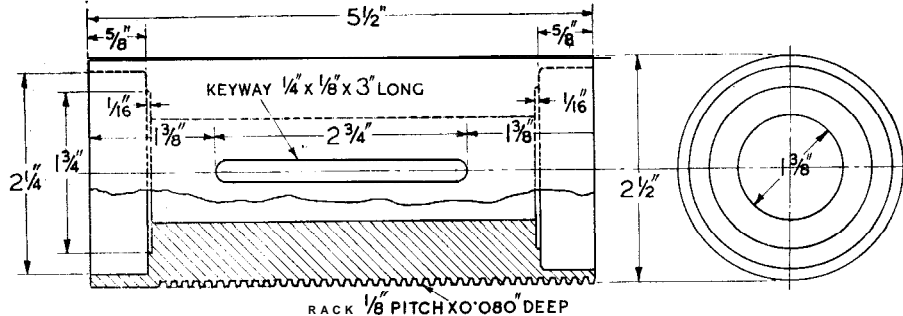
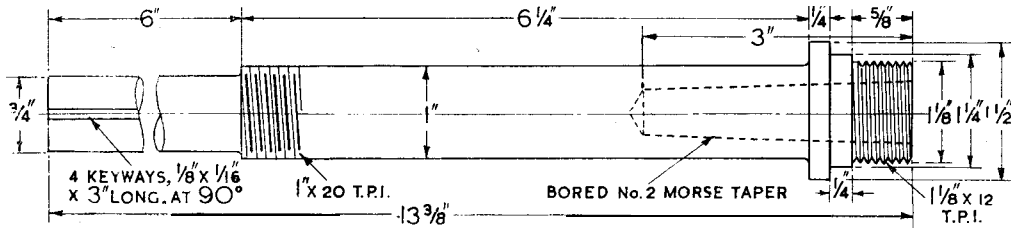


# Light vertical MILLING MACHINE



QUILL I OFF M.S. OR C.I.



SPINDLE I OFF M.S.

Continued from April 15

BY  
Edgar T. Westbury

THE spindle bearings are of a type specially suited to the duty of vertical milling, taking radial and axial loads simultaneously and eliminating end play. They differ from the bearings normally fitted to drilling machines, which are intended to guide the drill axially and take cutting end-thrust but have only a limited capacity to withstand side-loading, and have no endwise adjustment. The chucks used for drills, and their amount of overhang from the bearings, are not well suited to driving milling cutters. Drilling machines are sometimes fitted with a compound slide, so that they can be used for vertical milling, but their success for this purpose is generally limited unless the spindle and bearings are drastically redesigned.

After considering several different bearings I decided to use angular contact ball races at the two ends of the quill, with light preload applied to them by the adjusting collars on the spindle. This arrangement has so far proved highly satisfactory, though it is not ideal for continuous or relatively heavy work, such as would be done on an industrial machine. The spindle has a No 2 Morse taper socket and is externally threaded to take the fittings of the ML7 lathe, including the Myford patent collets, which hold cutters up to 1/2 in. shank diameter with the minimum overhang.

Drive is transmitted to the upper extension of the spindle, through splines, from a stepped pulley, which runs on a steel sleeve mounted concentrically on the top of the quill housing. In this way the spindle is isolated from any side load or shock which may be produced by the driving belt. The pulley is lined with a sintered bronze bush which, when impregnated with oil, provides automatic lubrication. At the rear end of the horizontal cross-tube the driving motor is mounted, so that in any position of the head, the alignment and centre distance between its shaft and the milling spindle is constant, and its weight serves as a counterpoise to the spindle head. As nearly all the work for which the machine is designed can be carried out with relatively high speed cutters, I have not provided reduction gear to the spindle; it could be added if necessary.

