented further on in this record of the convention's work.

The entire remainder of the first day's sessions after reading these reports was occupied with the discussion of the committee reports presented at the Denver, Colo., convention of 1897. Only two of these reports called out much discussion, viz., "The Most Suitable Material for Roofs of Buildings of all Kinds," and "Floor System on Bridges, Including Skew Bridges." In regard to roofing materials, the general concensus of opinion was that for station buildings of the first class nothing was superior to slate shingles. Regarding the best roofing material for shops, round houses, freight sheds, etc., the opinions and practice of different members differed widely, and pine or cedar shingle, gravel and tar, felt with gas tar and sand, asphalt, tile, granite felt, were all well spoken of. For roundhouse roofs, however, iron or steel was considered a poor material, and any material in fact which depended upon iron nails or other iron fastenings, was regarded as objectionable. Some of the members had used both slate and wood shingles, with copper nails, and had experienced no trouble from the destruction of the nails.

The discussion on bridge floors was confined largely to the method of placing guard rails and fastening them to the ties. Not much that was new was brought out in addition to the original report, and after transacting some routine business the first day's proceedings were concluded.

Second Day's Sessions.

The principal technical work of the convention was contained in the proceedings of the second day, when the discussion of the special committee reports came up. The first report considered was that on

Pile Rings and Methods of Protecting Pile Heads in Driving.

The committee considered the best protection for pile heads during driving to be a 1 x 3-in. iron ring. It was recommended that these rings should be made of iron hammered from old car axles. Such rings, 1 x 3 x 14 ins. diameter would cost about $1.75, as compared with $2 when made of the best bar iron. One hammered ring would also last to drive 75 oak piles and 300 cedar piles, as compared with 50 oak piles and 200 cedar piles for a bar iron ring. A pile driver tool car should carry ten 15-in., thirty 14-in., ten 13½-in., and ten 13-in. rings, or 60 rings altogether. In fitting the pile ring, it was recommended that the pile should be chamfered down at least 5 ins. from the end, making the diameter of the head at the top such that the ring would just catch on and be driven home by the first blow of the hammer.

The face of a pile hammer should be concaved to a depth of 1½ ins. at the center and run out to nothing at a distance of 2 ins. from the edge. This form of hammer face acted to drive the fiber of the wood down slightly over the edge of the ring, and to make a neat fit of the hammer. The best weight of hammer was 3,300 lbs. The fall of this hammer should not exceed 12 ft. in driving cedar piles, nor 20 ft. in driving oak piles; short, quick blows will drive a pile as fast as long slow blows, and there will be much less danger of fracturing the pile. Piles should be neatly trimmed of knots and sharpened to a 4-in. square point for hard driving. Care should be taken not to overdrive piles. When, with a 3,300-lb. hammer, the penetration is not over 1 in. for a 10 ft. fall, the fall should be reduced to 6 ft., and the pile carefully driven until the penetration is only ¼-in., when the driving should be stopped.

The use of an iron cap or bonnet is not practicable for driving piles in trestles, as it interfered with getting the pile close to the stringers, but where it can be used freely the device is an excellent one. In driving piles through shale rock or soapstone, where shoes are required, the best shoe is four pieces of old car truck arch-bar iron welded together, with the end drawn to a point and the four arms flared out to fit the four sides of the pile, to which they are attached by spikes through punched holes.

The discussion divided itself into a consideration, first, of the recommended method of protecting the head; second, of the concaved faced hammer, and, third, of the best form and material for the shoe. Most of the members who spoke concurred in the committee's recommendation to use a single ring for protecting the pile head, and to chamfer the head down to the diameter of the ring. The practice of some simply to place the ring on the top of the pile head and drive it into place without removing the outside material was regarded as objectionable, in causing slivering or the splitting off of the outside in slabs often several feet long. Mr. Wm. O. Eggleston (Chic. & Erie), spoke in favor of using a cap or bonnet to protect the pile during driving, and thought that there were very few cases in which it could not be employed to advantage. Referring to the same device, Mr. A. Shane (C., C., C. & St. L.) stated that in a test made by him a gain in speed of fully 20% had been obtained in actual work by its use. The choice of the members seemed to be about equally divided between hammers having concave faces and those having flat faces. The use of the wrought-iron point, recommended by the committee was pretty unanimously objected to, a cast-iron point with a good socket for the end of the pile being generally preferred. Mr. C. M. Large (Erie & Pitts.) and Mr. A. E. Killan (Intercolonial) both stated that their experience had been that the strap point mentioned would frequently split the pile in hard driving, and accordingly they preferred a cast-iron socket point or shoe. The next report was that of the committee on

Cost and Manner of Putting in Pipe Culverts.

