seen in Fig. 322. It is just drawn down with little regard to shape or dimensions, and bent round before stamping. Another is the railway-carriage key finished in the die (Fig. 323), having a deep grooving, from a rough blank, seen in Figs. 324 and 325.

These dies, and all those for the lighter class of work, are cut from lumps of mild steel in the shop located on the plan view in a previous article.

But for most of the dies used at Swindon cast iron vastly predominates, and scarcely any are banded. As the work is chiefly done under the hydraulic presses, the jar which is so destructive to cast-iron dies under hammers is eliminated. Apparently, cracked dies are nearly unknown. The metal is very massive, ranging between 3 in. and 5 in. in thickness. Handles are seldom cast in, but plenty of holes are cast in the die bodies for the insertion of rods by which the dies can be lifted and turned. Very strong lugs are cast for the attachment of dies to the presses, and the holes invariably come clear out to the outsides of the lugs, which renders the insertion of bolts easier than it would be if ordinary holes were cast in.

THE NEW VICTORIA STATION AT NOTTINGHAM.

In the sixty-seventh volume of Engineering we described and illustrated many of the important works on the Great Central Railway extension to London; but pressure on our space prevented us from following up this most interesting topic, and we now return to the subject, principally to deal with the splendid joint station at Nottingham, the convenience of which has now been established by its use for some time by the two owning companies—the Great Central and the Great Northern.

This station is certainly the most important piece of work on the northern section of the line of which Mr. Edward Parry, M. Inst. C.E., is engineer. In this and other work he has been assisted by Mr. Frederick W. Bidder, M. Inst. C.E., who has had charge of the details of the constructional work, while Mr. A. E. Lambert has been responsible for the architectural details. Mr. A. A. Barker has been resident engineer on the Nottingham works. The station, as we have stated, is the joint property of the Great Central and Great Northern Railway Companies, the latter using the permanent way of the former for some distance south, as well as north, of the station, and in this way obviating a long detour on the route from Grantham to Derby and the Midlands.

The site of the station is very central, and the plan is admirably arranged alike for dealing with a large volume of traffic and for the convenience of passengers. A plan is given on page 678 (Fig. 1), from which it will be seen that the station lies between two tunnels, known as the Victoria-street and Mansfield-road tunnels. The length between the tunnel faces is 650 yards. At the north end the rail level is 58 ft. below the original surface, at the south end 29 ft.; but in the centre there was a depression in the original contour, the depth there being only

23 ft. The total amount of material excavated for the station was 580,000 cubic yards. At the northern end, as in the Mansfield-road tunnel, it was good sandstone, which had to be blasted, and was subsequently removed by a steam navvy. Towards the south end, however, as in the Victoria-street tunnel (Fig. 3), it was soft, being partly made ground, and it was easily removed. At the south end very heavy walls were built, as shown in section in Fig. 2. The thickness at the base is 9 ft. 6 in., and the height about 40 ft. Near this end, by the way, the old town wall was discovered during excavation at a depth of 20 ft. below the surface. It was built of sandstone in clay instead of cement, the width being about 7 ft.

As shown on the plan, there are two island platforms, each of a maximum width of 68 ft., the length being 1270 ft., and the total length of platforms at which trains can stand is about 1¼ miles. There is a bay at each end of each platform 400 ft. long, with two lines of rails in each. The platform walls are built of brickwork faced with Staffordshire brindle brick, the height being 3 ft. The copestone, like the paving, is of granolithic stone. There are nine lines of rails through the station, excluding the double-line bays at each end, so that the platforms will accommodate fourteen trains at the same time, the total rail mileage within the station being about 5½ miles. The plan clearly indicates the distribution of up and down and of fast and slow traffic for passengers and goods. In addition to the fourteen passenger trains, two goods trains can be accommodated on the outermost roads through the station, and two trains of empty carriages on the middle siding. There are also docks at either end for dealing with fish and market goods traffic, 50-ft. locomotive turntables, 60-ft. engine pits, &c. The Mansfield-road tunnel, at the north end of the station, is through sandstone, the length being 1188½ yards; the Victoria-street tunnel, 392½ yards long, at the south end of the station is also through sandstone, but difficulties were experienced here owing to the crown of the arch being so close up to the foundations of the buildings above—in some cases cellars were passed through.

