ENGINEERING NEWS AND AMERICAN RAILWAY JOURNAL.

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TABLE OF CONTENTS.

THE LARGEST STORAGE BATTERY PLANT ever built is to be installed by the Chicago Edison Co. in the basement of its Adams St. building, the site of the company's original plant, which point is about the center of distribution of the large down-town system. The battery will be used principally for taking care of the large winter peak and incidentally as a means of reducing generating cost, and also as an assurance of uninterrupted service. The battery is being built by the Electric Storage Battery Co., of Philadelphia, and will have 166 cells (83 on each side of the three-wire system), each with 87 plates, known as type "H." It will have a capacity of 22,400 amperes on the eight-hour rate, and a maximum capacity of 11,200 for 1¼ hours. It is arranged to discharge on two voltages, thus making certain long feeders in the distributing system of more value and at the same time insuring an even distribution of pressure throughout the entire down-town system. It will be charged directly during the light load on the system from midnight until morning from one of the 200 K-W. direct-connected units at the Harrison St. station, which will be used on its regular work during the remainder of the 24 hours, thus dispensing with the booster investment and the consequent loss of such a system. During the period of charging, the field rheostats of this unit will be operated by small series motors controlled from the battery switchboard at Adams St. The above particulars were furnished by Mr. T. W. Creden, Assistant Mechanical Engineer of the Chicago Edison Co., who states that this battery will be about 70% larger than any other battery ever built.

AN ELECTRIC CABLE-WAY ALONG THE CHAMPLAIN Canal, 60 miles long, is to be constructed by the Cataract General Electric Co., according to an announcement made by that company. This company was granted a State franchise to furnish electric power to the canals. The electric trolley system of towage is proposed, with the motors traveling on a cable-way.

ELECTROLYSIS OF WATER MAINS and telephone cables is attracting attention in Washington, and in a recent report, prepared by the Engineering Department of the District, under the direction of Capt. W. M. Black, Engineer Commissioner, the subject is quite fully considered. In one test, made to determine the conditions due to leakage currents, a section was removed from a 3-in. pipe used to supply the gas works with naphtha from the Standard Oil Co.'s works, and a difference of potential of 1 volt was obtained with a current of 4 amperes. Between this pipe and other pipes near at hand a potential difference of from ½ to 4 volts and a current as high as 6 amperes was found. Other tests indicate the same state of affairs, and a letter from Mr. C. H. Davis, the Superintendent of the Naval Observatory, states that the magnetic instruments at the observatory are useless from the same cause. To remedy the trouble the Commissioners have prepared and transmitted to Congress a bill which provides that all street railways using a single trolley ground return system must equip their lines with the double trolley, or some other approved metallic return system. The second section considers other companies generating current for any use whatever, and makes it unlawful to use any apparatus that is grounded. Certain conditions as to filing of plans and fines for non-compliance are also inserted.

OVERHEAD WIRES IN WASHINGTON, D. C., will all be placed underground if a bill prepared by the Commissioners and transmitted to the Senate Feb. 7 is passed. This bill provides that all overhead wires within the fire limits shall be removed within one year after the passage of the bill, and that the present system of underground conduits be utilized to the fullest extent possible. Authority is given the Commissioners to remove at the owners' expense in case the latter fails to comply with the law.

OVERHEAD WIRES IN CHICAGO must come down, according to an ultimatum issued by Mayor Harrison. This order involves some 4,000 overhead wires owned by various telegraph, telephone and fire protection companies. All of the wires within the district bounded on the north and west by the river and on the south by 12th St. will be cut down unless steps are taken to put them underground before March 1.

AN ELEVATED RAILWAY for electric surface cars is proposed by the Chicago City Ry., the line to be built on Dearborn St. from the Chicago River to 39th St. The object is to shorten the time of transit across the city, where the cars are now frequently delayed by crowded street traffic, so that they cannot compete with the suburban trains of the steam railways. The street cars would be run up inclined planes to the elevated structure and then hauled by motors taking current from an overhead wire or a third rail. It is expected that the time from the city to the southern suburbs can be reduced 15 to 20 minutes in this way. The company proposes to build a light structure, using riveted trusses instead of plate girders, and there will be stations at all important cross streets. The line would have two grade crossings at the elevated loop line, which would involve some danger and considerable delay to the heavy traffic on both lines. Considerable opposition is expected from property owners on Dearborn St., but the company has already had an auxiliary company incorporated to carry out the work under the name of the Chicago City Railway Transit Co., with a capital stock of $1,000,000.

THE MOST SERIOUS RAILWAY ACCIDENT OF THE week occurred on the Louisville & Nashville R. R., near Kirkland, Ala., on Feb. 10. Two trains met in a head end collision, killing five men and injuring two others. The engineer is said to have run by Kirkland, where he had orders to pass the other train.

THE U. S. BATTLESHIP "MAINE" was blown up on Feb. 15 in the harbor of Havana, Cuba. The cause of the explosion is at this time unknown. Press dispatches state that 100 men were killed or seriously injured. The explosion was felt all over the city of Havana.

FIRE DESTROYED THE TRANSFORMER HOUSE of the Citizens' Power & Light Co., of Montreal, Canada, on Feb. 6. This sub-station is part of the large Lachine Rapids plant (Eng. News, Feb. 18, 1897), recently put into operation to supply Montreal with light and power. The loss is estimated at $100,000 and will interrupt the service for some time.

THE EXPLOSION OF A LOCOMOTIVE BOILER on the Norfolk & Western Ry., near Welch, W. Va., Jan. 30, was reported by the daily press as blowing the tender some 200 yds. from the track, where it landed unharmed. In a letter to us Mr. W. H. Lewis, Superintendent of Motive Power of the Norfolk & Western Ry., says:

This appears to be a case which was caused by low water, as the crown sheet was very blue at the point of fracture, plainly showing heating in the absence of water. The entire crown sheet, the upper half of the flue sheet and the upper half of both side sheets were blown down, stay-bolts and crown bolt braces remaining in the sheet of the boiler, showing them all to be sound and in proper condition. The entire boiler, including the smoke box and extension front, was blown clear of the frames and was carried over the telegraph lines, striking the ground at a point about 280 ft. from the point of explosion. One of the driving wheels was blown from the axle, the remaining portion of the engine and tender remaining on the track and running about 150 ft. The fireman was killed and found lying in the tender. The engineer was found lying across the side rod of the engine, being only slightly injured, and was able, with the assistance of two men, to walk home on arriving at Bluefield. His escape is certainly marvelous, when we consider the tremendous force of the explosion. The boiler was of the Belpaire type, had been thoroughly overhauled, the flues removed on Sept. 30, 1897.

THE HOLLAND-AMERICAN STEAMER "VEENDAM," formerly the "Baltic," of the White Star Line, on Feb. 6, struck a submerged wreck just outside of the British Channel and was sunk. The "Veendam" left Rotterdam on Feb. 3, with 9 saloon and 118 steerage passengers and 85 in the crew. Her distress signals were answered by the "St. Louis," of the American Line, and all the passengers and crew were safely transferred to that ship and brought to New York. The wreck of the "Veendam" was fired to prevent her also becoming a derelict.

A SEVERE TEST OF THE THIRD RAIL SYSTEM is reported as occurring on the New Britain section of the New York, New Haven & Hartford R. R., as a result of the recent severe snow storm. The morning of Feb. 1 the tracks and conductor rails were completely covered. Steam locomotives and snow plows were first sent over the line between Hartford and New Britain. As soon as the rails were uncovered current was turned on and the trains started and maintained on schedule time, and although the track and conductor rail were surrounded with snow, no appreciable leakage was reported. There is little doubt but that a proper electric snow plow could have cleared the tracks fully as well as the steam locomotives and snow plow, which were doubtless used as a matter of convenience.

BROOKLYN DRY-DOCK NO. 3, says Naval Constructor Bowles, to the Secretary of the Navy, has passed the crucial stage of repair, and Mr. Bowles is now confident that it can be saved. He has driven new bearing piles at the entrance, restored the concrete and is completing the floor. As a consequence, the leakage has so decreased that one steam pump, working slowly, keeps the work dry.

THE BATTLESHIPS "KEARSARGE" AND "KENTUCKY" are about ready for launching at the Newport News Navy Yard. They are sister ships of the "Illinois," "Alabama" and "Wisconsin," now under construction. The Senate Naval Committee has voted in favor of allowing $400 per ton for the armor of the latter three vessels, and the House will doubtless agree and thus end the deadlock on the armor question. The trouble began in the Senate two years ago, with a provision forbidding the Secretary of the Navy to enter into any contract for the armor of these battleships until Congress should specially authorize him to do so. Meanwhile the Secretary was to have estimates made for establishing a government armor plant; and though the Secretary recommended paying $400 the Senate and House agreed upon $300 per ton as a maximum. The estimates for the plant far exceeded the amounts first talked of, and as the plant would be idle much of the time the Senate has changed its mind.

THE STEEL FLOATING DRY-DOCK, which the Platt amendment to the naval appropriation bill would authorize the Secretary of the Navy to contract for under an annual subsidy of $90,000, has already been commented upon in this journal. But Mr. W. N. Dykman, President of the New York Dry-Dock and Repair Co., lately advanced before the House Committee on Naval Affairs some practical reasons against this proposed contract. The provision limiting the type of dock to be built to the English patent owned by Clark & Stanfield, of London, is extremely unjust to American enterprise, and would be legislation in the direct interest of the particular corporation owning the American patents on this dock. He contended that if a subsidized dry-dock was to be built by private parties, the field should be open to all bidders. Mr. Dykman also claimed that it would be unsafe to dock a modern battleship in such a dock. The dock proposed is made up of five independent pontoons, which cannot, from their construction, give equal support to the warship. For example, with an 11,000 ton battleship, the heaviest part of the vessel is where the turrets are located, and this weight, of about 8,000 tons, falls upon one pontoon; the ship would be sustained by the end pontoons and the middle pontoons would inevitably sag and strain the hull. In this view Mr. Dykman claims the support of Commodore Matthews, of the Bureau of Yards and Docks, and other naval officers.

A LAKE ST. CLAIR-LAKE ERIE SHIP CANAL scheme is again being broached at Ottawa, Canada. This canal would cut across the "great toe" of Ontario, and shorten the distance between Lakes Huron and Erie by 78 miles. The new canal would be only 13½ miles long, and the Canadian government is asked to guarantee the company's bonds to a limited extent.

A 7-MILE PNEUMATIC MAIL CIRCUIT in New York city, between the Main Post Office and Station H, at the corner of Lexington Ave. and 44th St., was opened with due ceremony on Feb. 11. Two lines of 8-in. pipe are used, each 3½ miles long, one for transmitting and the other for receiving. The apparatus used at the stations is the same as that used on the Produce Exchange circuit (Eng. News, Oct. 14, 1897).

A MUNICIPAL BUILDING for the down-town district of Chicago is proposed by Mr. L. E. McGann, Commissioner of Public Works, and plans for a five-story structure are being prepared by the city architect. It will contain accommodations for the Central police station, the justice courts now located at the Armory station, the Lake Front fire engine station, office and warehouse of the city purchasing agent, and the offices of the bureaus of streets, sewers and street and alley cleaning.

THE REPORT OF THE ELECTRICAL BUREAU of Philadelphia, states that during the year 1897 the Bureau laid 28,632 ft. of conduit, or 203,591 ft. of duct. There are at present in use 932 fire-alarm boxes and 889 sets of telephones, all under the direction of the Bureau. With reference to street railway service, the report states that the several electric railways are placing return feeders as fast as they can, and that the city is bonding the city cables and water pipes to them. There are 7,119 street electric lights in service, using 2,379,388 ft. of conduit, and 17,675,306 ft. of duct. There are 53,110 poles, exclusive of those along the railway tracks, and 9,503 miles of overhead wire in service.

BALLASTING AND FILLING WITH THE RODGERS BALLAST CAR.

In delivering material for ballasting railway tracks or for raising the grade of the line, the usual method is to haul it on flat cars to the place where it is required, and then plow it off on one or both sides of the train by means of a plow which is dragged along the train by a wire cable attached to the locomotive or to a winding engine on the front car. Under this arrangement, however, all the material required between the rails must be shoveled back, involving extra handling.

The Rodgers ballast car, which we illustrate this week, is designed to effect a better and more economical method of distributing the material. The material is dumped between the rails in a long ridge, which is then leveled down by a scraper or plow under the rear car of the train, this plow throwing the surplus outside the rail, ready to be tamped under the ends of the ties. The ballast or gravel train is made up of the required number of dump cars, with a flat car fitted with the plow at the end of the train, in front of the caboose.

Figs. 1 and 2 represent work on the Chicago & Eastern Illinois R. R., where the track is being given a raise of 5 ins. In order to secure these views, the plow car and caboose were cut off, and the cars then run ahead and dumped, beginning just opposite the group of trees on the right of the view. Fig. 1 shows the ridge of ballast between the rails, the top being cut down into a groove by one of the brake rods. The plow car was then hauled over the line, plowing the gravel over the rails to form the shoulder, and leveling it down between the rails, while also forming flangeways along the rail heads, so that the line is put in safe condition for traffic. With the material left as in Fig. 2, the jacks can be put in place, the track raised, and the gravel tamped directly under the ties, without any handling of the material by shovels. If desired, two train loads can be deposited and plowed out before the raising is done.

One of the ballast cars, built for the St. Louis & San Francisco Ry., is shown in Fig. 3. It is a hopper car, with steeply sloping sides and ends, so as to give a free flow of the contents. The door is formed by the lower part of one side of the bottom of the hopper. The sides are supported by posts and braces on the side sills, cast-iron shoes being used for the bearings on the sills and plates. There are four longitudinal sills and four truss rods. The car is mounted on two diamond-frame trucks with trussed oak bolsters or the "Common-Sense" steel bolster, and body bolster. The brakes are inside hung, and are placed much higher than usual, as no obstruction is allowed below the line of the axles. The doors are operated by chains of ½-in. iron, with ⅞-in. rods and turnbuckles, as shown, the chains being wound upon worms on a 1¾-in. shaft running along one side of the hopper. This shaft is turned by means of a hand lever and double ratchet, shown at the front end of the car. When this is released, the weight of the load opens the door. In unloading a train, the front car is unloaded first, the door being opened only enough to let out what ballast the track will hold between the rails. The entire car load will not be deposited at one place, the ridge of gravel on the track preventing the rest of the material from running out. The train is then moved slowly forward and the balance of the load runs out, one car usually filling 75 to 90 feet of track. The second car is then unloaded in the same way, and then the third, and so on. No two cars are unloaded at the same time, as this would flood the track and flow over the rails. When the plow car at the rear of the train reaches the point where the first car was unloaded, the plow is lowered to rest on the rails, and as it moves forward it plows out and levels the gravel, flanges the track and leaves the rails clean. Three men operate the train. The conductor and one brakeman dump the loads in succession, while the other brakeman attends to the lowering and raising of the plow. Large or small amounts can be delivered at any required points.

Fig. 1.—Ballast Dumped.

Fig. 2.—Ballast Plowed.

BALLASTING WITH THE RODGER BALLAST CAR ON THE CHICAGO & EASTERN ILLINOIS R.R.

Each car has a capacity of about 16 cu. yds., level full, but as the load is always heaped up above the sides the average load is 20 to 22 cu. yds., and even this is exceeded in some cases. This, of course, results in great economy of operation as compared with the use of flat cars with loads of 7 to 10 cu. yds. per car. On the Chicago & Eastern Illinois Ry. it was found that two trains of 45 Rodgers cars would do the work of four trains of 44 flat cars with 7 cu. yds. per flat car, effecting a saving of $183 per mile, and avoiding much switching and delay to traffic. The cars have been used on a number of railways during the past eight years, and the following is a letter from Mr. W. B. Stimson, Superintendent of the Grand Rapids & Indiana Ry., dated June 5, 1897, giving interesting details of the cost of ballasting with Rodgers cars:

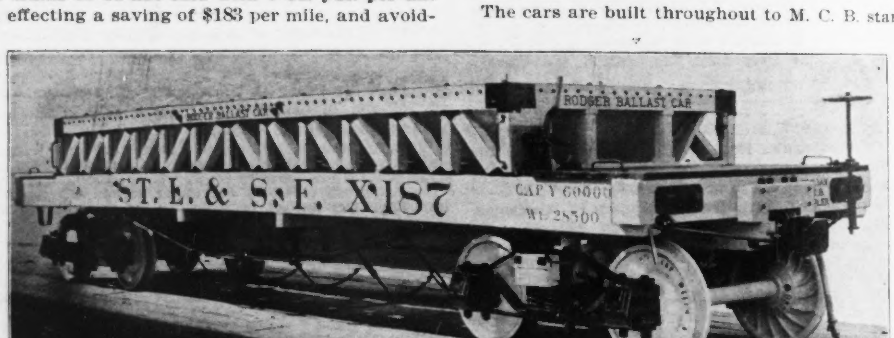


FIG. 3.—RODGER BALLAST CAR FOR THE ST. LOUIS & SAN FRANCISCO RY.

We finished work at Elmira on May 28, having hauled and distributed 1,039 cars of ballast (20,800 cu. yds.), with an average haul of about 7 miles. Miles of ballast distributed, 16; an average of 1,300 cu. yds. per mile, working two trains of 20 cars per train, with consolidation engines having cylinders 20 × 24 ins. Below please find statement of cost of handling:

Two train crews, 12 days each	$175.00
Locomotive, enginemen and watchmen	199.25
Fuel for locomotives	254.10
Pit foreman	28.84
Telegraph operator	15.50
Pit men	100.35
Steam shovel, including rent of shovel, fuel and wages	323.52
Total	$1,096.56
Cost per cu. yd., 5.3 cts.	

Cost of distributing does not include repairs to locomotives or cars, but does include cost of removing sod from top of pit ($50).

Included in the above is the expense of moving the steam shovel and two trains of 25 Rodger ballast cars each, from Grand Rapids to Elmira; distance, 166 miles; and in addition to this half a day consumed in setting up shovel and getting ready for work, so that the actual time the shovel worked was about 10½ days, making an average of about 2,000 cu. yds. per day of 12 hours.

All loading was done on main track, so that it was necessary for ballast trains to keep out of the way of all trains. In order to do this when loading it wss necessary to go to a passing track ¾-mile from pit, in the opposite direction to that in which ballast was being hauled from pit. Number of trains to keep clear of, 5.

Cost of putting gravel in track distributed by Rodger cars averaged per man (including foreman), 75 ft. per day, an average cost of 6.7 cts. per cu. yd. of ballast distributed. Total cost for distributing and putting in, 12 cts. per cu. yd. This does not include dressing up, but includes half a day lost on account of derailed cars and lifting 7 switches in Boyne Falls yard.

Taking into consideration the fact that the cars were all new, and that none of the men had any previous experience in their use, and the fact that the character of the pit in which shovel was working was a cut alongside of main track, an average depth of about 8 ft., the results obtained are certainly very satisfactory.

The cars are built throughout to M. C. B. standards for cars of 60,000 lbs. capacity, and the following are the dimensions of the regular 34-ft. cars of this capacity, such as shown in Fig. 3:

Length over end sills	34 ft. 0 ins.
Width over side sills	8 " 9 "
Length of hopper, top	25 " 9 "
Length of hopper, bottom	18 " 3 "
Depth of hopper	4 " 11 "
Height, rail to top of sill	4 " 4 "
Side sills (2), Southern pine	6 × 16 "
Intermediate sills (2)	10 × 10 "
End sills (2), oak	9 × 11 "
Headers	9 × 10 "
Plates and girths	5 × 7 "
Posts (oak)	4 × 4 "
Braces (oak)	5 × 4 "
Hopper planks: Southern pine, dressed two sides and ship-lapped	⅝ × 6 × 1¾ "
Hopper door	19 ft. 1 in. × 1 ft. 4½ ins.
Hopper opening	18 ft. × 1 ft. 4 "
Wheels (600 lbs.), diameter	2 ft. 9 "
Capacity	60,000 lbs.
Weight	28,000 "

These cars are used also for filling trestles, and are claimed to be superior to flat cars or side dump cars for this work, on account of building the bank from the middle instead of from the sides.

The ties must be shifted together in pairs or otherwise, so as to leave sufficient opening for the dirt or gravel to fall through. The cars are also used for carrying coal and ore, dumping the loads from elevated trestles, and the Great Northern Ry. has had very good results from them. For this work, the cars are fitted with stake pockets for long stakes supporting sides and ends which extend above the top of the permanent sides of the cars. When the cars are required for ballasting, these extra sides can be removed and stacked ready for use when again required for coal service.

These cars are built by the Rodger Ballast Car Co., Fisher Building, Chicago, and we are indebted to Mr. E. S. Hart, General Manager of the company, for photographs and information respecting their use. The car shown in Fig. 3 was built at the works of the Wells & French Co., of Chicago, under contract for the company. As our illustrations every week include so many half-tone reproductions from photographs, it may interest some of our readers to know that in order to ensure a good photograph, the woodwork of the car and the wheels and axles, were painted a light grey (the tint being selected after several trials), and all the iron-work was painted black.

RAILS, PAST AND PRESENT.

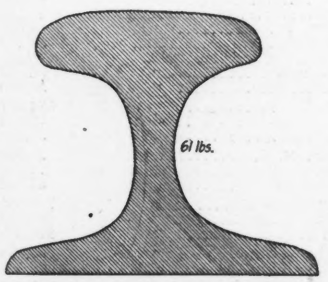
At the January meeting of the Western Railway Club, Mr. E. C. Potter, for many years actively engaged in the manufacture of steel rails, presented a paper with the above title, which is here abstracted.

The first steel rail ever made in America was rolled in 1872* at the old North Works of the North Chicago Rolling Mill Co., and up to the time of the merging of this company into the Illinois Steel Co. over a million tons of steel rails had been rolled, a large proportion of which are still in service. At first almost any kind of steel rail was accepted by the railway companies, as the immense superiority of steel over iron warranted the very high cost of the former. But as the demand increased, processes were cheapened, competition grew and the price of steel rails steadily fell until the low point of 1885 was reached. Then came doubts as to quality in these rails; and it became evident that increase of weight did not bring increase of service. The railway managers charged that the cheapening in cost resulted from the use of inferior raw materials; and the makers retorted that it was impossible to make steel at all out of any but the best materials. Many efforts were made to make steel that would duplicate the qualities of ten years before. As an example, in 1876 a certain Western road purchased a lot of 56-lb. rails from a mill employing a hammer for blooming ingots, instead of rolls, and they happened to use in their mixture of pig-iron about 20% of charcoal iron. The resulting rails gave very excellent service, and in 1885 the road placed an order with the same mill to duplicate in every way the rails of 1876. This was impossible, as the hammer was an obsolete machine; but, though charcoal iron was then a luxury, the rails were made with the 20% mixture. Nevertheless, the rails did not wear like those of 1876, and the circumstance gave rise to learned discussions on the relative merits of hammering and rolling.

