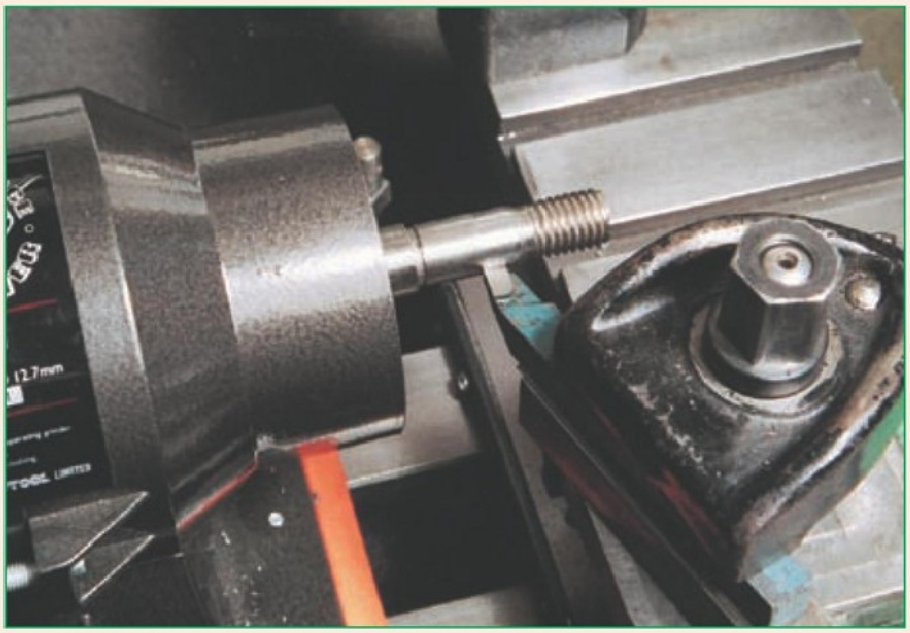
TOOL AND CUTTER GRINDING HEAD



1. Machining the grinder's spindle whilst powered by its own motor.

As an addendum to the Milling projects series, Harold Hall describes the modification of a cheap bench grinder for accurate T & C grinding.

Rationale

Having put to use the grinding rest and its accessories described at the end of the milling projects series I was more than delighted with the results achieved. However, using a standard off hand grinder, I soon became aware that having both cup and saucer wheels available would improve things still further. This is not surprising as such wheels are standard practice for serious tool and cutter grinding. Several of the standard wheel forms are given in the accompanying sketch, (**Sk 1**).

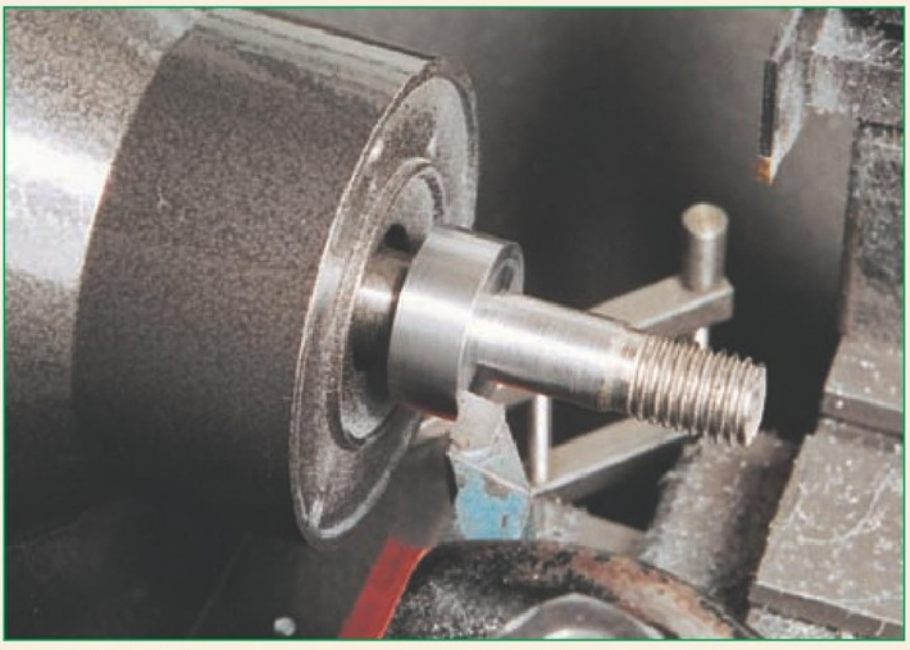
Making a spindle and motorising this with some form of belt drive I considered to be too much effort for what would be of limited benefit. I had though, purchased previously, a small (125mm) off hand grinder to use as a drive motor, having stripped it of its wheels, and thought that I could convert this to take the cup and saucer wheels.

