UNIVERSAL CUTTER GRINDER (1)

Background

Some years ago I bought a second hand milling machine. Until then I had limited myself to some milling on my lathe. The cutters I used seem to have endless life in this situation. But putting them at work on a real machine meant that the keen edges were fairly quickly dulled. You can then try to continue milling with a blunt cutter or buy a new one. The latter alternative is simple but expensive? So the only real alternative is grinding the mills before surface quality gets too bad.

The famous make or buy decision had to be made! At that time I was not aware of the existence of the Model Engineers' Workshop magazine. It is not readily available in the Netherlands (I know of only one bookshop where you can buy it). Had I known more about the magazine and the trade suppliers, I probably would have tried to get the parts for the Quorn, or the Kennet. But as this was all unknown to me I decided to develop my own grinder. Since this machine turned out to work very well and was built without any castings it might be of interest for those readers not easily able to buy the castings for the machines mentioned above.

Safety conscious readers will note that for illustrative purposes, the wheel guard is absent in all photographs. Likewise none is detailed in the drawings. Prospective builders will no doubt make their own provision, and depending on the location, may need to conform to local legislative requirements. Some comments on safety will be included in the second section of this article

Victor Elsendoorn of Sassenheim, Holland, produced this effective design based on commercially available stock materials.

Operation

Before starting the detailed description on how to build, a few words on how to operate the machine may be of interest. It is very easy to sharpen the end teeth of end mills and slot drills, (**photo 1**). After the cutter is installed in the fixture the work head has to be placed in its horizontal position. This can be done with the help of a centre gauge. To this end, I use a modified scribing block that is adjusted to the centre height of the head, setting to the centre of the knob which clamps the head pivot (**photo 2**). Next, the first tooth is placed in the horizontal plane. The centre gauge is used as a reference, and the adjustment made with the help of the tooth rest, (**photo 3**). The cutting angle can be adjusted now by rotating the head on its horizontal axis to the desired angle. After setting the head on its vertical axis, the machine is ready for grinding.

The grinding process starts by placing a stop dog to prevent the longitudinal slide moving to far and allowing the grind wheel to damage the centre of the cutter. The cross slide should then be moved towards the stone, making use of the handwheel in front of the machine. The slide should be moved till a light cut can be taken. By moving the slide by hand in the longitudinal direction, the full length of one cutting edge can be ground. After one stroke, the cutter is turned to the next tooth and the next edge given similar treatment. Repeat this sequence until all edges are sharp along full length. The grinder may also be reset to allow the helical edges to be sharpened (**Photo 4**). Harold Hall's recent article gave comprehensive guidance on primary and secondary relief angles, and on grinding the helical edges, so it is probably not necessary to repeat this in detail.

The building process

Some aspects of construction will benefit from a high degree of precision. For readers who may not be familiar with the convention, it may be worth noting that some drawing dimensions carry a suffix e.g. H7, which is an internationally recognised tolerance.

The work head

I started with the work head. This part consists of a body (cast iron) and a spindle (mild steel) which can turn in the body. Inside the spindle a collet for holding the mill can be placed. I decided to make use of the collets that were supplied with the milling chuck. These are of a Clarkson style, made by Bakuer, and fit neatly in the conical seating and the 27mm bore. It is understood that some Clarkson style collets feature a slightly larger diameter (28mm) and if yours are to that pattern, then the 27mm bore in part 9 should be altered to 28mm, and the 29mm x 1.5mm thread on parts 9 and 10 should be changed to 30mm x 1.5mm. The collet design is a straightforward conical arrangement which can be home made with no great difficulty if you do not have standard commercial collets.

The best way is to start with the spindle (**item 9**). Turn a piece of mild steel roughly into the right shape and drill a hole of 13 mm through the centre. Open up the bore to give 27 mm dia. over a length 30 mm.. Produce the thread with a pitch of 1.5 mm. The outside of one end will be brought to its nominal size without removing the item from the chuck.

