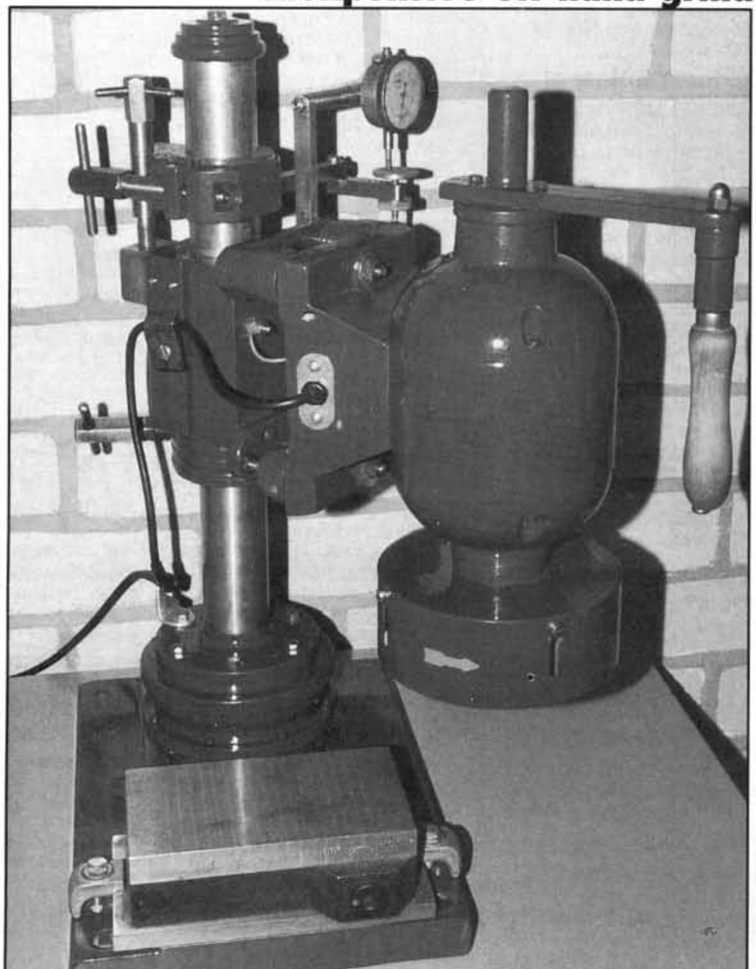
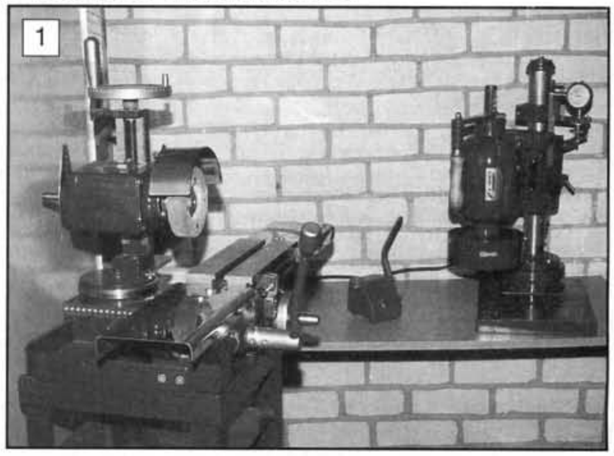
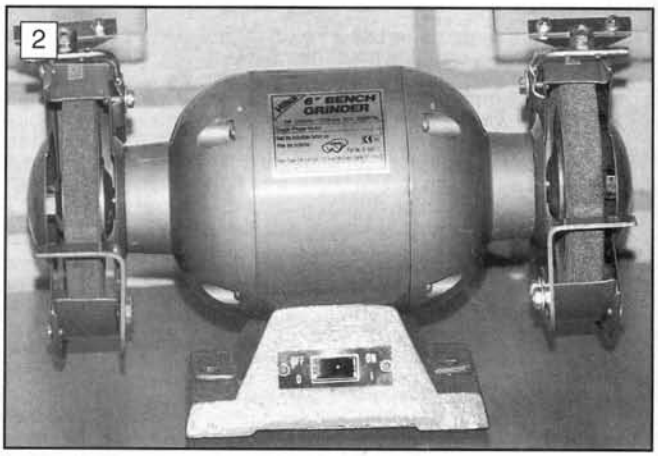
A 'SWING' SURFACE GRINDER

An accurate, fine finish on flat surfaces is best achieved by surface grinding. Machines capable of carrying out this process are usually too bulky for the average home workshop. Alan Jeeves has constructed a neat unit which works on the 'swing' principle, and which utilises an inexpensive off-hand grinder as the workhead.





The Author's 'Grinding Department'.

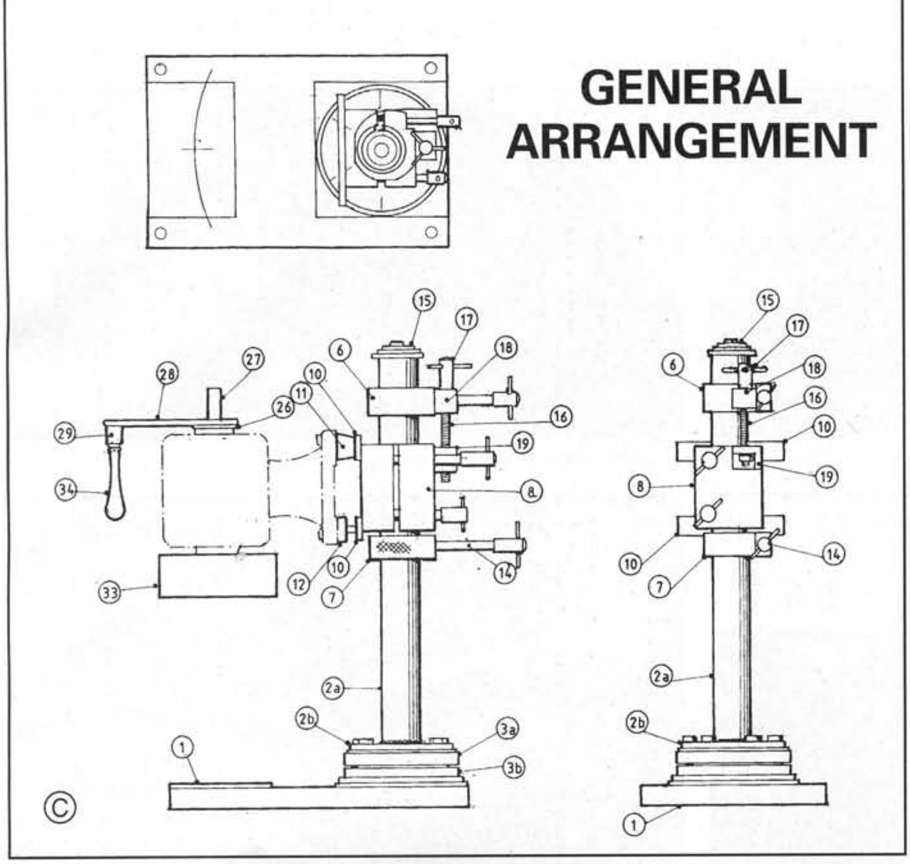


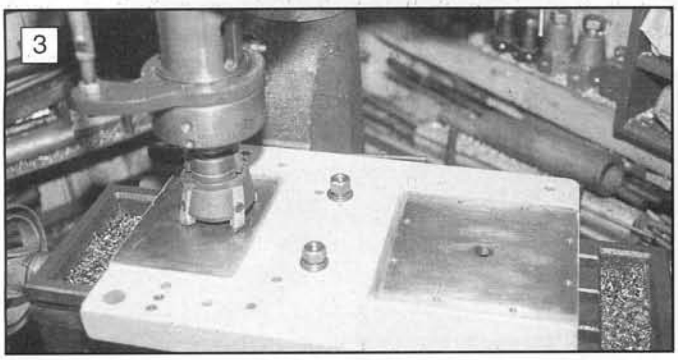
The standard bench grinder.