As it had cost only around £18-00, I was concerned that at this price the bearings may not be up to scratch, but checking for shake and end float found them to be perfectly adequate. I originally purchased this from the local DIY superstore but they no longer seem to be available from this source. However, at the time of writing this article, Machine Mart do still list a grinder of this size, but failing this similar quality grinders with 150mm diameter wheels are available at only a few pounds more.

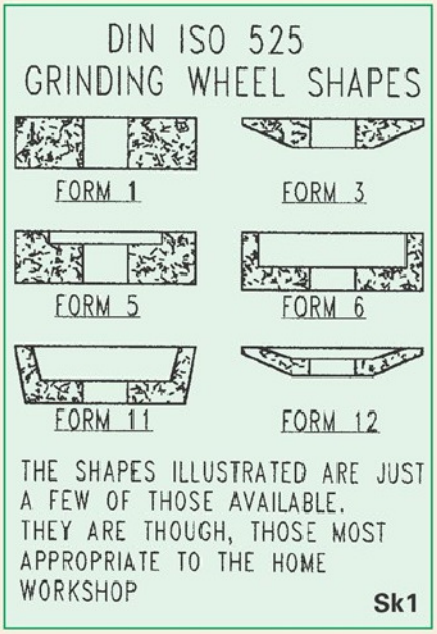
Design considerations

Common practice when using these types of wheels, which usually have larger centre holes than the wheels originally fitted to budget grinders, is to fit them with permanent adapters (although cheap commercial, non permanent items are frequently plastic mouldings). These enable wheels of differing styles to be interchanged very quickly and with only minimal need of truing up at each change. The published assembly drawings **GA 1** and **GA 2** should make the situation clear. I have also included dimensioned detail part drawings though these will need to be checked carefully against your own situation. Spindle diameter and length, hole diameter in the wheels and their thickness are areas that must be considered.

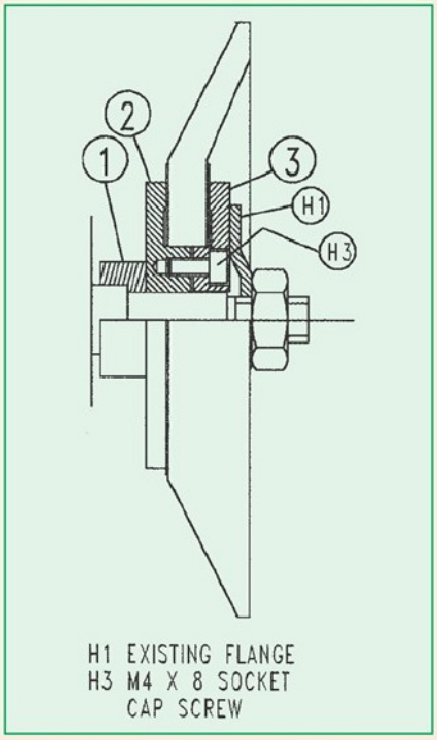
The dimensions given suit a 12mm spindle and a nominal wheel bore size of 31.75mm. In order to work with complete wheel and flange assemblies, I have indicated an arrangement using a combined bush/flange (parts 2 and 3) on each side of the wheel, clamped lightly together by three capscrews (H2 & H3). This does not give much scope for positioning the screws H2 and H3 and this would become more difficult if the grinder has a larger spindle. My 150mm grinder does though have a 12mm spindle so perhaps the problem may not arise. Since the screws do not carry any great load, it is likely that their diameter could be reduced to M3. It would also be quite feasible to produce an arrangement having one bush/flange as part 2, working in conjunction with a flange/washer combining the functions of parts 3 and H1. In this case, the individual components would naturally separate on removal of the spindle nut, losing much of the advantage of the pre-assembled quick change.



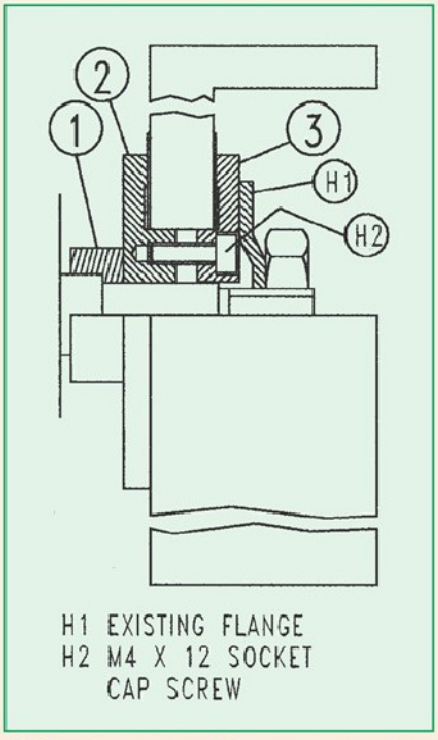
2. Machining the face of the added bush again powered by its own motor.



