ported by a grip from the upper part of the conveying-rope and by wheels on the lower part. This carriage can convey two loaded bags weighing 420 lb. each suspended from a hook below the carriage. An elevator takes the coal bags from the deck and hoists them to the masthead. The conveying carriage, in coming in to the masthead, immediately locks itself. As soon as the lock is released by an attendant, the engine operator hauls in the lower part of the conveyor line. The upper part of the line is thus drawn from the rear drum, thereby shipping the specially-contrived friction devices. In this way the carriage crosses from collier to warship, sufficient tension being supplied to insure that the bags shall clear the water between the vessels. The rope is drawn in at the rate of 1000 ft. per minute. The object of the sea-anchor line is to support the carriage, when empty, on its return to the collier. It allows the conveying-line to be slack, and prevents the overturning or twisting of the carriage; and at times it also helps to support the load in its transit across.

Another important exhibit was the Gruson turret, which has been erected between the two Ordnance Buildings. It is 55 ft. in diameter, and mounted within it was a 12-in. gun. This type of gun represents the largest which will be manufactured in the United States for coast defence. The turret and its equipment are the first of the kind made in the country; they served to show the latest steps taken towards forming an impregnable system of defence. The exhibit was so arranged that visitors could go inside and examine the interior, the magazine, the method of supplying ammunition to the gun, and the various contrivances for attaining efficiency in actual service.

The collective ordnance exhibit was extensive, all the largest builders of arms and ammunition in America having been represented. The collection made an imposing display, and attracted great numbers of visitors.

THE NEW VICTORIA STATION AT NOTTINGHAM.

(*Concluded from page* 800.)

THERE are four interesting bridges across the station at Nottingham, and the important features in the design of these are illustrated on our two-page plate this week and on pages 832 and 833.

In substitution of some of the streets demolished to provide a site for the station, a bridge, 40 ft. wide, for all kinds of traffic, has been constructed across the cutting at the northern end of the station, in addition to the public footbridge. It is known as York-street Bridge, and connects Mansfield-road with the eastern part of the town. This bridge is illustrated by Figs. 115 to 144 on the two-page plate. Two roads run at an angle on to the bridge at the western, or Mansfield-road, end, as shown on the plan (Fig. 115), forming a **Y** on end on the girder plan. The outside girders carrying the flooring of the triangular spaces at each side rest on the main bridge girders, which are therefore of heavy section, especially as their span is 70 ft. 10 in. The main girder on the north-west corner has the heaviest load. It is 5 ft. deep, with ⅝-in. web, reduced to ½ in. at centre, and divided into 3-ft. 4-in. bays. The flanges at the centre, where the diagonal girder rests, is 1 ft. 10 in. wide, and is built up of six ⅝-in. plates. The diagonal member is connected with angles and bent plates for the whole depth of the girders, as shown in the various sections given. It has a span of 74 ft. 2¼ in., and is on a gradient of 1 in 36, and does not differ materially from the other members of the bridge. Figs. 134 to 138 illustrate the general type of longitudinal girder (D 1). There are five spans in the length of the bridge, which is 278 ft. 3 in. over all between abutments, the structure being at about the widest part of the station. The spans vary, as marked on plan, from 66 ft. 9 in. to 47 ft. 8 in., and there are five lines of longitudinal girders, diagonally braced at intervals of 10 ft. along the length of the structure, as shown, while between two of them provision has been made for a pipe-way for gas and water mains, &c., as shown on the cross-section (Fig. 116).

As shown in section, the cross-girders are 1 ft. 4 in. deep, They are spaced 10 ft. apart, and are riveted to the webs of the longitudinal members. Trough flooring, 8 in. deep and ½ in. thick, is laid upon and connected to the top flanges of the main girders. Concrete and granite sets make up the roadway. The parapets are carried by brackets built at 10 ft. centres as cantilevers upon the outer longitudinals. They are of ⅜-in. plates, and 6 ft. high.