The report showed quite a diversity of practice in employing and constructing pipe culverts, on the 30 railways from which information was obtained regarding the subject. The kinds of pipe culverts used and the maximum and minimum sizes employed were as follows:

	Cast-iron.	Wr't-iron.	Steel.	Cement.	Vit. pipe.	Wood.
No. of road using....	24	2	3	2	14	1
Maximum size, ins...	24	60	48	..	48	72
Minimum size, ins. ..	8	30	36	..	12	24

The majority of roads built end walls for all pipe culverts, but others employed them only for certain kinds of pipes, or under certain conditions only, while a few did not use them at all. In putting in pipe culverts to replace timber culverts, the general practice was to make an open cut, supporting the track on stringers resting on piles or mud sills, but some roads tunneled deep embankments, and in a few cases the pipe was pulled through the old wooden culvert, the space between the two being finally tamped full of earth. When the pipe culverts were placed where no previous opening existed, the general practice was to make an open cut, or, in the case of deep embankments, to tunnel. Little trouble was had with the breaking or flattening of cast-iron pipe culverts, except for diameters of from 36 ins. to 6 ft. On the other hand, considerable trouble of this sort seemed to be experienced with vitrified pipe and cement pipe. The means generally adopted to overcome this difficulty were to use more care in packing the earth around the pipe. In the case of large size cast-iron pipe, it was the practice of some roads to place wooden or iron shoes inside and let them remain until the ground was settled firmly. In one case the remedy adopted was to line broken cast-iron pipe with a ring of paving brick. The costs of different kinds of pipe culvert per lineal foot were given by the report as follows:

Creosoted Stave Pipe Culverts; Southern Pacific Co.

Diam, ins.	Cost per lin. ft.
24	$1.06*
36	2.11
48	2.42
66	4.70
72	4.90

*This does not include cost of laying or of portals.

Cast-Iron Pipe Culverts.†

Diam. of pipe, ins.	Material.	Labor.	Total.
18	$1.11	$0.16	$1.27
20	1.00 to 1.62	.09 to 1.08	1.76 to 2.08
24	1.20 to 3.32	.17 to 1.82	2.09 to 5.19
30	1.22 to 2.90	.23 to 1.42	3.09 to 4.67
36	2.51 to 3.69	.30 to 1.64	2.81 to 6.50
42	3.35 to 5.00	.70 to 1.98	5.08 to 5.70
48	4.30 to 7.70	.36 to 3.12	5.29 to 10.32
60	2.94 to 10.61	1.26 to 2.66	10.60 to 11.82

†The cost of cast-iron pipe per ton, as given, ranges from $14.50 to $16.80. The cost of stone-masonry end walls ranges from $4 to $8 per cubic yard. The costs are exclusive of the cost of masonry end walls.

Steel Pipe Culverts.

24	$1.12	$0.12	$1.24
30	1.55	.17	1.72
36	2.28	.25	2.53
42	3.00	.30	3.30
48	4.13	.46	4.59
60	8.25	.45	8.70

Vitrified Pipe Culverts.

18	$0.30	$0.45	$0.75
20	.45	.51	.96
24	...	...	1.50 to 2.57

In the discussion Mr. J. B. Snow (B. & M.) stated that the usual cause of pipe culverts flattening was the failure to put in good, solid foundations and to pack the earth firmly around the pipe. Mr. A. S. Markley (C. & E. I.) stated that a frequent cause of failure in pipe culverts was leaky joints, the water from which washed holes under and around the pipe thus leaving it without support. A number of other members confirmed the statements of Mr. Snow and Mr. Markley. The next report was that of the committee on

Best Floors for Shops and Roundhouses.

