IN THE WORKSHOP

by "Duplex"

No. 72.—*A Small Power-driven Hacksaw Machine

FOLLOWING the V-belt drive, a further reduction of the drive ratio is obtained by gearing the 25-tooth countershaft pinion with a 96-tooth gear wheel fixed to the end of the crankshaft.

The general arrangement of the drive is shown in a previous photograph, Fig. 5, and the constructional details are now given in the accompanying working drawings.

A 25-tooth pinion was chosen, as this was the smallest size of wheel that could conveniently be fitted. To obtain a gear reduction of approximately 4 to 1, a Myford standard lathe change wheel having 96 teeth was employed; as the tooth numbers have no common factor except unity, the wear on the teeth will be more evenly distributed than would be the case were, say, 25-tooth and 100-tooth wheels fitted.

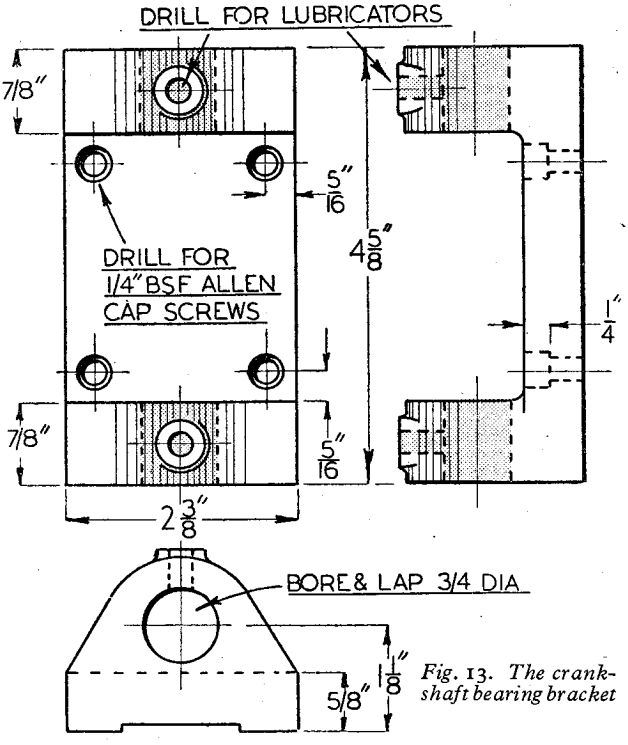


Fig. 13. The crankshaft bearing bracket

The Crankshaft Bearing Bracket —Fig. 13

The casting for this part is similar to that used to mount the countershaft.

As in the previous example, the two side faces and the end faces are machined truly at right-angles to one another, for the right-hand side face is again used as a datum surface for locating the casting correctly on the base plate. In addition, the inner faces of the bearing lugs are either filed true or surfaced in the shaping machine; this becomes necessary, as these surfaces form abutment faces for the two end-location collars fitted to the crankshaft; but, as an alternative, it may be found possible to back-face these surfaces when the bearings are being bored.

After the casting has been marked-out to determine the bearing centres, guide circles should be scribed to indicate the full diameter of the bores. The vertical centre-lines should be conspicuously marked, as they will be required later when setting the gear shafts to the correct distance apart.

As a preliminary operation, the bearing lugs are drilled to form a passage for the boring bar used to finish the bearings to size, or this passage can be machined by mounting the casting on an angle plate attached to the lathe faceplate and boring each lug in turn. For the final boring operation to machine the bearing bores to their finished size, it was found that the casting could be mounted conveniently by gripping it in a machine vice attached to the lathe cross-slide. The fixed jaw of the vice is aligned parallel with the lathe axis with the aid of the test indicator, and the datum surface on the side of the casting is placed against this jaw. The test indicator, when fitted with its internal contact attachment, is then used to centre the preliminary bearing bore formed in the casting.

