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THE BOSTON TERMINAL RAILWAY STATION, which has been under construction for the past two years, was opened to partial operation on Dec. 30, 1898. When fully completed this station will be used by the Boston & Albany R. R., the New England R. R., the Boston & Providence R. R., the Old Colony R. R. and the New York, New Haven & Hartford R. R., but at present only the Old Colony R. R. and the Plymouth & Midland divisions of the New York, New Haven & Hartford R. R. will run their trains into it. These roads will use the present Old Colony R. R. draw-bridge until the six-track rolling lift-bridge now under construction is completed, which will be in from three to six months. At the opening exercises on Dec. 30 addresses were made by Mayor Josiah Quincy, of Boston, and Mr. Charles P. Clark, President New York. New Haven & Hartford R. R. A full description of the new terminal was published in our issue of Jan. 14 and July 8, 1897, and March 24, 1898.

MOVING A 100 x 65-FT. FIVE-STORY BRICK BUILDING was successfully accomplished recently in New York city. The building had an estimated weight of 3,000 tons, and was moved 75 ft. south and 35 ft. east, 350 jack-screws being employed to furnish the power. Timber ways and shoes lubricated with soap were used, and the movement at each turn of the jack-screws was 3-16-in. The greatest distance which the building was moved in one day's work was 9 ft. 8 ins., and the whole movement of 75 ft. to the south was accomplished in 17 days. From the beginning of the work only five weeks elapsed until the building was jacked up ready to receive the new foundations, and a force of about 20 men accomplished the entire work. The contractor was Mr. Frederick Damm, of New York city, and the contract price was $10,000.

THE DEPARTMENT OF JUSTICE BUILDING, built in 1868 for the Freedman's Savings Bank, in Washington, D. C., is in danger of collapse, according to the report of the architect. Wide cracks have appeared in the front walls. The building has been repeatedly declared unsafe, and it is overcrowded and unsuitable for the purpose to which it is devoted. The chief trouble seems to come from the library of 30,000 heavy law books stored on the fourth floor. Ground is available alongside for a new building, and the Supervising Architect of the Treasury Department reports that the floor space now used should be doubled in the new structure. According to the Washington "Star," the front wall seems to be bulging out, from the fourth floor to the basement, and the foundation is yielding. There are over 120 persons employed in this building, including the whole staff of the Attorney General of the United States, and unless early precautions are taken there may be another Ford Theatre disaster.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred on the Philadelphia & Reading R. R. on Jan. 3, near Bowers station, a short distance from Reading, Pa. In this the boiler of a locomotive blew up, killing the engineer and fatally injuring the conductor of the freight train which the engine was drawing.

A 12-IN. NATURAL GAS MAIN BURST near Red Key, Ind., causing a fire which destroyed the large compressing station owned by the Ohio & Indiana Pipe Line Co., causing a loss of $100,000 and great suffering in 30 towns, which were in consequence deprived of fuel at a time when a blizzard was prevailing.

THE EXPLOSION OF A STEAM PIPE in the power house of the Brooklyn Heights Ry. Co., at Division and Kent Aves., Brooklyn, N. Y., on Jan. 3, resulted in the death of one man and interrupted the car service for several hours.

THE GAS EXPLOSION IN THE BOSTON SUBWAY, which occurred on Mar. 4, 1897, is again brought to notice by a verdict given by a jury in the Superior Court in Boston for $3,000 in favor of one of the parties injured by the accident. The explosion seems to have been due to an accumulation of gas which leaked from the gas main into the subway, and was fired, possibly, by an electric spark. At first there were five defendants, the Boston Gas Light Co., owners of the gas main; the West End Street Ry. Co., lessees of the subway; the Metropolitan Construction Co., builders of the subway, which was then under construction; the Edison Electric Illuminating Co., and the Boston Electric Lighting Co., whose wires may have furnished the electric current which gave rise to the spark, but the complaint against the two electric companies was discontinued by the plaintiff's counsel during the progress of the suit. The charge of the judge left it to the jury to say whether the Metropolitan Construction Co. had exercised proper care under the circumstances, and whether it had such knowledge of the condition existing in the subway cavity as could reasonably have given it reason to anticipate an explosion. He also left it for the jury to say whether the inspector of the West End Street Ry. Co. was negligent in failing to report the odor of gas which was constant during the time of construction, and whether the constant smell of gas was not such a condition as made it imperative for the railway company, which was dealing with electricity, to be more than ordinarily watchful.

As to the gas company, the Court said it was for the jury to say whether the company had, as the result of its experience with other leaks, and from its correspondence with the Transit Commission and the latter's officials, reason to anticipate such a condition of affairs as existed at the time of the explosion. The jury was also to say whether the gas which exploded was in whole or in part that of the Boston Gas Light Company. It was also for the jury to say whether the gas company had a proper system for detecting and repairing leaks.

The jury gave a verdict against the gas company, exonerating the other defendants. The case will probably go to the Supreme Court on exceptions, and another year may elapse before a final decision is reached. The trial was one of the longest on record; the testimony covering over 3,500 type written pages. It was a test case, and there are over 70 other cases depending on it, involving claims for over $1,000,000.

THE WATER SNAILS AT CHICAGO, which were noted in our issue of Dec. 29, have so far been found only in a few instances, and only in the Lake View water pipes. Mr. Ericson, the City Engineer, informs us that they have caused no pollution of the water, and as this is the first experience of the kind in Chicago, the methods of removing the snails and preventing their future entrance have not yet been decided on. Prof. Frank C. Baker, of the Chicago Academy of Science, informs us that the snail is the bythinia tentacalata, a member of the gastropod class of the phylum mollusca. It has been introduced from Europe, and has gradually spread over the eastern and northern parts of the United States. He considers that the only way to get rid of it, is to scrape the tunnel and flush the pipes. It can only be kept out by employing screens of smaller mesh at the intake, as the eggs are quite small. As this would diminish the flow of water, the screen area must be increased to maintain the necessary intake capacity.

THE REMOVAL OF IRON AND CRENOTHRIX from the water supply of West Superior, Wis., is now being investigated by the Superior Water, Light & Power Co. Experiments with slow sand and mechanical filters are being made, with Mr. Robt. S. Weston as Chemist in Charge. The results will be reported to Mr. Allen Hazen, Assoc. M. Am. Soc. C. E., of New York city, Consulting Engineer to the company. Dr. H. L. Russell, of Madison, Wis., is Consulting Bacteriologist. The water supply of the city is drawn from 82 6-in. Cook wells on Minnesota Point, a sand bar 500 ft. wide and 4,000 ft. from the mainland. The wells have been in use since October, 1897. The water contains 1.5 parts of iron per 1,000,000 parts by weight. The city has withheld about $50,000 of hydrant rentals, and under the direction of Dr. Floyd Davis, of Des Moines, Ia., has prepared to bring a suit to annul the company's franchise, on the ground that the water is polluted. The company maintained, up to last August, that the supply was satisfactory from a sanitary standpoint, in which it was supported by Prof. E. G. Smith, of Beloit, Wis. We are indebted to Mr. Weston for the above information, who states that "the case here is a good illustration of the fact, that a disagreeable unpolluted, or slightly polluted, water is more often the source of complaint than an agreeable grossly polluted one."

THE NORTH BRANCH OF THE CHICAGO RIVER, by an agreement made between owners of adjoining property and the Board of Local Improvement, is to be straightened and deepened between Belmont and Lawrence Avenues. The property-owners give to the city a strip of land along the river front 180 ft. wide, says the Chicago "Record," and the city agrees to construct a ditch 80 ft. wide and 8 ft. below city datum and to fill up the old canal; the city to pay all costs. The improvement will give land owners first-class dock property on a navigable stream; whereas the present channel is worthless for this purpose. The city, on its part, will obtain an outlet for the Lawrence Avenue conduit, now under construction for conveying water to the Sanitary District canal.

TORONTO HARBOR IMPROVEMENTS are advocated by the Board of Control and Harbor Commissioners, as follows: Piers of east channel to be extended to 18 ft. of water and the whole channel to be dredged to this depth; divert the Don River from the harbor into Ashbridge Bay; make a new western channel and dredge out the whole harbor. This petition submitted to the government would require the expenditure of about $500,000.

THE LAKE SUPERIOR IRON ORE SHIPMENTS, for 1898, aggregate 13,650,788 gross tons, to the close of the season on Dec. 13. This exceeds the greatest previous shipment of 12,215,645 tons in 1897. Including 450,000 tons sent by all-rail routes, the total shipment for 1898 was over 14,000,000 tons.

A CANAL ROUTE CONNECTING the Caspian Sea and the River Oxus has been found by Russian engineers. The canal would leave the Caspian near Michailovsk, touch Igdi, and then turn north to the Sary Kamish lakes and reach the Oxus about midway between Khiva and the Sea of Aral. The distance would be nearly 500 miles; but such a waterway would connect Europe with the heart of Asia by way of the Volga and its tributaries. Incidentally, the engineers find evidence to refute the long-accepted theory that the Oxus, now emptying into the Sea of Aral, once flowed into the Caspian Sea through an existing depression and a line of unconnected lakes extending towards the Caspian, over the Black Sand desert, and from a point near Bokhara, on the Oxus. While the engineers have not found any other old bed of the river they have conclusively proved that it was not on this line.

A NEW TIE PRESERVATIVE has been patented by Mr. Hasselmann, of Munich, and has been successfully tried on the Bavarian railways. The process is intended to produce a chemical union between the wood substance and the preservative. The ties are double baked and then treated to sulphuric acid and sulphate of iron. After this they are placed in a bath of chloride of lime, to which milk of lime has been added, and at a temperature of 100 to 125° C. they are submitted to a pressure of about 40 lbs. per sq. in. The whole process takes about six hours, and is said to be very cheap. We give the above on the authority of the English "Iron Trade Review."

THE USE OF OLD RAILS FOR STREET RAILWAY TIES.

The accompanying illustrations, Figs. 1 and 2, represent a type of steel railway track construction recently employed by the Rochester Ry. Co., Rochester, N. Y. In this instance brick pavement was being laid on the street and advantage was taken of the opportunity to relay about 8,000 ft. of track, replacing the 4½-in. girder rails by 60 ft. grooved girder rails 6 ins. deep with a 6-in. base. As the old rails would sell for so little it was determined to cut them up in proper lengths and use them for ties. These ties are 7 ft. in length and on double track every third tie, and all joint ties are 16 ft. in length and extend under all four rails.

AN EXAMPLE OF THE USE OF OLD RAILS FOR STREET RAILWAY TIES.

The rails were cut by nicking around them with a cold chisel, and then dropping over a block. The long ties extending across both tracks were bent to conform to the curvature of the street with an ordinary rail bender. The ties were inverted and secured to the rail by cast-iron clips bolted through the base of the rail ties, Fig. 2. They were placed about 6 ft. apart and bedded in Portland cement concrete, extending 4 ins. below the bottom of the tie, the rail resting upon and imbedded 1½ ins. in a Portland cement concrete beam 16 ins. wide and 12 ins. deep, the space between the ties and rails being covered with not less than 6 ins. of concrete. Outside of the track a concrete foundation was used to support the brick pavement.

The tracks are 5 ft. apart and laid with broken joints. Previous to concreting, as described, the ties and track were securely blocked up to grade with stone and wedges. A small portion of the track was laid with the Pennsylvania Steel Co.'s channel tie 1⅜ × 7 ins., 6 ft. long, of 5-16-in. steel, bolted to the rails with angles, the old rail ties, however, being used under all joints and extending under all four rails.

Fig. 3 shows a form of concrete tie construction used by the same company on West Main St., at the time it was being asphalted.

In this instance the street for the full width of the track was excavated, ditches being dug under the rail positions, as shown in the figure. Every 6½ ft. two ¾-in. bolts about 14 ins. long were supported by strips of wood which were lined and leveled up. Concrete was then filled in the ditches around the bolts and over the road bed to such a depth that when the asphalt was put on the street surface was level with the tops of the rails. The anchorage of these bolts was a 5 × 7 × ½-in. plate. Just before placing the rails a ½-in. layer of asphalt was spread over the concrete sleepers to insure an even footing for the rails, and a cushion to prevent jarring.

The method of bolting down the rails is clearly shown in Fig. 3, which also shows how the ends of the 60-ft. rails were joined.

In speaking of this work Mr. Le Grand Brown, M. Am. Soc. C. E., Chief Engineer of the Rochester Ry. Co., to whom we are indebted for the photograph and information from which this description was prepared, says that it makes a solid road bed, but is an expensive and slow construction, especially when the asphalt strip costs 8 cts. per foot of rail.

THE MECHANICAL PLANT OF A MODERN COMMERCIAL BUILDING.*

By William H. Bryan, M. Am. Soc. M. E.†

The modern commercial building is, in many respects, an engineering structure. The problems of foundations, design of frame and walls for the desired loads and wind pressures, the plumbing and sanitary arrangements, call for engineering skill of the highest order. This paper, however, will be confined to the discussion of the mechanical, steam and electrical plants, which are of fully equal importance.

The author submits with some diffidence the methods employed in designing the equipment for a large building recently constructed in St. Louis. It is not claimed that they involve anything particularly original, or that any special or unusual difficulties were encountered. It is offered simply as an example of what is believed to be good current practice.

The building is a brick and stone building, of the character known as "standard slow combustion," as defined by the Board of Fire Underwriters. It is owned by the Commerce Realty Co., and is situated on the north side of Washington Ave., between 9th and 10th Sts. Its ground space is 109 ft. front by 225¼ ft. deep, and it is eight stories high, besides basement. The tenants are the Hargadine-McKittrick Dry Goods Co., an old established wholesale firm. The architects were Messrs. Eames & Young, of St. Louis, who, at an early stage of the work, called into association with them as advisory and consulting engineers, the firm of Bryan & Humphrey. Ground was broken Nov. 16, 1897, and the work was pushed urgently when the weather permitted, and for part of the time, night and day. The tenants moved in on June 1, 1898, partial service from the mechanical plant being then available, and complete service being furnished shortly thereafter.

In the designing of this plant, a prime consideration was the necessity of getting a high grade installation for as little first cost as possible.

To begin with, the location and character of the building, and the work to be carried on in it, were discussed by the architects and engineers, in consultation with the owners of the building, and their prospective tenants. Having determined on the general character of the plant as nearly as possible, detail plans and specifications were prepared, and tenders were solicited from a limited number of experienced and responsible bidders.

The work of preparing detailed plans and specifications was taken actively in hand about Jan. 10, 1898, and they were completed and sent out about Feb. 1st, bids being asked for until Feb. 16. The specifications were, in general, in line with the suggestions made by the author in the paper presented at the Niagara meeting of the Society on "The Relations Between the Purchaser, the Engineer, and the Manufacturer" (Transactions, vol. xix., Eng. News, June 2, 1898). They embodied the following divisions:

*Condensed from a paper presented at the New York meeting of the American Society of Mechanical Engineers.
†Consulting Engineer, St. Louis, Mo.

First: The "Notice to Bidders," indicating the time and place of receiving bids; the manner of their preparation, whether on single or combined sections; each bid to be in good faith, not requiring later approval; the bids themselves to become the property of the purchaser, and not be returned. The tenders were to be made on proposal forms which were given the bidders, and not on their regular forms.

This was followed by the "General Provisions," covering the conditions under which the different divisions of the work were to be executed, such as replacing of unsatisfactory work and material; supervision; the decision of disputed points; compliance with laws, ordinances, and underwriter's rules; changes, how made; damage done to building by contractor; course to be pursued in case of failure or delay by the contractor; time of beginning and completing the work; deduction for delay in completion; services of expert; standard of excellence, where special makes of goods are mentioned by name; guarantee of one year on all parts of the work; accuracy of data furnished, contractor being required to verify same and see that the plant went together properly; the requirement of bond; and terms of payment. As nearly every section required foundations, a paragraph was added covering once for all the character of foundation required, the method of conducting the work, etc. The foundations, by the way, were to be built of concrete, of Atlas or Empire American Portland cement, one part of which was mixed with three parts of sand, and four to five parts of crushed macadam, cleaned and screened.

Following these come the different sections of the work itself, which will now be taken up in order:

Section A—The Boiler Plant.

Steam was required for three purposes: Heating, lighting and elevator service.

The maximum amount of steam required for heating was about 250 boiler HP. More than this amount would be necessary for the lighting and elevator service, even with the most economical steam engines. As there would always be a surplus of exhaust steam available for heating, it was evident that the heating requirements need not be considered further as a factor in determining boiler capacity.

The maximum electrical requirements were about 150 K-W.—exclusive of the elevators—or about 200 E. HP. Assuming a combined efficiency of engine and dynamo unit, from steam cylinders to switchboard, of 80%, the maximum I. HP. is 250. Using simple steam engines at a water rate of 40 lbs. per I. HP. per hour, the steam requirements would be 10,000 lbs. per hour. Or, for compound engines at 28 lbs. of water per I. HP. per hour, 7,000. These being divided by 30 to reduce them to boiler HP., give us 333 for the former, and 233 for the latter.

For steam elevators, 67 I. HP., at 100 lbs. water rate, ÷ 30	223
For hydraulic elevators, with simple duplex pumps, 75 I. HP., at 100 ÷ 30	250
For hydraulic elevators, with compound steam pumps, at 60 ÷ 30	150
For hydraulic elevators, with high duty pumping engines, 75 I. HP., at 28 ÷ 30	70
For electric elevators, with dynamos driven by simple engines, 75 I. HP., at 40 ÷ 30	100
For electric elevators, if driven by compound engines, 75 I. HP., at 28 ÷ 30	70

The following table shows some of the combinations which were possible, all of which were under serious consideration. It will be seen that the maximum steam requirements for electrical and elevator service might vary all the way between 303 and 583 boiler HP.

	HP.
Compound dynamo engines and electric elevators	303
Compound dynamo engines and hydraulic elevators, driven by high-duty pumping enginea	303
Compound dynamo enginea and hydraulic elevators, driven by ordinary duplex compound pumps	383
Simple dynamo engines and electric elevators	433
Compound dynamo engines and steam elevators	456
Simple dynamo engines and hydraulic elevators, driven by compound duplex pumps	483
Simple dynamo engines and steam elevators	556
Simple dynamo engines and hydraulic elevators, driven by simple duplex pumps	583

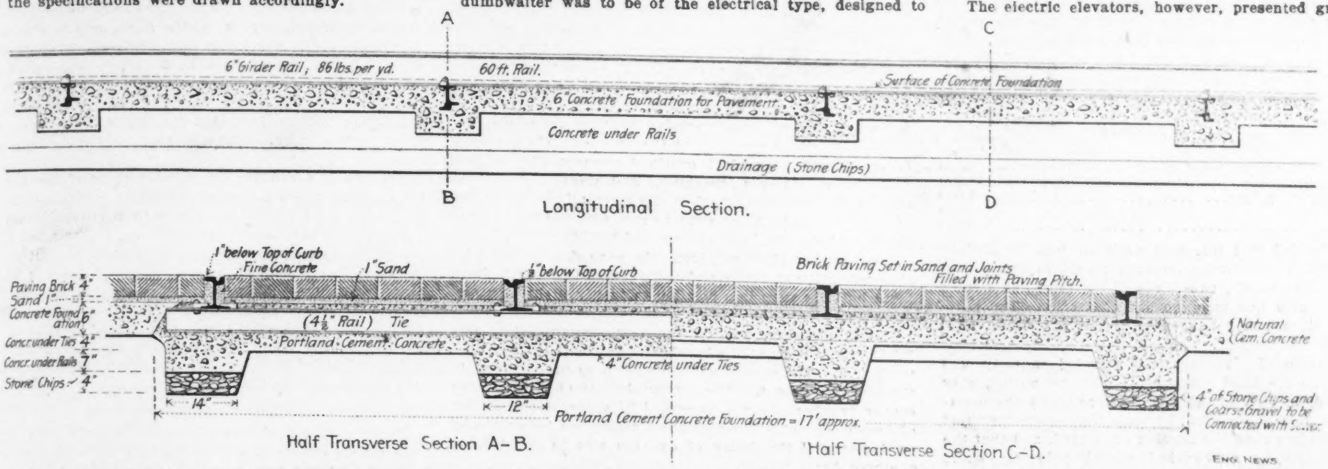
After due consideration, it was decided to ask for proposals on three boilers, each having a rated capacity of 6,000 lbs. of water per hour, with feed-water at 212° into dry steam of 125 lbs. pressure above atmosphere, equivalent to 181.7 boiler HP. each. Each boiler was to be capable of doing this work continuously with natural draught under regular working conditions, and of being overworked one-third in emergencies. It was assumed that this capacity would probably take care of the building; two boilers being operated regularly, and the third being held in reserve for cleaning or repairs, or used on rare occasions of unusually large demands. There was, at that time, considerable doubt as to whether the owners could be induced to put in the most economical type of apparatus. The capacity was purposely stated in pounds of water to be evaporated per hour, rather than in horse-power, so as to avoid discussing the question of heating surface per horse-power adopted by the different makers.

The next question was as to type of boiler—whether of the water-tube or of the ordinary horizontal return tubular variety. The writer's experience had led to the conclusion that the water-tube boiler possesses three important advantages:

1. Large capacity in small space.
2. Large capacity in single units.
3. Safety—particularly with the higher pressures required for modern steam plants of high efficiency.

On the other hand, the ordinary boiler has the advantage of lower first cost—particularly in the smaller units; simplicity, and ease of being cared for.

A consideration of the requirements of the present plant clearly "indicated" the adoption of the water-tube boiler, and the specifications were drawn accordingly.



Ties are of old 52 lb. Rails, Spaced 6' C. to C. and Bedded in Portland Cement Concrete. Concrete Extends 4" below and 1½" above Tie, with 12" Depth and 16" Width under each Rail. Rails Laid to Break Joints. Ties 7' long. On Double Track Construction every Third and all Joint Ties are 16' long, extending under and Fastened to all 4 Rails. The 16' Ties are Bent at the Center so as to Allow all 4 Rails to Conform with Surface of Pavement.

FIG. 2.—SECTION OF EAST MAIN ST., ROCHESTER, N. Y., SHOWING DETAILS OF STREET RAILWAY TRACK CONSTRUCTION.

The boilers were designed to burn low-grade slack and nut coal from Southern Illinois, and to use St. Louis hydrant water. The boilers and furnaces were to have a combined efficiency of at least 70% of the calorific value of the fuel when operating at anywhere between their rated capacity and 20% above. The evaporative trials to be made with a coal equivalent to Mount Olive lump, having a calorific value of not less than 11,000 B. T. U. per lb. The entrainment was not to exceed 1% when operated at rating, or 1½% when operated at one-third above rating. The working pressure was to be 125 lbs. with a factor of safety of 5. The boilers were to be submitted to a hydraulic pressure test of 50% greater.

Material in shells and heads was to conform to the latest specifications of the American Boiler Manufacturers' Association, a stairway was to be provided, affording ready access to the tops of boilers. The contractor was to look after the city and insurance tests, and furnish and attach to each boiler a smokeless furnace, equivalent in capacity, efficiency, and smokelessness to the downdraft with lower grate. This requirement was inserted for two reasons: First, this type of furnace unquestionably improves the fuel efficiency of the boilers; and, second, the plant being located in the heart of the city, it was desired to avoid any smoke nuisance.

The writer specified the same form of fire-doors which he first used in the summer of 1897, opening across the entire width of the grate surface, permitting access to all parts of it for observation, slicing and cleaning. This has proved a very desirable feature in practice.