For several years now, I have enjoyed the many advantages of having a small surface grinding machine on hand in my workshop, to provide me with the capability of working small flat metal items. This machine, comprehensively equipped with a selection of attachments, often also doubles as an indispensable tool & cutter grinder, and as a consequence of this dual role, it is more often than not left set up for various tool making or cutter sharpening duties. These, then have to be reluctantly broken down for the odd surface grinding job, as and when the situation arises. Some time ago, therefore, I decided that I would make provision for the installation of a second small capacity surface grinding machine in the workshop. This additional machine did not really need to be a complex piece of equipment, but just adequate to carry out small and light grinding work. Hence, after due consideration, I elected to build a 'swing' grinder. The two units are shown in **Photo. 1**.

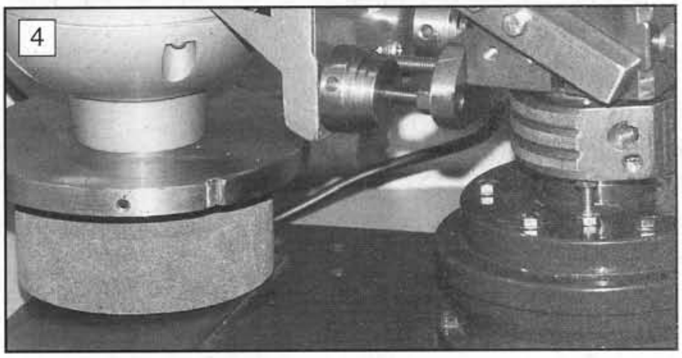
The very fact that an engineer needs to use a surface grinder at all usually means that he already has access to a comprehensively equipped workshop, and so this project may well be of interest to anyone having all the tooling on hand with which to construct the various components of this compact little machine. For my own swing grinder, I used in the main, a 5in. centre lathe, along with a small mill/drill. A light duty welder came in handy too, but it is by no means essential. There are no gears to cut, no complicated slideways to machine accurately, no dovetails to mill and no 'T'-slots to slot, making this interesting project an attractive proposition for the amateur. The result is an extremely useful machine which, being bench mounted, will take up just a minimal amount of precious workshop space.

The main characteristic of this particular design (**Figure 1**) is that the all-important wheelhead is simply a standard off-hand grinding machine, which was originally intended for bench mounting. These grinders are now very widely available at little cost, and the one shown here is a





Machining the base on the mill/drill.



The swing grinder can grind its own table.

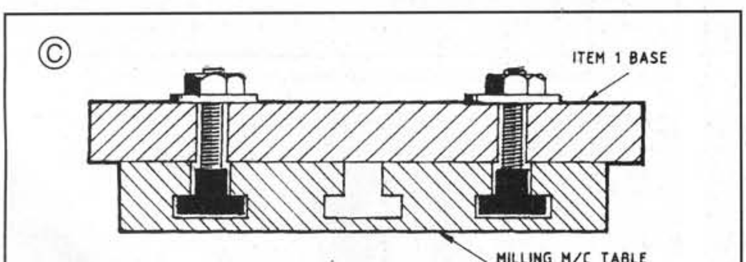


FIG. 2 DIRECT CLAMPING OF BASE

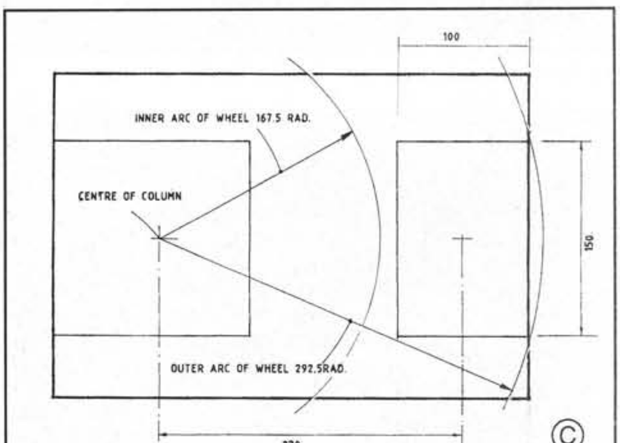


FIG.3 AREA COVERED BY GRINDING WHEEL OF 125 DIA.

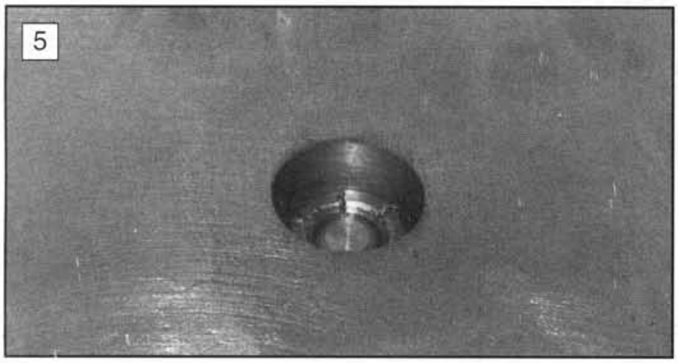
Hilka 6in. 1/2 hp model (**Photo. 2**) which was purchased at one of the many large DIY stores (in 1996) at a cost of £19.95. When slightly modified, this unit provides a quick and economical method of furnishing a wheel head for our swing grinder, without the need for acquiring an electric motor and drastically altering it.