Packing strips are employed, where necessary, to adjust the vertical height, and the cross-slide is locked after it has been set to locate the bore correctly in the horizontal plane.

A boring bar, of sufficient length to enable the inset cutter to machine both bearings, is next mounted between the lathe centres.

As the diameter of this boring bar will be small relative to its length, it will lack rigidity; only

*Continued from page 382, "M.E.," September 7, 1950.

light cuts should, therefore, be taken with a fine self-acting feed to avoid springing the tool. In fact, when the full diameter has been nearly reached, the tool should be put through the bearings without altering the depth of cut. If a sharp tool is used for the final cut, the finish of the bores may be found satisfactory and not in need of reaming, for it may be taken into consideration that the crankshaft runs at only some 90 r.p.m. and the large bearing surfaces provided are only lightly loaded. As a matter of interest, the bearings were actually bored with a $\frac{7}{16}$ in. diameter boring bar furnished with a single inset cutter, and the tool marks were removed from the bearing surfaces by taking a series of very fine cuts with an adjustable hand reamer.

To complete the machining of the casting, the holes are drilled for the attachment screws and for the lubricators.

The next step is to clamp the casting in position on the base plate, as was done when securing the countershaft casting, and then to drill and tap the holes for the Allen fixing screws.

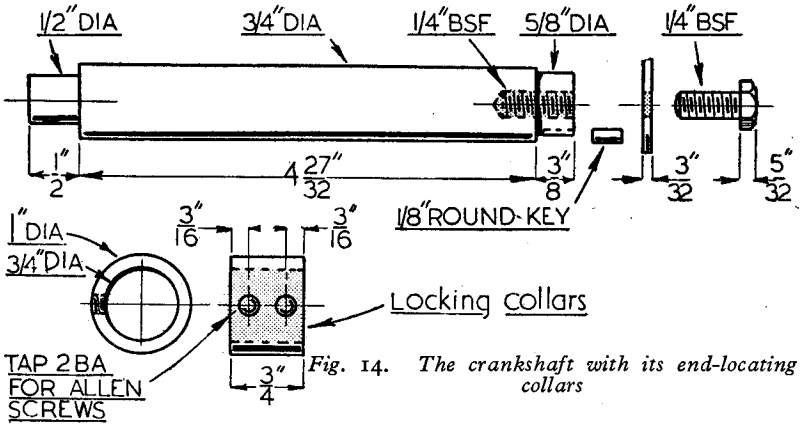


Fig. 14. The crankshaft with its end-locating collars

The front face of the casting is set $\frac{7}{16}$ in. back from the front edge of the baseplate, and a try-square is used against the datum face on the side of the casting to align it exactly parallel with the countershaft casting. The gear wheels are set at the correct centre distance apart by referring to the centre lines scribed on the two castings. The gear centres are, of course, measured from the pitch circles of the two 20 diametral pitch wheels. The radius of the pitch circle of the 25-