The committee considered its subject under two heads, viz., roundhouse floors and shop floors, and its report was in abstract as follows:

Taking up first roundhouse floors, we find in general use: brick, concrete, granolithic concrete, cinder, disintegrated granite, cedar block, timber and plank. Of these, the four most commonly used are probably brick, concrete, plank, and cinder. In order to determine the most satisfactory floor for use in a roundhouse and the kind of material best suited for the purpose, it is necessary to consider the varying causes which combine to wear out the floor. Heavy repairs require the use of hydraulic jacks which bring great pressure to bear upon the floor adjacent to the cinder pits. To withstand the pressure requires a wide pit wall or else very firm foundation and rigid surface in the floor. In washing out boilers large quantities of water are used, much of which is spattered upon the floor. Besides this, there are numerous occasions for spilling all kinds of oil and grease. And with all, the demands for cleanliness are unceasing. Not the least of the destructive elements is the rolling of heavy trucks or driving wheels, or the dragging back and forth of jacks and large pieces of machinery. To find a material which will successfully withstand all of these destructive forces is the problem.

Your committee believes that good vitrified brick, properly laid, will give the best satisfaction in all roundhouses which are used for anything more than storage purposes. In this we have a floor that is smooth, firm, hard, and practically indestructible. It is absolutely unaffected by water, heat, oils, acids, or grease, and is easily cleaned, while one important advantage is in the ease with which it can be repaired, since any part may be taken up and replaced by common labor without the slightest injury to the floor as a whole.

The following method of laying brick floors conforms to the generally accepted practice: Assuming the soil to be firm and well drained, excavate the ground to an even surface 8 ins. below grade of desired floor. Tamp well with heavy rammers to secure a firm foundation, then fill in with good clean sand or gravel to within 3½ ins. of grade, making a crown of about 2 ins. between pits for drainage; wet this down well, tamp with rammers, and trim off with straight edge, taking care to get an even surface. Lay brick on edge close to each other and breaking joints so that tops come ½-in. above grade. After laying, roll bricks with 2,000-lb. or 3,000-lb. roller, cover the surface with 1-in. fine sand and broom it well into cracks, or fill cracks with cement grout. A concrete foundation is recommended by some, but, except in cases where the natural ground is not firm, or where the floor is to be subject to extremely heavy loads, it is not considered necessary.

The cost of brick floors in a number of isolated cases were given in the report and they ran from 6 cts. to 12.7 cts. per sq. ft., but averaged generally from 10 cts. to 13 cts. per sq. ft.

For blacksmith shops or foundries the natural earth frequently forms a very suitable as well as substantial floor. In localities where the soil is too soft in its natural state, the addition of cinders or clay will solve the problem cheaply and satisfactorily.

In machine shops the conditions are different, and here we find the recommendations almost as varied as are those for roundhouse floors. A brick floor in a machine shop answers many of the requirements, but there is good evidence in support of the objection that men cannot stand all day on such a floor or upon a surface of concrete or asphalt without feeling the bad effects of cold upon the feet. This difficulty is overcome to a large extent by the use of slatted floor racks or platforms at the machines where operatives stand. When machines are set upon a brick floor there should be special provision made for foundation. But this can hardly be urged as an objection as it is necessarily the case with heavy machines under almost any circumstances.

A bedded plank floor has recently been laid in an extensive shop plant of the Boston & Albany R. R. As this is somewhat novel, a description of the methods of building may prove interesting. The earth is well compacted and brought to the proper surface and a bed of coal-tar concrete put down in three courses. This bed is 4 ins. thick when finished. The specifications are that the stones of the lower course shall be not less than 1 in. in diameter and those of the second course not more than 1 in. in diameter. Stones of each course to be well covered with tar before laying and thoroughly rolled afterward. The finishing course to be composed of good clean sharp sand well dried, then heated hot and mixed with pitch and tar in the proper proportions. This is to be carefully rolled and brought to a true level to fit a straight edge. Roller to weigh not less than 700 lbs. on a length not exceeding 22 ins. On this finished surface of the foundation there is spread a coating ¼-in. thick of best roofing pitch put on hot, into which the lower course of plank is laid before it cools. Care must be taken to have the plank thoroughly bedded in the pitch and after laying the joints must be filled with pitch. If vacant places occur under plank they should be bored and filled. The finishing flooring is laid across the lower and thoroughly nailed. For the lower course 2½-in. spruce plank are used, and for the upper 1⅛-in. spruce plank. The cost of such a floor is given at 18 cts. per sq. ft. using spruce lumber.