The Base

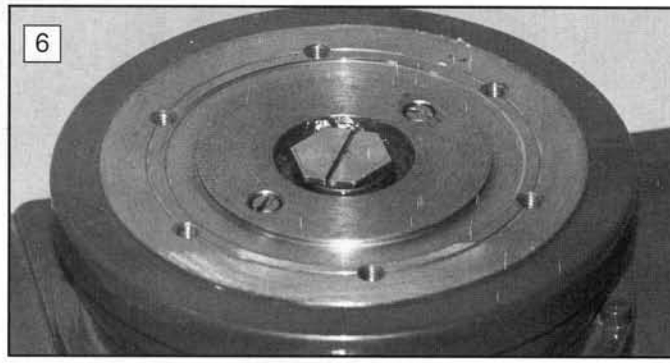
There are, alas, one or two rather large lumps of material required to make up this machine, and the foundation of its design, the base (**Item 1**), is one of them. Even though it is intended that the swing grinder should be securely bolted to a workbench or a sturdy machine stand, it must not be allowed to become top heavy, as this situation always makes for very poor machine tool design. A ready made base may well be available, (say from a scrap drilling machine), but I made mine out of a piece of 30mm thick mild steel plate. As there are no slideways, there is no real advantage in using cast iron, other than that this material offers marginally (in this case) better vibration absorption qualities. The plate was cut out for me by a local fabrication shop, so it was the correct size to start with, and only required light dressing of the edges. For the bed, I simply milled away a relief, leaving two 'pads', one for the mounting of the column/turntable and the other to form the work table. This done, the pads were skimmed up to ensure that they were in the same plane - a task which was only just possible in one clamping on the mill/drill table (**Photo. 3**). As the piece of material required for the base is likely to cover most of the table area of a small milling machine, clamping down in the conventional way may be difficult. However, if a couple of holes are drilled through the base plate in a convenient position and in alignment with two of the milling table 'T' -slots, adequate securing can be achieved by direct clamping (**Fig. 2**).

I must admit that, after milling, I hand scraped the two pads using a surface plate as a master, thus ensuring a higher degree of accuracy. This process was probably not necessary, as a feature of the design is that the wheel is able to grind its own table area (**Photo. 4**). Nevertheless, the pads do need to be finished accurately in relation to each other for the initial setting of the wheel head when the time comes.

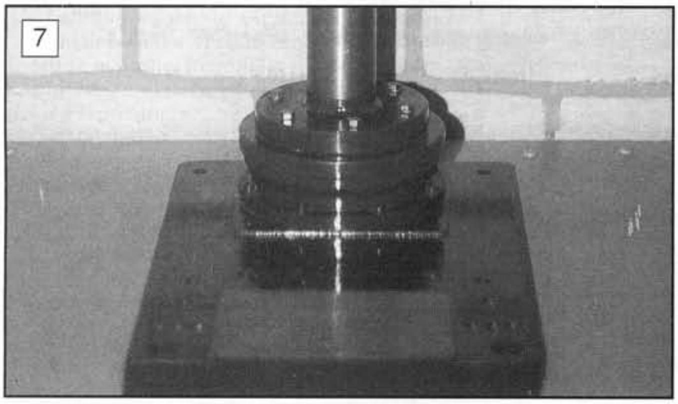
Four fixing bolt holes are drilled in the base, the front pair being counterbored or countersunk so that the bolt heads, after bolting the machine down, repose well below the surface of the worktable. The grinding wheel must pass over them without obstruction. Holes drilled in the vicinity of the worktable provide a means of clamping the workpiece, machine vice,



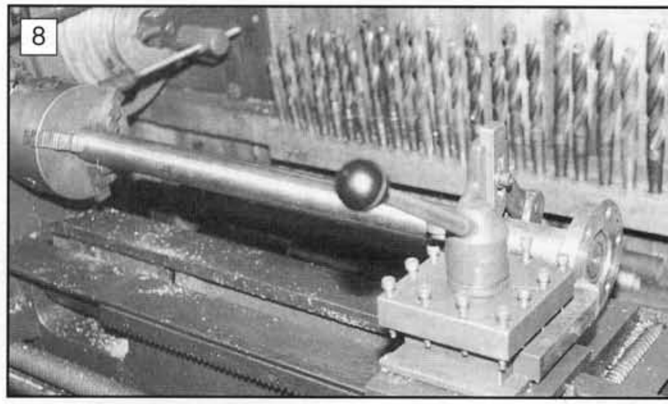
Counterbore in underside of base.



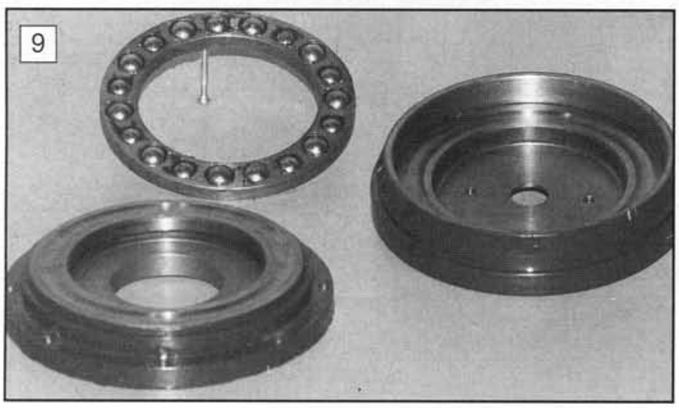
Central screw (item 5a) tapped into base.



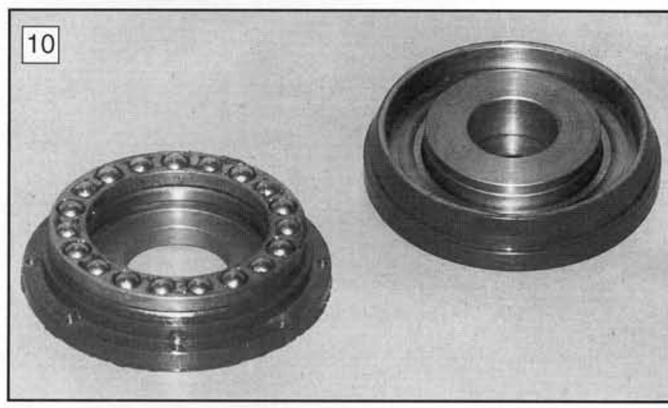
The column assembled.



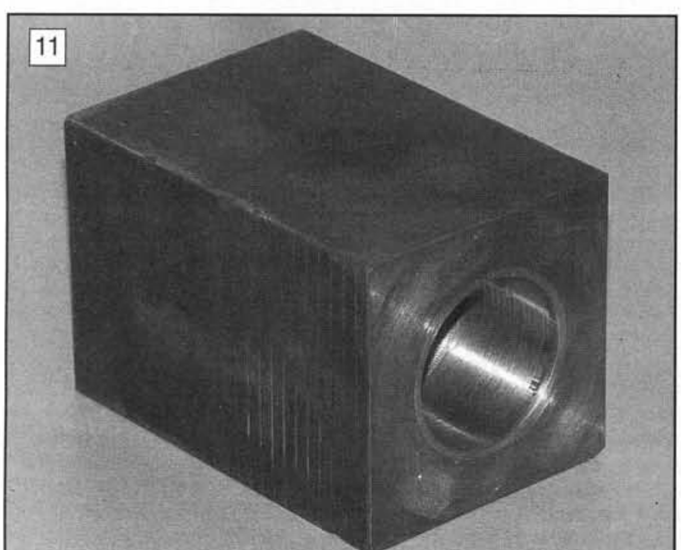
Turning the column in the lathe.