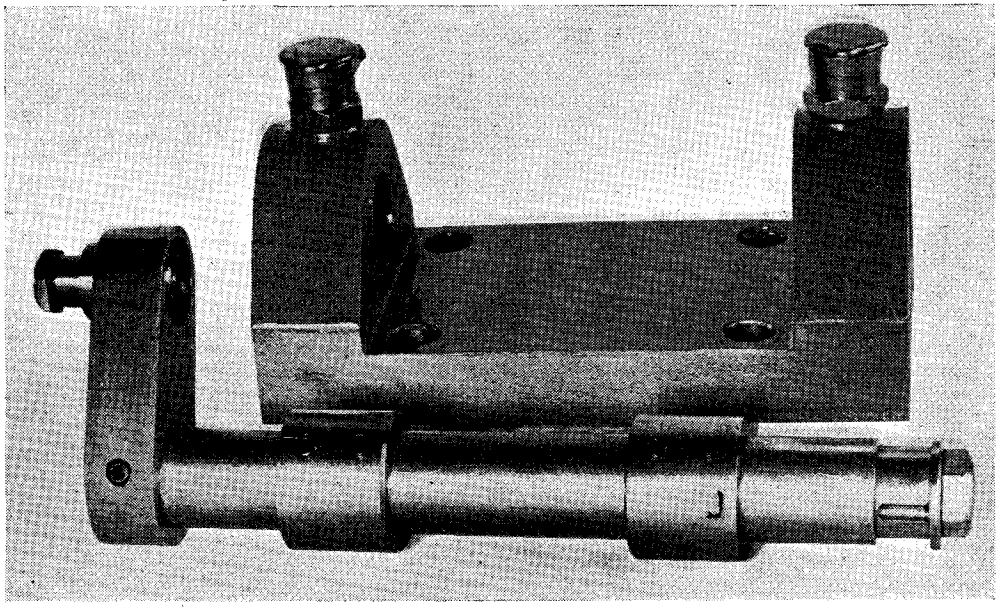


Fig. 15. The complete crankshaft assembly with its bearing bracket

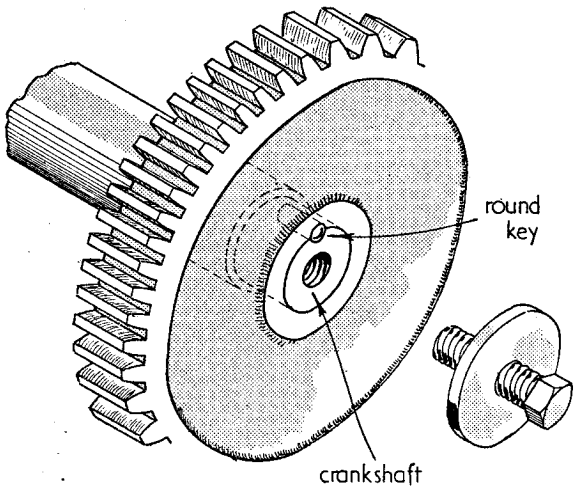


Fig. 16. Method of securing the gear wheel to the crankshaft

tooth pinion equals $\frac{25}{2 \times 20}$, and for the 96-tooth wheel $\frac{96}{2 \times 20}$.

Adding these two values gives 3 1/40 in. for the sum of the two radii, that is to say the correct working distance between the wheel centres.

If the centre-lines of the two castings are, therefore, set 3 1/32 in. apart, this will serve quite well, as the eccentric mounting of the pinion shaft allows for a range of adjustment of $\frac{1}{8}$ in.

The Crankshaft

The dimensions of this part are given in Fig. 14, and the complete crankshaft assembly is shown in Fig. 15.

As it is important that the gear wheel at one end and the crank at the other should run truly, the crankshaft is best turned between centres to ensure that both the wheel seat and the crank mounting are in proper alignment with the bearing surfaces.

If a standard change wheel is used for the large gear wheel, it may be found that the bore is slightly larger than the nominal size to enable the wheel to turn freely on its quadrant stud ; this must be taken into account when machining the crankshaft so that the wheel is made a light press fit on its seating.

If a sharp tool is used, together with a fine feed, the bearing journals may be finished by machining them to a running fit in the bearing casting, but, preferably, the journals should be turned slightly oversize, and finished by a lapping operation.

Should lapping be used for this purpose, much time and labour will be saved if the centre portion of the shaft is reduced in diameter by a few thousandths of an inch to form a waist, but parallel seatings must be left for the two collars that provide for the end-location of the shaft. These collars should be bored to a close sliding fit on the shaft and, as shown in the drawing, they are secured in place with Allen set-screws.