The bridge is supported on abutments and columns, and as a type of the columns in use throughout the station we reproduce the principal drawings on the two-page plate (Figs. 124 to 138). They are 2 ft. 6 in. by 2 ft. over all, and have been built up of twelve angles 4 in. by 4 in. by ½ in., connecting ½-in. plates. The base of each column is 5 ft. by 4 ft. by 1 in. thick, connected to the shaft by gusset-plates, as shown in Figs. 125 and 126. The cap and its connection are somewhat similar (Fig. 124). Each set of five columns for carrying the girders of the York-street bridge are braced together by lattice horizontal members, 1 ft. 4 in. deep, spaced 5 ft. apart, with diagonal bars 7 in. by ½ in. braced at the points of intersection (Figs. 120 and 121). The foundations of these columns and the cast-iron bases are illustrated by Figs. 120, 130, and 131.

The public footbridge across the station, under the main roof, is illustrated on the two-page plate by Figs. 145 to 160. It is practically independent of the station; although the requirements of the town necessitated such a position that it penetrates right through the blocks of buildings on the platforms marked A and C on plan (Fig. 1 on page 678 *ante*). The girders are carried right through without any connection with the buildings; but it militates somewhat against the otherwise effective architectural appearance of the buildings. The construction of the bridge, which is 15 ft. wide, will be readily understood by reference to the engravings, Figs. 145 to 150 showing the main lattice girders, Figs. 151 to 154 the columns, and Fig. 152 the section through the station generally, while the bracing is shown on Figs. 153 and 154. Two massive stone fronts in the classic style of architecture have been built at the entrances to the footbridges from the new street along the east side of the station. Along this street, too, is a boundary wall partly carrying the main roof of the station and its principals, and this is faced with best pressed red facing bricks, with stone dressings, the bricks having been supplied by the Nottingham Patent Brick Company.

The footbridge reserved for railway passengers, and extending from the booking-office across the station to the new street on the east side of the cutting, is 20 ft. wide for the greater part of its length, but is reduced to 8 ft. beyond the second platform, as it provides only an exit to the eastern part of the town, and not as an entrance to the station platforms. This bridge is illustrated on page 832 (Figs. 161 to 178). The bridge is constructed of lattice girders. The western span is 63 ft. 3 in., the centre span 86 ft. 9 in., and the eastern span 65 ft. 3 in. The girders in the two former cases (Figs. 161 to 168) are 7 ft. 11 in. deep over angles, but in the last-mentioned span, where the width of the structure is reduced, it is only 6 ft. 6 in. The main girders are braced at top with a flat arch of lattice construction (Figs. 171 and 172). The floor is composed of rolled steel joists 15 in. deep, placed at 3-ft. 8-in. centres, with $\frac{5}{16}$-in. curved plates between, and resting on 2½-in. by 2½-in. by ⅜-in. angles riveted to the joists (Figs. 172 and 175). These in turn are filled in with cement concrete, upon which 3 in. jarrah block flooring is laid (Figs. 177 and 178). This superstructure is carried on steel columns bolted at the platform level to foundations of brickwork carried to the bed-rock. At the western end one of the longitudinals is supported by a steel built-up column, similar to those shown by Figs. 151 to 154 on the two-page plate, the other being carried upon the projecting end of one of the girders carrying the floor of the booking-hall, and forming a cantilever. This form of support was determined upon as it was desired to have a gangway from this passenger footbridge communicating with the public footbridge which crosses the railway a few yards to the north. This gangway, 12 ft. wide, will facilitate the exit of large crowds from the west end of the passenger footbridge without blocking the booking-hall. The gangway is immediately to the east or station side of the booking-office building, and, as already indicated, is supported on a projection of the girders carrying the floor of the booking-hall. This is the only connection the public footbridge has with the station, and gates will cut it off when the traffic can be dealt with under ordinary conditions. From the passenger bridge there are two flights of stairs, 12 ft. wide, to each platform. They are built of steel, resembling in design the footbridge itself.

