

# This home-made 3-1/2in. lathe has

first of four articles by GEORGE B. ROUND,  
in which he gives an account of the construction of a basic piece of machinery

## novel features

**T**HE machine to be described is not put forward as an "ideal" lathe, but as an example of a plain lathe of simple and straightforward construction to which additions can be made as time, fancy, or necessity dictates. The lathe came into being through the acquisition of a set of Stuart No 10 engine castings and the realisation that I had no means of machining.

Certain limited facilities became available, and it was decided to make up a simple lathe rather than deal with the engine castings, as this would leave me with a lathe after the engine was finished. As things turned out, this was a wise decision, the facilities for machining ending much sooner than was expected.

Only a plain lathe was needed and something on the lines of Maudslay's triangular bar bed was favoured, a type I had always wanted to try out. I dislike anything that looks obviously home-made, however good its performance may be. As castings were out of the question for a variety of reasons, commercially obtainable sections, plus the junk heap had, to provide the materials for construction. They required careful selection to ensure that appearance did not suffer. It was decided to keep costs down to the minimum, and in fact, the only items purchased specially for the machine itself, were Allen-type screws and the mandrel ball-thrust bearing.

### Design of the bed

The first item to be considered was the bed, and the proposed design was quickly modified for triangular section bar is not readily obtainable, nor particularly easy to machine from round bar. The use of two round bars was then considered but rejected in favour of a square bar bed as approximating more to the original idea. No square bar over 1 in. being to hand, the idea of arc-welding two mild steel angles to form a square tube was quite sound, and 2 in. x 2 in. x 3/8 in. thick angle was made the basis of the design.

The lathe itself is 3-1/2 in. centre height, taking about 13 in. between

centres, with a bed 27-1/2 in. long, the extreme overall length being 2 ft 11 in. and the overall width 15 in. It is fitted with a form of back gearing together with a worm drive to mandrel, is screwcutting and has a back-shaft drive for power traverse. Fig. 1 shows the general arrangement and end view, and collectively these show the main features of the machine, which started as a plain lathe and has gradually acquired considerable elaboration.

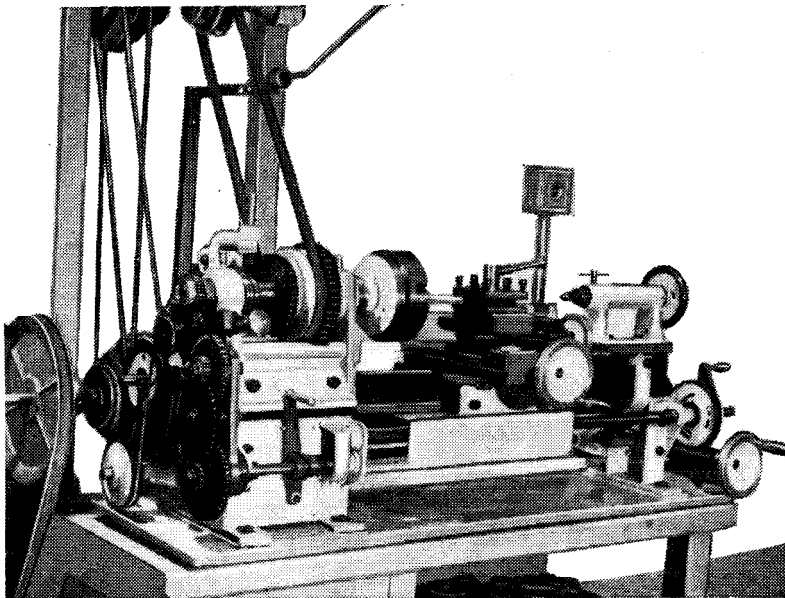
To return to the bed, trouble was encountered straight away. The maximum traverse of the milling machine was only about 20 in., and this was not nearly long enough. A large diameter plate was fixed to the milling spindle with a single inserted fly cutter, and with this a length of 27-1/2 in. could be machined. This had to suffice although I would have preferred a few more inches of bed.

No attempt was made to machine the sides of the bed to a definite dimension, care only being taken to clean off all rough scale and to get

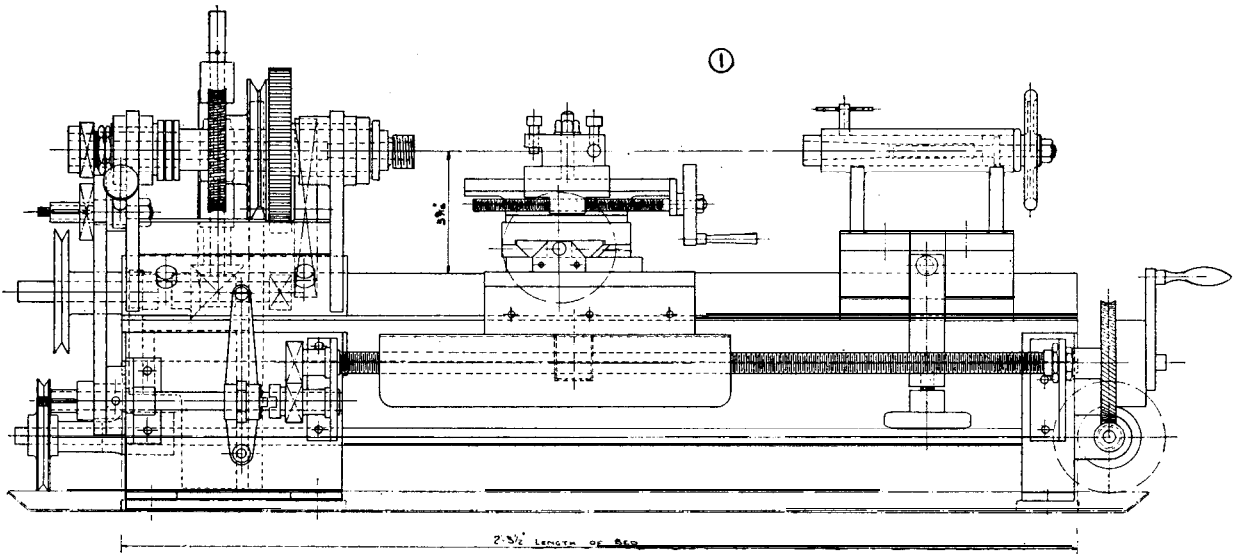
true parallel surfaces. The four corners were machined to clean up the welds and to remove sharp edges. Beyond drilling and tapping eight holes, this finished the bed, the fly cutter leaving the faces very smooth and requiring little hand work. The actual finished section of the bed is shown in Fig. 2.

The headstock was the next consideration. It was fabricated by arc welding mainly from angle and plate, and is shown in Fig. 3. It was formed from two 3/8 in. thick plates cut to a V at the bottom to fit over a 6-1/2 in. length of 2-1/2 in. angle with two smaller angles between to act as stiffeners.

The bosses were formed of slices of 2 in. dia. b.d.m.s. bar, the whole being welded up into a strong and rigid unit. Holes 3/8 in. dia. were drilled through the centres of the bosses and at appropriate places in the plates and bolted together for location in weldline. Thicker plate would have been used but it was not available and 3/8 in. has proved to be amply rigid in use.



General view of the 3-1/2 in. lathe to be described in these articles



The milling machine was fitted with a universal vertical milling attachment. This was really accurate so that the headstock was completely machined in only two settings, first, set upside down to machine out the underside, using the vertical attachment set alternately 45 deg. each side of the centre. Without disturbing the setting, a vertical and horizontal datum surface was machined on each side of the V, as shown in section x-x, Fig. 3.

This was used for locating squarely on the table in the second set-up, using the milling machine as a boring machine, to bore and face the housings for the bushes parallel with the V-base, as with this form of bed any angular adjustment of the headstock for lining up is virtually non-existent. The accuracy achieved with these set-ups fully justified the trouble taken.

It will be seen from Fig. 4 that the mandrel front bearing is of substantial dimensions, 1-1/4 in. dia. x

2-1/4 in. long, the back bearing being 1 in. dia. x 1-5/16 in. long; the latter would have been made longer had material been available. If it becomes necessary to fit a replacement, it will be made 1-3/4 in. long, the mandrel being turned down to suit.

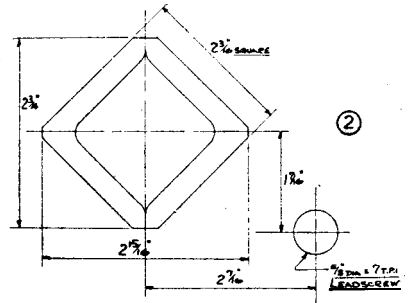
#### Bearing bushes

The gunmetal bearing bushes are solid and without a means of adjustment. This may cause some lifting of eyebrows, but in my experience with lathes of various makes and sizes, only two were entirely free from chatter and they were the only two fitted with solid bushes. Admittedly, both had taper front bearings for endwise adjustment, but a Pratt and Whitney 4 in. had a parallel rear bearing, and the other, a 5 in. Pittler, was, I think, tapered though I never removed the mandrel and so cannot be certain.

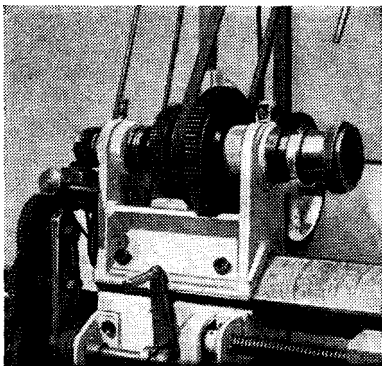
However, the parallel bushes fitted in my lathe show no signs of play after nearly seven years of use. The

rear bush was fitted with the flange between the housings to form a shoulder for the thrust bearing to bed against. The front bush was flanged only for appearance.

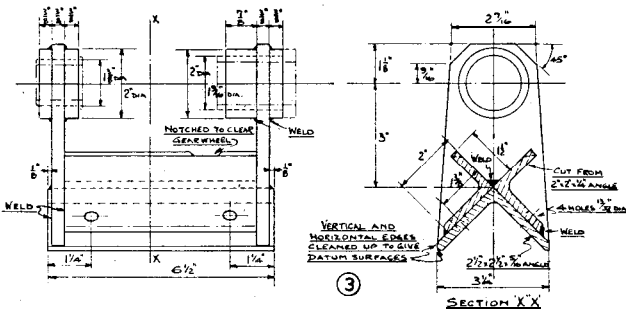
Bright mild steel bar was used for the mandrel and it was intended to make the nose suitable for Myford backplates and to take No 2 Morse taper drills and centres, hence the



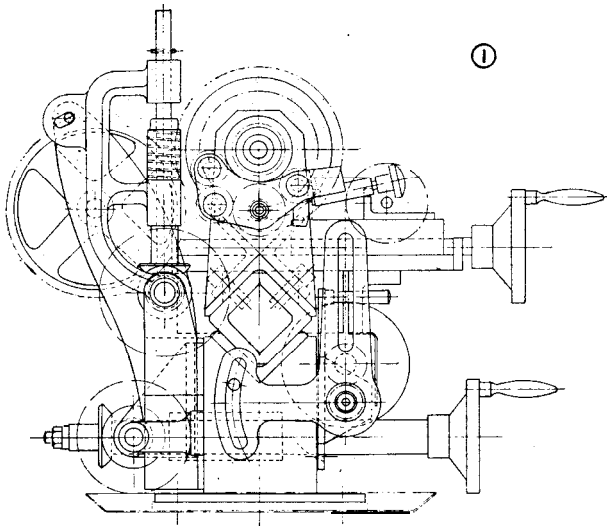
SECTION OF BED



Headstock in close-up. Angle and plate were the main items used in fabrication



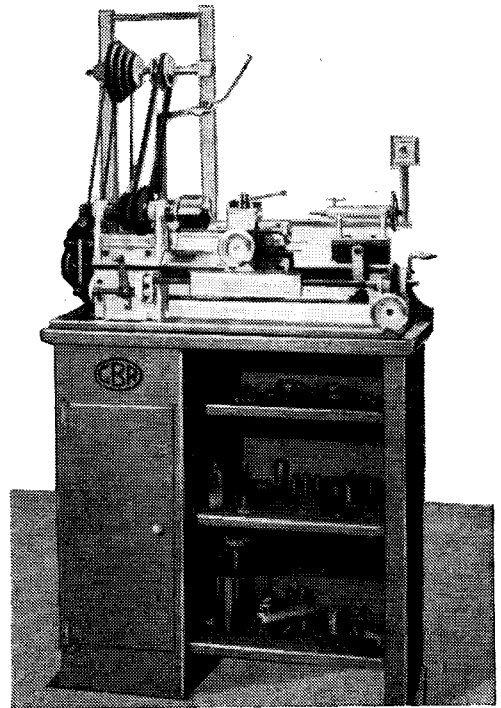
FAST HEAD STOCK



17/32 in. dia. hole through the body of the mandrel. This was hurriedly altered to 1 in. Whit. to use commercial hex. nuts welded to steel discs as chuck backplates, which also meant a change to No 1 Morse for the taper. But 1 in. nuts are easily obtained whereas specially threaded backplates are not, except at a price. A 1 in. roller thrust bearing of cheap manufacture was used to take care of thrust from drilling, etc., and a plastic washer for the opposite thrust.