Admirable arrangements have been made for the convenience of the public. As we have said, the station is in the heart of the town. Along the western side of the cutting near Mansfield-road—one of the principal thoroughfares in the city—the station buildings, hotel, booking-office, parcel-office, &c., have been built. A new road has been laid out along the eastern boundary. In place of several streets demolished, a fine new girder bridge—York-street—of 40 ft. width has been built across the station towards its northern end. A footbridge of 15 ft. width also extends across the station at about the centre of its length, entirely for the use of the public; a second footbridge gives access from the booking-hall to each of the platforms, with exit to the public footbridge and to the new street on the eastern boundary of the station; and here special commendation must be given for the arrangement whereby luggage is dealt with in entirely separate passages from those used by passengers. Two hoists from the booking-office communicate with an underground passage under the rails and platforms, with lifts to each platform and to the refreshment departments. At the south end of the station—Parliament-street—one of the busiest thoroughfares of the city is carried across the station near to the face of the Victoria-street tunnel. From this bridge, also, there is access to the platforms. The various buildings and bridges we shall refer to in detail later.

Meanwhile it may be said that on each of the two long platforms there are two blocks of buildings, as shown on plan. They are 135 ft. long, 20 ft. wide and 40 ft. high. The two blocks at the north end marked respectively A and C on plan comprise porters' and guards' rooms in the basement, ladies' and gentlemen's and general waiting-rooms on the platform level, with lavatories, &c. On the first floors suites of offices have been provided, with lavatory accommodation for the staff. Provision has been made for additional floors to be added to each block at some future time, as we shall presently explain. Through these two north blocks the public footbridge passes, and considerable difficulty was experienced and successfully overcome. The bridges are carried entirely independent of the walls, so that vibration or expansion and contraction of the metal will not affect the building. The blocks at the south end of the station marked B and D on plan comprise refreshment and dining-rooms, telegraph office, lavatories, and station-master's offices, with kitchen and larders, telegraph operatives' room, and other offices, on the first floor, and commodious wine and beer cellars in the basement.

The walls of the dining and refreshment rooms are lined with faience tiles, the floors are of ceramic mosaic, and the internal fittings and finishings are in walnut. The decorative effects, notwithstanding the limited size, are very pleasing, suggesting the best of London restaurants. The buildings on the platforms and the internal elevations of the east and west boundary walls are faced with various colours of best glazed bricks and with glazed vitreous terra-cotta dressings supplied by the Burmantofts Brick Company, Leeds.

The buildings are surrounded immediately below the platform level by subways for the accommodation of water, gas, and drain pipes, and electric conductors. These are 5 ft. 6 in. wide and 6 ft. high, affording sufficient room for workmen to make inspection and repairs without interfering with the traffic on the platforms. Blocks marked B and D on plan, which, as already mentioned, accommodate the refreshment and dining rooms, &c., are connected by an underground passage for the convenience of the culinary department only, and from Block B there is a similar subway, for the same purpose, communicating with the main luggage subway across the station. By this means supplies can be brought from stores or from public thoroughfares. These subways are 14 ft. wide and 11 ft. high, with brick arch roof, and are served by hoists at each platform and booking-office. The two lifts in the booking-office are 9 ft. 4 in. by 8 ft. 10 in., of 30 cwt. capacity, the travel being 40 ft. 4½ in., and luggage may be delivered at the basement floor, intermediate between the booking-hall and subway. The hoists at the platforms, of a similar capacity, have a lift of 18 ft. 6 in. There are three other hoists, 8 ft. by 4 ft. 6 in., of 20 cwt. capacity, making seven in all. Two of these are in the parcels department to the north of the booking-hall, communicating from the street level to the basement. The seventh is in the left-luggage office, with a lift of 20 ft. 10 in. to the stores in the basement. The power-house, it may be said, is at the north end of the station, the machinery being provided by Mr. R. Middleton, Leeds. A noteworthy point is that the pumps are driven by gas engines; the working hydraulic pressure is 700 lb. to the square inch.