A central, hexagon-headed screw is fitted to press the gear wheel against the shoulder formed on the shaft, and the drive is taken by a cylindrical key lying half in the shaft and half in the wheel, as shown in Fig. 16. To form the seating for the key, a punch mark is made at the line of junction of the two parts, to form a guide centre for a small centre drill ; the drilled recess is then machined to the full depth with a drill that gives a push fit for the round, silver steel key. This method of mounting the gear wheel provides a reliable form of light drive and, more-

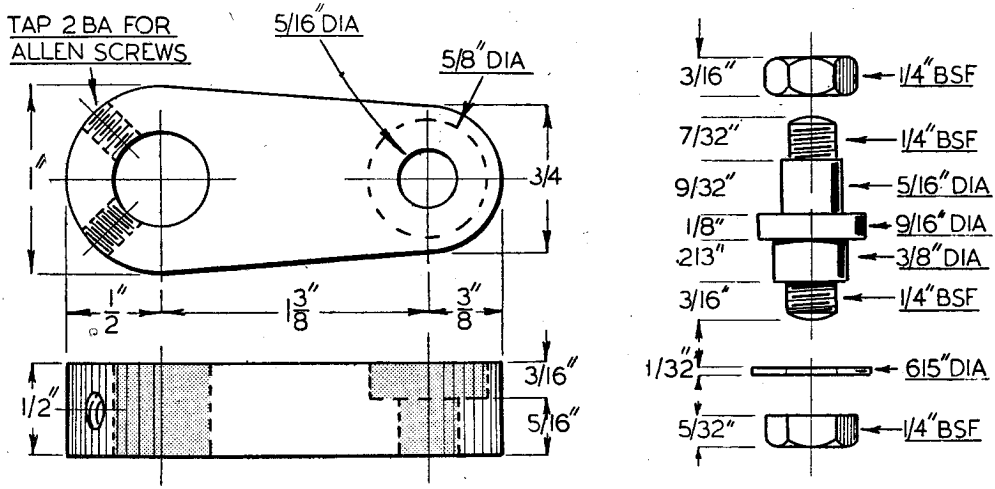


Fig. 17. The crank web and its crankpin

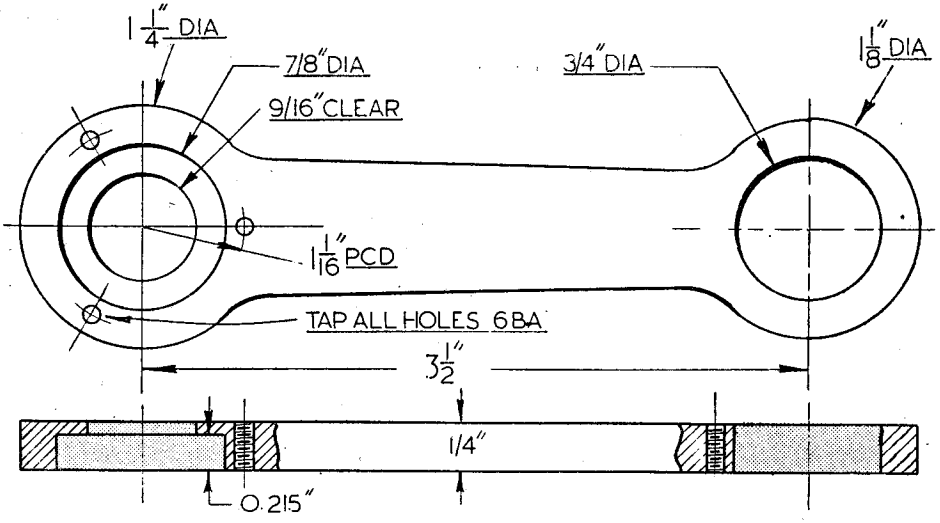


Fig. 18. The connecting-rod

over, the parts can at any time be easily dismantled.

The Crank

The crank is made from a short length of mild-steel machined and filed to the dimensions given in Fig. 17.

It is advisable to machine the bore of the crank in the lathe to a firm press fit on the end of the crankshaft. A single Allen set-screw should be sufficient to lock the crank to its shaft, but, if there is any doubt, it is better to fit two set-screws at right-angles to one another, as shown in the drawing.