I was presented with some difficulty in getting material for the bed section of the tailstock. Eventually a cast iron firebar was located which machined up into a nice rectangular bar 1-1/4 in. x 1-15/16 in. x some 27 in. long. A piece 5 in. long was milled out to fit the bed and a tailstock body welded up from mild steel tube and flat section bar. The tube was reamed out to 7/8 in. dia. to take a lever-

*Lathe mounted on a metal cabinet with a self-contained countershaft unit*



operated barrel, 7/8 in. dia., this being easier to make up than the screw-operated pattern. It was also more handy for drilling, as the machine would have to do duty as a driller.

The bottom face was machined to suit the headstock centre height when bolted to the cast iron block. Two 5/16 in. hex. head setscrews were used and fitted solely for lining up purposes. I rarely require the tailstock to be set over for taper turning, and the extra refinement of a cross-guide was felt to be unnecessary in a plain lathe. Clamping of the barrel is by a thumbscrew and brass pad on

to the barrel. This is crude but effective, and about the only suitable method in the circumstances.

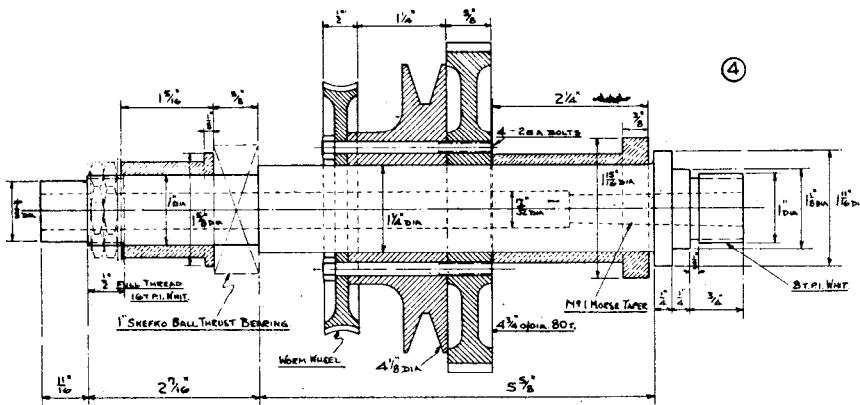
*\* To be continued on November 5*

The Festiniog Railway, Vol. II, by J. I. C. Boyd. *The Oakwood Press, price 30s.*

MR BOYD'S second volume carries the history of the Festiniog Railway from 1889 to the present time. It thus covers the period from the death of Charles Spooner, the dynamic force behind this little railway, the Colonel Stephens era, the post-war slump of 1923-1928, the partial closure of 1939 and the closure of 1946, and finally the re-opening during 1955.

The author has made a lifetime's study of the Festiniog Railway and its associated lines, and this book covers its subject most thoroughly. Appendices are included giving full details of the locomotives, passenger coaches and goods wagons; the track, stations, yards and shops, as well as a chronology from the original Authorisation in 1832.

Excellent produced, and well illustrated with 47 photographs, 28 drawings, maps and plans, this new book will appeal to all who are interested in the fascinating narrow-gauge railways of this country. -R.M.E.



MANDREL AND BUSHES

# 3-1/2 in. SCREWCUTTING LATHE

Continued from 22 October 1959, pages 293 to 295

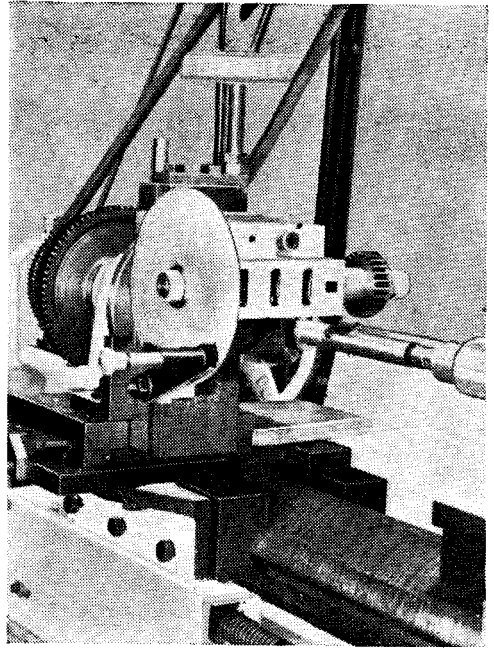
## Constructing a suitable slide-rest, cross-slide and tool block

By G.B. ROUND

**A**t this stage the whole affair was somewhat unwieldy, so two temporary bench legs were made up out of 1-1/2 in. slices of angle welded to bits of 1/4 in. plate. These were bolted to the ends of the bed providing a support while the head and tailstocks were fitted. The headstock was secured by four 3/8 in. Whit. Allen screws and the tailstock by a forked clamp tightened with a 2-1/2 in. dia. black moulded plastic handwheel, as shown in Fig. 5.

Attention was next turned to the question of a suitable slide-rest. After giving much consideration to

*Cutting change gear-wheel using vertical slide and directing attachment*



various schemes to get the longest traverses, it was realised that in the bed itself lay the obvious answer to the problem, for here was the basis of a slide the fulllength of the machine. A V-groove was, therefore, milled in each of two 6 in. lengths of the firebar and bolted to a piece of thick plate surfaced on both sides, with a cut-away to clear the tailstock.

The bolt holes in the front piece were slotted for adjustment and an angle fitted to take the screws for adjusting purposes. Two strips were

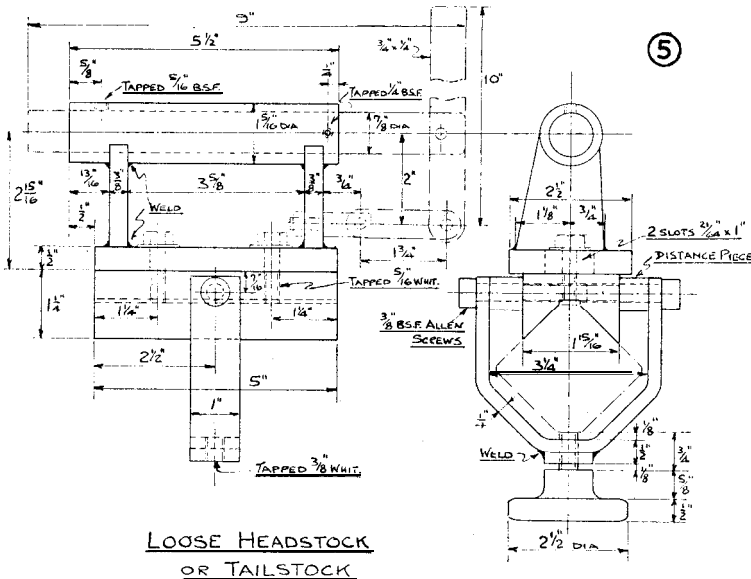
machined and screwed to the top face with 3/16 in. Allen screws and this made an excellent saddle. The arrangement was as shown in Fig. 6 and also in the photograph.

It was at this stage that a most unexpected snag developed, for the firm which had given me machining facilities closed down and I had barely time to finish off the mandrel. However, a cross-slide was made up from a chunk of cast iron and operated by a long 3/8 in. Whit. bolt threaded its full length, giving about 3 in. of cross traverse. A piece of 1/2 in. round bar threaded 1/2 in. Whit. was pressed into service to operate the saddle up and down the bed, both being operated by handwheels salvaged from the junk heap. A tool block was fashioned out of an offcut from the firebar, and a tryout to ascertain what could be anticipated, seemed advisable.

### The drive

This meant that a drive had to be arranged and for this I used an 1/8 h.p. Brook Cub motor together with a 9 in. V-pulley and belt. The 9 in. pulley bore just fitted the end of the mandrel. With the 1-1/2 in. pulley already on the motor, it was felt that it would do to just turn it round and perhaps handle a 1/8 in. drill, and in no time it was connected up and running.

The motor was very large for such a small rating, and as the 1/8 in. drill seemed to have little effect on the motor, a 1/4 in. drill was tried. This too, was well within its stride, so



# SCREWCUTTING LATHE

continued

turning was gingerly attempted with complete success. In this state the lathe was used for a considerable time, machining up the Stuart engine castings with no difficulty, the motor giving ample power to turn the 3 in. dia. flywheel.

One speed was a handicap and eventually a 5 in. dia. pulley was acquired which gave a much faster speed for small drills and turning. But it was awkward to change as it involved moving the motor as well as changing the pulley. So two four-speed pulleys were turned up from mahogany with diameters of 3 in., 4 in., 5 in., and 6 in., arranged in an angle iron frame on two 1/2 in. shafts, one above the other.

The drive from the motor was on to the lower shaft and a single V-belt drive from the upper shaft went to the mandrel, the diameter of the four-

speed pulleys being too large to be fitted between the headstock bearings. Lignum vitae blocks were used for the countershaft bearings and 1/4 in. round leather belt for the cone pulleys. A 4-1/8 in. dia. V-pulley was secured in the normal position on the mandrel with a 5/16 in. Allen grub screw, and an A size V-belt drive from the countershaft completed the arrangement.

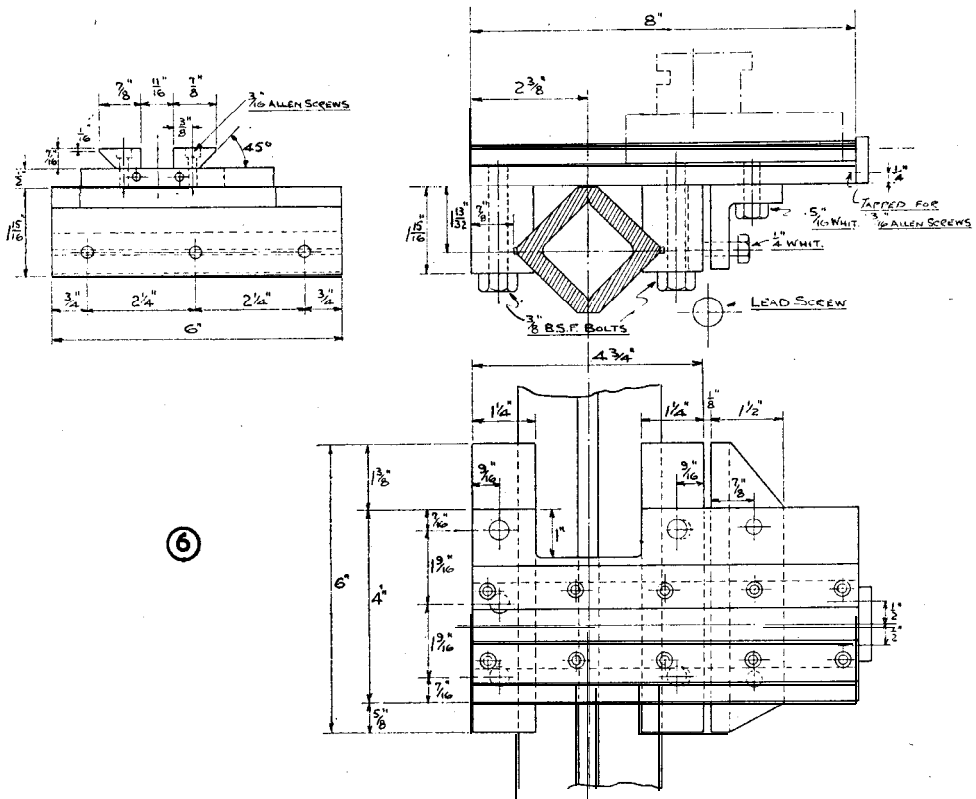
## Square threaded screw

This extra load had little effect on the motor, and it was much more convenient in use. As the end of the mandrel was now free, I had thoughts of making some sort of automatic traverse. At this stage a friend produced a square threaded screw #in. dia. It was too short for a normal leadscrew, too long for the available traverse of the saddle, being screwed for its entire length. Above all, it had seven threads per inch, but it was much better than the 1/2 in. screwed bar I was using, and extended my plans to include screwcutting.