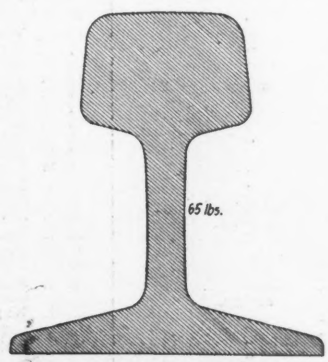
Another railway company had in its service a 50-lb. rail rolled in the early '70's, which gave better service than succeeding 56, 60, 65, 72 and 80-lb. rail sections. In those days the perfect rail was the John Brown rail, rolled by that well-known English firm in the early days of steel rail manufacture. The Michigan Central Ry. had a considerable amount of this rail in use, some of it rolled in 1866, and in service 20 years. This rail weighed 61 lbs. per yd., and the comparison between its section and the newly-designed 65-lb. rail was as startling as the comparison in wear. The head and flange of the John Brown rail were nearly equal in width and thickness; but, says Mr. Potter, the new 65-lb. section intended to replace it was the worst-designed rail ever rolled. The Chief Engineer of the road realized that something was wrong, and he asked every steel-maker in the country to submit a design for an 80-lb. rail that would wear well. The result was the present 80-lb. Michigan Central rail, the first of the new type of rail section now so generally accepted.

About this same time, Mr. F. A. Delano, now President of the Western Railway Club, was commissioned by his road to investigate the manufacture of steel rails in this country, and he spent a year in visiting rail mills. He found the principal trouble to be the sections employed, and Mr. Delano designed a group of rail sections, which Mr. Potter believes to be the best ever made. About the same time Mr. P. H. Dudley designed rail sections on similar lines which are now used on the New York Central and other roads. Mr. Potter discusses these sections as follows:

Up to the time of the appearance of the new type of section, the acme of perfection was thought to have been reached in the Pennsylvania 75-lb. rail. The basis of this design was a 56-lb. rail, which was increased to a 60, a 70 and a 75-lb. section by constant increments to the head only. It is a fact that the same angle bar fitted each section from the 56 to the 75-lb. Since the head was the vulnerable part of the rail, it seemed to be incontrovertible that the larger the head the longer the wear. The history of the service of heavy rails has fully exposed the fallacy of this idea. The failure of rail sections has been due to the same cause that the failure of many men can be attributed, namely, an attack of "big head." No one can appreciate the reason for it as well as the manufacturer, but even he did not find it out until a direct comparison of sections was made. The constant aim of the manufacturer is to keep the percentage of second quality, or defective rails, as low as possible, and naturally he has a fondness for those sections which invariably yield the least seconds. The 50-lb. section previously referred to was the most easily rolled section in my experience, and, as we have seen, gave eminently satisfactory service. The Michigan Central 65-lb. and the Pennsylvania 75-lb. were difficult to roll, and always gave a high percentage of seconds. Their wear was never satisfactory. The new Michigan Central 80-lb. rail, which was practically designed by the manufacturers, was designed primarily to roll easily, and was a vast improvement over the 65-lb. section. Now, what is the connection between easy rolling and good wear, or high seconds and poor wear? Simply that the badly designed big-headed section is entirely out of balance, more than half the total metal being in the head. While the rail is passing through the finishing rolls and receiving its final shape, the large head is still hot while the thin flange is nearly, if not quite, black, and hence easily torn, making a second-class rail. In order to keep the flange at such a temperature as will permit of rolling, the initial temperature of the bloom is often carried too high, resulting in a coarse, open texture in the head, which, because of its size, does not receive the compression that the flange does. The large head, therefore, actually wears out faster than the small one. The densest metal of a large headed rail is in the flange, and if the rail could be turned bottom side up you would get a better wearing rail by running on the flange, thin as it is. Moreover, I never could understand the logic of having a head 2½ or 3 ins. deep, when a wear of ¼, or, at most, ½-in. will necessitate the rail being removed. The purchaser pays for metal that never can be made available, and, worse still, materially aids in the rapid consumption of that metal by having it in the wrong place. The more nearly equal the head and flange is in weight, the easier the rail will be to roll, the more uniform will be the metal in density, and the better the rail will wear.



Section of 61-lb. Steel Rail for the Michigan Central R.R., 1866. Rolled by John Brown & Co., Ltd., Sheffield, England.



Section of 65-lb. Steel Rail for the Michigan Central R. R., 1886. Rolled by the North Chicago Rolling Mill Co.

With the adoption of what are known as the American Society of Civil Engineers' rail sections, and their liberal use, says Mr. Potter, many of the difficulties formerly experienced in quality, wear and manufacture have disappeared. Mr. Potter, however, claims that we are still far from having a standard set of sections, and much of the trouble is due to the adherence of some engineers to some insignificant feature of design, which results chiefly in requiring a new set of rolls at the mills. He notes one case where the only difference between two rail orders was ⅛-in. in the radius of the upper head corner; yet the engineer adhered to his blue-print and new rolls had to be made. And aside from the cost of manufacture the change of the rolls required the loss of an hour's time, the equivalent of 100 tons of rails rolled.

Mr. Potter raised the question of a standard for drilling rails; though he admitted that this meant a standard rail-joint, a standard very far from being realized. At present almost every road has its own peculiar joint, and rails must be drilled accordingly—to the worry of the makers. In connection with the chemical composition of rails, Mr. Potter thinks that common sense rail sections are largely doing away with the necessity of trying to explain rail failures by chemical make-up. He notes that he had once sent to him several hundred tons of old rails, which were to have the battered ends removed preparatory to relaying. All these rails had been made previous to 1875, and a dozen or more makers were represented, including all the prominent English mills. He analyzed samples frome each lot, and the result was a revelation. In one John Brown rail the carbon, phosphorus and silicon were all about equal at 0.17%. No rail inspector would dare to accept that rail now, though this rail had seen 15 years' service and was going back for 15 more, so far as the looks of the rail would indicate. The ample metal in the flange was alone responsible for the excellent service. Mr. Potter says that:

Modern heavy sections make it possible to increase the content of carbon in the steel with advantage to all concerned. I am convinced that a considerable increase in the percentage of silicon will be beneficial. Some experiments that have come under my observation within the past two years have impressed upon me the great value of considerable percentage of silicon in steel.

In less than 30 years, says Mr. Potter, Yankee ingenuity has reduced the cost of the steel rail from $150 per ton gold to $20, or one-eighth the original cost. To-day the rail is the cheapest finished product in the whole domain of iron and steel manufacture. But it requires an expenditure of at least $3,000,000 before a single rail can be rolled; and one of the most complicated and delicate operations known to metallurgy is involved in the turning out of over one ton of product per minute, day after day, within limits that will not permit a variation of more than 0.05% either way from a standard.

THREE LINES OF ARMORED LEAD PIPE were recently laid across a tidal stream at Amsterdam, Holland. The internal diameter of each pipe was about 2 ins., and its length about 1,335 ft. The thickness of the pipe was 0.156 ins. The armor was formed by first wrapping the pipe with a layer of tarred hemp. Upon this steel wire was wound, and then two more layers of hemp were placed outside the wire. The wire had a special section designed for interlocking, the shape being something like the figure 8, bent over at the top, but remaining fixed at the bottom. The total diameter of the armored pipe was about 3¼ ins. Before the pipe was laid it was tested for tensile strength by applying a load of 5,500 lbs. and for bursting strength by subjecting it to an internal pressure of 750 lbs. After the pipe was laid it was tested for leaks. All the tests gave satisfactory results. The pipe was laid in dredged trench. Each of the three pipe was laid simultaneously, being paid out from drums mounted on lighters, which were slowly towed across the stream. The whole of the pipe was laid in 35 minutes. The pipes supply a small outlying district of the city, one conveying water for domestic uses and the other two carrying water for industrial purposes. They replace two old lines of ordinary lead pipe, 1½ and 2 ins. in diameter respectively. These lines had been damaged by anchors, and besides this the deepening of the channel made the laying of new pipe necessary. The above information has been taken from the "Journal fuer Gasbeleuchtung und Wasserversorgung" for Jan. 29, 1898.

*This date, 1872, is an error, due probably to a slip of the pen or a printer's mistake. The correct date is May, 1865. See Trans. Am. Inst. Mining Engineers, Vol. VI., p. 59.—Ed. Eng. News.

COST OF DREDGING IN THE UNITED STATES.

The following tables were compiled for the Nicaragua Canal Commission by Mr. T. Jenkins Hains, Assistant Engineer in charge of the New York office of the Commission, and have been copyrighted by him. The data here given are taken from the latest reports of officers of the Engineer Corps, U. S. A., and from other engineers in charge of works of importance in the United States. The first column of the tables refers to the Appendices of the Report of the Chief of Engineers, U. S. A., for 1896 and 1897, and in these appendices can be found further details of each piece of work. The prices given are from 1895 to the present time. While the tables are necessarily limited as to exact details in each case, the prices given will be generally useful to engineers and contractors in making estimates for this class of work.

COST OF DREDGING IN THE UNITED STATES IN 1896. (Copyright. 1898, by T. Jenkins Hains.)

For details of projects see Appendix to Reports Chief Engrs., '96.	Location.	Material.	Amount. cu. yds.	Finish'd depth, M.L.W., ft.	Contract dated.	Cost, per cu. yd.
A 3.	Narraguagus River, Me...	Mill waste.	87,798	11	1895.	$0.127
A *9.	Belfast, Me.	Not stated; prob. soft.	49,962	8 to 15	1895.	.14¾
A 10.	Camden, Me.	Not stated; prob. soft.	55,981	10	1895.	.19¼
A 14.	Kennebec River, Me.	Sand, mud & hard.	6,142	13 & 10	1895.	.24
A 16.	Harraseeket, Me.	Soft.	162,840	5	1893.	.17 &.175
A 18.	Back Cove, Me.	Soft.	116,386	12	1893.	.16½
A 22.	Little Harbor, N. H.	Sand & mud	62,500	9 & 12	1895.	.16
B 3.	Powow River, Mass.	Hard.	64,000	12	1895.	.39
B 4.	Essex River, Mass.	Soft.	47,000	4	1894.	.19
B 8.	Lynn, Mass.	Not stated.	32,000	8	1894.	.23
B 9.	Mystic River, Mass.	Not stated.	75,229	6	1894.	.23⅞
B 10.	Boston, Mass.	Not stated.	150,000	27	1895.	.29
B 12.	Weymouth River	Not stated.	37,000	6	1894.	.29
C 9.	Taunton River, Mass.	Sand, gravl.	3,943	11	1894.	1.00
C 12.	Prvdnce R., NarragansetB.	Not stated.	73,479	25	1895.	.12
C 13.	Green Jacket Shoal, R.I.	Mud.	36,647	25	1895.	.15
C 18.	Block Island, R. I.	Sand.	2,704	12	1896.	.30
C 19.	Block Island, R. I.	Sand.	Not stated.	Nt statd	.....	.14⅞
C 28.	Stonington Harbor, Conn.	Sand & mud	129,200	Nt statd	Estimate.	.18
D 2.	Thames R., Shaw's Cove.	Not stated.	50,000	12	Contract.	.09
	Norwich, Conn.	Sand.	40,000	12	"	.16
D 3.	Connecticut River	Sand.	70,000	12	"	.10½
	Connecticut River	Sand.	40,000	12	"	.09⅞
D 5.	New Haven, Conn.	Mud.	93,500	16	"	.09
D 7.	Housatonic River	Sand.	5,000	16	"	.19¾
D 8.	Bridgeport, Conn.	Not stated.	70,000	15	"	.11½
D 9.	Saugatuck, Conn.	Sand, gr'vel, & stones.	9,759	4	Hired by Govrmt.	$3,000
D 11.	Five-Mile River Harbor, Ct.	Not stated.	15,000	8	Contract.	.13½
D 12.	Stamford, Conn.	Sand, gr'vel and mud.	50,000	7	"	.12&.09⅗
D 13.	Cob Harbor, Conn.	Not stated.	31,000	6	"	.093
D 15.	Port Chester, N. Y.	Not stated.	28,900	8	Hired by Govrmt.	.123
D 17.	East Chester Creek, N. Y.	Mud.	5,467	9	Contract.	.12
D 20.	Port Jefferson, N. Y.	Not stated.	26,308	12	"	.26
D 21.	Huntington	Not stated.	14,000	8	"	.12
D 23.	Flushing Harbor	Mud.	20,000	8	"	.18
D 24.	Patchogue	Mud & sand	24,000	6	"	.14[1]
D 25.	Brown's Creek	Mud & sand	17,000	4	"	.15[1]
D 27.	New York Harbor	Not stated.	938,000	26	"	.15[2]
	New York Harbor	Not stated.	174,954	26	Rittnhse-Moore.	.25
D 30.	Saugerties	Not stated.	14,000	9	Contract.	.16½
D 33.	Passaic River	Mud.	35,000	6	"	.289
D 38.	Mattawan Creek	Mud.	7,600	4	"	.20
D 39.	Keyport	Mud.	20,000	7¾	"	.20
E 3.	Harlem River	Not stated.	......	......	.....	...
E 5.	New York Harbor	Not stated.	66,000	24	U.S.drdg. "Gedney"	.06½†
	New York Harbor	Not stated.	55,000	24	"	.04⅖†
CC 1.	Ohio River	Prob'ly soft	11,260	Nt statd	Hired dredge.	.18½
	" "	Prob'ly soft	62,560	"	"	.19
	" "	Loose rock, cem. grvl.	11,887	"	"	.22
	" "	Gravel and bowlders.	47,700	"	"	.117
	" "	Gravel and bowlders.	18,351	"	"	.10⅗
	" "	Cem. grvl & loose r'k.	20,442	"	"	.301
	" "	Cem. grvl & loose r'k.	12,529	"	"	.14⅖
CC 7.	Muskingum River, Ohio	Gravl, sand and mud.	70,000	"	"	.06½to.11
HH 1.	*Grand Marias, Minn.	Gravl, sand and mud.	324,448	"	Contract.	.24½
HH 12.	*Allouez Bay, Minn.	Clay excavating.	2,336,882	"	"	.28
	*Allouez Bay, Minn.	Dredging. not stated.	60,087	"	"	.15
HH 12.	*Brule River	Not stated.	98,333	"	"	.20
HH 12.	*St. Croix River	Not stated.	60,801	"	"	.20
II 20.	Racine, Wis.	Not stated.	21,371.8	17	Special agremt.	.12¾
II 21.	Kenosha, Wis.	Not stated.	10,751	15	"	.09
II 26.	Oconto, Wis.	Maj. Davis' estimate.	45,000	16	.....	.12½
CC 7.	Eaglesport, Ohio	Sand, grav'l and mud.	4,260	......	Hired dredge.	.07
CC 7.	Stockport, O.	"	700	......	"	.10
CC 7.	Taylorsville, O.	"	18,536	......	"	.06½
CC 7.	Taylorsville, O.	"	7,925	......	"	.08½
CC 7.	Zanesville, O.	"	100	......	"	.12
CC 7.	Lowell, O.	"	9,220	......	"	.08
EE ...	Wabash River	Sand, grav'l.	6,094	......	"	.27½
GG 6.	Kentucky River	Sand, grav'l and clay.	37,000	......	U.S.drdg.	.08½
HH ...	Lake Superior	Sand, grav'l & bwldrs.	Not stated.	14	Williams & Co.	.20
II 21.	Kenosha River	Soft.	10,750	15	Contract.	.09
II 26.	Oconto Harbor	"	873,000	16	"	.15
II 26.	Oconto Harbor	"	1,290,000	16	"	.12
JJ ...	Chicago	"	24,755	18	"	.14
JJ 3.	Calumet River	"	180,000	16	"	.16½
JJ 6.	Ill. & Mississippi Canal	"	13,403	......	"	.22
JJ 6.	Ill. & Mississippi Canal	"	99,600	......	"	.20
KK ...	Michigan City	Sand, mud and clay.	270,300	14 to 18	U.S.drgd.	.15½
KK 2.	St. Joseph	Sand, grav'l.	31,000	20	"	.14
KK 4.	South Haven	S'nd & logs.	17,000	9 to 15	"	.18
KK 6.	Black Lake	Sand and stone.	22,700	15	"	.20
KK 5.	Sag Harbor	Soft.	175,000	12	U.S.drdg.	.10
KK 8.	Muskegon Harbor	Soft.	......	15	Contract.	.11½
KK 10.	Average cost	Mixed.	1,027,005	......	U.S.drdg.	.11⅗
KK 25.	Rouge River	Sand.	74,000	12	Estimate.	.15
KK 26.	Kalamazoo	Sand.	175,000	12	"	.10
KK 27.	Sebewaing River	Sand, grav'l and mud.	111,267	5½	"	.30
KK 28.	St. Clair	Hard.	22,000	12	"	.20
LL 1.	Ship channel in lake bet. Chicago, Duluth & B.	Bwldr, clay and sand.	47,900	21	R.J.Cram.	.44
LL 1.	Same location as above	"	24,200	21	Contract.	.22
LL 1.	" "	"	532,500	21	Mitchell.	.257
LL 1.	" "	Bwldr, sand and grav'l.	256,000	21	R.J.Cram.	.58
LL 1.	" "	"	2,900,000	20	Bozeman.	.14⅘
LL 13.	St. Mary's Falls Canal	Sand and bowlders.	27,800	21	Dunbar.	.28
MM ...	Toledo, Ohio	Not stated.	249,485	19	Rooney.	.11
MM 4.	Sandusky, O.	Not stated.	15,000	18	Contract.	.16
MM 4.	Sandusky, O.	Not stated.	14,800	18	"	.13½
MM 9.	Fairport, O.	Sand.	175,000	20	Estimate.	.16
MM 10.	Ashtabula, O.	Sand.	20,000	20	"	.20
MM 11.	Conneaut, O.	Sand, grav'l and stone.	100,000	20	"	.20
NN 5.	Niagara River	Bed & loose r'k, cly, gvl & bwldrs.	30,660	18	Contract.	.94
NN 5.	Niagara River	Sand, clay & hard-pan.	24,911	18	"	.267
NN 6.	Niagara River	Clay, bwldr & h'd-pan.	27,300	12	"	.32
NN 9.	Dunkirk, N. Y.	Sand & mud	280,000	17	"	.25
OO ...	Chalmette	Sand.	245,000	15	"	.15
OO ...	Chalmette	Sand.	3,600	15	U.S.drdg.	.10
OO 4.	Little Sodus Bay	Hard-pan & bwldrs.	10,600	15	Contract.	.47
PP 5.	Lake Champlain, N. Y.	Soft.	89,800	12	"	.15
QQ ...	Oakland Harbor, Cal.	Soft.	174,480	14 to 20	"	.19⅘
RR ...	Napa River, Cal.	Not stated.	12,000	4	"	.29
SS ...	San Joaquin, Cal.	Soft.	4,243	8	"	.149
SS 2.	Mokelumne, Cal.	Soft.	30,184	......	"	.12
SS 4.	Petaluma, Cal.	Soft and hard-pan.	172,500	6	U.S.drdg.	.087
TT 16.	California River, Ore.	Soft.	400,000	20	Estimate.	.10
WW ..§	Medley Bar, Cairo (Miss.R.)	Fine sand.	205,684	14	Dredge "Alpha."	.02⅗
WW ..§	Point Pleasant Bar	Fine sand.	296,310	Below srf. rvr.	"	.009
WW ..§	Cherokee Bar	Fine sand.	107,565	"	"	.02⅗
WW ..§	Wolf River	Stiff.	13,090	"	"	.153
WW ..§	Sam. Phillips' Bar	Soft sand.	196,000	"	"	.00⅘
	Chicago, Ill. (lowest bid)	Soft.	20,000	16	Contract.	.14
	Calumet, Ill.	Soft.	27,500	16	"	.17½
	Calumet, Ill.	Estimate.	1,038,000	16	"	.20
	Calumet, Ill.	Not stated.	180,000	16	McGillis & Co.	.16½
F ...	Wilmington, Del.	"	154,000	26	Contract.	.15
F 2.	League Island	"	3,500,000	26	"	.10¾‖ .16‡
G 13.	La Trappe River, Md.	"	27,000	8	"	.15
G 21.	Wilmington, Del.	"	1,429,000	21	"	.13
G 21.	Wilmington, Del.	"	1,400,000	21	Estimate.	.13‡
H 3.	Baltimore, Md.	"	2,228,000	27	"	.12½
I 1.	Washington	Mud.	......	20	Contract.	.12 to .15
I 3.	Occoquan, Va.	Mud.	5,148	6	"	.20
I 3.	Occoquan, Va.	Sand.	1,272	6	"	.40
I 4.	Virginia	Mud.	60,438	6	"	.12½
I 4.	Virginia	Sand.	17,731	6	"	.15
I 5.	Machodoc, Va.	Hard.	10,500	9	"	.22½
I 7.	Rappahannock, Va.	Hard.	39,760	9	"	.27
I 8.	Fredericksburg, Va.	Soft.	19,285	9	"	.16
I 9.	York River, Va.	"	58,809	21	"	.15
I 9.	York River, Va.	"	38,000	21	"	.13
J 1.	Norfolk, Va.	"	574,067	25	"	.09
J 4.	Appomattox River, Va.	Sand.	18,000	18	"	.18
J 6.	Norfolk, Va.	Mud.	51,850	9½	"	.13½
K 1.	Ocracroke, N. C.	Hard.	21,800	9	"	.31
K 9.	Beaufort, N. C.	Hard.	14,600	3 to 4	"	.35
K 15.	Folly River, N. C.	Hard.	51,042	5	"	.19
L 7.	Santee River, S. C.	Soft.	122,000	8	Labor.	.05
L 10.	Charleston, S. C.	"	493,000	20	Contract.	.19
L 11.	Wappoo, S. C.	"	216,000	6	"	.20
N 6.	Indian River, Fla.	"	56,000	6	"	.14½
N 9.	Florida	Hard.	50,000	13	"	.24
O 6.	Pen Harbor, Fla.	Pumped; sand.	391,646	20	Govmt. dredge.	.0431
P 13.	Mobile	Sand.	500,000	23	Contract.	.17
P 13.	Mobile	Mud.	1,700,000	23	"	.08
S 1.	Galveston, Tex.	Sand & mud	419,000	17	Govmt. labor.	.17½
S 1.	Galveston, Tex.	"	112,000	17	Contract.	.35
S 2.	Galveston Bay, Tex.	"	228,000	12	"	.24½
S 2.	Galveston Bay, Tex.	"	346,000	9	"	.12½
S 5.	Buffalo Bayou	......	36,000	10	"	.30
T 1.	Red River	Mud.	284,000	......	"	.1389
CC ...	Five-Mile Bar, Ohio River	Rock, gravl and sand.	5,567	......	Hired dredge.	.87
CC ...	Five-Mile Bar, Ohio River	Rock, gravl and sand.	10,752	......	"	.25
CC ...	Five-Mile Bar, Ohio River	Gravel and bowlders.	8,652	......	"	.11
CC 7.	Taylorsville, Ohio.	Sand, grav'l and mud.	1,975	......	"	.08

*Cash estimates by Maj. C. B. Sears, Corps of Engineers, U. S. A.
†Including all expenses, cost, 10⅕ cts. per cu. yd.
[1] Place measurement.
[2] Scow measurement.