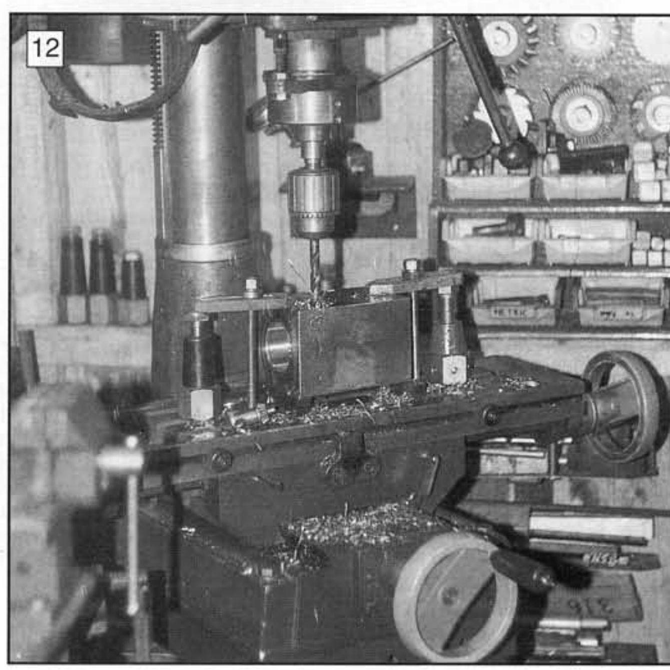
The turntable with bearing.



The turntable with bush (item 4) fitted:.



Mounting block with bushes fitted. ▲



Drilling mounting block. ▶

or magnetic chuck to the machine. These holes should be carefully and squarely tapped using the same screw thread as that of the usual workshop clamping set, and positioned at the discretion of the builder.

An M16 tapped hole is situated squarely in the column/turntable pad, at the correct centre distance from the centre point of the worktable pad (**Fig. 3**) and counterbored from below, an easy chore for the mill/drill. The purpose of this counterbore (**Photo. 5**) is to fully accommodate an M16 locknut for the central screw which holds the turntable together (**Photo. 6**). The base can now be laid aside while other components are made.

The Column

The machine column (**Item 2**) is made up of a piece of stock diameter solid bright steel bar which is permanently fitted at one end with a circular flange (**Item 2b**). This flange is included for the purpose of mounting the column vertically, but it does not bolt directly to the machine base, being fastened to the turntable (**Photo. 7**). The bottom face of the flange must therefore, be carefully machined to be quite square with the axis of the column. As there are six separate mating faces to be machined to form the indirect mounting of the column to the base, small errors of squareness at these faces may accumulate to throw the whole column out of truth with the base by a considerable amount.

Having cut the column material to length, it should be carefully centre drilled at each end by setting up in the lathe, using a fixed steady to support the outlying end. Once centre drilled, the tailstock centre can be introduced and the job checked for accuracy using a dial test indicator fixed to the lathe saddle.

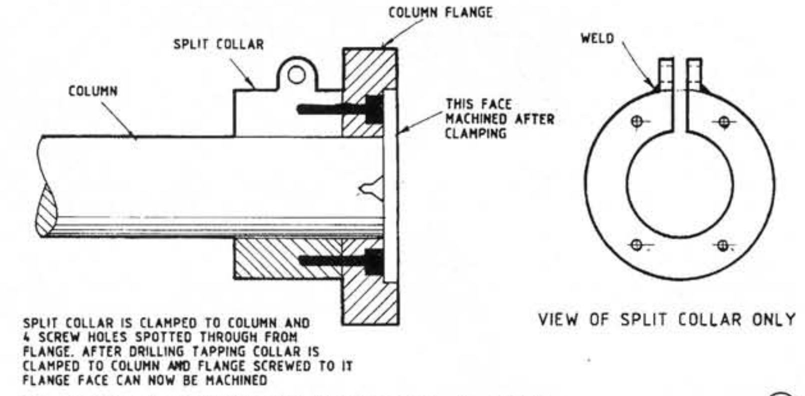


FIG. 4 OPTIONAL PINCH COLLAR ARRANGEMENT FOR COLUMN

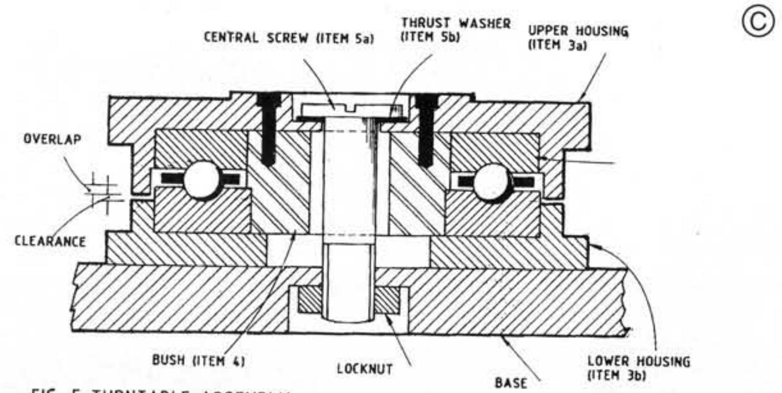


FIG. 5 TURNTABLE ASSEMBLY

The flange (**Item 2b**) is now turned and drilled for attachment to the bottom end of the column. There are several possible methods of securing it in place, and I have chosen to bore it a light press fit and weld. If you feel that you are not able to carry out the welding work without distorting the column, an alternative pinch bolt system can be used instead (**Fig. 4**). It is also quite feasible to accurately bore the flange to an interference fit of 0.075mm (0.003in.) and to heat it up to expand it. The flange is carefully slipped onto the column and left to cool, so attaching itself securely.

Whatever the method of attachment, the assembly can be re-mounted in the lathe using centres and the fixed steady, and the bottom of the flange faced up, thus ensuring that the column is square to the flange (**Photo. 8**).

It will be noticed that a tapped hole is provided in the top of the column and that a cap (**Item 15**) is screwed into it. The cap serves two purposes, firstly preventing the wheelhead assembly from accidentally rising too far up the column when adjusting the height and secondly providing a neat termination to the column for appearances sake.

The Turntable

The turntable assembly (**Fig. 5**) is included in the design as a means of causing the whole of the column to rotate freely and squarely to the worktable. It consists essentially of two separate halves (**Items 3a and 3b**) which contain a standard ball thrust bearing (**Photo. 9**). When properly set up, the column is quite sturdy, yet it spins smoothly. Each half of the thrust bearing is pressed into its corresponding housing and the ball race is loosely sandwiched in between them. In order to ensure that the assembly has adequate rigidity, a close fitting steel bush (**Item 4**) is placed inside the thrust bearing (**Photo. 10**), thus preventing any side to side movement. It will also be seen that this bush is stepped on its outside diameter. This is because the two halves of the thrust bearing have different diameter bores. One of the bores is a 'fit' and the other, mating half, is a clearance dimension. As already mentioned with reference to the column flange, the four faces must all be exactly parallel on the turntable.