As has already been mentioned, a further entrance or exit is provided from Parliament-street Bridge at the south end of the platforms. Parliament-street crosses the site of the station about 210 ft. from the face of Victoria-street Tunnel, and is one of the principal thoroughfares, communicating directly with the market, and the average width of the bridge is 80 ft. : we say average, as the sides of the street are not quite parallel. The railway lines at this point converge into the double set of rails in the tunnel, and thus the span on the north side—furthest from the tunnel—is 126 ft., and at the south side 76 ft. The abutments are of ordinary brickwork faced with blue brick, the foundations being carried to the rock. A cross-section of the superstructure, with one or two details, is given on page 833 (Figs. 179 to 185). It will be seen that the main girders are of the plate type, spaced at 12-ft. centres, and braced together at 10-ft. intervals along their length by angle-iron diagonals. The girders vary in depth and strength according to the span. The heaviest girder—which has not only the greatest span, but helps to carry the entrance gangway to the two platforms below—is illustrated by Figs. 179 to 183. It is the northernmost girder in the bridge, and weighs 74 tons 10 cwt. This girder is 9 ft. deep over the angles, but the other girders are only 7 ft. 6 in. The parapets are of ¼-in. steel plates 8 ft. high above the pavement level, and are stiffened with curved lattice brackets outside (Fig. 184). On the inside they are lined to enhance the appearance with red brick and stone dressings. The flooring, as shown on the section (Fig. 185), is of troughs resting on the tops of the flanges of the girders, and filled up in the usual way with asphalte and concrete, the roadway being laid with granite sets. The space between the two southernmost girders is left open for carrying water and gas mains, &c., and the headroom is sufficient for workmen to walk through from manhole to manhole. Another interesting point is that at the south side holes are left in the parapet opposite each trough, to allow the steam emitting from passing locomotives to get away instead of condensing on the inside of the troughs. In view of this passage-way, the conduit left for water pipes, &c., is covered with a ¼-in. plate, so as to prevent the steam from getting into the conduit, either to incommode the men working there or to damage the pipes. The total weight of the bridge is about 620 tons.

From the north side of Parliament-street Bridge there is an entrance to the station platforms, which are 34 ft. 9 in. apart at this point. Between the two platforms there is a footbridge of a length of 53 ft., supported on columns at a height above rail level almost, although not quite, the same as that of the Parliament-street Bridge. This footbridge runs parallel with, and 42 ft. distant from, the northern girder of the Parliament-street Bridge, and connection is formed by a gangway carried at one end on this northern girder, and at the other end on the southern girder of the footbridge between the two platforms. This latter girder is of the plate type, 4 ft. deep, with heavy flanges to carry the gangway. The other longitudinal member of the footbridge is of the lattice type, the load being considerably less. The flooring is generally of the same construction as the footbridge across the station, shown in Fig. 175. The gangway between Parliament-street Bridge and the footbridge is of lattice girders 4 ft. 11 in. deep, suspended to the bottom of which are cross-girders 10 in. deep, placed at 3-ft. 8-in. centres, and supporting on top a flooring of $\frac{5}{16}$-in. curved plates, with 3-in. wood blocks on cement concrete. The stairway leading from the footbridge on to the platforms is supported on steel built-up columns. Gangway, footbridge, and stairways are all covered in with woodwork and glazing, with zinc-covered roof.

In Nottingham, apart from the Victoria Station, there are several interesting works, and without attempting to deal exhaustively with the subject, one or two of these structures may be here referred to; but as to the work generally on the northern section of the line, that will be found described most completely in the paper entitled "The Great Central Railway Extension; Northern Division," read by Mr. Frederick William Bidder before the Institution of Civil Engineers, and published in vol. cxlii., part 4, of the Proceedings of the Institution, Session 1899-1900.