For paint shops and car shops a brick floor has been found very satisfactory. Your committee believes that a brick floor generally speaking is the most economical, durable and satisfactory floor for shops as well as for round houses.

The discussion was opened by Mr. Jas. Stannard (Wabash), who stated that on his road vitrified brick floors were used for both shops and round houses. He considered them to be durable and easy to repair, and especially convenient to take up and replace when pipe lines, etc., had to be installed or taken up from underneath the floor. The brick used was a vitrified paving brick. Mr. J. P. Snow (B. & M) had found common brick to be equal to all the requirements of round house floors. His practice was to lay the bricks flat and to grout the joints. For shop floors he considered brick objectionable on account of the difficulty of fastening heavy machinery to them and also because they were easily injured by falling tools and other heavy articles. Mr. A. E. Killan (Intercolonial) stated that his company had formerly used wood floors for shops and round houses, but they soon gave out. Vitrified brick floors were adopted later and were now used largely. The latest floor used, however, was one composed of a foundation of broken stone covered with firmly packed cinders, upon which was placed a layer of concrete with a 1½-in. top covering of cement. This floor was not much more costly than wood and had proved satisfactory so far. For shops he preferred wood floors, as workmen could not stand and work on concrete on account of the cold. A number of other members spoke, and nearly all expressed their preference for brick floors for both shops and round houses.

Round-House Smoke Jacks and Ventilators.

The committee contented itself with presenting drawings of different forms of smoke jacks and ventilators in use on various railways and with calling attention to the experience of those who had used them. From these it appeared that there was a great diversity of opinion as to the best style of smoke jack, the opinions in many cases being directly opposed to each other. The jacks illustrated comprised the standard round wooden smoke jack of the Chicago & Eastern Illinois R. R.; the Pickering wooden smoke jack (Eng. News, Feb. 18, 1897); the Chicago & Erie R. R. standard dormer ventilator; Fitchburg R. R. wooden monitor ventilator; metal telescope jack of Baltimore & Ohio R. R.; Scott ventilator; Roe ventilator; Pancoast metal ventilator; and the Portland Stoneware Co.'s terra cotta smoke jack (Eng. News, March 11, 1897).

The discussion was opened by Mr. Jas. Stannard (Wabash), who stated that, after having tried nearly all kinds of smoke jacks, he had settled down to the use of wooden jacks as being the best. He did not favor the use of a drop hood on smoke jacks. Mr. A. S. Murkley (C. & E. I.) stated that he used circular wooden smoke jacks and dispensed with painting and sanding, as he had found that the soot soon covered the interior of the jack and protected it from fire. These jacks had been in use two years and showed no depreciation. Mr. J. H. Cummin (Long Island) used wooden jacks altogether, and considered painting and sanding a waste of time and material. His jacks were square, 6×6 ft. at the bottom and 2×2 ft. at the top. He did not favor cast iron or other metal jacks. Had tried galvanized iron, lead-lined jacks, but they soon gave out. Copper jacks used to replace them had lasted two years and were yet in place. Mr. Jas. McIntyre (Erie) had in use smoke jacks made of cast iron, wrought iron and wood, and preferred the wooden jacks. A wrought-iron jack would last about five years. He had had several accidents from the drop hoods of cast-iron jacks falling, and was not in favor of using them. Mr. J. P. Snow (B. & M.) had used stoneware jacks with cast-iron hoods and had found them very durable but quite expensive. His present practice was to use the Pickering wooden jack. Mr. Wm. A. Eggleston (Chic. & Erie) had adopted the Pickering jack as a standard. Mr. A. E. Killan ((Intercolonial) had recently erected Pickering jacks. He did not think that much benefit resulted from painting the inside, as the covering of soot prevented fire, but he did paint the outside to preserve the wood from the weather. One objection to vitrified pipe jacks was the great weight they brought on the roof. Mr. Fred. Eilers (C., B. & Q.) used the Roe cast-iron smoke jack and had found that it did good work. One great advantage was the movable hood, which could swing aside without damage when an engine happened to be run out in a hurry. There was in his opinion danger from wooden jacks catching fire. The general concensus of opinion of the members named and of the others who spoke on the subject was that metal jacks and ventilators of iron or steel soon failed through corrosion. Wooden and stoneware jacks did not suffer from this cause and were therefore preferable. The wooden jack especially seemed to meet with general favor.