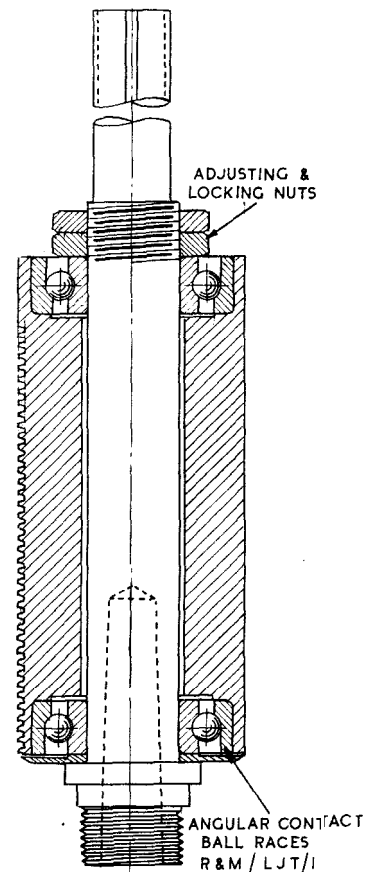
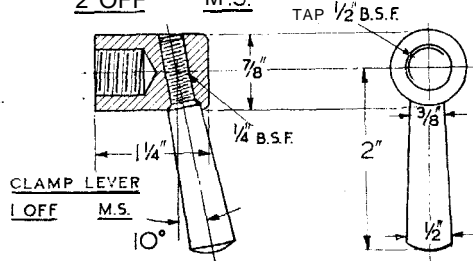
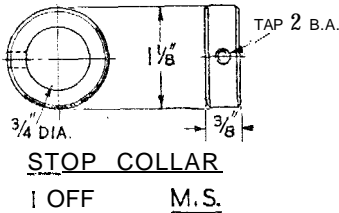
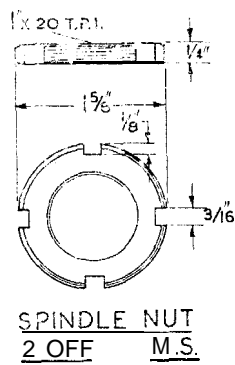
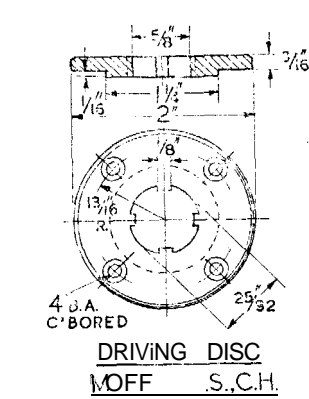
Several details have been improved and modified since

## No great difficulty w

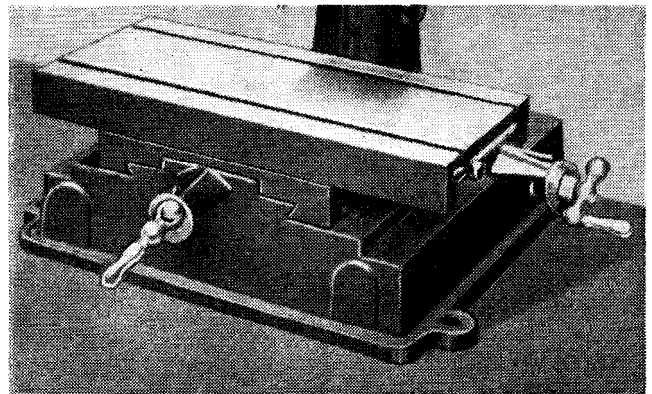
the original machine was made. These have been included in the drawings and will be described, together with the reasons for adopting them, when I deal with the individual components. Castings for the machine may be had from Woking Precision Models Ltd, Victoria Road, Woking, Surrey. Some of the heavier structural parts will undoubtedly be beyond the capacity of the average model workshop; but they involve only straightforward machining operations, within the facilities provided by some model engineering societies, or they can be farmed out to a general engineering firm.

The largest and heaviest single component is the base-plate. Iron casting is specified, but light alloy would be satisfactory; it is not subject to sliding friction, but serves only as a true base on which other parts are erected. Apart from fettling on the underside to eliminate high spots and make it rest truly on a flat surface, only the top needs to be machined. You could do this by facing it in a lathe with sufficient faceplate and gap capacity, or in a planing machine. Modern industry would probably favour the use of a heavy surface grinder. But some engineers of an older generation would be prepared to tackle this work with hand tools only; the essential thing is that it should be flat and smooth all over, to the same limits as are generally accepted for a marking-out table.