The step in the spindle against which the wheel flange adjoins was not well made and more importantly only 1mm high. This was improved by the addition of the Spindle Bush (**Fig 1**) which was fixed to the grinder spindle using a two part resin adhesive. I did not though consider this alone was sufficiently accurate, and machined the bush's face, whilst in situ, using the grinder's own motor for power. I mentioned above a spindle diameter of 12mm, however, as purchased, the spindle was ½in. diameter and machining took place as follows. Leaving the spindle at ½in. and making the bush to suit should be satisfactory but I would still recommend machining the face against which the wheel clamps whilst on the spindle, doing this whilst powered by the grinder's own motor. I would also check that the ½in. spindle runs true before leaving it at that diameter. The following is the sequence of events as I undertook them.



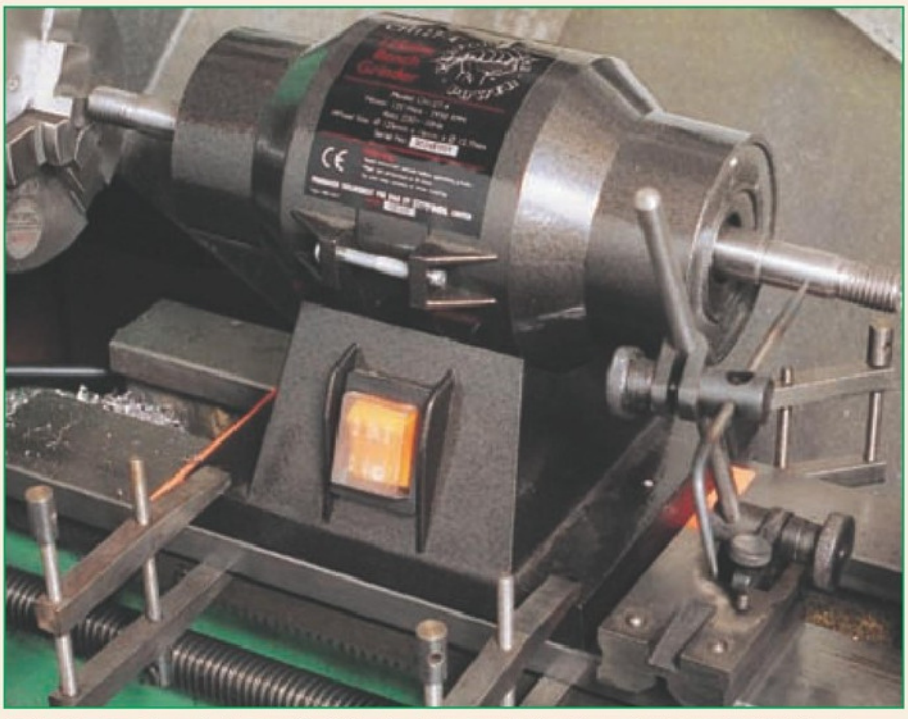
GA1 - Saucer wheel flange assembly



GA2 - Cup wheel flange assembly

Grinder spindle

First I checked to see if the spindle ran true using a dial test indicator. It was OK but I still decided to reduce to 12mm as there was a small difference in diameter between the two ends, also they were poorly machined. The preparatory work involved making both Spindle bushes (1), and cutting a piece of tube to length and trueing up the ends on the lathe. The grinder was then set up on the lathe bed (see later comments re this requirement) and the first end machined to 12mm diameter as illustrated in **Photo 1**. Whilst the grinder was still on the lathe, the first bush was fitted using two part resin adhesive, the part being held in place using the piece of tube and the spindle nut. This was then left for a few hours for the adhesive to set, after which the nut and tube were removed, and a very light cut taken across the bush's face, **Photo 2**. The grinders speed of 2950 rpm was on the high side but for the limited machining taking place and with a carbide tip, there was no problem. The grinder was then removed from the lathe, turned round, refitted and the sequence repeated on the second end.



3. Setting up the grinder on the lathe bed for machining the spindle and added bush.

Mounting the Grinder

Mounting the grinder on the lathe bed will depend both on the type of lathe bed and the form the grinder base takes, as a result precise details cannot be given. On the plus side, only very light cuts will be taken so the security of the mounting will not be severely tested. Because of this, no matter what form the bed takes, adequately mounting the grinder should not present a problem. If the bed ways are rectangular then four small toolmaker's clamps (**Photo**

