A SIX STATION TURRET HEAD

by Ken Metcalfe

IN INTRODUCING this piece of workshop equipment, a little explanation of machine tool phraseology would not go amiss.

The capstan rest for the tool head of a capstan lathe is mounted on a short slide which is in turn fitted to a suitable base; the base is arranged to fix to the bed in the required working position. The movement of the tool head is therefore limited.

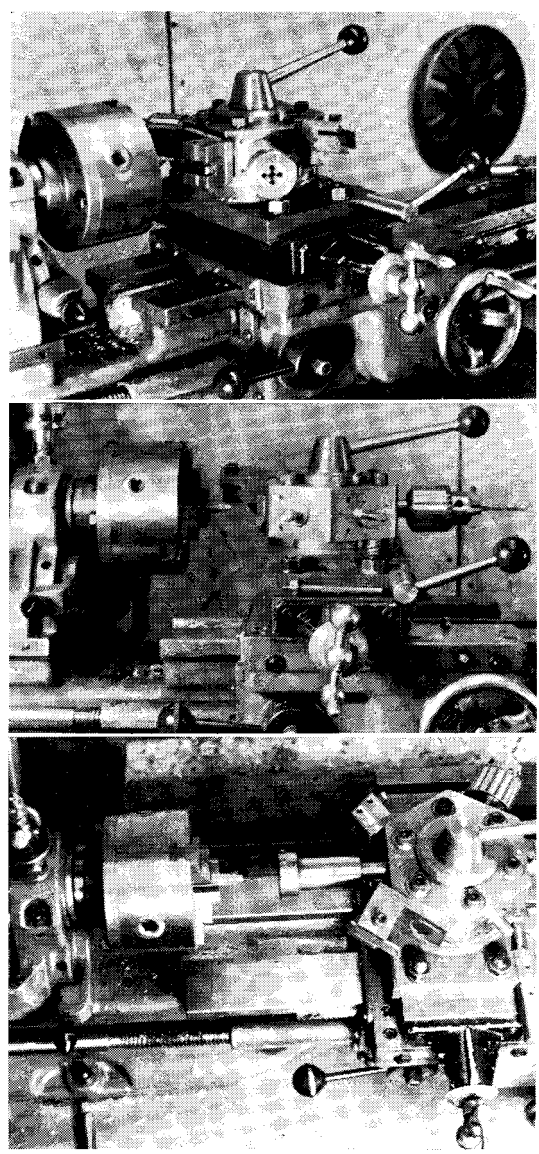
The turret saddle which carries the tool head of a turret lathe, slides directly on the lathe bed, and with this type of construction the movement of the saddle is only limited by the length of lathe bed. The tool head on both types is usually hexagonal, but any number of faces may be used to suit the design requirements of the machine. A square tool head is the next choice.

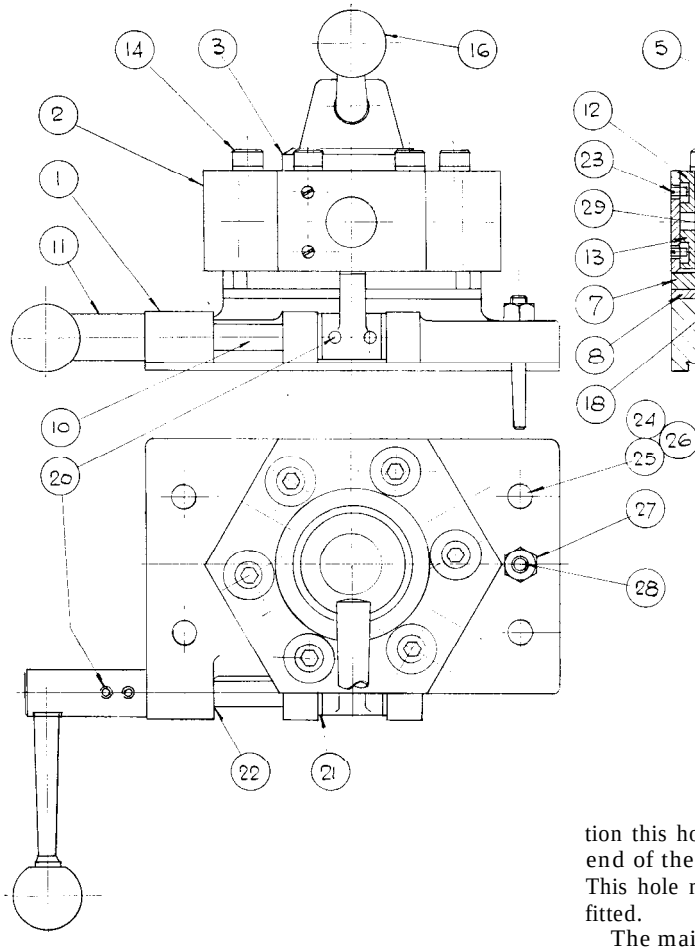
The turret head about to be described therefore converts the centre lathe into a cross sliding turret lathe. Large industrial machines of this type are fitted with a narrow saddle and cross-slide between the chuck and turret, which allows forming and parting tools to be fitted and used independently of the turret. This will not be available on your machine, so all tools will be fitted to the turret head, an ideal arrangement for short chuck work, as all tools including drills have power traverse.