As was indicated the collets have a conical seat. The matching contra-cone should be produced inside the spindle. This will be done by setting over the top-slide of the lathe to the right position. My method of copying the angle from existing collets, involved putting the collet between the headstock and tailstock centre and running the top-slide along with a DTI mounted in position. My collets have a slope of 8 degrees. If you intend to produce the collets yourself, set the top slide over to approximately 8 degrees and do not disturb it you have produced the required number of cones. (I need only four collets: 6, 10, 12, 16 mm)

After setting the top slide angle, you can mount the spindle in the 3-jaw chuck. Make sure that the work runs true by using the 13 mm hole as a reference. (If your three jaw is significantly out then you may achieve better accuracy with a four jaw.) Open up this hole to the size of the small end of the collet. Having reached that position start with machining out the taper making use of the top slide. Unfortunately there is no way to check the taper with the

2. Setting the centre gauge

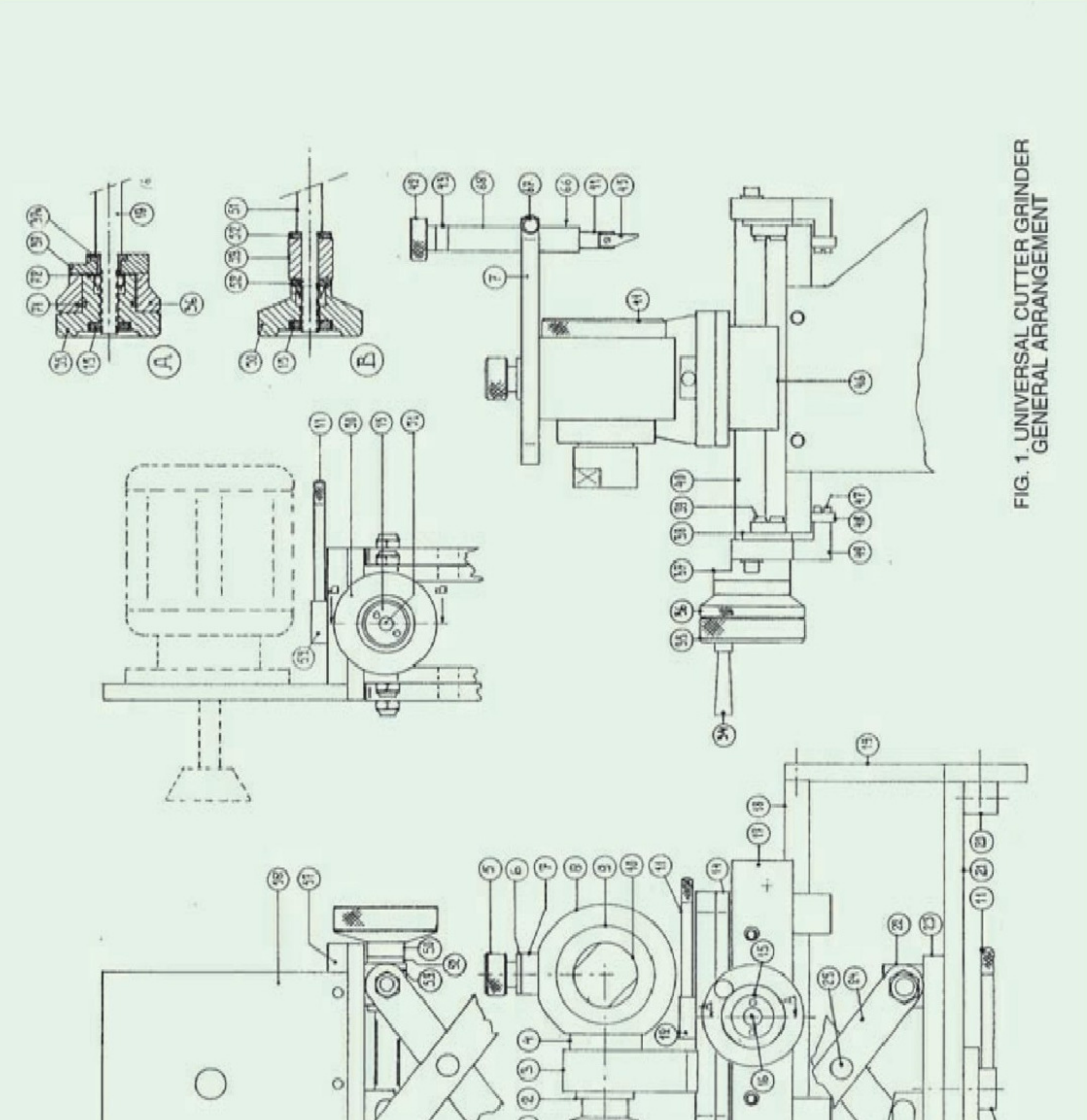


FIG. 1. UNIVERSAL CUTTER GRINDER GENERAL ARRANGEMENT

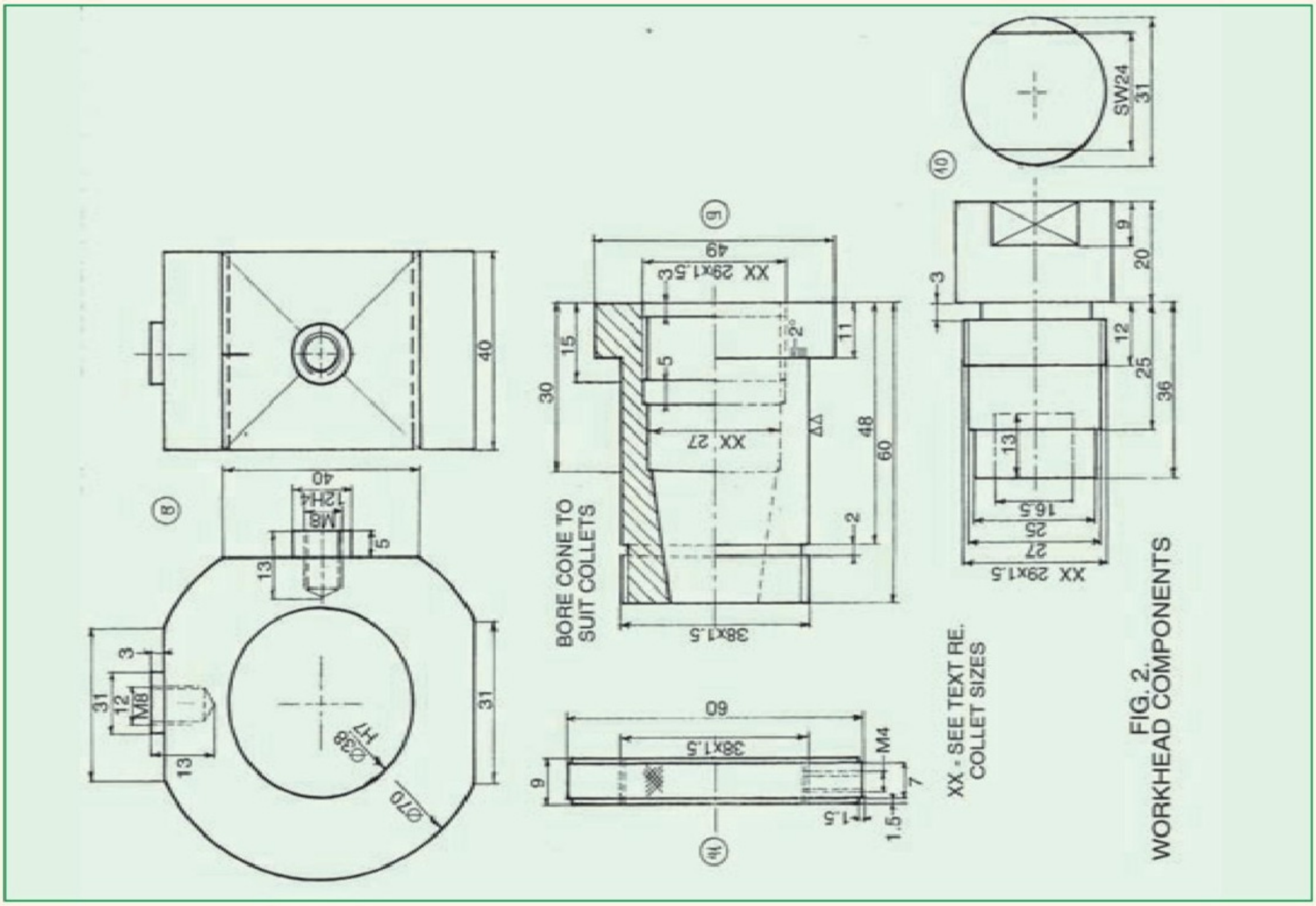


FIG. 2. WORKHEAD COMPONENTS

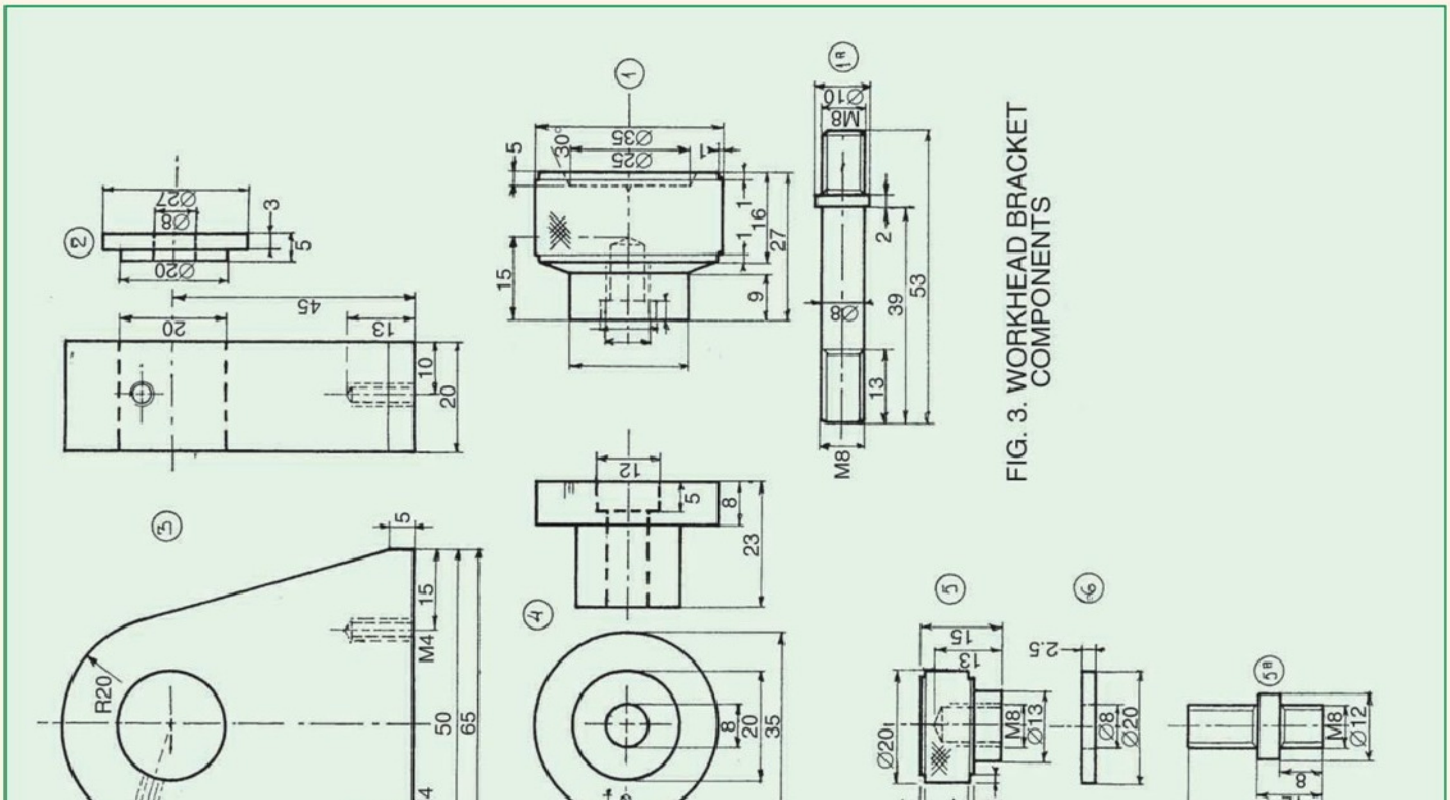
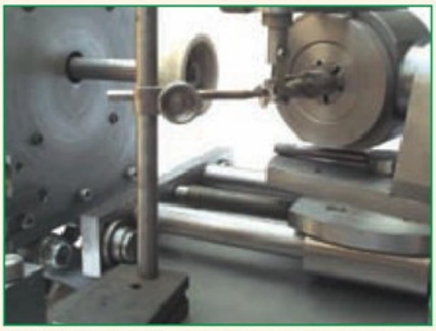