The chimney was included in the building contract. It was located inside a square brick shaft, and was made of riveted steel ¼-in. thick, resting on a substantial cast-iron foot plate. It was lined its entire length with firebrick. Its dimensions were 48 ins. internal diameter by about 135 ft. high, above floor level of boiler room. It would ordinarily be rated at about 400 HP. The dimensions were decided upon when the building was begun, before any of the computations as to actual steam requirements had been made. It was assumed that only two boilers would ever be operated at one time, and that the stack could be overworked in emergencies, as experience has shown to be possible.

Section B—The Elevator System.

This division presented the most complicated problem encountered, and one on which there was the widest difference of opinion among interested parties. Steam elevators had been used by the tenants in the old building with entire satisfaction. The architects had recently installed in a large system of warehouses a modern high-pressure hydraulic plant, which had displaced a system of steam elevators, and had made an enormous fuel saving. The engineers had devoted considerable time to the study of modern electrical elevators, and recognized that they were destined to come into extensive use.

Some interesting data were secured from the tenant's old plant. Tests were made on their single passenger and three freight elevators on an average busy day. It was found that the passenger elevator was in actual motion 47% of the time, and the freight elevators, 35% of the time.

The tenants indicated their elevator requirements as follows: There were to be two passenger elevators, each to have a safe carrying capacity of 2,500 lbs. of live load at a maximum speed of 300 ft. per minute. These elevators were to be operated by conductors and to run between basement and top floor, stopping at all floors. The other six elevators were to carry freight only. Two of these six elevators were to be operated by conductors, and to have a capacity of 3,500 lbs. at a speed of 225 ft., operating from basement to top floor, stopping at all floors. The other four were to carry 4,000 lbs. at 150 ft. The dumbwaiter was to be of the electrical type, designed to carry 200 lbs. 100 ft. per minute. The contractor was to provide ornamental metallic gates on each floor for passenger elevator shafts. Separate proposals were invited for safety gates at the freight elevator doorways on all floors.

The original specifications were written to cover hydraulic elevators, alternative proposals being invited on electric and steam machines capable of doing the same work. Contractor was to furnish the machinery complete ready for service, and allow $300 for each passenger car. The travel of the northwest elevator was about 87 ft. and that of all others, 105 ft. Working steam pressure, 120 lbs. The water pressure for the hydraulics was not to exceed 750 lbs. at the pumps. Guide posts, of steel. Cables to be of such number, dimensions, and strength, that in case half of them should fail simultaneously, the remaining half would carry the maximum load, with a factor of safety of 4. Counterbalancing was to be employed as far as possible. Complete safety devices were to be supplied, preventing excessive speeds in either direction, automatic stops at end of travel, and other features, such as slack cable stops, buffers, grips, etc. The pumping engines were to be two in number, each sufficiently large to handle the plant at a piston speed not exceeding 100 ft. per minute, with the aid of the accumulator. Both pumps were to be horizontal direct-acting duplex, with compound steam cylinders, and outside packed water plungers. One was to be of the high duty pattern, having a water rate of not over 28 lbs. per I. HP. hour. The other pump was to be of the ordinary duplex pattern, with a water rate not exceeding 60 lbs. per I. HP. hour. There was to be a weighted mechanical accumulator for the hydraulic system of such capacity that with six elevators operating continuously in the same direction, stopping only at the top and bottom floors, and one pump in operation at not

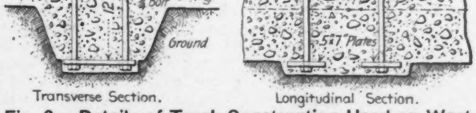


Fig. 3.—Details of Track Construction Used on West Main St., Showing Method of Anchoring Track.

exceeding 100 ft. piston speed, the elevators would do the specified service. The discharge tank was to be located in the attic. Contractor was to furnish and erect all necessary apparatus, and do all water piping. He was to furnish the lubricating apparatus, paint the plant, and submit it to such tests as the engineers might require.

The determining of the horse-power required to operate the elevator plant presented many difficulties. There is a lack of authentic data as to elevator performance covering wide range of service, and it is not possible to make such computations accurately.

The problem was finally solved for hydraulic elevators in the following manner: The average net HP. required by each freight elevator lifting its full live load was 20 HP., and for each passenger elevator, 22½ HP. There were six of the former in operation one-third of the time, but as they use no power coming down, the average work done was 20 net HP. The two passenger elevators were assumed to be in operation one-half of the time, and their requirements were, therefore, 11¼; a total for the eight machines of 31¼ net HP. Assuming an average efficiency of 55% from water end of the pump to work done, the HP. of water end of the pump would be 56. On the basis of a mechanical efficiency of 75% for the pump, the I. HP. of the steam end is 75, the figure already used in determining the boiler capacity.

The electric elevators, however, presented greater complications. Tests have shown that where drum machines are counterbalanced to half the average load, and where the same total load is carried both up and down, the net work done is simply that necessary to overcome friction, plus an allowance to cover the "surge" of energy required at each start. A study of this subject, in connection with records of tests made on similar plants, indicated that when operated under favorable conditions of loads, counterbalancing, frequency of stops, etc., these elevators should have an efficiency, running in both directions, about as follows:

	K-W. hrs. per car. mile
The two passenger elevators	3½
The two southwest freight elevators	4¼
The four north freight elevators	4½

On this basis, the E. HP. required to keep each elevator in motion was found to be 4⅔, 5⅔ and 6, respectively, per car mile. The speeds specified, however, were 3.4, 2.55, and 1.7 miles per hour, respectively, on which basis 15.9, 14.45 and 10.2 HP. were required. Assuming that the passenger elevators might be in motion one-half the time, and the freights one-third, and multiplying by the number of elevators, the power consumed is found to be 15.9, 9.6, and 13.6 HP., respectively; a total of 40, in round numbers. In view of the fact, however, that ideal conditions of loading and counterbalancing would never be reached, and also that uncertainty existed as to the actual number of stops per trip, and percentage of time which the elevators would be in operation, and in order to avoid any appearance of partiality to the electric installation, it was thought wise to increase this allowance by 50%, and to call the total 60 E. HP. at switchboard. Assuming a combined engine and dynamo efficiency of 80%, the average I. HP. at cylinders of dynamo engines is 75, as already stated.

In computing the horse-power required to drive steam elevators, it was presumed that they would be run by direct connected steam engines in the ordinary manner. Assuming the net power consumed by the elevator mechanism itself at 50 HP., and the mechanical efficiency of the steam elevator engines at 75%, we arrive at the figure of 67 above referred to.

The clause in the specifications providing for alternating bids on electrical elevators stipulated that the elevators were to be of the same general character, as the hydraulic, modifying the design only in so far as necessitated by electrical driving. The purchaser agreed to supply electrical current at 220 volts at the switchboard. The contractor was to do all wiring from that point to elevators. Elevators to be of the single or double worm type, with steel worm and gun-metal gear. The motor was to have an automatic starting device to give the car an easy start independent of the operator and cable, returning to the starting point automatically in case of interruption of the current. When starting from rest to full speed within five seconds, the starting current was not to exceed the operating current at full speed by more than 50%. The purchaser was to provide a third electrical generating unit of 75-K-W. capacity in case electric elevators were adopted. The plant to be so designed as to be capable of operating in multiple with the lighting system without noticeable interference with the steadiness of the electric lights.

The alternate proposals asked for on steam elevators were to comply with the same general conditions as before, except that the elevators were to be driven by direct-connected steam engines of the duplex double-acting vertical type. Separate proposals were invited on an ash-hoist to have a platform of about 60 × 23 ins.; capacity, 1,000 lbs.; speed, 50 ft.; travel, about 20 ft.

Section C—Dynamos and Switchboard.

The contractor for Section C was to furnish and erect the generators and switchboard, with connections between same. Proposals were to state the commercial efficiency of the generators at ¼, ½, ¾, and full load, subject to test after the machines were installed. A study of the purchaser's needs showed that they could be best met by a combination of arc and incandescent lamps. In addition, there were three motors driving fans in basement, and an allowance was also made for small fan motors throughout the house, and about 1% for drop in the wiring. These were summarized as follows:

	Watts.
200 arcs at 2¼ amperes, and 220 volts—550 watts =	110,000
600—200-volt 16-c. p. incandescents at 60 watts =	36,000
For motors, drop, etc.	4,000
Total	150,000

It was decided that this load could be best handled by two 72-K-W. generators. As such machines can run at considerable overloads, two-thirds of the total lights could be handled with one machine out of service. Three 50-K-W. machines would have been better, but would have cost more.

The selection of dynamos whose rated capacity was equivalent to the total number of lights connected, may be criticised, in view of the fact that ordinarily the maximum number of lights burned at one time—even for short intervals—is less than the number connected, and that the generators can be overworked considerably for short periods. The anticipated load factor, however, was large and some margin for growth was necessary. No special or reserve machine being provided, it was not desired to cripple the plant more than absolutely necessary when one machine might be shut down on account of accident, or for repairs.

150 K-W. at the switchboard is equivalent to 200 E. HP. Assuming a combined efficiency of engine and dynamo unit of 80%, the indicated HP. in the steam cylinders is 250.

The question might be asked why the maximum load was taken for the boiler horse-power, when the average load would be much less, and the entire number of lights would probably never be burned at one time. As explained above, the work done in this building was of such a nature that what is known as the "load factor," or ratio between the maximum number of lights operated at one time, and the total number connected would be large, and it would sometimes happen that every light would be burning. Furthermore, experience has shown that more lights and motors are added as business increases and the necessity for them develops, so that some margin for growth must be allowed.

A departure from established practice was made in adopting a voltage of 220, instead of 110. This was done for three reasons: (1) It was desirable to have an outside connection from a central station for use in the event of any serious accident in the plant. No central station, however, furnished direct current for power at 110 volts, but two convenient stations offered such service at 220 volts, both being from 220 to 440 direct-current three-wire systems. (2) It was believed that the electric motors would give better satisfaction at this voltage, and stopping and starting them would have less effect on the lights, as it was intended to run the entire light and power service from the same electrical apparatus. (3) The distances covered being quite large for an isolated plant, both the investment in copper and the "drop," or percentage of loss in wiring system, were materially reduced.

It is true that the 220-volt incandescent lamp is not as efficient as the 110, and that it costs more, thus increasing the cost both of fuel and of lamp renewals. The 110-volt 16 c. p. lamp ordinarily used, consumes about 55 watts, and the 220 volt, about 60. This means 9% more generating capacity and fuel burned. The 16 c. p. 220-volt lamp costs from 23 cts. to 25 cts. each, and the 110-volt, 18 cts. to 20 cts. This inferiority is largely due to the fact that the number of 220-volt lamps in use is still small. The efficiency is improving and the price falling, as the demand increases, and it is believed they will, in the not-distant future, approximate closely to the 110-volt lamp. In the present case, it was believed that the advantages of the 220-volt system overbalanced the objections named.

At the time this work was taken up the 220-volt arc lamp was in an experimental stage. It was a question whether to burn the arcs singly across 220 volts, or to use two 110-volt lamps in series. In either case, the enclosed arc lamp, burning in multiple, was to be used, for reasons explained later. A large number of sample 220-volt arc lamps were tested in the offices of the engineers, and a reasonable number of these were found satisfactory. The arc is long, and the light has a bluish purple tinge. The former, however, was not objectionable with the ground-glass inner globe. The latter also yields to treatment; so that, on the whole, it was thought entirely safe to use the single lamp, thus greatly simplifying the system.

The electric elevators could, of course, have been operated alone, with less than 75-K-W. average; 75 HP., or 56 K-W., being the average amount of energy required, as already explained. As electric elevator service, however, is frequently subject to sudden and severe overloads for short periods, due to the starting and operating of a number of loaded elevators simultaneously, a surplus of power was necessary; and as it was desirable to have all the electrical units alike, and interchangeable, it was thought best not to reduce the size of the third unit.

The specifications provided that the generators should be of the direct-conected type, mounted on engines, each generator to be rated at 75 K-W. at 220 volts. Speed about 250 revolutions per minute. When run continuously, at rated load, the temperature was not to rise above the surrounding air more than 72° Fahr. in the armature; 54° in the fields; 72° in the commutator. They were to be capable of carrying 25% overload for two hours, and 33⅓% for one hour, without excessive heating anywhere, and without injurious sparking at the brushes. They were to be capable of taking 50% overload momentarily, without flashing or injurious sparking, and were not to flash around the commutator when the circuit breaker opened at 50% overload. They were to run without sparking or shifting of the brushes from no load to 25% overload.

These rather rigid requirements were due to the possible operation of electric elevators, and as several prominent builders were in a position to supply such machines, competition was not limited.

The winding of the fields was over-compounded to give 3% higher voltage at the brushes at full load than at one-tenth load. The rise in voltage was to be proportional to the load throughout. The current density at rating in the copper brushes was not to exceed 27 amperes per sq. in. of brush contact. The insulation resistance between any conductor and the frame of dynamo was to be at least one megohm.

The switchboard was to be of white Italian marble, 1½ ins. thick, located 24 ins. from wall.

This board is designed with an extra power bus bar, so that the elevators can be operated separately from the lights, if desired. This has never been done, however, except when the plant was started, and before engines and generators were adjusted. The large double-pole double-throw switch enables either the motors or lights to be connected to outside reserve connection, the other being operated from the dynamo. When both sides of this switch are thrown to outside connections, the entire building is operated from central station on three wire 220 to 440 system.

Each proposal was to name a price on two generators as above, with an extra price for a third unit, with one feeder panel, the latter to contain eight 150-ampere double-pole single-throw switches; eight 200-ampere single-pole circuit breakers, and one 220-volt 500-ampere recording station wattmeter—all of these being required for the electric elevator service.

Section D—Steam Engines.

These were to be of the direct-connected type, for driving the two 75-K-W. generators, each to be operated independently. The assumed efficiency of 80% fixed their capacity at 125 HP. each. The operating steam pressure, if compound engines were selected, was to be 120 lbs. above atmosphere. Contractor was to furnish and erect these engines, ready for pipe connections, including foundations for engines and dynamos. Each proposal was to embody a guaranteed water rate per I. HP. hour, and be accompanied by a drawing showing space occupied, foundations required, dimensions of cylinders, weight of engine, fly-wheel, and sub-base, and diameter of shaft. The proposal was also to state additional cost of a third unit identical with the others, for use in case electrical elevators were adopted.

The specifications were drawn for compound engines. Condensing apparatus was not deemed desirable, on account of its increased cost, complication, and space required. The fuel saving would have been small, as the exhaust is used for heating during the five months of cold weather, when the load on the engines is also a maximum. Bidders were asked to state the price of simple engines of the same I. HP. The engines were to be of the horizontal center-crank tandem, compound, high speed, non-condensing automatic type, built extra heavy throughout, speed about 250, stroke at least 14 ins., designed for an overload of 50% for short periods, water rate not over 25 lbs. per I. HP. hour; shaft governor to be equivalent to the Rites, controlling both high and low pressure cylinders. The drop in speed with constant steam pressure between no load and 50% overload was not to exceed 2%, and was not to exceed 1½% with constant load and steam fluctuating between 100 and 125 lbs.; and 3% for the combined changes in load and pressure. Engines were to operate smoothly, noiselessly, and without heating or undue wear, at all loads and pressures. Heavy cast-iron sub-bases were to be furnished of proper width to receive dynamos. Shaft to be of steel, in one piece. The usual fittings, fixtures, and lubricating apparatus to be furnished. One extra heavy fly-wheel, steam cylinders lagged, bright work highly finished. Crank pin to be of same dimensions as shaft. Engines to be finished, painted and submitted to such tests as might be required.

Section E—Wiring, Arc, and Incandescent Lamps, Fans and Motors.

This section covers all the apparatus and material necessary to transmit the electricity from the switchboard to the points of use. The 220-volt multiple arc distribution was adopted, for reasons already explained. The arc and incandescent lamps were run from the switchboard on independent systems of wiring.

Edison key sockets were to be used throughout, with porcelain bases. Contractor was to furnish and connect 600 16-c. p. lamps, with anchored filaments, and 600 hours guaranteed life. The intention was to select that type of lamp which would give this life with the best guaranteed efficiency and maintenance of candle power.

Three motors for ventilating fans were to be supplied—one in basement, one in engine room, and one in boiler room; the air to discharge into space surrounding stack. Each fan was to be 24 ins. in diameter, with speed variable between 200 and 600 revolutions per minute. Motors to be ½ HP. each, series wound, equipped with switches, regulating devices, iron-clad armatures, large mica insulated commutators, carbon brushes, and self-oiling bearings.

The two hundred arc lamps were to be of the enclosed type, burning 150 hours continuously without trimming. Proposals were invited on lamps to burn singly on 220-volt circuits consuming not over 2½ amperes each, and also upon lamps to operate two in series, without robbing each other, and with equal steadiness. All lamps were to have resistance enclosed in top of lamps, and be hung from ceiling on independent supporting wires. They were to have opalescent inside globes, and clear glass outside globes. To have the usual fittings and adjustments, and polished brass finish. Thirty days' supply of carbons was also to be furnished.

Section F—Steam Heating.

In installations of this character, all the pipe work—both high and low pressure—together with necessary apparatus, is usually included in one specification and contract. In the present instance, however, the details of the high pressure and exhaust connections and apparatus could not be determined upon until the boilers, engines, and elevators had been selected. The heating plan was therefore taken up as an independent problem.

It was decided that the most severe conditions would be met by assuming an external temperature of 10° F., the building to be heated to 70° F., with steam pressure not exceeding 2 lbs. The temperature occasionally drops below 10° in St. Louis; but on these rare occasions it was thought that the pressure could be carried a little above 2 lbs., or that a slightly lower temperature than 70° might be permissible. The heat loss was computed on the basis of 80 B. T. U. per hour per sq. ft. for exposed glass surface, and 16 B. T. U. for brick wall—the units given by Wolff. For the east and west walls, which were in contact with adjoining buildings, it was concluded to assume that one of these buildings might be vacant in cold weather, and might reach as low a temperature as 32° F. On this basis the heat loss would be about 10 B. T. U. per hour per sq. ft. of wall. The changes of air to be provided for were assumed at 4 per hour for the shipping room on the first floor, 2 for the balance of the first floor, and 1 for the rest of building.

From Carpenter we learn that 1 B. T. U. will heat 55 cu. ft. of air 1°, and following his reasoning we get the following formula for total heat loss:

$$H = 80G + 16W \quad \frac{80nC}{55} + 10w$$

in which:

G = exposed glass surface in square feet.
W = exposed wall surface in square feet.
w = wall surface adjoining west store.
C = cubic feet of space to be heated.
n = changes of air per hour.

It has been shown that 1 sq. ft. of ordinary direct radiating surface will give off about 280 B. T. U. per hour, with steam of 2 lbs. gage pressure. Dividing the heat loss by 280, and reducing, we get the following formula for radiating surface:

$$R = \frac{2}{7}\left\{G + \frac{W}{5} + \frac{w}{8} + \frac{nC}{55}\right\}.$$

In using this formula, the factor 2-7 was changed to ⅓ to allow for the severe northern exposure, and to admit of the building being heated quickly when cold.

No special ventilation was provided for the upper floors. The rooms were all very large and occupied by but few people. It was thought, therefore, that sufficient fresh air would find its way through the doors, windows, stairways, elevator shafts, etc., to keep the rooms pure. As this air would have to be heated, however, it was, as already stated, assumed that the leakage would amount to two entire changes of air on main floor, four in shipping room—where the doors were constantly opening and closing—and one on the upper floors. The roof not being ceiled in, was assumed to have a heat loss equal to that of the exposed brick walls. This, with the skylights, made necessary a large amount of heating surface on the eighth floor.

The heat loss in basement being very small, no radiating surface was provided here. The steam and return pipes, however, were all left uncovered.

The system of steam distribution was that of a main distributing riser going to the top floor, and there branching both ways along the four walls, and supplying single-pipe descending risers, from which branch connections were taken to all radiators. A few coils of 1-in.

pipe were placed in skylights and provided with double-pipe connections. The basement return for descending risers was divided into two sections. The radiators on first floor were to be supplied by an independent single-pipe main, going entirely around basement, and carrying both steam and returns.

The selection of the maximum heating pressure at between 2 and 3 lbs. fixed the velocity of steam in mains at about 37½ ft. per second, causing a drop of pressure about 0.1 lb. in 100 ft. These values were used in proportioning the mains and branches with proper allowance where the double-pipe system was used.

It was recognized that the unit values here assumed would result in a liberally designed system, capable of heating and circulating easily and quickly, and of taking care of extreme conditions satisfactorily. Many engineers would have figured the work more closely, and have taken the chances on satisfactory service, but it was not deemed good engineering to do so in this case.

The radiator connections and valves specified were as follows, being single pipe in each case:

Under 24 sq. ft., 1 in.; 24 to 50 sq. ft., 1¼ ins.; 50 to 125 sq. ft., 1½ ins.; 125 to 200 sq. ft., 2 ins.; above 200 sq. ft., 2½ ins.

The main riser is also intended to be used as a free-exhaust pipe, thus saving a long length of large pipe. This necessitates placing the back pressure and controlling the valves of the eating system in the top floor, an inconvenience which was justified by the saving in first cost. All branches were to be attached to mains by flanged unions, and to be independently valved. Branches from risers to radiators were to have a pitch of 1 in. to the foot, and if over 18 ins. long, were to be one size larger than the radiator valve.

The radiators were to be of the plain cast-iron three or four column pattern, 38 ins. or 44 ins. high. The use of such large radiators was due to the desire to simplify the plant and keep down its cost. It was believed that they would answer the purpose satisfactorily, as the rooms were all large and the heat would readily distribute itself. Some of the radiators on the first floor were to be covered with marble slabs, and others were to have deflecting shields. Approved air valves were to be located where necessary.

The fittings were to be of the "sweep" or long radius pattern to reduce friction. No plugs or bushings were to be used. Fittings were to be eccentric where necessary. All work 8 ins. and larger was to be flanged, except couplings on low-pressure work. The valves were to be angle or gate; radiator valves, corner or angle. Valves under 2½ ins. to be of best steam metal. Pipes to be properly protected with sleeves where passing through floors, ceilings, or walls. All pipe lines were to have a pitch of ¼ to ½ in. in 10 ft., in the direction of the current of steam or water. They were to be supported or anchored by approved devices at intervals not exceeding 10 ft., with due provision for expansion and contraction. All work was to be thoroughly cleaned and painted. The entire system was to be tested with 50 lbs. steam pressure and made absolutely tight. Bidders on this section were to state make of radiator offered, whether three or four column, and its height. They were also to file discount sheets on material and labor, on which basis extra work could be ordered if needed.

Bidders were also to submit alternative propositions on the Paul and Webster systems of air removal. It is not intended to discuss these systems here at length. Both provide means for quickly and positively removing the air from radiating surfaces, and thus maintain it at all times at the highest efficiency. The positive means by which this is done permits the circulation of a greater amount of steam through the system, and the net result is that more work is done by a given amount of radiating surface. The system works without noticeable pressure, and therefore relieves the engines of the back pressure which ordinarily accompanies the use of exhaust steam in heating, thus permitting the use of compound engines, and making higher engine economies possible. Other incidental advantages are the removal of noises, odors, water, etc., due to air valves discharging into the rooms.

In the Paul system, the air valves on the radiators, steam lines, etc., are connected to an independent system of air mains of small pipe leading to an air jet or siphon operated by steam in the engine room. This "exhauster" produces a vacuum on the air line reaching to the radiators. The air valves are so located as to collect the air to best advantage. The cooling due to the accumulation of air causes the air valve to open, when the vacuum system immediately exhausts the air from the radiator. The air valve closes as soon as it is warmed by the incoming steam. In this way the entire radiator is kept warm at all times. The Paul system does not handle any water, and is applicable to the single pipe system.