Do not dismiss this attachment as being only of use on production work. It is surprising just how much repetition work is done by the model engineer. Take boiler fittings, sleeve nuts, pipe olives, steam chest studs, for example, once you have made the turret you have got it for life, so consider how much time can be saved over this period and start construction. Actual time to make the turret and attachments shown in the photographs was 42 hours.

The Author's workshop now consists of two ML7 lathes and the " M.E." light vertical miller, so construction details are based on the use of both types of machine. The prototype was produced using the ML7 only, so do not be put off if you have no milling machine. When the prototype was made some twenty years ago, none of the parts were hardened and the fact that it is still in use, (not in my workshop I might add, that is why I made another) convinces me that hardening is unnecessary unless the tool is to be used all day and every day. The drawing therefore shows no hardening or grinding. Just get the best finish you can and keep the working surfaces well lubricated.

Should the reader wish to fit the attachment to a lathe other than the ML7 or Super 7, adjustment will have to be made to the height of the tooling holes above the base. On the ML7 this dimension is 2-1/16 in. If the required dimension is greater than





LIST OF STANDARD ITEMS.

ITEM	QTY	DESCRIPTION.
6	1	SPRING 5/16" O/D TO SUIT (HEAVY)
14	6	5/16" BSF SOCKET CAP SCREW 1 3/8" LONG
17	6	1/4" BSF SOCKET C'SUNK SCREW 1/2" LONG.
18	6	2 BA SOCKET C'SUNK SCREW 3/8" LONG
19	1	SPRING PIN 16'S GAUGE x 1/2" LONG
20	4	2 BA SOCKET GRUB SCREW 3/16" LONG.
25	4	3/8" DIA WASHER.
26	4	3/8" WHIT NUT
27	1	1/4" BSF NUT
29	6	RELEASE SPRING 1/8" O/D x 1" LONG.