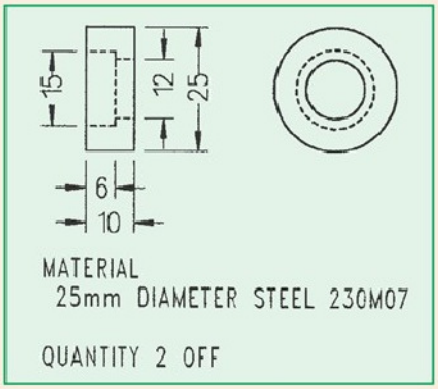
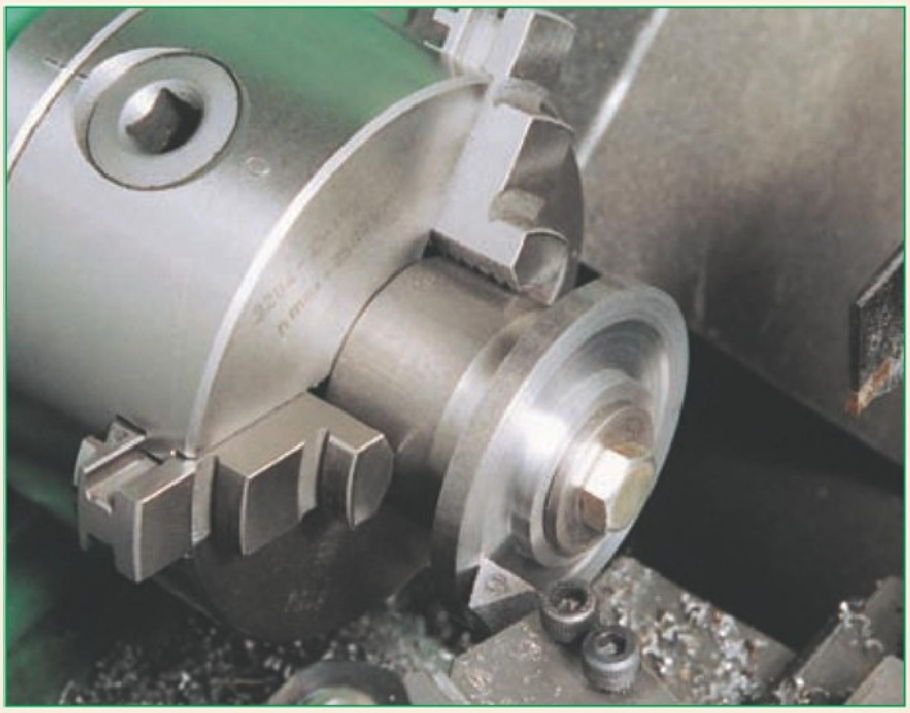
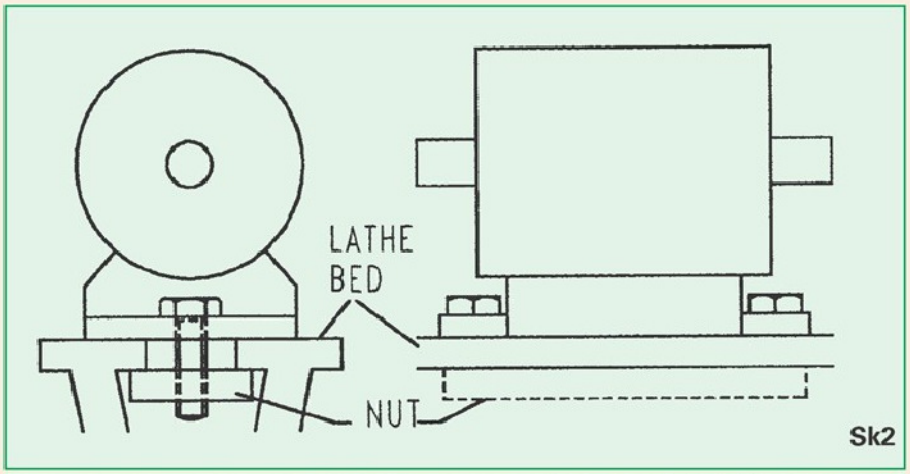
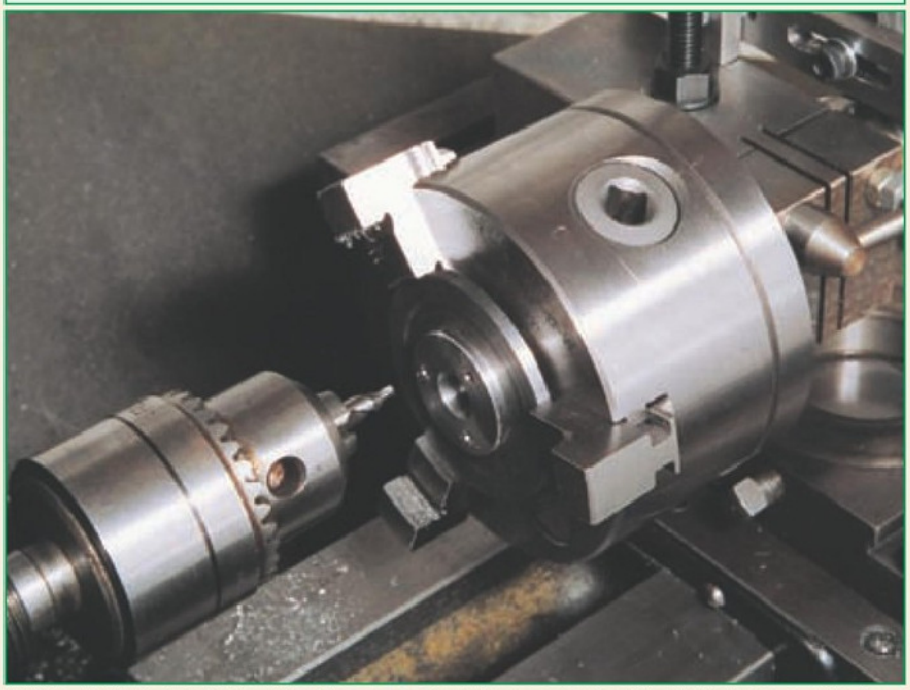