The Trent Viaduct is, perhaps, one of the most interesting bridges on the whole line. It is situated in the southern portion of the city and crosses the river and valley, the rails being 32 ft. above the average water level. The viaduct carries four lines of rails, the width of the river spans being 103 ft. each. The river is about 270 ft. wide, but is crossed at an angle of 74 deg. 27 min., and owing to the heavy overflowing of the banks a long series of arches had to be built as approaches to the main spans. Flood-openings had also to be left in the piers of these arches. On the south side there are seven arches, then the three river spans, next three more arches and a girder span of 66 ft. for the new boulevard along the river embankment at the north end. The total length of the viaduct is 864 ft. The arches are all alike, segmental, with a radius of 17 ft. 2½ in. The span is 31 ft. 3 in., the arch has a rise of 10 ft., and its thickness at the crown is 1 ft. 10½ in., and at the springing 2 ft. 3 in. The piers for these arches are founded on gravel beds, the width being 4 ft. 6 in. at the springing and 4 ft. 10½ in. at the base. The piers are 74 ft. 9 in. from nose to nose of cut-water. In this length there are three arches, one 9 ft. wide and two 6 ft. wide, the top extending to flood level. The spandrils are dealt with in the same way as in the three and five-arch structures on the line.

The south abutment is 20 ft. thick at the bottom and 18 ft. at the top, with five pockets in the width. These are 8 ft. 9 in. square, the two outermost being rather less in width. They are arched over at the top. The banks behind were carefully built up in layers as with the other bridges. There are straight-back wings for a depth of 28 ft. 6 in., and in addition heavy retaining-walls for the purpose of guiding the flood water through the arches. It is also intended to lay 12-in. stone pitching along the toe of the embankment for a considerable distance beyond the abutment to counteract any wash from the floods.

The abutments immediately adjoining the river, and carrying the heavy girders, are truncated to suit the skew of the river, being 14 ft. 11 in. thick at the one end and 35 ft. 4 in. at the other. They are built with pockets similar to those in the main abutments only to save brickwork. The foundations for these abutments are carried down 25 ft. below the surface level—right down to the sandstone rock. The first 6 ft. is of concrete, above which the work is entirely of brickwork. The concrete extends beyond the brickwork by 18 in. on all sides.

The abutment for the "boulevard" span, which is 66 ft., is 13 ft. 6 in. thick on the river side, with pockets 3 ft. 9 in. wide and 8 ft. long, and on the city side 6 ft. 9 in. thick, with counterforts at the back. On this latter straight-back wings are built into the bank for a distance of 29 ft. 9 in. from the face of the abutment.

Coming now to the steel superstructure, and taking first the main river spans, it may be said that the centre girder is 111 ft. 9 in. and the two side girders 112 ft. 6 in. long, but the steelwork of all three is practically the same. The supports in the rivers are piers—one for each of the four girders for each span—so that there are two lines of four piers. These piers had to be sunk under compressed air, for the stratum was sand and gravel, so that prudence required that it should be taken out by hand, and not with steam diggers worked from above, which might have involved trouble in insuring that the piers would be vertical. Although laborious, the work was without noteworthy incident, and the usual compressed-air plant, with locks, was mounted on a staging extending right across the river. The bottom part of each cylinder provided with a cutting edge was 10 ft. in diameter and of 2-in. metal, but above the cutting edge it is only 9 ft. outside diameter, and of 1¼-in. metal. It was built up in sections of 4 ft. in depth. Three or four were jointed together in the first instance, and the soft material in the bed of the river—in which there was 5 ft. to 6 ft. of water—removed from the interior by grab dredgers; then compressed air was brought into use and the pressure of 10 lb. to 15 lb. was found sufficient to keep the water from coming in under the cutting edge or through fissures. The cylinders were filled with 4 to 1 cement concrete and brickwork above, and at the top the two forming one pier are braced together by lattice girders forming a box section, the depth being 4 ft. and the distance apart 3-ft. centres, making the width also 4 ft.; steel bands surround the cylinders and the girders are riveted to the projecting ends of the bands. Granite stones, 8 ft. by 5 ft. 6 in. by 2 ft. 3 in., are placed on the top of these cylindrical columns, carrying the bearings for the girders in the form of an iron casting. On the brick abutments at either end roller bearings are provided In this case the base stone is also granite, the bearing consisting of a lower and upper plate of cast iron, with seven steel rollers 4½ in. in diameter and 2 ft. 9⅛ in. long, with bearing ends about 2 in. in length, carried on steel bars, forming the sides of the cast-iron box.