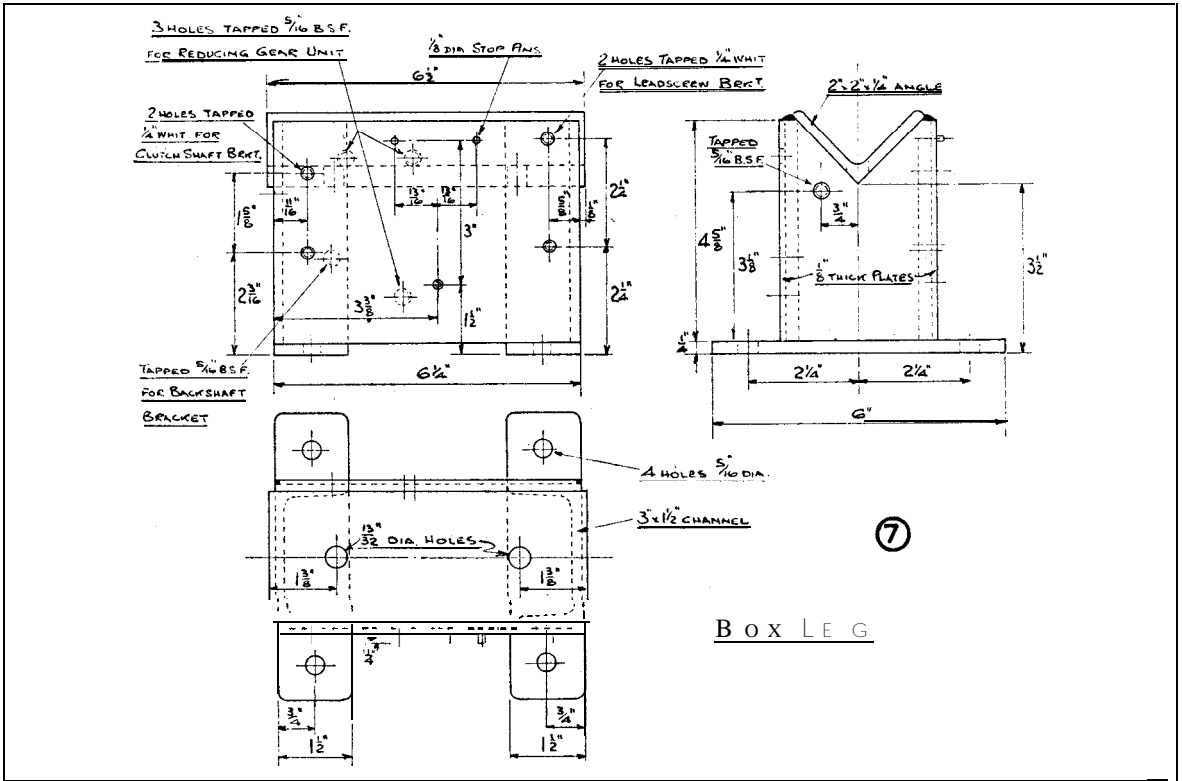
All turning had to be done on the lathe itself and to fit this screw called for careful planning. Once the existing traverse screw was removed the lathe was out of action as far as turning was concerned. Because of this new dwarf legs were first made, the one at the headstock end being of box form, and welded up from angle, channel and flat bar, as shown in Figs 7 and 8.

Next a nut was cast in white metal, as there was no nut with the screw and cutting a nut in the normal way was out of the question. A mould was made by cutting a recess in a block of wood, with holes at each end through which to pass the leadscrew, the recess being twice the required length of nut, and forming an open topped mould. The white metal used was a mixture of all the broken die-cast toys I could find, melted in a tin can on the gas stove and poured into the open mould.

As soon as it was set, the mould was split off and with little trouble, the



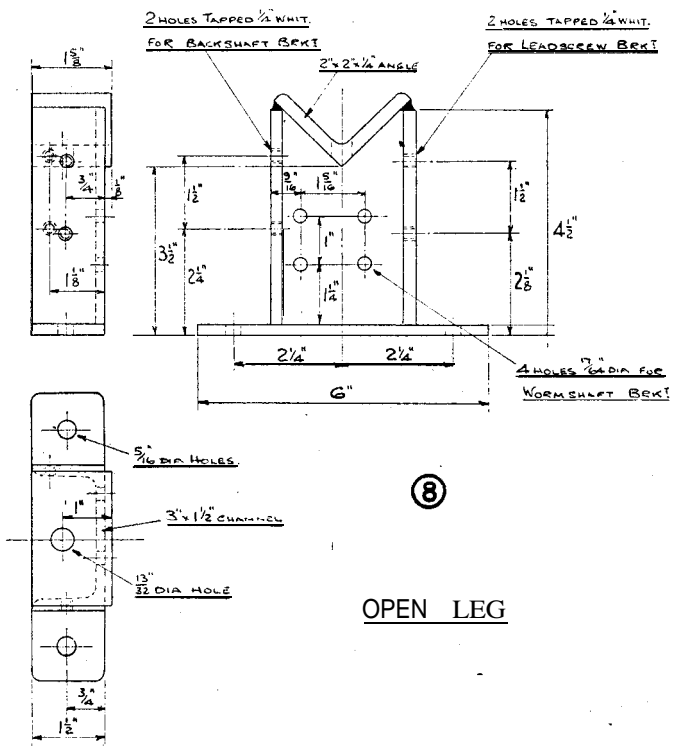
- DETAIL OF SADDLE



BOX LEG

cast nut was screwed off the leadscrew, which had been "smoked" to prevent sticking, and then cut into two, thus providing a spare nut when required. The resulting thread was good, and the metal stands up well to wear, so that it will be a long time before the spare is needed.

\*To be continued on November 19



OPEN LEG

**WORKING DRAWINGS FOR A MARINE BOILER**  
 For the ship modelling enthusiast who is seeking a suitable boiler to power the engine of his tug the Scotch return-tube marine boiler has a lot to recommend it. Being of compact design it fits snugly in the limited length of a vessel such as *Gondia*, which has a length of 42 in., a beam of 10 in. and a draught of 5 in.  
 Working drawings for a Scotch marine boiler are now available. The details are contained on one sheet, price 6s. 6d. including postage, and may be had from the Plans Service, Percival Marshall Ltd., 19-20 Noel Street, London W1. Plans for *Gondia* are also obtainable, price 14s. 6d.

# 3-1/2 in. SCREWCUTTING LATHE

Continued from 5 November 1959, pages 353 to 355

# Fitting a new cross-slide and other units

By G. B. ROUND

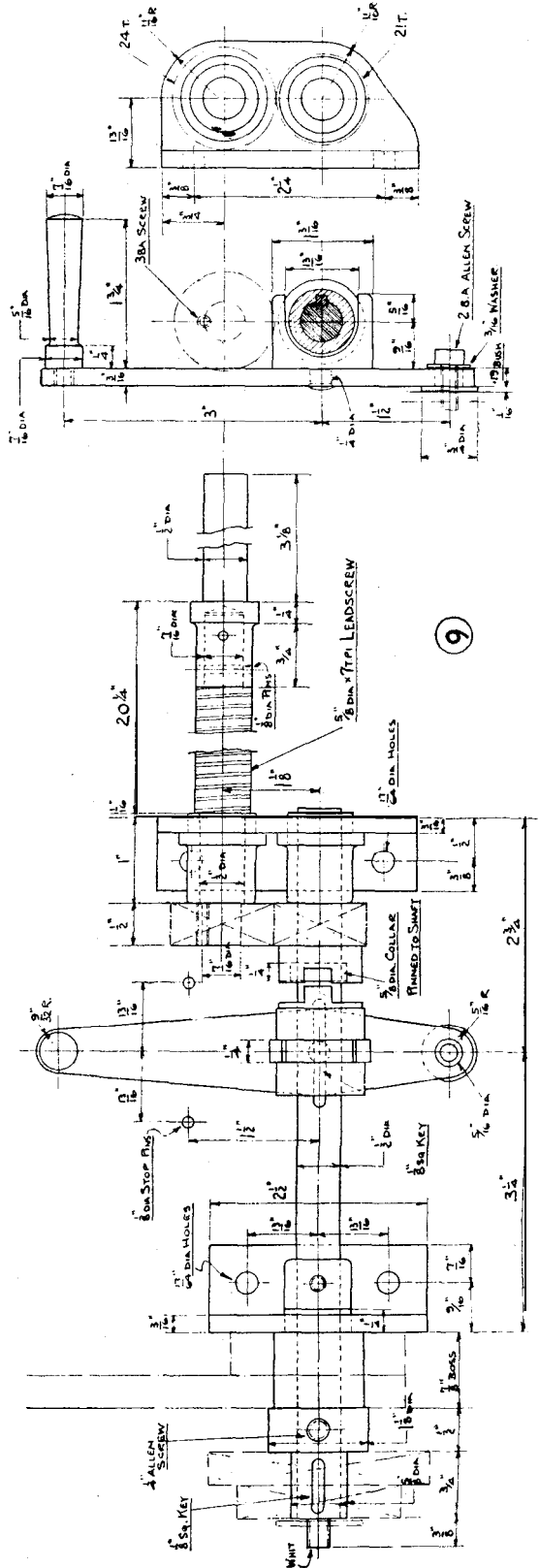
THE leadscrew brackets were made up from mild steel angle. At the tailstock end a steel sleeve made from scrap with a brass bush was used. This was secured with a fine thread locknut, the sleeve being already threaded to suit. For the headstock end bracket, brass bushes forced into suitably sized holes were used.

Two bushes were fitted to enable a reduction gear to be added at a future date, to give the equivalent of an 8 t.p.i. leadscrew for changewheel calculations. It also helped to offset the shortness of the leadscrew and provide room for a clutch instead of the more usual split nut arrangement. This is shown in Fig. 9 which illustrates the final form of leadscrew and clutch.

### Adapting the leadscrew

To adapt the leadscrew, it was necessary to turn down a plain portion at each end. This was done by fitting a brass bush in place of the tailstock barrel and using the tailstock body as a steady while the screw, held in the four-jaw chuck, was being turned down. Both ends were thus treated, the small portion of screw held in the chuck being cut off afterwards. A plain extension piece was then fitted and pegged at the tailstock end. It was left on the long side to take a handwheel and leave room for possible future developments.

The nut was secured to the saddle by means of a cage, bent up from 16-gauge sheet riveted to an angle bracket and attached by a couple of