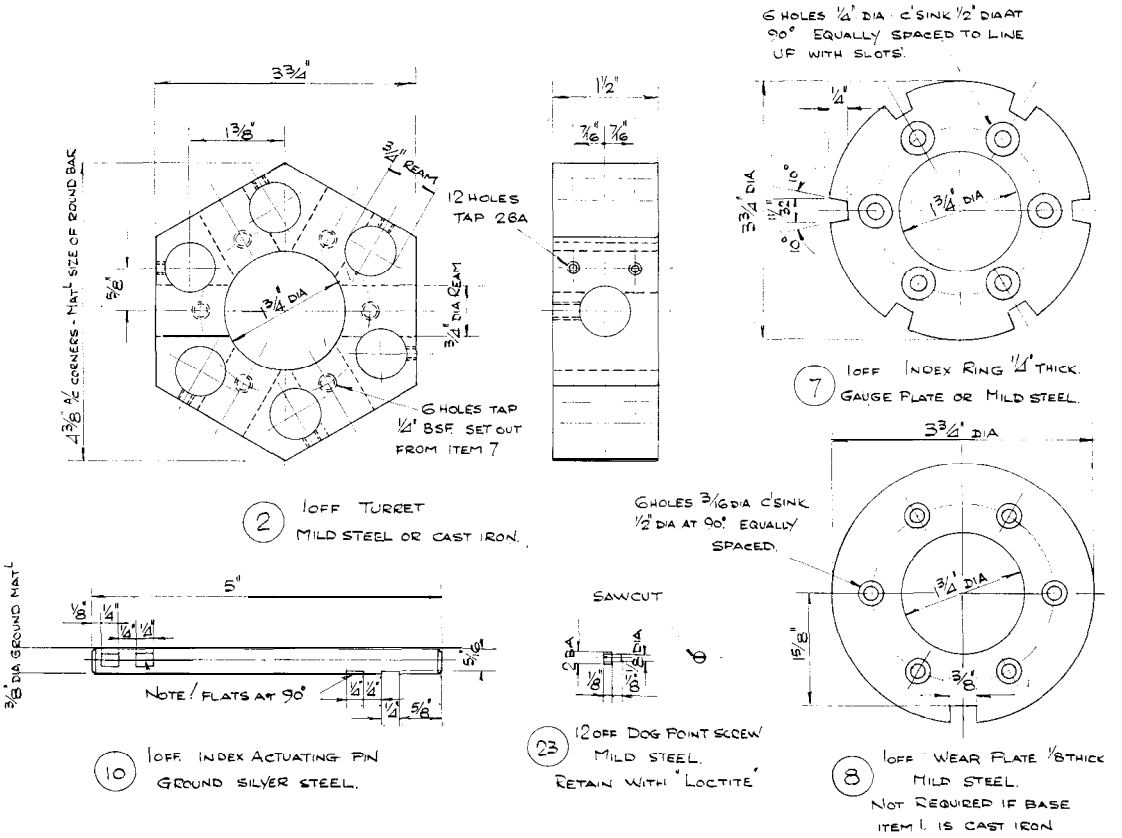
this, it is suggested that the additional metal be placed below the bosses for the index actuating pin, lengthening the clamp pillar accordingly. Should, however, the centre height be less, a little bit will have to be pinched from the base, wear plate, index ring and the turret itself. Do not overdo it or it will be extremely difficult to get the index plunger in. In this case shorten the clamp pillar.

So that it can be used as a gauge when boring the other parts, construction should commence with the clamp pillar (4). This is a straightforward turning job, and one advantage of not hardening is that the cross hole can be left until all the parts are assembled, making drilling in the correct place so much easier. In fact, most of the parts are simple turning jobs, and it is suggested that they all be made before attempting assembly. There are only a few points that really need watching.

When making the clamp handle (5), do not drill and tap the 3/8 in. BSF hole until all the parts have been assembled. It will then be possible to position this hole so that the ball is facing the right hand end of the lathe when the turret is clamped down. This hole may now be drilled and the lever and ball fitted.

The main item is the base (1) which can be either cast iron or aluminium. It is recommended that cast iron be used if available, in which case the bushes (21 and 22) and the wear plate (8) are omitted, holes and gaps being machined to suit mating parts direct. However, the original is in aluminium and the following notes are for this material.

There are numerous ways of gripping the base casting for milling. By using the special 'T' bolt shown, the three-jaw chuck can be firmly fitted to the milling table. Gripping of the large diameter boss presents the undersurface for end milling. Use the largest end mill available and machine to the dimensions shown on the drawing. Marking out and drilling of the mounting holes should next be done, taking care to ensure that the centres of the holes are exactly those of the 'T' slots the attachment is to be mounted on. When drilled, these holes are used to mount the base to the lathe faceplate, accurately thicknessed packing washers being placed between the job and the faceplate to allow clearance for the location step. Bore the 1-3/4 in.