A large lathe is also recommended for the boring and turning of the column casting. Because of the long bore, which must be exactly parallel and smooth, it is best mounted on the saddle and bored with a cutter bar between centres. It can then be mounted on a mandrel, or with truly centred plugs at each end, for turning the underside of the flange and the spigot. Before the boring of this or other components which have to fit the vertical or horizontal tubes, the dimen-



SPINDLE BEARINGS L  
QUILL ASSEMBLY



ing societies may possess or have access to it. A planing machine with a maximum stroke of not less than 15 in. will cope with the operations required; in modern industry, a heavy vertical milling machine would be favoured for slides of this size, but it is less likely to be used in a small jobbing shop. Compound slides can be bought ready-made in certain sizes; one is made by E. W. Cowell of Watford, whose drilling and shaping machines are well known to ME readers. As the compound slide is a self-contained unit which can be located as required on the flat top of the baseplate, any slide of suitable size can be fitted. The complete assembly can be removed from the baseplate for plain drilling.

# tywith the heavier parts

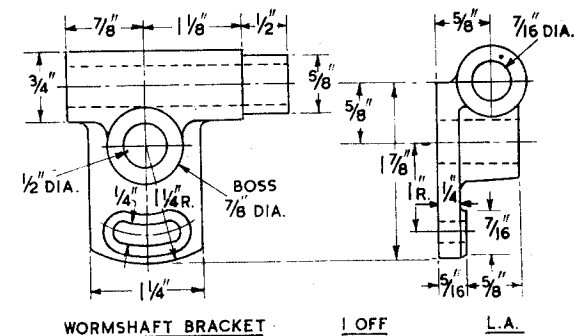
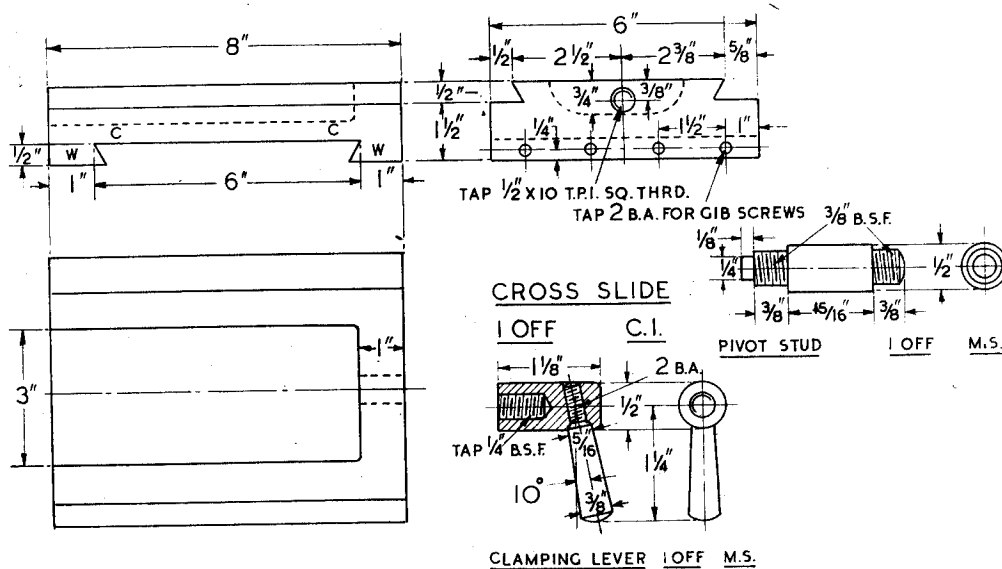
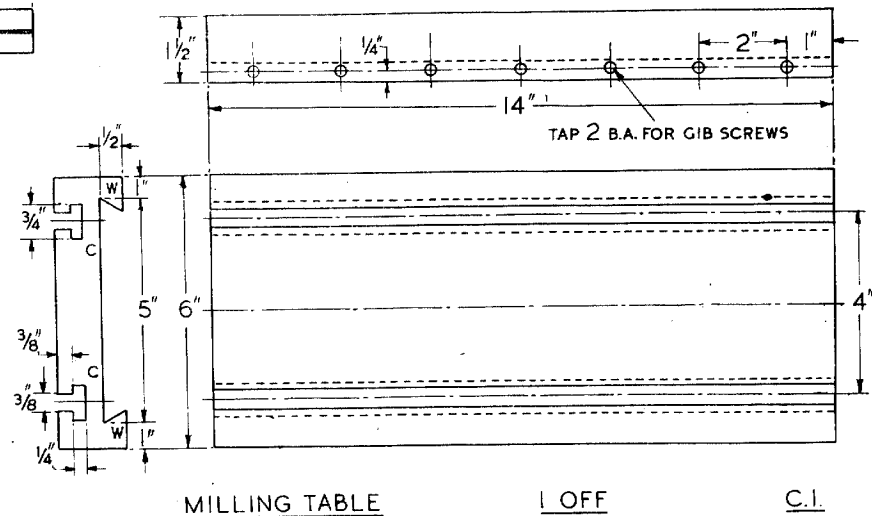
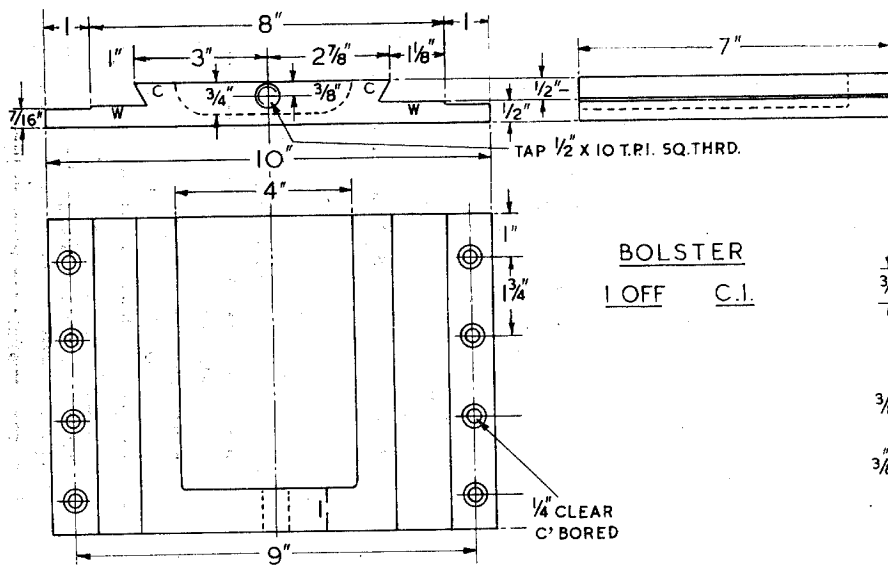
sions and circular accuracy of the tubes should be carefully checked.