The parts are simply turned in the centre lathe and, where necessary, drilled for their respective securing screws. The top half of the turntable is machined to suit the central fixing screw (**Item 5a**) as the column has to be fixed without the flange fouling on the screw head. This screw passes through the whole turntable and enters the tapped hole in the base and, when correctly adjusted, is fitted with the locknut for which we have already counterbored the underside of the base. A brass thrust washer (**Item 5b**) is also provided for the central screw head to bear against.

Having made certain that the faces of the turntable are exactly parallel (**Fig. 6**), it is also essential that the thrust races are pressed into their individual housings cleanly and squarely. Care should be taken, of course, to make sure that everything is thoroughly cleaned before final assembly.

The top half of the turntable slightly overlaps the bottom half as a means of keeping grinding dust out of the bearing compartment when in use. The halves should not, however, bind at the overlap as they rotate.

All that remains to do to complete this section of the machine is to screw the turntable to the base. The central screw is fed through the assembled turntable and screwed into its tapped hole in the base. When it is tightened up, the fastening screw holes can be marked through to the base for subsequent drilling and tapping. It is a good idea to remove the first threads of these tapped holes by counterboring, to prevent the thread spiral from 'stretching' and thus stopping the turntable from seating flat (**Fig. 7**)

The Bearing

The bearing itself is an 'off the shelf' thrust race. Any thrust bearing of suitable dimensions will suffice for this job. I have used an 'HT $3^1/2$', which denotes a heavy

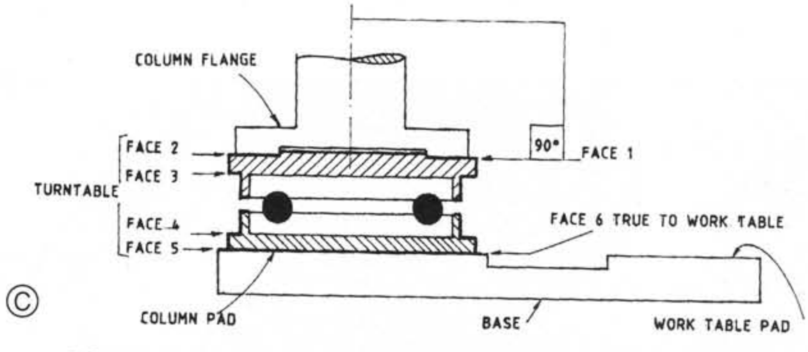


FIG 6 SIX TRUE FACES TO MOUNT COLUMN

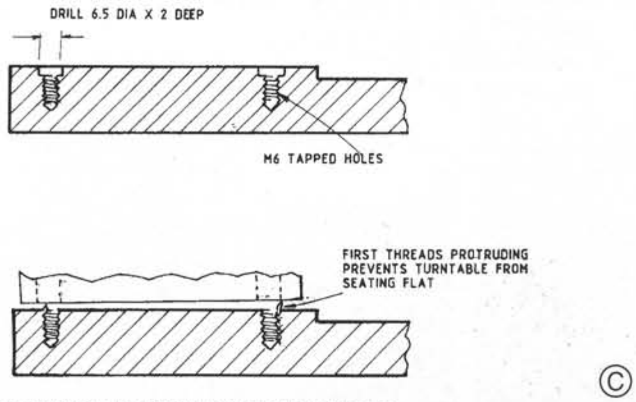
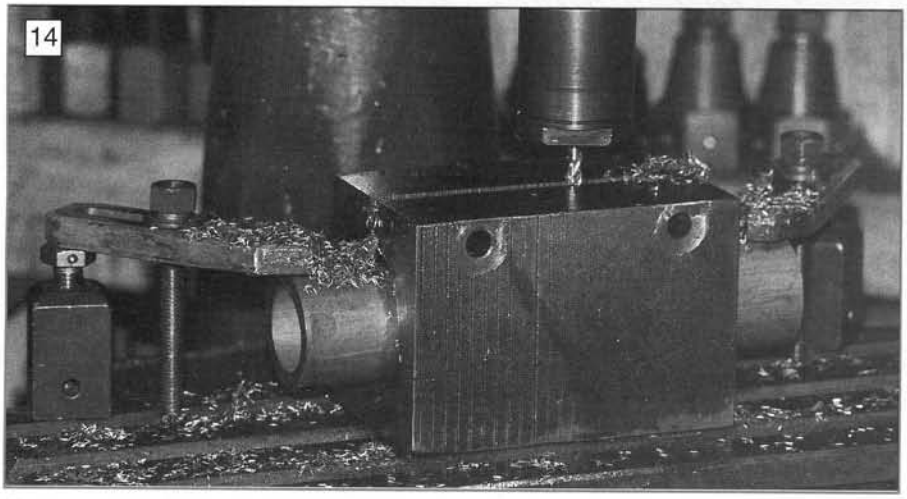
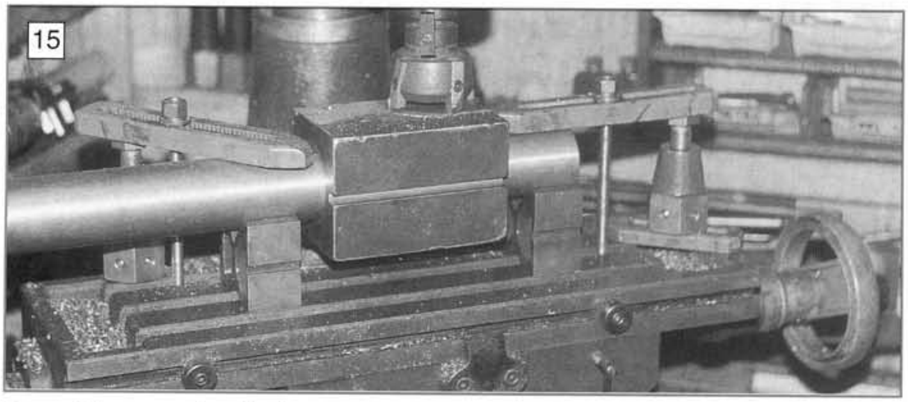


FIG 7 EFFECTS OF SCREW THREAD "STRETCHING"

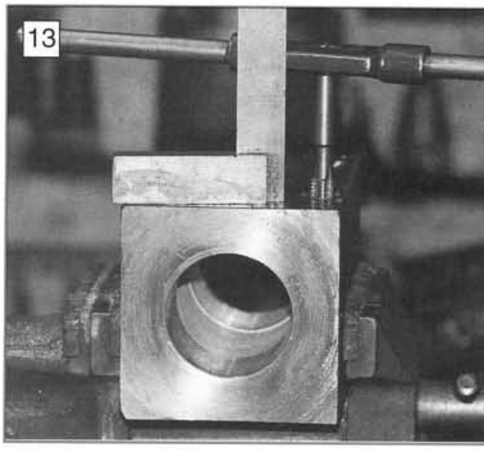


Slitting mounting block.