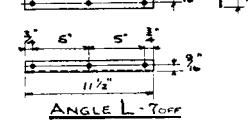
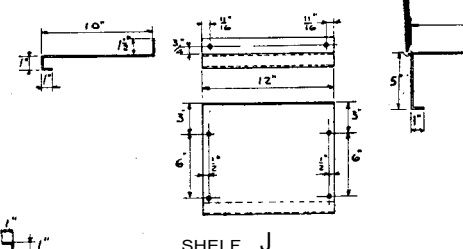
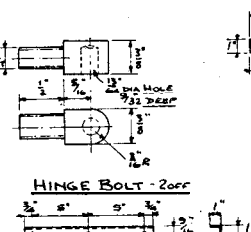
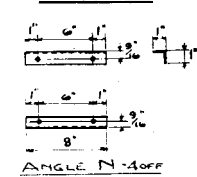
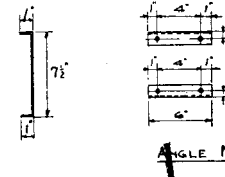
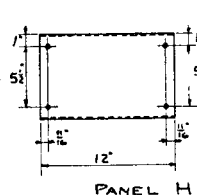
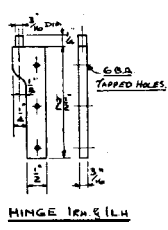
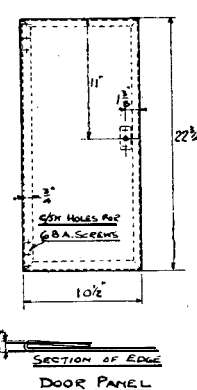
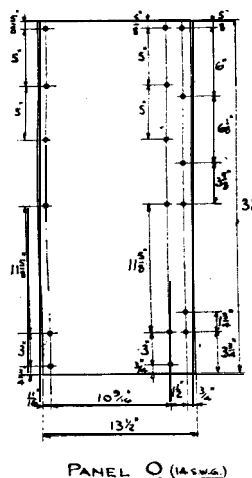
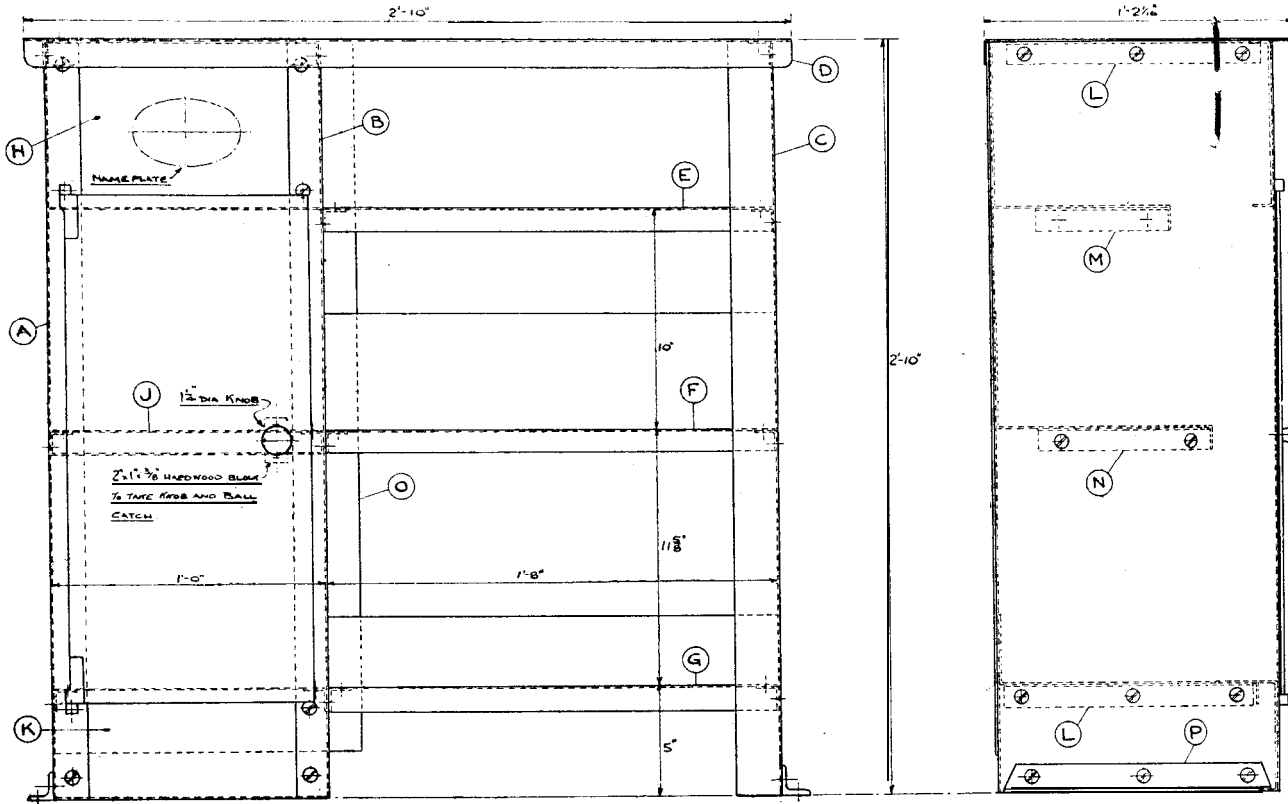
LEADScrew AND CLUTCH

Allen screws. It allows for the nut being readily removed and at the same time restrains it from turning and moving endwise, see Fig. 10. An apron or cover, Fig. 11, was also fitted to keep swarf off the lead screw as far as possible. This was sprung

into place and secured endways by means of a tab, held by two screws at the right-hand end.

A chip tray, Fig. 12, was made and fitted between the lathe and the bench to help retain turnings and keep things tidy.

Being restricted for bench space, it was felt that a separate stand for the lathe would be a valuable asset and as a quantity of 20-gauge galvanised sheet offcuts were to hand, a cabinet stand was designed to suit the sizes available. The arrangement and





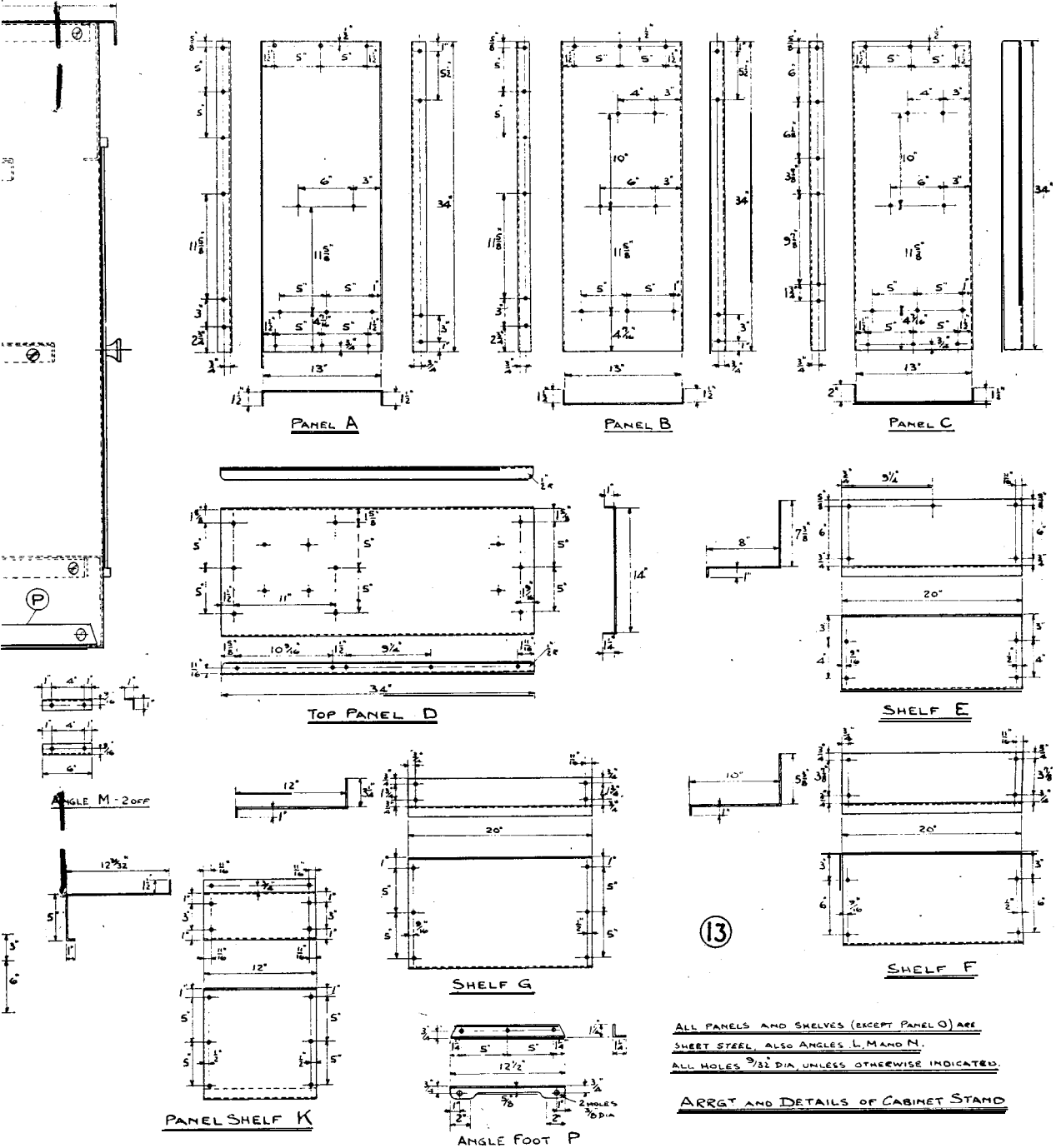
details of this are shown in Fig. 13 and also in the photograph of the complete machine.

With the exception of the 14-gauge backplate and the angle feet, it was constructed throughout from 20-gauge sheet fastened together with 1/4 in.

galvanised gutterbolts. It has proved to be rigid and yet is much lighter than cast or angle iron legs and provides ample storage space for tools and equipment belonging to the machine.

The construction was simple, only

plain bends being used. Although I had the use of a hand-folding machine, all bends can be done between two angles. All pieces were formed, drilled, and finally bolted together. The countershaft angle pillars were bolted to the cupboard sides through



the 14-gauge plate, thus making a solid unit.

The object of the thicker plate for the back of the cupboard was to carry the motor and so form a self-contained unit, but for a number of reasons this has not been done. To give a professional touch a monogram plate was fitted over the cupboard door. It was cut from plywood with two of the plies cut away to leave raised letters and surround. It was in fact a pattern for a casting, used as the casting.

The lathe was mounted with 1/4 in. plywood packings between the feet and chip tray, and also between tray and cabinet top. It has proved very satisfactory, 1/2 in. thick rubber pads being inserted between stand and floor as it is used in an indoor workshop

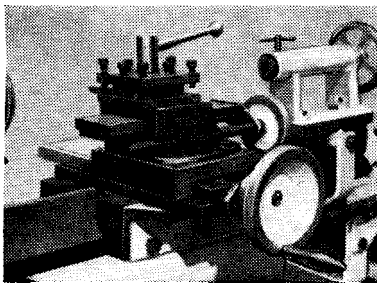
### Changing power units

At this stage I acquired a Leyland Barlow 6 in. power shaper with a traversing head, complete with stand and 1/2 h.p. motor. The first thing to be done was to arrange a drive to the lathe from the shaper motor and so free the lathe motor to work a sensitive drilling machine which had been made up in the meantime from oddments. Up to this time all drilling had been done on the lathe.

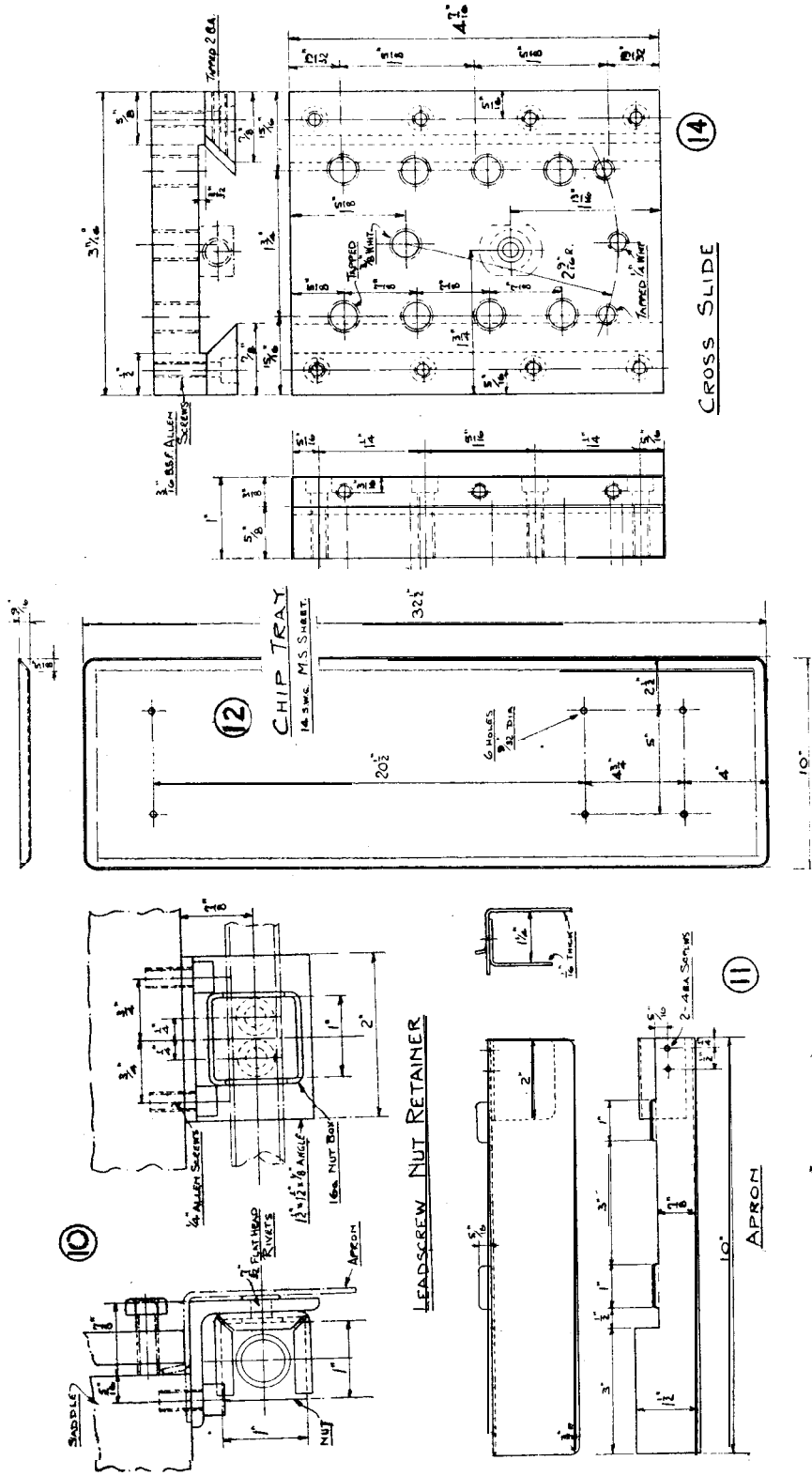
With the advent of the shaper, a new cross-slide was made up in steel, as shown in Fig. 14. It has a number of tapped holes instead of T-slots, and the fitting of a topslide was now essential. I wanted to get ample clearance between the tailstock and topslide handle and also to try out a square guide in place of the usual V-pattern.