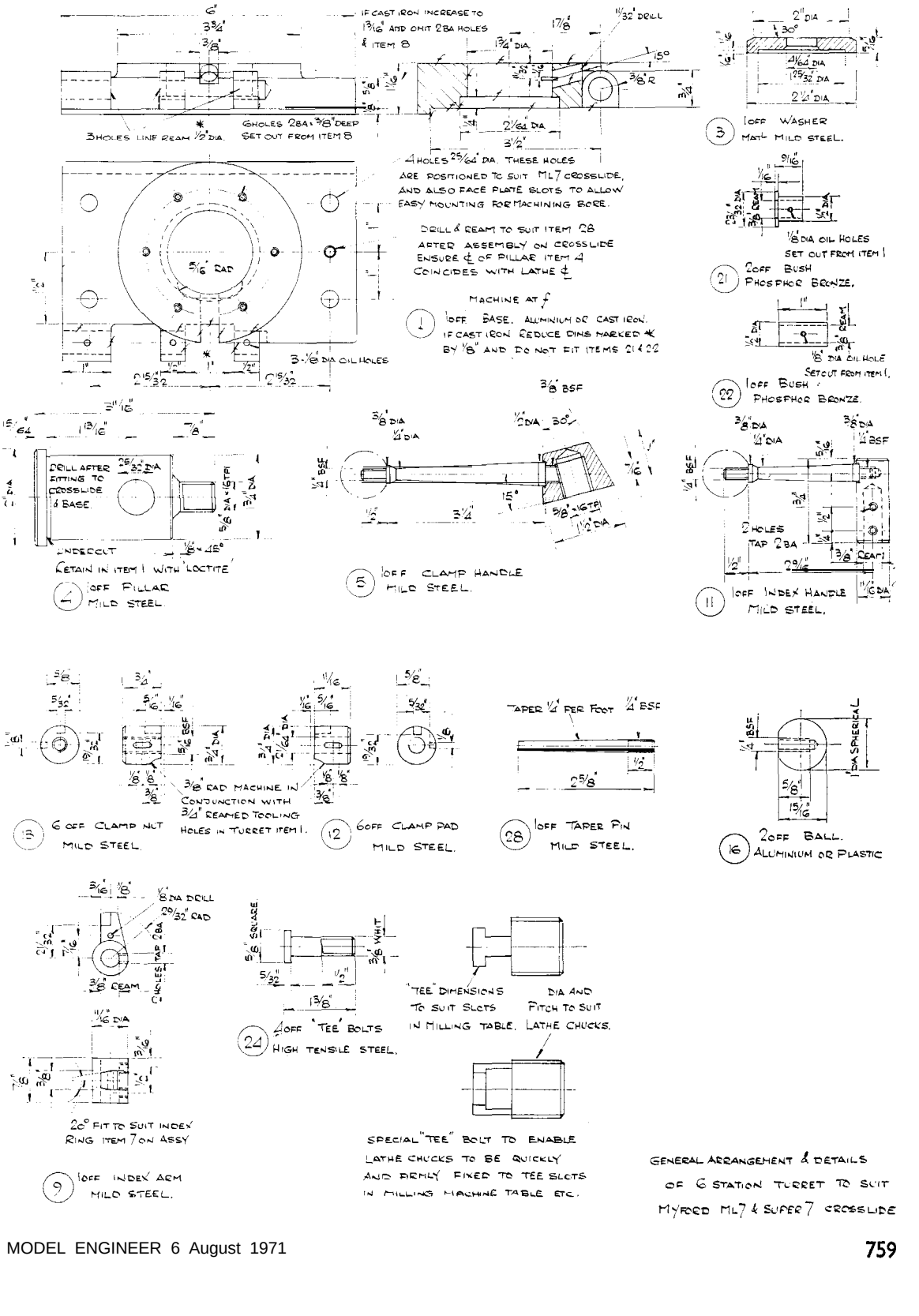
diameter hole .002 in. to .003 in. smaller than the clamp pillar and face to thickness. The 211/64 in. x 1/4 in. deep back recess should be machined at this set up, as the face of the recess must be square with the bore.

