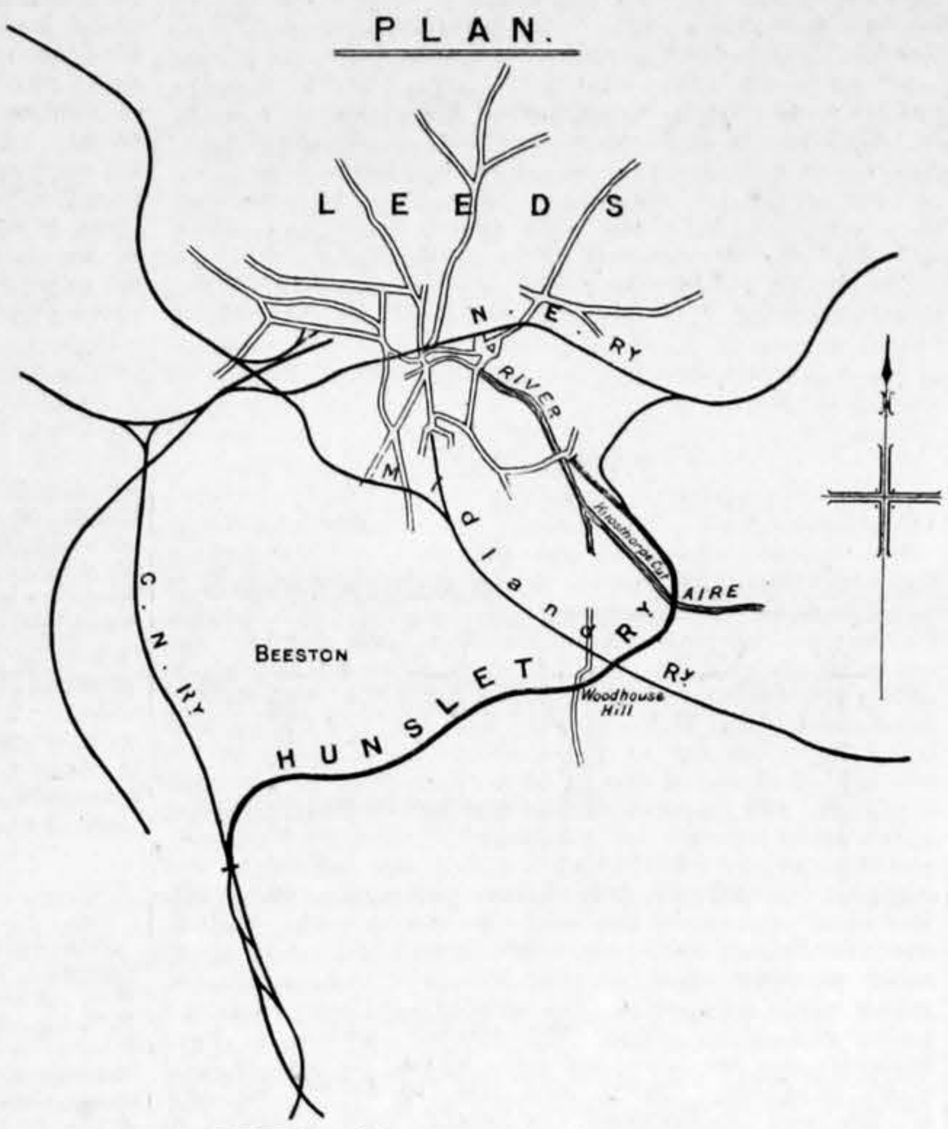
THE GREAT NORTHERN RAILWAY.—BRIDGES OVER THE RIVER AIRE.

The railway at the bridge over the diversion of the Aire is upon a gradient of 1 in 100, and is shown on the plan, Fig. 2, to be on a curve of twenty-five chains radius. Owing to the axes of the girders, piers, and abutments, being inclined at different angles of skew, the spans of the four main girders are unequal, measuring respectively 92ft., 100ft., 101ft., and 110ft. between centre of bearings. They are divided into panel lengths of 10ft., as in the elevation in Fig. 1, and are all 15ft. 6in. in depth at the centre. Similarly to the swing bridge, which we illustrated in our last week's issue, the one under notice is approached by a small two-span viaduct at one end, and by an embankment at the other, so that it will be unnecessary to give, so far as the non-metallic part of the structure is concerned, other details than those in Figs. 3 to 6, which represent a transverse section at L L, and sections through the abutments and wingwalls at E E, N N, and D D.