As I still had some of the firebar left, a piece was machined as detailed in Fig. 15. The slide pivots on a 3/8 in. Allen screw, which was also used as the main fixing, with an angle-plate attached to the side, and curved slots with setscrews to facilitate setting for taper turning. These are clearly shown in the photograph.

\* To be continued on December 3



Saddle and topslide with four-tool turret. Note topslide screw



# Completing the vertical slide, back gear and change wheels

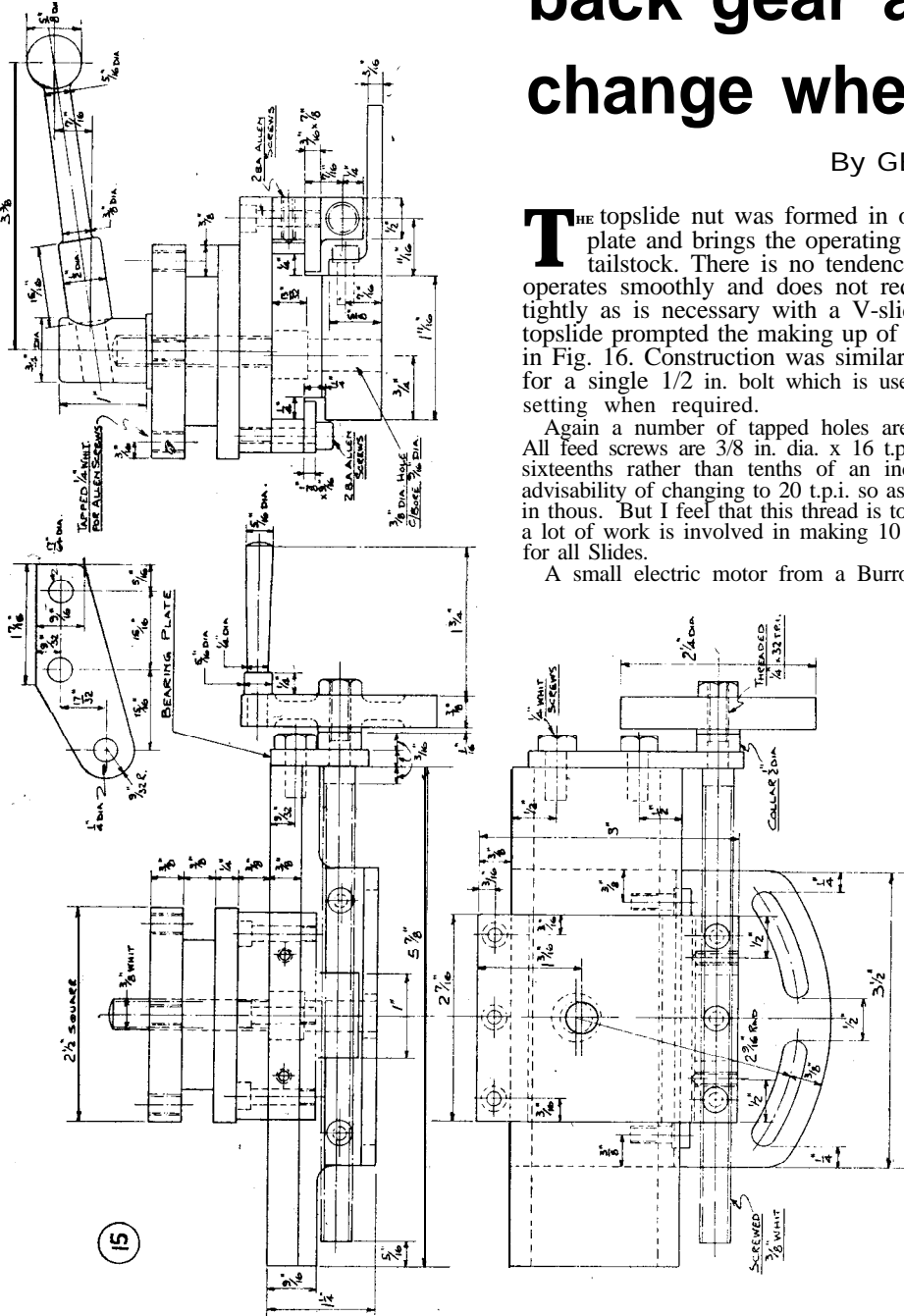
By GEORGE B. ROUND

**T**HE topslide nut was formed in one piece with the keep plate and brings the operating screw well clear of the tailstock. There is no tendency to bind and the slide operates smoothly and does not require to be adjusted as tightly as is necessary with a V-slide. The success of this topslide prompted the making up of the vertical slide shown in Fig. 16. Construction was similar to the topslide, except for a single 1/2 in. bolt which is used to 'allow for angular setting when required.

Again a number of tapped holes are used instead of T-slots. All feed screws are 3/8 in. dia. x 16 t.p.i. as I prefer to work in sixteenths rather than tenths of an inch. I am considering the advisability of changing to 20 t.p.i. so as to fit feed dials graduated in thous. But I feel that this thread is too fine for feedscrews, and a lot of work is involved in making 10 t.p.i. square-thread screws for all Slides.

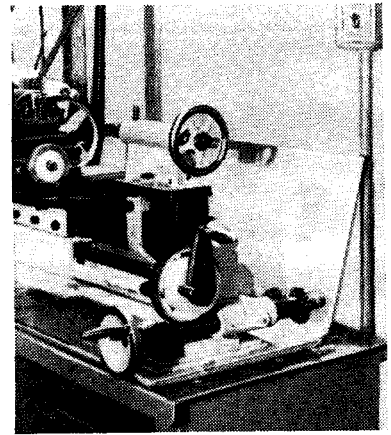
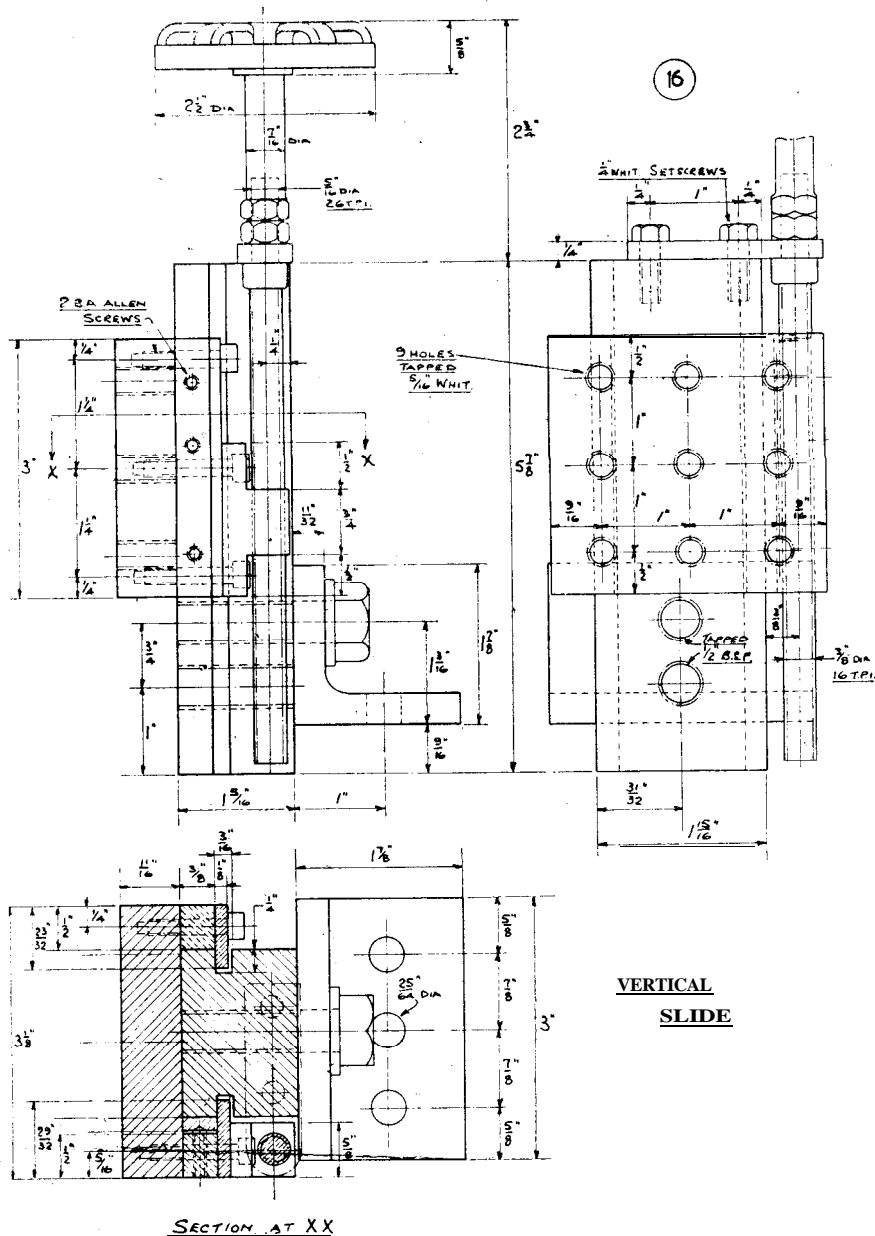
A small electric motor from a Burroughs calculating machine had been obtained to drive the drilling machine before I had the shaper. This was fitted with a gearbox which yielded a bronze worm wheel and steel worm with a ratio of approximately 10-1/2 : 1. It also had a peculiar clutch arrangement fitting on a shaft of the same diameter as the leadscrew extension, which gave promise of a fine feed a la Pittler.

The worm was made in one piece with the shaft, but was detachable from the motor armature? and fitted into a piece of 1 in. x 14-gauge steel tube, secured to the end leg of the bed by an odd aluminium casting. An extension shaft allowed for the fitting of a pulley at the rear of the machine to



DETAIL OF TOP SLIDE AND 4-TOOL TURRET

15



*View of the handpower drive to leadscrew at tailstock end of bed*

clearly shows this arrangement, together with the finalised form of power drive to give a longitudinal feed.

The vertical slide in use with the side and face milling cutters of 3 in. and 4 in. dia., emphasised the need for a back gear. This was also a necessity for screwcutting, which by this time was deemed to be essential. Screwcutting meant change wheels. These in turn, meant some form of indexing the blanks for cutting the teeth, all of which I was determined to produce on the lathe itself. These additions were more or less fitted concurrently as the various requirements were dependent on one another.

### Sorting out the gears

In the search for a wormwheel suitable for dividing, a broken circular knitting machine was discovered. This provided a worm and wheel, but of 77 teeth—too large for a dividing head, but big enough to fit on the mandrel of the lathe. Although this was an awkward number for dividing purposes, it was better than nothing. Also discovered were two gearwheels of 80 and 90 teeth and 1.5 module pitch, of which size I had a milling cutter: No 8 for 135 teeth and over. These, together with some useful bits and pieces from the knitting machine, were all the ready-made parts available.