Face milling mounting block.

thrust bearing having a bore of 3¹/2in. An 'LT 3¹/2' is also available signifying that it is a light thrust bearing of similar dimension. Either bearing will work equally well, as will a bearing of a different size if the turntable is amended to suit. The afore-mentioned overlap on the top half of the turntable may have to be adjusted to suit any difference in the overall width of the selected bearing assembly. It is



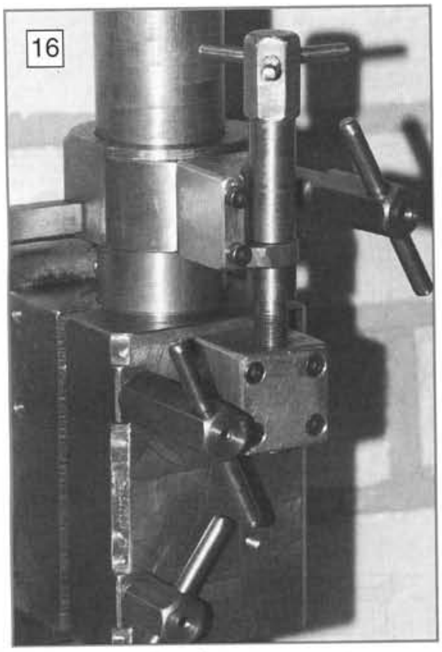
Tapping mounting block.

essential that no grinding dust is allowed to contaminate the bearing when in use. I don't know if this bearing will ever need replacing during the life of the machine, but I am sure that it will last for an extremely long time, considering the relatively light use to which it is being put. Nevertheless, I have included pairs of jacking screw holes in the turntable halves, so that the individual races may be extracted if so required in the future.

Wheelhead Mounting Block

To avoid vibration during grinding, the wheelhead must be securely attached to the machine, yet it must be able to move up and down on the column for short distances as well. This state of affairs is brought about by the use of a split block (**Item 8**), which can be adjusted by tightening two pinching screws in order to achieve the required fit on the column, but still allowing it to be moved up or down by rotating a jacking screw (the leadscrew), a system which has the benefit of simplicity.

The rectangular piece of material (cast iron or steel) which is to be used for the mounting block is set up in the 4-jaw chuck of the lathe faced, drilled and bored (accurately and parallel to the sides) to accept a brass sleeve. The sleeve in turn is bored to be a good close fit over the column. Another approach is to use two separate bushes (**Item 9**) inserted from opposite ends and pressed up to a small shoulder inside the block. This is the method which I have chosen to use (**Photo. 11**). The brass bushes are 'superglued' into place. The block, which should now be a tight sliding fit on the column has eventually to be split completely through longways, but before this is done, the pinch bolt holes can be drilled and tapped whilst the block is still solid. A straight-forward operation on the mill/drill, tapping drill first and then the clearance drill half way down (**Photo. 12**). The holes need to be tapped squarely, so that the pinch screws don't bind when in use (**Photo. 13**). All the other sundry holes in the block can be drilled and tapped, then the block is ready for slitting. I used a 6mm end mill to slit the piece (**Photo. 14**), but a slitting saw may well be used instead, as the bore will only need to close up a few thou. when in use. To assist the pinching screws, I have milled a 6mm slot in the opposite side to the slit, this being done prior to the actual slitting operation.



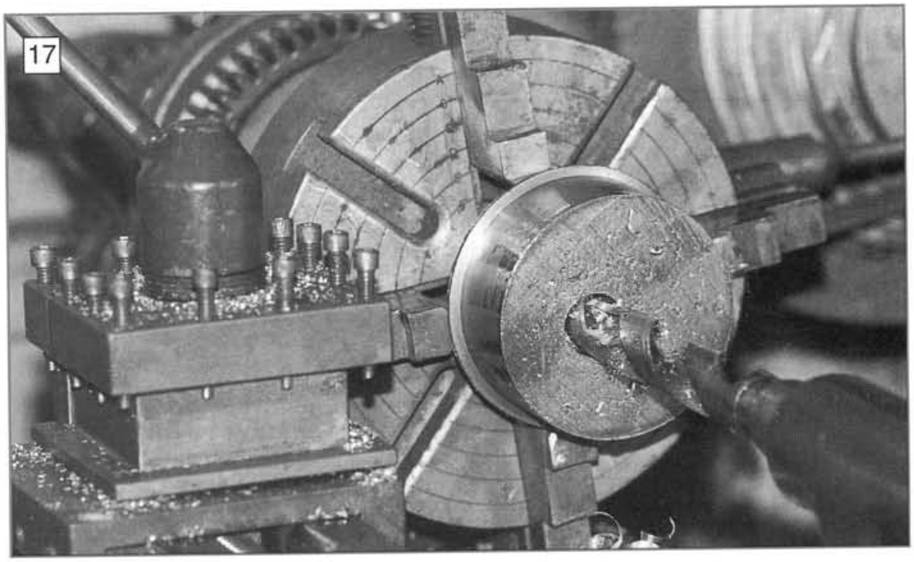
Top collar and leadscrew.

The wheelhead has to be mounted on one of the four sides of the block, hence the reason for getting the appropriate side flat and parallel to the bore. Some adjustment is provided in order to set the wheel spindle square with the worktable, as separate plates are screwed to the block and these, in turn, form a mounting for the wheelhead distance pieces. If bright mild steel has been selected as the block material, no additional machining should be necessary, but if one side of the mounting block does need to be milled flat, **Photo.15** shows how this can be achieved. A bar of the correct diameter (perhaps the column bar itself) is passed through the bore of the work and clamped on to a matched pair of V-blocks located on the milling table. The mounting block is clamped to the bar utilising the pinch screw holes. All sharp edges should be removed from the block, as the operator's hands are often in the vicinity when the grinder is being used.

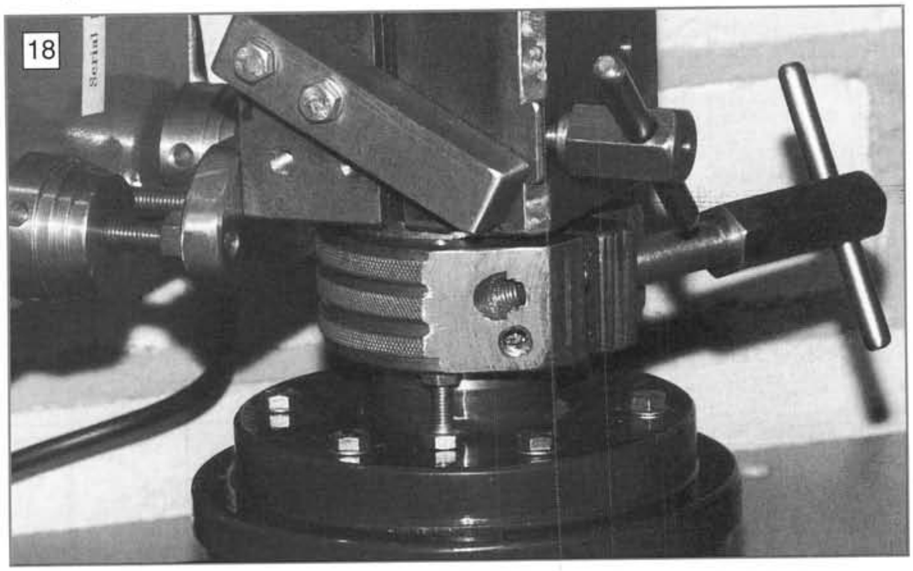
The Collars

Two collars are required to fit over the column. One is placed above and the other one below the wheelhead mounting block, each obviously having a bore diameter which corresponds with the diameter of the column. The purpose of the lower collar (**Item 7**) is simply to act as a stop which is there (when correctly set) to prevent the wheelhead from falling too far when the pinch screws are fully released. It is a split collar, and is moved up or down by hand then locked in position with a single pinch screw.