§Mississippi River hydraulic dredging.
‖ Scow measurement.
‡ In place.

COST OF DREDGING IN THE UNITED STATES IN 1897. (Copyright, 1898, by T. Jenkins Hains.)

For details of projects see Appendix to Reports Chief Engrs., '97.	Location.	Material.	Amount, cu. yds.	Finish'd depth, M.L.W., ft.	Contract dated.	Cost, per cu. yd.
A 29.	Little Harbor, N. H.	Soft.	60,000	12	1897.	$0.14⅞
A 30.	Harraseekett River, Me...	"	35,000	5	1897.	.20
A 31.	Royal River, Me.	Gravl & cly.	8,000*	7	1897.	.50
F 2.	Mamaroneck, N. Y.	Mud, sand and grav'l.	46,000*	6	1896.	.19½
F 3.	East Chester, N. Y.	"	15,000*	2	1897.	.41
D 7.	New Haven, Conn.	Soft.	90,000	16	1897.	.08
D 8.	Housatonic River, Conn.	Not stated.	50,000	9	J.P.Randemon.	.23½
D 11.	Stamford, Conn.	Soft.	80,000	9	1896.	.09½
D 15.	Cos Cob, Conn.	"	60,000	6	1896.	.09
D 16.	Greenwich, Conn.	"	35,000	6	1896.	.107
NN 3.	Great Sodus Bay, N. Y..	"	48,620	15	U.S. Govern'm't.	.13
NN 9.	Ogdensburg, N. Y.	Sand, mud and clay.	130,000	16	1897.	.13
NN 9.	Ogdensburg, N. Y........	Hard-pan & bowlders.	1,400	16	1897.	.40
F 6.	Port Jefferson	Soft.	28,400*	12	1897.	.23⅞
F 7.	Huntington Harbor	"	47,000	8	1897.	.09½
F 9.	Flushing Bay	Not stated.	20,500	6	1897.	.17
F 10.	Patchogue, L. I.	Soft.	25,000†	6	1897.	.23
F 11.	Brown's Creek, L. I.	"	23,000†	4	1897.	.15
F 12.	Canarsie Bay	"	35,000*	6	1897.	.28
F 13.	Red Hook Channel	"	3,000,000	26	1897.	.21
F 15.	Newtown Creek.	"	965,000	18	1896.	.17⅜
A 3.	Narraguagus, Me.	"	34,000	Nt statd	1897.	.13
A 9.	Belfast Harbor, Me.	"	50,506	"	1896.	.13⅞
A 10.	Camden, Me.	"	62 000	"	1896.	.14¾
A 13.	George River, Me.	"	50,000	"	1896.	.14¾
A 14.	Kennebec River, Me.	"	Not stated.	11	Contract.	.24 to .29
A 16.	Portland, Me.	"	Not stated.	29	1897.	.20
B 10.	Boston Harbor	Not stated.	2,910,718	27	1897.	.17½
B 11.	Town River, Mass.	"	33,000*	4	1896.	.27
B 12.	Weymouth River	Hard.	9,600	6	1896.	.47
B 12.	Weymouth River	Not stated.	48,000	12	1896.	.23
B 13.	Scituate, Mass.	"	14,000	7	1896.	.38½
B 27.	Back River, Mass.	Gravl & m'd	129,439	4	Estimate, 1897.	.35
B 29.	Plymouth, Mass.	Not stated.	25 000	9	1897.	.30
A 1.	Lubec Channel, Me.	Hard.	16,000	12	1897.	1.00
A 1.	Lubec Channel, Me.......	Soft.	134,000*	12	1897.	.27
E 14.	New York Harbor	Sand, mud and gr'v'l.	32,550,000	35	U.S.drdg. "Gedney"‖	.10
C 1.	Hyam's, Mass.	Not stated.	14,780	15½	1895.	.173
C 1.	Hyam's, Mass.	"	4,000	15½	1896.	.21
C 3.	Martha's Vineyard	"	6,485	10	1896.	.27½
C 6.	New Bedford	"	68,887	18	1896.	.127
C 8.	Taunton River, Mass.	Bowlders.	3,355	7½	1896.	1.18
C 11.	Narragansett Bay	Soft.	1,122,000	6 to 20	1897.	.08⅞
C 12.	Green Jacket Shoals	"	39,951	16	1896.	.18
C 13.	Wickford Harbor	"	32,200	9	1896.	.157§
C 17.	Block Island	Sand.	5,000	10	1897.	.35
C 22.	New Bedford	Mud, sand and gr'v'l.	1,275,723	20	Estimate.	.12½
B 2.	Merrimac River	Bowlders.	1,250	7	1896.	$4 to $10
B 3.	Powas River	Prob'ly hrd.	26,795	5½	1896.	.39
B 8.	Lynn, Mass.	Not stated; prb'ly hrd.	40,000	8	1897.	.21⅞
B 9.	Mystic River	Hard.	26,000	6	1896.	.34½
F 16.	Passaic River	Not stated.	98,447	13	U S. Govern'm't.	.19½
F 18.	Elizabeth River	"	8,235	2	1897.	.34
F 20.	South River	"	18,500*	8	1897.	.24½
F 21.	Raritan Bay	So. Amboy channel.	223,000*	15	1897.	$0.19¾
F 21.	Raritan Bay	Seguim Pt. channel.	137,000	21	1897.	.16
F 22.	Mattawan Creek	Not stated.	14,400	4	.....	.18¾
F 23.	Keyport	"	12,000	8	Contract.	.18
F 25.	Shrewsbury River	Sand & mud	28,000	9	1897.	.28
D 1.	Pawcatuck River, Conn..	Soft.	30,000	6	Hartford Co., '97.	.23

* Scow measurement.
† Place measurement.
§ $16.50 for bowlders.
‖ Estimate by Colonel Gillespie for 35-ft. channel.

COST OF ROCK EXCAVATION UNDER WATER IN THE UNITED STATES IN 1896.

For details of projects see Appendix to Reports Chief Engrs., '96.	Location.	Material.	Amount. cu. yds.	Finish'd depth, M.L.W., ft.	Contract dated.	Cost, per cu. yd.
A 2.	Moosabec Bar, Me........	Ledge.	*630.7	16	1895.	$13.20
A 14.	Kennebec River	"	*2,166	15	1893.	12.47
	Kenebec River	"	957	15	1895.	9.87
A 21.	Cocheco River, N. H.	"	1,732	7½	1895.	6.20
B 10.	Boston Harbor	"	8,772	27	1894.	16.48
C 15.	Newport, R. I.	"	Not stated.	9	1895.	10.57
C 20.	Pawcatuck River, R. I. ..	Sand, grav'l & bw'ldrs.	8,815	8	1895.	.29½
CC 1.	Ohio River	Ledge,† bwldrs,&c.	15,147	......	1895.	.76
HH 12.§	Allouez Bay, Minn.	Rock excavation.	77,046	Nt statd	Not statd	1.30
HH 12.§	Brule River	"	32,500	"	"	1.50
HH 12.§	St. Croix River	"	51,254	"	"	1.30
HH 12.§	Totogatic River	Loose rock.	841	"	"	.60
D 15.	Port Chester	Ledge.	1,700	10	Contract.	40.00
G 21.	Wilmington, Del.	"	6,434	21	"	14.00
MM 10.	Ashtabula, Ohio.	Rock.	8 000	20	Estimate.	1.00
MM 11.	Conneaut, O.	"	11,000	20	"	2.00
NN 9.	Dunkirk, N. Y.	"	35,200	17	Contract.	2.50
PP 4.	Otter Creek, Vt.	Ledge.	11,060	8	Lynch & Co.	5.00

* Measured in place.
† 1,958 holes; 2,736 cu. yds. rock blasted.
§ Cash estimates; Maj. C. B. Sears.

COST OF ROCK EXCAVATION UNDER WATER IN THE UNITED STATES IN 1897.

For details of projects see Appendix to Reports Chief Engrs., '97.	Location.	Material.	Amount, cu. yds.	Finish'd depth, M.L.W., ft.	Contract dated.	Cost, per cu. yd.
A 19.	Cocheco River, N. H.....	Ledge.	1,300	7	1897.	$7.50
F 4.	Bronx River, N. Y.	"	1,300	6	1896.	6.89
A 5.	Sullivan Falls	"	Not stated.	10	1897.	16.48
A 14.	Kennebec River	"	1,300	10	1895.	9.87
A 15.	Sassanoa River	"	800	Nt statd	1897.	10.48
A 2.	Moosabec, Me.	"	800	"	1897.	13.75
B 10.	Boston Harbor	"	8,772	27	1896.	16.48

COST OF CONCRETE IN THE UNITED STATES.

Tables covering the cost of concrete in different localities in the United States cannot be very accurate, owing to prevailing conditions and the varying expense of transport of the different materials used. The following table, compiled by Mr. T. Jenkins Hains, for the use of the Nicaragua Canal Commission, is issued with this caution. It will give a general idea of cost, and by reference to the several projects the engineer and contractor can gain much useful information relating to this important factor in construction:

COST OF CONCRETE IN THE UNITED STATES. (Copyright, 1898, by T. Jenkins Hains.)

For reference project, see Appendix Report of Chief of Engin'rs.	Location.	Amount, cu.yds.	Kind of cement.	Machine or hand-made.	Done by Gov'm't or contract.	Cost, per cu. yd.
1893.						
1 A.	Mortar bat'ry, N. Y. harbor	13,827	Natural.	Machine.	Gov'm't.	$5.11
1 A.	Mortar bat'ry, N. Y. harbor	13,823	"	"	"	4.23
HH.	Great Kanawha, W. Va....	3,081	Portland	Not statd.	Contract.	7.25
HH.	Great Kanawha, W. Va...	1,819	"	"	"	7.50
Report.	12-in. gun bat., N.Y. harbor	26,852	Natural.	Machine.	Gov'm't.	5.20
2 B.	Mortar bat., San Francisco	528	"	"	"	4.18
2 A.	9-in. gun bat., S. Francisco.	10,547	"	"	"	5.22
1 B.	Gun lift, N. Y. harbor.....	39,000	"	"	"	4.136
1889.						
NN 4.	Buffalo harbor	120	Portland	Hand.	"	8.75
NN 4.	Buffalo harbor	2,054	" in blks.	Hand.	"	[1]6.305
1894.						
Report.	Battery at Portland, Me...	4,088	Natural.	Machine.	"	4.95
"	Magazine, New York harbor	10,362	"	"	"	4.166
"	Torpedo shed	253	Nt statd.	Hand.	"	8.022
"	10-in. gun bat., N.Y. harbor	9,489	Natural.	Machine.	"	3.55
4.	Mortar bat., San Francisco	7,625	Portland	"	"	4.89
1897.						
EE 10.	Rough River, Ky.	3,680	Natural.	"	"	[2]6.78
EE 13.	Green River, Ky.	13,600	....	Estimate	"	9.00
FF.	Big Sandy, Ky.	746	....	Machine.	"	4.45
DD 1.	Locks, dam, Monongahela R.	4,686	Natural.	Not statd.	Contract.	5.29
"	" "	9,557	Portland	"	"	7.39
"	" "	4,686	Natural.	"	"	8.00
"	" "	9,557	Portland	"	"	10.00
"	" "	5,796	Natural.	"	"	4.23
"	" "	9,402	Portland	"	"	11.00
DD 7.	Herr Island, Allegheny R..	3,363	Natural.	"	"	3.59
DD 7.	Herr Island, Allegheny R..	12,341	"	"	"	4.99
1896.						
C 3.	S. e coast of Massachusetts	Not statd.	....	"	Gov'm't.	4.40
I 3.	Hampton Roads, Va.......	"	Nt statd.	Machine.	"	7.29
J 3.	Coast of North Carolina...	723	"	Not statd.	"	7.83
K 3.	Coast of South Carolina...	435	Nt statd.	Not statd.	Gov'm't.	$7.59
M 3.	" " " ...	6,800	"	"	"	5.13
"	" " " ...	47½	"	"	"	6.66
"	" " " ...	590	"	"	"	8.25
R 3.	San Diego, Cal.	352	"	Hand.	"	4.71
"	" " "	80	"	Machine.	"	4.00
"	" " "	628	"	Hand.	"	4.71
"	" " "	3,849	"	Machine.	"	4.00
"	" " "	241	"	Hand.	"	5.39
S 3.	San Francisco, Cal.	776	....	Asph'ltic cncret.	"	10.39
"	" " "	495	Portland	Hand.	"	5.34
"	" " "	1,319	"	"	"	8.14
CC 7.	Muskingum River	1,040	Nt statd.	"	"	5.67
CC 7.	Muskingum River	17,013	"	" in plce.	"	5.70
DD 7.	Herr Island, Pittsburg	11,987	Natural.	Not statd.	"	4.09
EE.	Ohio River	4,822	....	"	"	4.00
TT.	Great Kanawha, W. Va. ...	3,640	....	"	"	4.38
GG 5.	Rough River, Ky.	1,860	Natural.	Machine.	"	[3]7.50
HH.	St. Croix, River	550	Portland	Not statd.	"	6.00
HH 9.	Marquette, Mich.	Not statd.	"	Hand.	"	4.57
HH 9.	Marquette, Mich.	"	Natural, in blks.	"	"	4.72
MM 13.	Ohio Canal	Not statd.	....	"	"	5.00
TT 17.	Columbia River, Ore.	4,656	Portland	"	"	6.25
TT 17.	Columbia River, Ore.	11,174	"	Machine.	"	6.25
JJ 6.	Illinois & Mississippi Canal	2,831	Nt statd.	Hand hird lbor	"	6.96
"	" " "	2,513	....	"	"	8.03
"	" " "	2,676	....	"	"	7.38
"	" " "	2,694	....	"	"	7.99
"	" " "	2,295	....	"	"	7.52
L 9.	Congaree River, S. C.	1,500	....	Estimate	"	8.00
O 9.	Coosa River, Ga.	10,079	....	Machine.	"	5.225

[1]Total cost, including all accessories, $7.54 per cu. yd.
[2]Cost, including plant, $10.62 per cu. yd.
[3]Cost, including plant, $9.45 per cu. yd.

A 557-FT. TELEPHONE SUBWAY UNDER THE HARLEM RIVER, NEW YORK CITY.

Early in January of the present year a timber subway or conduit, to be used to convey telephone trunk lines under the Harlem River, was successfully placed, and the construction and launching of this submarine conduit, involving, as it did, a

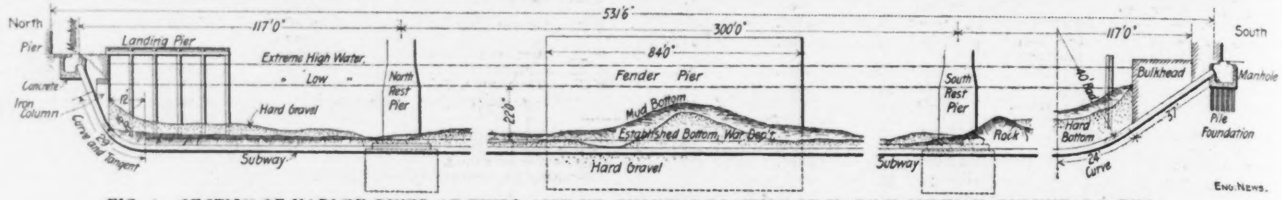


FIG. 1.—SECTION OF HARLEM RIVER AT THIRD AVENUE, SHOWING POSITION OF MARINE SUBWAY, BULKHEADS, ETC.

number of novel features, affords an interesting example of the difficult problems presented to the modern telephone engineer.

The need for such a subway followed the rapid growth of the Borough of the Bronx, the extensive use of the telephone and the constant risk of interruption of the service resulting from the anchoring of boats in that vicinity, the latter making it necessary to construct some protected form of conduit. This work naturally devolved upon the Empire City Subway Construction Co., which is the construction department of the allied telephone and telegraph companies of New York city. Starting from the intersection of 130th St. and Third Ave. (Fig. 1), just east of the New Third Avenue Bridge, the subway crosses to 134th St. and Third Ave., the exact horizontal distance being 531 ft. 6 ins. Owing to the ends being turned up to get above the water level and prevent flooding, the actual length of the conduit is 557 ft. The idea of a concrete conduit using divers in its construction, and afterwards pumping out the ducts was considered, but abandoned in favor of the wooden structure recently placed.

This, as will be seen from Fig. 2, has an elliptical cross-section 25 × 19 ins., built up of 10 Georgia pine planks 12 × 3 ins., and 8 4-in. wrought-iron pipes, surrounded with ⅛-in. of rubber asphaltum, and spliced with screw couplings. In building the subway the planks were grooved by machinery, creosoted, and spiked about the pipes, as indicated in the figure, one plank at a time, care being taken to break joints. In building the curved ends the planks were cut on the proper curve and grooved by a pendulum device with a length equal to the radius of curvature. As the building progressed wires were run through the ducts for use in drawing in the cables when the time came. In screwing up the sections of pipe forming the ducts the following method was adopted to prevent damaging the asphaltum coating put on the pipes to prevent corrosion should any salt water soak or leak through the planking. This is shown in Fig. 5, in which it will be noticed that an ordinary 4-in. screw coupling had a wrought-iron band shrunk upon one end to prevent splitting, while the other end was intentionally split and provided with a clamp ring. A short section of pipe was screwed into the solid end, while the split end was screwed upon one end of a section composed of several lengths of pipe screwed together loosely by hand. The bolts of the clamp ring were then firmly set, thus locking the short length to

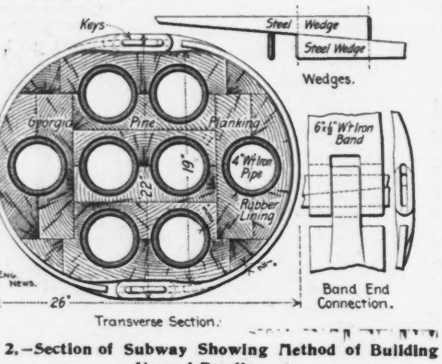


Fig. 2.—Section of Subway Showing Method of Building Up and Banding.

the main pipe. Chain wrenches were then used upon this end in the usual way.

After the planks were spiked in place, iron straps 6 × ½-ins. were placed every 3 ft. 6 ins. c. to c., and the whole bound up very tightly by long taper keys or wedges, Fig. 2. On the curved sections at each end these straps were placed only 2 ft. 6 ins. c. to c. It was considered advisable to keep the interior of the ducts dry, and this reason, coupled with the facts that there was a tide of several feet at this point, and the considerable length of the conduit made it necessary to construct the subway in sections.

On the south bank of the Harlem, and extending from some distance back of the present bulkhead line to the south rest pier of the draw of the Third Avenue bridge, piles were driven and ways built. These were inclined at such an angle as to have their lower ends just under water at low tide. On these ways a floor was placed and the three sections built as described. These points, as well as the general construction of the conduit, are well shown in Figs. 3 and 4. The two curved sections, 220 ft. in actual length, were built each side of the straight section, which was 117 ft. long, and when finished the ends were tipped up by derricks, as shown in Fig. 4.

Returning for the moment to Fig. 1, which shows the position of the subway, relative to the bridge, it will be noticed that for its entire length it is 22 ft. below mean low water, or 2 ft. below the bottom established by the United States Government. This depth was considered necessary for proper protection, and it required dredging from shore to shore. The original estimate for this called for the excavation of about 5,000 cu. yds., but as the work progressed it was found necessary to make the ditch much wider than anticipated owing to the wash from the bottom, and some 12,000 cu. yds. were removed. In this work considerable difficulty was experienced, and in places blasting had to be resorted to. Fully two months were occupied in the work, and at the time of launching the conduit the trench had an average depth of 8 ft. below the mud bottom. The line ran so close to the bridge that it was necessary to cut out a section of the fender pier through which the dredge and other apparatus could pass.

As already stated, the conduit was built in three sections. This necessitated the making of two splices, which had to be as rigid as the conduit itself. Fig. 5 represents the plan adopted, while in Fig. 7 are shown two sections about to be joined. Heavy cast-iron coupling plates were forced on the ends of the 8 wrought-iron ducts, which were afterwards expanded into suitable countersinks. The dowel pins for centering and the deep keyways can also be seen in Figs. 6 and 7. It was at first intended to use heavy screw bolts, but this idea was given up in favor of the wedging bolt.

The ditch ready and the sections finished, the work of launching was begun. A floating derrick was towed up to the end of the ways at low water and the curved end of the north section was raised to a vertical position. A rope rove about a windlass on a dredge anchored in midstream was at-

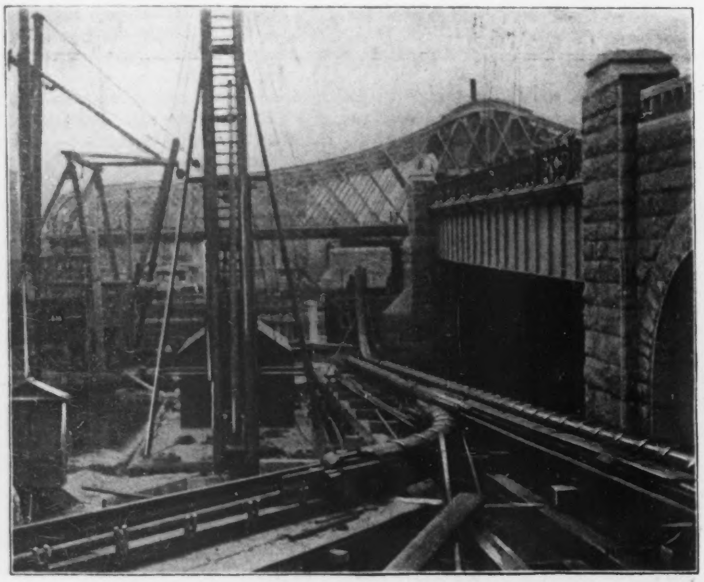


FIG. 3.—GENERAL VIEW SHOWING SUBWAY IN PROCESS OF CONSTRUCTION, THE LAUNCHING WAYS AND THE THIRD AVENUE BRIDGE.