The main girders are of the lattice type, 12 ft. 9 in. deep, the top flange being 2 ft. 6 in. wide, and the bottom boom 1 ft. 9½ in. wide. The top flange has a hipped end. The weight of one of these girders of a total length of 112 ft. is about 54 tons. As to the decking of the bridge, the cross girders are of the plate type. Their connection with the longitudinals is interesting: a web-plate is riveted to the lower ends of the verticals of the main girder, and to this web again are riveted four angles, forming a + with connecting plates between. This construction extends below the bottom boom of the main girder, and to it is connected the web of the cross-girder. The cross-girder is therefore suspended, the idea being that by this arrangement the strain due to the deck and its load will be centralised in the main lattice girder.

The cross-girders are placed at 8-ft. centres, the vertical stiffening members of the longitudinals being fitted accordingly. The transverse girders are 2 ft. 2 in. deep at the centre, and 1 ft. 9 in. at the ends, that being in both cases the depth of web. The rail bearers are supported on the bottom flanges of the cross-girders, which are 1 ft. 3 in. in width. The longitudinals are tied at 32-ft. intervals by curved bracing of the lattice type. The main girders were built up on staging across the river, so that there was no feature of note in connection with the work of erection.

Plate girders of the hog-back type were used in the construction of the span over the boulevard on the north bank of the river. The depth in the centre of these girders is 9 ft. 6 in., and at the end 7 ft. 6 in. The girder is divided into 18 bays, each of 4 ft., and the web is of ½-in. steel. The flanges at top and bottom are 2 ft. wide. There are four such girders—two for each double line, as in the main river spans. The top flanges of the cross-plate girders are also curved, the depth at centre being 2 ft. 2 in. They are carried at 8-ft. centres on the bottom flange of the main girder, with a gusset plate to strengthen the connection. The ½-in. curved plate of the floor is riveted to the top flange of the girders and the rail bearers. Weeping holes are left at the end of the floor plates, to which there is a fall, with pipes to carry off the water to the river.

Through the southern part of the city of Nottingham there is a viaduct about 1000 yards long. This viaduct consists of 53 arches, interspersed with which are twelve girder spans, some of them of considerable importance. One of the brickwork spans is 45 ft. on the square, and 48 ft. 2⅜ in. on the skew, and the others vary from 36 ft. to 31 ft. 3 in. The first-mentioned span is over the Nottingham and Grantham Canal. The others are for the most part between thoroughfares which are crossed on girders. In some cases the foundations for piers and abutments had to be carried to a depth of 26 ft. The station at Arkwright-street is on the Nottingham Viaduct; a light structure on columns carrying the platforms, the booking-office buildings being on the street level below.

The crossing over the Midland Railway at their Nottingham Station, however, calls for more than a passing note. The Midland Railway is here over 270 ft. in width, and to secure an intermediate support between abutments it was necessary to divert some of the lines slightly to the southward. The lines cross each other on the skew. One of the spans is 171 ft. on the skew and 163 ft. on the square, the other being 104 ft. and 100 ft. respectively.

The main girders are of somewhat similar construction to but heavier than in the case of the Trent Viaduct, the 171-ft. girders being 19 ft. 7 in. deep in the centre, and, instead of being hipped at the ends, they are of the hog-back type, the depth at the ends being 13 ft. These girders are placed

PASSENGER FOOTBRIDGE AT THE VICTORIA RAILWAY STATION, NOTTINGHAM.