FIG. 3. WORKHEAD BRACKET COMPONENTS



3. Setting the first tooth edge horizontalz

collet since the smallest side of the hole is pointing towards you. So you have to trust that everything works out well inside the spindle. Place the tail stock centre in the hole and turn the outside to size. Make sure that the surface is well polished. The last step is producing the external thread. By taking this production sequence there is a good chance that inside and outside features are concentric which is absolutely crucial for producing good grinding work. The graduation of one end of the spindle can be made using a dividing head on the milling machine. Other methods will no doubt be applicable, depending on your own equipment. My own choice was to produce divisions at two degree intervals, with every fifth division being extended.

Item 10, which will push the collet into position, and close it on the cutter, is a straightforward piece of turning work. Make sure that it fits with the collets you are using.

The body (**item 8**) is made out of cast iron. The advantage of using this material is that a very good finish can be produced and that it is somewhat self-lubricated. While opening up the centre hole the spindle should be used to check for the bore size. I chose to cut the three flat surfaces by using the four-jaw chuck. It would equally be effective to mill from an angle plate. Make sure that everything is square and that the features for mounting the knobs are exactly on the centreline.

The ring (**item 41**) is a straightforward piece of work. It is fixed with a grub screw. To prevent the screw damaging the thread a small soft metal disk (brass, copper or aluminium) should be made and placed under the screw.

The bracket

The drawing of this, (**item 3**) is self-explanatory. The hole, after it was drilled, has been bored out in the lathe, gripping the work in the 4-jaw chuck. By doing so a good surface quality can be achieved. The bracket has to be very rigid, and this is the reason for using this size of material. A bush is produced with two-degree graduations (**item 4**), which is used for setting the cutting angle of the cutter to be ground. A small hole (2 mm) is bored in the side of the bush and is used for aligning it in horizontal position.

The head is fastened to the bracket by a steel knob (**item 1**) working with a pillar screw (**item 1a**). This arrangement prevents the head from moving too far, and also serves to avoid undue wear in the relatively short hole in the cast iron.

The bracket base

The bracket base (**items 13 &14**) is made out of two parts of black steel 70 x 15 mm. This material was turned flat and to size in the 4 jaw chuck. While doing this, a spigot of 25 mm dia. and 2.5mm high should be left in the centre of one of the plates. In the other plate a corresponding recess should be cut. A M12 thread has to be tapped though the centre of the stub. This provides the means of clamping the two plates together In one of the corners a 4 mm hole has to be drilled. A small pin can be put in the hole. This is to mark out and fix the zero position. By clamping both plates in the 3 jaw chuck, making use of a stub mandrel and the M12 thread, the outside can be turned. If a dividing facility is available on the lathe, the two degree divisions can be marked while keeping both plates clamped in position.

After having machined both long edges of the plates, the grooves can be milled out. The purpose of the grooves is to ensure that the bushes on one side and the bracket on the other side are all parallel to one another. Make sure that your vice is well positioned for this purpose and that all work is done with the same side of the plate towards the fixed jaw of the vice.