The roof of the station proper is in two parts; the central part, defined by the length between the outer ends of the platform buildings, being roofed in by principals which rest partly on the top of the walls of these buildings, partly on columns in line with these walls, and on screen walls built on the side boundary retaining walls of the station (Fig. 2). The idea in carrying the roof at such a high level was to secure the maximum of light and ventilation within the station, notwithstanding that it is in a deep cutting. The remainder of the platforms north and south of this main roof are covered with awnings. The photograph reproduced on page 679 gives a good idea of the central span of the main roof, and on our two-page plate this week there will be found details of this span, including the main standards and girders (Figs. 4 to 19), roof truss, with details (Figs. 20 to 34), and the purlins, with details (Figs. 35 to 47); while on page 679 are details of the gutters and down pipes for surface drainage, with the gangway provided for inspection (Figs. 48 to 54). We defer our illustrations of awning, roof, &c.

The main roof extends for a distance of 425 ft., and the full width of the station, or 245 ft. As shown on plan and section (Figs. 1 and 2), it is divided into three main spans, with two small spans coincident with the width of the platform buildings. This arrangement was adopted so as to utilise as far as possible the walls of these buildings for carrying the roof principals and to minimise the number of columns obstructing the platform; but as it was not desirable to build the walls of greater strength than the building itself demanded, columns were built into the walls for supporting the main principals, the thickness of the wall being increased at these points by octagonal pilasters. The west span, from the west, or booking-office, side of the station to over the down platform, is 63 ft., the main central span is 84 ft. 3 in., and the main eastern span 63 ft. The two spans which take the place of the platform buildings, as shown on Fig. 2, are each 18 ft. 6 in.

The space intervening between the platform buildings is 150 ft., and in line with the buildings rows of columns have been built at 30-ft. centres, connected by lattice girders to continue the line of support for the roof principals. These main columns have a height of 41 ft. 6 in. from the baseplate to the top. They are built up of angles, channels, and plates, as shown in Figs. 8 and 9, and are 18 in. square over all. The baseplate is 3 ft. 6 in., and ⅞ in. thick, with ½-in. gusset-plates and angles to secure the trunk. They are carried on a bed stone 4 ft. 6 in. square by 2 ft. thick, founded on solid rock, the baseplate being held down by 1½-in. lewis bolts let 9½ in. into the stone (Figs. 10 and 11). The base of the columns is protected by a cast-iron ornamental plinth 8 ft. 1 in. high from the base, and 6 ft. 6 in. from the platform level (Figs. 4 to 7).

The girders which run longitudinally between the columns are of the lattice type, the bottom boom being curved, so that while the depth of the ends is 5 ft. 8¼ in., it is only 2 ft. 8¼ in. in the centre. They are built in pairs, 11 in. apart, and at the ends are attached to the main angles at the back and front of the columns, as shown (Figs. 14 to 18). The pairs are connected on the bottom flange by a diaphragm plate 2 ft. 6 in. long, but on the top, which is horizontal, there is a plate 18 in. wide by ½ in. thick for the whole length.

The two lines of columns along the platform are only 17 ft. 6 in. apart, to suit the width of the platform buildings, and they are braced in this transverse direction by somewhat similar lattice girders riveted also to the angles forming the column (Fig. 19). The bottoms of all these semi-elliptical girders are finished by a small ornamental cast-iron console. The system of drainage in connection with these columns is interesting. The water is brought down from the main gutters on each side of the columns in cast-iron pipes 5 in. by 3 in. internal dimensions and of ½-in. metal. These lie closely into the channel irons forming the two sides of the columns, and are held in position there by cast-iron straps secured to the main angles. At the foot they discharge into the main drainage system under the platform (Figs. 48 to 54).

The columns built into the walls of the platform buildings are of less dimensions. They only reinforce the support given by the wall. These columns are 12 in. by 12⅜ in., built up of two channels at the side 12 in. by 3½ in. by ½ in. thick, with two channels at front and back 5½ in. by 3 in. by ½ in. The longitudinal and cross-girders in this case are rolled steel joists 10 in. by 4½ in., bracing the whole structure together. These columns are also based on Derbyshire gritstones, 13 in. deep, with lewis bolts to secure them.