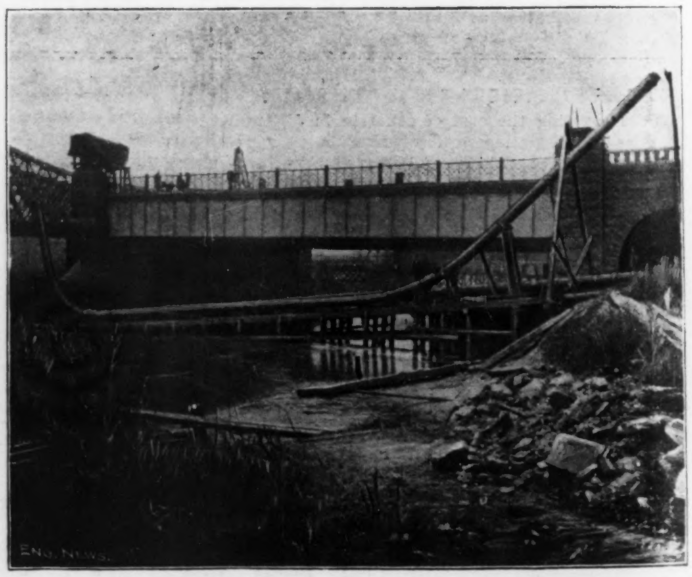


FIG. 4.—THE THREE SECTIONS FINISHED AND READY FOR LAUNCHING.

tached to the end of the section, while a hold-back rope was taken on to the south shore. In this way the section was slowly drawn out, the curved end being gradually lowered to keep the conduit in line with the ways. When the coupling end was opposite the end of the second or straight section the latter was shifted over into line, the "drawing in" wires were spliced, a thin sheet of rubber was placed between the plates, and the bolts were dropped into place and wedged up tight. The launching was then continued until the sec-

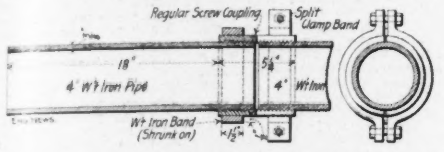


Fig. 5.—Device Used for Screwing Up the 4-In. Wrought Iron Pipe.

ond length was out, when the second splice was made. The last section had been built directly over the trench in which it was to rest, and the ways were so constructed as to permit it to be lowered directly into position.

The weight of the structure per running foot was about 230 lbs., or a total of about 128,110 lbs. The displacement was such, however, that when

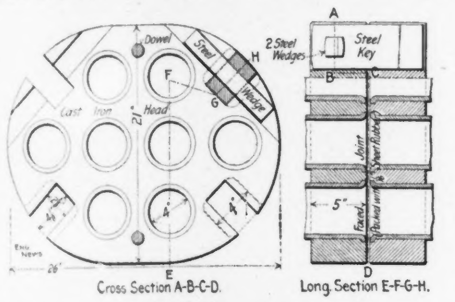


Fig. 6.—Coupling Plates at Ends of Sections and Bolts Used in Clamping Together.

immersed in the water this was reduced to only 28 lbs. per ft. Thus it was only necessary to support 14,000 lbs., or 7 tons, when all but the turned-up ends of the conduit were submerged. After the conduit was in place, the trench was allowed to fill up. Water-tight brick manholes 6 × 6 × 6 ft. were constructed about the ends to house the

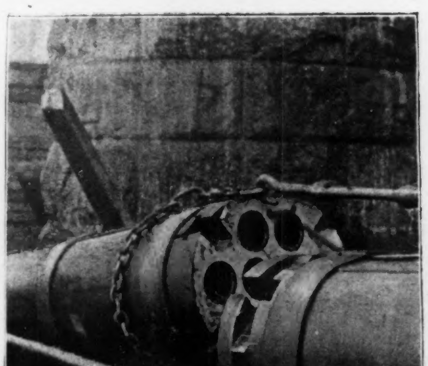


Fig. 7.—View Showing the Ends of Two Sections Ready to be Joined.

cable terminals. To test the tightness of the ducts they were used as speaking tubes.

The iron wire put in the ducts during construction will later be used to draw in a hemp rope, which in turn will serve to haul in the 3½-in. cables, each containing about 200 insulated wires. After these cables are placed the ducts will be filled with some oil, with a specific gravity greater than water, to prevent sweating and any possible chance of small leaks at the joints.

The plans for the work were developed by Mr. Robert Wier, Chief Engineer of the Empire City Subway Construction Co., who also had supervision of the construction. The dredging and work of launching was done by Mr. E. C. Moore, Contracting Engineer, 130 Pearl St., N. Y. We are indebted to Mr. Wier for the information, photographs and drawings from which this article has been prepared.

THE EXPOSURE FIRE IN THE FIFTEEN-STORY, FIRE-PROOF VANDERBILT BUILDING, NEW YORK CITY.

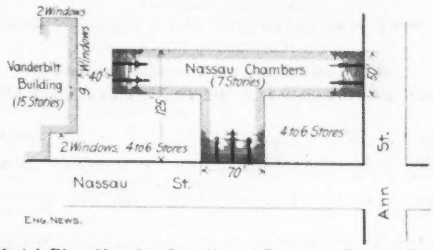
Early in the evening of Feb. 11, the destruction of a composite brick and wood building by fire subjected the adjacent 15-story, steel skeleton Vanderbilt Building, fronting on Nassau St., in the block bounded by Nassau, Ann, Beekman and William streets, New York city, to a severe exposure fire. The accompanying sketch plan shows the relative location of the Vanderbilt Building and the buildings destroyed and injured by the fire, and an examination of the burned buildings after the fire brought out the following information concerning the damage done by the flames.

The fire started in the "Nassau Chambers," a seven-story building with brick walls and timber floors, supported on cast-iron columns. This building, with its contents, was entirely burned out, leaving in position only the outer walls and portions of the floors at the ends. The flames burst through the roof and were carried by the wind against the Vanderbilt Building, and the neighboring four and five-story brick and wood buildings occupying the area between Nassau St. and the Nassau Chambers. Only the rear ends of these smaller buildings suffered much damage, and they contributed very little, if anything, to the heat which attacked the Vanderbilt Building. In the Nassau Chambers the lower floors were occupied by a bicycle store, clothing store, stationery store and the salesrooms of the Derby Desk Co., besides smaller stores, and the upper floors were devoted to offices of various kinds. From all evidences the fire seems to have been very hot, and to have spread very rapidly in this building.

From the sketch it will be seen that one corner of the T formed by the Nassau Chambers approached to within about 40 ft. of the exposed side of the Vanderbilt Building, but no other portion came within from 100 ft. to 125 ft of it. This face of the Vanderbilt Building had on each floor nine windows protected by iron shutters, but none of these shutters was closed. Practically the only thing between the flames and the interior at these window openings was the window glass, and it was the breaking of this that admitted the flames to the rows of offices occupying that side of the building. The window framing, doors and finish in these offices and in the hallways were wood and the outer ledges of the windows exposed to the fire were also of wood. The effect of the fire within the Vanderbilt Building was briefly as follows:

Very little damage was done below the eighth floor. On the ninth floor the office in the southwest corner was badly damaged, the furniture and books being partly destroyed, and the other offices had the window framing and adjacent woodwork and furniture charred and scorched. On the tenth floor the damage was the most severe. Here the flames had deeply charred the woodwork and furniture, burned the papers and books badly, peeled the plaster from the walls and ceiling, and burst through into the hallway and scorched the woodwork on the opposite side. The center of the greatest heat was about opposite the adjacent arm of the Nassau Chambers, and it apparently decreased both right and left from this point. On the eleventh floor the relative location of greatest and least damage was about as on the tenth floor, but the damage was very much less, the flames having hardly reached the partition between the offices and the hallway. The damage was considerably less on the twelfth and thirteenth floors, and comparatively nothing above this point. Nowhere in the Vanderbilt Building, so far as could be seen, had any damage been done to the steel framework.

The fireproofing in the Vanderbilt Building was hard tile floor arches and terra cotta partitions and column protections. The outer walls were brick, backed by terra cotta tile. In two places on the tenth floor a ceiling tile was found broken through the bottom flange. At no point, except, possibly, on the tenth floor, did the structural fireproofing undergo what would be called a severe attack from the fire. It furthermore seemed quite probable from the examination made that



Sketch Plan Showing Location of Exposure Fire Suffered by the Vanderbilt Building in New York City.

if the iron shutters on the south and west fronts had been closed the flames would never have entered the building enough to cause any great damage. The estimated loss by damage done to the Vanderbilt Building is $6,000, and the tenants suffered an additional loss of about $4,500 on personal property.

PROGRESS OF THE NICARAGUA CANAL SURVEYS.

The following notes on the progress being made with the Nicaragua Canal Commission's surveys are condensed from a despatch to the New York "Times," dated at San Carlos, Jan. 23:

The hydrographic party, under Lieut. G. C. Hanus, U. S. N., and the surveying force, under Mr. G. W. Brown, were then both at San Carlos. After several trials in different localities and the encounter of almost bottomless swamps, Mr. Brown succeeded in establishing a base-line about three miles long, with an initial station in old Fort Carlos, but Mr. Brown has been called away as a witness in the Carter trial. Since Jan. 15, Lieut. Hanus has taken about 300 miles of soundings in the San Juan River, and is now supposed to be at work on Lake Nicaragua, on the crossing line of the canal route. This party will work its way down to the site of the Ochoa dam, where the regular soundings will stop.

Though the Commission started with $150,000, funds are running low, and to complete the surveys as planned will probably cost at least as much more. The previous Commission estimated an expenditure of $350,000 as necessary for a proper investigation of the canal project. The party in charge of the rainfall and evaporation investigation and the determination of limits of water shed will have to continue these investigations for at least 18 months, to be of any permanent value.

In connection with the rainfall observations the "Times" correspondent credits Admiral Walker with telling the following story on his colleagues: Col. Hains would prefer a heavy rainfall, as telling against the feasibility of the canal, to which he is supposed to be somewhat opposed; Mr. Menocal, Chief Engineer of the Maritime Canal Co., of course, favors a small fall for opposite reasons, and Prof. Haupt, of the Commission, is supposed to have charge of the rain-gages at Greytown. As the story runs, Col. Hains fills up the gage with water at odd intervals, and Mr. Menocal as industriously empties the same gage; and Prof. Haupt is distressed to find that while he is morally certain that it has rained considerably at Greytown, he has no official evidence of how often or how much.

THE SPEARFISH BRANCH of the C., B. & Q. R. R. was one of the most expensive pieces of railway work in this country, on account of the heavy work in getting over the Bald Mountains. The line is 31 miles long, extending from Englewood, So. Dak., to Spearfish, and has about 375 curves. The summit station, Portland, is 6,225 ft. above sea level. The grades are very heavy, and in descending the north side of the mountains the line has to be developed in loops in order to maintain a practicable grade. In the Spearfish canyon the upper track is 800 ft. above the lower track, and only 300 ft. distant horizontally from the latter. The loop is about 8 miles long, and effects a change in elevation of about 800 ft.

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In discussing from time to time the action of fires upon modern fireproof building construction, we have been at some pains to point out to engineers the danger of emphasizing matters of fireproofing or incombustible construction to the neglect of precautionary and protective constructions. The necessity of such warnings, it seems to us, is very clearly shown by the results of the fires which have within the same week damaged the fifteen-story fireproof Vanderbilt Building in New York city, and destroyed nearly $2,000,000 in property and 20 lives at Pittsburg, Pa. The nature and effects of both of these fires are described quite fully elsewhere in this issue.

So far as can be judged from the information which is available, both of these buildings seem to have been good examples of construction of their respective classes. The structural parts of the Vanderbilt Building were incombustible, and by themselves could not burn nor spread fire. If these were the only requisites of fireproofing little fault could be found with the fire-resisting qualities of this structure. To be habitable for business, however, such buildings must contain furniture and merchandise, and in a large city they are very likely to be surrounded by inflammable buildings of the worst type. It is because of these facts, as we have often explained, that fireproof construction of buildings in its broadest sense includes, besides the erection of a framework and walls, which will not themselves burn, precautionary and protective constructions against fire.

To the neglect of these constructions the Vanderbilt Building owes the damage done to its contents. It had, it is true, fireproof shutters at its exposed windows, but as these shutters were not closed at the time of the fire, and perhaps not since the building was erected, they might as well never have existed. This was, however, not the only instance of short-sightedness in protecting this building from fire. It had neither hose connections nor hose for fighting fire, and the quenching of a blaze on the fourteenth floor meant that the firemen must connect their hose to a street hydrant and carry a line up fourteen flights of stairs. Such conditions are not exceptional with this building, but exist in perhaps a majority of tall office buildings, the mere fact that they have put up a shell of incombustible steel and terra cotta seeming to be an all-sufficient excuse in the mind of the owners.

How poor an excuse this is it is made plain whenever a fire occurs in one of these buildings, but there is another feature of the question that it is well to notice more particularly. Without hose connections and hose on its different floors, the tall office building, with all its incombustible qualities, is clearly a worse structure in which to fight fire than an old-fashioned wooden floor building only four or five stories high. During the night, when fires in such buildings are most likely to gain headway, it is seldom that the elevators are running, and the firemen are thus obliged to carry their lines of hose from story to story. This is a task which attains pretty serious proportions at any time, and which may, under centain conditions of inconveniently-arranged stairways, and obstructions from smoke, be practically impossible, even with a fire of no very great proportions. In the comparatively insignificant Vanderbilt Building blaze the firemen were overcome by exhaustion and smoke in several cases during the work of getting their hose up the winding stairways to the eleventh floor.

In the Pittsburg fire, on the other hand, blame can hardly be laid upon the building construction for the disaster. It seems quite evident that if it had not been for the explosion of the stored whiskey and ammonia, the fire might never have spread beyond the building itself. The fact pointed out by our correspondent that there is always danger in storing such merchandise in large quantities in thickly built-up city districts is self-evident, and the recent Pittsburg fire is a forcible example of what may easily happen despite every reasonable precaution in constructing fireproof storage houses. What improvements might have been introduced to enable the firemen to cope more successfully with the flames it cannot be said without a detailed study of the conditions, but it would seem that in this case there existed one of those series of conditions which can only be met by insurance and a highly-drilled fire department.

Users of cast-iron pipe will be interested to know that the "cast-iron pipe trust" has been declared illegal, and the contract between the six companies composing the Associated Pipe Works pronounced void, by the U. S. Circuit Court of Appeals for the sixth circuit. The decision was rendened at Cincinnati on Feb. 14. The records in the case show that the companies forming the trust were as follows: The Addyston Pipe & Steel Co., of Cincinnati; Dennis Long & Co., Louisville; Chattanooga Foundry & Pipe Works, Chattanooga; South Pittsburg Pipe Works, South Pittsburg, Tenn.; Anniston Pipe Works, Anniston, Ala.; Howard-Harrison Iron Co., of Bessemer, Ala. The records also show that the trust had divided the country into "free" and "pay" territory. The free territory included New York, Pennsylvania and Virginia, and all States north or east of these; the pay territory included the balance of the country. The plan under which the trust operated was described in the brief for the government at the opening of the case in the lower court, as follows:

The six appellees above named have formed a combination, under the name of the Associated Pipe Works. They are powerful enough to control the market for cast-iron pipe in some portions of the United States and to control it partially in other portions—their only rivals in the latter case being certain companies whose output enables them to compete only to a limited extent.

These associated companies have divided the United States, for their purposes, into two portions. One of these is called free territory. The other is called pay territory. Certain municipalities are set apart under the name of reserved cities. Each of these municipalities is assigned to the care of some one of the six associates. The others cannot compete with it. For its monopoly it pays a premium or bonus into the pool. The rest of the pay territory is also deprived of the benefits of competition as between the six associates. When a contract for cast-iron pipe is to be awarded by any unreserved municipality, gas company, water company, railroad company, or other large consumer, the associates do indeed bid against each other for the contract, but the bidding is among themselves only, and not for the benefit of the consumer. The price has already been fixed by their own committee. The bidding is to decide which of the six shall obtain the contract. The highest sum bid is a premium or bonus which is paid into the pool, and divided up among the associates according to a prearranged schedule of proportions.

The details of the scheme will be more fully considered at a later point in this argument. It may be summarized as a successful attempt by companies having a partial monopoly of the cast-iron pipe trade in certain portions of the United States to abolish competition among themselves, so that the difference between the maximum obtainable price and the lowest price affording a fair profit shall go into the pool and be divided among themselves. The restraint is not placed upon the manufacture of the pipe, but upon the commerce in it, and this is every instance is inter-state commerce.

The government based its case on the testimony of the trust. It concluded its arguments as follows:

This secret and hypocritical combination is a violation of the anti-trust law. If necessary, it can easily be established that it is unlawful at common law, so that the only question that the Attorney-General would have had to consider, had the anti-trust law never been enacted, would have been whether the injury to the public was sufficient to justify his filing a bill upon general principles of equity, as in the Debs case.

These water pipes and gas pipes belong to the class of articles monopolies in which are especially disfavored by law. Every combination tending to prevent competition for public contracts is absolutely void. Combinations to divide up territory, and thereby maintain rates free from influence of competition, are void per se, at common law, and their validity does not depend upon the result of any inquiry as to the percentage of any profits actually obtained.

The court decided that the trust agreements were in violation of the common law because in restraint of trade, and that this was true without regard to the prices actually obtained; that the prices secured were at times unreasonable; that the trust was in restraint of inter-state commerce; and that it was in violation of the Federal anti-trust law.

The exact effect of this decision upon the price of cast-iron pipe in different sections of the country cannot be stated. In general, it would seem that water-works and various other public and private undertakings will be stimulated by it, and that it will be a great relief to thousands of officials upon whom rests the responsibility of awarding contracts; because for some years past many of these have been baffled in their attempts to secure what they believed to be fair prices for such cast-iron pipe as they have found it necessary to buy.

The supplying of water and gas to municipalities and their inhabitants are undertakings of such a nature that competition is virtually impossible; but in furnishing the materials necessary for building and operating the works that deliver these supplies another rule holds good.

In the first case, the monopoly feature should be recognized and the public be protected through proper government control. In the second case, competition is natural, and the public interests demand that every effort be made to secure it, in so far as such efforts will not so hamper the industries in question as to defeat the real objects of competition—the best goods or service at the lowest possible price.

In our description of the Boston Subway in our issue of Feb. 3, mention was made of the fact that the ties for the track were all treated with Woodiline. In the following issue, by a slip of the editorial pen, in reviewing the catalogue of another wood-preserving compound, it was stated that that compound was used for the Boston Subway ties. The former statement was the correct one, and the mistake in the "Trade Publication" notice was due solely to a "slipped cog" in the memory of a member of the editorial staff, and not to any unauthorized claims on the part of the rival manufacturer.

PLANS OF ENGLISH ENGINEERS FOR THE COOLGARDIE PIPE LINE.

We gave considerable space in our last week's issue to a description of the plans proposed for a water supply for the Coolgardie Mining District in Western Australia, and the report made upon the project by a commission of eminent English engineers.

The magnitude of the enterprise and the novel and difficult engineering problems involved, together with the fact that American engineers and contractors are likely to compete with English in carrying out this work, makes it a subject of no small interest on this side of the water.

Briefly stated, the engineering problem presented is the delivery of a supply of water, amounting to 5,000,000 gallons per day, to the arid gold mining district in Western Australia. This water is to be taken from a storage reservoir on the Helena River, in the mountainous district near the coast where rainfall is abundant, and it is to be delivered into reservoirs at Coolgardie, 328 miles distant, and at an elevation 1,330 ft. above the level of the reservoir from which the supply is taken. The water, of course, must be forced through the pipe and up this elevation by pumping; and as coal delivered at the pumping stations along the pipe line is estimated to cost on the average $7.68 per ton, it is an object to reduce the frictional head as much as possible, and to adopt economical pumping engines. In general, the plan proposed is to divide the pipe line into a number of sections, with a reservoir and pumping station at each section. In this manner the pipe line is nowhere subjected to a pressure greater than is frequently reached in ordinary water-works practice.

The general plan, as proposed by Mr. Chas. G. O'Connor, M. Inst. C. E., the Chief Engineer of the project, seems to be excellent in its conception and calculated to furnish the desired supply in a satisfactory and economical manner. The Government of Western Australia, however, felt that in an enterprise of such magnitude it would be wise to seek the advice of some eminent consulting engineers upon some of the features of greatest importance, and a report upon the pipe line and pumping machinery was, therefore, requested from a board of three engineers, Messrs. W. C. Unwin, Geo. F. Deacon and John Carruthers; Prof. Unwin's name is familiar on this side of the water as a writer on mechanical engineering topics, and Mr. Deacon, the engineer of the Liverpool water works, is hardly less well known here; Mr. Carruthers is an "M. Inst. C. E.," of a quarter century's standing.

The report of these engineers was published in our contemporary, "The Engineer," of London, for Jan. 28, and we abstracted it at length in our last issue. Doubtless the most important question which these engineers were asked to consider is the design of the pipe line, and their opinions make exceedingly interesting reading, to American engineers at least.

Cast-iron pipe was excluded from consideration at the outset, as its cost would be so great as to make the scheme financially impracticable. In considering the best kind of pipe to adopt for the line, certain controlling conditions should be borne in mind. One is that the country across which the pipe line will extend is an arid region, and the soil is impregnated with "salt," according to the engineers' report. Whether by this is meant sodium chloride or the ordinary alkaline salts usually present in the soil of arid regions, we do not know; but the latter is the more probable. In either case, however, any metal pipe is sure to be rapidly corroded unless it is protected at every point from contact with the soil. A second point to be considered is that the great length of the pipe line makes tightness an important matter. Slight leakage or evaporation from the surface of a porous pipe which would be too trivial for consideration upon a pipe line of ordinary length might amount to the loss of a considerable percentage of the total flow in a pipe line 328 miles long.

Turning now to the report of the Commission we find, first, an investigation of a pipe made up of a steel spiral embedded in concrete. They seem to have spent considerable time investigating this pipe, but arrive at the conclusion that at present they cannot recommend it. From this distance one is unable to see why such a conduit should be seriously considered at all for such a place. It will be evident that the steel spiral must be the sole reliance for strength to sustain the pipe against internal bursting pressure, hence no considerable economy in the amount of steel will be possible compared with a line made up of steel plates. A more serious objection, however, is the very small longitudinal strength of the pipe. With the great temperature changes of the Australian climate, expansion and contraction would seem quite likely to cause cracks in the concrete, the repair of which would be difficult, to say the least.

Next the Commission takes up another patent pipe, which is an ingenious device for avoiding a longitudinal weld or riveted joint in a pipe made of steel plates. The edges of the plate to be joined are inserted in grooves in a specially-rolled bar, and the joint is then rolled under pressure in such a manner that the bar is flattened, and a tight joint is, supposedly, made. There are two or three inventions of this class now being exploited in England. They may, perhaps, have merit for certain situations; but the only advantage it could offer over ordinary riveted pipe would be a possible small saving in cost. To employ any such untried invention on a work of such magnitude would be absurd. The Commission, in fact, confesses that until such pipes have been manufactured commercially and tested on a large scale, they are unable to recommend their use, though they strongly intimate that they would like to do so.