The Webster system is similar, except that it handles water as well as air, and is usually connected to the regular return system. Where the single-pipe system is used a small separate return main is run. The actuating mechanism in basement is a steam pump, which handles both water and air, and maintains the necessary vacuum.

Many other incidental advantages are claimed for both systems, and they are found quite satisfactory in service, and are coming into general use.

It was thought desirable to ask for bids in the above manner, rather than to specify one or both systems, in order that a comparison could be made between them, and a system designed to accomplish the same results with a back pressure so low as to be unobjectionable.

In determining the boiler horse-power necessary for the heating, it was assumed that each of the 24,916 sq. ft. of radiating surface would condense about 0.3 lb. of steam per hour as a maximum when in active service, a total of 7,475 lbs., which, being divided by 30, gives the boiler horse-power as 249.

Section G—Large Pipework and Other Apparatus.

While the exact data for this section could not be secured until the boilers, engines, and elevators had been selected, it was possible to map it out in a general way. It included the high-pressure connections from boilers to engines and pumps, exhaust connections to roof, and heating system, all the necessary covering, drains, blow-offs, receivers, controlling and relief valves, and other apparatus.

High-pressure steam at 125 lbs. was to be provided for the engines and pumps. The exhaust was to be used for heating, supplemented by live steam when required. The contractor for this section was to take the heating plant from where the contractor for Section F left it, and connect it with the rest of the system complete. Each steam engine was to have a separator near its throttle of the "Sweet," or equivalent make. The engines were located so close to the boilers, and the steam pipes were so large, that the writer deviated from his usual practice of combining the separators with receivers. Returns from the separators were to be trapped into receiver. Two 300-HP. Hoppes, or equivalent feed-water heaters were to be supplied. This large capacity was due to the fact that these heaters served also as receivers and expansion tanks. It was intended also that one could be cut out for cleaning or repairs without seriously disturbing working conditions. No separate grease extractor was provided other than those which come with this type of heater. Three 6×4×6 outside plunger duplex pumps were specified—one for boiler feeding; one for the water service of the building; the third a reserve, capable of taking the place of either of the others. The house pump was to have a regulator to maintain a constant water level in the house tank on top floor. The contractor was also to furnish a small direct-acting air pump, of the locomotive type, for the sprinkling system. All pumps were to be properly connected, with steam, exhaust, and feed-pipe connections, blow-offs, and drains, leading to blow-off tank. The latter was to be of ¾-in. cast-iron, 36 ins. by 36 ins., located under boiler-room floor, provided with manhead, overflow to sewer, and 2-in. vent pipe to roof. Blow-off pipes from boilers, heaters, and miscellaneous drains, discharged into this tank. There was to be a 5×10 pressure reducer, guaranteed to work anywhere from a slight vacuum to 10 lbs. gage pressure, to admit live steam automatically to the heating system whenever there was a deficiency of exhaust. This regulator was to be by-passed so that it could be taken out for examination or repairs without interfering with the working of the system. A 10-in. back pressure valve was to be located in the eighth story on free exhaust, which would open to the atmosphere in case of excessive pressure on the heating system. A complete lubricating system was to be supplied for oiling all engines and pumps from a central source. A marble gage board was to be erected in engine room, holding a high-pressure gage for main steam line; a low-pressure gage for heating main; a combination water pressure gage for city water main, and another for house supply system, and an 8-day clock, all to be 10-in. dial, nickel plated. The same general provisions were made as in Section F for covering, material and workmanship. The feed-water heaters, and all high pressure and exhaust lines in boiler and engine rooms, were to be covered with high-grade covering, equal to the K. & M. Magnesia, or Nonpareil cork, of standard thickness, canvased and painted. Smoke flues, and domes of boilers, were to be covered with 1½-in. blocks of the same material. All high-pressure work was to be tested to 125 lbs., and made tight at that pressure. This contractor was to furnish all foundations necessary for his work.

Contracts and Prices.

In view of the central location and general character of the building and its tenants, and the fact that the installation was intended to be a model one, there was great competition for the work. Furthermore, as all bidders were figuring on practically identical specifications, there was no chance to claim advantages due to superiority of apparatus or methods. The figures, therefore, were strictly comparative.

On account of this competition, the work was let at exceedingly low figures, as will be seen below, the usual profits being cut out, and in some instances, losses sustained. These figures should, therefore, be used with caution, and from 10 to 20% added when estimating the cost of new work. Due allowances should also be made for differences in the character of buildings and the service rendered, as determined by the peculiarities of the business carried on in it. This is wholly a question of experience and judgment.

Section A—Water-Tube Boilers.—Compound engines and electric elevators having been selected, requiring 303 boiler HP., it was thought safe to reduce the boiler capacity to three units of 150 HP. each, two to do the ordinary maximum service. This was equivalent to 4,955 lbs. of water per hour per boiler, from feed of 212° F., into steam of 125 lbs. gage pressure. Water-tube boilers proving not as high in price as expected, that type was selected, the boiler being the "O'Brien," made in St. Louis. This boiler is similar to the Heine, except that the steam and water drum is horizontal, and not parallel to the tubes. Each boiler contained 1,411 sq. ft. heating surface, including drums and tubes of the Hawley furnace, or 9.4 sq. ft. heating surface per HP. The grate surface (upper grates only) was 31.5 sq. ft.; ratio grate to heating surface, 1 to 44.78. The cost of the three boilers set up, including Hawley furnaces, brickwork, foundations and smoke flue, as specified in Section A, was $6,288, being $13.97 per HP., or $1.48 per sq. ft. of heating surface.

This section and also Sections F and G, were let to Kupferle Bros. Mfg. Co., of St. Louis, at the gross price of $16,511.

Section B—Elevators.—The selection of the elevator system presented the greatest difficulties. The bids based strictly on the specifications seemed excessive in price, and the owners directed that the data be revised, with a view of getting more reasonable figures. The capacity of the elevators was, therefore, reduced. The two passenger and two southwest freight elevators had their average loads cut down to 1,500 lbs., and the four north machines to 1,800 lbs., being required to carry these loads at the speeds specified. They were also to be capable of carrying the larger loads originally specified, at reduced speeds. Wooden guide posts and strips were substituted for the steel T guides. The allowance for passenger cabs was reduced to $200, and the indicators omitted.

On this revised basis, the Sprague system was selected, at the price of $22,070, including ash-hoist and safety gates. This low price was due partly to the conditions already named, and was made possible by arrangements made with local parties for erection, under a Sprague expert. The four north elevators were to be of the "X 38" type, with solenoid control; and the four south elevators of the "Z" type, with pilot motor control.

To the above price should be added $3,134 for the cost of third engine, dynamo, etc., making a total of $25,204 for the elevator plant complete.

The selection of the electric elevator for this important installation was decided upon after a thorough investigation. They were found to be more economical in fuel than any other type—even the high duty hydraulic—on account of the light loads usually carried, and the corresponding saving in power. There was also some saving in first cost. The electrical plant afforded a much more compact arrangement in engine room. As no pumping engines were required, and no tanks or accumulators, one reserve unit answered for both the lighting and elevator plants. The electric elevator has not, as yet, fully established its reliability and low repair account as well as the hydraulic, but the latest and best types seem to leave but little to be desired in these directions.

The steam elevators were, of course, the lowest in first cost, but were not given serious consideration on account of their large fuel consumption.

Section C—Dynamos, Switchboard, etc.—General Electric dynamos were selected, the guaranteed efficiencies being:

At ¼ load	84 per cent.
At ½ load	89.5 per cent.
At ¾ load	91.5 per cent.
At full load	91.5 per cent.

The three 75-K-W. generators, with switchboard, etc., as specified, cost $5,135, or $22.80 per K-W. Speed, 260.

Section D—Dynamo Engines.—The three 125-HP. engines selected were of the "Imperial" compound type, built by the Weston Engine Company, of Painted Post, N. Y. Dimensions of cylinders: High pressure, 12 ins. diameter; low, 20 ins.; stroke, 14 ins.; speed, 260. Price, $4,268, or $11.38 per I. HP. The same builders offered three simple engines, 15 x 14 ins., for the same service at $3,616, or $9.64 per I. HP. This should be reduced about 5% to be strictly comparable with the cost of compounds. Computations showed that the horse-power hours of service per year would be sufficient to make the fuel saving of the compound over the simple enough to warrant the additional investment.

The cost of engines and dynamos together was $9,403, which is $41.80 per K-W. of dynamo capacity, and $25.07 per I. HP. of engine capacity.

Section E—Wiring, Lamps, Fans, and Motors.—This work was let for $6,315, in accordance with the specifications, to the General Electric Co., their 220-volt arc lamp being selected. On the basis of 150-K-W. capacity, the price per kilowatt was $42.10, including the entire work from the switchboard to the lights and fans, exclusive of special fixtures on first floor. Adding to this two-thirds of the contract price for Sections C and D (engines and dynamos), gives the total cost of the electric lighting plant (exclusive of elevators) as $12,584, or $83.90 per K-W., exclusive also of boilers and piping.

Section F—Heating System.—This work was let for $6,984, including the Paul system; satisfactory plans having been submitted for reducing the amount of radiation, size of mains, etc. The number and location of radiators was the same as specified, their sizes being reduced. No other changes were made, except that the first floor radiators were supplied from basement return main, instead of from an independent main. As satisfactory performance was guaranteed with standard fittings, the requirements for long radius fittings were waived.

The following table is interesting, as comparing the bids on original specifications with the contract price for the Paul system:

	As specified.	Paul system.	Paul system with boilers & piping.
Radiating surface, sq. ft.	24,916	18,073	18,073
Cu. ft. heated per sq. ft. radiating surface	93	128	128
Cu. ft. gross per sq.ft. radiating surface	122	169	169
Cost of heating plant	$7,689	$6,984	$16,511
Per sq. ft. rad. surface, cts.	31	39	91
Per cu. ft. heated, cts.	0.33	0.3	0.71
Per cu. ft. grass, cts.	0.25	0.23	0.54

It will be noticed that the radiating surface specified does not appear excessive after all, as each square foot takes care of 93 cu. ft. of space heated, while each square foot under the Paul system must heat 128 cu. ft.

When a heating system is properly proportioned for hard service, with ability to heat a cold building quickly in severe weather without material back pressure, it is necessary to use ample radiating surface and piping, which, of course, mean increased first cost. In the present instance the prices indicate that the reduced surface, etc., which would do the same work under the Paul system, saved enough money to not only pay for all special apparatus, royalties, etc., but to make a considerable saving to the owners besides.

Section G—Large Pipe Work and Apparatus.—This was let for $3,239, being $7.20 per unit of boiler HP., and 18 cts. per square foot of radiation contracted for.

Total Costs.—The total cost of the mechanical plant ($54,299) may be divided as follows:

Per cubic foot of gross space	$0.0178
Per cubic foot of space heated	.0234
Per square foot radiating surface contracted for.	3.00
Per rated horse-power of boiler capacity	120.66
Per indicated horse-power of engine capacity	144.80
Per kilowatt of generator capacity	241.32

The total cost of building, including mechanical equipment, ready for the tenant's use, was $301,000, or 9.9 cts. per gross cubic foot, and 13 cts. per cubic foot heated. The cost named included $20,000 for the use of the party walls of the adjoining buildings, and $10,000 for Luxfer prism glass, and $9,000 for a sprinkling system. The value of the ground was $200,000, making the total investment a trifle over $500,000.

Tests and Performance.

During construction and erection the work was under the supervision of the engineers, and on completion it was submitted to careful inspection and tests to determine whether the contract guarantees had been met. Since going into service the plant has been under the observation of the engineers, so that close track has been kept of its performance.

Section A—Boilers.—These were submitted to a number of evaporative trials to determine their capacity and efficiency. The boilers give good service, particularly in capacity, dryness of steam and smokelessness.

Section B—Elevators.—An exhaustive detailed test of capacity, speed and efficiency was made on No. 5 elevator, type "X 38," situated on the northeast shaft, and on No. 1, type "Z," located in the southwest shaft. Simultaneous readings at 2½-second intervals were taken of the voltage, speed, and current—the latter being checked by two instruments, two observers reading independently. The live loads upon the platforms, were obtained by weighing.

The speed of travel was calculated by dividing the revolutions of the armature by the known ratio between speed of armature and speed of car. The power consumed per trip was obtained by plotting the curves of current readings, the area of which—multiplied by the voltage—gives the watt hours per trip. This was reduced to mile of travel by multiplying the watt hours per trip by the fraction that one round trip is of one mile. The following table gives the results:

Elevator.	Live load, lbs.	Speed, ft. per min. Up.	Speed, ft. per min. Down.	K-W. hours per car-mile.	Remarks.
Z, No. 1	147	271	268	3.14	
	908	256	256	3.14	
	2,997	153	157	4.22	Slow speed.
	2,997	256	290	4.19	High speed.
	4,000	147	192	4.05	Slow speed.
X 38, No. 5	147	153	153	3.14	
	1,008	157	155	3.19	
	4,000	152	160	3.34	
	5,012	153	160	3.81	

It will be noted that No. 1 elevator has a down speed, with operator only, of 268 ft. per minute. With the same counterbalancing, it carries a load of 3,000 lbs. up at 153 ft. per minute, with motor operating on slow-speed notch of operating lever. When operated at high speed, this elevator lifted 3,000 lbs. at a speed of 256 ft. per minute, and with an economy per round trip slightly better than when operated at slow speed. This elevator carried 4,000 lbs. up at 147 ft. per minute, when operated on the slow-speed point of operating lever.

It is particularly interesting to note that the efficiency in kilowatt hours per car mile increased but slowly with increased loads. The kilowatt hours per car mile of travel are equal to good average practice, and will probably improve after longer operation of the plant.

The adjustment of the starting devices on the elevators was found to be for a 2½ to 3 seconds' start. This made the starting current exceed the running current by more that the 50% specified, which was based on a 5 seconds start. When the starting devices were readjusted for a 5 second start, this condition of the specifications was practically met. It is a question of judgment, therefore, whether the tenants prefer a slow and easy start and a smooth-running electric plant, or a quick start, and a correspondingly severe and sudden demand upon the dynamo and engine.

Two dynamos were operated in multiple, running both elevators and lights. With a variation of load from 250 to 600 amperes, the ordinary variation of voltage was from 220 to 226, and the maximum, 218 to 228. With a variation of load from 200 to 500 amperes, the average variation of voltage was from 216 to 220, and the maximum, 214 to 222. This variation did not affect the lights sufficiently to be noticeable, unless the observer's attention was called to it, but has been further improved by a more careful adjustment of the elevator-starting devices.

The wattmeter on switchboard shows the electric power used by the eight elevators from July 12 to 27, 1898, inclusive, or 138½ hours' operation, to have been 1,920 K-W. hours, or an average E. HP. per hour of 18.6 for the plant, or 2.3 HP. per elevator. During the month July 12—August 12, 1898, the hours of operation were 283.5, and the average E. HP. was 19.2, or 2.4 per elevator. Unfortunately, no records were kept of the miles of travel during this time, but they may be roughly approximated as follows, taking the first period mentioned:

Assuming an average efficiency of 4 K-W. per car mile, the 1,920 K-W. hours mean a travel of 480 miles. The travel of the eight elevators per round trip is 1,608 ft., or 0.304 mile. Dividing 480 by 0.304, the number of round trips is found to be 1,579 in 1,385 hours, or 11.4 per hour, or 5¼ minutes per round trip. As the average travel is about 201 ft., and the average speed about 200 ft. per minute, the round trip should have been made in about a minute. This indicates that the elevators averaged about 1-5 the time in motion, instead of ⅓ to ½, as originally assumed for maximum service. It will be seen that the power actually required to operate the elevator plant is considerably less than originally estimated. This is due to the use of apparatus of higher efficiency than assumed, to smaller percentage of time in motion, and to the loads contracted for being less than specified.

The data in the following table, showing the relative performance of three elevator plants in St. Louis, will be found interesting.

A and B are high-pressure hydraulic plants of the most modern type, plant A having a high-duty compound crank and fly-wheel pumping engine, and B an ordinary direct-acting compound pump. The Hagardine-McKittrick plant is shown in column C, and is furnishing arc and incandescent lights from the same bus bars. The fuel and water results are computed from the guaranteed efficiencies of boilers and engines; the elevator data, however, being based on actual test:

	A.	B.	C.
Cost of coal	$1.35	$1.50	$1.40
Water evaporated per lb. coal	8.	8.	7.64
Water required per I. HP. hr.	...	54.21	25.
Coal required per I. HP. hr.	...	6.78	3.27
K-W. hrs. per car-mile, av'g load	...	...	3.165
HP. hrs. per car-mile, av. load, elec.	...	...	4.24
HP. hrs. per car-mile, av. load, ind.	...	...	5.30
Lbs. coal per car-mile, av'g load	24.	58.54	17.33
Cost of same, cts.	1.62	4.39	1.21
Average I. HP. per elevator*	...	...	3.00
Cost of coal, per elev., per hr., cts.	...	2.92	.69
Per day of 10 hrs, av'g cts.	...	29.24	6.87
Cost on basis of a round trip,† cts.	4.13	9.75	2.75

*From July 12 to Aug. 12, 1898. †Trip made every 9 minutes.

The unfavorable showing of plant B is due almost wholly to the low duty pumping engine. The ordinary hydraulic plant using low water pressures, and the ordinary duplex pumps—sometimes not even compounded—is still more wasteful in fuel. The favorable showing of the electric elevators is due to good counterbalancing, reduced power with loads under the maximum, and compound steam engines. The tests of K-W. hours per car mile were made with stops and starts at terminals only. The power required will, of course, be larger when many intermediate stops are made.

Section C—Generators.—Exhaustive tests were conducted on the dynamos, covering capacity, heating, efficiency, and general operation, with varying loads, both under and above rating. Very satisfactory performance was found, and complete conformance with the rigid requirements of the specification. The efficiency of the generators at various loads was computed by means of indicator diagrams and switchboard readings, using carefully calibrated instruments.

Section D—Engines.—These were tested for capacity, regulation, and general performance, and were found acceptable. The following results were secured:

Indicated horse-power	126.74
Electrical horse-power at switchboard	102.37
Efficiency of engine and dynamo unit—per cent	80.77
Water rate per indicated horse-power hour—pounds.	26.79

The latter was a trifle higher than the guarantee of 25, but the test load was a little too large, and the engine was a trifle out of adjustment. The engine efficiency was determined by a four hours' trial, measuring the water which entered the boiler, and collecting the condensation in pipe system by means of separators, drains and traps, and deducting its weight from that of the water which had been pumped through the measuring tanks.

Section E—Wiring.—This section required but few tests, those made covering the points of insulation, resistance, and the operation of the 220-volt enclosed arc lamps, and the accompanying mechanism, switchboard, etc., all of which was found satisfactory.

Section F—Heating System.—Tests on this part of the plant have not yet been made, as they could not be carried on successfully until cold weather. The system, however, was in use during a number of cold days in October, and its performance was satisfactory. The Paul exhausters maintained a vacuum on the exhaust line of 15 to 20 ins., and the heating was done with ½-lb. back pressure, and, no doubt, could have been done with less. The circulation throughout the system was found to be complete, and all radiators hot, within 20 minutes after turning steam of ½-lb. pressure into the cold system.

Section G—Large Pipework.—No special tests were required on this work, other than the observation of the actual performance of the different units in service. All were found to do their work satisfactorily.

In conclusion, it is interesting to note the actual working efficiency of the plant, as compared with that of the building formerly occupied by the same tenants. There the lighting, heating and elevator service were less than half that of the new building, as were also the floor space, cubic feet, and actual business transacted. The old building employed old-style boilers and furnaces, simple dynamo engines, and steam elevators. It was a corner building, however, and required but little artificial light during the day. In spite of this, however, the improved apparatus in the new plant has kept the coal consumption down to only about 25% more than in the old building, although the work done has more than doubled.

APPENDIX.

Recapitulation of Data as to Costs, Ratios, Performance, Etc.

In using these figures, or comparing them with others reference should be made to the explanation in the body of the paper, to determine the exact meanings.

Boiler Plant.

Square feet heating surface per rated horse-power	9.4
Ratio grate to heating surface	1 to 44.78
Cubic feet of building—gross—per rated horse-power	.6771
Cubic feet of building—heated—per rated horse-power	.5146
Cost of complete boiler plant, per horse-power	$13.97
Cost of complete boiler plant, per square foot heating surface	1.48
Cost of ordinary boilers to do the same work, per rated HP.	11.44
Cost of ordinary boilers to do the same work, per sq. ft. HP.	.95

Electric Elevator Plant.

Cost per gross cubic feet of building:	
Elevators, alone	$0.0072
Elevators with engine and dynamo	.0083
Per sq.ft. total fl'r space, elevators alone	.105
Elevators with engines and dynamo	.120
K-W. hours required per car-mile of travel.	3.14 to 4.22
Average electrical HP. required pr elevator	2.35

Dynamos and Swtchboarda.

Cost per K-W. of rated capacity	$22.80
Gross cu.ft. cared for per K-W. for lighting	20,312.0
For all purposes	13,541.0

Steam Engines for Dynamos.

Cost:	
Comp'd engines and foundations, rated HP.	$11.88
Per rated K-W. of dynamo capacity	18.97
Simple engine, same work, per rated HP.	9.64
Dynamos and engines, per rated K-W. dyns	41.80
Per rated HP. of engines	25.07
Efficiency, dynamo and engine unit, %	88.77
Gross cu. ft. cared for per rated HP. of engines	8,125.0
Water rate—lbs. per I. HP. per hour	26.79

Wiring, Lamps, Fans and Motors.

Cost, per K-W. of dynamo, lighting capacity	$42.10
Including lighting, dynamos and engines	83.90

Heating System.

Cu.ft. gross space pr sq.ft. radiating surface	169.0
Heating space, per sq. ft. radiating surface	128.0
Cost, per sq. ft. radiating surface	$0.39
With boilers and piping	.91
Per cu. ft. gross space	.003
With boilers and piping	.0071
Per cu. ft. heated surface	.0023
With boilers and piping	.0054

Large Pipework and Apparatus.

Cost, per rated boiler HP.	$7.20
Per sq. ft. of radiating surface	.18

Complete Mechanical Plant.

Cost, per cu. ft. of gross space	$0.0178
Per cu. ft. of space heated	.0234
Per sq. ft. radiating surf. contracted for	3.00
Per rated HP. of boiler capacity.	120.66
Per I. HP. of engine capacity	144.80
Per K-W. of generator capacity	241.32

Completed Building.

Cu. ft. of space, gross	3,046,727.0
Cu. ft. of space, heated	2,315,612.0
Sq. ft. of floor space	210,116.0
Cost of building, per cu. ft., gross	$0.099
Per cu. ft. heated	0.130

Discussion.

Mr. George Hill, of New York city, in discussing the paper gave the following table comparing the coal consumption per hour of the building described by Mr. Bryan with that of three other large buildings, of which Mr. Hill had obtained data:

Building.	Cubic contents, cu. ft.	Duty. Lights	Duty. Mot'rs HP.	Duty. Elevators, lbs. ft.	Coal per hour, lbs.
Commerce Realty	2,315,600	2,469	1¼	(2) 1,500×300	(750)
				(2) 1,500×225	600
				(4) 1,800×150	
American B'k Co.	2,180,000	1,830	280	(2) 3,000×400	
				(3) 2,500×250	503
Temple	2,170,000	3,000	45	(2) 3,000×400	359
De Courcy Bldg..	483,000	300	64	(3) 2,500×250	
				(1) 2,000×200	172

Mr. Hill commented on the figures as follows: The Commerce Realty is the building described in Mr. Bryan's paper. The coal consumption in brackets is as stated to me in a telegram from Mr. Bryan. The figure 600 is Mr. Bryan's estimate of the equivalent coal consumption in anthracite buckwheat.