A general elevation, Fig. 7, of one of the four main girders, namely, that having the maximum span of 110ft., will be sufficient to demonstrate the general principles of the design, which in many of its details has a good deal in common with the other bridges already described and illustrated in our previous articles, so that it would be mere recapitulation to again introduce them. The upper and lower booms are of the trough section, 2ft. 6in. in width over the horizontal plates, and 2ft. in depth along the vertical side plates. All the vertical members of the web, which are under compression, are built up of bars and angle steels, and the diagonal tension members consist of plain flat bars, increasing in their scantlings from the centre to the ends of the truss. The total weight of the main girder itself is a little over 63 tons.

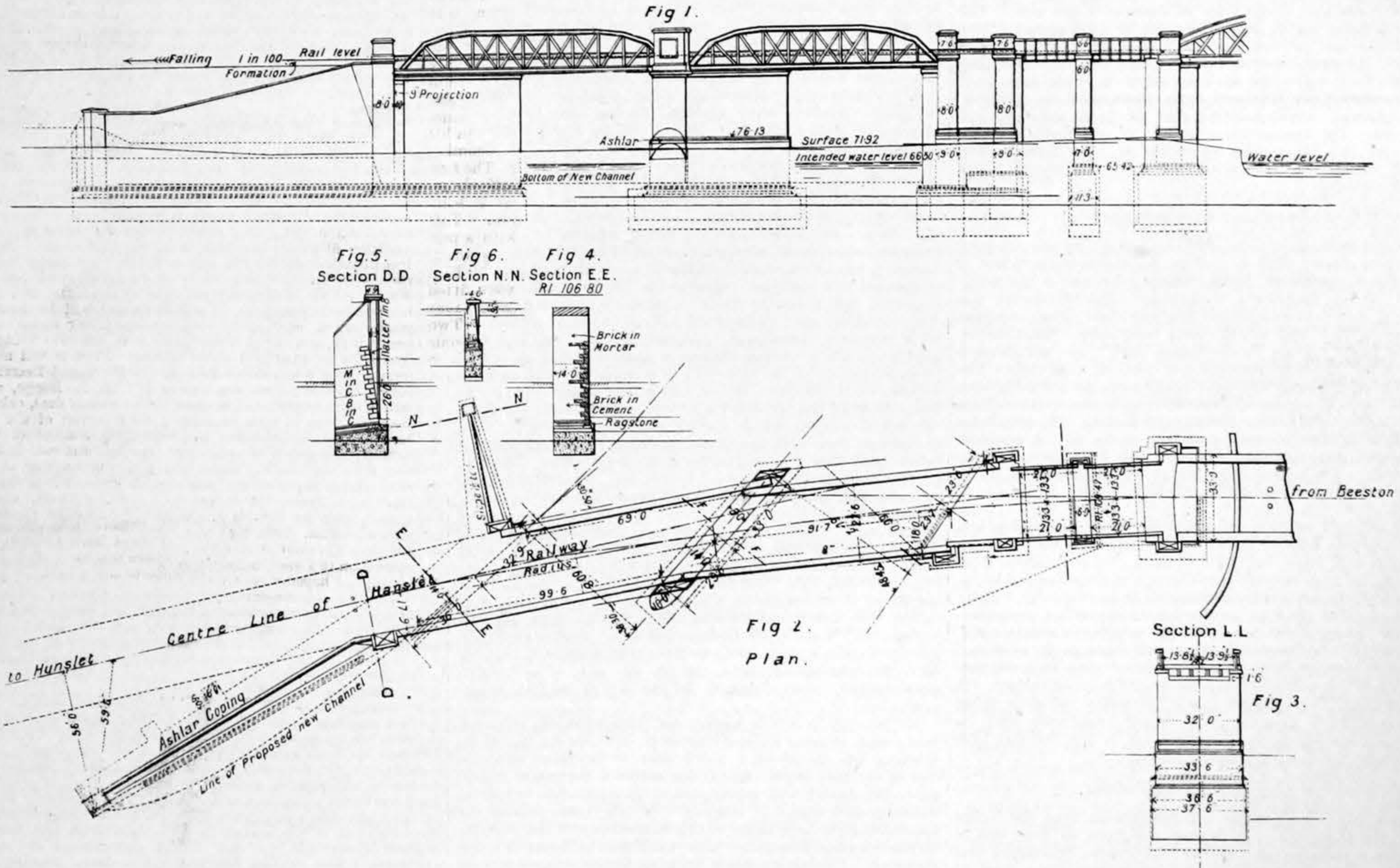
The cross girders, shown in elevation, and cross section, in Figs. 8 and 9, have a uniform depth of 3ft., and are riveted at their extremities to the vertical members of the web of the main girders. On the upper flange of the cross girders is placed the pressed steel troughing, 8in. deep, and ⅜in. in thickness, which forms the platform or flooring. At the junction of the cross and main girders, strong raised ledges, or fenders, built up of plates and angle steels, are provided. These are carried up to the level of the upper surface of the rails, and are intended to protect the main girders in the event of a possible derailment. This bridge, similarly to that over the river Aire, is supported on hinged bearings, which are bolted down to the bed-plates on the abutments at the lower end of the gradient, and carried on rollers at the upper ends. The total quantity of wrought steel required for this structure amounted to 412 tons. Throughout the whole line the floors of the bridges are covered with Cliff's patent asphalt, and where there are more than one span, gutterings and down-pipes are supplied for drainage purposes. The whole of the steel work on the railway was executed by the Cleveland Bridge and Engineering Company, of Darlington, and the manner in which their contract has been so successfully performed, is another tribute to their already well-known reputation. The small accompanying plan is introduced into our illustrations in order to clearly show the junction of the new branch line with the main tracks of the Great Northern Railway.