In order to maintain the crank in true alignment it is provided with a seating $\frac{1}{2}$ in. in length, and it also abuts against the shoulder formed on the crankshaft. The overhang of the crank is reduced by fitting the nut, securing the crankpin, into a recess formed in the crank web, as represented in the working drawing, and as is shown in the photograph Fig. 15.

The crankpin itself is also made a firm press fit in the crank web, and the large diameter shoulder affords an ample abutment face for maintaining the pin in accurate alignment.

When turning the crank pin, the overhanging portion must be machined to afford a light press fit for the inner race of the ball-bearing fitted to the big-end of the connecting-rod.

The Connecting-Rod

To make the machine compact, the connecting-rod has been kept short, but as the length of the rod between centres is $3\frac{1}{2}$ in. and the stroke is $2\frac{3}{4}$ in., a ratio rather greater than $1\frac{1}{4}$ to 1 has been maintained. Moreover, by fitting a ball-bearing to both the big- and the small-end, the thickness of the rod, and the length of its bearings have been reduced to $\frac{1}{4}$ in. As will be seen in the working drawings, Fig. 18, the outer race of the ball-bearing fitted to the big-end is clamped with a pressure plate, Fig. 19, against a shoulder formed in the eye of the rod. The outer race of the small-end bearing, however, is made a light press fit in its housing. These small ball-bearings are largely used in aircraft control mechanisms, and the balls are then given some radial clearance to allow the outer race to be pressed into a housing without causing locking or rough running of the bearing.

Nevertheless, the freedom of a bearing of this type should be tested after fitting, and if necessary

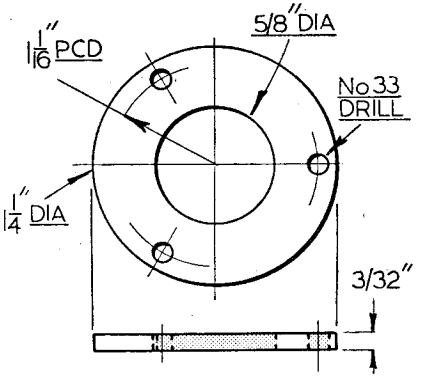


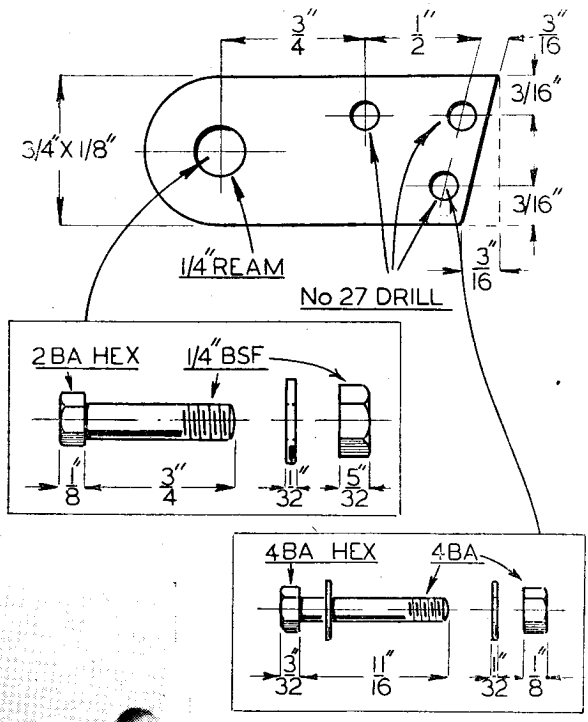
Fig. 19. Pressure plate for securing the big-end ball-race

the bore of the housing must be eased to give free running.

