Light vertical MILLING MACHINE

# THIS ROTARY TABLE IS SIMPLE AND EFFICIENT

***It compares well, says Edgar T. Westbury, with more elaborate** fixtures **of similar size***

***Continued** from **August z***

IN machining the baseplate for the rotary table, you must be sure that the top and bottom surfaces are exactly parallel with each other. You should machine the underside first, by holding the casting in the four-jaw chuck. A 6 in. chuck with the jaws reversed will hold it comfortably, and it will swing clear over the bed of a 3 1/2 in. lathe. Only a facing operation is needed, as the inside does not have to be machined, except for the inturned edge of the table seating, which can more conveniently be done later.

If you clamp the casting to the faceplate for machining the top side, its parallel accuracy will be certain provided that the faceplate runs truly. It is set up central with the hole for the table seating, and the hole can be bored at the same setting as the facing operation. To avoid the need for re-setting the casting for facing the underside rim of the seating, you may use an internal recessing tool. The depth of the seating bore is 7/16 in. as shown, and all machined surfaces should be finished as smooth and true as possible. The holes for the holding-down bolts, and the two smaller holes in the top surface, are drilled and spot-faced, the smaller ones from the underside, and a tangential hole is drilled to take the eyebolt which anchors the tension spring. Two further holes will need to be drilled in the underside, preferably at a later stage.

The table casting has to be machined all over. All the surfaces must be true with each other. You should begin by chucking the casting top face outwards, for roughing this surface and the outer edge, to within about 1/32 in. of the finished size. The remaining part, including the stalk or pilot, the bearing surface, underside rim and recess, and the centre hole, can then be machined in the reverse position, after the table has been set up as truly as possible by reference to the edge and upper face.

I should explain that the primary object of the centre hole in the table is to serve as a location for centring work which is mounted on the table for milling. A gauge pin may be fitted to the hole, and radial measurements taken from it as required, or it may be used to locate a spigot on a chuck backplate or similar fixture. For some purposes, a much larger register may be required; but where small workpieces have to be dealt with, it is often inconvenient to bore out the centre of the table to any great extent. Sometimes a recess is provided, fitted with a disc which can be knocked out from the back when it is not needed. To ensure the flush fitting of the replaced disc is, however, rather difficult.

Whatever method of centre location is employed, the concentric truth of the hole is extremely important. It should be used as a location point for setting up in further machining operations. A truly centred mandrel, fitted to the hole, may be used to check accuracy in finishing the top surface and edge of the table. A number of concentric circles, at a uniform distance apart, should be incised on the face of the table with a point tool, as a further aid to setting up work on it.

If you have a suitable milling appliance, you can use the lathe to machine the three T-slots in the table. With the spindle set at centre level, the centre channel is end-milled to full width and depth, and followed up with the T-slot cutter. As the cutter must complete its work at one pass, it has to be very rigidly mounted, and fed in radially with due caution. Cutters of this type have a tendency to work endwise if they are mounted in a collet chuck or taper socket, unless you provide some means to prevent it. Home-made cutters, with the sides of the teeth undercut, but not backed off to form cutting edges, are less liable to this fault than the more efficient ready-made ones. The T-slots stop short of the table centre, as shown, unless a register disc is fitted as I have described.

Graduations on the edge of the table are desirable, if not absolutely essential. It is not really difficult to mark them with the aid of a simple indexing gear on the lathe mandrel; the most convenient arrangement is a worm-geared attachment with a ratio of 60 : and a division plate with a multiple of 6. If only *direct* indexing is practicable, a smaller number of divisions, with the index on the wormshaft of the rotary table, may be sufficient.

Another possible method is to attach a graduated strip to the edge of the table. When I looked for ready-made strips of the correct circumferential length, etched or engraved in 360 divisions, I was told that they could be supplied in not fewer than 100 lots. If a strip of this kind is used, the edge of the table must be machined to a diameter which just allows the ends of the strip (cut exactly to the 360 mark) to butt together.

The top face of the table may be hand-scraped to check with a precision surface plate, though this is not absolutely necessary for a utility fixture. You can locate the tapped holes in the underside of the register from the clearance holes in the worm gear. As the end-location dimensions of the table are between the underside rim face and the top face of the worm gear, the depth of the register should be such that it comes exactly flush with the bottom edge of the seating when it is fitted. To correct errors, or compensate for wear, you could re-machine the work, or fit shims between the faces of the worm wheel and the register.