SKETCH MAP OF HUNSLET RAILWAY

In the Hunslet district one of the principal mechanical requirements is that of large crane power, and in order to meet it, one worked by hydraulic power is in course of construction in the goods yard by Tannett, Walker, and Co., Ltd., of Leeds. This firm has supplied all the hydraulic machinery and appliances, which is capable of lifting forty tons to a height of 30ft. above rail level at the end of a jib, having a radius of 20ft. If it is necessary to lift a load of only ten tons, the radius may be increased to a maximum of 50ft., so as to enable the crane to command any part of the loading or unloading area. Upon the high loading wharf there is also a crane adapted for raising loads of ten tons each, with a jib radius of 17ft. It is furnished with a double power to allow it to deal with light loads, with a corresponding economy of water. In addition to a small five-ton machine, with a sweep of 25ft., there are thirty hydraulic capstans placed in convenient positions. The hydraulic working pressure is 750 lb. per square inch, which is furnished from the engine-house, where there are fixed a pair of Lancashire boilers, each 28ft. long and 7ft. in diameter, with a working pressure of 120 lb. per square inch. There are besides two pairs of hydraulic pumping engines, of the direct-acting compound type, with surface condensers, and having cylinders with a stroke of 21in., and diameters of the respective dimensions of 14in. and 24in. The accumulator is 15in. in diameter, with a stroke of 17ft. Six double track coal hoppers, and cattle pens and stabling for over thirty horses, are on the premises. Denison and Son, of Leeds, supplied the truck and cart weighbridges, and the station buildings, near the entrance to which the general offices have been erected, were constructed by Kell Bros., of Leeds, from the designs of Mr. J. B. Fraser.