Fig 1 - Spindle bush



4. A stub mandrel is used for holding the flanges for machining.





5. The dividing head, described in a recent article, mounted on the lathe's cross slide for marking out the three holes in the flanges.

3) make an ideal method. Alternatively, if the grinder has a two screw mounting, then a length of steel of suitable width could be tapped to take two fixing screws as illustrated in **Sk 2** or, if four hole fixing, with clamp bars as in **Sk 3**. If the lathe has a Vee bed format then probably these methods could be adopted using some additional packing. If concerned regarding possible damage to the slide ways some thin card packing will eliminate the possibility. Having said that the mounting will not be called upon to withstand heavy loads, do not be complacent. Do give the spindle of the grinder a good tug to check adequacy of mounting prior to machining.

When mounting the grinder the spindle should run parallel to the lathe's axis. Using a surface gauge, with the two pins lowered and against the lathe's bed, check the position of the spindle at both ends using its scriber as seen in **photo 3**. If you have always wondered what the two pins in the surface gauge are for, now you know. For greater accuracy, a dial test indicator could be used in place of the scriber, with care though the scriber should give adequate results. When setting up for machining the second end, allowance must be made for the different spindle diameters. If the diameter of the first end has been reduced to 12mm, then if using the surface gauge with its scriber, the use of a 0.35mm (0.014in.) feeler gauge at the first end will compensate for the difference in the two diameters.

Inner and outer flanges

(Figs 2 and 3)

The essential requirement for these is for their bore, the face which contacts the wheel and that which locates against the spindle bush to be true and parallel and the 32mm diameter concentric with the bore. A detail section of the flanges is given, illustrating the profile which ensures clamping towards the outer diameter, and avoids the possibility of interference with the ends of the wheel bore.

Cut two pieces of 60mm diameter 11mm long and two pieces 9mm long. Place in the three jaw using the reverse jaws and face one side of each. Then reverse, making sure that the already machined face sits cleanly on the chuck jaws, and face the second side to 10 and 8 thick, respectively. At the same time bore each one to a little under 12mm, say 11.6mm. It is essential that the holes in all four flanges finish up the same size. To achieve this, continue opening up the fourth flange to 12mm diameter and leave the boring tool set at this diameter. Replace each flange in turn and using the boring tool at this setting open up to 12mm at one pass. Again ensure that each flange sits cleanly on the jaw steps for this operation. Note that the outer flange is opened up to 12.5mm. at a later stage.

Make a 12mm Stub Mandrel using a piece of material in the three jaw and at least 25mm diameter. First, face and tap the end M8 then turn a 12mm stub 7.5mm long. The 12mm diameter must be a close fit, almost a light push fit, in the bored holes in the flanges. Once made do not remove the mandrel from the chuck until

all four flanges have been machined.

Fit the first flange using an M8 screw and large washer and machine to the 32mm and 5mm dimensions, make also the 0.5mm deep recess, **Photo 4**. Ensure that the 32mm dias. are an easy fit in the grind wheels. Any form of interference fit here would risk cracking the wheel. Repeat for the remaining three flanges. Return the two outer flanges (3) to the chuck and open up bore to 12.5mm as per the drawing. Drill, tap and counter bore as required. Using a centre drill and the dividing head described in the milling projects series mounted on the lathes cross slide, position the holes as shown in **Photo 5**. For this arrangement I added an additional hole in the body of the dividing head for easy fixing, - see the single stud fixing visible in the photograph. It would be a good idea to make a tubular spacer, say at least 30mm diameter and of the correct height to bring the dividing head's spindle exactly up to lathe spindle height, retaining this for future applications.