The American Book Co.'s building contains general offices, store rooms, printing and bookbinding establishments (output 20,000 books per day); the two high-speed elevators are hydraulic, others electric; there are two sidewalk lifts in addition. Hydraulic elevators were installed because of owner's requirement. This was the pioneer electric transmission plant in a book manufacturing establishment. The duty of the elevators is very severe since the hydraulic machines make the first landing at the eighth story, and are in constant demand, and the electric machines are used for passenger and freight service constantly. I should think that the duty in useful work done was fully double that demanded by the Commerce Realty. In addition to the power development live steam is furnished to the paste-making kettles through a pipe over 100 ft. long, the amount required being unknown. There are four dozen glue-kettles kept at a temperature of about 180° by means of electric stoves.

The Temple Building is occupied in part by offices and in part by lodge rooms for Odd Fellows' meetings. Elevators are hydraulic, running a large number of car-miles, and always heavily loaded. The building is not well lit naturally, and there are in consequence never less than 200 lights burning.

The De Courcy Building is a manufacturing building, and in addition to the power consumption indicated by the plant, we furnish live steam through 1½-in. pipe for paste-making, steaming caps, boiling water, etc., that is in constant use. The weekly record of pounds of coal per hour, and the K-W.-hours of work done, show but a very slight relation. The output of the engine varies from 25% to 125% of the rated capacity, the average fluctuations being about 25% and occurring almost continuously. A little live steam is required for heating in severe weather. The hours of service are very long, running 337 to 423 hours per month. The coal consumption for the past year has been 405 tons.

All of the above hydraulic elevators are operated by compound duplex pumps. The engines are all simple, high-speed, operated at pressures from 80 to 100 lbs. The coal burned is anthracite buckwheat. It is to be borne in mind that the fluctuations in load are instantaneous, so that while the engines rarely make three successive revolutions at the same cut-off, the demand for steam from the boilers is practically uniform and it is possible to fire them at a practically uniform rate.

PORTABLE GRAVITY CONCRETE MIXER

The accompanying illustrations show a new form of concrete mixer designed to operate with no other power than that developed by the men who shovel the ingredients into the hopper. It consists of an inclined steel trough, 10 ft. long, containing 15 rows of wrought iron pins, staggered, supplemented by piping and a spray for wetting the material. Fig. 1 shows the hopper at the upper end of the mixer, and Fig. 2 is a view of the device from below. The upper row of pins is nearer together than the others, so the material passing here cannot clog below. The directions for operating the mixers state that the stone, sand and cement should be spread on the floor in layers, in the order named, and in proper proportions, after which the shovelers should begin at the edges and throw the material into the hopper. Water is admitted to suit, the water man standing below, where he can see the output and vary the amount of water as required for the desired results. It is claimed for the mixer that no more labor is required to operate than that usually employed to shovel the concrete into the wheelbarrows, the latter being loaded by simply placing them under the lower end of the mixer.

The mixer is made by the Contractors' Plant Co., L. C. Wason, proprietor, 85 Water St., Boston, Mass. Mr. Wason states that several of the mixers have been put into practical use.

Fig. 1.—Shoveling the Material into the Hopper.

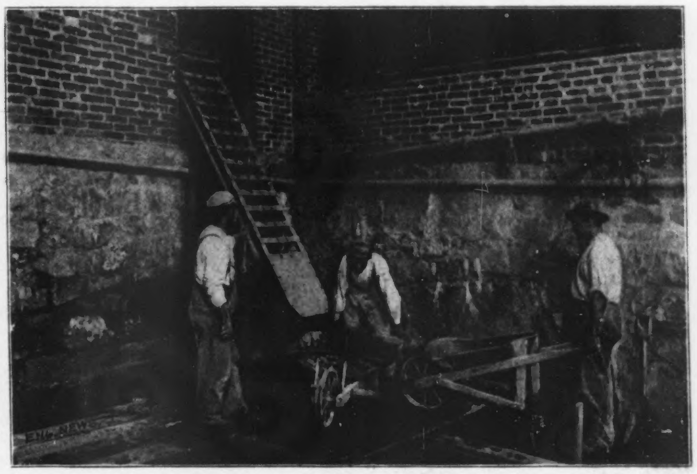


Fig. 2.—Controlling the Water and Wheeling Away the Concrete.

VIEWS OF A PORTABLE GRAVITY CONCRETE MIXER.

THE USE OF THE WATERPHONE FOR DETECTING WATER WASTE AT MEMPHIS, TENN.

One of the most useful instruments ever devised for carrying on a campaign against water waste is the waterphone. Its essential principle is an ear piece and connecting medium for the transmittal of the sound of running water from a house service pipe to the ear of an inspector. The following information regarding the use of this device in Memphis, Tenn., has been kindly furnished us by Mr. Lawrence Simpson, Secretary of the Artesian Water Co., of that city:

We once had a waterphone made by "Bell," of Cincinnati. It was lost or broken. He is either dead or out of business. But under the old system of making one call a night it was a failure, as every single consumer would claim that for one reason or another they happened to be using the water when inspection was made.

To begin with, our waterphone is a makeshift, being nothing more or less than a telephone-receiver with the inside magnets taken out. By placing the stopcock key on the cock at the sidewalk and turning the cock half off, and then touching the key with the receiver, the slightest leak can be detected.

Our inspectors get to work about 11 p. m. and quit about 4 a. m. When water is found running upon any premises, the exact hour is noted in a book for that purpose, and the inspectors pass on, leaving water as they found it, assuming that it is being legitimately used. About three o'clock they again visit those places where water was found running earlier in the night. If it is still running, of course that means either carelessness or fixtures out of order, and if it be the second time water is found wasting it is turned off. If it be the first time we usually give a printed notice accompanied with a personal lecture.

The same inspector who does this night work calls again the next morning, between 7 and 9, and gives notice of wastage, or informs them why their water is cut off, as the case may be.

By pushing these inspections and standing up for our rights (you know water companies have some rights), we have reduced our consumption several million gallons per day. During the last year we discovered not less than 30 underground leaks that did not show at the surface at all, the water finding its way into old sewers, drains, and low places. In these cases customers often insist there is no leak, but when this instrument indicates it you can bet on its being there.

Enclosed find a copy of the notice we use. Reading matter could be changed to suit the conditions or the taste of superintendents.

The form used for serving notices of waste is reproduced herewith, reduced to half its original length and height.

NIGHT INSPECTION.

No.________________Street

1st Hour________________

2nd Hour________________

____

________________189__

________________Inspector

________________189__

Dear Sir:

Our Night Inspector attached a waterphone to water pipe at No.________________Street, at________o'clock, and again at________o'clock, last night. Water was running at both inspections, showing clearly that it ran all night.

Five million gallons would easily meet the legitimate needs of Memphis, and yet we are pumping from ten to twelve millions daily.

We have repeatedly appealed to consumers against this wholesale waste and we must protect ourselves if possible, and to that end will continue these waterphone night inspections.

Notice is hereby given that if water be found running again it will be discontinued and money refunded. We cannot be expected to supply those who so grossly abuse their privilege and cause us such needless loss.

Respectfully,

CAUSE OF WASTE:

____

________________Inspector,
FOR ARTESIAN WATER CO.

FORM USED AT MEMPHIS, TENN., FOR NOTIFYING CONSUMERS OF WATER WASTE ON THEIR PREMISES.

COMPETITIVE DESIGNS for a garbage wagon, or "dust cart, for use in connection with the collection and disposal of house refuse," are wanted by the County Council of London, England. The cart must be so constructed and covered as to prevent the escape of any refuse or the creation of a nuisance. A prize of about $120 will be paid for the best design. The award will be made by Captain Sir Douglas Galton, Chairman of the Council of the Sanitary Institute. All designs must be delivered to C. J. Stewart, Clerk of the Council, Spring Gardens, S. W., London, England, by 10 a. m., Feb. 28, 1899.

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

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

The preliminary report of the Nicaragua Canal Commission, which we print elsewhere in this issue, is somewhat of a surprise in two important items. The commission recommends the Luli, or low-level location as being easier of construction and presenting no problems not well within good engineering precedents; further, the majority of the commission estimates the approximate cost of the canal at $124,000,000, with one million less for construction on the Luli route. While this cost approaches the provisional estimate of $133,472,893 of the Ludlow commission of 1895, it is lower than was expected by many who have studied the engineering features of this great work. Bearing upon this estimate, however, we have the minority report of Gen. Hains, the member of the commission having the ripest engineering experience, and whose opinion as the senior engineer officer and the ranking officer in that line on the commission is, therefore, of much weight. Gen. Hains very properly takes into consideration the increased dimensions deemed necessary by this commission, and the difficulties incident to work in tropical countries, and he believes that the estimate of the majority is lower than it should be "by about twenty per cent." Adding this percentage to the above estimate, we would have nearly $149,000,000 as the actual engineering estimate of the cost of the canal.

According to certain reports from Washington, private advices to this commission called for a canal whose cost should not exceed $125,000,000; and the close tally of the provisional estimate presented by the majority of the commission would seem to bear out this rumor. But that there is some difficulty in sticking to these figures is made evident by the further rumor that the final majority report will call for an estimate of $128,705,400. In this estimate the Ochoa dam is set down at $6,432,000; the six locks will cost nearly $14,000,000; the double-track railway, $5,000,000; and the estimated cutting aggregates 150,000,000 cu. yds., valued at from 18 cts to $2.29 per cu. yd. For policing and for sanitary precautions, one million is set aside, and the right of way through Costa Rica is to cost somewhat less than this. The matter of route is still in controversy; two members favored the Maritime Canal Co.'s location until lately, when one of these became decidedly convinced that the low-level route, favored by Gen. Hains, was the cheapest and best.

As to these rumors, we give them as they come to us, without pretending to guarantee their accuracy. The only point which seems certain is that the final estimate, when it is made public, will exceed that already given out. The percentage of this excess will apparently be measured by the degree to which Gen. Hains can influence his associates and convince them that what the public actually wants in this report is an honest estimate of cost, based upon the data obtained, and regardless of preconceived Senatorial notions as to what such a canal should cost. As to the relative merits of the alternate routes considered, nothing can be said until the full report is available; for neither of these proposed routes embrace all the component parts of their respective original locations. The changes made in them, however, are as yet unknown to the public.

The discussion of the outlook for the New York Rapid Transit Ry., presented in these columns last week, has been continued by the New York daily papers; and our argument in favor of a two-track express train tunnel system, in combination with the surface electric railways, has been generally approved. The one point of our editorial to which exception is taken is our assertion that if the four-track Rapid Transit system were built as originally proposed, its local trains could not attract passengers enough to give them a profitable traffic in competition with the electric cars on the surface roads. Our critics allege that the growth of the traffic up and down Manhattan Island is such that by the time the four-track tunnel road could be completed the present elevated and surface roads will be taxed to their full capacity and passengers will be glad to take the underground trains even for short distance travel.

It is doubtless true that the traffic up and down Manhattan Island has grown enormously in the past and will grow—at a more moderate rate—in the future; but the fact we desire to emphasize is, that this future growth is bound to be in long distance travel rather than local travel, especially if real rapid transit facilities for long distance travel are provided. The population of the residence district between 23d St. and 59th St. has increased very little in the past decade. The great growth has been, and will be, in the district east, west and north of Central Park, and north of the Harlem River.

Before the close of the present year there will be six separate double-track electric conduit railways, reaching the lower part of Manhattan Island, and branching to form a still larger number of lines as they proceed northward. With these for short distance journeys, and with the present elevated railways for somewhat longer journeys, the needs of passengers making trips a half-mile to two or three miles in length, will be amply provided for, especially with the large reduction in the crowding of both elevated and surface cars which would follow the introduction of a high-speed express system for long distance journeys. This is a point which we believe our critics have overlooked; but it is a most important one. A single passenger who takes a surface or elevated car for an 8-mile journey has as much effect in utilizing the traffic capacity of the car and of the railway as four passengers who take the same car for a journey averaging two miles.

We believe, therefore, that with the long distance traffic transferred to an underground and express system, the local traffic could be comfortably carried for very many years to come by the existing elevated railways, and by the surface car conduit lines built and under construction, together with such other surface roads now operated by horses, as may be hereafter changed to electric traction.

In conclusion, we may remark that in our discussion of the rapid transit problem we did not by any means intend to convey the idea, as one journal has quoted us, that two underground tracks will be sufficient for long distance travel. On the contrary, we believe that the growth of long distance travel will demand not one, but several, such express train tunnels as soon as the advantage of such a system on a single line is demonstrated by actual experience.

We give up a large amount of space in this issue to a reprint of a paper by Mr. Wm. H. Bryan, of St. Louis, describing the mechanical engineering work in connection with the construction and equipment of a large mercantile building in that city. The paper was read at the recent meeting of the American Society of Mechanical Engineers, and was by far the most valuable of all the papers presented at that meeting. In fact, we may go further, and say that among all the contributions to the general literature of mechanical engineering during the past year, we recall very few that compare with Mr. Bryan's in their practical value to the working engineer.

It will not be disputed, we presume, that the independent practising mechanical engineer is by no means on so secure a footing, professionally speaking, as his brother in the civil engineering field. In carrying out such typical civil engineering works as bridges, dams, systems of sewerage and water supply, railways, etc., the public now recognizes the civil engineer as a necessity. In the purchase and installation of machinery, engines, boilers, heating and lighting apparatus, and similar articles, however, it is not yet recognized that the purchaser needs the advice and assistance of an independent mechanical engineer. In the case of buildings the architect is generally relied upon to furnish all the advice the owner requires in planning and purchasing the mechanical equipment; and the tendency of the architect to lean upon the manufacturer as respects questions of engineering detail is well known.

There are several reasons why the mechanical engineer's services are not appreciated as they should be; but one reason to which we wish to call especial attention is that the mechanical engineer is by no means so well equipped to render valuable service as the civil engineer. Take for example the question of the relative merits and comparative cost of different makes of elevators or different forms of electric lamps. The engineer can find very little in professional literature to aid him in preparing designs and estimates for which he will be willing to assume responsibility. On the other hand, the civil engineer designing a dam or a dry-dock or a water main, has the accumulated experience of a great number of engineers put on record in technical literature, and can proceed with confidence.

If mechanical engineering is to be placed on a firm basis as a profession, it needs more such papers as this of Mr. Bryan's, replete with facts and figures, given with a detail which enables another engineer to make practical use of them. Our condensation, in fact, does not do full justice to Mr. Bryan's work in this respect, for we have been compelled, in order to bring the paper at all within the limits of our space, to omit many interesting portions of the original paper. Even in its condensed form, however, we feel safe in saying that no such detailed, reliable and useful figures of the cost of the mechanical details in a modern large city building have ever been made public.

One other feature of Mr. Bryan's paper we desire to notice, because it is something in which much engineering literature is woefully deficient. Mr. Bryan tells not only what he designed, but why he designed it; which is exactly what the reader wants to know. It is of small interest to a reader to learn that a given plant uses A boilers, B engines, C dynamos, and D arc lamps, even when, to give the article a color of scientific importance, the external dimensions of various parts of the apparatus are added. What he wants to know in connection with the description of a given plant is: What were the problems presented to the designing engineer; how did he solve these problems; and why did he adopt this or that or the other solution? It is just this sort of information that Mr. Bryan has given to the profession in his paper, and we commend it to our readers as in this respect a model that may be profitably studied.

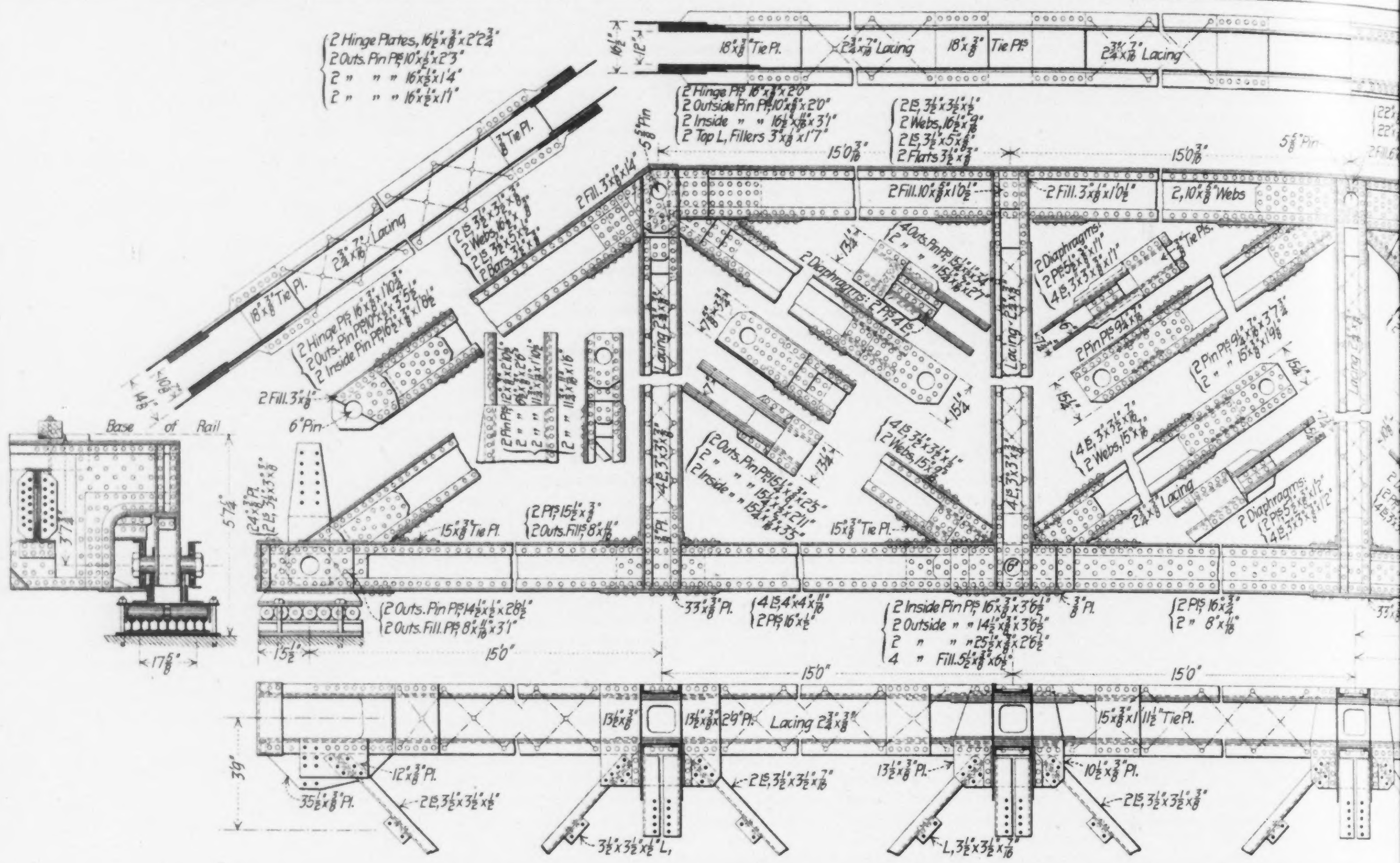


FIG. 1. ELEVATION, PLANS AND SECTIONS OF 120-FT. PONY TRUSS.

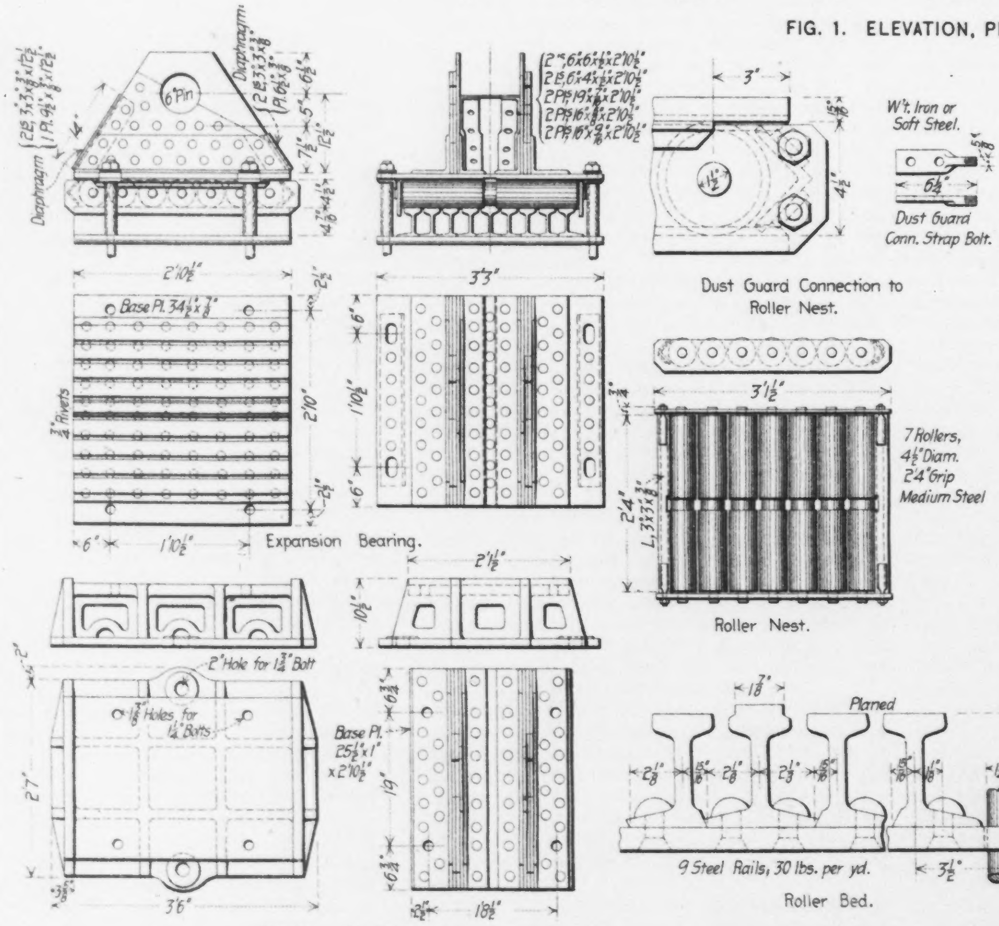
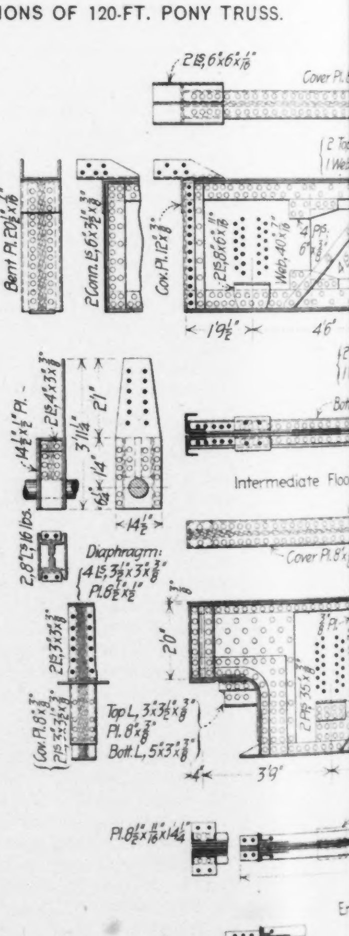
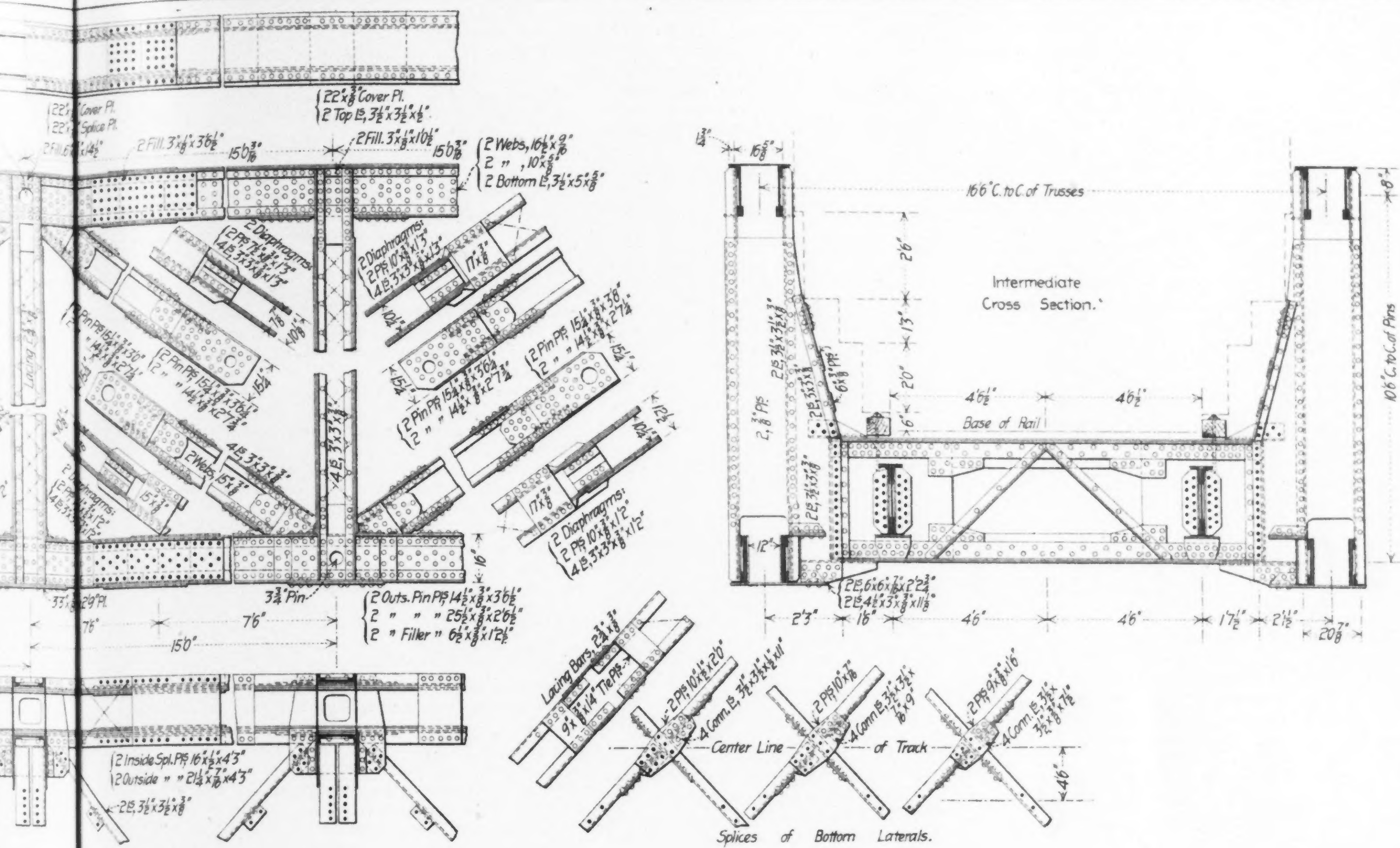