If the wormshaft bracket is made from a casting as I recommended, the major operation on it is the boring of the hole for the shaft and the facing of the end flange, which can be done at one setting in the four-jaw chuck. You may have a little difficulty in drilling the two dimensions of the hole in exact alignment : the use of a 5/16 in. piloted D-bit, after drilling and reaming the 3/8 in. portion, will ensure accuracy. The flat top and bottom surfaces of the bracket should not need machining if they are reasonably true, but the inner end of the 3/8 in. bore should be spot-faced or otherwise machined to form an end-locating seating for the boss of the worm.

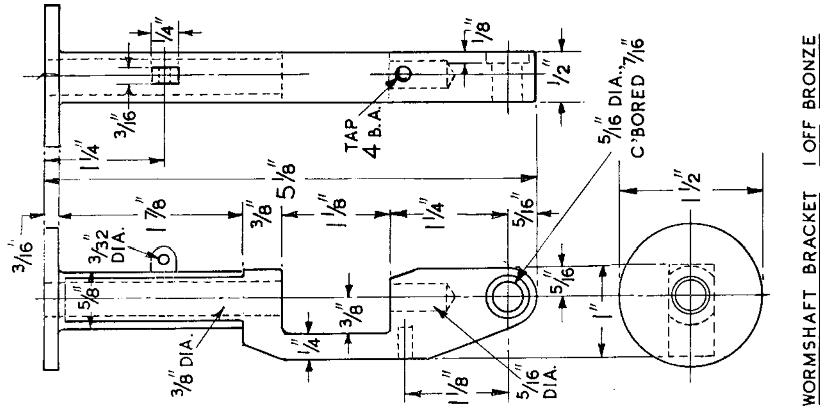
If a small lug for the attachment of the tension spring is not provided on the casting, it will need to be fitted on the side of the bracket; it may be made in the form of a screw eye and fitted to a tapped hole, about 3/16 in. or 2 BA. The hole for the pivot screw is drilled and reamed in the end of the bracket, and counterbored to fit the head of the screw, as shown, on the side which will be underneath when the bracket is assembled in the bedplate recess.

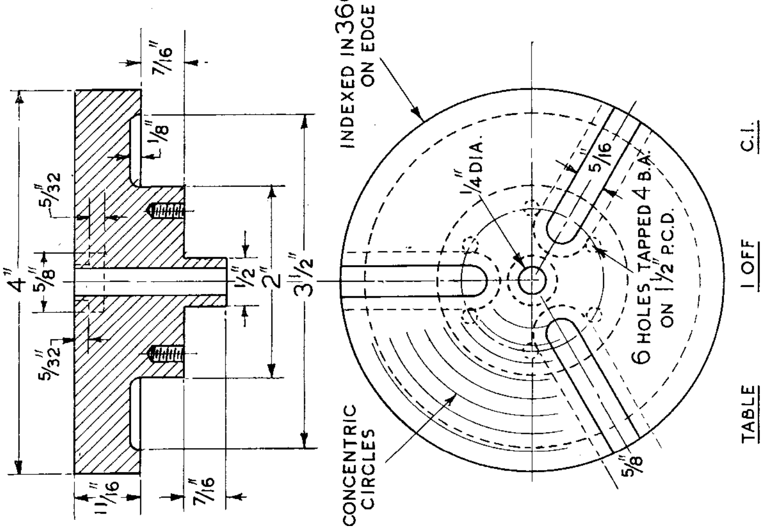
The only suitable ready-made worm wheel which I have been able to find is one supplied by Bond's o'Euston Road, and listed as Part No 7/35 in their catalogue; it has 60 teeth, of a pitch equivalent to 20 d.p. Normally, the gear is supplied as a pair, the steel worm being integral with its shaft, but unfortunately it is not practicable to use this unless an entirely different form of wormshaft bracket is employed. It is comparatively simple, however, to machine a separate worm by screwcutting methods.