The upper collar (**Item 6**) serves a very different purpose, however. As the position of the wheelhead on the column is regulated by a small jacking leadscrew, this screw must have something fixed against which to jack. The upper collar is made in a similar way to the lower collar, except that it has a bracket attached to it to accommodate the leadscrew (**Photo. 16**). With all the pinch screws free,



Drilling a collar blank in the lathe.



Lower collar stop.

wheelhead and collar may be set in position on the column. If the upper collar pinch screw now tightened, the position of the mounting block can be controlled by the leadscrew, so it is this technique which is used to apply a 'cut' to the work.

Photo. 17 shows the collar blanks set up in the lathe, gripped eccentrically in the 4- jaw chuck. This offsetting produces a thin wall to one side of the collar, which allows it to 'spring' as the pinch screw is used. The thick wall left on the opposite side provides enough material for further machining. As with the wheelhead mounting block, the collars have to be split, and the same 6mm end mill was used to do this. The pinch screw holes are drilled and tapped first, though, and the flats milled on.

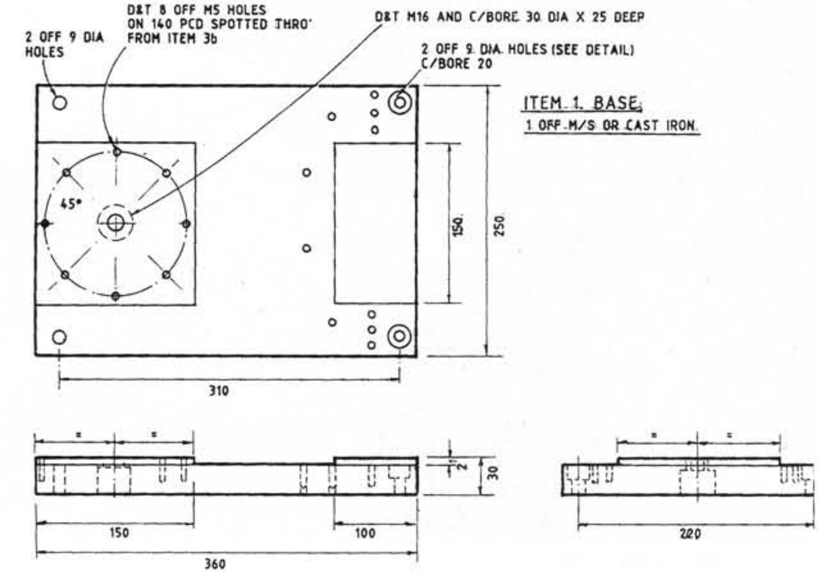
The lower collar has a tapped hole in the underside, into which are fitted a small screw and locknut (**Photo. 18**), which can be used as a positive stop and which can be adjusted so that the grinding wheel will never come into contact with any part of the machine, such as the face of the magnetic chuck. If the wheelhead is accidentally dropped all the way down the column, no damage will be done if the stop is set.

The Pinch Screws

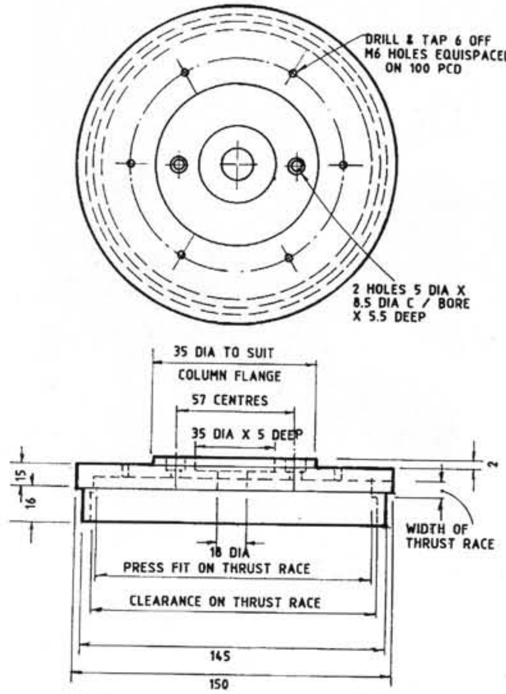
Four pinch screws (**Item 14**) are actually used on the machine - two on the wheelhead mounting block and one on each of the two collars. They are each fitted with a small tommy bar which acts as a light handle with which to tighten or release them. As the screw is tightened, the slot on the collar or the mounting block is closed up by the small amount needed to securely grip the column. Upon release, the slot springs open again and the bore is free.

In use, both of the collars are locked up solid, the small tommy bars on the pinch screws being just long enough for this purpose. The wheelhead block is not locked up solid, but the tommy bars provide enough sensitivity to 'tweak' them sufficiently.

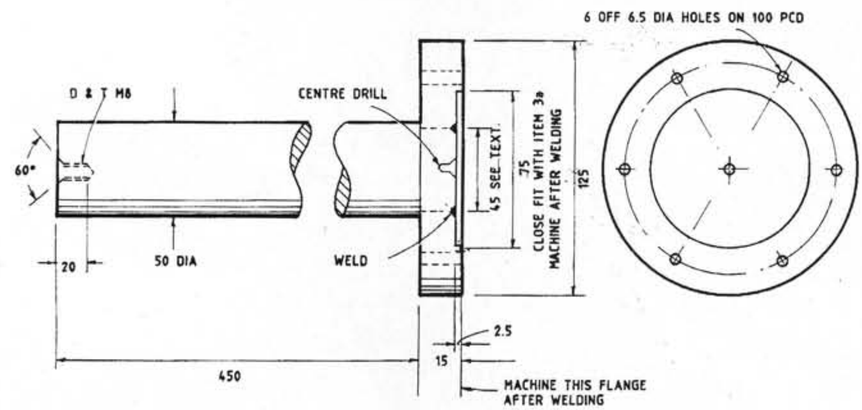
I have manufactured these pinch screws out of stock hexagon bar, but they might just as easily be made from round bar. It will be noticed that the overall lengths vary, this being to effect easy access to them in the midst of all the other paraphernalia which is fitted to the column.