Bright drawn tubing with a good finish, avoiding the need for machining, is now obtainable, but it should not be taken for granted, and if there is any doubt, a ring lap may be used to correct any inaccuracy. The bores of the column, and also the horizontal part of the column head, should be left  $\pm$  or  $\pm$  thou undersize for lapping or honing to an exact fit. Many garages have honing equipment for bores of about this size.

There is a discrepancy between the column of the machine shown in the photographs and the column in the detail drawing. The machine has a single clamping bolt at the top while the drawing shows two; the obvious reason for the alteration is to improve the security of clamping by distributing the grip over a greater length of the tube. So far, I have had no trouble with the clamp in any operations; but extra precautions against it are well worth while.

The spigot of the column does not necessarily have to fit closely in the hole in the base, as the broad flange gives adequate stability, but if the hole can be machined without difficulty it may as well be a good fit. Its object is to increase the length of column bore available for the guidance of the tube. This is especially useful if the machine is to be mounted on a pedestal or bench with a clearance hole to allow of a longer column tube for height extension. For some kinds of work, such as deep drilling of large components, such an extension may become almost a necessity.

Our conventional form of slide assembly consists of a baseplate or bolster, a cross-slide, and a longitudinal sliding table. The machining of these parts, and particularly of the sliding surfaces, calls for equipment which is not normally found in the home workshop, though some model engineer-



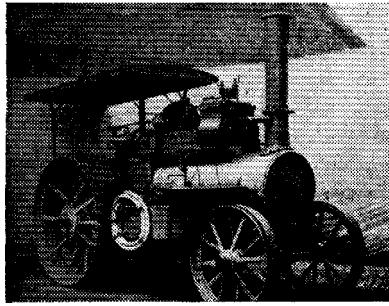
The bolster should first be machined flat on the underside, to bed down on the bedplate, where it is secured by eight Allen screws with sunk heads. You may relieve the centre part of the surface to simplify the fitting, but as the thickness is limited I have thought it better to provide a bearing over the whole surface. On the top side are machined the

normal dovetail slide-ways, with sides at 60 or 55 degrees (both common in the workshop). The working surfaces *W* make contact with their mating counterpart; those marked *C* should have a definite but not necessarily large clearance when they are fitted. This applies to all the sliding parts. Although there is no apparent need to machine the end faces

and edges of the bolster, it is best to do so, for neatness and for the checking of squareness.