The principals are placed at 15-ft. centres, so that they rest alternately on the top of the columns and on the longitudinal girders. We illustrate in detail the principals in the central span of 84 ft. 3 in. (Figs. 20 to 34). The rafters are composed of two channels 6 in. by 3 in. by ⅜ in., with a 4-in. space between them. They are stiffened at intervals by channels 4 in. by 2½ in. by ½ in. The lower member is built up of two 5-in. bars of varying thickness—from ¾ in. at the springing to ½ in. at the centres. The principals are divided into nine bays, the centre one being 13 ft. and the others 8 ft. 9 in. The bracing consists of channels and flat bars. The channels forming the struts are stiffened at short intervals by cast-iron distance pieces. The details are clearly shown in Figs. 21 to 34. The main principals are surmounted by lanterns with frames at 7 ft. 6 in. centres, the general design of which is shown on the cross-section (Fig. 21). The ridge is of corrugated iron, 16 B.W.G., bent over pitch-pine blocks, spaced 2 ft. 6 in. apart and bolted to the two angle-irons carrying the glazing bars. The intervening space between the blocks, of course, allows for the escape of steam, &c. Louvres are provided at the sides of the lanterns, and still further to insure effective ventilation spaces have been left over each bay between the purlins, with weather boards fixed to the upper T, so that snow or rain is not likely to find entrance. The purlins carrying the lantern frame (Figs. 35 to 40) are double, and are composed of four angles, with lattice bracing bars connected at intervals by 4 in. by ⅜ in. plates at top and bottom. The intermediate purlins are single, the top and bottom flanges being of T's with lattice bars (Figs. 41 and 42). All the purlins are secured to the backs of the principals

with ¾-in. bolts. The glazing is on Mellowes's system, the thickness being ¼ in., secured to 2¼-in. bars. These bars are of special depth, owing to the long span they carry.

The main roof covers an area of 94,968 square feet; the weight of steelwork, which was provided by the Horseley Company, of Tipton, being about 587 tons, excluding columns, wind screens, &c., or 13.8 lb. per square foot of area covered. The structure is handsome in appearance, and it may be added that 92 per cent. of it is glazed.

Walking gangways are provided along each side of the lanterns and also over the main gutters, and these also are illustrated on page 679 (Figs. 48 and 49); on both standards are provided carrying 1¼-in. steam tube, which has been preferred to the usual iron gas-piping for durability. It carries a cleansing water supply to all parts of the roof. The water is taken from the city mains, the pressure available being 75 lb. to the square inch. At convenient intervals provision has been made for the attachment of hose-pipes, &c. The main gutters are 18 in. wide and 9 in. deep, constructed of ⅝-in. metal, with outlets at convenient points into the pipes down the columns. These gutters are carried over the longitudinal girders by cast-iron shoes 3 ft. 9 in. apart, and on the platform building walls they rest partly on the brickwork and partly on stools bolted to the brickwork. The quantity of cast iron in the gutters, bases, and columns, ornamental work, &c., is about 183 tons.

(*To be continued.*)

THE VICTORIA STATION AT NOTTINGHAM; GREAT CENTRAL AND GREAT NORTHERN RAILWAYS.

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

(*For Description, see Page 672.*)

GREAT CENTRAL RAILWAY.
Extension to London.
G.C.R. AND G.N.R JOINT STATION AT NOTTINGHAM.
Fig. 1.