After shelving, temporarily at least, these two inventions, the Commission very properly dismisses spiral riveted pipe, and then takes up the discussion of the use of welded or riveted pipes. In order that we may present the Commission's opinions fairly, we quote this portion in full:

> Pipes with gas-welded longitudinal joints are undoubtedly the best. They are stronger for a given thickness than riveted pipes, and having a smooth surface, they present less interruption to the free flow of the water. But the immunity from possible leakage at joints is a still more important advantage. Per unit of length they are somewhat more expensive than riveted pipes, but being about 30% stronger for equal diameter and thickness, it is actually cheaper to employ them wherever the necessary thickness of the riveted pipe is at least ¼-in., below which thickness welded pipes become difficult to manufacture of the required diameters.
>
> We therefore recommend that those pipes which will be subject to the heavier pressures, and which therefore require a thickness of ¼-in. or more, should have two gas-welded longitudinal joints, and that they be made in tubes of about 14 ft. length, coupled into pipes of about 28 ft., by inserting a plain end of one tube into a socket formed on the other tube, the transverse joint being riveted. Welded tubes can be manufactured of somewhat greater length, and it would be desirable that they should be as long as possible, because it would reduce the number of joints and the possible points of leakage. We understand, however, that lengths greater than 28 ft. would be inconvenient for carriage on the Western Australian railways.
>
> The riveted pipes should be made with only one longitudinal joint, each "ring" or "tube" being therefore formed of a single plate. The greater part of the aqueduct will consist of such pipes, 28-in. to 30-in. diameter and 3-16-in. thick, and the greatest length of the tubes of which such pipes are made up will be about 5 ft. 6 ins. The longitudinal joints should be double-riveted lap joints, and those of contiguous lengths should not fall in one line. Each tube should be made of the maximum length that can be obtained from a single plate. These tubes should be single, riveted together into lengths convenient for transport. The question of the connection of these lengths will be dealt with in our final report. The tubes may be made of uniform diameter, butt-jointed, with single-riveted covering rings. This, however, involves two rows of rivets at each transverse joint, two circular joints to be calked which can be calked only at the outer edges, and special difficulty of calking and rendering water-tight where the ring covers the overlap of the longitudinal joints. As there are two other ways of making the transverse joints, either of which is less liable to these objections, we do not recommend butt joints. One of these ways is to expand one end of each tube, thus forming a socket to receive the plain end of the next tube, and to join the two by single riveting. The other plan is to construct the tubes alternately of larger and smaller diameter, the diameters differing by twice the plate thickness. Each larger tube will then overlap the smaller tubes at either end, and will be connected therewith by single riveting. Having regard to all the circumstances, we recommend that the riveted pipes should be constructed of tubes of alternately larger and smaller diameter. In coming to this conclusion we have, of course, considered the increased hydraulic resistance, which we are satisfied is unimportant.

The grounds upon which the above recommendations are based are by no means clear in every case, and some of them are still a puzzle to us. For example, pipe made up with "two gas-welded longitudinal joints" is not a well-known product on this side of the Atlantic. We can only conjecture that the Commission desires a thinner pipe than can be made in so large sizes by the ordinary lap welding process, and they have in mind some English process by which a welded joint is made by heating the edges of the plate to be joined. This process, the Commission says, however, is not applicable to pipes of such large diameter made of plates less than ¼-in. thickness. Hence for the principal part of the conduit they recommend a riveted pipe of 3-16-in. plates.

One is next puzzled to know why they limit the distance between circumferential joints to 5 ft. 6 ins. At first sight the simplest and cheapest way to make such a pipe would seem to be to take an 8-ft. wide plate, bend it into a tube, and rivet up the longitudinal joint. But there are two difficulties to be met. The first is that rolling such thin plates in such widths is quite difficult, and when attempted the spring of the rolls is apt to make the plate considerably thicker in the middle than on the edges. The second is that the size of the fixed stake of the riveting machine limits the length in which riveted pipes of such small diameter can be made. We presume the Commission have based their recommendations on what English rolling mills and riveting machinery can do. Possibly American manufacturers can do better; if so, they should not fail to make their ability to do so known.

It should be said, however, that the saving in frictional resistance by cutting down the number of circumferential seams will not be so great as might at first sight be supposed. It will be seen by those who carefully study the Commission's recommendations that they have adopted an exceedingly large size of pipe for the volume of water they propose to deliver. The velocity of the water flowing in the pipe will be only about 1 3-5 ft. per second, and this reduces the friction head so much that the difference between riveted pipe and smooth pipe is no very great amount. We assume that the Commission determined by careful compilations that the extra cost of the larger pipe was warranted by the saving in pumping expenses due to the decreased hydraulic resistance.

The Commission describes with much detail the method of treating the pipe to protect it from corrosion, a very proper precaution, considering the thinness of the pipe and the alkali deserts through which it is laid. We believe, however, that they might learn some valuable lessons by studying American experience in this field, which has been far more extended than experience in all the rest of the world combined, if we mistake not.

Notwithstanding the elaborate precautions which are proposed against corrosion, the Commission recommends that the pipe should be laid upon the surface of the ground, and this is, perhaps, the most surprising statement in the whole report. We know of no instance where a continuous riveted pipe of considerable length is exposed to any such extremes of temperature as would exist in the case of the Coolgardie line. We are informed that computations show a strain in metal between the rivet holes in circumferential seams of riveted pipes equal to about 16,000 lbs. per sq. in. from a change in temperature of 50°. That a much greater variation in temperature than this would occur in a pipe exposed to the sun on the arid plains of West Australia is beyond question, and that such strains must inevitably cause loosening and leakage at the riveted joints seems almost equally sure. The water cannot be relied upon to equalize the temperature, for the very great distance between pumping stations will cause the water to be heated or cooled to the temperature of the pipe itself, whatever that may be, in the course of its journey, provided the latter is exposed on the surface of the ground as is proposed.

Space forbids us to criticise further the recommendations of this report in detail; but enough has been said, we believe, to make clear the fact that it would be much to the advantage of the Colony to either employ American engineers to advise it regarding its great enterprise, or else insist that its English advisers shall thoroughly study American practice in the construction of long pipe lines.

Nothing is said whatever in the report concerning the use of wood stave pipe; very likely the eminent English engineers had never heard of its use in this country. We cannot pretend to say, of course, that such pipe would be the best for the Coolgardie line; but its extended and successful use here under conditions in many respects quite similar to those which exist in Australia makes it entirely certain that no investigation can claim to be complete that does not examine into the merits of this class of pipe.

As to its durability, it seems safe to say that it would be at least as durable as a 3-16-in. steel pipe laid on salt or alkali soil. Wood stave pipes which have been in use for 30 years in this country are still in good condition. The smooth interior surface of wood pipe results in less hydraulic friction than in any kind of iron pipe. Wood stave pipe could be built either of the native Australian woods or from the redwood of the Pacific coast, which could be delivered at Australian ports at a much smaller freight cost than would be charged on iron pipe. It could be built with native labor, and the cost of contractors' plant would be trifling compared with the cost of a plant for riveting-up steel pipe, dipping it, and relaying it.

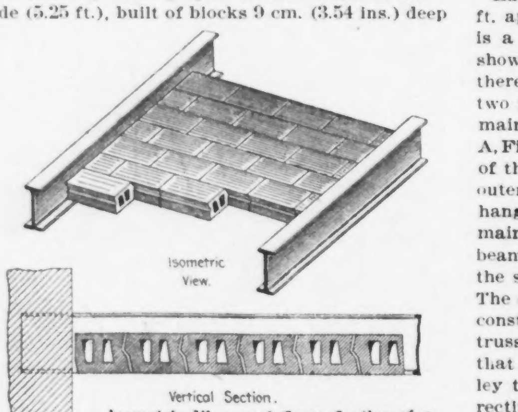
It would probably be inadvisable to use wood pipe for the parts of the line subjected to heaviest pressure; and American practice, as our readers well know, is to use steel pipe where the head is over 100 ft. or so. The Coolgardie pipe line, as planned, however, consists of a series of steep lifts at each pumping station, followed by a long down grade to the next pumping station, and an examination of the profile in our last issue will show that three-fourths or more of the line is under no pressure which would interfere with the use of wood pipe. The saving in cost which would result from the substitution of wood stave pipe for three-quarters of the line we shall not attempt to estimate; but we believe it is well worth looking into.

The published estimate for the whole enterprise is the very considerable sum of $12,500,000. Roughly speaking, the works to be built for this sum consist of the pipe line, 328 miles in length, pumping machinery to the amount of 3,000 HP., nine pumping stations with small reservoirs at each, and one large dam and storage reservoir at the source of supply. Our readers who are familiar with the cost of such construction can compute for themselves and form their own opinion as to what saving could be made by the use of wood pipe. The published estimate of the cost of the steel pipe, laid, is $9,150,000. The quantity is estimated at 90,000 tons.

Our latest information is that the West Australian Government has not yet been able to float the large bond issue which it offered to raise funds for this work at the rate of interest which the Colony was willing to pay; and matters are consequently at a standstill. Under these circumstances, the Colonial officers, if they desire to carry out their great enterprise, would do well to turn toward this country for aid. It is by no means impossible that they can obtain plans and advice here which will enable them to carry out their scheme at a saving of millions of dollars compared with the plans proposed by the English engineers, and at the same time to utilize in the work to a large extent their own home labor and materials.

A GERMAN IDEA IN TILE FLOOR CONSTRUCTION.

We illustrate herewith a peculiar fireproof floor construction, which has been extensively used in Germany, but which impresses an American engineer as a very unstable construction at first sight. In fact it was only after considerable study that we were able to understand how such a construction would stand up at all. Stand up, it certainly does, however, for a publication issued by the patentees of the system gives a long list of private and public buildings in Germany where it has been used. The circular illustrates also a test of this system in which a section of this floor of 1.15 m. span (3.77 ft.) entirely open on the sides, and 1.60 m. wide (5.25 ft.), built of blocks 9 cm. (3.54 ins.) deep



Isometric View and Cross-Section of a German Fireproof Floor.
Patented by Otto Forster, City Engineer, Weringerode, Prussia.

was loaded to the breaking point and carried a load of 11,000 kg. (24,250 lbs.), equivalent to about 1,200 lbs. per sq. ft.

It will be seen that the construction is not an "arch" in any sense, and its strength is due merely to the transverse strength of the hollow tiles of which it is made. The system is the invention of Otto Forster, City Engineer of Weringerode, Prussia, and has been patented in all countries. Tile manufacturers in half a dozen German and Austrian cities are equipped to make the peculiar shaped tiles that are used. The firm of Robert Heinrich, of Dresden, are contractors for the erection of this type of floor in buildings.

THE TOWERS AND END SPANS FOR THE NEW EAST RIVER BRIDGE.

(With two-page plate.)

The drawings on our two-page plate this week show the general details of the steel towers and end spans for the New East River bridge now under construction about 1½ miles above the present New York and Brooklyn Bridge. As stated in a previous article (Eng. News, July 30, 1896), this bridge will be 7,200 ft. long between terminals and will cross the river with a center span 1,600 ft. long. The cables, four in number, and each 17½ ins. in diameter, are supported by anchorages and two steel and masonry towers, and will carry between the towers a lattice stiffening span, on which are the railway tracks, carriageways and foot walks. Between the towers and the anchorages, however, no weight will come upon the cables, the necessary spans being supported independently by the main towers and anchorages and by intermediate towers about midway between. Fig. 1 shows the nature of this construction and is also intended to explain the location of the parts shown in more detail on the two-page plate and by the accompanying cuts.

In our issue of May 27, 1897, the caisson foundations and masonry portions of the main towers were described in detail, and in our issue of Sept. 9, 1897, a similar description and drawings of the anchorages were published. The illustrations of the steel towers and end spans which we publish in this issue are reproduced direct from the engravings accompanying the specifications, and from the body of the same specifications we select the following information as being of chief interest in connection with the drawings. Proposals for constructing the towers and end spans complete, except for the anchorages and foundations for the main towers, will be received Feb. 28, 1898.

End Spans.

Each "end span" will consist of two spans, namely, the cantilever span B C, supported by the anchorage and the intermediate tower, and the connecting span A B, carried by the main tower and one end of the cantilever span (Fig. 1). Figs. 3, 4 and 5 show details of the trusses at B, C and D. It will be noticed that the trusses of the intermediate span are connected to the main stiffening truss between the main towers. The chord and web construction and the supporting pedestals and shoes are shown fully by this and the remaining engravings.

Each span consists of two main trusses, spaced 67 ft. apart, c. to c. At each lower panel point there is a plate girder floor beam of the construction shown by Fig. 6, and at each upper panel point there is a transverse cross frame or truss carrying two floor beam-hangers, which give support to the main floor beam immediately below, as shown at A, Fig. 6. These hangers also support the inner ends of the foot walk floor beams (B, Fig. 6), while the outer ends of the same beams are carried by short hangers suspended from the intersection of the main truss web members (A, Fig. 4). The main floor beams carry the columns X and Y, which support the stringers carrying the elevated railway tracks. The carriageways are carried by cantilever bracket constructions of the floor beams outside of the main trusses. Referring now to Fig. 6, it will be seen that the roadways occupy the space D E; the trolley tracks, the space D A, with the foot walk directly above at B C; and an elevated railway, the space B F. This arrangement is duplicated on the other half of the space. A system of bottom lateral bracing and the proper portal bracing systems complete the main features of the end span framing proper.

Intermediate Towers.

The essential structural details of this tower are shown by Fig. 7. The steel work is supported on a foundation consisting of masonry piers resting on a pile and grillage foundation. These piles are required by the specifications to be driven until a blow from a 4,000-lb. hammer, falling 15 ft., causes a penetration of no more than 2 ins. The grillage consists of two layers of 12×12 ins. timbers laid at right angles to each other and thoroughly drift bolted together. The top of the platform will be leveled off with a bed of concrete, upon which the masonry will be laid. To this masonry each foot casting of the tower will be fastened by a steel anchor bolt 2½ ins. in diameter passing down into the concrete and having a cast-washer at its bottom.

The construction of the steel work of the tower is clearly shown by the several drawings of Fig. 7, and need not be described further here.

Main Towers.

For illustration the main towers have been divided into four sections, A, B, C and D, Fig. 1, and Figs. 8, 9, 10 and 11 show the details of each section. These towers are 309 ft. 8½ ins. high from the top of the masonry to the center of the cable over the tower. Each tower consists of eight columns, braced together laterally in all directions. At about the floor level there is a system of girders to support the end spans, and the ends of the stiffening span between towers. At the tops of the towers there is another system of girders on which will

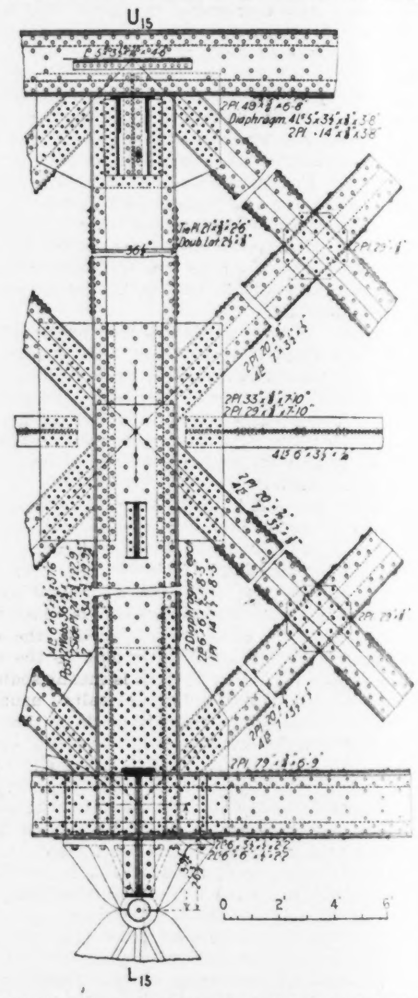


Fig. 5.—Details of Cantilever Span at Intermediate Tower.

rest the saddles with their friction rollers ready to receive the cables. All this framing, except the system of girders at the floor level, is shown by Figs. 9 to 11, inclusive.

The system of girders at the floor level consist of the trusses A A and the girders B and C, located as shown by Fig. 1. The trusses A A, are 14 ft. deep, c. to c. of chords, with a web system consisting of vertical posts and intersecting diagonals, and the girders B and C are plate girders. Girder C is 40 ft. long and 8 ft. 3¾ ins. deep, and carries the ends of the trusses A A, while girder B braces together the trusses A A at the line of main stiffening truss and are 17 ft. 4 ins. long and 8 ft. 6½ ins. deep.

Fig. 12 shows the construction of the saddles, friction rollers, column pedestals and other cast steel work for the main towers.

Material.

The following are the specifications for the steel and other metal work of the towers and end spans:

Steel.—All steel shall be acid open hearth, made by a process and from stock satisfactory to the engineer, and

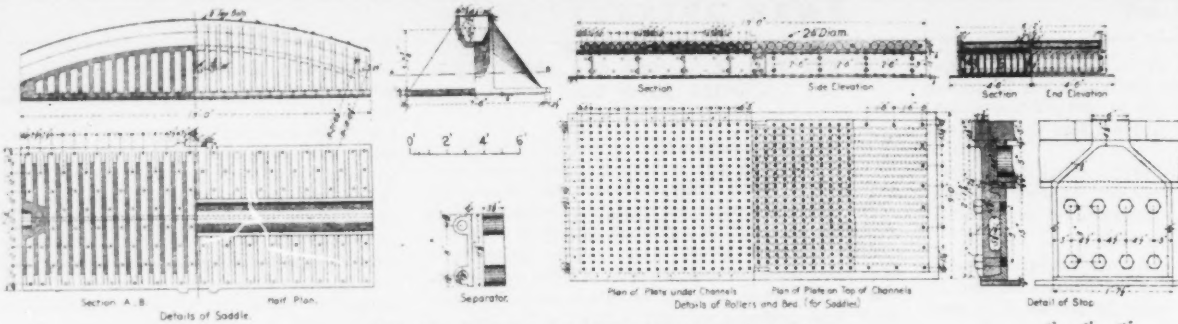


FIG. 12. DETAILS OF SADDLES AND BEARINGS.

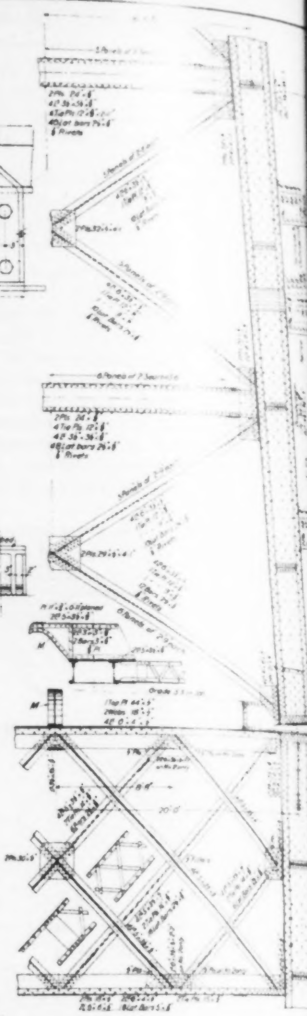


FIG. [cut off]TAILS OF MA[cut off]

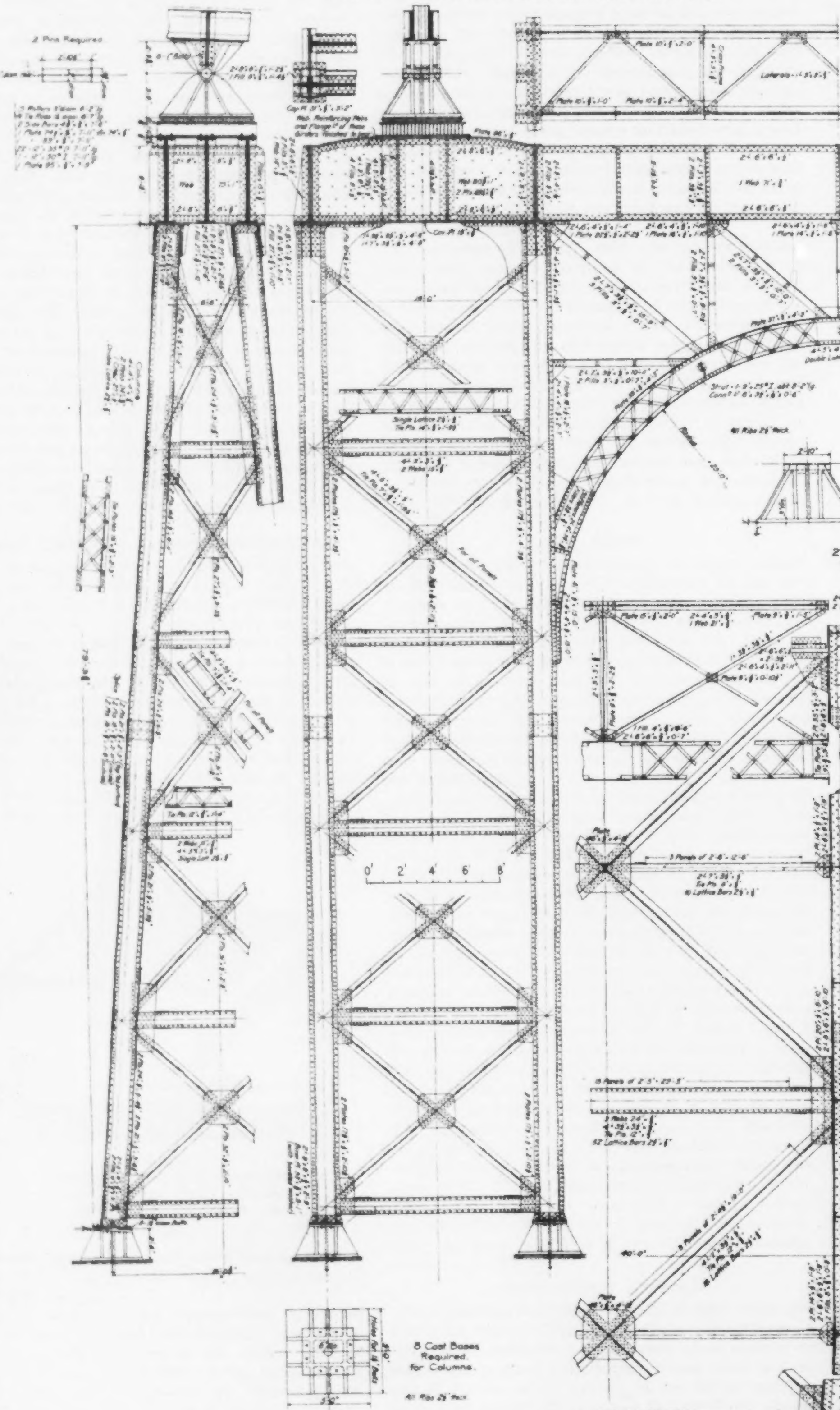


FIG. 7. DETAILS OF INTERMEDIATE TOWER.