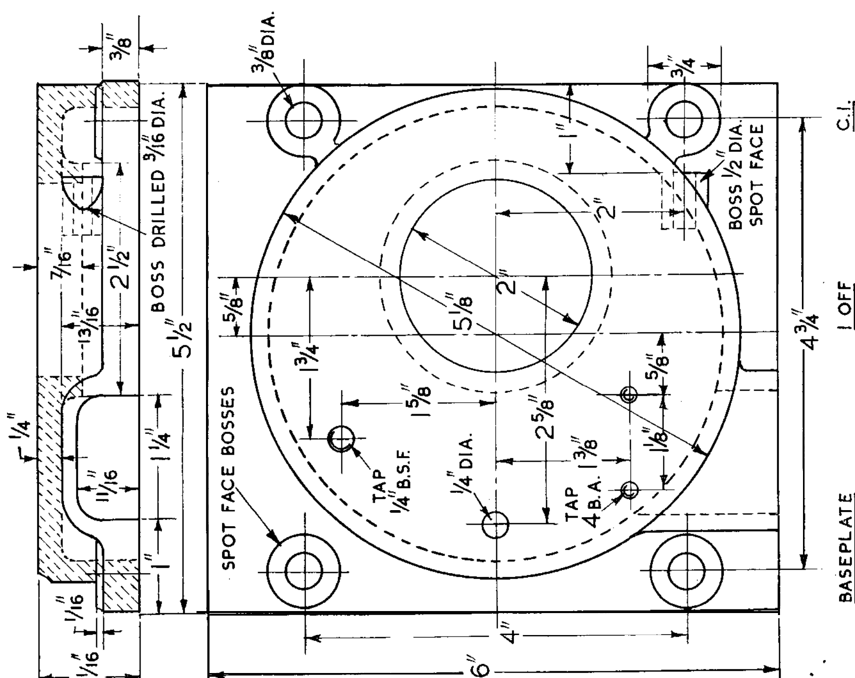
Another way is to cut off the shaft ends of the standard worm and set the worm up truly for boring and reaming the centre. It should be a tight fit on the shaft, though not so tight as to involve a major problem should it have to be removed later, and it should be taper-pinned or grub-screwed securely.

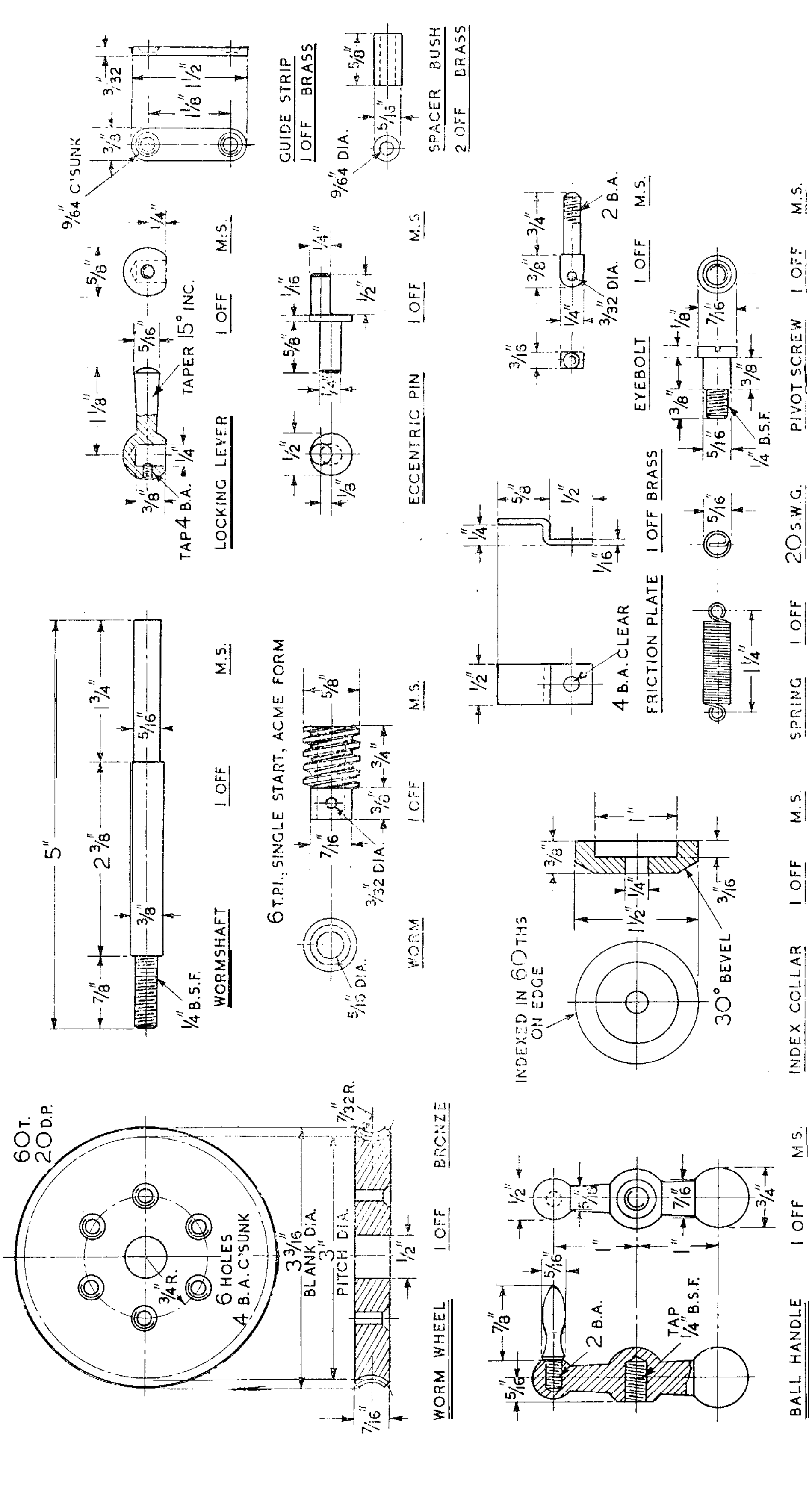
Needless to say, the worm must run truly if accurate indexing movement is to be obtained. The end of the wormshaft is screwed for attachment of the index collar and ball handle, and also to provide for end play adjustment, so that the worm just works freely without backlash.