4. The grinder set up for helical edges.

The two bushes (**item 46**) should be made out of brass or bronze. The centre holes have to be opened up to 14.9mm and then reamed with a 15mm H7 reamer. Silver steel, is chosen for the slide bars as it is normally very close to nominal size, and will accurately fit these holes. Slide both bushes on one of the bars, and clamp them together in the mill vice. By clamping the bushes together, and machining as a pair, the T-form on both will be exactly the same. The nut, which has to fit the lead screw, will be produced after the lead screw is made.

The second section of the article will cover the remaining sub-assemblies, slide, base and motor mount.

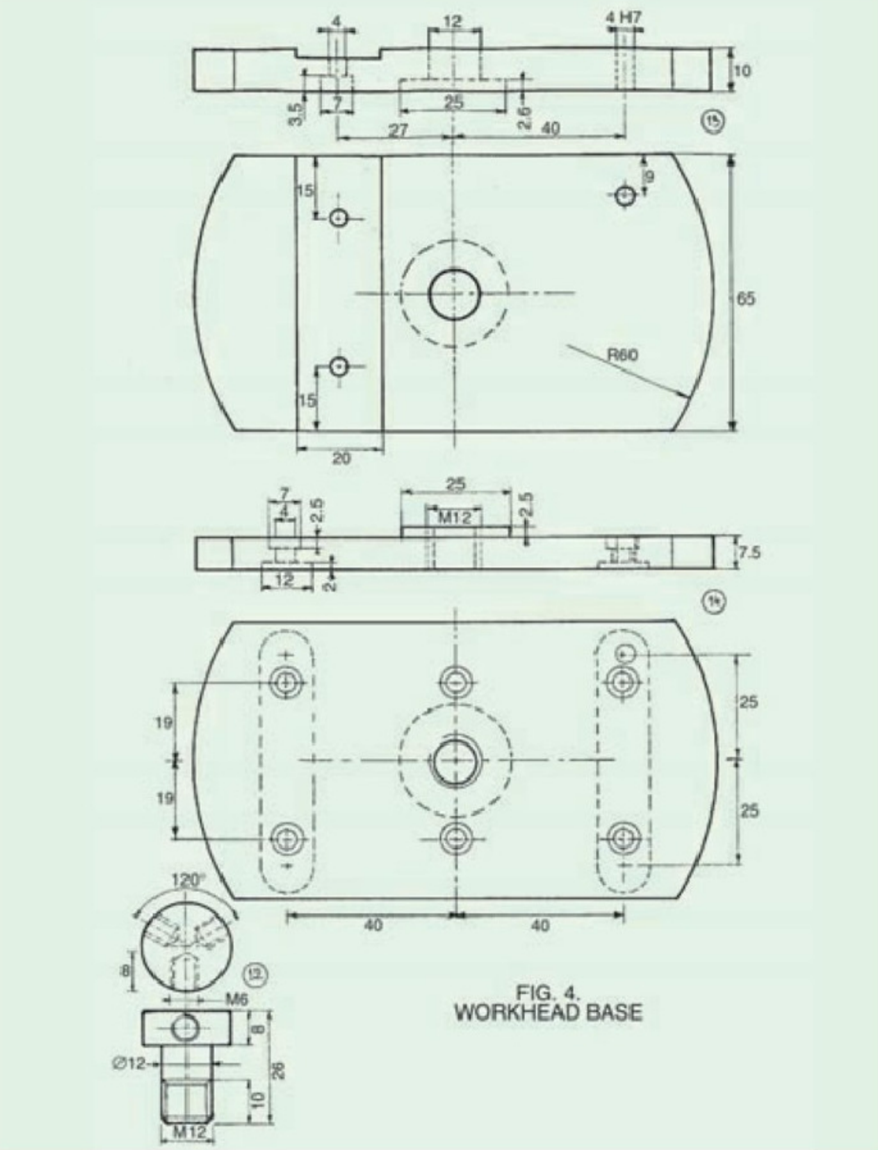


FIG. 4.
WORKHEAD BASE