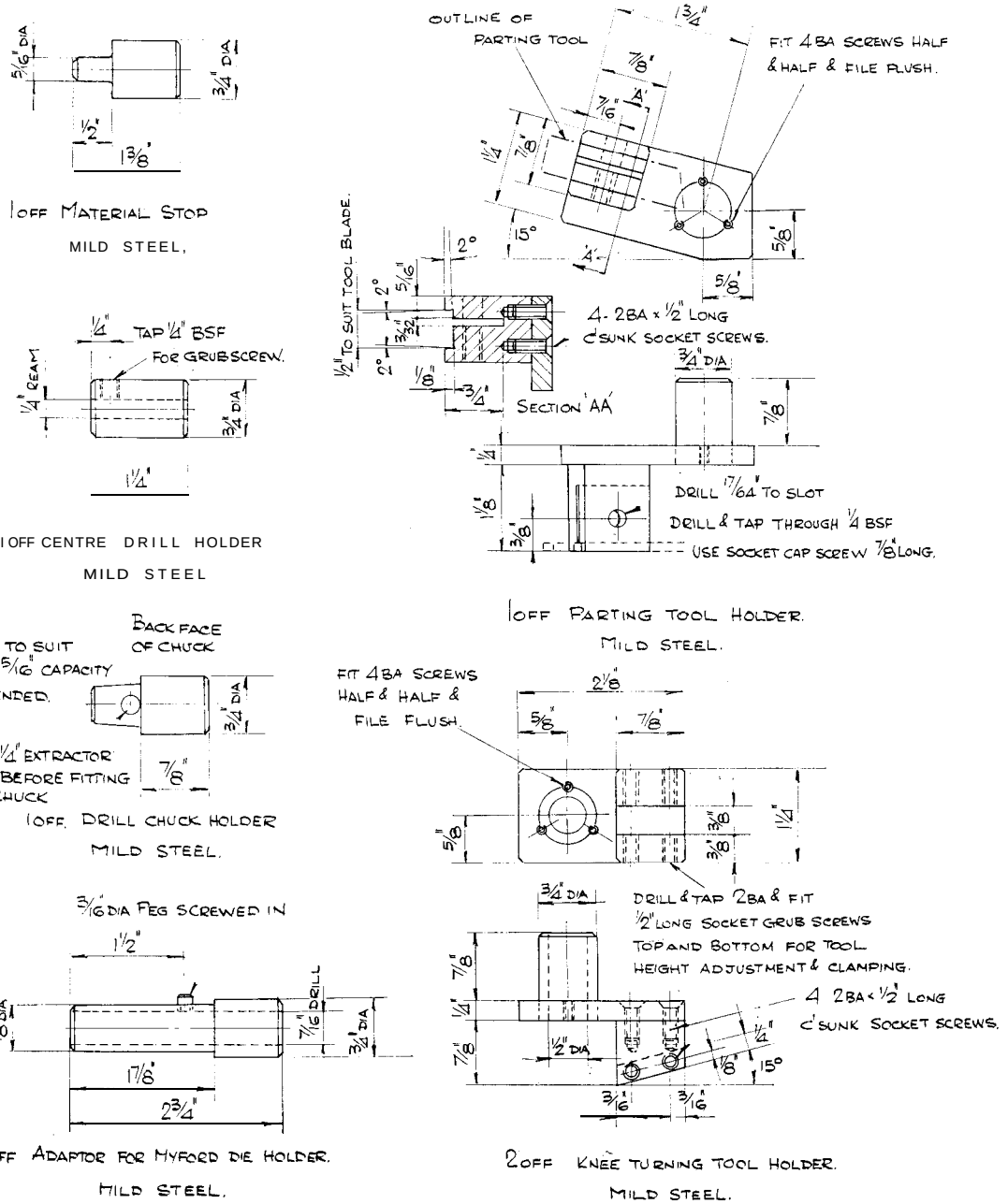
Drill and line ream the three 1/2 in. dia. holes for the index actuating pin (10). A spot facing cutter is used to clean up the boss faces. Next mill the 3/8 in. wide slot and drill the 11/32 in. dia. hole for the spring (6). The 1/16 in. wide groove for the spring pin (19) is milled with a Woodruffe type cutter. Except for fitting the wear plate (8) and the index plunger (9) the base is complete. More of this later however.

The phosphor-bronze bushes (21 and 22) should be fitted to the base before the index plunger (9) is made. This will make it easier to get the plunger a good fit in the gap. This is very important. Aim at a neat push-fit. Any shake here will be magnified at the cutting point of the tool so take care. Do not at this stage machine the 20 deg. taper at the top of the plunger arm. The plunger should now be assembled on the index actuating pin (10) and the spring (6) fitted as it will be impossible to do so after the clamp pillar has been fitted.

This assembly is the next item on the list, a shrink fit is specified here. Warm up the base with a blowlamp, keeping the flame away from the plunger and spring. Alternatively, a good soaking in boiling water will just about do it, especially if the clamp pillar has been in the freezing compartment of the fridge for a couple of hours. If I had thought about it sooner, I would have made the pillar and base a sliding fit and used 'Loctite' High Strength No. 35 to secure these two parts. When the temperature has returned to normal, or the 'Loctite' cured, the wear plate (8) should be fitted with the countersunk screws (18).