The ready-made worm wheel is true in the bore and on the faces, so that no machining is required. It should be a wringing fit on the pilot of the table, for concentricity, and the fixing screws should have ample clearance so that they do not impose






any stresses. One of the objects of mounting the wheel in this way is to prevent any tendency for it to be forced out of truth; this is not easy to achieve with the more common methods of hub mounting.

If a worm wheel must be made, the teeth may be gashed with an involute cutter of appropriate d.p. and size number to about two-thirds of their full depth, before the hobbing. The most accurate indexing of the teeth is essential, as the worm wheel itself is required to serve as an indexing device. Correct tooth form on a worm wheel can be produced only by a hob which is to all intents and purposes a replica, in both pitch and diameter, of the worm with which it will engage. But for our purpose, the worm wheel does not have to be throated-to have concave teeth which partly embrace the worm-though this gives the maximum area of tooth contact, and therefore a long working life. Worm wheels for indexing often have a flat crown, with the teeth cut to full depth only in the centre, or spiral-hobbed parallel to the axis like a skew gear.

Worm and wheel in the original table are of fine pitch. The ratio is 120 : 1. The wheel was produced by a positively-driven hobbing attachment originally made for the steep-angle gearing of the locomotive r831, described many years ago. A coarser table movement might be considered a retrogression; but apart from the difficulty of obtaining a pair giving a ratio finer than 60 : 1, the more robust gearing will give fine enough adjustment for all normal purposes. and is less tedious to manipulate when it is used for milling circular or accurate work-pieces. The torque load on the gearing always tends to throw the worm out of mesh, whether the teeth are coarse or fine, but the coarse are likely to be better in resisting wear or shock. A 60 : 1 gear, of course, gives six degrees of table movement for each revolution of the worm; a convenient alternative would be 72 : 1 ratio, giving five degrees per revolution.

With the gearing specified, and an index collar graduated in 6oths, increments of one-tenth of a degree can be directly read against a fixed mark on the flange of the bracket. Finer adjustments could be read with a vernier scale on the flange if desired, but to be of reliable accuracy

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and construction of workshop tools and equipment; readers' descriptions of their own workshops (once a regular feature) and articles on prize-winning models with the descriptions of the methods used and the ways of reproducing details-more particularly on the locomotive side as the ship modellers have just had a wonderful serial by Oliver Smith on the *Cranborne.*

Stockport,
Cheshire.

D. BOOTH.

## Sir Douglas

SIR,--The name of the Denby Dale Fowler engine No 15732 is St ***Douglas.*** The engine was formerly owned by M. Young of Lancaster. It began life as a roller of 5 n.h.p. Its smart conversion to a traction may account for the Aveling front wheels.

Whitby,
Yorkshire.

l?. CALVERT.