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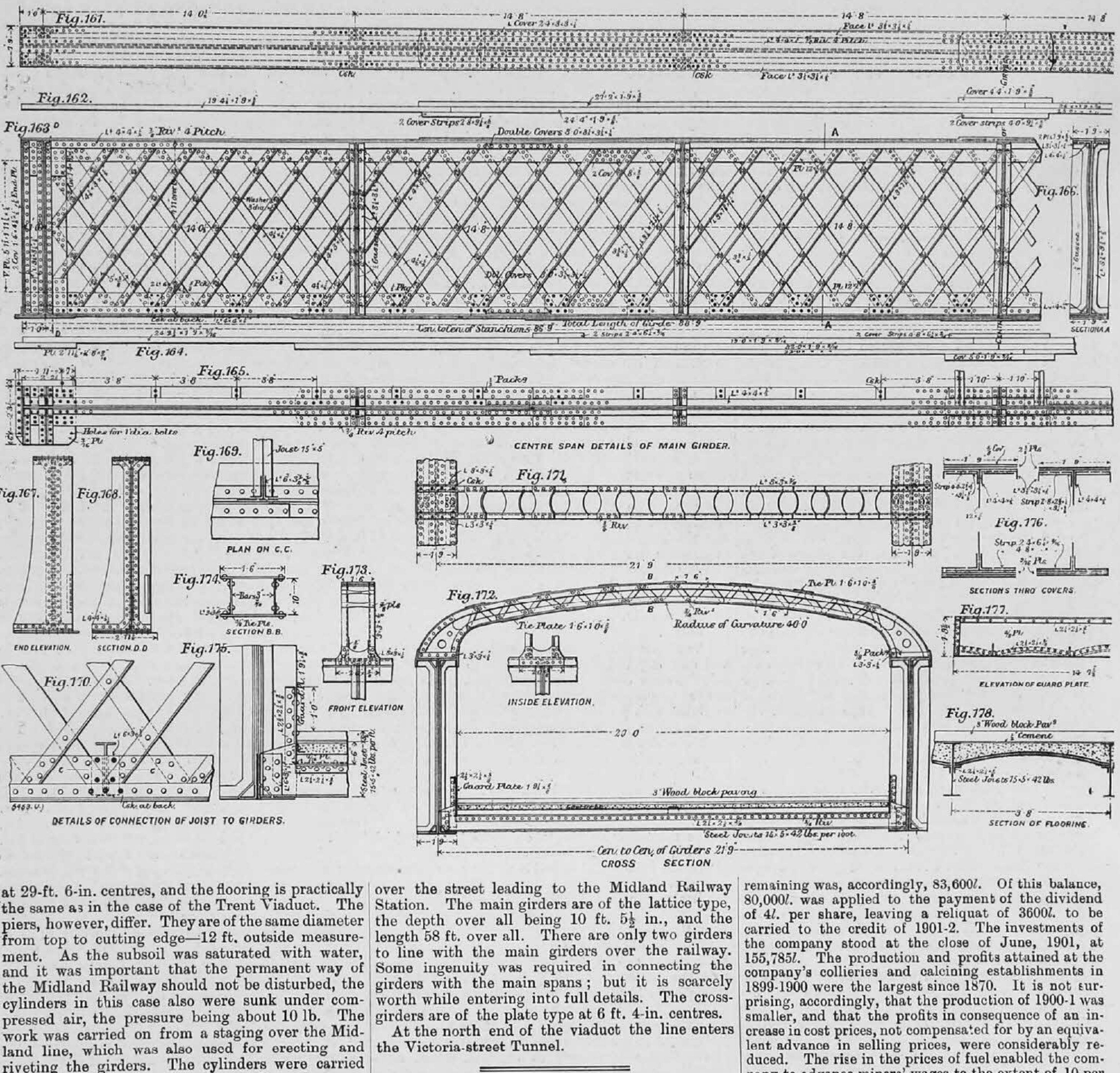


at 29-ft. 6-in. centres, and the flooring is practically the same as in the case of the Trent Viaduct. The piers, however, differ. They are of the same diameter from top to cutting edge—12 ft. outside measurement. As the subsoil was saturated with water, and it was important that the permanent way of the Midland Railway should not be disturbed, the cylinders in this case also were sunk under compressed air, the pressure being about 10 lb. The work was carried on from a staging over the Midland line, which was also used for erecting and riveting the girders. The cylinders were carried right down into the rock, and even then a bore was driven about 8 ft. further into the rock, as in the case of the Trent piers, to insure that it was not merely a narrow belt. Cast-iron cylinders were only carried to above the water-bearing strata. They were filled in the bottom with concrete, and in the top part with brick, which was carried to the surface level, where a granite block was placed to serve as a base for a steel built-up stanchion on which the main girders are carried. The steel columns consist of four squares, formed separately of channels, angles and plates, as shown on plan, and these again are connected by webs and angles, forming a column 5 ft. by 4 ft. They are fitted with a heavy base-plate at the bottom, through which they are secured by lewis bolts of great length, extending through the granite base right into the concrete enclosed by the cast-iron cylinders below surface level. Ornamental cast-iron caps help the appearance of the columns. Each pair of columns for the width of the bridge—for a double line—are braced together.