Laying out these items in various ways, I suddenly realised that by breaking away from tradition an effective backgear was possible. An article in *MODEL ENGINEER* by George Gentry many years ago provided the solution, viz, an independent drive for the mandrel when slow speeds were required. Other additions (or complications) suggested themselves at the same time, and Fig. 18 shows the final scheme, also seen in the

enable a power drive to be arranged later.

The worm wheel, together with the centre portion of the clutch, revolves loosely on the shaft, and the outer portion, to which a handle is fixed, was pinned to the shaft, thus driving the leadscrew through the medium of a removable pin. As the worm has seven starts this gearing is reversible. After a slow traverse with the handwheel or power feed, the saddle can be returned for another cut by means of the handle without

the necessity for disengaging the clutch. This is an advantage when screwcutting as it is not essential for the wormwheel to be disconnected from the leadscrew.

This was a fault on my 5 in. Pittler, where it was possible to get the worm-driven screwcutting gears engaged at the same time as the worm-driven feed at the opposite end of the leadscrew. No doubt Pittler fitted some sort of device to prevent this occurring, but if so, it had been removed from my machine. The picture on this page

second picture given here.

The 80 T wheel would just fit on the mandrel if a slight clearance was cut in the stiffening angles of the headstock, allowing the 90 T wheel to be used as an idler wheel between an 18 T wheel on the drive shaft, giving a ratio in the region of 4-1/2 : 1.

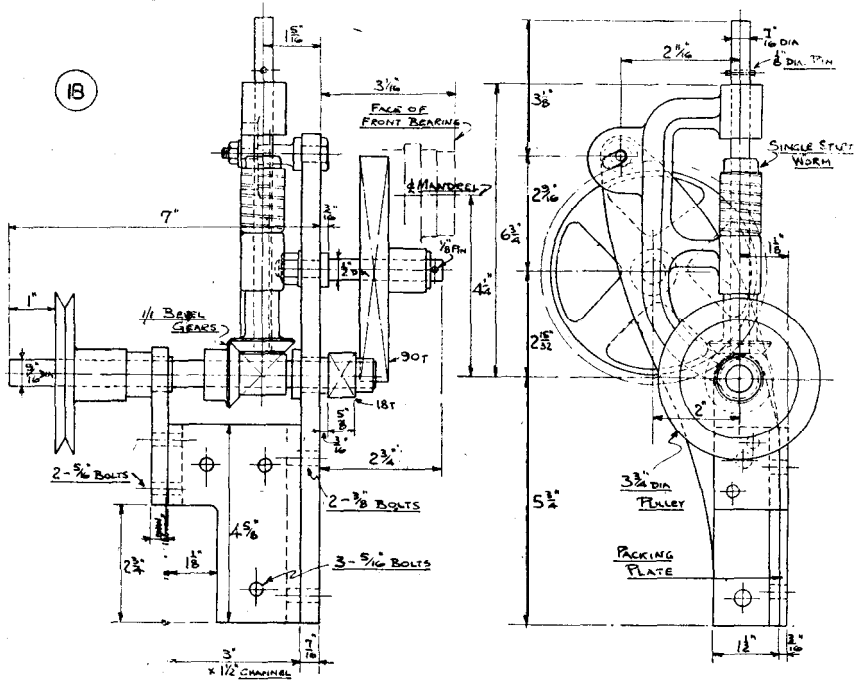
At the same time the worm and wheel together with their cast iron frame, were fitted with their integral bevel gear drive to give an extra low gear when desired, i.e., for circular milling. Both were driven by a 3/4 in. dia. V-pulley, also off the knitting machine. All this was carried by two plates secured to a channel bracket bolted to the box leg at the rear of the headstock.

#### Fixing the 80 T gear

Brass was used for the 18 T gear, this being easier to cut in the circumstances. With a little touching up with a fine file to remedy the deficiencies of the shape of the teeth as left by the cutter, the basic elements were complete. Fixing the 80 T gear to the mandrel was something of a problem, as owing to the solid bearing bushes for the mandrel, raised keys could not be fitted until the mandrel was in place. Furthermore, the keyway had to be cut by hand. So as the pulley had previously been secured with an Allen grub screw, it was decided to use the same method with the addition of a dimple in the mandrel for greater security.

The wormwheel and 80 T gear were, therefore, bored a close fit to the mandrel and before final assembly, the pulley and wormwheel were drilled with clearance holes, and the 80T gear with tapped holes for four 2 BA hex. head bolts to secure all three together as one unit.

These were assembled individually on the mandrel and the four bolts tightened up. At the same time a new 1 in. ball-thrust was fitted. It was felt the arrangement deserved a



**REDUCTION GEAR UNIT**

thrust race that was above suspicion, and that it would avoid the necessity for dismantling later to fit a new race.

Assembly went well, tightening up being a bit tricky owing to the confined space. Finally, the whole unit was solid with the mandrel, and not until the reduction gearing had been in use for some time was it discovered that the grub screw in the pulley had not been tightened. Friction alone had provided an adequate drive due no doubt to slight inaccuracy in facing the bosses.

#### Changing gear

The gear unit has proved most effective and rigid in use, backgear being engaged by sliding the 90 T idler wheel into mesh with mandrel and drive shaft gears. Withdrawing a spring-loaded pin in the countershaft V-pulley drives the mandrel direct, two movements only being necessary as in normal backgearing. The bevel gears for the extra low ratio gearing are only in mesh when required, being secured by a grub screw. The frame carrying the worm is secured by a locknut in the engaged or disengaged positions, this frame being pivoted on the drive shaft.

A detachable handle on the drive shaft allows the mandrel to be turned slowly by hand for special operations, and a 3 in. dia. pulley screwed to the upper four-speed countershaft pulley

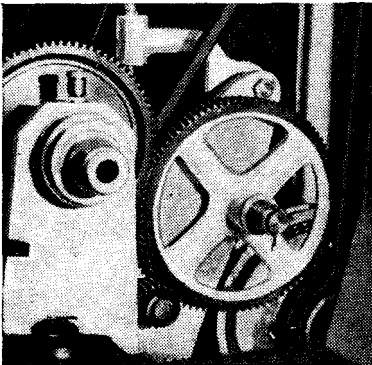
provides an adequate range of speeds. It is a reduction gear rather than a backgear. The drive shaft is, of course, always revolving whether the gear is in use or not—unless the belt is removed. But this is not a serious drawback. Provision has also been made for fitting a handle at the top of the vertical worm shaft.

To cut the gears a dividing head on the direct indexing principle was made. A gear cutting set-up on one of the change wheels is shown in the issue for November 5. A block of duralumin was used for the body. Two interchangeable spindles were used, one with a 3/8 in. dia., and one (as drawn) with a 5/8 in. dia. seating for the gear blanks being cut.

Division plates, four in number so far, are in 1/8 in. thick hard aluminium sheet, brass not being available. Steel was considered too hard and troublesome in which to drill a large number of small holes. The aluminium has proved to be quite satisfactory.

I made a drilling spindle to drill the holes, the body being formed from a piece of 1 in. dia. round brass bar, with a No 0 size Jacobs chuck fitted to a taper on the spindle. When in use, the gadget is clamped on the top slide and driven by a spring belt from the 1/8 h.p. drilling machine motor, set up in a convenient position.

\* To be continued on December 17



*Reduction gear drive to mandrel*

# Fitting the gears and other parts

By GEORGE B. ROUND

**M**ACHINE-CUT gearwheels were borrowed and fixed on an extension of the lathe mandrel to divide the plates during drilling, the plates being held on a stud in the centre hole to ensure concentric rings of holes. These were first "spotted" with a 1/32 in. centre drill and then opened out to 5/64 in. dia. using the same set-up.

The drawing shows the details of the spring-loaded plunger. Dividing head has also been used on the shaping machine, with equal success for gearcutting as on the lathe. The fly cutter is mounted in a toolholder and fed downwards for each tooth. This makes an interesting variation in the method of cutting the teeth involved in a set of change wheels.

All change gears are 20 d.p., this being settled by a Myford gear of

65 T that was already to hand. It was used as a gauge in grinding the fly cutter and it also meant one gear less to cut. A small amount of easing with a fine file was necessary for the smaller gears to ensure smooth running. Various materials were used for the gears, brass, steel, cast iron and Tufnol, and the complete set consists of 20, rising by fives to 80, plus 63 and 100 and duplicates of 20 and 30. All are 3/8 in. wide x 5/8 in. bore, the 100 wheel being made from two 3/16 in. thick layers of Tufnol riveted together.

## The cluster gear

Fig. 21 shows the arrangement of the cluster gear, which is of the five-wheel type, a design I wanted to try out as it is considered to be free from the "gathering into mesh" effect of the four-wheel pattern. The cluster gears are of Tufnol and the mandrel and stud wheels of steel. All are of 20 d.p. x 3/8 in. face and have proved exceptionally smooth in action.

Detailed in Fig. 22 is the pivot pin for the cluster frame. The leadscrew clutch is detailed in Figs. 9, 24 and 25. It is of steel throughout and 1/8 in. dia. stop pins are provided in the box leg to limit the travel of the operating lever.

Details of the quadrant and change gear studs are given in Figs. 26, 27 and 28, these again being in steel. The quadrant has a separate arm and curved slot for locking in position, an Allen screw in the boss being used for temporary adjustment when meshing the gears. The boss is a separate item riveted to the quadrant.

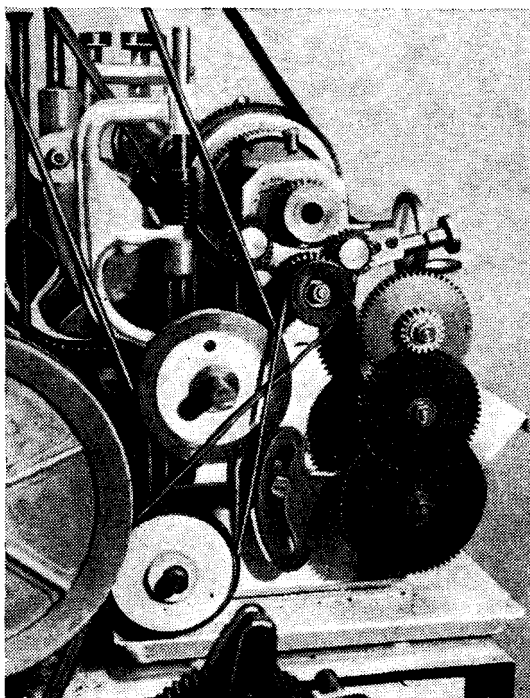
An odd shaped bracket from the knitting machine, together with a pair of dural bevel gears from a scrapped aero engine, finalised the longitudinal power feed. These were fitted as shown in Fig. 29 and Fig. 7. An aluminium packing block suitably cut to shape furnished the bracket at the tailstock end of the bed. The backshaft is 1/2 in. dia. x 16-gauge drawn steel tube, with solid ends pegged to the tube, and a cork washer 1 in. dia. recessed into one of the bevel gears, making an effective clutch.

## The pulleys

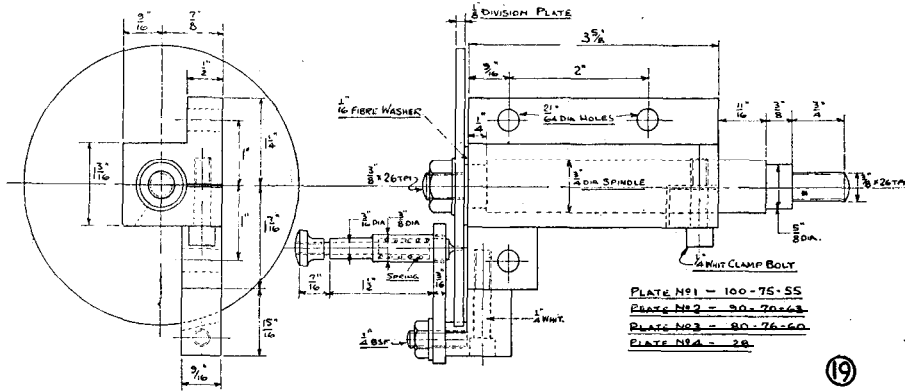
A hardwood pulley, Fig. 30, is fitted in place of the change wheel on the stud- and drives by means of a spring belt to the pulley on the backshaft. This belt is crossed to clear the driveshaft for the mandrel reduction gear. The backshaft pulley is "rubber" and was a moulded castor wheel with an inserted boss of steel, turned down and grooved for the belt and has exceptional gripping power.