Cattle Guards and Wing Fences.

The report described briefly the various types of cattle guards in general use and stated that experience showed that each of them gave different results under different conditions. A guard which stopped highly domesticated tame cattle with fair success often failed entirely to hold the half-wild cattle which were allowed to run almost at free will on the western and southwestern cattle ranges. For the last kind of cattle a wide and deep pit guard—one deep enough to allow the beast to fall clear below the rails—was as satisfactory as any. No guard would turn cattle at all times.

The discussion brought out only a few points of especial interest, the principal one of which was that by whitewashing or painting white the ordinary surface guard and the wing fences adjoining it its effectiveness in stopping cattle was greatly insured. The patch of color differing from that of the surroundings served to frighten the cattle against attempting to cross. An objection which was raised to metal surface guards with pointed, sharp surfaces was their danger to brakemen called upon to run back in the dark to flag an approaching train. Mr. A. E. Killan (Intercolonial) mentioned an accident of this kind which resulted in the death of the brakeman.

Storage of Fuel, Oil and Other Station Supplies at Way Stations.

The report stated that this problem seemed to have been pretty generally neglected by railways, and recommended the following solution:

Keep office records and stationery on shelves and pigeonholes in a cupboard built for that purpose. Keep cupboard locked when not in use. These cupboards can be made at the shops. Files for tariff sheets should also be provided. Coal stored at way stations, unless the station be very small, should be kept in a small house holding from a half car load to a car load of coal. Locate the house about 100 ft. from the station, on account of danger from fire, and, if possible, near a track, so the coal can be unloaded directly from the car through a trap-door in the roof of the coal-house. Partition off one end of the coal-house for an oil-house, of a size sufficient to suit the needs. Build a counter across one end, and cover it with zinc. Build a shallow box under the counter, and fill it with sand, so the oil will not soak into the floor. Place a ventilator in the roof to carry away all gases, and line the inside of the house with tin or zinc, to guard against fire. A shallow cast-iron pan with a grating over the top, to catch the oil while the lamps are being filled, should be placed on top the counter. This catches the waste oil. Where the size of the station warrants it, the coal and oil-house should be built of brick and provided with iron doors and shutters. No oil or coal should be stored in the freight house, as it is a constant source of danger from fire and often damages freight. Oily rags, waste, etc., should be kept in a galvanized-iron pail with a cover, to guard against fire from spontaneous combustion.

The discussion was opened by Mr. J. H. Cummin (Long Island), who stated that he provided at local stations small houses just large enough to hold a barrel of oil and resembling an ordinary dog house as much as anything. The upper half of this house was hinged and opened off the lower half like the lid to a trunk, to enable the barrel to be removed and renewed. This house was placed 100 ft. from the station. For filling lamps, a special table was placed inside the station building. This table had a top 2½×4 ft. with boards at the four edges projecting up 4 ins., and was lined with zinc. Mr. A. E. Killan ((Intercolonial) had recently made oil-houses for a number of small stations by cutting old box car bodies in two, boarding the open ends and placing them on suitable foundations. One car body made two houses. Mr. G. W. Smith (C., M. & St. P.) stated that his company had a series of standard oil and coal-houses for small stations which were made up in the shops and shipped to the stations as needed.

Railway Highway Crossing Gates.

The report stated that the gates in common use were either mechanical or pneumatic. In mechanical gates the arms were operated by wire connections to cranks or levers, and the great difficulty had been the freezing of the wire fast by water in the pipes. One way in which this could be prevented was to use larger size pipes and be more careful to make the connections water tight and to lay the pipe carefully. Another method of preventing freezing was to close the ends of the pipe by glands having holes making a tight fit for the passage of the wire, and to fill the pipe with oil. This device had been employed successfully in signal work. The great advantage of the mechanically operated gate was its positive action. It was considered that, notwithstanding the claims often made by their manufacturers, pneumatic gates had not proved their immunity from freezing. In order to carry the air at all the pipes had to be of fair size and laid with tight joints. The same construction would prevent pipes containing wires from freezing. In conclusion the report described briefly the Bogne-Mills & Pneumatic Gate Co.'s pneumatic gates, the "single connection" gate of the Standard Railway Gate Co. (Eng. News, May 29, 1897), and the special lift gate employed at some of the Brooklyn, N. Y., street crossings of the Long Island R. R.