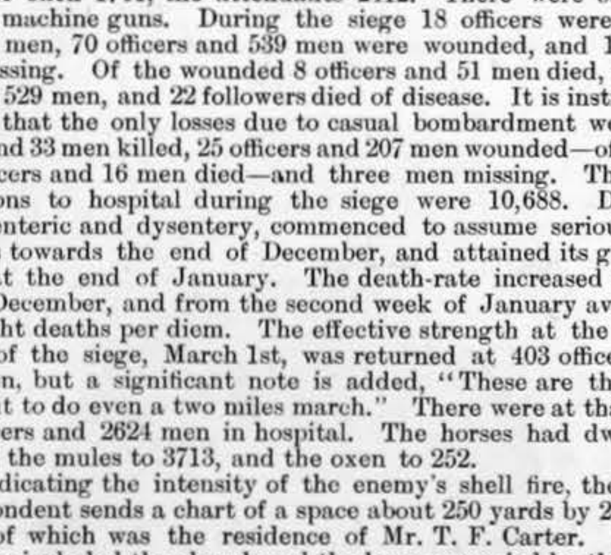
The goods yard and all the buildings are lighted by electricity supplied from the Leeds Corporation installation. The pressure of 2000 volts is transformed down to 500 volts before it arrives at the principal switchboard. From that point the current passes by a couple of concentric armoured main cables through the entire length of the yard. In case of accidents, the cables have been so proportioned that each is capable of conveying the whole of the current. Except where the cables pass under the rails, they are laid in timber casings, but when in that position they are protected by cast iron pipes. Both cables are divided into sections of about 250 yards each, and the ends of every two consecutive sections are connected inside a section box by a link. The arrangement is such that, in the event of the breakdown of one section, it can be disconnected from the circuit, and as both cables can be joined at the ends of the yard where they meet, the light can be maintained, with the exception of that part of it supplied from the damaged section. As it is of especial importance that the light in the goods yard and warehouses should never be exposed to the risk of becoming extinguished, it can be supplied separately from either cable. There are in all sixty arc lamps, which are made with double sets of carbons available for continuous lighting during



BRIDGE NEAR HUNSLET

thirty-two hours, and they are enclosed in lanterns of muronese glass of high diffusive power. Each lamp is fitted with its own transformer, which converts the tension of 500 to 38 volts, and is controlled by a double-pole switch placed on the primary side of the transformer. In the yard there are forty-four arc lamps which are supported on cast iron columns at an altitude of 21ft. about the ground, and spaced at distances varying from 120ft. to 200ft., according to requirements. The transformers are very easy of access, as each with its accompanying switch is placed inside the base of the columns. There are fourteen arc lamps in the goods warehouse, and a pair in the engine and in the boiler-house, all slung from the roof. In the offices, in the upper floor of the warehouse, and in the stables, the lighting is effected by means of incandescent lamps 100 in number, and varying from 8 to 32 candle-power. These lamps are furnished with the necessary current through six transformers, which change the tension of 500 to 100 volts. Crompton and Co. were the contractors for the electric lighting installation. Some parts of the yard are illuminated by gas lamps containing Bray's burners of 80 and 100 candle-power, and incandescent gas burners are also used in the buildings.

The contract for the works on this branch line was accorded to Mr. I. F. Firbank in the month of November, 1896. By the exercise of great energy and perseverance on the part of all concerned in the execution of the heavy and important engineering works, the new route was opened before the expiration of the contract time, although some few minor details stood over for final completion. The whole of the works were laid out and executed from the designs and under the superintendence of Mr. W. B. Myers-Beswick, M. Inst. C.E., as engineer-in-chief. It is to this gentleman that our thanks and acknowledgments are due for his courtesy in allowing us the use of his valuable plans, sections and working drawings, which we have published for the information and benefit of our readers.



BRIDGE NEAR HUNSLET

THE SIEGE OF LADYSMITH.

THE special correspondent of the *Times* lately in Ladysmith has sent home some interesting statistical information respecting the siege, of which the following is an abstract:—When the siege commenced on November 2nd, the effective strength of the garrison was 572 officers and 12,924 men. There were 20 officers and 229 men sick and wounded. The horses numbered 5309, the mules 4539, the oxen 1701, the attendants 2412. There were 55 guns and 18 machine guns. During the siege 18 officers were killed and 193 men, 70 officers and 539 men were wounded, and 10 men were missing. Of the wounded 8 officers and 51 men died, and 12 officers, 529 men, and 22 followers died of disease. It is instructive to note that the only losses due to casual bombardment were one officer and 33 men killed, 25 officers and 207 men wounded—of whom two officers and 16 men died—and three men missing. The total admissions to hospital during the siege were 10,688. Disease, chiefly enteric and dysentery, commenced to assume serious proportions towards the end of December, and attained its greatest height at the end of January. The death-rate increased at the end of December, and from the second week of January averaged over eight deaths per diem. The effective strength at the termination of the siege, March 1st, was returned at 403 officers and 9761 men, but a significant note is added, "These are the only troops fit to do even a two miles march." There were at that date 154 officers and 2624 men in hospital. The horses had dwindled to 2907, the mules to 3713, and the oxen to 252.