The wheels

Whilst perhaps not readily available from normal suppliers to the home workshop, the wheels required are widely used in industry and should therefore be available from your local (or maybe not so local in remote areas) abrasives or engineering equipment supplier. Reference to your local Yellow pages should provide an address. The following items are those that I used, though your local supplier may offer something different, albeit only slightly:-

Taper cup wheel, Type 11, 125mm outer diameter, 40mm outer depth with a stated hole size of 31.75mm, grade WA60 KV1

Saucer wheel, Type 12, 125mm outer diameter, 13mm outer depth with a stated hole size of 31.75mm, grade WA60 KV1

(Both stated a hole size of 31.75mm but both measured 32mm)

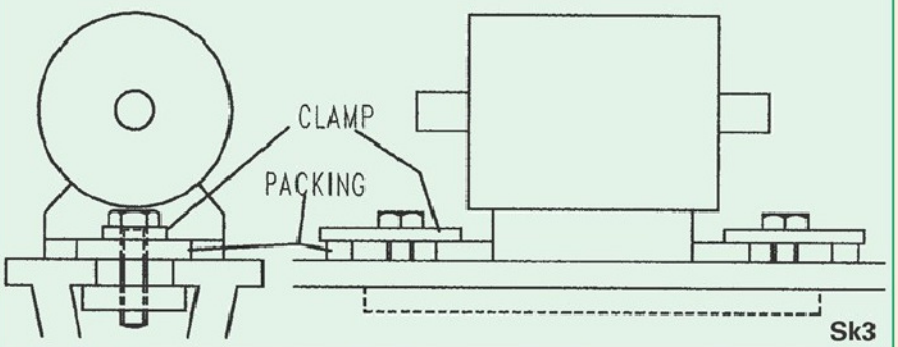
As an alternative to the taper cup (type 11) a straight sided cup could be considered, this would be a type 6. The outlines given in Sk 1 show the more appropriate DIN ISO 525 shapes that are available.

A brief explanation of the wheel material code may be of interest to readers from non engineering backgrounds. WA indicates that the abrasive material is high purity white aluminium oxide. The number 60 identifies the grain size, which may vary from very coarse (circa 12) to very fine (up to 600). K denotes the hardness grade on a scale from A - soft to Z – hard, and V indicates a vitrified bond or process. Other process symbols which may be encountered include S – silicate, RF – rubber reinforced, and O – oxychloride.

If you use a 150mm grinder there is no need to increase the wheel diameters to 150mm as 125mm and 150mm grinders will both run at the same speed, around 2950rpm. The larger wheels are also likely to be significantly more expensive, and maybe more difficult to obtain. Expect to pay around £40 total for the two wheels, whilst opting for a type 6 wheel could make the total cost a few pounds cheaper.