Immediately north of this there is a third span over the street leading to the Midland Railway Station. The main girders are of the lattice type, the depth over all being 10 ft. $5\frac{1}{2}$ in., and the length 58 ft. over all. There are only two girders to line with the main girders over the railway. Some ingenuity was required in connecting the girders with the main spans; but it is scarcely worth while entering into full details. The cross-girders are of the plate type at 6 ft. 4-in. centres.

At the north end of the viaduct the line enters the Victoria-street Tunnel.

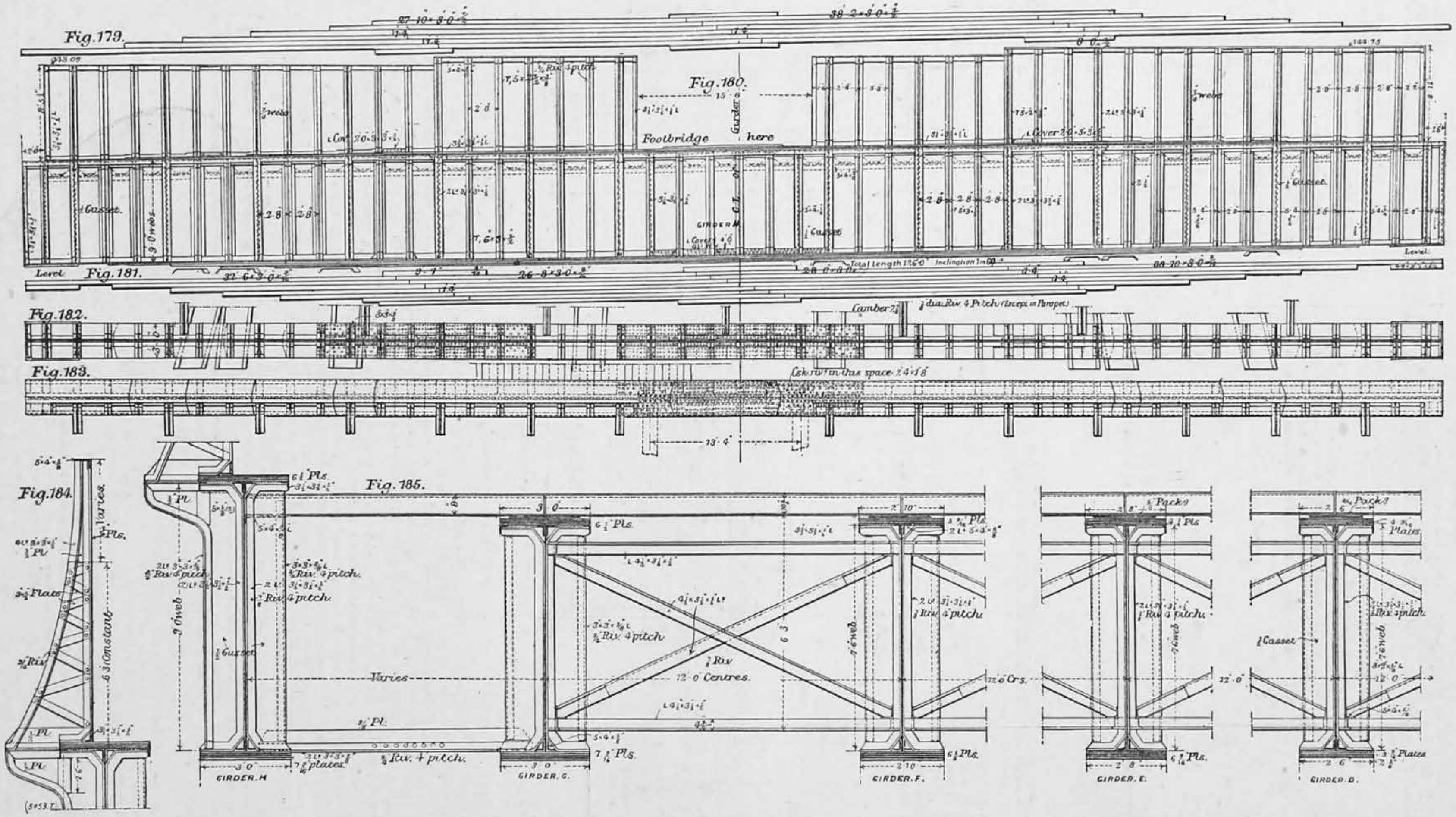
THE JOHN COCKERILL COMPANY.