As indicating the intensity of the enemy's shell fire, the *Times* correspondent sends a chart of a space about 250 yards by 200, the centre of which was the residence of Mr. T. F. Carter. In the space are included the church and the house occupied by the archdeacon. Thirty-eight shells from 6in. guns fell into this area, of which thirty-three came from the Bulwana battery, the remainder from Pepworth Hill, Gun Hill, and Lombard's Kop.

The statistics relative to the expenditure of ammunition by the besieged are remarkable as showing that, although at the end of February the naval guns were running short, the field artillery and infantry were amply supplied. There were on hand on November 2nd the following rounds:—4·7in. naval, 556; 12-pounder naval, 1036; 6·3 howitzer, 887; 15-pounder, 11,437; 9-pounder, 208; 2·5in., 2417; Maxim-Nordenfelt, 189; Hotchkiss, 1567; ·303in., 5,678,716; and pistol, 98,149. During the siege the 4·7in. guns fired 514 rounds, leaving only 42 on hand; the naval 12-pounders 784, leaving a balance of 784; the 6·3in. howitzers 3705, leaving 776 unexpended. On March 2nd there were still 7732 rounds in hand for the 15-pounders, 183 for the 9-pounders, 2316 for the 2·5in., 141 rounds Maxim-Nordenfelt, 1487 Hotchkiss, 5,465,316 rounds ·303, the pistol ammunition remaining at the same figure as on November 2nd, though doubtless a certain number of rounds previously issued was expended in the sorties.

CONTRACT OPEN.

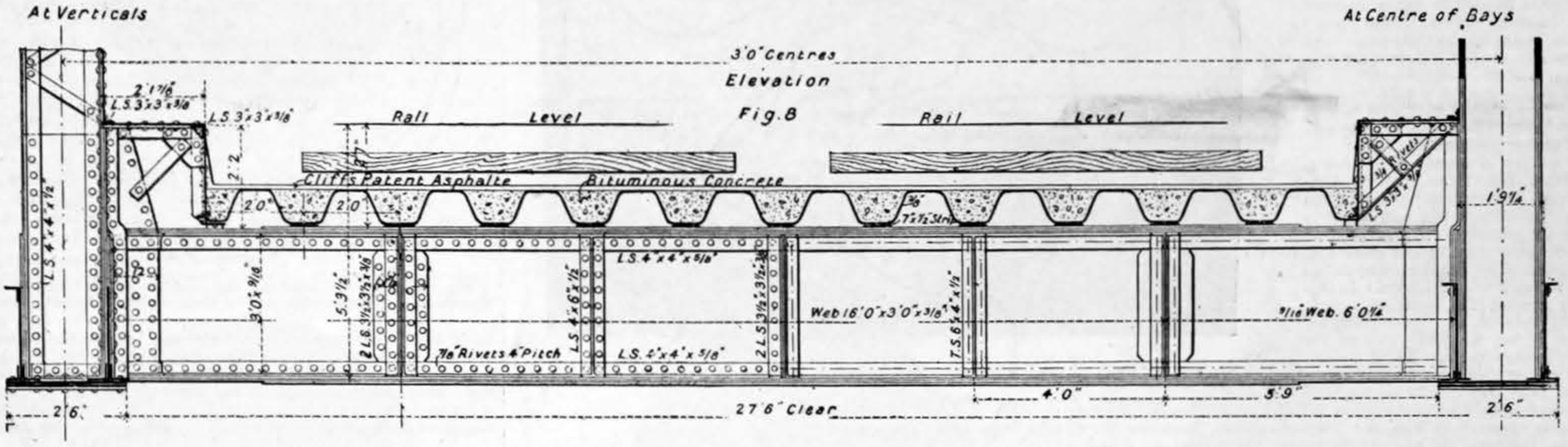
INDIAN STATE RAILWAYS.