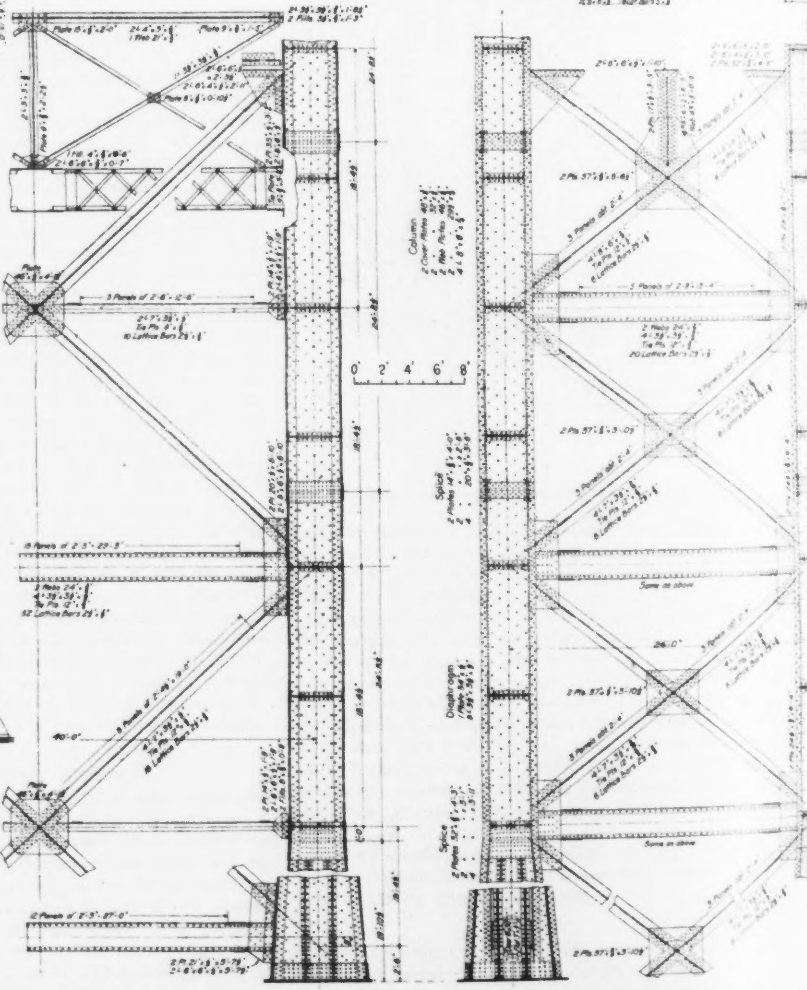


FIG. 8. DETAILS OF MAIN TOWER BELOW FLOOR LINE.

MAIN AND INTERMEDIATE TOWER[cut off] FOR N[cut off]

L. L. Buck, M. Am. Soc. C. E., Chief Engineer.

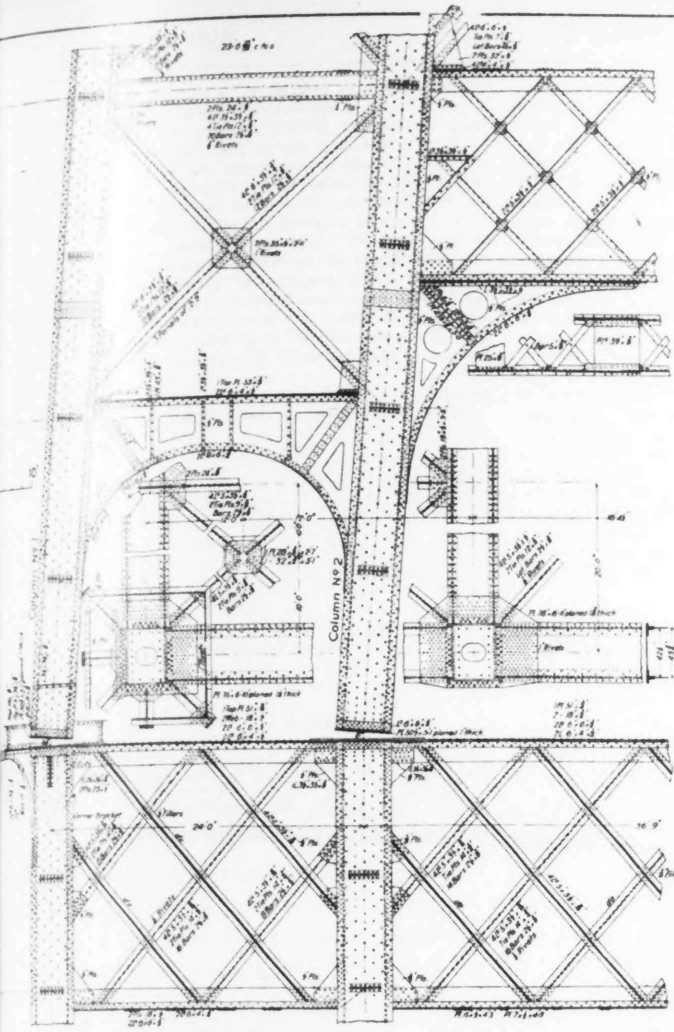


FIG ETAILS OF MAIN TOWER AT FLOOR LINE.

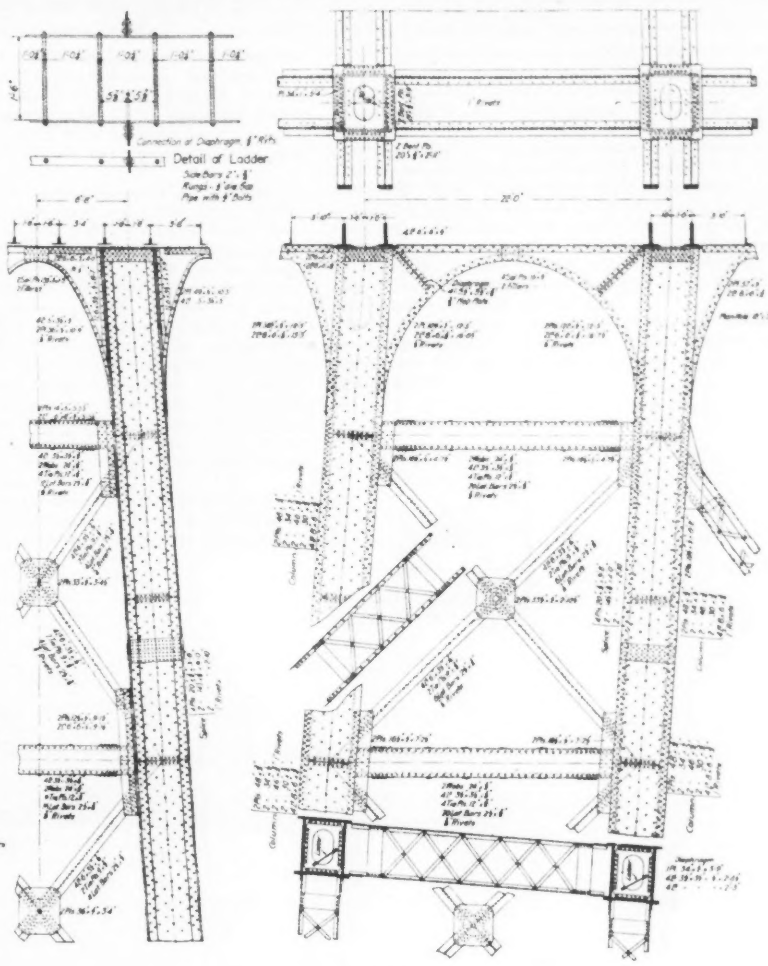


FIG. 10. TOP OF MAIN TOWER.

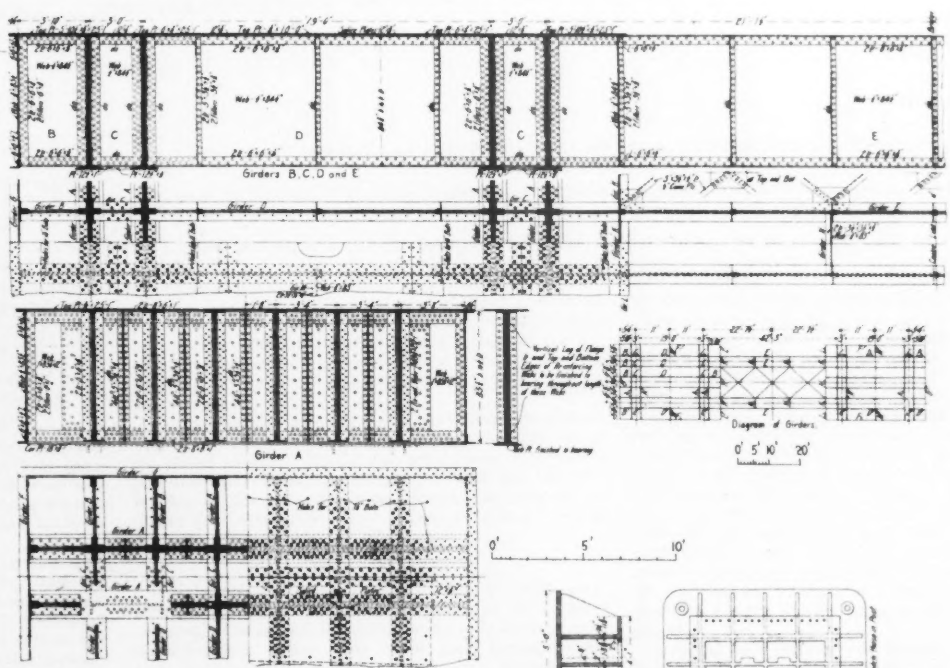
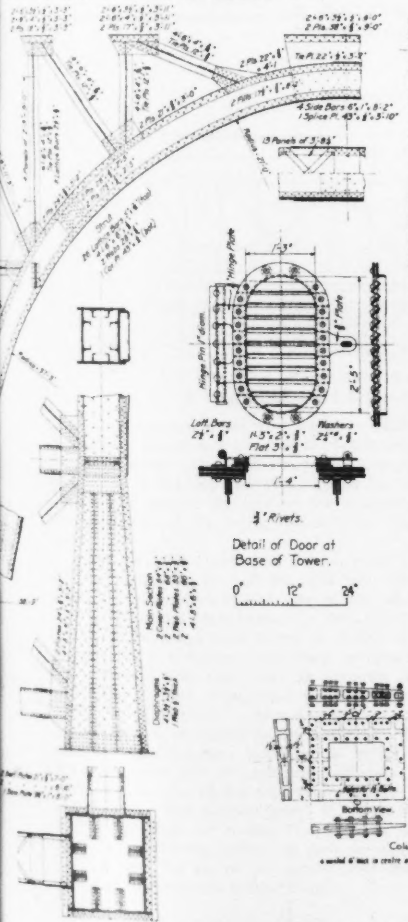
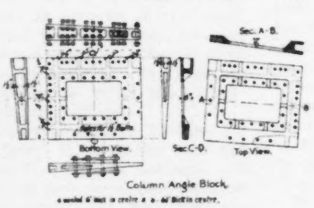


FIG. 11. DETAILS OF GIRDER CONSTRUCTION AT TOPS OF MAIN TOWERS.





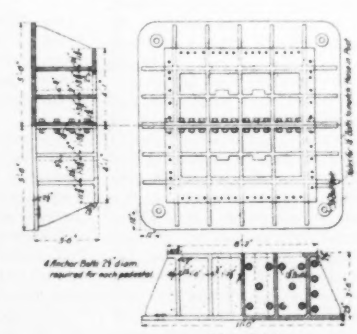


FIG. 13. DETAILS OF COLUMN ANGLE BLOCKS AND COLUMN PEDESTALS FOR MAIN TOWER.

INE

TOWER FOR NEW EAST RIVER BRIDGE.

O. F. Nichols, M. Am. Soc. C. E., Principal Assistant Engineer.

CHAS. HART & SONS, LITH., 36 VESEY ST., N. Y.

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shall be made in mills of established reputation for the kind and character of materials specified.

All superintendents, foremen, melters, helpers and others engaged in the manufacture of acid open hearth steel for this work, shall be men experienced in this line of work, and of sufficient recent practice to insure the best results.

All stock and materials used in the manufacture of the steel and all operations at the furnaces or rolls or elsewhere about the establishments where the steel is made or manipulated, shall be subject to the examination, approval and acceptance of the engineer, or his authorized inspectors, who shall have free access to all records appertaining to the manufacture and manipulation of the steel, from the beginning until its final acceptance, and shall upon their request be furnished with neat and legible copies of the same.

When acid open hearth steel is made in mills producing other kinds, no material will be accepted unless especially made for this work; and when so made it shall be subject to a system and manner of identification approved by the engineer; and, furthermore, such especially made steel shall be handled and manipulated by itself or isolated in any manner required by the engineer, to prevent the possibility of its being mixed with other kinds of steel.

In all steel, the amount of silicon shall be less than 0.1% for Grades I, II, and III, and less than 0.35% for Grade IV, of phosphorus less than 0.08%, of sulphur less than 0.03%, and of manganese less than 0.5%. Steel shall not be melted below from 0.12% to 0.15% of carbon, nor recarbonized in a careless, uncertain or irregular manner.

The manufacturer shall have an analysis of every melt made by a chemist satisfactory to the engineer, and two copies thereof certified by such chemist shall be delivered to the inspector appointed by the engineer. Every facility shall be afforded to the inspector to verify the requirements for every melt of each grade of steel.

The steel will be of the following grades: I.—Steel for angles, plates, and anchor bolts; II.—Steel for pins and rollers; III.—Steel for rivets; IV.—Steel for castings. All specimens for testing, excepting rivet specimens, shall be not less than 0.5 sq. in. in section, and shall meet the following requirements respectively:

Grade.	I.	II.	III.	IV.
Max ult. in lbs. per sq. in.	68,000	....	56,000	....
Min. ult. in lbs. per sq. in.	60,000	68,000	47,000	60,000
Min. elastic limit in lbs. per sq. in.	33,000	35,000	30,000	....
Min. P. C. elong. in 8 in.	20%	17%	25%	....
Min. P. C. elong. in 2 ins.	....	....	....	20%

Specimens of Grade I, bent cold 180° about a diameter equal to the thickness of the specimen, shall show no crack on the convex side. Specimens of Grade II, bent cold 180° about a diameter equal to 1½ times the thickness of the specimen, shall show no crack on the convex side. Specimens of Grade III, bent to closing, shall not crack.

All ingots for plates, angles and other shapes shall be bottom cast. All shapes shall be rolled from billets, blooms or slabs which are of a size to reduce sixteen times in area in forming the shape. All rolled and hammered shapes shall be entirely free from piping, checks, cracks or other imperfections, and shall have smoothed finished edges and surfaces. Rivets cut out of work into which they have been driven shall be tough and show a silky texture without crystalline appearance. All casting shall be sound and as free from blow-holes as the latest and best practice in steel casting can produce. Each casting shall have not less than two coupons from which to cut specimens for testing. All steel fractures shall show a fine silky texture of a bluish gray or dove color, and be free from black or brilliant specks. Rigid tests will be made for red shortness.

Specimens for Testing.—Specimens for testing shall be cut from the actual shapes made for the work. There shall be a sufficient number of them to satisfy the engineer that the material is what is required. Specimens from plates, angles, pins and rollers shall be planed or turned to a prismatic or a cylindrical form, for an observation length of 8 ins., and shall have a transverse sectional area of not less than ½-sq. in. Specimens for pins and rollers shall be cut at a depth from the cylindrical surface of the bar equal to one-third the radius of the bar. Rivet specimens shall be cut from the rods, and tested without further preparation.

General Remarks on Quality of Steel.—Acceptance of steel shapes or castings at the mill or the foundry will not be considered as final. Should any piece prove to be defective under any of the manipulations until it is in its final position on the work, it will be rejected, and must be replaced by a satisfactory piece without additional compensation to the contractor.

Workmanship.

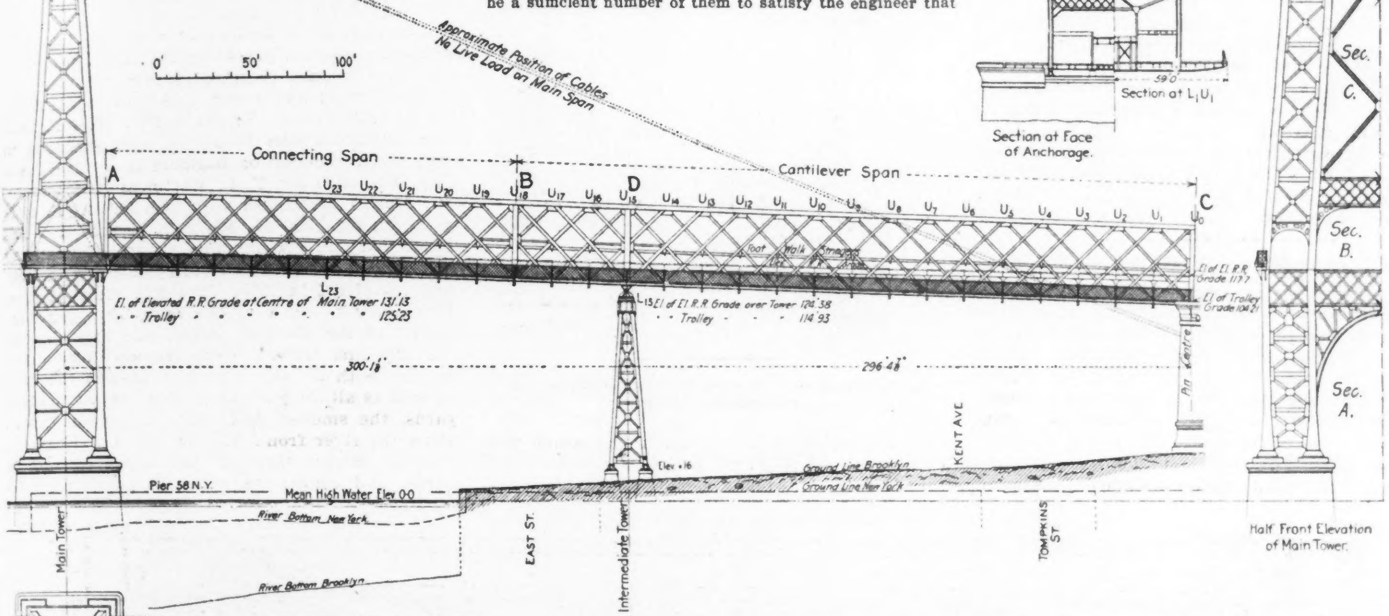
The towers and the end spans will be made non-adjustable. Hence all the parts must be of accurate lengths. This applies especially to the towers, which will be stiff-braced. Each main tower from bottom to top must be symmetrical about a vertical center line intersecting the axis of the bridge.

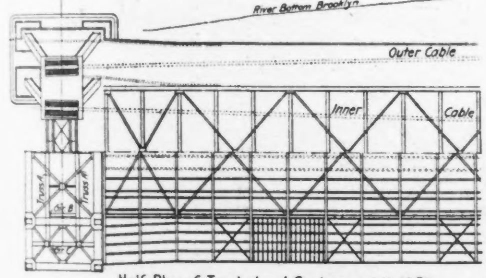
Steel Castings.—All steel castings must be thoroughly annealed. They must be true to the drawings, with smooth surfaces, and all re-entrant angles must be neatly filleted. They must be planed smooth and true where the drawings require. The saddles must have the grooves, in which the cables are to lie, chipped and filed sufficiently to remove all inequalities, and leave them smooth and true, so as to afford a satisfactory bearing for the cables.

Riveted Work.—The main girders and the beds for supporting the saddles at the top of the towers must be of especially fine workmanship. The lower edges of the vertical legs of the flange angles and the backs of both legs must be planed true, so that the fillers and stiffeners can be fitted exactly between these angles; the stiffening angles must have their ends milled or ground to fit neatly against the angles. The edges of the webs must be full, so that when the upper and the lower edges of the girders are planed the other members abutting against them will have a perfect bearing on the webs and the angles.

All plates and angles to be riveted, which do not exceed ¾-in. in thickness, shall be punched ⅛-in. less in diameter than the rivets to be used; and, after being straightened, shall be assembled and reamed to the size proper to admit the rivets. Those thicker than ¾-in. shall be assembled and drilled to the proper size to admit the rivets without punching. The plates and angles shall then be taken apart, and all fins shall be removed from the edges of the holes by a countersinking tool, which shall slightly fillet them. All sheared edges must be removed by a planer to the depth of at least ⅛-in.

Surfaces to become inaccessible shall then receive a protecting coating, to be approved by the engineer, after which they will again be assembled and thoroughly and tightly bolted.





Half Plan of Top Lateral System and Half Plan of Floor System and Bottom Laterals.

FIG. 1.—GENERAL PLAN AND ELEVATIONS OF STEEL TOWERS AND END SPANS FOR NEW EAST RIVER BRIDGE.

L. L. Buck, M. Am. Soc. C. E., Chief Engineer. O. F. Nichols, M. Am. Soc. C. E., Principal Assistant Engineer.

Riveting.—Wherever practicable, all rivets shall be machine driven, both in the shop and in the field. Whenever hand-riveting is necessary, the entire driving must be done with sledges weighing at least 8 lbs., and the rivets must be held by dollies capable of holding them firmly against such driving. All rivets must thoroughly fill the holes, have full hemispherical heads concentric with their bodies, and grip the work tightly. All work must be kept thoroughly and tightly bolted while the rivets are being driven, and all members must be true and out of wind when completed. Great care must be taken that all rivets are properly heated, and no overheated rivets shall be driven in the work.

Removal of Mill Scale.—Previous to assembling for riveting, all steel for the main towers shall have the mill scale entirely removed by sand blast, and must be fully protected from rust, either by oiling or painting, till it is ready to leave the shop, when all grease and dirt shall be removed, and it shall be immediately covered with a thorough coating of such paint as the engineer shall approve.

Abutting Ends, Splices and Gussets.—All abutting ends and edges shall be milled or planed, so that the parts shall fit neatly and tightly together. All joints must be assembled after milling, and the holes in the splice plates and gussets must then be reamed or drilled, so that they will agree perfectly.

Pins.—All pins must be turned smooth and truly cylindrical to the diameters required by the drawings. They must be of the required lengths. All pins more than 5 ins. in diameter shall be hammered or pressed. All pins having diameters greater than 6 ins. must have holes 1½ ins. in diameter, concentric with their cylindrical surfaces, drilled through from end to end. All pin holes must be bored smooth and true to diameters not exceeding 1-50-in. larger than those of the pins to be used.

Rollers and Beds.—All rollers must be turned smooth and truly cylindrical, and all which go into the same frame must be of the same diameter. They shall be fitted neatly into their frames, and the frames shall be planed and secured together in such a manner as will keep the rollers truly at right angles to the direction of movement, and exclude as completely as possible all dust and dirt. The bearing plates resting on the rollers, and those on which the rollers rest, must be planed smooth and true on their faces and edges. They must be rolled to a thickness sufficient to enable them to be planed down so as to leave the longitudinal guide ribs shown on the drawings.