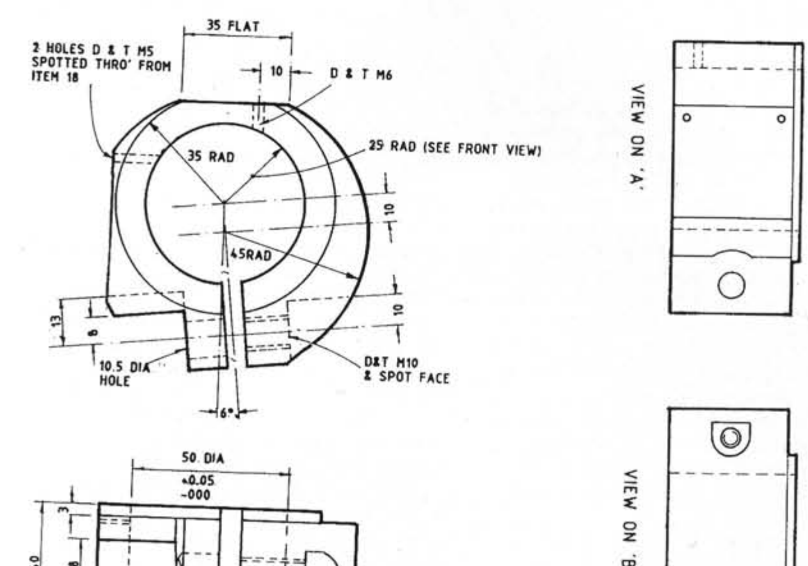
ITEM 1. BASE.
1 OFF M/S OR CAST IRON.



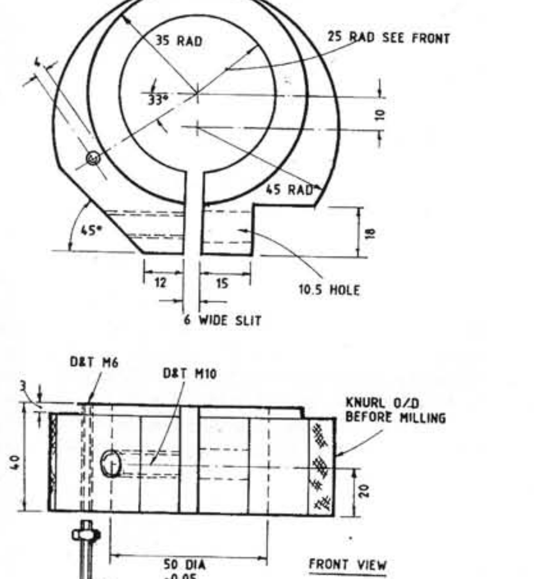
ITEM 3a TURNTABLE (TOP HALF)
1 OFF M / S



ITEMS 2a & 2b COLUMN UPRIGHT AND FLANGE 1 OFF : M/S



ITEM 6 UPPER COLLAR 1 OFF M/S



ITEM 7 LOWER COLLAR 1 OFF M/S

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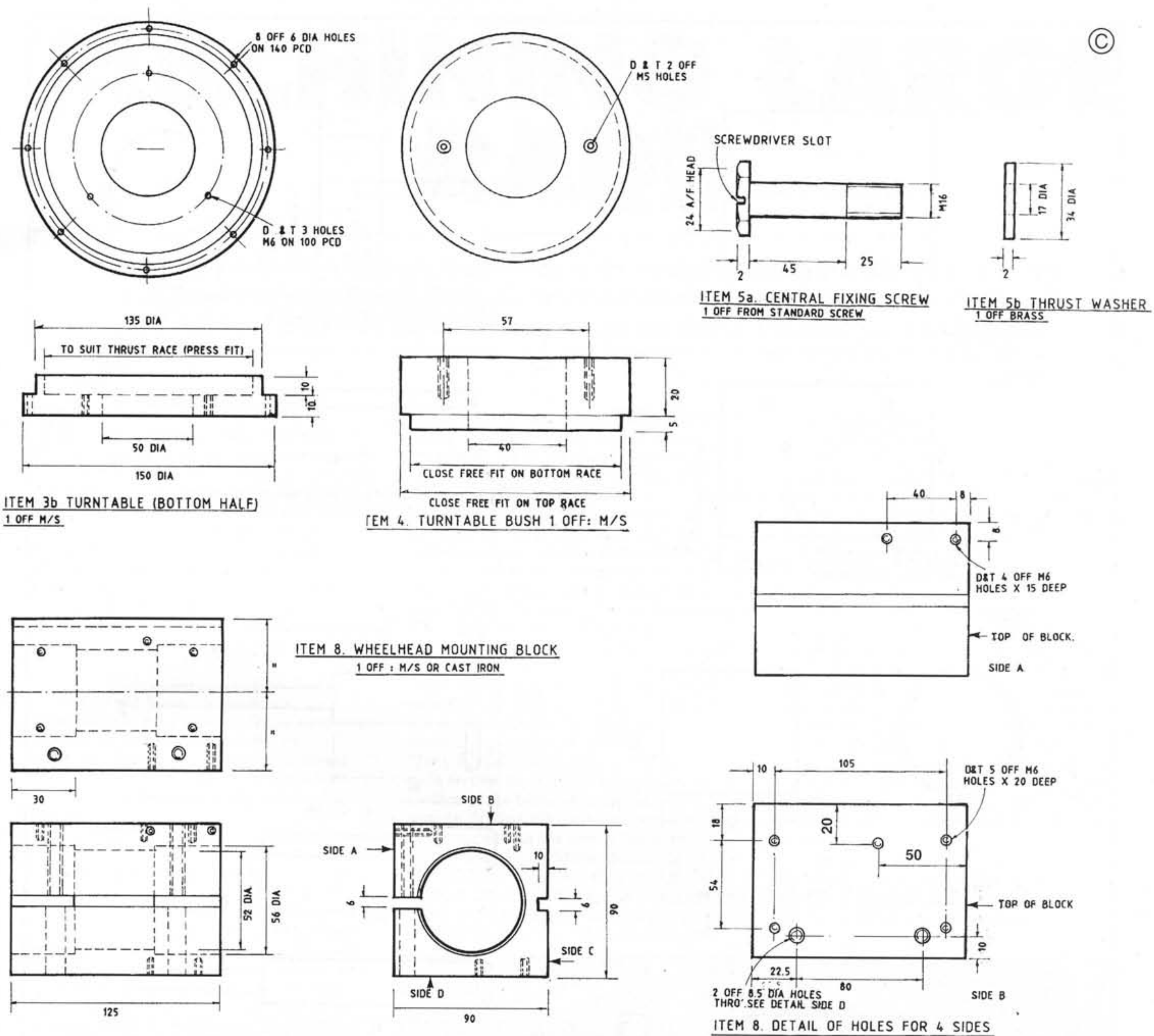

SWING GRINDER Parts List

Item No. Description

(Part 1)

Item No.	Description
1	Base
2 a	Column Upright
2 b	Column Flange
3 a	Turntable - Top Housing
3 b	Turntable - Bottom Housing
4	Turntable Bush
5 a	Turntable Central Fixing Screw
5 b	Thrust Washer
6	Upper Collar
7	Lower Collar
8	Wheelhead Mounting Block
9	Mounting Block Bush
10	Spacer Plates
11	Spacer Bushes
12	Spacer Jacks
13	Wheelhead Studs
14 a, b, c, d	Pinch Screws