FIG. 2. DETAILS OF FIXED AND EXPANSION BEARINGS FOR PONY TRUSS.





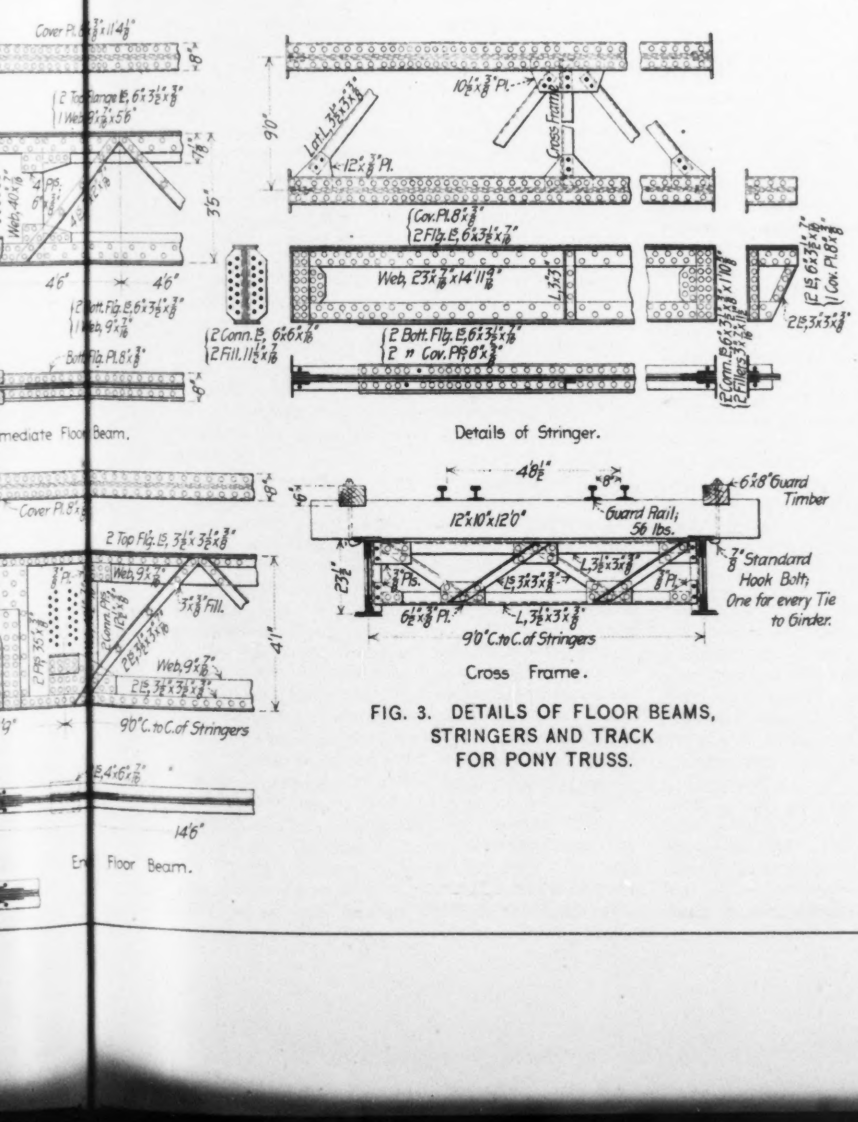


FIG. 3. DETAILS OF FLOOR BEAMS, STRINGERS AND TRACK FOR PONY TRUSS.

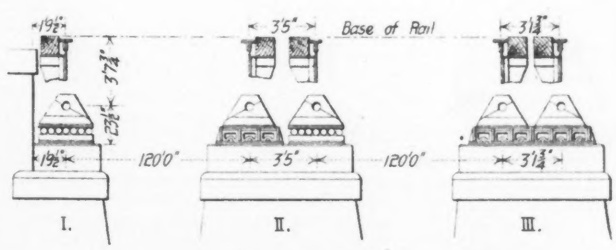


FIG. 4. DIAGRAM SHOWING ARRANGEMENT OF FIXED AND EXPANSION BEARINGS.

STANDARD 120-FT. SPAN
PONY TRUSS BRIDGE,
NORTHERN PACIFIC RY.

E. H. McHenry, M. Am. Soc. C. E.,
Chief Engineer.

K. E. Hilgard, M. Am. Soc. C. E.,
Designing Engineer.

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

PERMANENT WAY FOR RAILWAYS.

In another column of this issue a well-known engineer presents an argument in favor of a more permanent construction for railway track, and proposes a design for a track which will better deserve the title of "permanent way" than the present standard construction.

The questions which Mr. Schaub's paper raises are such as deserve and must, sooner or later, receive serious consideration at the hands of both the financial and operating officers of our great railway systems.

In the year ending June 30, 1896, the railways of the United States expended in round numbers 110 millions of dollars in maintaining their tracks and renewing ties and rails, or an average of a little over $600 per mile of railway. Of this amount $10,419,000 went for renewals of rails, $21,855,000 was for renewals of ties, and over $77,500,000 was expended in repairing and keeping up the track itself. To put the case another way, almost one-sixth of the entire cost of operating the railways of the United States is expended on the mere care and maintenance of the track. This does not include, be it noted, other expenditures in the maintenance of way department, such as fencing, bridges and culverts, repairs to buildings, etc., but is the amount actually expended on the tracks alone. Of course the expenditures per mile on track repairs vary very greatly on different roads, according to the volume of traffic. Many branch lines with thin traffic get along with an annual expenditure of $150 per mile of main line track, or even less. Roads with a fairly heavy traffic, such as is carried by the principal companies of the central West, expend $400 to $500 per mile; and on the trunk line roads of the East the expenditure reaches $700 to $900 per mile of track, or even more on some sections subjected to the heaviest traffic.

The two great items in the cost of keeping up track are labor and tie renewals. It is not so long ago that it cost the companies more to purchase new rails than new ties. A large proportion of the railways of the country were built with ties cut adjacent to their own lines at a trifling cost. That day has long since passed. Tie renewals alone represent 3 per cent. of the entire cost of railway operation in this country, and the increasing scarcity of timber is bound to make this percentage increase steadily year by year. The increased weight of rolling stock and speed of trains, moreover, is cutting out the ties and shortening their life. The tie-plate has proved a great help, but it must be frankly confessed, by every careful student of these problems, that the tieplate is, after all, but a makeshift. It is only a question of time when our railways of heavy traffic must find something better and more permanent than a perishable timber platform on which to support their rails.

There is a general feeling that when the wooden tie has to be discarded the substitute will be some form of steel tie. Perhaps this opinion may prove correct; but there is no small reason, on the other hand, to believe that the railway track of the future will involve a return to the longitudinal system of construction which was adopted to a considerable extent in the early days of railway construction.

Let us see what are some of the defects in actual practice of the cross-tie system of rail support.

In the first place, it is unmechanical. Here is a line of rails which have to carry rolling loads reaching 20,000 lbs. and more per wheel. They are to be held as nearly as possible in absolute surface and line, and the weight which they carry must be distributed over a large area of the supporting earth. The cross-tie system effects this by inserting 14 to 18 independent supports under each 30-ft. rail, and upon the track department is placed the impossible task of so adjusting these independent supports that each shall bear an equal part of the load. This is the real secret of the enormous amount of labor which has to be expended on every railway of importance to keep its track smooth. "Surfacing" is a work which is never done. Raising, or in any way changing, any one tie disturbs its relations to the two or three ties on each side of it, and they must in turn be adjusted and readjusted, until an even distribution of load is again restored. Every time a tie is removed, the process must be gone over anew; and the difference in supporting power between new ties and old ones is so considerable that good roadmasters prefer, when possible, to renew all the ties where they renew any, and save such ties as have further life for replacing in track by themselves.

While the short life of wooden ties makes it necessary for the trackmen to keep continually at work tamping up the weak ones, if they would keep the rail in good surface, it is true on the other hand that their elasticity and compressibility have been the essential factor in the long season of popularity which the cross-tie system has enjoyed. There is enough "come and go" in the timber which is commonly used for railway ties to take care of the last quarter-inch of adjustment which the trackman's shovel and tamping bar are too coarse instruments to make. But when a change is made to a steel tie system we will no longer have this factor of compressibility to help us out. More accurate work by the trackmen will be a necessity, and slight carelessness in this matter will not mean merely a tie cut into by the rail as now, but a kink in the surface of the rail that can never be removed.

One of the most serious defects of the cross-tie system of track supports in this country is its susceptibility to the effects of frost. Many days of weary toil in hot summer suns the section gang devotes to getting the track into good surface; and just as it is in fine condition along come the winter's frosts, and the work is all undone. On our northern roads in winter the track gang can only watch the heaving rails and ties and "shim up" here and there to keep the track in fairly safe condition till spring comes. The effect of frost is as serious, of course, with steel as with wooden ties; and it is a noticeable fact that the chief successes of metal ties have been made in tropical countries. We do not now recall any extensive use of metal ties on roads where winters are as severe as those in the northern United States.

Of course in such severe climates as that of Dakota, for example, it will not be possible within any limits of reasonable expense to place the foundations of the track entirely below the frost line; but it is at least worth an effort to keep water away from the roadbed foundations, since it is this which makes the frost harmful.

Much more might be said concerning the defects of the present system of wooden cross-ties as a support for railway rails did space permit; but we can sum up the whole story in this. The system is admirable in its adaptability to roads of a wide range of traffic, and none other could have served so well the first century of the railway era. But while it is economical in first cost, it is too expensive in maintenance to suit the conditions which confront railway companies at the present day, viz.: low interest charges, and small margins of profit.

Let us turn now to the design which is proposed by Mr. Schaub as a substitute for the cross-tie system, and which he advocates elsewhere in this issue. It will be seen that this consists in brief of a solid concrete covering for the roadbed, and directly upon this concrete the rails are laid.

Doubtless the very first objection which will be brought against this design will be that it is lacking in elasticity. The story has been retold time and again in engineering literature how on some of the first railways ever constructed the rails were laid directly upon stone blocks, and it was found that the vibration due to the lack of elasticity in these supports brought about the rapid wear and deterioration of the rolling stock. From constant repetition of this story can be traced the belief that elasticity is a necessary element in a railway roadbed; let us see how much there is in it. In the first place, it is easy to see that an elastic rail support was far more necessary with the rough cast-iron or wrought-iron rails of the '30's than it is with the wonderfully perfect steel rails of the present day. The fact is, of course, that the need for elasticity is in proportion to the amount of shock which is to be taken care of. One can easily understand how those rough old rails, with their frequent joints, resting on granite blocks not too smoothly dressed may have been rapidly pounded out under the traffic; but it does not follow at all that modern steel rails secured to a smooth and unyielding concrete foundation would suffer as did these early rails, or would cause wear and deterioration of the rolling stock.

As it happens, moreover, we are not obliged to go so far back as the '30's for examples of rails resting directly on masonry supports. As many of our readers are aware, the latest and most successful system of street railway track construction dispenses entirely with ties and places the rail directly upon a longitudinal beam of concrete.

With this system of construction, according to our best information, experience shows a smoother riding track and less wear of cars and machinery than with rails laid on cross-ties in the ordinary fashion. Here, it seems to us, is sufficient precedent for what we may call the "concrete longitudinal" system of track construction to secure for it at least a fair hearing. If modern electric cars, with their heavy motors suspended from the axles, can run over rails resting directly on a concrete base, it is at least probable that steam railway trains can do the same; for it is a well-known fact that a much heavier track construction is required to stand up under electric car service than under the traffic of a trunk line railway.

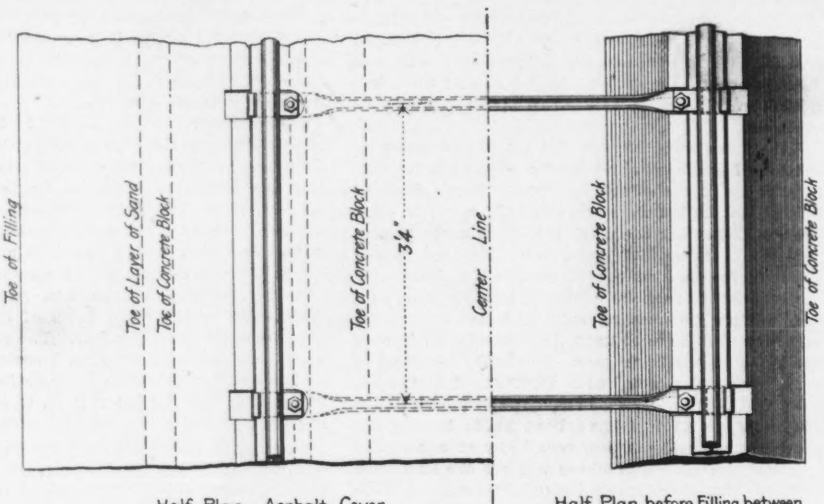
The next objection which will be brought against Mr. Schaub's design, we presume, is its great cost. Of course any such permanent track is only suitable for railways whose traffic is heavy enough to justify it; but an investment of $14,000 per mile, in place of what is now comprehended in the item, ties and ballast, must show a very large saving in the operating expense account to justify its use. Mr. Schaub's comparison between the cost of laying one or the other form of track, moreover, appears to us not quite fair. The real question for a railway manager is: Can I save enough in annual operating expenses by substituting this form of track to pay the interest on the cost of making the change and a fair profit besides?

Still again we notice that Mr. Schaub estimates a saving from his improved track of 10% in fuel for locomotives due to decreased train resistance, and 25% in repairs to rolling stock. We look with much doubt on both these items. The smoother track will not affect the train resistance due to axle friction, air resistance, grade or acceleration, and the bulk of the locomotive's work is in overcoming these items, the rolling friction proper being exceedingly small. Yet it is only this item of rolling friction which would be affected by a smoother track. In the department of rolling stock repairs there are very few items on which the smoothness or roughness of the track can have any effect.

In our opinion, therefore, we must look to the saving in the maintenance of way department alone to pay for an improvement in the character of the track; and here we are inclined to believe that Mr. Schaub underestimates the saving which a "permanent way" deserving of the name might effect.

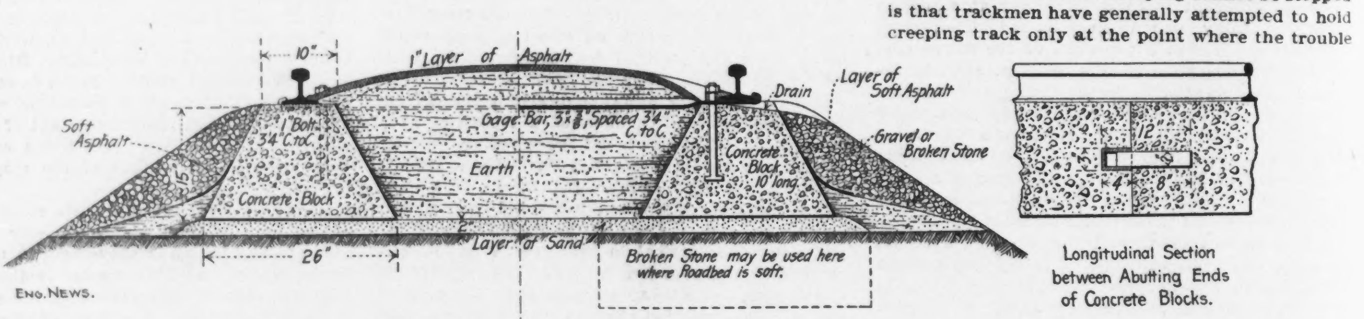
Let us next examine Mr. Schaub's design and see how its cost can be reduced. We see no necessity in the first place for the 12-in. layer of telford stone which he places under his concrete. The latter might as well rest directly on the earth of the roadbed. If this is well compacted in the first place, it will support the concrete as well without the broken stone base as with it.

In the second place, Mr. Schaub has, it seems to us, been much more lavish with his concrete than is necessary. He has a bearing area on the earth underneath far greater than that which the present system of wooden ties affords. As for the mound of concrete between the rails, it serves a useful purpose in shedding water, but it is an expensive means of making a roof to the roadbed. Still again, it will be noticed that Mr. Schaub adheres to the 100-lb. rails which are now standard for the heaviest class of railway track. But the increase in rail sections which has gone on during the past quarter century has been made necessary, in large degree, because of the cross-tie system of railway construction. We have made rails heavier, partly on account of the wear of the heads, partly to give greater bearing area upon the tie, but chiefly to make the rail stiffer. It is the function of the rail as a girder, to span the space from tie to tie, that has made necessary the deep, stiff rails that are now standard. With the rail supported at every point, however, the requirement of stiffness to a large extent disappears. What is needed is plenty of head to wear and a wide foot to distribute the pressure over the concrete, but the depth of web can be considerably reduced. It is reasonable to suppose that upon a solid and continuous support a rail of about 70 lbs. would give as good results as are now obtained from rails of 100 lbs. weight. The objection may be raised that with shallow rails it would not be possible to make stiff and durable joints. This is very likely true, if the plain angle-bar joint were to be rigidly adhered to; but there are other joints which give a base support to the rail, and either some of these or the continuous rail proposed by Mr. Schaub ought to meet this difficulty.



Half Plan, Asphalt Cover in Place.

Half Plan before Filling between Blocks and Asphalt Cover are Laid.



Cross Section between Gage Bars.

Cross Section through Gage Bars.

Longitudinal Section between Abutting Ends of Concrete Blocks.

DESIGN FOR A PERMANENT WAY FOR STEAM RAILWAYS.

As it happens, a member of the staff of this journal has had in mind for some years the project of a longitudinal concrete system of track support for steam railways, and the accompanying cuts represent the design which he has developed. Like Mr. Schaub's design, the rail is supported on a solid concrete base, but, instead of being a platform, there is a separate sill or beam under each rail, so designed as to give the maximum strength with the least volume of concrete. It is proposed to make these concrete beams, not by mixing and depositing the concrete in place, but by molding them in the most convenient place along the railway line where good gravel or broken stone can be obtained. Here a regular plant, with machine concrete mixer, etc., would be set up for making these concrete blocks, and under these circumstances they could be turned out at a minimum cost, and in perfect condition; further, they could be left to attain some age and additional strength before being placed in the track. It is proposed that they be made in lengths of about 10 ft. They could then be easily handled by an ordinary crane on a construction car, and the straight blocks could be used on curves as well, except on lines of very sharp curvature.

To secure the rail to this concrete base, holding-down bolts of 1-in. round iron are molded into the concrete when it is made, and project from the upper surface of the block on the inner side of the rail. A clip formed to fit the flange slips over the projecting end of this bolt, and a nut above holds the rail firmly down, the fastening being, in fact, many times as strong as the ordinary method of spiking to ties now in use.

To hold the rails to gage, pressed steel gage-bars are used, spaced 3 ft. 4 ins apart. These are made from flat steel plates 5 ft. 6 ins. long, 3 ins. wide and ⅝-in. thick. The ends are turned up to form claws, which engage the outer edge of the rail flange, and the central part is stamped into a semi-circular trough shape to stiffen it to resist compression. These bars are also punched to slip over the holding-down bolts. It will be seen at once that these gage-bars would offer vastly more resistance to the spreading of the rail than the present spikes in wooden ties. The rails would, in fact, be solidly held to perfect gage, and it would be impossible for the trackmen to change the gage. Again, the tendency of the rail to roll outward, which with the present track construction is a permanent source of trouble and expense, would be resisted in this design by 1 in. steel bolts anchored in solid concrete, and spaced 9 to a rail length. The security of this as compared with the rail braces, tie-plates and spikes which are now used will be apparent.

Besides the above, it will be seen that the construction shown also provides against any unequal settlement of the concrete blocks, causing their tops to spread, while settlement tending to bring their tops closer together is resisted by the gage-bar acting as a strut.

To lay such a track as this the first step would be the preparation of the roadbed. The old rails and ties would all be removed for a considerable length and the roadbed smoothed off at the level of subgrade. A heavy steam roller would then go to work running back and forth over this, and workmen would fill in the hollows that developed under the roller until the roadbed was made perfectly hard and firm. On this would be spread a layer an inch or two deep of sand or fine gravel, and this would be smoothed off with a former, as in laying a brick pavement. On this prepared surface the concrete blocks would then be placed, care being taken to see that they were well and evenly bedded. Elevation for curves would be made in the level of this sand layer, and in the case of sharp curves the roadbed itself should have an inclined surface.