Screw Threads.—All screw threads shall be of the United States standard. The threads shall be full and the nuts must fit neatly.

Coatings.—Before shipment all steel work, except bright machined work, shall be thoroughly cleaned with wire brushes and receive a thorough coating of paint approved by inspector. Bright finished work shall be covered with a slushing oil to prevent rusting.

Ventilation and Access.—To secure thorough ventilation and access, each main tower leg will be provided with an opening at the bottom, and a continuous passage from the bottom to the top, where there will be another opening to allow passage to the saddle floor. Each opening at the bottom will be provided with a steel door, and their will be a substantial iron ladder from the bottom to the top in the interior of each leg.

The specifications also require that the metal shall receive after erection two coats of "paint approved by the engineer, and that all friction rollers and the surfaces with which they come into contact shall receive a coating of vacuum, flushing oil mixed with graphite.

The engineers of the New East River Bridge are: Mr. L. L. Buck, M. Am. Soc. C. E., Chief Engineer, and Mr. O. F. Nichols, M. Am. Soc. C. E., Principal Assistant Engineer.

THE KANSAS CITY, PITTSBURG & GULF R. R.

The railway system of the United States has become so great and comprehensive that it is difficult to plan or construct a line, which by its length and importance may be properly termed a trunk line, and which will have a traffic legitimately belonging to it and not simply stolen from competing lines. Numerous trunk lines have been planned on paper in recent years, but most of them are merely parallel and competing roads designed to secure traffic from cities and districts already supplied with railway facilities. During the past year, however, there was added to the list of large and

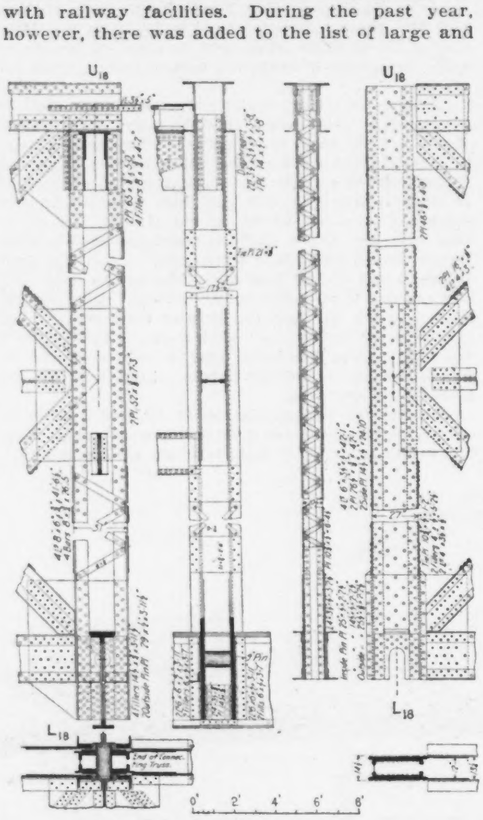


Fig. 3.—Detail of Connection Between Cantilever and Intermediate Spans.

important railways, a real trunk line which will develop a new territory, and one which, while of course entering into competition with other lines, does so in a legitimate manner, and is calculated to assist many of its connecting lines. The line to which we refer is the Kansas City, Pittsburg & Gulf R. R., completed in September, 1897. The railway extends from Kansas City, Mo., south to Port Arthur, Tex., 788 miles, and has at the latter point a new city and a new gulf port, so that the line offers a new seaboard outlet for the products of the Northwest and the Southwest, while it will also develop a region affording considerable local traffic. The above facts appear to us to warrant a somewhat detailed description of this road. For much of the historical information we are indebted to Mr. E. L. Martin, Vice-President, who was one of the original projectors, while to Mr. Robert Gillham, M. Am. Soc. C. E., the General Manager and Chief Engineer, we are indebted for information, drawings, etc., relative to the physical characteristics of the line. The general route of the line is shown on the map, Fig. 1, which also shows the various railway connections.

History.

This railway originated in a freight belt line planned about ten years ago to connect the various railway lines entering Kansas City, Mo., on the east, west and south, and thus to facilitate the interchange of freight traffic. The Kansas City Suburban Belt R. R. Co. was organized in 1887 by a number of business men of Kansas City, Mo., with Mr. E. L. Martin as its president. Mr. Martin associated with him Mr. A. E. Stilwell, President of the Missouri, Kansas & Texas Trust Co., and through this channel the railway enterprise was financed. Work was begun in 1889, and completed in 1895. The line extended from Brush Creek, south of the city, down the Blue Valley to the Missouri River, and thence along the Missouri River to the Kansas River, connecting with all the railways entering the city, as well as all the packing houses, elevators, stock yards, the smelter, and other industries located along the river front. It then followed along the Kansas River, through the quarantine stock yards, and connecting with the packing houses

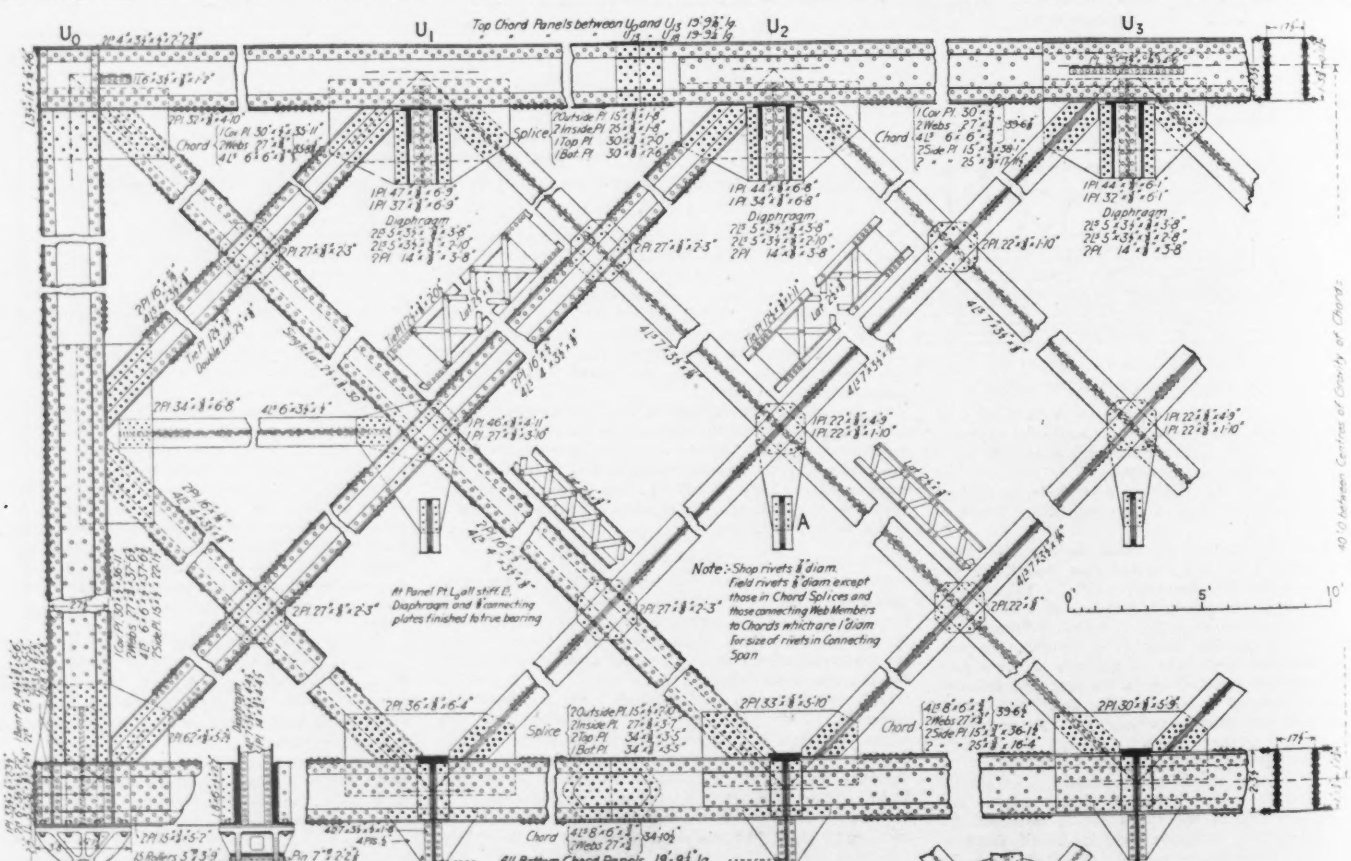


FIG. 4—DETAILS OF END BEARINGS AND THREE END PANELS OF SHORE END OF CANTILEVER SPAN.

and other industries along its banks, to a connection with the Atchison, Topeka & Santa Fe Ry. at Argentine, Kan. Work was greatly delayed by the opposition of all the roads crossed by the tracks of the Suburban Belt Line, by means of injunctions and other methods. The long legal contest cost the company a large sum of money, in addition to great loss by reason of the long delay in completing the system, but the company won in

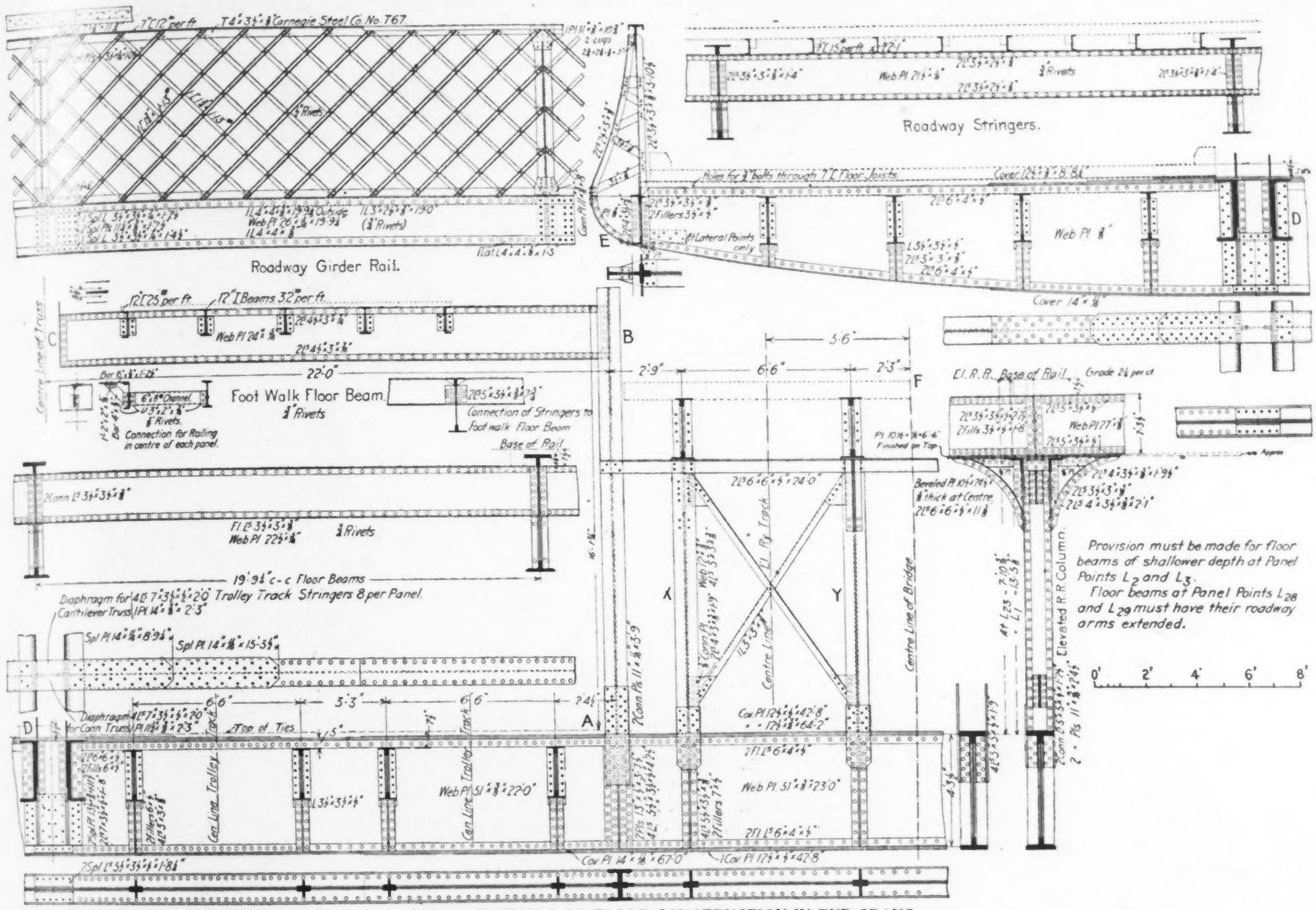


FIG. 6.—DETAILS OF FLOOR CONSTRUCTION IN END SPANS.

the end. This line has about 60 miles of track, cost about $4,000,000, and will eventually be one of the most valuable terminal roads in the country.

The terminal facilities being thus secured, the same interests took hold of the line projected south to the Gulf of Mexico. Sometime during the early '50's Thomas H. Benton, standing upon the ground where Kansas City now stands, proclaimed that it was a commercial necessity that a line of railway should be built from the Mississippi River, via Kansas City, to the Pacific Ocean, and that another be built from Kansas City to the Gulf of Mexico. He predicted that both of these roads would be built within a surprisingly short time, and though at that time many people thought his optimistic views were wild, his predictions have proved more than true. Six trunk lines now extend from the Mississippi to the Pacific and four from Kansas City to the Gulf of Mexico.

About 1867 Congress passed an act granting the right of way through the Indian Territory to any railway that would first reach, with its tracks, the northern line of the Territory in the Neosho Valley. It was then a race between the Missouri River, Fort Scott & Gulf Ry. (now the Kansas City, Fort Scott & Memphis Ry.) and the Missouri, Kansas & Texas Ry., as to which would gain the prize. The latter won in 1870. It was the intention to build the M. R., Ft. S. & G. Ry. directly south through the Indian Territory and Texas to the Gulf, but its defeat in securing the right of way forced it to turn east to the Mississippi River at Memphis. The M., K. & T. Ry., instead of building directly south toward the Gulf, was pointed westward to Denison, Tex., on the Red River. The Atchison, Topeka & Santa Fe Ry. and the Chicago, Rock Island & Pacific Ry. both located west of a direct line south, the former reaching the Texas line west of Denison, and the latter going still farther to the west, leaving for the Kansas City, Pittsburg & Gulf Ry. the opportunity to occupy the territory directly south and to get the shortest line from the Missouri River to the Gulf, passing through a good country, every mile of which, it is said, will contribute traffic to the road.

The Kansas City, Nevada & Fort Smith R. R. Co. was organized by Mr. E. L. Martin and associates in 1889, and in 1893 the name was changed to the Kansas City, Pittsburg & Gulf Ry. The Missouri, Kansas & Texas Trust Co., and Mr. A. E. Stilwell, its President, undertook to finance the enterprise. A large sum was subscribed by local capitalists and business men of Kansas City, after which Philadelphia capital was enlisted. Drexel & Company, E. T. Stotesbury, John Lowber Welsh, and other banking houses of that city, took large blocks of stock of the construction company that undertook to contract to build the road. The line was completed to Hume, Mo., 81 miles from Kansas City, in October, 1891. The general depression throughout the country made progress quite difficult, but the enterprise was pushed on, more Eastern capital was solicited and secured, and the road was completed as far as Joplin, Mo. (155 miles), by Sept. 1, 1893. In October, 1893, the Kansas City, Fort Smith & Southern Ry. was purchased. This line ran from Joplin to Sulphur Springs, Ark., a distance of 50 miles. The Texarkana & Fort Smith Ry., running from Texarkana north to Little River, a distance of 20 miles, had already been acquired in 1892, and these two lines fitted admirably into the general route. The work of closing up the gap between Sulphur Springs and Little River, Ark., and the extension from Texarkana to Port Arthur remained to be done. In 1893, Mr. Stilwell went to Europe to enlist capital for the completion of the line as far as Shreveport, La. Large amounts were subscribed in Holland (through the assistance of Mr. G. de Geoign, of Amsterdam), Germany and England, and more American subscriptions were also secured. Work was at a standstill during 1894, but was recommenced in 1895, and the gap between Sulphur Springs and Little River was closed and the last spike driven on March 4, 1897. This completed the line between Kansas City, Mo., and Shreveport, La., 560 miles, making rail connections at Shreveport for Galveston and New Orleans.

It then became necessary to raise funds to complete the line from Shreveport to its own gulf terminus at Port Arthur. Mr. Stilwell made another trip to Holland and brought back with him a committee of the Dutch stockholders to investigate the manner in which the work had progressed, and to report on the value of the line. This committee made such a favorable report that the entire amount necessary to complete the line was subscribed at once, and the work was done under a separate name, as the Kansas City, Shreveport & Gulf Ry., which is now a part of the Kansas City, Pittsburg & Gulf Ry. The general business depression existing throughout the country during the period of construction of this road did not interfere to any great extent with the rapid prosecution of the work, and finally, on Sept. 11, 1897, the last spike was driven, about twelve miles north of Beaumont, Texas, closing up the direct line between Kansas City and the Gulf of Mexico, at Port Arthur. During about two years, more than 500 miles were constructed, including the heaviest work on the line.

It will be seen from the map that this railway has direct connections reaching Omaha, Neb., on the north, and Quincy, Ill., on the east, while from Kansas City, Mo., in the central West, it has its own rails through to tidewater on the Gulf, on a line 125 miles shorter than any other. There are no divisions to be made with other lines, but the railway will haul freight through to steamships at its own docks at Port Arthur.

The idea uppermost in the minds of Mr. Stilwell and Mr. Martin was to form a short line to tidewater, intercepting east-bound business from the farms, forests and mines of the Northwest and

Fig. 1.—Map of the Kansas City, Pittsburg & Gulf R. R.

central West on its way to tidewater on the Atlantic coast, and diverting this business to tidewater on the Gulf of Mexico. It will be especially a grain route, and will be aided in this business by the fact that the owners of the railway have a controlling interest in several of the large grain elevators at Kansas City.

The Kansas City, Pittsburg & Gulf Ry. proper begins at Grand View, Mo., 24 miles south of Kansas City, access being obtained to that city over the Kansas City, Osceola & Southern Ry. (under a long lease), to Belt Junction, 9 miles, and then over the Kansas City Suburban Belt Ry. The latter line is owned by the same interests as the K. C., P. & G. Ry. The same interests also control the Kansas City & Northern Connecting R. R., which extends north from Kansas City to Smithville, 22 miles, from which point an extension of 52½ miles is being built to Pattonsburg, Mo., which will be completed in February. Here connection will be made with the Omaha & St. Louis Ry., extending west to Omaha, Neb., and with the Omaha, Kansas City & Eastern R. R., extending from Pattonsburg east to Quincy, Ill., thus giving a direct line from Omaha and Quincy to the Gulf by way of Kansas City, all under the control of the same interests. The K. C., P. & G. Ry. itself has connections with numerous other railways along its route, and has a branch seven miles long from Wilton to White Cliffs, Ark., and another branch, 21 miles long, from De Quincey to Lake Charles, La. The company, therefore, owns 792 miles (764 miles of main line and 28 miles of branches), and operates 816 miles. It has also begun work on a branch 15 miles long from the main line at Oak Lodge, Ind. Ter., to Fort Smith, Ark., and this will be completed in the early spring. The railway uses the Grand Central passenger station (at Second and Wyandotte Sts.), Kansas City.

The construction work from Kansas City to Siloam Springs, Ark., was done under the supervision of Mr. Richard Gentry, as Chief Engineer. In August, 1895, Mr. Gentry resigned, and was succeeded by Mr. Robert Gillham, M. Am. Soc. C. E., M. Inst. C. E., who has had charge of the work since, and is now General Manager and Chief Engineer of the road. Mr. E. L. Martin was President of the company from its organization until April, 1897, when he resigned on account of ill health, and Mr. A. E. Stilwell was elected to fill the vacancy. Mr. Martin was then elected to and accepted the position of First Vice-President. The present list of officers is as follows:

President	A. E. Stilwell
First Vice-President	E. L. Martin
Second Vice-President	G. M. Titsingh
Third Vice-President	E. T. Stotesbury
Secretary and Treasurer	W. S. Taylor
Auditor	R. J. McCarty
General Manager and Chief Engineer	Robert Gillham
Purchasing Agent	I. C. Hubbell
General Superintendent and Superintendent of Motive Power and Equipment	F. Mertsheimer
General Passenger Agent	H. C. Orr
General Freight Agent	J. A. Sargent
Division Superintendent (Northern Div.)	W. A. Williams
Division Superintendent (Southern Div.)	W. E. Green

In October, 1897, Mr. Martin, Vice-President, wrote us that the future prosperity of the road appeared to be well assured. The expectations of the projectors of the road had already been more than realized, the earnings of the line at that early date having been sufficient to meet the first interest upon the bonds due Oct. 1, 1897. The showing was so satisfactory that Mr. Martin estimates that the net earnings for 1898 will greatly exceed the fixed charges.

Location.

In regard to the physical characteristics of the line, it is stated by Mr. Gillham that the Kansas City, Pittsburg & Gulf R. R. can claim a superior location from Kansas City to the Gulf of Mexico. Other north and south lines, with one or two exceptions, usually suffer great loss and damage due to their having been built on locations that traverse the swamps and overflow districts of the Mississippi and Red rivers, and it often happens that the railways operated through the overflow districts during the spring floods are compelled to suspend traffic (sometimes for weeks) until the subsidence of the water and necessary repairs to tracks have been completed.

The K. C., P. & G. R. R. is so located that there is no possibility of overflow in the districts traversed. Special care was exercised in treating local conditions in order to secure what may be termed a "ridge line" throughout, and wherever it was possible to do so ridges were followed, having also due regard for curvature and grades.

Track.