As the hexagon faces of the turret and the tooling holes are machined when the whole job has been assembled on the cross-slide, the angular location of the slots in the index ring (7) is not all that critical. The most important point is that the form of all six should be the same. Make a thin plate gauge to locate on the outside diameter of the ring and file the slots to suit this. If a dividing head is available, mill the slots. After producing the index slots, drop the ring over the clamp pillar and file the plunger arm so that it does not bottom in any of the slots. This is a taper location and is as important as the fit between the bearing bushes mentioned


IF CAST IRON INCREASE TO 3/16" AND OMIT 2BA HOLES & ITEM 8
3 HOLES LINE REAM 1/2" DIA.
6 HOLES 2BA × 3/8" DEEP SET OUT FROM ITEM 8
4 HOLES 25/64" DIA. THESE HOLES ARE POSITIONED TO SUIT ML7 CROSSLIDE, AND ALSO FACE PLATE SLOTS TO ALLOW EASY MOUNTING FOR MACHINING BORE.
DRILL & REAM TO SUIT ITEM 28 AFTER ASSEMBLY ON CROSSLIDE ENSURE ℄ OF PILLAR ITEM 4 COINCIDES WITH LATHE ℄
MACHINE AT ℄
3-1/8" DIA OIL HOLES
1 OFF BASE. ALUMINIUM OR CAST IRON. IF CAST IRON REDUCE DIMS MARKED * BY 1/8" AND DO NOT FIT ITEMS 21 & 22
3 OFF WASHER MATL MILD STEEL.
2 OFF BUSH PHOSPHOR BRONZE.
1/8" DIA OIL HOLE SET OUT FROM ITEM 1.
22 1 OFF BUSH PHOSPHOR BRONZE.
DRILL AFTER FITTING TO CROSSLIDE & BASE.
UNDERCUT
RETAIN IN ITEM 1 WITH 'LOCTITE'
4 1 OFF PILLAR MILD STEEL.
5 1 OFF CLAMP HANDLE MILD STEEL.
2 HOLES TAP 2BA
11 1 OFF INDEX HANDLE MILD STEEL.
13 6 OFF CLAMP NUT MILD STEEL.
3/8" PAD MACHINE IN CONJUNCTION WITH 3/4" REAMED TOOLING HOLES IN TURRET ITEM 1.
12 6 OFF CLAMP PAD MILD STEEL.
TAPER 1/4" PER FOOT
28 1 OFF TAPER PIN MILD STEEL.
16 2 OFF BALL. ALUMINIUM OR PLASTIC
2 HOLES 2BA TAP
20° FIT TO SUIT INDEX RING ITEM 7 ON ASSY
9 1 OFF INDEX ARM MILD STEEL.
24 4 OFF 'TEE' BOLTS HIGH TENSILE STEEL.
'TEE' DIMENSIONS TO SUIT SLOTS IN MILLING TABLE.
DIA AND PITCH TO SUIT LATHE CHUCKS.
SPECIAL "TEE" BOLT TO ENABLE LATHE CHUCKS TO BE QUICKLY AND FIRMLY FIXED TO TEE SLOTS IN MILLING MACHINE TABLE ETC.
GENERAL ARRANGEMENT & DETAILS OF 6 STATION TURRET TO SUIT MYFORD ML7 & SUPER 7 CROSSLIDE



previously. When you are quite satisfied that the fits are as good as you can get them, drill the ring for the countersunk screws (17).

The turret (2) should only be bored and faced to width at this stage. It is not essential that the turret be hexagonal and it can, in fact, be 4 in. diameter, (my own piece of material did not quite clean up which accounts for the rounded corners seen in the photographs). However, if you do make it hexagonal, machine the flats after the index ring (7) has been fitted. Use the clamp pillar (4) to line up the two parts for the screws which hold the two parts together. When secured together, fix the whole lot on the cross-slide.