Mounting the wheels

Fix the flanges to the wheels ensuring that the supplied paper disks, known as



Sk3

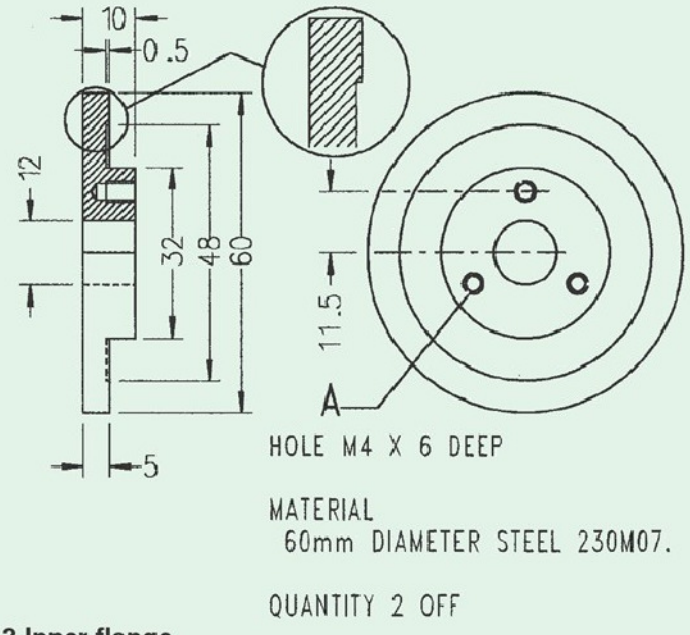


Fig. 2 Inner flange

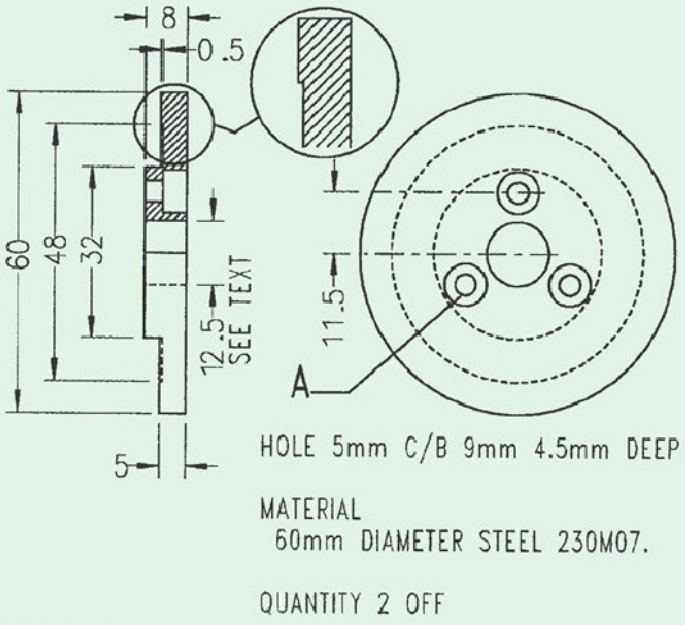


Fig. 3 Outer flange

6. The two grinding wheels and the flanges for adapting the large hole in the wheels onto a smaller spindle diameter.

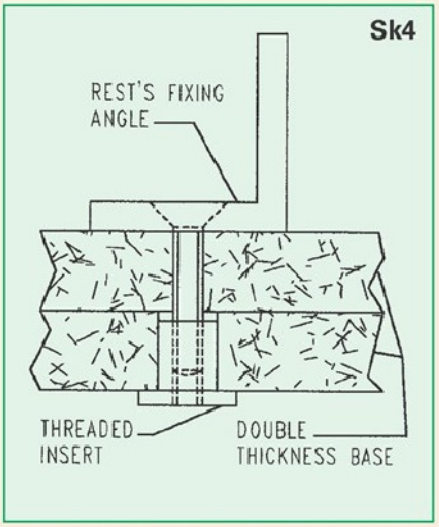
blotters, are used. Very lightly tighten each screw in turn then gradually increase the tightness of each screw, again in turn. They should be tightened just sufficiently to securely hold the assembly together without movement, but certainly not as tight as would be done with a metal to metal assembly. Over tightening must be avoided! Then, using one of the flanges supplied with the grinder mount the assembly onto the spindle as shown in the assembly drawings. Again do not over tighten, just apply sufficient pressure to ensure reliable rotation of the wheel. **Photo 6** shows the two wheels, one already fitted with its flanges.

Mounting the grinder

Both grinder and rest need to be mounted on the same rigid base, any flexibility will cause problems with finish and accuracy, and maybe even safe working. For this I used white melamine faced chipboard using two boards laminated for extra rigidity. These were held together using wood screws from below at the four corners, and with the grinder's and rest's fixing screws also helping. To cope with the fixing screws and nuts that would project on the underside, the edges were finished with strips of soft wood. These were wider than the thickness of the two boards thereby raising the assembly off the work surface.

Direction of rotation

I have read articles, though where at this time I am not sure, so cannot recap, which mention the need for cutter grinder spindles to be reversing. This caused discussion on the advisability of this when using a single central nut for fixing the wheel as it may tend to come loose. In this arrangement there will be no problem as the apparent direction of rotation differs from end to end, the right hand end being anti clockwise and the left hand, clockwise. As a result the spindle has left and right hand threads to cope safely with this situation.



Mounting the Rest

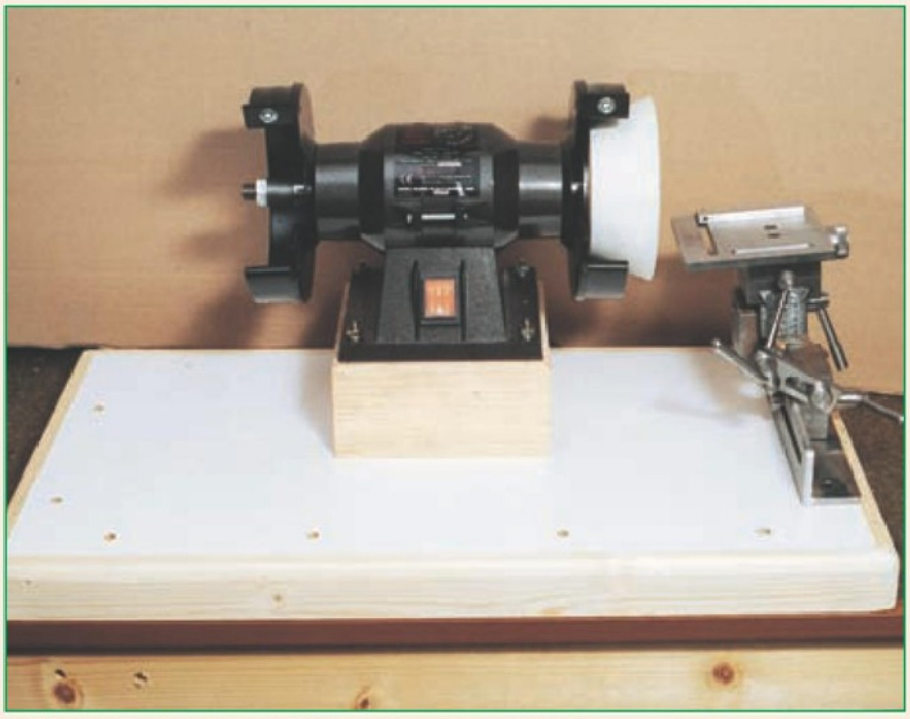
Mounting the rest with the grinder follows the same basic set up as was illustrated in the earlier articles. However, a second position for mounting the rest should be provided at the grinder's side as approaching the cup wheel from this angle will be beneficial in some instances. The mountings should also be repeated at the left hand end. **Photo 7** shows the set up, note the three additional pairs of holes for mounting the rest in the alternative positions. For ease of use, consider fitting inserts in the lower board as shown in **Sk4** as this will avoid the need to gain access to nuts on the underside when changing the rest's position. Make the inserts a push fit, and retain if necessary with two part resin adhesive.