TENDERS are invited by the North-Western Railway for the supply and delivery of the following permanent way material:—2712 tons of new standard 75 lb. steel rails, with 4in. foot, in lengths of 30ft., with proper proportion of 27ft. and 24ft., for twenty-three miles; 123 tons of steel fish-plates, for new standard 75 lb. f.f. rails, with 4in. foot, for twenty-three miles, the weight of one pair of fish-plates to be 32 lb. The rails are to be made from a mixture of best English or Spanish hematite pig iron and charcoal spiegeleisen. The fish-plates are to be made of the same, and the steel cast into ingots of not less than 10in. square at the base. The ingots for fish-plates are to be heated and cogged down into blooms not exceeding 6in. square, or 36in. of cross section. The blooms are to be again heated and rolled off into bars of the section shown; they are then to have at least 1ft. of crop taken off at each end to ensure soundness, and whilst these bars are still hot they must be sawn off into fish-plates of the required length. The plates, whilst hot, are then to be punched with four holes, the punching of all the holes in each plate being done at one stroke of the machine. All fish-plates must be punched at the first heat while red hot. No re-heating of the fish-plates will be allowed; any that are not so punched at the first heat may be drilled.

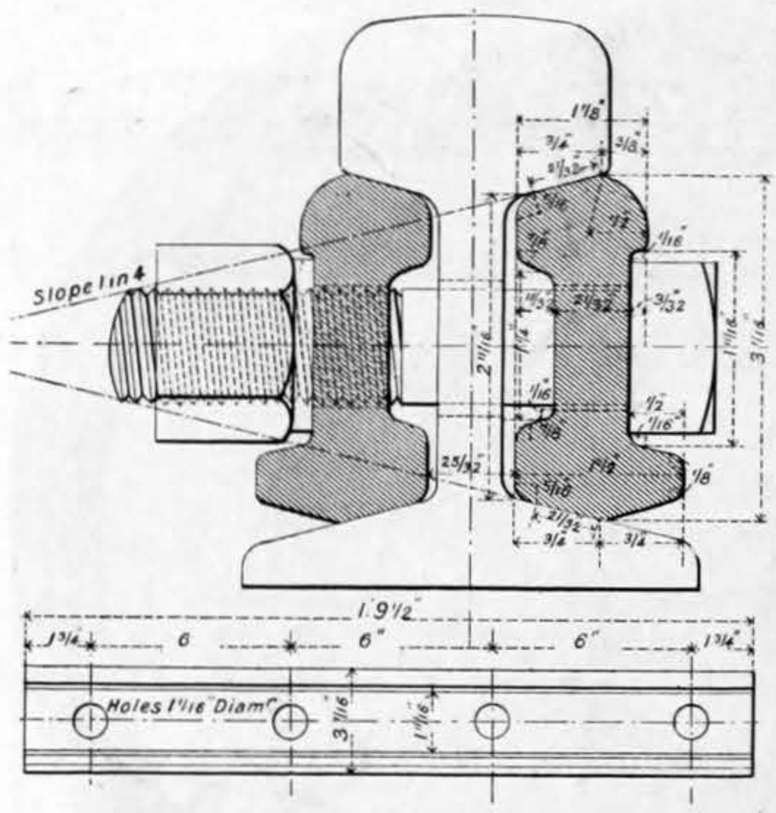
Every cast of steel from which the rails are to be manufactured must be analysed by the contractor for carbon and phosphorus. The quantity of carbon must not be less than ·3 per cent., or more than ·45 per cent.; the quantity of silicon must not be more than ·06 per cent.; the quantity of phosphorus and arsenic together must not be more than ·06 per cent.; and sulphur must not be more than ·06 per cent.