There are 816 miles of main track and 57.7 miles of side track. The track is laid with 60-lb. steel rails, spliced by the Continuous rail joint and

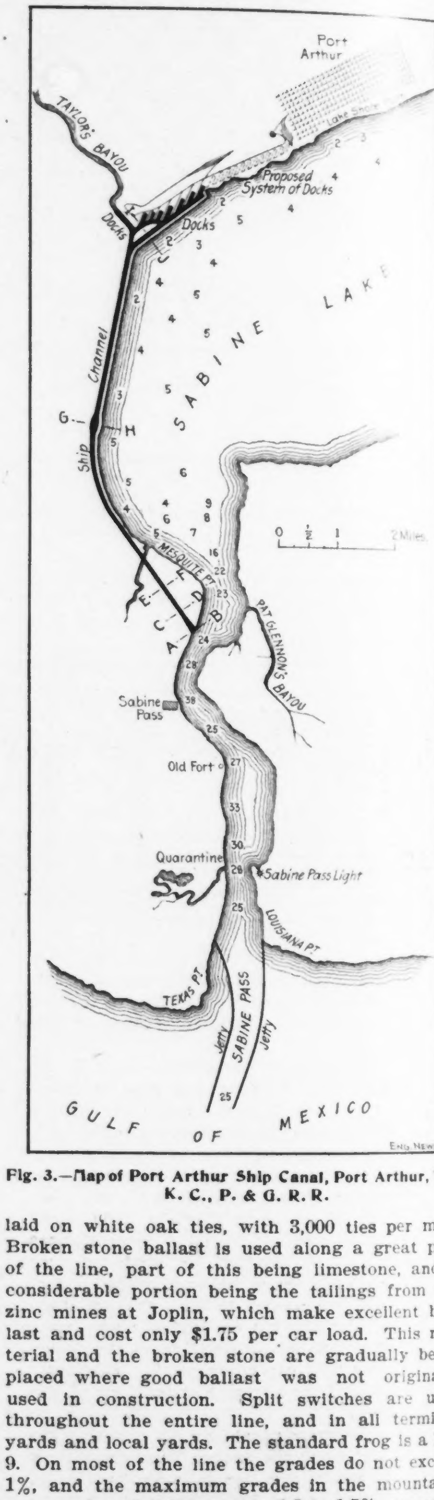


Fig. 3.—Map of Port Arthur Ship Canal, Port Arthur, Tex. K. C., P. & G. R. R.

laid on white oak ties, with 3,000 ties per mile. Broken stone ballast is used along a great part of the line, part of this being limestone, and a considerable portion being the tailings from the zinc mines at Joplin, which make excellent ballast and cost only $1.75 per car load. This material and the broken stone are gradually being placed where good ballast was not originally used in construction. Split switches are used throughout the entire line, and in all terminal yards and local yards. The standard frog is a No. 9. On most of the line the grades do not exceed 1%, and the maximum grades in the mountainous country of Arkansas are 1.3 to 1.5%, generally for short distances only. The total alinement comprises 80.34% of tangent and 19.66% of curvature, the proportion in each of the six divisions being given in the table. The curves are mainly easy, the maximum being 6°, and all the curves are compensated for grades. On the sixth division, from Hornbeck to Port Arthur, 92 miles, there is one tangent 30 miles long and another 27 miles long.

The main line is not equipped with block signals, but it is interesting to note that for 1¼ miles where the K. C. & N. Connecting Ry. uses the Chicago, Milwaukee & St. Paul Ry. tracks and bridge over the Missouri River at Kansas City, the traffic is operated by the train-staff system. A semaphore signal, controlled from a signal tower, is placed at each end of the section, and beyond the signal is a staff delivery crane. If an engineman finds the signal clear he does not stop, but takes the staff from the crane as he passes, delivering the staff at the crane at the other end of the section.

Bridges.

The location of the line is such as to give a minimum of trestle work over low ground, and the amount of bridge and trestle work, as well as the proportions of tangents and curves, are shown by the accompanying table. In another article we shall describe some of the bridge work, and the concrete piers of the Arkansas River bridge. As it was found that stone of proper quality could not be readily obtained, it was determined to build these piers of concrete made with imported German cement. The piers are coped with stone and have given very satisfactory results. Mr. J. A. L. Waddell, M. Am. Soc. C. E., was Consulting Bridge Engineer.

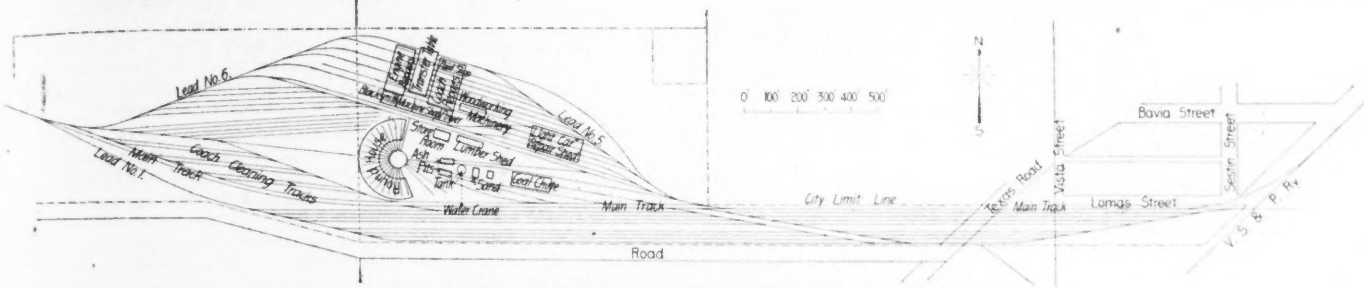


FIG. 2.—YARDS AND SHOPS AT SHREVEPORT, LA.; K. C., P. & G. R. R.

Alinement and Bridge Work of the K. C., P. & G. R. R.

First Division.—Kansas City, Mo., to Pittsburg, Kan., 129 miles.	
Wooden trestles (97 ft. per mile)	10,315 ft.
Truss bridges	556 "
Tangents	85%
Curves	15%
Second Division.—Pittsburg to Stilwell, Ind. Ter., 129 miles.	
Wooden trestles (83 ft. per mile)	10,769 ft.
Steel truss bridges, total	1,050 "
Steel plate girders	225 "
Tangents	71%
Curves	29%
Third Division.—Stilwell to Mena, Ark.; 122 miles.	
Wooden trestles (52 ft. per mile)	6,356 ft.
Arkansas River bridge	1,471 "
Steel truss bridges	1,200 "
Steel plate girders, 30 to 50 ft. long	1,410 "
Steel I-beams	1,204 "
Tangents	73%
Curves	27%
Fourth Division.—Mena to Shreveport, La.; 179 miles.	
Wooden trestles (113 ft. per mile)	20,490 ft.
Steel truss bridges (one draw, 140 ft.)	1,200 "
Tangents	77%
Curves	23%
Fifth Division.—Shreveport to Hornbeck, La.; 94 miles.	
Wooden trestles (176 ft. per mile)	16,690 ft.
Tangents	84%
Curves	16%
Sixth Division.—Hornbeck to Port Arthur, Tex.; 135 miles.	
Wooden trestles (140 ft. per mile)	18,842 ft.
Steel truss bridges	450 "
Plate girder	60 "
Tangents	92%
Curves	8%

On the Sixth Division (on the extension to Lake Charles) is also a drawbridge with approach spans of 175 ft. each and one girder span of 50 ft. The Sabine and Neches rivers are also crossed on this division by two steel drawbridges with truss approach spans. The latter bridges are included in the bridges reported in the last division. The Sabine River is crossed on this division on a steel drawbridge, as is also the Calcasieu River at Lake Charles. The pivot pier on this bridge is located in 50 ft. of water. The Neches River, at Beaumont, is also crossed by means of a steel drawbridge.

Shops and Yards.

The principal shops, for building and repairing locomotives and cars, will be at Shreveport, La., but there are also important machine and repair shops at Pittsburg, Kan. At other divisional points there are only roundhouses and shops for very light repair work.

The arrangement of the yards and shops at Shreveport is shown in Fig. 2, from which it will be seen that the main track passes to the south of the shops, but that through tracks are provided along each side of the yard, these two tracks connecting with the main track at the west end of the yard by a three-throw Wharton switch. The shops include a 20-stall roundhouse, engine repair shop, boiler shop, machine shop, blacksmith shop, coach repair shop, paint shop, light car repair shed, woodworking shop, power house, store room, lumber shed. There are also a sand house, oil and waste house, coal chute, water tank, and two ashpits on the roundhouse tracks. All the buildings are of brick with slate roofs. The coach-cleaning tracks are at the west end of the yard. The K. C., P. & G. R. R. has built a union passenger terminal station on Louisiana St., and has its own track connections with the station. Its tracks in this city form practically a belt line running to the Red River levee and the manufacturing districts. The terminal station has eight tracks terminating at a headhouse or passenger station 124 × 45 ft., with a platform 25 ft. wide between the building and the ends of the tracks, while parallel with the tracks is an express and baggage building 30 × 215 ft. The station building is of buff brick with trimmings of light gray stone. The eight tracks all connect with a main line lead track by 17° curves, and this track passes outside the station, forming the line for through traffic. The station is used by the five railway systems centering at Shreveport.

Equipment and Train Service.

The present equipment consists of 108 passenger and freight locomotives, 62 cars in passenger service and 6,000 cars in freight service. The passenger cars are vestibuled, and all the equipment is new and is gradually being increased. The traffic at present consists of two passenger trains and 20 freight trains each way per day. The average freight train load is 700 tons, and the engines can take this load over all grades except one, where the trains are either split in two or run as double headers.

The Gulf Terminal at Port Arthur.

The railway company has established a city and terminal port of its own, about 80 miles east of Galveston and 275 miles west of New Orleans. The town of Port Arthur, Tex. (named after Mr. Arthur E. Stilwell), is 788 miles from Kansas City. It is situated on the north shore of Sabine Lake, a body of water 24 miles long and 8 miles wide. At the southwest corner of the lake the waters find an outlet to the Gulf of Mexico by means of a short river, half a mile wide and eight miles long, called Sabine Pass. On the strip of land lying between the Gulf of Mexico and Sabine Lake is the town of Sabine City (with a population of 500) at the end of a branch line of the Southern Pacific Ry. from Beaumont. It was at first intended to have the terminal of the K. C., P. & G. R. R. at Sabine City, but upon a careful study of the question it was decided to abandon this plan for the reason that owing to its peculiar location the town is subject to serious inundations from both the Gulf and the Lake. In 1886 a flood of 8 ft. of water swept over Sabine City, destroying 90% of the buildings and drowning over 120 persons. The storm of September, 1897, forced the waters of the lake over the lands at Sabine City to a depth of 6 ft., washing out from seven to eight miles of the Southern Pacific Ry. track. The fear of inundation, therefore, caused the company to locate the terminal town of Port Arthur on the main land, 16 miles from the Gulf of Mexico, and the wisdom of this conclusion was clearly shown in the September storm of this year.

The United States Government has spent about $2,000,000 in building extensive jetties at the mouth of Sabine Pass, and is now engaged in a further extension of the system to the 30 ft. contour line. The result of the jetty work has been to deepen the channel across the bar in the Gulf at

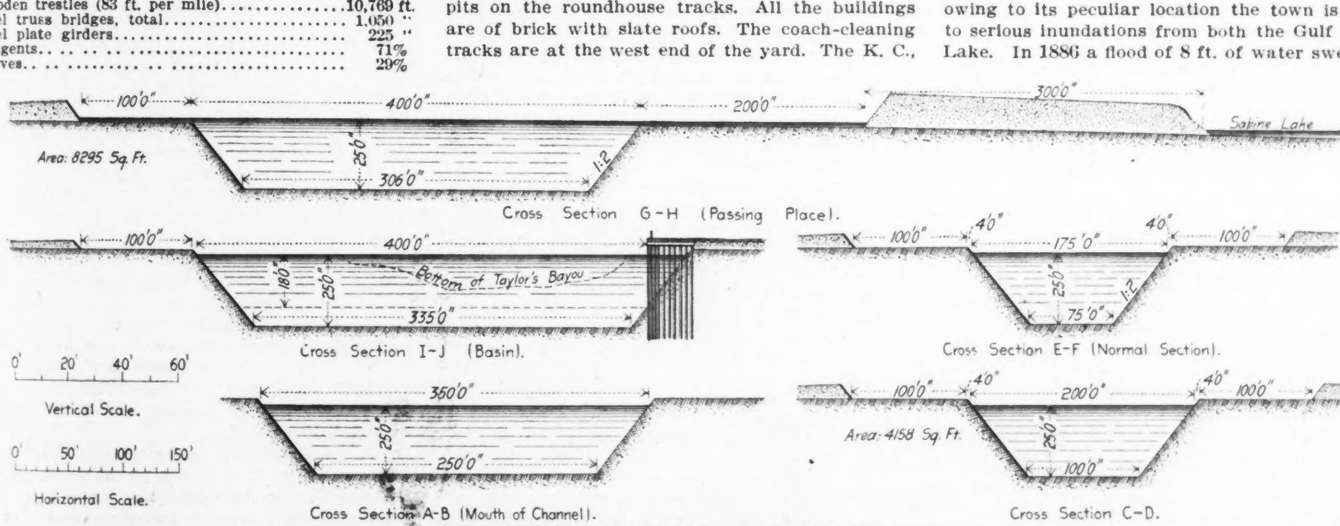


FIG. 4.—CROSS SECTIONS OF PORT ARTHUR SHIP CANAL.

the entrance to Sabine Pass, so that there is now 24 ft. of water across the bar and seven miles up the Pass to a point half a mile from Sabine Lake. In many places the water is over 40 ft. deep in the Pass.

From a point half a mile below the outlet from Sabine Lake to the Pass the Port Arthur Terminal Co. is building a ship canal, Fig. 3, having a depth below water line of 25 ft. The length of this canal to the system of docks at Port Arthur is eight miles, so that deep water will shortly be extended from Sabine Pass to Port Arthur. The normal section of the canal will be 175 ft. wide on the water line, 75 ft. wide at the bottom and 25 ft. deep. Some of the cross sections are shown in Fig. 4. The hydraulic dredge system is being used in building the canal, and one dredge (owned by the New York Dredge Co.), now at work in the canal, has a capacity of from 5,000 cu. yds. of excavated material per day. Careful borings were made along the canal to determine the character of the excavation, and most desirable materials were found in the nature of stiff yellowish and blue clays, so that the canal banks will require no treatment, but will remain permanent. The canal will probably be completed by the end of 1898, and 16 ft. of water will be secured throughout the entire canal by June 1.

A dry dock is also to be built at Port Arthur, so that this port may be available for the overhauling and repair of ships, while the dock will be made large enough for the largest battleships, so as to be suitable for naval purposes. It will be 550 ft. long, 95 ft. wide, 27 ft. deep on the sills, and the cost is estimated at $300,000 for a dock of this size built of timber, brick and concrete.

The terminal system will be very extensive, including freight yards, grain elevators, warehouses, docks and piers, etc. Beyond the passenger and freight stations and the railway yards are the freight yards, with tracks extending to the lumber docks on the basin on Taylor Bayou (Fig. 3), and to several shipping docks, which are separated by piers 1,000 × 300 ft., the docks being 260 ft. wide. These docks front on a basin having 25 ft. of water for a width of 500 ft. A track also extends along the transfer pier. The company is building two piers 2,100 ft. long. One of these has a double track and a freight warehouse 100 × 1,200 ft., and the other has a single track and is used for shipping the stone of the Sabine Pass jetties, the stone being handled by a 25-ton derrick crane. The present contract for this work calls for the handling of 400,000 tons of rock, which comes from quarries along the line of the railway. During the building of the canal, export and other business is being handled by means of lighters from the Port Arthur piers in the lake, and taken to Sabine Pass, eight miles across the lake, where it is transferred to steamers. By the time the canal is completed, the railway company will have ready a large grain elevator for their own use at Port Arthur.

Industrial Conditions and Resources.

The first division of the railway extends from Kansas City, Mo., to Pittsburg, Kan., a distance of 129 miles, and on this there are no objectionable curves, and no grades in excess of 1% (or 52 ft. per mile). This division runs through an agricultural country, in which all manner of farm products are produced and stock growing is well developed. Near Pittsburg the bituminous coal district is reached, from which thousands of tons of coal are mined for use and distribution at Kansas City.

The second division is from Pittsburg to Stilwell, Ind. Ter., a distance of 129 miles, and this penetrates the Ozark apple region as well as one of the richest lead and zinc mining districts in the country. Ores from the mines are exported in considerable quantity, and the crushed rock of the tailings is utilized for ballast, as already noted. The southern section of this division lies in Indian Territory, from which walnut logs and other wood products are gathered and shipped to the various markets.

The third division is from Stilwell to Mena, a distance of 122 miles, running through the easterly section of the Indian Territory, traversing the rich cotton lands of the Arkansas Valley and the primitive forests of the territory, which contain much upland Arkansas pine. Ties, piling and oak lumber are secured in large quantities. Lumber mills are in operation, producing shipments of finished lumber for the northern and western markets. On this division also is the noted semi-anthracite coal field at Poteau, Ind. Ter., the coal containing as high as 90 to 95% of carbon. These coals are hauled north for steaming and domestic purposes, as well as south for use on vessels engaged in the Gulf trade. It is claimed that actual tests on southern and western railways show that one ton of this coal will run a locomotive ten miles further than one ton of the bituminous coals used by many of the railways. This coal is delivered at a low rate to the railway and it is claimed that no other railway in the west can procure fuel so cheaply.

The mountainous country on the line is on this division, extending from Stilwell to 60 miles beyond Mena. In this country there is much heavy work, with many steel bridges and girders with masonry abutments, including the large steel bridge over the Arkansas River. The mountain scenery is said to be most interesting. The highest point between Kansas City and the Gulf of Mexico is reached at Grand Summit on this division, between Black Fork and Rich Mountain, being 1,800 ft. above sea level. The waters north of Grand Summit reach the Arkansas River and those south of this point flow into the tributaries of the Red River. This division is largely rock-ballasted, as are many miles on the other divisions of the railway.

The fourth division extends from Mena, a town one year old, with a population of 3,000, to Shreveport, La., a distance of 179 miles. The first 60 miles of this division are mountainous, and a prosperous agricultural region as well as a great lumber district. Texarkana is on this division, and there important connections are made with the Texas Pacific Ry., St. Louis, Iron Mountain & Southern Ry., and St. Louis Southwestern Ry. (Cotton Belt) systems, for points in Arkansas and Texas. The country passed through is a well-known cotton producing section, and many thousand bales will be handled this season. At Shreveport are the principal shops and the union station, already noted. The Texas Pacific Ry., Houston, East & West Texas Ry., Vicksburg, Shreveport & Pacific Ry., St. Louis Southwestern Ry., and the Kansas City, Pittsburg & Gulf R. R., all use this station, and here connections are made with lines reaching Texas points, including Paris, Fort Worth, Houston and Galveston, also with New Orleans, Vicksburg and other points east of the Mississippi.

The fifth division extends from Shreveport to Hornbeck, La., a distance of 94 miles. The character of the country passed through is somewhat rolling and high. Cotton, sugar cane and cattle are the chief farm products, and short-leaf yellow pine lumber from the woods.

The sixth division extends from Hornbeck to Port Arthur, a distance of 135 miles. From Hornbeck almost to the Gulf of Mexico is found long-leaf yellow pine. Primitive forests, miles in extent, lie on each side of the railway, from which no trees have been cut. By an extension of the line from De Quincey southward for a distance of 24 miles, Lake Charles, having a population of 8,000, is reached, and there another New Orleans connection is established with the Southern Pacific Ry. About 20 miles north of Port Arthur is Beaumont, having a population of 6,000. Lake Charles and Beaumont are the largest lumber mill centers south of the Great Lakes, and last year there was shipped from these two points not less than 30,000 car loads of lumber. Long-leaf yellow pine lumber for car construction is now being hauled from these points to Kansas City and thence to Chicago in competition with other lumber reaching this market, and one shipment of 200 cars has been moved.

Near Hornbeck is found limestone of superior quality, suitable for buildings. From these quarries the railway is delivering 400,000 tons of rock for the Sabine Pass jetties now being built by the U. S. Government. It is also delivering large quantities of crushed stone for the wearing surfaces of the boulevards of Kansas City from granite quarries near Mena, Ark.

The railway company owns a controlling interest in seven large grain elevators at Kansas City, and is planning to develop trade with foreign countries at Port Arthur. A line of steamers from that port to Mexico and the West Indies has already been arranged for, and this service will probably be extended to parts of South and Central America, while a regular line of steamers to European ports has been secured. The first steamer of this line, the "Drumelzier," of 4,500 tons, sailed from Port Arthur on Jan. 29, with a cargo consisting of 4,000 bales of cotton, cottonseed oil-cake, and meal, spelter flour and corn meal, lard, meat and other packing-house products.

DESTRUCTION OF A STORAGE WAREHOUSE AT PITTSBURG, PA., BY EXPLOSION OF BURNING WHISKEY.

On Feb. 9 a fire, which broke out in the storage warehouse of the Chautauqua Lake Ice Co., located at Twelfth and Thirteeth and Pike Streets, Pittsburg, Pa., caused the explosion of a large amount of stored whiskey, which destroyed the warehouse and damaged a number of adjacent buildings. The total loss is set at $2,000,000, and about 20 people were killed. An examination of the ruins made on behalf of Engineering News by Mr. J. G. Spellman, brought out the following information concerning this disaster:

The fire started about 8 p. m., Feb. 9, in the storeroom of the Chautauqua Lake Ice Co., and burned up to the sixth floor, where a large amount of whiskey was in a bonded warehouse, causing it to explode with such force that all the walls were blown out, crushing the neighboring buildings and communicating the fire to them.

The Chautauqua building was six stories high, and 100 × 225 ft. in plan, divided into four compartments by three fire walls 22 ins. thick extending from the second floor to the roof. The second floor and columns below were steel, fireproofed with tile, but the other floors were slow-burning wood construction. But for the explosion the fire would have burned itself out without communicating to the rest of the building. There were no stairs in the building, and the elevators were not running, and since the firemen could not get through the steel fire doors they were unable to do much towards controlling the fire.

About one-half of the steel-work seems to be injured beyond repair. A large girder which laid diagonally over the corner, forming a door lintel admitting two railroad sidings, was blown into the street, allowing the connecting steel floor to go down, and in turn to carry down several more girders. This brought the fire down to the first floor, which up to this time had probably not been injured, and but for the fall of the four floors above, with their heavy loads, the second floor would not have been injured at all. The explosion of a large number of cylinders of ammonia also did considerable damage; one fireman had both legs almost severed by a piece of one of the cylinders, and hose was cut a number of times.

The Union Storage Co.'s building was adjoining the above, and was filled with groceries and provisions. This building was also six stories high, with a steel frame, and it is probably a complete wreck. Across the street was the warehouse of the W. A. Hooverler Storage Co., a building 275 by 100 ft., and three stories high, filled with household goods and furniture. The front walls of this building were crushed in and the building was entirely consumed.

In the bonded warehouse were about 5,000 barrels of whiskey. The falling of the walls threw a large number of these into Mulberry Alley, and the unusual sight of street gutters filled with rivulets of pure whiskey was presented for a number of hours.

This fire presents several lessons which may not be new, but are sometimes forgotten.

(1) The storage of a large amount of liquor or ammonia in a city is a menace to life and property.

(2) That a building supposed to be fireproof, unless provided with special facilities for fighting a fire within as well as without, may be more difficult to save than a more combustible one.

(3) That Fire Departments should spend more time examining all large buildings in their districts, so that they would be better prepared to meet the "unexpected."

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