To be continued

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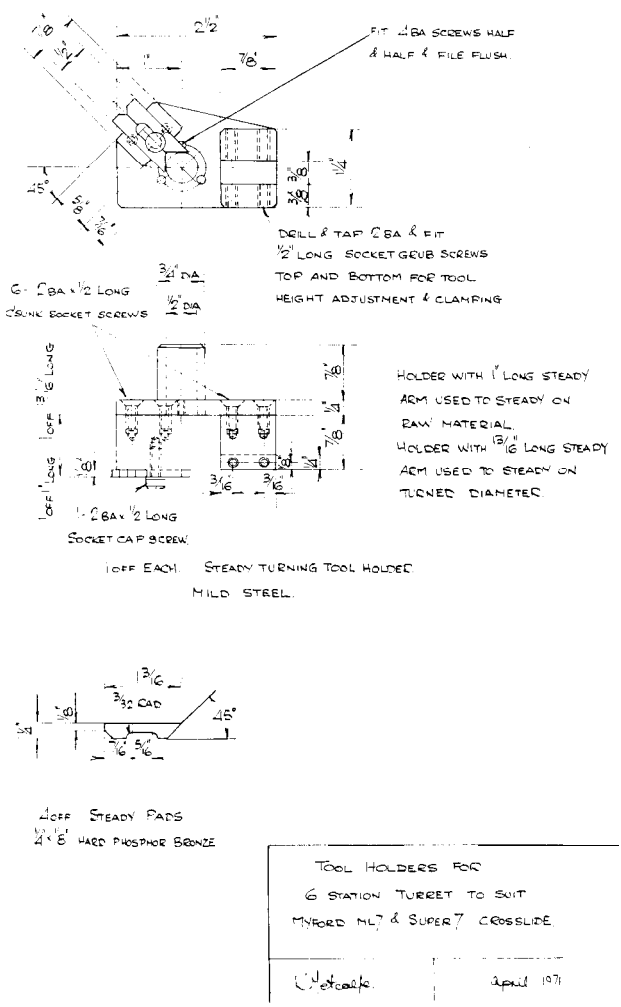
Part II ***Continued from page 760***

The 'T' bolts (24) can be made complete from bar material, but it has been found that coach bolts can easily be converted to 'T' bolts. These are readily obtainable, are reasonably priced and save a lot of time.

Machining of the turret hexagon is the next job, using each of the index slots in turn. The faces can be flycut, but this is a tedious operation. Use a side and face milling cutter gripped in the bore by the three-jaw chuck. A cutter of about 4 in. diameter is ideal with a bore of at least 1-1/4 in. to allow it to fit over the smallest step on the outside of the chuck jaws. The cutter must be wide enough to prevent the chuck jaws projecting through. Run the lathe in lowest back gear. By setting up the lathe in the manner just described each turret face is presented square to the cutter and the hexagon produced will be as perfect as the positioning of the index slots allows. Before taking a final cut, the saddle should be locked to the bed and the turret indexed for each pass.



Now position the cross-slide so that the centre of the clamp pillar is exactly on the lathe centre line, clamp up the cross-slide and drill and ream for the taper pin. This hole is drilled right through the turret base, cross-slide and saddle, locking the whole lot together so that when the turret is indexed each tool will repeat to its previous position. It is best to remove the saddle from the lathe to drill this hole. Quite a simple job, there are only nine screws to remove and the saddle lifts off. A hole to clear the taper pin should also be drilled through the rear retaining strips. This is a good opportunity to give the lathe bed and the underside of the saddle a much needed clean up.

After reassembly, centre drill each turret face, the smaller the better, as this assists marking out. Hold the centre drill in the lathe chuck and advance the saddle. Remove the turret and dismantle the index plate, marking the relative position of the two items so that they can be reassembled in the correct place. Mark out the six 3/4 in. diameter holes for the tool clamp pads (12 and 13) and also those for the twelve 2BA holes that carry the retaining screws (26). Drill a 3/8 in. diameter pilot hole through the tool clamp pad holes and mount on the vertical-slide for drilling and reaming to size. This is a far safer way than trying to do it on the drilling machine, and you have traverse for the drill.