The cross-slide has slide-ways on top and underside. They must be exactly square with each other, besides being parallel in thickness. Clearance is allowed in the slide-way for a 1/8 in. gib strip on

*Continued on page 336*



# Indicator diagrams are rarely seen

By Ronald H. Clark

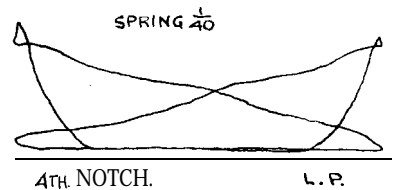
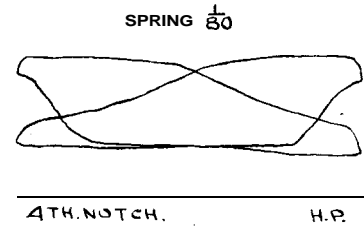


Fig. 10: Indicator diagrams from a 7 n.h.p. compound road locomotive

A CLAYTON boiler was straightforward. The  $\frac{7}{8}$  in. hornplates were extended and braced across at the top by plates of the same thickness, to form a very strong and inflexible box which housed the bearings for the first two shafts. No roof girders are used, the inner and outer crown sheets being tied together by the  $24\text{-}\frac{1}{2}$  in. roof stays. Note the rather high fire-hole and the ample water spaces.

Fig. 9 shows the 5 n.h.p. traction boiler; the dimensions of the other sizes in the range will be proportionate.

Apparently few indicator diagrams were made regularly by companies. A set from a Clayton compound with slide valves and Stephenson gear has come into my possession (Fig. 10). Unfortunately the speed in r.p.m. is not recorded and so it was not possible to calculate the i.h.p. The reversing lever was in the 4th notch. For the h.p. the springs were 80 lb. and for the l.p. 40.

For many years Marshall, Sons and Co. Ltd have handled the Clayton spare parts business and kept the books and drawings. I am indebted to Major H. D. Marshall for putting these records at my disposal. 8

## HACKFLY . . .

*Continued from page 335*

finger to push it through the cylinder. If the fit is not good, wear will cause water to pass the piston, taking the packing with it and creating an everlasting nuisance.

We make the operating handle of steel cut from  $\frac{1}{2}$  in. X  $\frac{5}{16}$  in. bar. All the profile is on one side of the bar for convenience. The axis hole is reamed  $\frac{3}{8}$  in. dia. The lower end is forked to take the  $\frac{1}{4}$  in. X  $\frac{1}{2}$  in. connecting rod, and has a hole a driving fit for a pin  $\frac{1}{8}$  in. dia. Both holes in the connecting rod are drilled No 30 (0.1285).

The cylinder bore is reamed straight through, and a thread 32 t.p.i. and  $\frac{1}{8}$  in. deep is put in the front end for a plug. When all the other machining is done and the piston fit established, the plug can be sweated into position. This gives us a starting point for positioning the stroke of the pump. When the lower part for the operating handle is forward against the metal of the body, and the connecting rod and piston are assembled, there should be not more than  $\frac{1}{8}$  in. clearance between it and the screwed plug in the bore.

The drawing for the footplate (Fig. 9) shows the openings to receive the pump. Couple it with Fig. 29 to be sure of a good register, and a good fixing by the two 2 BA  $\frac{1}{4}$  in. hexagon screws, with as much of the thread in the pump as possible.

*To be continued*

## LIGHT VERTICAL MILLING MACHINE . . .

*Continued from page 320*

the right-hand side, looking from the operating end. The strip is simply a piece of  $\frac{1}{8}$  in. X  $\frac{1}{2}$  in. flat mild steel, with the edges machined or filed to the angle of the dovetail, and running the full length of the slide, 7 in. A similar strip, 14 in. long, is fitted to the slide of the milling table. These strips are not shown in the detail drawings, but can be seen in the general views.

All machined surfaces of the milling table, including the underside slide-ways, top and edges, should be truly parallel and square with each other. The T-slots for securing fittings to the table should also be parallel to the line of traverse; while they can be eased out in the casting, it is unlikely that they will be true and smooth enough to avoid the need for any after-treatment, and generally it will be found just as easy to machine them from the solid. This is best done by milling, with a side or end mill for the narrow channel and a special cutter for the wide base. If we machine the slots on the machine itself after assembly we must improvise to obtain the full length of traverse, and the process is slow compared with the use of a larger and more powerful milling machine.

*To be continued*