THIS company was in a less prosperous condition during the year ending June 30, 1901, than in 1899-1900. A stagnation prevailed in business during the closing months of the past financial year, but the company maintained its ground better than might, perhaps, have been anticipated, in consequence of sacrifices made by it in former years to improve and develop its means of production. The policy of making considerable redemptions of outlays on capital account for improvements was continued last year; but notwithstanding this, the council of administration was enabled to maintain a dividend at the rate of 4*l*. per share. The rough balance at the credit of the profit and loss account for 1900-1 was 260,474*l*. Of this sum, 85,366*l*. was further written off for depreciation of premises and tools—viz., 8 per cent. for premises and 16 per cent. for tools. The revenue account was also debited with the following items: Bank interest and commission, interest on obligations, &c., 7937*l*.; general expenses, 20,764*l*.; subsidies in favour of employés and workpeople, 11,200*l*.; allowances for bad debts, 6374*l*.; depreciation of securities, 11,200*l*.; and reduction in value of stores, 34,000*l*. The balance remaining was, accordingly, 83,600*l*. Of this balance, 80,000*l*. was applied to the payment of the dividend of 4*l*. per share, leaving a reliquat of 3600*l*. to be carried to the credit of 1901-2. The investments of the company stood at the close of June, 1901, at 155,785*l*. The production and profits attained at the company's collieries and calcining establishments in 1899-1900 were the largest since 1870. It is not surprising, accordingly, that the production of 1900-1 was smaller, and that the profits in consequence of an increase in cost prices, not compensated for by an equivalent advance in selling prices, were considerably reduced. The rise in the prices of fuel enabled the company to advance miners' wages to the extent of 10 per cent. in 1899-1900; the present state of affairs is, however, less favourable, the cost price not having fallen in the same proportion as the selling price. Notwithstanding the reduction in production occasioned by industrial depression during the second half of 1900-1, the profits derived from the company's mineral deposits last year were in excess of those obtained in 1899-1900. Some important works have been carried out in the company's Ottange and Kirchberg mines; and these improvements have considerably reduced the cost of production. The production of the company's blast-furnaces in 1900-1 exceeded the corresponding production in 1899-1900 by 17,000 tons, but the rise in raw materials, coupled with the decline in the selling prices of pig, involved a reduction of profits. The recent firmness of hematite pig in England has brought more activity to Belgian markets, and the company will be shortly enabled to re-light certain blast-furnaces which it had blown out in order to avoid an excessive accumulation of stocks. The company's construction workshops having first to execute numerous clients' orders for gas engines, were only able to supply the blast-furnace division last year with a single engine of 600 horse-power, which has worked in a satisfactory

PARLIAMENT-STREET BRIDGE OVER THE VICTORIA RAILWAY STATION AT NOTTINGHAM.

MR. EDWARD PARRY, M. INST. C.E., LONDON AND NOTTINGHAM, ENGINEER.

(*For Description, see Page* 830.)



BRIDGES ACROSS THE VICTORIA RAILWAY STATION AT NOTTINGHAM.

MR. EDWARD PARRY, M. INST. C.E., LONDON AND NOTTINGHAM, ENGINEER.

(For Description, see Page 830.)