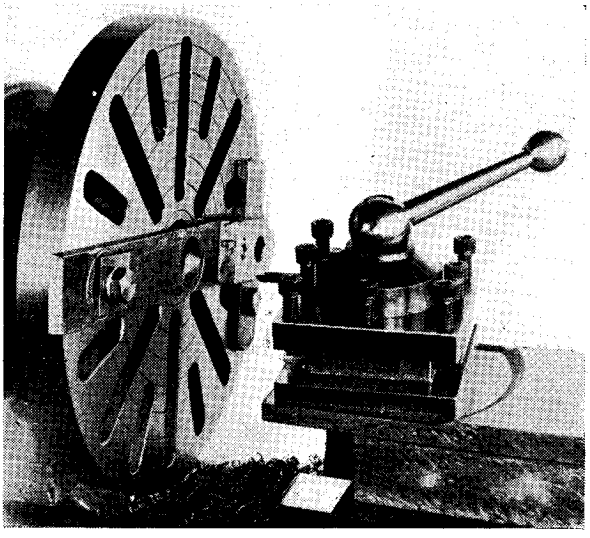
After the rod has been marked-out in accordance with the drawing, the profile lines should be dotted with a centre punch to ensure that they are not obliterated by the subsequent machining operations. The rod centres are drilled with a centre drill, and these centres are used for setting up the rod on the lathe face-

plate for machining the bearing housings. A convenient way of mounting the rod is illustrated in Fig. 20, and, when in position, either bearing centre can be set to run truly with the aid of a centre finder. As shown in Figs. 21 and 22, the small-end of the rod is connected to the saw frame by means of a bracket, which also carries the small-end bolt or gudgeon-pin. This pin is made a close sliding fit in the inner ball-race, and packing washers are inserted between this race and the side members of the bracket, so that when the gudgeon-bolt is tightened, the race is firmly clamped and kept from turning. These packing washers also serve to keep the bracket members just clear of the connecting-rod itself when all the bolts are tightened.

To ensure that all the bolt holes in the bracket are drilled correctly in line, it is advisable to mark out one of the bracket members and then to clamp it with toolmakers' clamps to a similar piece of material,