When turning the tool clamp pads (12) and the clamp nuts (13) leave the 1/16 in. on the mating faces and remove later. Both these items should be locked, together with the screws (14) and inserted in the reamed holes. Lock in place with 2BA Allen screws. You only need two as they can be used in each position as required, when that particular tooling hole is being machined. Do not worry about marking the diameter of the clamp pads with the screws as this will indicate just where the little keyways have to be cut. Before replacing the turret, drill the 25/32 in. diameter hole in the clamp pillar. This will enable the drill and reamer to pass through when the tooling holes are being produced. The drilling is easily accomplished as the clamp pillar is in the correct position relative to the lathe centre line. So just mount the drill in the chuck and proceed with caution. By the way, do not forget to mark which tool clamp fits which hole,

because if your marking out is not perfect, they will not be interchangeable.- This is also a good time to stamp the station identification numbers. Mark clockwise so that when indexing, the turret is turned anti-clockwise, thus tending to further unscrew the clamp nut. If marked in the reverse direction, trouble will be experienced with the clamp nut tightening before the turret is fully indexed.

Replace the turret, clamp down firmly, drill and ream the 3/4 in. diameter tooling holes. Repeat for each of the six stations. Do not attempt to drill and ream right through the turret. Remember your index ring is probably slightly out. Remove the turret for the last time and thoroughly de-burr. The tool clamps should be similarly treated. All that now remains to be done is to mill the little key-ways in the position indicated by the marks left by the clamping screws. Also mill the slots for the release spring while the pads and nuts are still clamped together. Finally, face the surplus 1/16 in. from the mating faces. When reassembling, use dog point grub screws (26) retained by ' Loctite '. These screws can be made from screwed rod with a sawcut for the screwdriver. They are not tightened down, and are only to stop the tool clamps rotating or falling out. The clamps must be free to slide up and down.

The turret itself is now complete and only needs some toolholders to make it work. They are a fairly simple job and were made as fabrications, but could be iron castings, probably for the better. It will certainly reduce the amount of tapping and socket head screws required. The drawing gives the quantities and shows the type of toolholders needed for a start. A knurling toolholder would be quite useful for example. It will be seen that the knee toolholders are designed for the fitting of tools at an angle. This allows tools to be reground with a minimum of waste as well as ensuring that the cutting point of the tool projects from the leading edge of the holder.

The steady type of toolholder need only be made if work of the long slender variety is envisaged. A little more work is required on this type and the tool is presented square to the job. With both types of toolholder, tool height adjustment is made with the screws fitted to the bottom of the slot. This saves fiddling with a multitude of assorted packings-a pet hate of mine. The phosphor-bronze steady is double ended and split to assist correct setting. Tungsten carbide tips could be used here with advantage if any are available, just silver solder to mild steel carriers. When setting up this type of toolholder, a decision must be made as to which diameter to steady on. When using bright drawn bar it will be practicable to steady on the bar size with the cutting edge of the tool trailing the steady, using the holder with the long steady arm. However, when turning black or formed material, i.e. hexagon or square, the steady will have to be set on the diameter being turned and this time the cutting edge of the tool will have to lead the steady, using the toolholder with the short steady arm.

The parting toolholder is for blade type tools, and providing the tool is only reground on the front edge, and the projection from the tool block is kept constant, it will always be on centre height. This pre-supposes that the toolholder has been set up horizontal in the first place.

Shanks for the fabricated toolholders and the plain round ones are made from bright drawn bar. When making the drill chuck holder etc., take care that the diameters are concentric. If you have any doubts about the truth of your three-jaw, do take the trouble to set up true in the four-jaw. A 5/16 in. drill chuck has been found to be plenty big enough. If you need to use any larger drills, split bushes fitting into the tooling holes and bored out to suit should be used.

Taps are best gripped in a holder similar to that used for the centre drill. Only a few sizes are needed as shanks are constant for a particular tap diameter.

Instructions were given earlier for the positive location of the turret to the saddle. However, in operations involving the use of knee toolholders, it will be simpler to set up the lathe without the taper pin, as this will allow adjustments to the depth of cut, and therefore the job diameter, to be made with the cross-slide screw. In fact, this is the only way in which parting off can be accomplished. The taper pin must always be fitted when drilling, tapping or threading is undertaken, as it should be when using the steady toolholders. The taper pin is made with a screwed end fitted with a nut for easy removal.

There have been a few saddle stops described recently, Mr. J. A. Radford's six-position one being the most suitable. The author intends to adapt this design to suit his own traverse knock-off which has also been published in " M.E." Thanks are due to Mr. Peter Stevenson for the photographs. *

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