The rails will be treated as follows:—First, a rail 30ft. long will be placed in iron bearings 8ft. 6in. apart in the clear, and equidistant from its end, and a weight of 28 tons will be suspended from the centre of the rail. The deflection must not exceed ⅜in. after the weight has been on the rail half an hour. No permanent set must appear upon the removal of the load. Secondly, the same rail will be supported as before, and a cast iron monkey, weighing one ton, will be allowed to fall freely upon the centre of the rail from a height of 20ft. The rail must bear two such blows without showing the least sign of fracture. The permanent set caused by the first blow must not exceed 2½in. The total deflection of the rail, measured on the distance between the centre of the bearings, after the second blow has been given, must not exceed 5in. Thirdly, the rail is then to be broken through by further blows, when it must show a perfectly sound and homogeneous fracture.

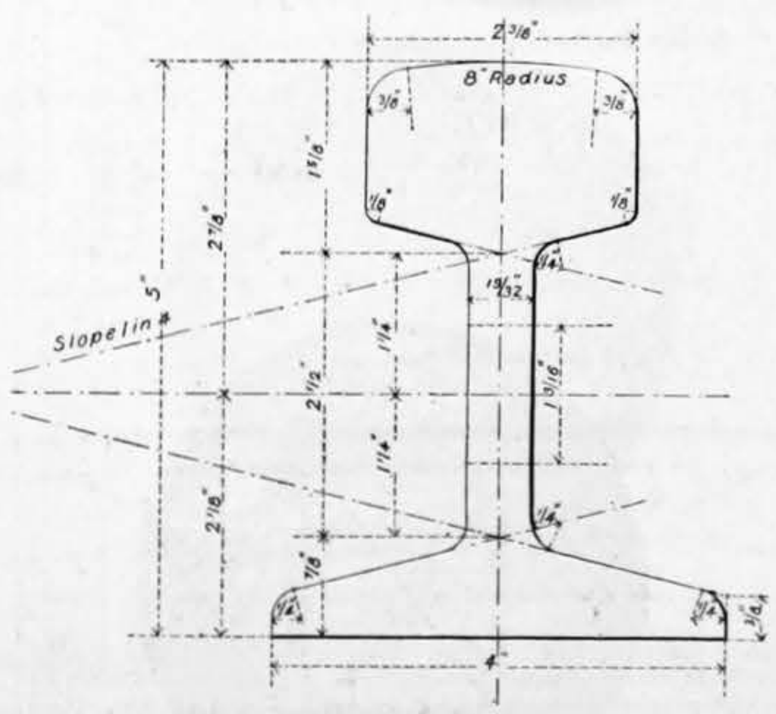
The steel for fish-plates must stand a torsional strain of not less than 28 tons, or more than 32 tons per square inch, and must give an elongation of not less than 23 per cent. in a length of 10in.