Next upon the concrete blocks would be placed the gage bars; then the rails would be laid and shoved to place in the claws of the gage-bars. The rail clips would then be put on and screwed down tight, and the rail joints made. The alinement would then be gone over and adjusted if need be, and any evidences of uneven bearing of the blocks corrected by tamping under from the side. Last of all the filling between and at the sides of the concrete blocks would be put in place and the drainage arrangements completed, as hereinafter explained.

Let us next turn our attention to the difficulties that would probably be met in such a system of construction, and the possible methods of overcoming them. First would come the difficulty in getting the adjacent ends of the concrete blocks in exactly even surface. If this were not done, bad kinks in the rail would be apt to occur, or even breakage, for the concrete, as we have already pointed out, has no such large margin of elasticity as timber. To meet this condition, it is proposed to mold into one end of each concrete block a short piece of round iron, and into the opposite end a cast-iron socket adapted to receive this. In laying the blocks the projecting dowel on each would enter the socket on the next block, and in the case of inequality in the support under the adjacent ends of two blocks, the block with the ample support would assist in supporting its neighbor.

A second difficulty that may be urged is the matter of creeping. There is an idea, more or less prevalent, that a longitudinal system of track construction is impossible of success on account of the creeping of the rails; and there is another idea, also more or less prevalent, that rail creeping cannot be prevented, as it involves a force too great to be resisted. The latter idea is, perhaps, true, if nothing more substantial than wooden ties exists to anchor the rail to. With a solid concrete base, such as is here shown, however, no difficulty is apparent in anchoring every rail at its center to the concrete support, and holding it there. The reason for the idea that creeping cannot be stopped is that trackmen have generally attempted to hold creeping track only at the point where the trouble made itself evident. Of course, if the creeping force of a long length of rails is concentrated at one point, it becomes a difficult matter to control. If each rail is anchored in its place, however, the concentration of the creeping force cannot occur.

We have next to consider the two greatest difficulties in all railway track construction, the effects of water and frost. We believe that all engineers will concede that the construction here described and illustrated, if laid on a base of well-rolled earth of good consistency and not subjected to the effects of water or frost, would be practically permanent. But when the roadbed is drenched by long continued rains, will not unequal settlement of the concrete blocks occur? When the frost penetrates far into the wet embankment, will not the blocks be heaved out of surface? It is certain, we take it, that this might occur to a greater or less extent. Further than this, it is manifest that the task of restoring the blocks to their original position would be more difficult than the similar task in the case of track laid with ties. A deeper excavation must be made to get at the under side of the blocks, and they are so much wider than the ties that it would be correspondingly difficult to tamp beneath them.

To see what is essential to success here we must turn to the practice in laying street railway tracks on concrete beams. Here no difficulty is experienced in the settlement of the track in rainy weather, and the heaviest frost does not disturb its even surface. The reason for this is evident. The entire street is covered with impervious pavement which prevents the access of water to the foundations on which the track rests. If, then, we would make the longitudinal concrete system of track supports successful, we must keep water away from its base. Mr. Schaub has effected this in his design, but at a large expense for concrete. In the design herewith submitted it is proposed to protect the roadbed from water by laying a covering of asphalt between the rails, directly upon the earth filling. This asphalt might be of similar composition to that used for street paving purposes, but as it would not have to stand traffic, it could be made and laid more cheaply than paving asphalt, and could be of a softer composition, and freer from liability to cracks.

To give an exit for the water to the sides of the track, a shallow groove is formed across the top of the concrete blocks at the place where each gage-bar comes, which at once gives space for the gage-bar, and affords an exit for the water. The asphalt covering between the tracks is brought up flush against the web of the rail, except at the gage-bars, where it is formed around the drainage opening, leaving the rail clip and its fastening exposed. On the outer side of the blocks the filling would be whatever the circumstances made necessary to drain the water away to the ditches and prevent its reaching the foundation soil beneath the concrete.

An incidental advantage of this asphalt cover is that it would eliminate all dust, and thus at once increase the pleasure of travel and reduce the wear of journals and bearings, and the liability to hot boxes.

It may be of interest to consider the bearing area which this construction would afford upon the supporting earth. First-class track construction, according to present practice, uses 8-ft. ties with 8-in. face, spaced 3,000 to the mile. This would give a total bearing area of 16,000 sq. ft. per mile. With the construction proposed, two lines of concrete blocks with 26-in. base to support the rails, the total bearing area would be 22,880 sq. ft. per mile. Again, the largest locomotive yet built has a weight of 208,000 lbs., concentrated on a driving wheel base of 15 ft. 7 ins., or an average load upon the track of a little over 13,000 lbs. per lin. ft. As the width of bearing of the concrete blocks is 4 ft. 4 ins., it appears that the driving wheels of this locomotive would bring a load upon the earth beneath these blocks averaging 3,000 lbs. per sq. ft. This figure is well within the safe supporting power of earth, according to the best practice of engineers in designing foundations.

Let us now consider the question of the cost of such a construction as we have outlined. Taking up first the concrete blocks, computation shows that for the size shown in the drawing the amount of concrete required would be 735 cu. yds. per mile of track. For this we will accept Mr. Straub's figure of $5 per cu. yd., pointing out, however, that under the conditions assumed, making the concrete at a gravel bank or stone quarry with a permanent plant, the cost would be largely reduced over the usual conditions where it is made and laid in place, largely by hand labor on temporary construction work.

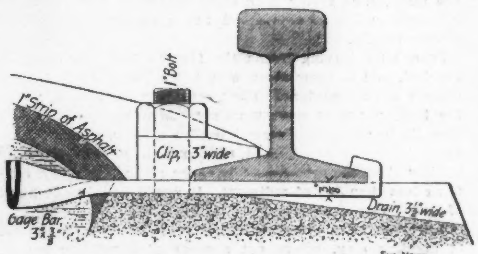
For the asphalt covering we have examined the figures given by Mr. J. H. Pearson in our issue of Dec. 15, and assume the cost of the asphalt concrete ready for laying at $6 per cu. yd. The remaining materials we have estimated at current market prices, and the entire estimate for one mile of track is as follows:

Concrete blocks,* 735 cu. yds. at $5.00	$3,675.00
Holding down bolts, 3,168, 12 ins. long by 1-in. diameter; complete with head and nut, 8,712 lbs., at 1½ cts.	130.68
Gage-bars, 1,584, each 5½ ft. × 3 ins. × ⅜-in., weight, 30,300 lbs., at 1.20 cts.	363.60
Rail clips, 3,168 at 4 cts.	126.72
Cast-iron sockets, 1,056 at 12 cts.	132.00
Dowels, 1,056, 2 ins. diameter × 10 ins., 9,680 lbs., at 1¼ cts.	121.00
Asphalt, 1-in. thick, 5 ft. wide, 5,280 lin. ft. = 81 cu. yds., at $6.00	486.00
Total for material	$5,035.00

*Ready for laying.

The cost of laying track under this system can only be roughly approximated; but it would seem that $1,000 per mile should be ample to cover it, or let us say $6,000 per mile for the total cost of the track complete, exclusive of the rails. As most roads whose traffic would be sufficient to warrant such a construction as we have outlined can borrow money at 3%, this means interest charges of $180 per year. But this interest charge would be just about met by the present annual outlay per mile for tie renewals, which outlay would be no longer necessary under the proposed system. Whatever saving was made in the item of labor on track repairs, therefore, would be a clear saving.

That the proposed system would effect a great saving in the track labor there seems every reason to believe. There would be no more adjusting of gage, no more tamping of ties, no more raising of low joints, no more shimming in winter. The trackmen's work would be confined to mere inspection,



Detail of Gage Bar and Rail Clip.

and repairs would only be necessary in case of accident.

We can best compare the two systems, however, by likening them to two large and expensive buildings, one supported on a timber crib work resting on the surface of the ground, the other upon substantial masonry foundations. The first costs less to build, and it is comparatively simple to repair its supports; but this repair must be kept up all the time, as the timbers decay and settle and the frost leaves them, to keep the building above from cracking. The masonry foundation, however, is put in once for all, and there is seldom need of expending money upon its repair during the whole life of the building.

Finally, we do not pretend that the design which we have outlined above is complete or perfect. Doubtless many of its details could be and would be improved upon as experience with the system developed. We present it simply as defining the direction in which the railway track of the future may not improbably develop, and as a subject which may well engage the attention of those responsible for the maintenance of track on our railways of heavy traffic.

LETTERS TO THE EDITOR.

The Establishment of a Standard Air-Brake.

Sir: We have in the United States about 200,000 miles of railway, nearly enough to belt the globe eight times. Most of this mileage has been built since the air brake was invented, at a cost of over $11,950,000,000. A large portion of this enormous sum was involved in the cost of freight cars, the successful operation of which can only be secured by the uniformity of the construction and operation of the air brakes. It follows, therefore, that as the number of freight cars increases, the argument for the establishment of a standard brake becomes more forcible.

The difficulties in operating brakes of different designs are a well-known source of great inconvenience to all roads. They result from one road having to carry cars with a different style of brake, or from a road using an inferior brake at the start and afterwards adopting a high-class equipment.

The use of the air brake to-day is a matter of legalized necessity, and the adoption of one design will be a matter of common usage. Although the first results of this will be to increase the prestige of one company, it is the only final and satisfactory solution of the one great difficulty experienced in freight traffic. The objections sometimes urged against leaving the business in the hands of one company are secondary to the logical necessity for the establishment of a standard.

The absorption of the patents and business of the Boyden Brake Co. by the Westinghouse Air Brake Co. only partially solved the difficulty, as there still remain two brakes. The claim of Westinghouse to the sole right to manufacture the "Quick Action" brake is now being contested by the New York Air Brake Co. Although the New York company was compelled to abandon three forms of brakes as being infringements on Westinghouse rights, they now have a fourth design on the market, the validity of which has been sustained by the lower court. This case was taken to the Court of Appeals on petition of Westinghouse and is still to be argued before that tribunal.

The time that will be involved in settling the present suit, together with the trying of three other cases brought by the Westinghouse company against the New York company, makes the much-desired solution of the air brake situation even more remote than ever. And, until it can be legally shown that all air brakes now in use are but variations and modifications of one, the matter must rest largely with the individual roads, who can either work toward a common uniformity, or, by adopting different designs, increase the present complications.

Dec. 30, 1898. Yours truly, Subscriber.

Notes by Rail in the Southwest.

Sir: The route to Southern California by the B. & O. Southwestern, the Illinois Central and the Southern Pacific railways has many points of interest to the engineer. The shops of the B. & O. S. W., at Chillicothe, Ohio, have been much improved during the last few years by new buildings and new equipment. The new roundhouse is served by a Pencoyd turntable, operated by electricity. The table is of the ordinary pattern, at one end of which is bracketed a trailing wheel to run on the circular track. This wheel is an ordinary car wheel connected by gearing with an electric motor, which is carried on the bracket frame, and enclosed from the weather. The controller is operated by an old locomotive reversing lever, and the current is supplied to the motor by means of wires connected to a frame over the center of the table.

The two notable pieces of engineering under way at Cincinnati are the new water-works (Eng. News, Dec. 8) and the nearly completed reconstruction of the Roebling suspension bridge. The bridge as originally constructed was one of the most pleasing examples of bridge architecture in this country, with the one exception of the insignificant finials which capped the towers. The reconstructed bridge is a failure as far as appearance is concerned, as the new stiffening trusses, with parabolic top chords, are too heavy in appearance. The new coverings over the saddles (hemispherical domes) are an improvement on the old finials, but it is to be regretted that an "attic story" was not added to the towers, after the style of those at Buda-Pesth. The stiffening trusses are anchored to the towers, and an expansion joint is provided at the center of the main span. This joint is telescopic in design so as to transmit shear but not moments. Portals are provided between the trusses at every third panel, and stiff hangers of four angles, laced on four sides drop from the cables at every sixth panel adjacent to the towers. The new cables, of less deflection than the old, are loaded by suspenders with sleeve-nut adjustment connecting to the old cables, and it is difficult to see how the adjustment can ever be made or maintained so that each cable will take its proper share of the greatly increased load. The feature most to be commended in the structure is its stiffness and freedom from vibration under the rapidly moving electric cars.

The Kentucky and Indiana cantilever bridge at Louisville, built by the Union Bridge Co., years ago, is still a noteworthy structure and one of the most pleasing cantilever designs ever built. One trestle approach was replaced by steel work a few years ago and the other by steel work constructed by the Louisville Bridge Co. last year, thus putting the entire structure in first-class shape.

The Illinois Central, from Louisville to Memphis, is the old Chesapeake, Ohio & Southwestern, acquired a few years ago. The physical condition of the road is much better than would be expected and work is in progress on a large amount of new roadbed near the old, of better grades, and, in some cases, of new and presumably better alinement. The temporary trestles, in use where fills were being made, to carry the light contractors' dump cars, are worthy of record. The posts for the bents, of extremely light round poles, were braced with diagonals which were branches of trees but little larger than bean poles, and the caps were also of round timber. But as the dirt soon filled around and supported the structure, no great risk was incurred of failure.

Little is seen of the city of Memphis by the traveler over this route. At South Memphis, new yards have been constructed by the Illinois Central to take care of increasing business. A fine view is had of the Morison cantilever bridge over the Mississippi at Memphis, but at such a distance that it looks like a spider-web.

The visitor to the French quarter of New Orleans would never dream that it was part of an American city. The narrowness of the streets is accentuated by the balconies or two-storied porches which cover the sidewalks, while the street pavements of large stone blocks 12 ins. or more square, and the large gutters running full of sewage, are hardly to be found in any other American city. The U. S. mint, located in this section of the city, is a large old building of little credit to the government. It has been selected as the base of money supply for Cuba and Porto Rico.

Canal St. is the principal business thoroughfare of New Orleans, and while wide, it is paved with the same large flat stones as the French quarter. The esplanade down the center of this and many of the other streets is a redeeming feature, and is used for electric car tracks. The business blocks are few of them modern and much of the sidewalk on Canal St. is covered by permanent timber awnings. At one point a pile driver was in operation, driving the round piles and sheeting for the underground canal which is being constructed as a storm sewer. The actual construction of the canal was in progress on an adjacent street, the excavation being carried down into the old swamp bed which underlies the city. The grapple dredge operated well in the muck, roots and branches, but when logs and stumps were encountered, blasting was resorted to. As fast as the excavation was completed between the timber casings, the bottom was concreted, the side walls of brick were built, the steel beams to carry the roof were placed in position coated with hot pitch, the brick arches built between them and the concrete top placed on the brick work. The canal will take care of the storm water by carrying it to a reservoir, from which it will be pumped by huge centrifugal pumps into a canal of higher level. This process being repeated until it reaches Lake Pontchartrain.

A few modern business blocks—such as the Hennen Building of the sky-scraper type—indicate that the day of modern improvements is at hand, while in the American part of the city many beautiful modern residences are to be seen. St. Charles Ave., the finest residence street, is paved with asphalt on either side of the esplanade, and has a double track electric railway. The architecture of the houses is generally of a Southern type—two-storied porticos with columns of classic design being common.

The station of the Southern Pacific Co. is located at the ferry slip, and is a very unpretentious wooden structure. The transfer bridge consists of several spans of double-track plate-girders, which are raised by a system of screws, connected by suitable gearing—the length being necessary to accommodate the range in the river. The traffic is heavy and keeps a shifter busy day and night to handle the cars. The passenger trains are made up in the train shed on the western side of the river and no change in these arrangements is likely to be made until the long-talked-of Corthell bridge is constructed.

After passing through the sugar and rice fields of Louisiana, the yellow pine region of Texas is entered. The timber is still moderately plentiful along the railway, although most of the larger trees have been cut out. Beaumont is the headquarters of the lumber district, and is a busy place with its sawmills and yards. Orders are very plentiful, especially from the Northwestern States. Shipments are also made abroad by vessel. The creosote works here began operations recently and are now creosoting ties. The creosote works east of Houston are also in full operation.

Houston is a surprise to one who thinks of Texas as the home of the cow-boy—a thriving city of about 45,000 people, whose bank clearings for November reached the amount of $35,178,596, or practically the same as Cleveland, Ohio, for the same month. It is expected that the present Congress will authorize the improvement of Buffalo Bayou in accordance with the engineer's plans reported in December, 1897, which will provide 25 ft. of water from Houston to the Gulf.

West of Houston are to be seen the finest cotton fields passed through on this route, and at Sugarland are large sugar plantations and a very large sugar mill.

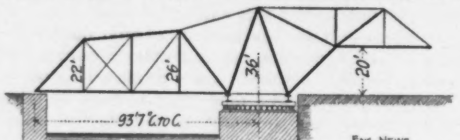
The Pecos River is crossed by means of the famous cantilever viaduct, one of the highest in the world, familiar to all American engineers (Eng. News, Jan. 5, 1893).

About two hundred miles farther westward, at Paisano, we reach the highest point on the line, an elevation of 5,082 ft. above sea level. At Marfa were seen fine specimens of houses and stores of adobe, or "doby" as it is called, two stories in height and fitted with regular doors and windows and timber roofs. The doby bricks have dried grass well mixed through them, but are so soft that a knife blade can be easily pushed in up to the handle.

El Paso looks like a Mexican town. The smelting works here were in full operation and the indications are for a busy season for the mining engineer and the irrigation engineer as well.

At Bowie, Ariz., connection is made with the Gila Valley, Globe & Northern Railway, which has been doing considerable construction work during the past few months. A recent act of Congress has made a grant of valuable mineral lands on the line of the road south of the Gila River which contains valuable copper deposits and beds of coal which is said to be of good quality for coking.

Yuma is without exception the most interesting point on this part of the line. The Arizona penitentiary occupies a prominent location on a high bluff adjoining the town. The old military post across the river is now used as an Indian school. The Colorado River at this point is navigable for very small "one-horse" steamboats, several of which were seen high and dry on the bank waiting for more water, the river being abnormally low. The Southern Pacific bridge—the only one—was formerly a Howe truss structure, but a new steel draw span was constructed by the Phoenix Bridge Co. at the Arizona end last year, and the balance of the bridge is now being rebuilt. The old timber bridge has been removed and the trains are carried on a pile trestle, which has the old bridge floor for a deck. The draw span is of the ordinary equal arm rim-bearing type, supported on a circular concrete pivot pier. The station being directly at the end of the span, it was originally proposed to put in a counterweighted span of a



Design for a Counterweighted Draw Span over the Colorado River at Yuma, Ariz.; So. Pac. Ry.

design which was novel enough to be worthy of record. The arm next the shore and station was designed, as shown in the accompanying sketch, to have 20 ft. headroom over the track, thus giving solid track up to the pivot pier and a length sufficient to demand but a moderate amount of counterweight.

Soon after leaving Yuma the famous Colorado desert is reached, and in comparison with it the Nevada and Mojave deserts are as gardens. First come the sand hills, which are kept in almost continuous movement by the wind, and they lie in great rolls resembling huge ocean swells. They often bury the track, and the sand is always piled up against the rails. The sand is sharp and whitish and contains less than 3% of sediment. It would delight the heart of a concrete maker.

After the sand comes miles of real desert—wide wastes of alkaline clay, where not a spear of vegetation grows. The surface is cut up by great cracks and water grooves, the work of occasional cloud bursts.

At Salton the railway is 263 ft. below sea level, and here is the place where the overflow from the Colorado River formed the Salton sea some eight years ago. This has now nearly dried up, and only a marshy tract meets the curious gaze of the tourist. A long building some distance from the station is the salt works, which manufactures table salt for shipment to all parts of the country. Except for this the "town" consists of several rows of Mexican one-story dwellings and the station.

At Indio one can realize what is meant by an oasis in the desert. The large square station and hotel building with its two-storied veranda on all sides, is surrounded by large cottonwood trees, palms and other foliage plants, which evidence the magical effect of plenty of water in a desert land. C. E. F.

Los Angeles, Cal., Dec. 19, 1898.

for lifting or for hauling heavy loads. The cut shows a section of the upper block only, and it will be understood that at the bottom there is an ordinary two-sheave block carrying a hook, from which the load is suspended. The side plate, which covers the sheaves in the upper block, is shown removed in the cut. The sheaves that carry the ropes at the upper end of the lift are journaled on two steel plates, one of which is fulcrumed on the other so as to allow a movement of one on the other, which is limited to a small amount, in one direction by a stop-pin, and in the other by the piece marked "lock," which is fastened to one of the plates. In operation, when the pulling rope, I, is pulled strongly, the end of the plate marked "rear" is depressed, moving the sheave, B, away from proximity to the lock, and the rope is then free to run, so that the load may be raised. Relaxing the pulling rope, however, allows sheave B to approach the lock, clamping the rope between the lock and the sheave, so as to hold the load without slip. Pulling the trip rope releases the rope from the lock and allows the load to run down. It will be noticed that there is no friction when hoisting other than that of the ordinary sheave friction, so that the block for hoisting or drawing heavy loads is equally efficient with the common block, while offering the advantages of holding the load automatically suspended.

While this block may be used for all ordinary rope blocks to advantage, it also enables rope to be substituted for the chain hoists which have come into such extensive use in machine shops, structural iron works, etc., on account of their holding their load automatically suspended.

TWO NEW STEEL PLANTS are to be erected, according to a press dispatch, one at South Chicago, for the manufacture of steel projectiles by a new process, and the other at Kensington, Ill., for the production of hollow steel car axles. It is stated that arrangements have been made between the Titan Steel Co., represented by the Mannesmann Bros., and the Federal Steel Co., and that a tract of land has been purchased at South Chicago where a plant will be erected to produce armor plate and shells.

THE LARGEST LAKE VESSEL ever constructed in Buffalo is to be built by the Union Dry Dock Co., of that city, for the Western Transit Co. It will be used in the package freight service, and will be either the same size

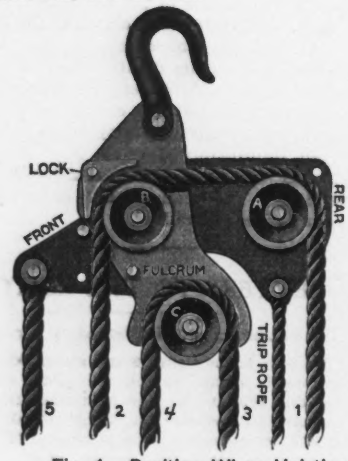
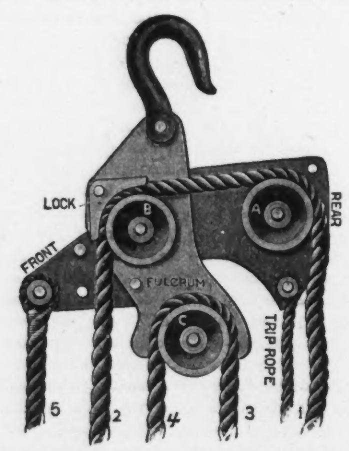


Fig. 1.—Position When Hoisting.



Position Standing; Rope Automatically Clamped by Lock.

AN AUTOMATIC SAFETY BLOCK FOR ROPE HOISTS.
Burr Mfg. Co., Makers, Cleveland, O.

Notes and Queries.

K. H. asks the reason why cement or concrete sidewalks break so frequently unless they are made very thick.

The most common reason is probably lack of care in making the foundations to secure an even bedding. Other causes are concrete too poor in quality or not thoroughly mixed, and forming the walk in blocks of too large size.