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they would call for extremely high precision of all working parts. A vernier scale on the top surface of the baseplate, to read against the graduated table edge, would be of more practical use, being unaffected by gearing errors.

A ball handle and index of the kind specified for the feed screws of the milling machine may be fitted to the worm-shaft, but a much simpler arrangement is quite adequate, as the index need not be shifted once its position has been set. The fitting shown is similar to the one commonly employed for the indices of lathe feed screws. A plain nut is screwed on to the end of the wormshaft and adjusted to take up end-play. While a standard nut, if accurately machined on both faces, may be suitable, it is better to make a larger nut, fitting the thread rather stiffly, in this position. The index collar is then put in place, preferably with a shakeproof or other thin locking washer in the recess, and the ball handle is screwed on and locked tightly against it. All this can be done before the wormshaft bracket has been assembled in the baseplate.

Methods of shaping ball handles were described earlier. Those who do not wish to undertake this work can get ready-made ball handles as lathe spares. If preferred, a handwheel incorporating a larger diameter index, or other form of handle, may be fitted.

The locking and disengaging of the worm gear is controlled by an eccentric pin and lever, both machined from mild steel. To make the pin, a piece of 1/2 in. dia. bar long enough to provide chucking grip is faced on the end, and marked out 1/8 in. off centre. After being offset to this extent, either in the four-jaw chuck or on a V angle plate, it is turned to 1/4 in. dia. for a length of 1/2 in. You can then turn the concentric part by holding the spare length of bar in the three-jaw chuck, before parting off at the required length.

A piece of 5/8 in. bar is used for the lever. Turn the ball end roughly to shape and finish it with a hand tool, using a 5/16 in.radius gauge for guidance in producing the correct form. The tapped hole in the, end should not be drilled at this stage, but it may be started with a small centre-drill to provide concentric location. Then the taper shank can be turned to size and parted off; you can round it off on the end by holding the ball end in the chuck. To drill and face the ball at right angles, it may be held crosswise in the four-jaw chuck, with its axis parallel to the chuck face or, if anything, set slightly inwards at the shank end. The blind hole cannot be reamed, though a D-bit could be used to produce a true parallel hole, a good fit for the top end of the eccentric pin. After the pin has been fitted through the hole in the baseplate, and the lever has been placed in position, eliminating end play, it is secured by a 4 BA grub screw with its point sunk well into it.

To provide positive disengagement of the gearing, through the action of the eccentric pin, you can slot the bracket to take the pin, but the arrangement shown, besides being simpler, applies frictional pressure to the pin, preventing inadvertent movement in either the engaged or disengaged position. The friction plate is simply bent to shape, with a slight inward set, from 1/2 in. X 1/16 in. brass strip. It is held in place by a single 4 BA screw, or two 6 BA screws if you prefer.

The tension spring which normally holds the worm gear in mesh is anchored by a small eyebolt in the baseplate, with a nut on the outside to provide some degree of tension control. For circular traversing of the table, the spring should be strong enough to keep the gearing in mesh, but the locking lever provides more positive control, and when the eccentric pin is near its inward position its cam action locks the worm and wheel to prevent any movement of the table. In the outward position, the pin, acting on the friction plate, withdraws the worm entirely out of mesh, and allows free movement of the table to any position.

When the pivot of the wormshaft bracket is fitted, a collar or thick washer will need to be interposed at its shouldered end, to centralise the shaft axis horizontally with the throat of the worm gear. Some adjustment of the thickness of the collar may be necessary, as the baseplate is not machined inside except for spot facing the holes. The bracket also rests on the guide strip which together with its two spacer bushes, forms a bridge and allows enough swing movement of the bracket for engagement control. As the length of the bushes, and possibly the location of the strip, may vary, the tapping holes for the fixing screws in the baseplate should not be drilled until these parts are ready for fitting.

This rotary table, though relatively simple in construction, is capable of dealing with all operations within its capacity just as efficiently as much more elaborate and expensive fixtures of comparable size. Though designed primarily for use on the light vertical milling machine, it is adaptable to nearly all orthodox milling machines, and certain other machine tools as well. So far as the lathe is concerned, limitations of height between the cross-slide and centres makes it difficult for any form of geared rotary table of reasonable size to be used in the normal horizontal position. But it could be fitted to a large angle bracket, in a vertical position, and employed to cope with many problems in rotary profiling and slotting, offset drilling, and angular spacing of holes.

***To be continued***