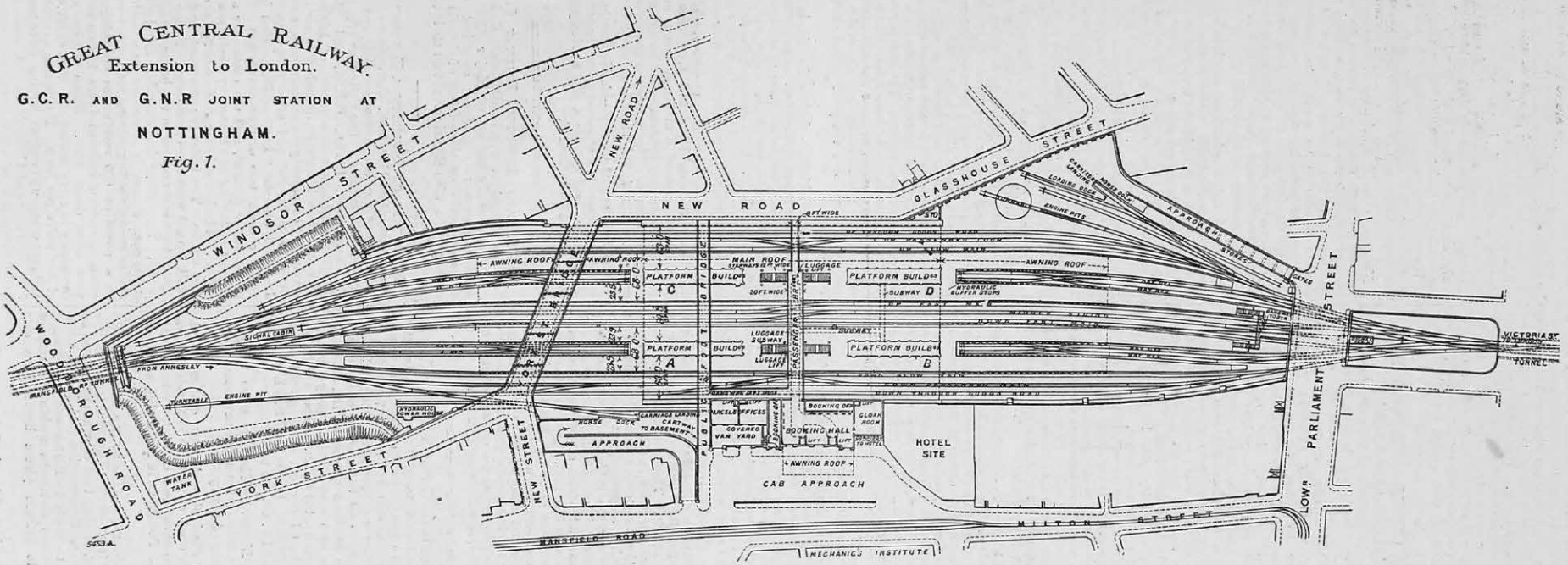

Fig. 2

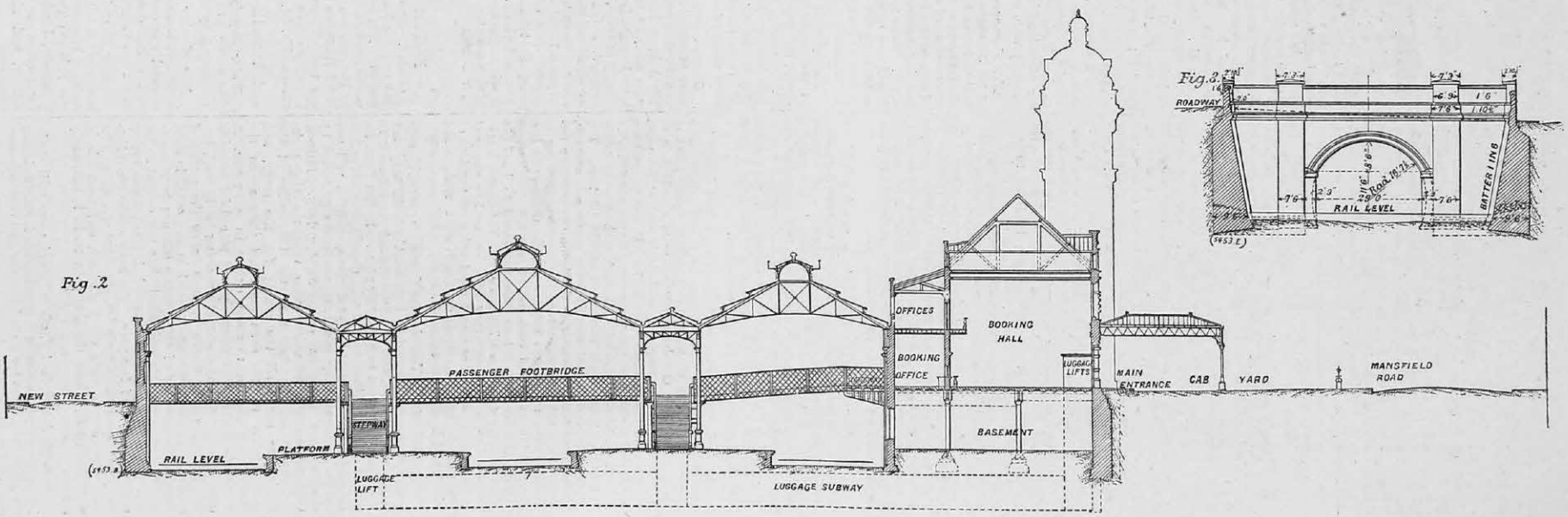

Fig. 3.