"Inspector" asks where he can obtain a copy of Southner's "Inspection of Pine Timber." Will any of our readers who have a copy of the book send us the name of its publisher.

AN AUTOMATIC SAFETY ROPE HOISTING BLOCK.

We illustrate herewith a new form of hoisting block, recently put on the market by the Burr Mfg. Co., of Cleveland, O., which seems to have many advantages over the ordinary rope block

as the "Troy"—a boat of 5,000 tons' capacity, which was built by the Detroit Dry Dock Co., and which now holds the record of package freight boats for tonnage and speed —or 700 tons larger. The Union Dry Dock Co. has recently increased its facilities, by enlarging its dock to accommodate the largest lake boats, and by installing a traveling crane and making extensive additions to its machine shops.

A FAST MAIL TRAIN on the Chicago, Burlington & Quincy Line has covered the 502 miles, between Omaha and the Union Station, in Chicago, in 10 h. 29 m., beating former records by 1 h. 15 m. The average speed maintained was 46½ miles per hour, including stops. The new New York-San Francisco mail train, over the New York Central and Lake Shore, on Jan. 2, made the 88 miles, between Buffalo and Cleveland, in 98 minutes, including two stops; and the 95 miles, between Erie and Cleveland, in 104 minutes, including stops.

A DESIGN FOR A PERMANENT TRACK FOR STEAM RAILWAYS.

By J. W. Schaub,* M. Am. Soc. C. E.

As civilization advances, we learn by experience that permanency in the construction of our works proves the best safeguard against waste. This applies to our pavements for streets, our buildings, our bridges for highways and railways, and, in fact, everything constructed for the benefit of mankind. But more particularly does this apply to the roadbed and track for railways, which must continually be adjusted and repaired to counteract the destructive agencies of nature, and the constant action of the passing loads.

As railways are constructed to-day, we find the rails laid on wooden ties, and held in line by spikes which are driven into the ties by the aid of the eye and main brute strength. If the spike is not in line it is knocked into line, or else it is drawn out, the hole in the tie is plugged up, and then the spike is redriven. At best it is a crude process, but what happens after the spike is in its proper place? First, we see that the yielding action or wave motion of the roadbed loosens the spike, and then the first lateral pressure on the rail throws it out of line. The spike is then ready to go through the same operation as when it was first driven.

On the most of our modern railways the ties are laid in rock ballast, and on a few the ties are laid on rock ballast as well as in it. Moreover, in some cases we find tie plates inserted under the rails to preserve the ties against indentation, and give the rails a stiff and unyielding bearing, and thereby preserve the alinement of the rails. This is approaching the idea of a permanent track and roadbed, but does it reach it? If the spikes are for the purpose of keeping the rails in line, why use spikes at all? If the ties are designed to give an unyielding support to the rails, why use wooden ties? If the roadbed is affected by the elements, why leave it exposed to the weather,

In the Engineering Magazine for August, 1897, Mr. H. G. Prout said:

> I am inclined to think that, if the roadbed could be made absolutely unyielding, the springs of the vehicles providing the elasticity, the best results would be had. If the track could be as smooth and relatively as stiff as a planer bed there would be a saving in the cost of maintenance of track and machinery, and in coal consumption. The stiffer the rails, the less the creeping due to the wave which runs ahead of the wheels, the less the wear of the ties due to this motion, the less the destruction of the track and running gear due to the pounding of the wheels and the easier the hauling of the trains.

Mr. P. H. Dudley, who has made careful measurements of the traction force with a dynamometer, says:

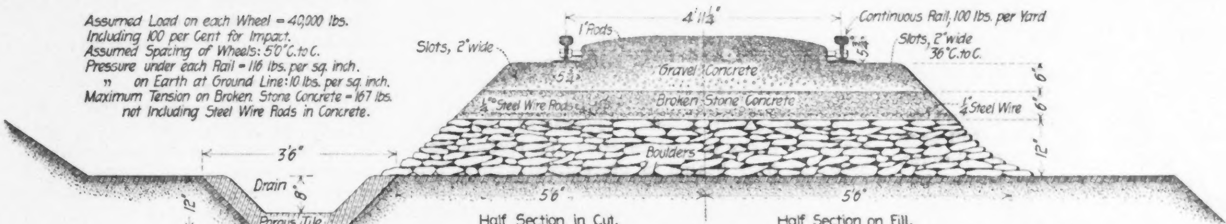
> Instead of making rail sections simply heavy, I have made them very stiff, which has reduced the deflection, or wave motion, under each of the wheels. Comparing the resistance of the Chicago Limited Express on the stiff 80-lb. rails with that on 65-lb rails, it makes a difference of 75 to 100 HP.

He designed some rails of 105 lbs. per yd. weight, nearly 100% stiffer than his 80-lb. rails, and estimated that on fast express trains he would save nearly 200 HP. as compared with a worn 60-lb. rail.

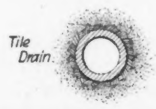
If we admit, then, that it is desirable to make the rails as stiff as we can with a given weight, it follows that the section should be such as to give relatively great depth to distribute the metal somewhat equally between the two members, and put the strained fibers as far as possible from the neutral axis. It also follows that by making the roadbed under the rails unyielding we tend to eliminate the wave motion which runs ahead of the wheels, and thereby also reduce the work performed by the traction force.

*1731 Monadnock Block, Chicago.

The writer begs to submit herewith a design for a permanent roadbed and track for railways, which he trusts will be received and discussed by engineers interested in railway construction and maintenance. In this design it is proposed to begin the foundation of the roadbed at sub-grade or ground line by laying at the bottom a bed of boulders, or, more properly speaking, large broken stones set on end, the largest as large as can be handled by a man. On this is laid a layer of small broken stone concrete, and on this a layer of fine gravel concrete, making a total depth of roadbed, under the rails, of 2 ft. In the bottom layer of the concrete are laid sixteen ¼-in. steel wires longitudinally, and one ¼-in. wire every foot transversely. The top layer of concrete is carried up between the rails so that the top of the concrete will be flush with the top of the rails. In this concrete are to be bedded tie-rods 1-in. in diameter, spaced 18 ins. c. to c. To these tie-rods the rails are to be fastened by nuts, one on each side. The threads on these rods and nuts are to be of a quality known as machine work, and are to fit perfectly one into the other.



CROSS-SECTION OF PROPOSED PERMANENT WAY FOR STEAM RAILWAYS.
Designed by J. W. Schaub, M. Am. Soc. C. E.



The rails are to weigh 100 lbs. per yd., and are to be continuous in lengths of about 300 ft. They are to be rolled in lengths of 60 ft., and spliced with angle bars and turned bolts in the field. Where expansion and contraction are to be provided for, the rail ends should be scarfed and one end provided with slotted holes. At the expansion joints the concrete roadbed should be discontinuous, so as to allow the concrete and track rails to expand and contract with perfect freedom.

The rails are to rest directly on the concrete, and are held in place only by the tie-rods spaced 18 ins. apart. All adjustments as to gage are made by the nuts on the ends of the tie-rods.

The concrete should be so proportioned that no rupture could occur, and the wire rods and tie rods buried in the concrete are designed to enable the concrete and rails to act as a unit. It is not supposed that by this form of track and roadbed all wave motion due to passing loads is eliminated. On the contrary, if there must be a wave motion it is proposed, first, that this motion shall be reduced to a minimum, and, second, that the rails and the roadbed directly under the rails shall vibrate in unison. It might be argued that the concrete will not submit to this motion and the effect of impact on the rails. To answer this question we must refer to the wonderful drop tests made on concrete floors reinforced by wire rods. It might also be argued that the rails cannot be held to resist the effect of changes in temperature. If we assume that a length of 18 ins. can be held, and that every section 18 ins. long is held exactly the same as every other section, there can be no question but that the entire rail, 300 ft. long, can be held.

A roadbed and track built on this plan should require no attention other than such inspection as may be necessary to guard against derailments.

The cost of such a track and roadbed, as compared to the present form, is as follows, leaving out the cost of the track rails in both cases:

Permanent Track.

Material.			Cost per mile.
Broken stone	2,000 cu. yds.	at $1.00	$2,000
Broken stone concrete	830 " "	" 5.00	4,150
Gravel concrete	1,100 " "	" 5.00	5,500
Tie-rods and nuts	3,520 each	" .35	1,232
Steel wire, laid	10.89 tons	" 30.00	327
Rail splices			300
Turned bolts			100
Laying track			200
Incidentals			191
Total			$14,000

Present Track.

Material.			Cost per mile.
Broken stone	3,000 cu. yds.	at $1.00	$3,000
Ties	3,000 each	" .60	1,800
Tie-plates	6,000 "	" .08	480
Rail splices			300
Bolts and spikes			100
Laying track			300
Incidentals			20
Total			$6,000

Cost of permanent track per mile	$14,000
Cost of present form of track per mile	6,000
Extra cost of permanent track per mile	$8,000

Assuming that the present form of track requires for maintenance one man per mile more than the proposed permanent track, and leaving out the question of renewals in both cases, we have the extra cost of maintaining one mile of present track, one man at $1.25 per day, or $390 per year; then, assuming that the first cost of the permanent track is $8,000 per mile more than for the present form of track, we have:

Difference in cost of maintenance	$390.00
Extra cost, $8,000 at 4%	320.00
Saving in maintenance per mile per annum	$70.00

Assuming that the difference in the cost of renewals is the cost of replacing the wooden ties, say every ten years, in the present form of track, we have the difference in the cost of renewals per annum in favor of the proposed permanent track:

300 ties at 60 cts. each	$180.00

The total saving will then be:

Saving in maintenance	$70.00
Saving in renewals	180.00
Total saving per mile per annum	$250.00

This applies to the track and roadbed only. In order to carry this speculation still further, let us assume that the proposed form of track will save 10% in the item of fuel, and 25% in the item of repairs to rolling stock; then, assuming the

Business of road 1,000 miles long, 1 year, say	$10,000,000
Cost of operating, say 60%	6,000,000
Fuel, say 10% of operating	600,000
Repairs, say 5% of operating	300,000

Then, assuming that the saving in fuel will be 10% and saving in repairs to rolling stock to be 25%, we have the total saving on 1,000 miles of railway:

Saving in fuel, 10% of $600,000	$60,000
Repairs, 25% of $300,000	75,000
Saving in fuel and repairs	$135,000
Saving in track and roadbed	250,000
Grand total	$385,000

Then, assuming the original cost of the 1,000 miles of railway to have been $10,000 per mile, or $10,000,000, we have, in addition to paying a fixed charge of 4% on the cost of reconstructing the roadbed, an income or saving of $385,000 per annum, or 3 85-100% on the original cost of the roadbed.

THE NEW BUILDING CODE COMMISSION of New York city, which was recently nominated by the Presidents of the two houses of the Municipal Assembly, has failed of appointment by a vote in the Board of Aldermen of 44 to 38. The appointment was, however, made a special order of business for the next meeting of the Board, when it is expected that it will be confirmed.

STANDARD PLANS FOR 120-FT. PONY TRUSS BRIDGES, NORTHERN PACIFIC RY.

(With two-page plate.)

In our issues of July 8 and 15, 1897, we outlined briefly the excellent work which is being done by the Northern Pacific Ry. in replacing its old wooden bridges with new standard structures of steel and iron. Owing to the fact that the piers and abutments of the old bridges were temporary structures it was found possible to adopt in the new work certain fixed or standard lengths of spans. For all spans up to 100 ft. plate-lattice girders were adopted. These girders have a solid plate web at the ends and a lattice web at the center, and were fully described in the issues of July 8 and 15, 1897, noted above. For through spans between 100 ft. and 125 ft., inclusive, pony spans are used if dimensioned for mastodon engines, but if dimensioned for consolidation engines the plate-lattice girders are used up to 110 ft. span. About the same limits of span are used for all deck-bridges, starting with semi-pin connected spans, similar to the pony spans, at 110 ft., if dimensioned for mastodon engines, and at 120 ft., if dimensioned for consolidation engines. The shortest purely "through" span used is 130 ft.

Both the pony span and the 130-ft. through span have novel features in their design, and details of the former are illustrated on our full-page plate this week. Details of the 130-ft. through truss spans will be given in a future issue. The plate-lattice girders used for all inferior spans have already been fully illustrated, as stated above. All of these structures were designed by Mr. K. E. Hilgard, M Am. Soc. C. E., formerly Engineer of Bridges, Northern Pacific Ry.

Standard 120-ft. Pony Truss.—The principal reason for using pony trusses instead of through

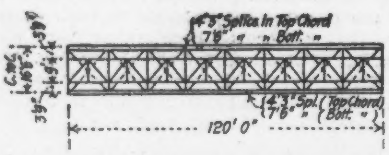


Fig. 5.—Diagram Plan Showing Location of Splices in Top and Bottom Chords, 120-ft. Pony Truss, Northern Pacific Ry.

trusses for spans between 100 ft. or 110 ft., and 130 ft., was to avoid employing the very long members required in a through span to give the necessary head room. In addition it was considered that the pony spans were more easily and quickly erected on account of the very small amount of field riveting in the main trusses. It will be noticed from the drawings that the 120-ft. pony span has only one field splice in each chord of the truss, and that aside from these splices the field riveting is confined entirely to the connections of the lateral system and the floor beam connections. At this point attention may be called to the character of these floor beam connections. It will be noticed that the rivets above the neutral axis of the floor beams, which in ordinary connections have to transmit some tensile strain through their heads, are all shop rivets; whereas the field rivets are clearly only strained in shear.

Turning now to the drawings, Fig. 1 shows details of the pony trusses and the lateral bracing. The trusses, it will be noticed, are semi-pin connected, and have two field chord splices each. The diagram, Fig. 5, is a general plan of the trusses, floor beams, stringers and lateral systems. All general dimensions and the dimensions of each member are shown by the drawings. The idea in using a semi-pin connected truss was to avoid clumsy and unsightly connection plates, and to do away with as much field riveting as possible, while keeping the necessary amount of stiffness in the truss connections. It will be noticed that each half of the entire truss is required to be shipped entirely riveted and with all the pins driven by the manufacturing shop.

Figs. 2 and 4 give the details of the fixed and roller bearings, base plates and shoes, and Fig. 3 gives details of the floor beams, stringers and track. It will be noticed that the outer portion of the floor beam has a lattice web and the ends a solid plate web. This construction was adopted to facilitate inspection, by permitting the inspector to climb along underneath the bridge, it being considered that the more convenient inspection was made the better it would be done.

The specifications for material and workmanship for pony truss spans contain the following requirements: All material in the ends posts, top chords, main diagonals, end bearings (shoes, pins and rollers), is medium steel. The vertical posts, bottom chords, floor beams, stringers and lateral bracing are soft steel. The bolsters are to be of cast steel or cast iron. All field rivets are of wrought iron or soft steel, and are ⅞-in. in diameter. All rivet holes are required to be punched to 11-16-in. diameter, and reamed to 15-16-in. diameter; all holes for field connections are required to be reamed while the members are temporarily assembled in the shop; all sheared edges are required to be planed, except on lateral bracing. The minimum distances from the center of the rivet to the nearest edge are required to be 1½ ins. when the edges are planed, finished or rolled, and 1¾ ins. when the edges are sheared. The diameter of the pin shown on the drawing is the finished dimension. All pins are to have wrought-iron filler rings and wrought iron or soft steel Lomas nuts. All members are designed for a rolling load of two typical 145-ton Northern Pacific mastodon locomotives.

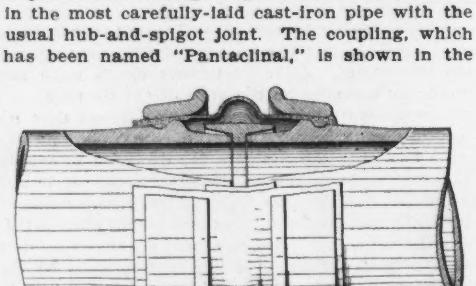
The method of erection suggested by these standard plans is first to erect the trusses, then drop the floor beams in place from above, then swing the stringers in sidewise, and finally to place the minor members. In construction one pair of angles connecting the stringers with the floor beams are shop riveted to the floor beams alternately on the inside and outside of the stringers. The other pair of angles is shipped bolted to the stringers.

It may be noted that during 1897 two of these standard pony truss spans were erected across the Green River, on the Pacific Division of the main line of the Northern Pacific Ry., and several more are expected to be built during the present year.

From the information from which this description has been prepared we are indebted to Mr. K. E. Hilgard, M. Am. Soc. C. E., under whose direction the designs were prepared.

A NON-LEAKING JOINT FOR GAS MAINS.

A new method of making joints or couplings for gas pipes, invented by Mr. James C. Bayles, M. Inst. M. E., is now after five years of tests and experiments being placed on the market by the Bayles Engineering Co., 14 Cortlandt St., New York city. The object of the new coupling is to prevent the leakage of gas which is unavoidable in the most carefully-laid cast-iron pipe with the usual hub-and-spigot joint. The coupling, which has been named "Pantaclinal," is shown in the



The "Pantaclinal" System of Coupling for Gas Pipes. The Bayles Engineering Co., 14 Cortlandt St., New York, Makers.

accompanying cut. Its elements are a bulbous sleeve of ductile, compressible metal, such as lead, a collar of T-shape in cross-section, and two compression rings. Pipes to be used with the system are cast without hubs, and are provided with small circumferential ribs, or beads, near each end.

In making a joint with this coupling, the rings are first slipped on the pipe ends, over the ribs, far enough back to be temporarily out of the way, and on either of the two pipes to be joined is slipped the lead sleeve. The pipe ends are then brought together inside of the collar, the function of which is to maintain the two pipe ends in line. The lead sleeve is then slipped into place, covering both pipe ends equally, and the portions of the sleeve extending an inch or more beyond the ribs cast on the pipes are then contracted by tapping with a light mallet, to make the sleeve smaller at the ends than the greatest inside diameter of the rings. The next operation is to bring the rings toward each other, over the lead, driving them up solidly, and making a gas-tight joint between the ribs in the pipe, the lead and the rings. The lead extending beyond the rings is then roughly set up behind them in three or four places, so as to lock the rings in place and prevent their sliding back.

The joint thus made is absolutely gas-tight, and is at the same time remarkably flexible. Longitudinal movement due to contraction and expansion, or bending out of line even 10° or 12°, due to settling of ground or other cause, will not make the joint leak. During the meeting of the American Gas Light Association in Niagara Falls, in October, Mr. Bayles exhibited in a large room at the International Hotel a line of 8-in. gas main running around the room, coupled by his system and filled with gas. The pipe was hung from overhead supports, and could be swung to and fro and bent out of line as much as 12 ins. in a length of 20 ft. Service pipes coupled to the main were also shown which could be bent at the coupling 20° or 30°. With all the tests to which it was subjected, the pressure, as indicated by a U-tube gage, remained constant, and there was not the slightest smell of gas in the room.

UNITED STATES PUBLIC DOCUMENTS FOR SALE.

The Superintendent of Documents, at Washington, publishes monthly a list of documents issued and for sale, or for free distribution by Congressmen. This list contains a number of documents interesting to engineers, and we have selected from the last issued some of the more important. These are for sale at the prices stated, and remittance should be made by money or express orders, to the Superintendent of Documents, Union Building, Washington, D. C. Cash remittances will be at the risk of the sender, and postage stamps will not be accepted.

American Practical Navigator. 217 pp.	$0.90
Analyses of Rocks, 306 pp. (Geol. Survey)	.20
Bridge Equipment and Pontoon Drill; with atlas	1.00
Mining Laws of United States	1.10
Water Power of United States. Part I	1.25
Water Power of United States. Part II	1.00
Census Compendium, 1870	.65
" " 1880. Part I	.65
" " 1880. Part II	.65
Civil Service, Executive Positions in	.75
Construction Materials: Resolutions of Conventions for Adopting Methods of Testing. 44 pp.; ill.	.05
Deep Waterways Commission, Report; 263 pp., maps	1.30
Dictionary of Geograpic Positions. 183 pp.	.15
Geographic Dictionary of Connecticut. 67 pp.	.10
" " Massachusetts. 126 pp.	.15
" " New Jersey. 131 pp.	.15
" " Rhode Island. 31 pp.	.05
Mineral Resources U. S. 1894. (I.). 646 pp.	1.20
" " 1894. (II.) 735 pp.	1.20
" " 1895. (I.) 542 pp.	1.00
" " 1895. (II.) 515 pp.	1.00
" " 1897. (I.) 642 pp.	1.00
" " 1897. (II.) 755 pp.	1.00
Hydrography Division, Progress Report. 1893-94	.15
Hydrography Division, Progress Report. 1895	.25
International Geological Congress, Report. 1891. 529 pp.	2.25
Irrigation Practice on the Great Plains. 39 pp.	.10
" in Mesilla Valley, N. Mex. 51 pp.	.10
" near Greeley, Colo. 90 pp.	.15
" near Phoenix, Ariz. 98 pp.	.15
" and Water Rights, Abstract of Laws on. 180 pp.	.10
" Preliminary Report on. R. J. Hilton	.35
" Final Report on. E. S. Nettleton	.35
" Final Geological Report. Robt. Hay	.25
" Underwaters of the Great Plains. J. W. Gregory	.10
Labor Laws of U. S., Report. 1892-96. 1,381 pp.	.95
Manual of Photography	.20
National Academy of Sciences, Memoirs. 484 pp.	4.15
Nicaragua Canal Board of Engineers, Report. 1895.	.70
Operations at River Stations. 1897	.10
Pumping Water for Irrigation. 57 pp.	.10
Results of Primary Triangulation. 412 pp.	.25
River Heights. 1896. 100 p.	.10
Safety Appliances on Railways. 1897. 32 pp.	.05
Seepage Water of Northern Utah. 50 pp.	.10
Sewage Irrigation. 100 pp.	.10
Ship Canal from Great Lakes to Hudson River. (Symons)	.25
Statistical Abstract, U. S. 1897	.25
Tests of Metals. 1895	1.00
Topographical Methods, Manual of. 300 pp.	.65
Underground Waters of Southwestern Kansas	.15
Windmills for Irrigation. 49 pp.	.10
Timber Physics. Part I. 61 pp.	.10
Forest Influences. 197 pp.	.15
Use of Metal Railway Ties and Preservative Processes and Metal Tie-plates for Wood Ties. 363 pp.	.20
Wood, Characteristics and Properties of. 89 pp.	.10
Timber Pines of Southern U. S. 176 pp.	.35
Lessons of Erosion Due to Forest Destruction	1.00
Roads, State Laws Relating to Management of. 1895	.05

Road System of Georgia, Improvement of..........	.05
" Materials and Transportation Rates, West of the Mississippi River..................	.05
" North of the Ohio River..................	.05
" In Certain Eastern and Southern states...	.05
Earth roads	.05
State Aid to Road-Building in New Jersey........	.05
Wide Tires	.05
Historical and Technical Papers on Road-Building in U. S. 52 pp..........................	.05
Progress of Road Construction in U. S. 1895.......	.05
Traction Tests on Roads.	.10

PRELIMINARY REPORT OF THE NICARAGUA CANAL COMMISSION.

The full text of the preliminary report of the Nicaragua Canal Commission, made public on Dec. 29, is as follows:

Washington, December 26, 1898.

The Honorable, the Secretary of State, Washington, D. C.

Sir: We have the honor to acknowledge the receipt of your letter of the 19th inst., inclosing a copy of a resolution of the Senate of December 15, requesting a report of the progress made by this Commission in investigating the question of the proper route, the feasibility and cost of construction of the Nicaragua Canal.