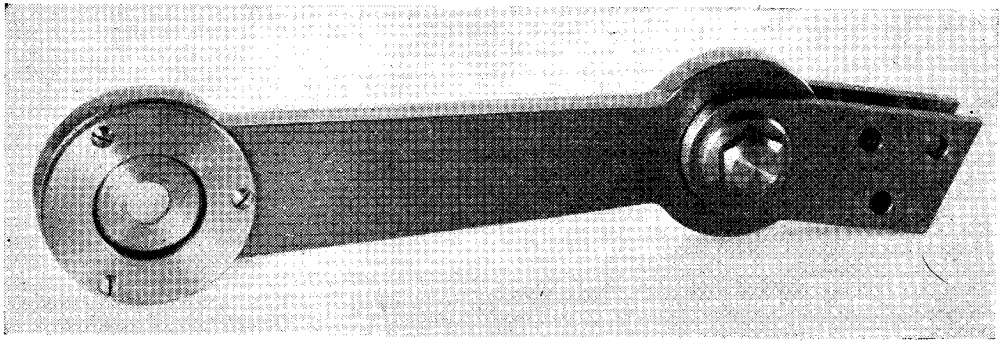


Above—Fig. 21. The small-end bearing bracket with its bolt fittings



Left—Fig. 20. Boring the connecting-rod mounted on the lathe faceplate

Below—Fig. 22. The connecting-rod assembly with its small-end bracket



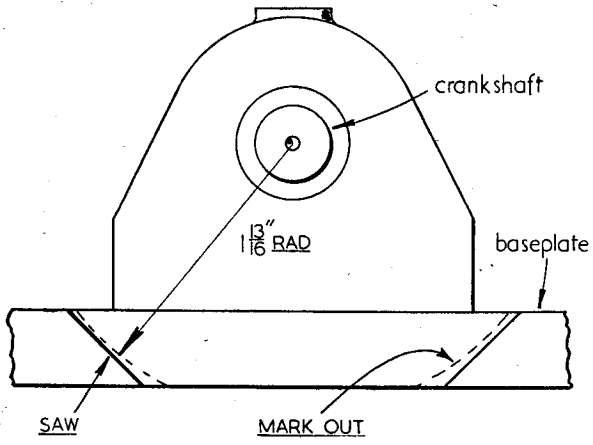


Fig. 23. Method of marking-out the crank pit

so that all holes are drilled at one setting. As the centre-line of the crankshaft is only 1⅛ in. above the upper surface of the baseplate, a gap, as shown in Fig. 23, must be cut in the baseplate to allow the crank to pass.

The contour of this gap can be marked out by placing one leg of the dividers in the centre hole in the end of the crankshaft, and then scribing segments of a circle of the correct radius on the front edge of the baseplate. When the limits of the gap have been marked-out, a hacksaw is used to cut away the surplus metal to a depth of ⅛ in., and the work is then finished by filing. After removing the connecting-rod, it will now be possible to run the complete driving mechanism. A little thin grease should be applied to the gear teeth, and the meshing of the gear wheels is adjusted until quiet but free running is obtained. It may be found that rather close meshing, to eliminate nearly all the lash or play, is required for quiet working.

(To be continued)

For the Bookshelf

Scottish Railways, by O. S. Nock. (Edinburgh. Thomas Nelson and Sons Ltd.) 214 pages, size 6 in. by 9 in. 14 full-page plates in colour; 16 half-tone plates. Price 18s. net.

The railways of Scotland had a history and romance which were theirs and theirs alone; nowhere else in the British Isles were the conditions to be faced quite the same, either during construction or, later, when the railways had been built and opened for traffic. Mr. Nock surveys the early history of each of the five Scottish main-line railways, and then entertains his readers to accounts of first-hand observations of the working of these lines in modern times. It is natural that a great deal of prominence is given to the locomotive department, because Mr. Nock has been privileged to travel many hundreds of miles on the footplates of locomotives operating in Scotland; but we are given glimpses, as it were, of the work of other departments which have to do with the running of the trains on land and the steamers on the rivers and lochs. The topography and climate also come in for their share of attention, and there are some judicious references, here and there, to unique scenic beauties without which any account of Scottish railway journeys would be incomplete.

The illustrations have been very well chosen; most of the half-tones are reproduced from photographs, many of which we do not recall having seen before, while among the tailpieces there are some excellent, small-scale reproductions of beautifully-executed line drawings of locomotives. The main feature in the illustrations, however, is the series of fourteen full-page coloured plates reproduced, with one exception, from paintings by V. Welch and Mr. Nock himself. The majority of these plates are of first-class quality, as regards drawing, colouring and reproduction; but there are three which we feel are decidedly open to question. The splendid study of a North British Railway Atlantic engine is, in our opinion, not green enough; but two plates depicting Highland Railway locomotives, presumably at the same period, are so unlike as to compel us to ask: Which is right? Mr. Nock's study of a double-headed Highland train shows the colour as a pale greenish yellow, but Mr. Welch's splendid painting of the 4-6-0 locomotive, *Clan MacKinnon,* depicts a rich, bluish green; we venture to suggest that the latter is far from correct. The Caledonian blue, on the other hand, is very successfully rendered; and here again, it is possible to compare two plates, one from a painting by Mr. Welch, and the other a reproduction of a direct colour-photograph taken by Mr. Kenneth Leech. There is little if anything, to choose between them, so far as the colours are concerned.

In all other respects, this is a really worthy book, one which can be taken up at any time, opened at any page, read with enjoyment and then put down with reluctance. The vivid descriptions of footplate trips and the ever-present impression of keen, but restrained enthusiasm for his subject are such as to ensure that Mr. Nock's writings can never fail to give unbridled pleasure to all who love railways.