If you are able to obtain a 125mm grinder it is likely that the rest may be a little on the high side for this, possibly more so for a 150mm grinder. The height may be readily adjusted by using a suitably thick piece of wood as a packer.

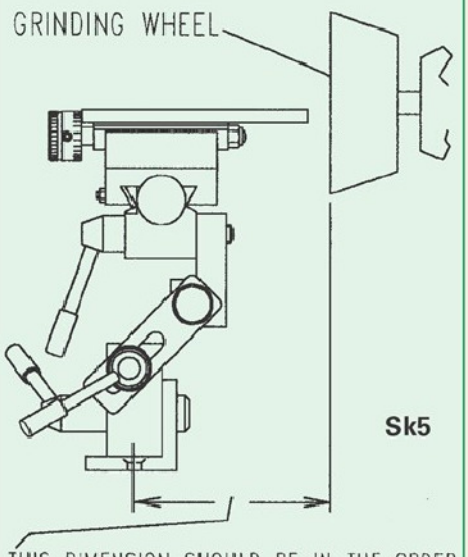
I have not given any dimensions for the overall assembly as these will depend on the dimensions of the grinder being used. However, there is one point that needs expanding on. The method of moving the rest's table closer to, or farther from, the wheel is to pivot the side arms. The design of the rest does though only provides for these to advance the table in front of the base angle as can be seen in **Photo 8**. The reason for this is that upright of the base angle limits the ability for the side arms to swing to the rear. This situation must therefore be taken into account when positioning the base angle relative to the grinding wheel ensuring that it is not too close as this will result in adjustments being difficult to make, see **Sk 5**.

Guarding

I have, as can be seen in the photographs, for the moment, chosen to retain the guards that were part of the original



7. The rest and grinder mounted on a purpose made base.

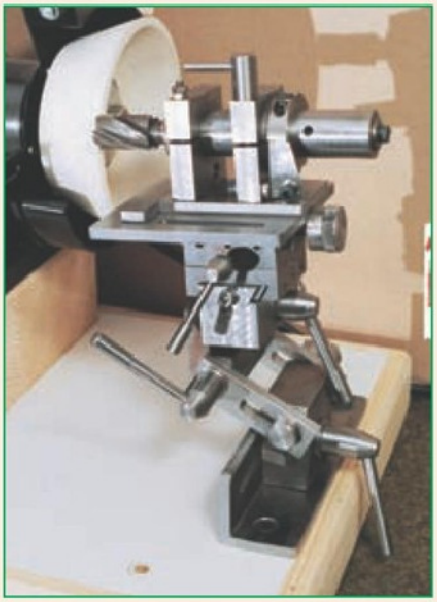


8. The side arms permit the table to be moved forward of the base angle, but the vertical web of the base angle prevents adjustment in the other direction.

grinder. As can be seen in photo 7, these are unsatisfactory in terms of coverage now that the wheel projects further forwards, but I feel that only through experience of use will I better understand the level of access required to the wheels, and will then construct a guard offering both protection and convenience. I would though suggest that as removal and fitting of the wheels is very easy, that only the wheel being used should be fitted. This leaves the second spindle without a grinding wheel thus preventing the possibility of accidental contact.

Using the set up

Methods for using the rest will differ little from those described in the earlier article (MEW issue 92 page 12) so have not included any further instructions, I have though included two photographs to show it in action. **Photo 9** shows the end teeth of an end mill being sharpened (sorry for the sharp shadows my slave flash must have been out of position) whilst **Photo 10** shows its cutting edges being ground. These two photographs ably illustrate my comments above regarding adjustments to the rest's side arms. One final comment regarding photo 9, which shows the base angle mounted close to the board's edge enabling the lower clamping arm to rotate a full 360 degrees. This makes it possible to remove the bulk of the rest from the base angle, making it easier to move the base angle between the four mounting positions.



9. Sharpening the end teeth of an end mill with the rest mounted at the side of the wheel and at the right hand end.

10. With the wheel moved to the left hand end and the rest in the front position the cutting edges are being ground.

Other reading

There have been numerous articles in the Model Engineers' Workshop regarding tool and cutter grinding, some of which illustrated the use of both cup and saucer wheels and in various forms of grinder. The following are a few of the more relevant ones that may prove beneficial reading:

Using the tool and cutter grinder (2) issue 17 page 22
Sharpening end mills and slot drills issue 25 page 30
Sharpening end milling cutters issue 44 page 42. This is continued in issues 45 to 48
Quorn Variations issue 79 page 16
The Raymac cutter grinder issue 80 page 42