The lever fed tailstock barrel was at some disadvantage since drilling was now normally taken care of by a separate machine. It had insufficient control over the drill for heavy drilling in the lathe and so a new barrel, operated by a handwheel and screw, as shown in Fig 31, was made and fitted. It can, however, be withdrawn by loosening two grub screws and the lever-operated barrel can then be inserted in a couple of minutes whenever required.

With the change in driving motors came the problem of continually stopping and starting. The 1/8 h.p. motor was dealt with by a 5 amp.

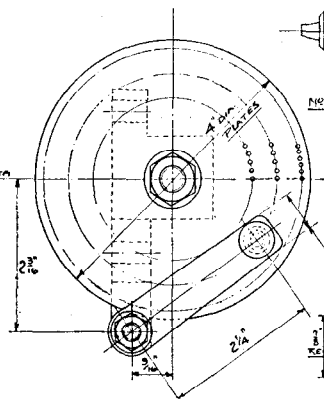


*Change gears, feed shaft drive, reduction and worm drive*

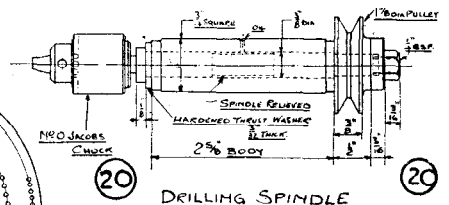


DIVIDING HEAD

PLATE NO1 - 100-75-SS  
 PLATE NO2 - 90-70-60  
 PLATE NO3 - 90-76-60  
 PLATE NO4 - 28



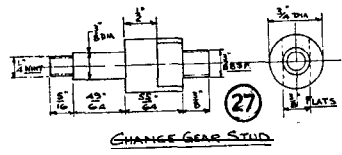
DRILLING SPINDLE



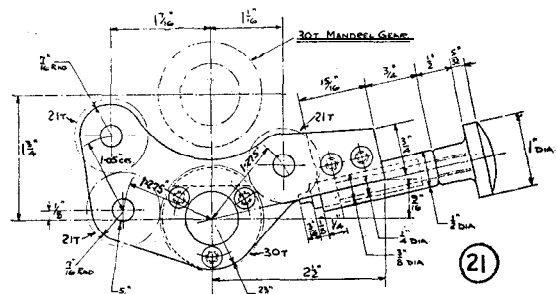
FEED PULLEY



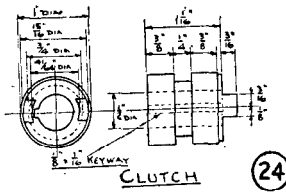
CLUSTER FRAME PIVOT



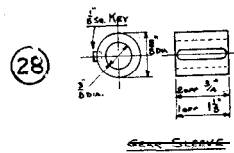
CHANGE GEAR STUD



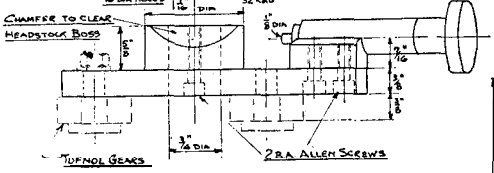
CLUSTER GEAR FRAME



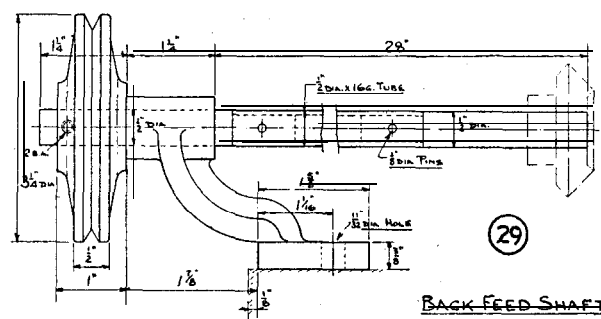
CLUTCH



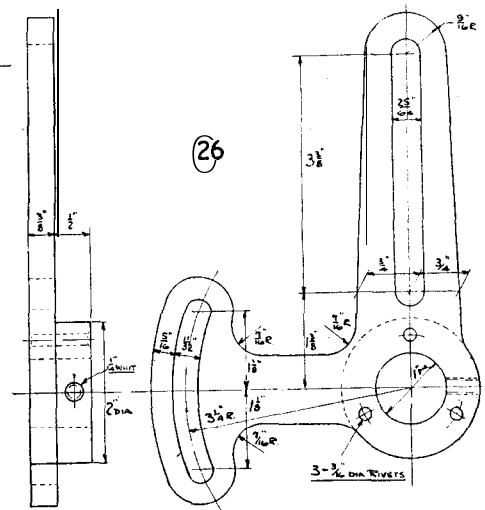
GEAR SLEEVE



CLUTCH PINION



BACK FEED SHAFT



QUADRANT

tumbler switch in a metal case mounted on a length of steel conduit bolted to the cabinet stand at the right-hand end, [ME, October 22]. This proved to be unsuitable for the 1/2 h.p. motor and for a short time, recourse was had to flicking the round belt on and off the four-speed pulleys. This was a most unsatisfactory arrangement which frequently resulted in the belt breaking at the fastener, usually when one was in a hurry to complete the job in hand.

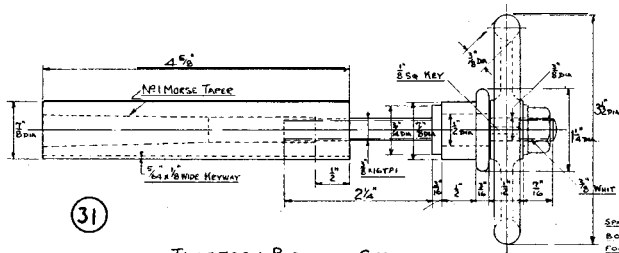
Some form of clutch was obviously called for, as owing to the use of

a new four-speed pulley was turned up from mahogany, and fitted with ball races so as to run freely on the shaft, and having a lining piece of 1/8 in. plywood on the large face. To this was glued a disc of sheet cork, 1/4 in. thick, to provide the friction drive.

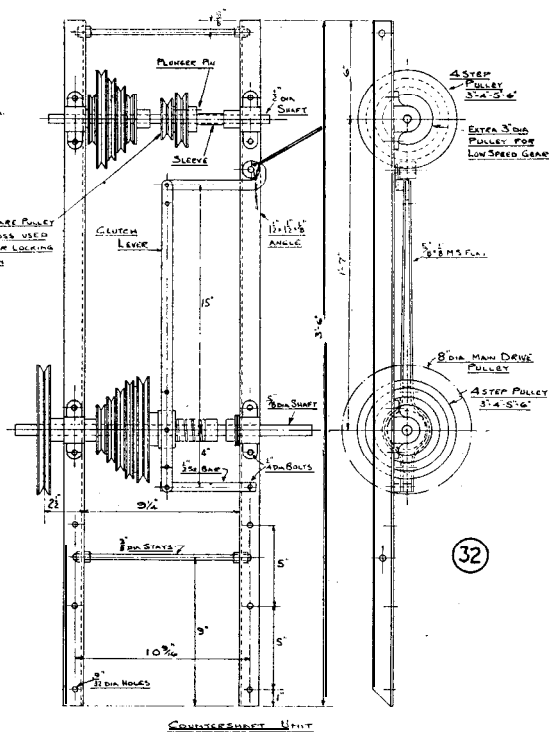
A 6 in. dia. light alloy V-pulley was fastened to a shouldered steel sleeve and faced off true with the bore of the sleeve, and suitably marked for reassembling. The 1 in. roller thrust race originally fitted to the mandrel was placed between the pulley and shoulder of the sleeve, with a light

in conjunction with pulleys grooved to the same angle as for A-size V-belts. These too, have proved to be capable of transmitting all the power required to drive the mandrel. While the work the lathe has done does not, of course, compare with factory production speeds and feeds, it has handled work up to its maximum capacity in steel.

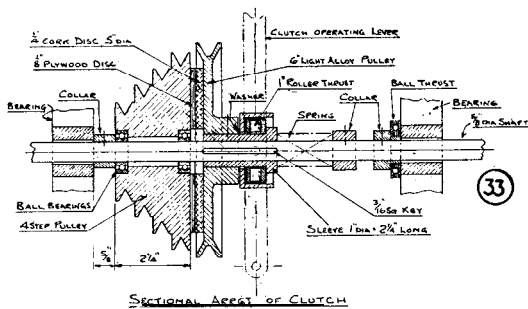
The machine incorporates a number of controversial features, some intentionally and some due to the fact that this was the only available means of construction. The parallel non-



TAILSTOCK BARREL AND SCREW



COUNTERSHAFT UNIT



SECTIONAL VIEW OF CLUTCH

rubber pads under the cabinet and shaping machine stands, a flat belt with fast and loose pulleys was unsuitable since neither machine was fastened to the floor.

Trouble free

As an experiment, the arrangement shown in Fig. 32, and in section in Fig. 33 was made up. After more than two years in use, it has proved completely effective and trouble free, while at the same time being smooth in operation and yet simple to make up. The 1/2 in. dia. lower shaft of the countershaft unit was replaced by one of 5/8 in. dia. running in die-cast alloy bearings, located at each end by collars, and having a ball-thrust washer at the right-hand end. Next,

aluminium casing to carry two withdrawal pins, the sleeve being keyed to the shaft, but free to slide endways. Another collar and a spare valve spring completed the set-up.

A clutch lever made up from 5/8 in. x 1/8 in. flat bar, with a leverage of 4 : 1 was pivoted below the 1 in. thrust race. It was controlled by a handle having a boss with a pin arranged to give an over-centre movement to a connecting link with the top of the clutch lever, the amount of axial movement at the clutch being about 1/32 in. It has not been found necessary to modify the original arrangement and there is complete absence of slip under any load.

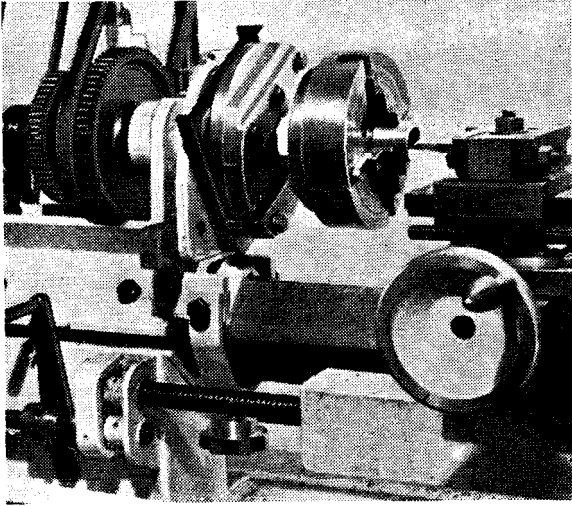
Round belts 1/4 in. dia. are used for both main and reduced speed drives,

adjustable bearings are perhaps the most outstanding matters of controversy, but the fact remains that they have proved eminently satisfactory with complete freedom from chatter. The square edge slides also, have been so successful that I prefer them, wherever possible, to V-slides. They are much easier to make up and still give that smooth silky action so desirable.

In use, the bed has proved to be very rigid, the square tubular section being, of course, highly resistant to torsional strains, and possibly the strongest form for this purpose. My only real regret is that it is not several inches longer, but that was not possible under the circumstances.