In the discussion which followed several members spoke in favor of each of the types of gates mentioned in the report, but little additional information was brought out. The next report was that of the committee on

Care of Iron Bridges After Erection, Including Best Method of Protecting Them from Salt Water Drippings.

The successful maintenance of a bridge depended upon the character and condition of the bridge to be maintained. Given a bridge in perfect condition the proper care of this bridge meant merely to keep it in as good condition as it was the day it was put up. The means adopted to do this must depend upon conditions, but above all other things the inspections should be frequent and thorough. One of the most important matters was to keep the metal well painted, and in painting much of the success depended upon seeing that the metal was carefully cleaned to receive the paint. With refrigerator cars venting their brine at various points the only successful method of protecting bridges from the drippings was to provide a water-proof decking over the metalwork. Should the car vents be placed so as to discharge midway between the rails, as had been suggested, the construction of a simple gutter to catch the brine and carry it away would perhaps be sufficient. It was considered, however, that the proper solution of the problem was to provide the cars with reservoirs large enough to hold the brine until discharged at regular stations.

In discussing this report Mr. J. P. Snow (B. & M.) gave the interesting information that his company was building a portable sand blast plant to be used in cleaning iron bridges for repainting. This plant had not yet been put in operation.

Turntable Construction.

This was one of the most complete and carefully prepared reports presented at the convention, but, on account of its length, it is not included in this report of the proceedings. Such parts of the report as are of principal general value will be abstracted in a future issue of Engineering News. There was no discussion of the report.

Subjects for Convention of 1899.

The following list of nine subjects were selected for special committee reports at the convention to be held in Detroit, Mich., in October, 1899:

(1) Most Economical Method of Painting Railway Bridges and Buildings and Best Materials to Use.
(2) Life of Different Kinds of Timbers in Bridges of Various Kinds and Advisability of Protecting it from the Weather.
(3) Best Method of Constructing and Maintaining Highway and Farm Crossings.
(4) Best Practical Sanitary Arrangements for Local Stations Where There Are No Water and Sewer Systems.
(5) Best and Most Economical Plant for Pumping Water.
(6) The Necessary and Kinds of Tools for the Equipment of a Gang of Bridge Men.
(7) Best Snow Fence, Stationary or Portable.
(8) Protection of Fire in Railway Buildings.
(9) What Repairs Can Be Made to Metal and Wooden Spans Without the Use of Falseworks and How Can They Be Made Safely?

Election of Officers.

The following officers were elected by the Association to serve during the ensuing year: President, J. H. Cummin, Long Island R. R., Long Island City, N. Y.; First Vice-President, Aaron S. Markley, Chicago & Eastern Illinois R. R., Danville, Ill.; Second Vice-President, C. C. Mallard, Southern Pacific Ry., Algiers, La.; Third Vice-President, Walter A. Rogers, Chicago, Milwaukee & St. Paul Ry., Chicago, Ill.; Fourth Vice-President, J. M. Staten, Chesapeake & Ohio Ry., Richmond, Va.; Secretary, S. M Patterson, Boston & Maine R. R., Concord, N. H.; Treasurer, N. W. Thompson, Pittsburg, Ft. Wayne & Chicago Ry., Fort Wayne, Ind.; Executive Committee, W. S. Danes, W. A. Eggleston, R. L. Heflin, F. W. Tanner, A. Zimmerman and J. H. Markley.

Third Day.

The third day of the convention was devoted entirely to sightseeing, and a number of excursions were taken to the historic places about the former Confederate Capital.

Exhibits.

Comparatively few manufacturers of railway supplies made exhibits at the convention. Among the exhibitors present, however, Fairbanks, Morse & Co., of Chicago, showed a gasoline engine air compressor and pumping plant, the compressor being operated in connection with pneumatic drills, chippers, hammers and other tools of the Chicago Pneumatic Tool Co. Another exhibit of special interest was an improved form of gasoline motor railway velocipede, made by the Sheffield Velocipede Car Co. The Norton Jack Co. showed several forms of its well-known ball-bearing jacks for heavy bridge work, and a number of other firms had catalogues and other trade literature and personal representatives present.