BRIDGE NEAR HUNSLET—CROSS GIRDER



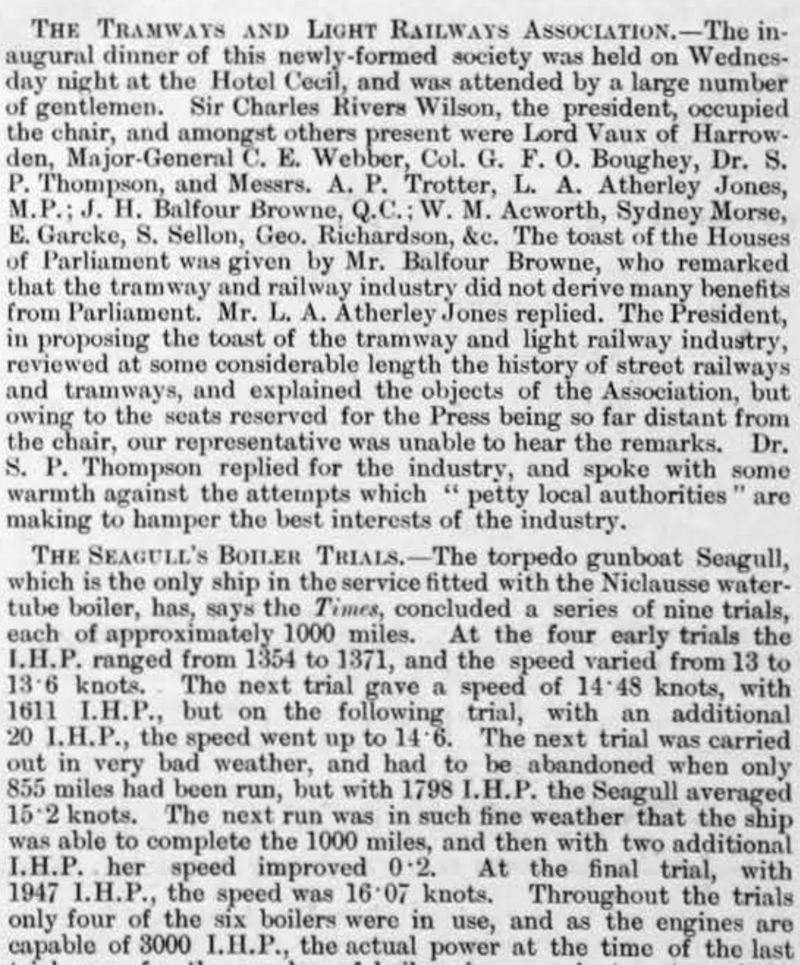
SECTION OF RAIL AND FISH PLATE



RAIL SECTION

The accompanying engraving illustrates the bolts for the permanent way.

Steel Fish bolt with Special Nut for New Standard 75 lbs. Flat footed Rail with foot 4" and 4·2" wide



Tenders are to be delivered before 2 p.m. on Tuesday 1st May, 1900, to the Director-General of Stores, India-office, Whitehall.

THE TRAMWAYS AND LIGHT RAILWAYS ASSOCIATION.—The inaugural dinner of this newly-formed society was held on Wednesday night at the Hotel Cecil, and was attended by a large number of gentlemen. Sir Charles Rivers Wilson, the president, occupied the chair, and amongst others present were Lord Vaux of Harrowden, Major-General C. E. Webber, Col. G. F. O. Boughey, Dr. S. P. Thompson, and Messrs. A. P. Trotter, L. A. Atherley Jones, M.P.; J. H. Balfour Browne, Q.C.; W. M. Acworth, Sydney Morse, E. Garcke, S. Sellon, Geo. Richardson, &c. The toast of the Houses of Parliament was given by Mr. Balfour Browne, who remarked that the tramway and railway industry did not derive many benefits from Parliament. Mr. L. A. Atherley Jones replied. The President, in proposing the toast of the tramway and light railway industry, reviewed at some considerable length the history of street railways and tramways, and explained the objects of the Association, but owing to the seats reserved for the Press being so far distant from the chair, our representative was unable to hear the remarks. Dr. S. P. Thompson replied for the industry, and spoke with some warmth against the attempts which "petty local authorities" are making to hamper the best interests of the industry.

THE SEAGULL'S BOILER TRIALS.—The torpedo gunboat Seagull, which is the only ship in the service fitted with the Niclausse water-tube boiler, has, says the *Times*, concluded a series of nine trials, each of approximately 1000 miles. At the four early trials the I.H.P. ranged from 1354 to 1371, and the speed varied from 13 to 13·6 knots. The next trial gave a speed of 14·48 knots, with 1611 I.H.P., but on the following trial, with an additional 20 I.H.P., the speed went up to 14·6. The next trial was carried out in very bad weather, and had to be abandoned when only 855 miles had been run, but with 1798 I.H.P. the Seagull averaged 15·2 knots. The next run was in such fine weather that the ship was able to complete the 1000 miles, and then with two additional I.H.P. her speed improved 0·2. At the final trial, with 1947 I.H.P., the speed was 16·07 knots. Throughout the trials only four of the six boilers were in use, and as the engines are capable of 3000 I.H.P., the actual power at the time of the last trial was, for the number of boilers in use, nineteen-twentieths of the maximum. The maximum coal consumption for the entire series of trials works out at 1·9 lb. per unit of power per hour for the main engines, and 2lb. for all purposes. When the trials were begun the lanterne, or end of the tube, was screwed on, but now the tube and lanterne form one solid drawn piece, which the *Times* states facilitates the substitution of tubes.