Concluded next week





Oval-fuming chuck in operation

# Machining the guide ring and base block

By GEORGE B. ROUND

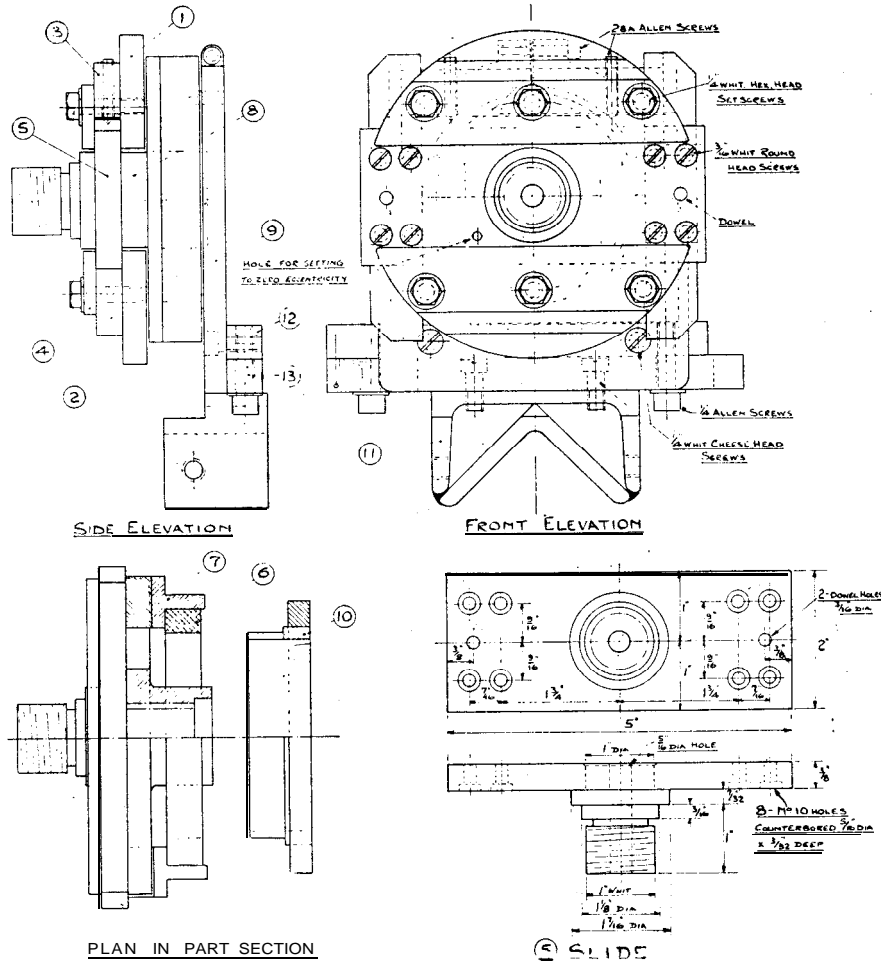
**T**HE general arrangement of the chuck together with details of the moving parts, are shown in Fig. 34, and Fig. 35 shows details of the fixed items.

The maximum amount of eccentricity that can be given to the guide ring is 1/2 in., giving a difference of 1 in. between the major and minor axes of the ovals. This allows quite a wide range of work to be done. It was constructed mainly of steel, the backplate being cut from a 5 in. dia. circle of 3/8 in. thick plate to which a boss had been welded. After the guides and cover plates had been secured in position, the whole was turned up to give a clean finish, hence the odd dimension of 4-15/16 in. for the overall diameter.

Bright mild steel bar 2 in. x 3/8 in. was used for the slide and a piece of the same material, sawn lengthwise, for the guide pieces. The cut was made off-centre in order to allow for the gib strip, and at the same time keep the chuck symmetrical and in balance. The cover strips were cut from 2 in. x 3/16 in. bright mild steel bar, and the gib strip from 3/16 in. thick brass bar, the latter being located endwise by means of dimples for the ends of the adjusting screws.

The screwed nose, of similar size to the mandrel nose, was shrunk into the slide, lightly riveted at the back, faced off flush and drilled and reamed with a 5/16 in. dia. hole for locating the slide centrally on the backplate during construction. This was done by means of a plug with a spigot, registering in the same recess that locates the backplate to the mandrel nose.

A strip of tissue paper under each cover plate provided just enough



clearance for a nice sliding fit. Before finally removing the centre plug, a hole 1/8 in. dia. was drilled and reamed in a convenient position so as to locate the slide at any time in a central position. Each guide was also fitted with two dowels to the backplate to ensure permanent alignment.

To the back of the slide are fixed two shoe guides made of 3/4 in. x 3/16 in. brass T, with 3/8 in. thick mild steel packing blocks between them, to clear the backplate. Each is secured by four 3/16 in. roundhead screws in lightly counterbored holes, and finally located with dowel pegs to prevent lateral movement in operation. The shoe is of 1/2 in-thick Tufnol, the impregnated linen grade, two opposite edges being made parallel and then bored exactly central to a nice running fit on the guide ring.

This guide ring was turned from a 2-1/2 in. mild steel shafting collar, the grub screw hole forming an excellent oil pocket, although larger

than necessary. It is clamped in position in the fixed backplate by a 2 BA Allen screw, at exactly the height of the lathe centres.

The backplate rests at the bottom upon a base block shaped to suit the bed section, and is secured to a clamp bar of 1/2 in. square bright mild steel bar. This in turn rests upon, and is bolted to, a lower clamp bar of similar section provided with slots screwed to the base block, thus providing for the adjustment of the guide ring relative to the axis of the mandrel in a horizontal plane.

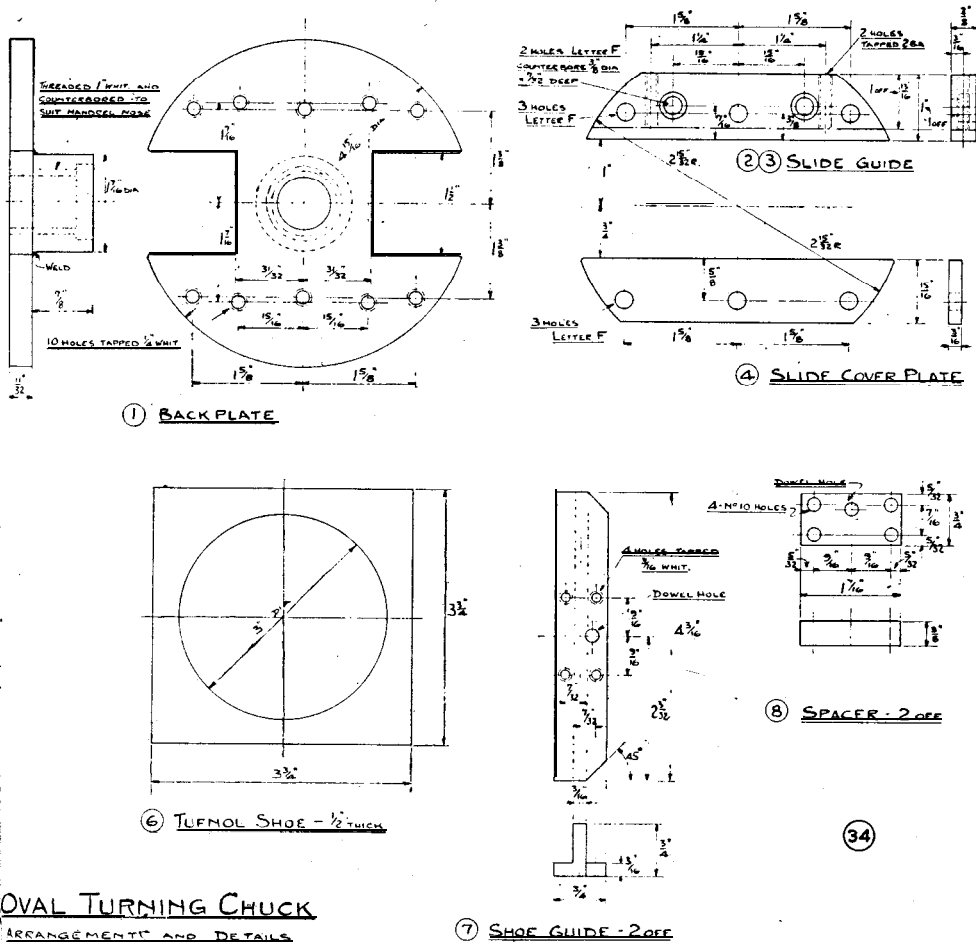
The base block is, of necessity, peculiar to the requirements of this particular bed, and is made up from mild steel angle and channel sections welded together and clamped to the bed in the manner of the tailstock. This clamp also secures a similar block carrying a small hand-rest when required for hand turning.

In operation, the chuck is smooth and easy running, taking good cuts

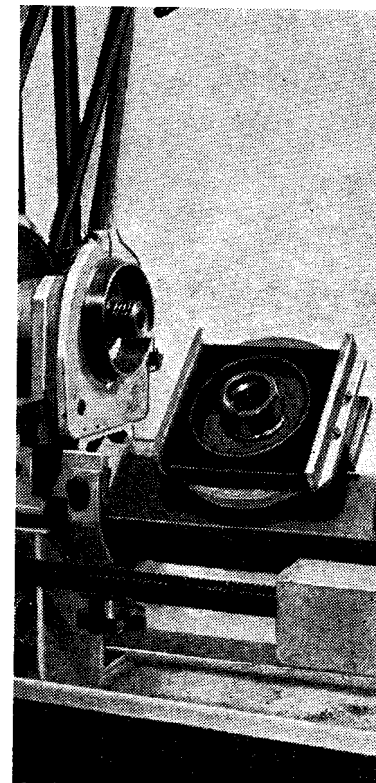
without chatter. It was made up for plain oval turning only. For ornamental work an independent rotary movement of the nose would be necessary, but as this was not required, the extra rigidity of the fixed nose was considered a more desirable feature.

Other equipment, in addition to that already mentioned, includes 3 in. "Scintilla" and 2-1/2 in. "Burner" three-jaw chucks, 49 in. "Burner" four-jaw chuck, 6 in. dia. faceplate, driver plate, tailstock drill pad, and a sliding centre for taper turning. Side and face milling cutters up to 4 in. dia., and a special 2 in. dia. facing cutter, are held on stub mandrels in the four-jaw chuck, and a 6 in. x 1/16 in. cutter is used for deep cutting-off or slitting.

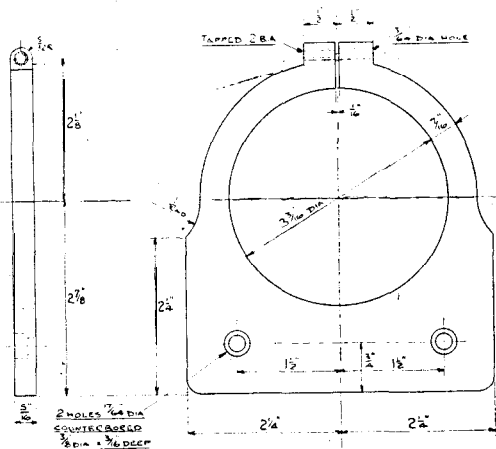
The four-jaw chuck, I would add, is still accurate and in first-class condition without shake in the jaws, despite 20 years' service. It is amazing value for the 25s. it cost in 1939. Cover plates are fitted to the cross-



Below: Body of oval-turning chuck. It has been unscrewed to show guide ring and shoe

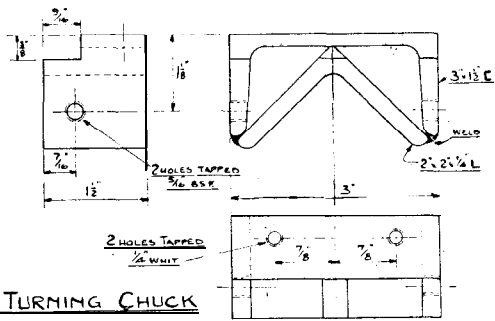


OVAL TURNING CHUCK  
ARRANGEMENT AND DETAILS  
OF MOVING PARTS



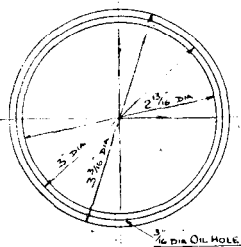
③ GUIDE RING BACK PLATE

OVAL TURNING CHUCK  
DETAILS OF FIXED PARTS

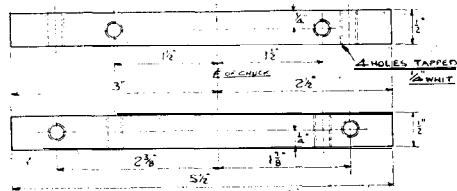


③⑤

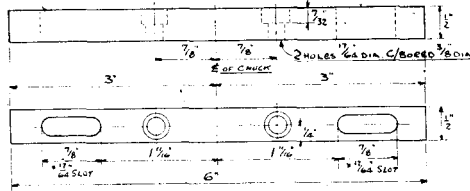
①① BACK PLATE BASE



⑩ GUIDE RING



⑫ UPPER CLAMP BAR



⑬ LOWER CLAMP BAR

slide and the leadscrew gears to exclude swarf, and there are also removable shields at the back and front of the chip tray, to confine turnings, as far as possible, to the tray.

The machine and stand are finished in an eau-de-nil green enamel paint, making it easy to wipe down and clean, besides looking effective. The switch which formerly did duty as a starter switch now carries an electric light mounted on a flexible holder. A 40 w. bulb at 12 v. is used, operating through a transformer, to prevent risk of shock through shorting of cables.

With regard to cost, the only items purchased specially for this machine, were the 1 in. ball-thrust race for 10s., and the various Allen screws and paint about 35s. in all. My own scrap box, and those belonging to friends, provided the rest of the materials. □