This Commission has understood the law by which it was constituted, approved June 4, 1897, to require that all routes heretofore proposed, having any merit, are to be considered, new routes that appear to have merit are to be developed, and the entire region of canal possibilities to be examined with sufficient thoroughness to enable a just and comprehensive comparison of the various routes to be made and the most desirable one selected. In short, to enable the Commission to make a complete and exhaustive report.

With this in view the Commission visited Nicaragua, personally examined the entire canal region from ocean to ocean, and employed some seventy engineers, with their laborers and helpers, for ten months, in making careful surveys and examinations of the canal region. Some meteorological and hydrological observers are still continuing in Nicaragua with a view to obtain a full year of observations of that nature.

The required field work has been obtained. The reduction of this field work, together with the compilation and comparison of former surveys going back nearly fifty years, has been in progress for more than two months.

The Commission believes that the construction of a canal across Nicaragua is entirely feasible.

The estimates for two of the best-known characteristic routes have been nearly completed. These routes are known as the Maritime Canal Company's route and the Lull route. Their estimated cost is approximately $124,000,000 and $123,000,000, respectively. The assumed dimensions are considerably greater than ever before proposed, both in length of locks and in width, depth and radius of curvature of canal. These increased dimensions have been made necessary by the demands of modern commerce, size and draught of modern ships, etc. This has necessarily made a corresponding increase in the estimated cost, and is in no way inconsistent with the estimates made from former surveys, which contemplated a much smaller and cheaper canal. A canal of smaller dimensions, just sufficient for present needs, is being estimated for. Such a canal would cost considerably less than the estimate for a canal suitable for modern necessities, which is referred to above.

It is the opinion of this Commission that of the two routes herewith estimated for the one called the Lull route is the more desirable, because it is easier of construction, presents no problems not well within good engineering precedents, and will be a safer and more reliable canal when completed. It also believes that the dimensions and form of construction preferred by the Commission are better than the cheaper form with smaller dimensions, which would undoubtedly call for expensive improvements within a short time after its completion. Both of the routes referred to above admit of variants, which may reduce the cost. These are now being considered by the Commission.

The work necessary for an exhaustive discussion of and report upon the entire canal problem is being pushed as rapidly as its great magnitude permits, and when completed the report will be submitted without delay. We are, sir, with great respect, your obedient servants,

J. G. Walker, Rear-Admiral U. S. Navy, President of Commission.

Lewis M. Haupt, Civil Engineer, Member.

I concur with the other members of the Commission in respect to the progress of the work and the feasibility of the canal, but I think, in view of the increased size of the canal estimated for and the difficulties incident to work in tropical countries, that the estimate is lower than it should be by about 20%.

Peter C. Hains, Colonel, Corps of Engineers, Member.

The Lull route here referred to is that located in 1873 by a government expedition commanded by the late Commander Lull, U. S. N., and of which Mr. A. G. Menocal, C. E., U. S. N., was chief engineer. The characteristic difference between this location and the one adopted by the Maritime Canal Co., is the avoidance of the deep cutting through the divide on the east side, and a location along the line of the San Juan River, below the San Carlos River. On the San Juan four dams were to be built; the uppermost at Castillo, and the lowest one mile below the San Carlos River; below the latter dam a canal was to be cut, following the left bank of the San Juan River to the outlet of the San Juanillo; from the latter river the canal was to lead directly to Greytown. The Lull location on the west side of Lake Nicaragua was also different from that of the Maritime Co. The line followed down the valley of the Medio, instead of the Lajas River in reaching the valley of the Rio Grande, but followed the latter to Brito. The Medio location crossed a much higher divide and called for more excavation; but the line was shorter than the Lajas line and was believed to possess advantages in avoiding interference with the canal by the discharge from the upper valley of the Rio Grande.

The Lull line, as then located, lowered the summit level to 107 ft., and the total length of the summit level was 102 miles; and the total length of the canal, from Brito to Greytown, was 181¼ miles, instead of about 170 miles for the Maritime Co.'s location. The several section lengths were given as follows:

Brito to Lake, at mouth of Medio............	16¼ miles
Medio, across Lake, to San Juan River.........	56½ "
Slack water in San Juan; 4 dams..............	66½ "
Canal along San Juan and to Greytown........	42 "

As the Lull report only contemplated a canal 26 ft. deep, and proposed eleven locks, of 10½ ft. maximum lift, on each side, it must be understood that the present commission only approves of some of its general features of location.

TESTS FOR BOILER TUBES FOR THE U. S. NAVY.

The Bureau of Steam Engineering of the U. S. Navy Department recently issued a code of rules to govern the inspection of material intended for use in the construction of machinery and boilers for United States naval vessels. The following are the test requirements for boiler tubes:

Lap-welded Mild Steel and Lap-welded Charcoal Iron.

The naval inspector will select three tubes from each lot of 100, and these will be subject to the following tests:

1. A piece 3 ins. long, cut from one tube, must stand being flattened by hammering until the sides are brought parallel with a curve on the inside at the ends not greater than three times the thickness of the metal, without showing cracks or flaws, the bend at one side being in the weld.

2. A piece 1¼ ins. long, cut from one tube, must stand crushing in the direction of its axis, under a hammer, until shortened to ¾-in. for stay tubes and to ½-in. for ordinary tubes, without showing cracks or flaws.

3. The end of one tube, cold, must stand having a taper pin, taper 1½ ins to the foot, driven into it until the end of the piece stretches to 1¼ times the original diameter, without showing cracks or flaws.

The failure to pass any one of these tests will reject the lot of 100.

Seamless and lap welded mild steel tubes 3 ins. in diameter, and larger, for steam and water pipes. These must pass requirement No. 1, but requirement No. 2 is altered to the following, and No. 3 is omitted:

2. Two pieces, which have been cut from the ends of two test tubes, shall, after annealing, stand flanging cold to a 1-in. flange, when the diameter of the tube is from 3 to 6 ins., or to a 1½-in. flange when the diameter of the tube is greater than 6 ins.

The failure to pass these tests in a satisfactory manner will reject the lot.

A NEW JAPANESE CUSTOMS TARIFF went into effect on Jan. 1. Copies of this law and blank declarations required for U. S. goods can be obtained from the Japan-American Commercial and Industrial Association, Times Building, New York city. The law covers the statutory tariff, and the conventional tariff, or a tariff framed under special concessions granted to England, France, Germany and Austro-Hungary. The United States refused to submit a special schedule on the grounds that Japan was an independent nation and thus entitled to frame its customs laws without outside interference. But Japan has decreed that the United States shall have the advantage of the more favorable duties granted to the nations named, on condition of filing a certain declaration of citizenship, and of the American source of the goods exported. The import tariff covers 525 items in 16 groups; rated in percentage, ad valorem; the specific tariff covers 485 items. The conventional tariff of the countries named is based upon ad valorem rates, which are fully set forth.

CONTROL OF THE HAWAIIAN OCEAN CABLE should remain in the hands of the United States, according to Secretary of State Hay, and practically the whole Cabinet, at its meeting of Dec. 30. This determination makes void the concessions and pending bills in Congress of both the Pacific Cable Co., of New York, and the Pacific Cable Co., of New Jersey. The first company owns the Scrymser concession, obtained from the Hawaiian Legislature before annexation and granting exclusive rights for 20 years; provided, the Secretary of State of the United States did not disapprove within six months from the date of the concession. These six months were up on Jan. 2, 1899. The Scrymser Company's bill in Congress is favorably reported upon by the House Committee on Commerce; and the rival company has a bill favorably reported to the Senate and granting an annual subsidy of $100,000. The decision of the Cabinet throws the whole matter open to competition, and the government may yet build and manage the line itself.

AMERICAN MOTOR CARRIAGES and cabs are to be introduced in Europe by the American Motor Agency, of Paris, whose president, Count de Totemps, is reported to have placed large orders in this country. The orders, as stated by the daily papers, include the electric vehicles (Wood's system) of the Fischer Equipment Co., of Chicago; the steam carriages of the Stanley Automatic Carriage Co., of Newton, Mass., and the gasoline and petroleum carriages of the Holyoke Motor Co., of Holyoke, Mass., and the Overman Wheel Co., of Chicopee Falls, Mass. The contract with the Fischer company is said to be for the supply of 500 carriages per year for ten years, at $1,000 each, while the total amount of all the orders is said to aggregate $15,000,000. These newspaper figures, however, can hardly be considered as reliable.

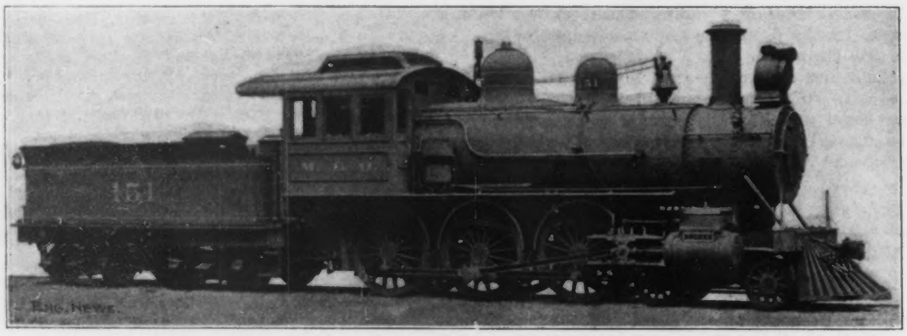
A CONTRACTOR'S MISTAKES IN ESTIMATING ON public contracts are not sufficient to annul the contract in a court of equity, according to the U. S. Circuit Court of Appeals. This is set forth in a lengthy opinion by Judge Wallace, in "The Moffett Hodgkins & Clarke Co., appellee, vs. the City of Rochester, N. Y., appellant." In January, 1893, the company named refused to enter into a contract to construct a pipe line for the city of Rochester for the sum named in its bid, $857,552, alleging that it had made two mistakes in its estimates. There was also another reason alleged, but as this has been given no standing in the case it need not be considered. One of the mistakes alleged by the company was the insertion of 50, instead of 70 cts. per cu. yd. for earth excavation, which, Judge Wallace states, is established by the evidence as a clerical error. The sum involved here is $36,800. The other alleged mistake was the insertion of $1.50 instead of $15 per cu. yd. for tunnel excavation. On this claim Judge Wallace says the evidence indicates that the contractor omitted "to take into consideration certain features of the work," which "was not a mistake in any legal sense, but was a negligent omission arising from an inadequate calculation of the cost of the work." and affords no ground for courts to allow contractors to recede from their engagements. The second alleged error amounted to $27,000, and the two errors, $63,800. The difference between the bid of the complainant and the next highest bid was $272,643. The suit was brought to prevent the city from proceeding to collect on the complainant's bond of $90,000, which bond, it will be noted, is about one-third the difference between the lowest and the next to the lowest bid. The lower court annulled the contract. The higher court reverses the decree and instructs the lower court to dismiss the bill. Judge Wallace states that had the complainant sought to reform the contract, increasing the price so as to include the amounts involved in the errors "it would have presented itself in an attitude which would at least have commanded the sympathy of the court." But this is small comfort, especially in view of the opinion already given regarding the inexcusableness of one of the alleged mistakes. He also states in another part of his decision that one of the reasons, not mentioned in this note, given by the company for not executing the contract, gave the city grounds for believing that its chief motive was a desire to avoid the contract after finding its bid was so much lower than the others. The decision apparently permits the city to sue on the $90,000 bond of the complainants. The last opinion is published in the Rochester "Democrat and Chronicle," for Dec. 23, 1898. A review of the case to the close of 1897, including an abstract of the decision of the lower court, is given by Mr. Emil Kuichling, M. Am. Soc. C. E., Chief Engineer of the Rochester Water-Works, in his annual report for 1897. Since the above was put in type we have received from Mr. Kuchling a carefully prepared review of the case, made under the direction of Mr. Adolph J. Rodenbeck, of Rochester, who prepared the case for argument while he was acting as Corporation Counsel. The following quotations are from this review:

The court here lays down the rule, enunciated for the first time by so high an authority, that for a mistake in the prices named in a proposal made in public competitive bidding, where there is no fraud or inequitable conduct on the other side, a bidder cannot be relieved from his proposal. . . . (The Corporation Counsel) insisted from the beginning that if the contention of the company prevailed, there would be no security in public bidding, and that any bidder could easily be relieved from an unfavorable bid.

TEN-WHEEL PASSENGER LOCOMOTIVE: MOBILE & OHIO R. R.

Ten large passenger locomotives of the ten-wheel type have recently been built for the Mobile & Ohio R. R., by the Rogers Locomotive Co., of Paterson, N. J., and we are indebted to the builders for views and particulars of these engines, one of which is shown in the accompanying cut.

The boiler is of the entended wagon-top type, with bell and sandbox mounted on the barrel, and dome mounted on the wagon-top, the whistle being fitted to an elbow in the side of the dome. The firebox is designed for burning bituminous coal, and has its crown sheet supported by radial stays. The driving wheels have cast steel centers and crucible steel tires, and are mounted on axles of Coffin steel. The tender has a frame of white oak, with sills $5\frac{1}{2} \times 13$ ins., and is mounted on a pair of diamond frame trucks. The equipment includes $2\frac{1}{2}$-in. safety valves, triple sight-feed lubricators, French & Co.'s springs, Leach's sand jet, the United States metallic packing, National hollow brakebeams, the New York brake, and automatic couplers of the M. C. B. type. The general dimensions are as follows:



TEN-WHEEL PASSENGER LOCOMOTIVE; MOBILE & OHIO R. R.
Rogers Locomotive Co., Builders.

Ten-Wheel Passenger Engines; Mobile & Ohio R. R.

Running Gear:	
Driving wheels, (6), diameter	5 ft. 2 ins.
Truck wheels (4), diameter	2 " 6 "
Tender weels (8), diameter	2 " 9 "
Driving-wheel centers	Cast steel.
Truck wheels	Steel tires; spoke centers.
Tender wheels	Cast iron; chilled tread; double plate.
Wheelbase: Driving..12 ft.; Truck	12 ft. 0 ins.
Total engine	22 " 4 "
Weight in Working Order:	
On driv'g wh'ls 102,000 lbs.; on truck wheels	28,000 lbs.
Engina total	130,000 "
Cylinders:	
Diameter and stroke	18 x 26 ins.
Form of crosshead and guides	Alligator.
Boiler: Type	Extended wagon top.
Diam. barrel, outside smallest ring	5 ft.
Thickness, barrel plates and smokebox tube-plate	9-16-in.
Injectors (2),	Monitor.
Working steam pressura	185 lbs.
Firebox:	
Length, inside...9 ft. ⅛-in.; width inside	2 ft. 9⅜ ins.
Thickness, side and back plates	5-16-in.
Thickness, crown plate ⅜-in.; tube plate	9-16-in.
Kind of crown stays	Radial.
Tubes: (iron) number	248
Thickness	No. 11 B. W. G.
Diameter, outside	2 ins.
Length over tube plates	13 ft.
Heating Surface and Grate Area:	
Heating surface, tubes (interior area)	1,688.13 sq. ft.
" " firebox	156.73 "
" " total	1,844.86 "
Grate area	25.05 "
Miscellaneous:	
Capacity of tender tank	4,000 gallons.
Brake fittings	New York Air Brake Co.

BOOK REVIEWS.

A STATISTICAL ACCOUNT OF THE SEVEN COLONIES OF AUSTRALASIA, 1897-8.—By T. A. Coghlan, Government Statistician of New South Wales. Seventh issue. Sydney: Government printer. Stiff paper; $8\frac{1}{2} \times 5\frac{1}{4}$ ins.; pp. 543. Rainfall map of Australasia.

This handbook is similar to those more fully noted in this journal in previous years, and it deals minutely with the material progress and present conditions in Australasia, as founded upon the statistics of the colonies here set forth in full. To those interested it is invaluable in its contents.

VIEWS OF ADMIRAL CERVERA REGARDING THE SPANISH NAVY IN THE LATE WAR.—November, 1898. U. S. Navy Department, Office of Naval Intelligence. Washington, D. C. Paper; 9 x 6 ins.; pp. 24.

The original of this document appeared in "La Epoca," of Madrid, on Nov. 5, 1898, and is mainly made up of extracts from letters written by Admiral Cervera previous to the declaration of war. The letters are a vigorous protest against the inefficiency of the Spanish government and prophesies the certain defeat of the Spanish Navy in case of actual war, owing to the superior power of the American Navy and the bad condition of Spain's ships and supplies. Cervera regarded Cuba as lost under any circumstances, and he tells why he looked upon it as the height of folly for Spain to go to war with a superior naval power. He enters into details concerning his ships, which would have carried conviction to any but the blindest and most foolish of administrators; he knew the superior condition and power of the American ships, and he finally set out under protest upon his voyage across the sea, with the prophetic remark that "jingoism finds numerous victims, perhaps myself to-morrow." Had there been more Spaniards in authority as alive to actual conditions and as anxious to reform a bad and corrupt system of naval administration, there might have been a different story to tell of the results of the war in Cuban waters.

CHARACTER OF PUBLIC WATER SUPPLIES OF OHIO.—Preliminary Report of an Investigation of Rivers and Deep Ground Waters of Ohio as Sources of Public Water Supplies. By the State Board of Health. Cloth; 7 x 10 ins.; pp. 259; tables, folding map and many plates.

Ohio is the pioneer among Western states in measures to protect the purity of its public water supplies. Under legislation of 1893, the State Board of Health had, in June, 1898, already passed on plans for water supply and sewerage improvements in 126 municipalities. It found that this work could not be done intelligently without more specific information regarding the natural waters of the state, and so started the investigation here reported on. The general subject of stream pollution was assigned to Mr. Allen Hazen, Assoc. M. Am. Soc. C. E., of New York, who has divided the State intro drainage areas and ascertained the extent and population of each area. From these figures, coupled with rainfall records, Mr. Hazen is able to indicate, in a tentative manner, what cities and towns already require or should have sewage purification plants, in order to keep the streams free from nuisances. Chemical and bacterial studies of these streams, the Scioto, Olentangy and Mahoning rivers, respectively, are presented by Prof. N. W. Lord and A. M. Bleile, of the Ohio State University, while Prof. C. N. Brown, of the same institution, gives the result of stream gagings of the same streams. The rock waters and flowing wells of Ohio are reported on by Prof. Edw. Orton, also of the State University.

The several reports give some specific information bearing upon the water supply and sewage disposal of a number of cities and towns, and form a good basis for further investigations. Numerous diagrams present the results in graphical form.

BATTLES AND CAPITULATION OF SANTIAGO DE CUBA.—By Lieut. Jose Muller y Tejeiro, second in command of Naval Forces of the Province of Santiago de Cuba. Translated from the Spanish. U. S. Navy Department. Office of Naval Intelligence: Washington, D. C. Paper; 9 x 6 ins.; pp. 108, with two maps.

The original of this book has just been issued at Madrid, and it contains matter of particular interest and value at the present time, as coming from an eye-witness of events from the enemy's point of view. Thirteen chapters of a more general character have been omitted in the translation, owing to the pressure of work on the Bureau. The story of Lieut. Tejeiro is exceedingly detailed and interesting, and considering the natural bias of the writer, it is seemingly a very fair statement of events. Those responsible for the condition of Spain's navy are handled without gloves, and he unreservedly states the condition of Admiral Cervera's fleet when it reached Santiago. The vessels were out of coal; the heavy guns of the "Colon" had never been placed on board; ammunition was scarce and bad; the hulls were foul and machinery out of order; much of the rapid-fire ammunition did not fit the guns, etc. But notwithstanding this, in the eyes of Lieut. Tejeiro, the battle of Santiago was more glorious than Trafalgar, for Cervera went out to certain destruction "from an overwhelming force" at the command of Gen. Blanco. The Lieutenant, however, counts the American ships actually at Manila, Havana and Key West as taking part in the battle of July 3, off Santiago de Cuba. The story covers the interval from May to the capitulation of the city, and is a valuable document, even though some of the statistics are much mixed and evidently wrong. But in explanation of this, Lieut. Tejeiro frequently complains of the falsity of the news sent from Spain and Havana, and of the absolute lack of any creditable information from the United States as to the movements of ships and armies.

THE REMOVAL AND DISPOSAL OF TOWN REFUSE.—By Wm. H. Maxwell, Assistant Engineer and Surveyor, Leyton Urban District Council. London: The Sanitary Publishing Co. Cloth; 6 x 9 ins.; pp. 372; tables and 73 illustrations. Price, 15 shillings in England; $7.50 in the United States.

This is the first work in the English language dealing in a comprehensive manner with the collection and disposal of garbage and other city refuse; and we are pleased to add that it is a good one. A few years ago another English book was published, antitled "Refuse Destructors." The author, Mr. Jones, laid no claim to having prepared a treatise on the subject, but stated that he had simply republished, with supplementary matter, a paper read a few years earlier. Mr. Jones' book was very welcome, as it contained illustrated descriptions of a number of different English garbage furnaces and statistical information from a number of plants built and operated by English municipalities.

The present volume is conceived and executed on broader lines than those followed by Mr. Jones. Mr. Maxwell first reviews the legal side of his subject, then takes up street cleaning and watering, the disposal of street refuse, the composition and collection of home refuse and the removal of excreta. Some 65 pages of the book suffice for these subjects, leaving the remaining 300 pages for a treatment of refuse disposal, most of which is devoted to refuse destructors, or garbage furnaces or crematories, as they are called in the United States. A dozen or more English types, or makes, of furnaces are described in one of the chapters, while another chapter gives statistical and other information regarding the modes of disposal employed by more than one hundred cities and towns, mostly English, which have or expect soon to have refuse destructors. There are separate chapters on boilers, thermal storage, chimneys, and such accessories or details of furnaces as fume cremators, fixed and movable grate bars and automatic feeders. Numerous illustrations add greatly to the value of the book.

The book contains practically no reference to American methods of garbage and refuse disposal. The English have little or nothing to learn from our garbage furnaces, but certainly we have made some very ambitious attempts to recover grease and manufacture fertilizing material from kitchen refuse, so-called utilization or reduction plants having been established in seven of our ten largest cities, including Greater New York. Nothing of this sort has been attempted in England, so far as this book and our information from other sources indicates. This seems strange in view of all that has been attempted in England in the way of recovering fertilizing material from sewage. But it should not be thought that no attempts have been made to utilize garbage and other city refuse in England. The Golden Dustman and his work typifies and will long preserve the memory of one class of attempts of this sort, while recently the utilization of heat from refuse destructors for the generation of electricity has given rise to great expectations, both popular and scientific. Mr. Maxwell takes a more reasonable view of this phase of the subject than do some English municipal officers.

Whatever the possibilities may be as to the utilization of heat from garbage furnaces, it is certain that the average American garbage furnace has been a large consumer of heat evolved from good coal and that thus far but few of our furnaces are able to operate without a heavy coal consumption, to say nothing of providing surplus heat from the refuse they consume. This difference in practice is probably largely due to the different composition of the matter sent to the American and English furnaces, but differences in the design of furnaces used in the two countries also have much to do with it. Another striking feature in English refuse disposal practice is the burning of sewage sludge in the furnaces. This has been done successfully here, but is not practiced now, that we know of, partly owing to the fact that few of our towns have both garbage furnaces and sewage purification plants, and that the most of the latter rely wholly on land disposal, and make no use of chemical precipitation. Still another difference between the two countries is the apparently extensive use of the ashes and cinders from English furnaces for making mortar, artificial stone and roads, while with us such material is seldom used, except for filling in low places, and occasionally the ashes are sold for fertilizing material. Most of our furnaces receive only kitchen wastes and paper, while the English furnaces receive a large proportion of ashes. This, of course, results in residue much less in amount and different in character than is obtained abroad.

From the above outline and comments, we think it will be evident that this book is full of valuable suggestions for American engineers and municipal officials.