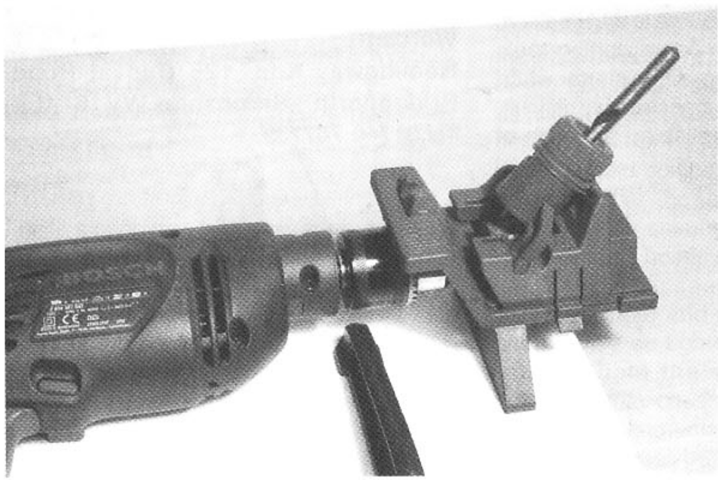
Chapter 2

Drill Sharpening

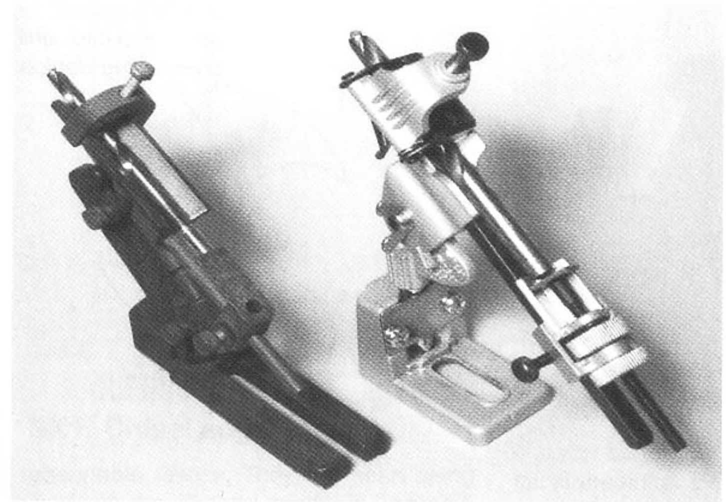
Of all the cutting tools, the twist drill is by far the most likely to require attention, not just in the metalworking workshop but also in other trades, builders, carpenters, DIY exponents to name but a few. Because of this there are many relatively simple devices commercially available for assisting with sharpening them, a situation that does not occur with any other cutting tool where the user is left largely to his or her own devices, apart from, of course, purchasing a tool and cutter grinder.

The methods

Available accessories for the task will divide loosely into three categories. The simplest, are those intended for coupling to a pistol drill and having a very small grinding wheel, that in **Photo 1** being an example. The twist drill is placed into the device being held in a suitable adapter and then rotated by hand causing the drill to be sharpened. There are a number of different units that basically work in this way, probably with more or less success. That in the photograph works well



1 Pistol drill with DIY drill sharpening device.



2 Reliance jig (left) and Modern jig (right).

enough for the less demanding trades but really is inadequate for the metalworking workshop involved in precision work. Many also have a green grit wheel for sharpening masonry drills. Some that work in a comparable way are self-contained with their own motor.

The second category comprises those intended for use in conjunction with an off hand grinder. I have said "those" but at the time of writing this book, reference to around eight catalogues all show the same unit on offer. This is the one on the right of **Photo 2**. Actually, this is less expensive than those I consider DIY items.

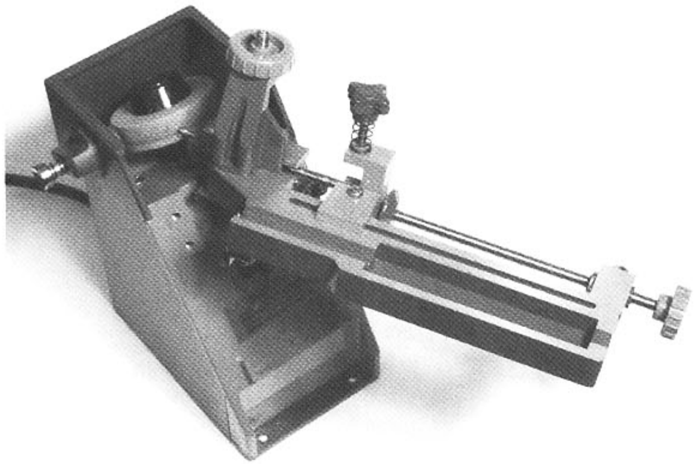
The unit on the left of the photograph is the Reliance drill sharpening jig that was available for very many years but sadly no longer, as the modern version has some minor weaknesses compared to its older colleague. These are:

A. There is some unwanted flexibility in the pivot arrangement that is not present in the older version.

B. The drill with its immediate mounting cannot be removed from the lower part making it a little difficult to rotate the drill for sharpening the second edge.

Having said that, the modern unit is capable of good work with only a little care once one gets used to its minor limitations. It does though have the advantage of the angle being adjustable for special drill shapes, countersinks, etc.

Whilst the unit just described will also find itself in the small commercial workshop, larger organisations will most certainly have dedicated machines for the task which fall into category three. That shown in **Photo 3** is an example, capable of sharpening drills up to 13 mm diameter. Large companies will no doubt have an even more robust and versatile version of this. Actually, I feel that the unit in the photograph really sits between categories two and three and some home workshop owners may consider the expense of owning one justifiable.



3 A high quality, self contained, drill sharpening device.

Sharpening drills free hand.

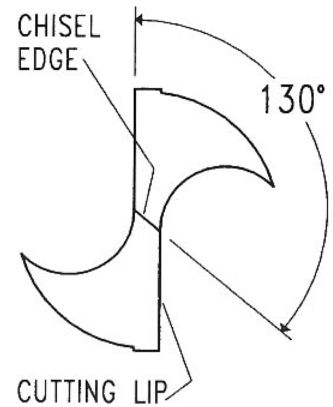
There are those who will claim that they can sharpen drills free hand and no doubt some can make a very commendable attempt. However, for the majority, the limited practice one gets makes it not worth attempting, except maybe for large size drills outside the range of the available jig. There are two requirements when sharpening a drill, getting it to cut freely and getting it to cut to size. With only a little practice, getting a drill to cut freely should not present a major problem, getting it to size within reasonable limits will. There is no point in having a drill set in 0.1 mm increments if typically the 6.1 mm drill drills at 6.3 mm diameter.

It is therefore in my estimation essential to have a drill sharpening jig if the workshop is involved in precise metalworking activity. There are of course limits to the range of drill sizes a single jig can accommodate. The Reliance will work with drills from 3 mm to 13 mm whilst the other will work up to 18 mm.

As I believe that at above 18 mm a larger jig would be difficult to justify, especially as this would have to be an industrial calibre item and have limited use, this would be a good situation to attempt manual grinding. Practice by holding the drill against a stationary wheel, moving the drill such that it remains in contact with the wheel from the cutting edge back to the furthest point of the clearance. Repeat the process until you feel sufficiently confident to switch on the grinder and take the first skim.

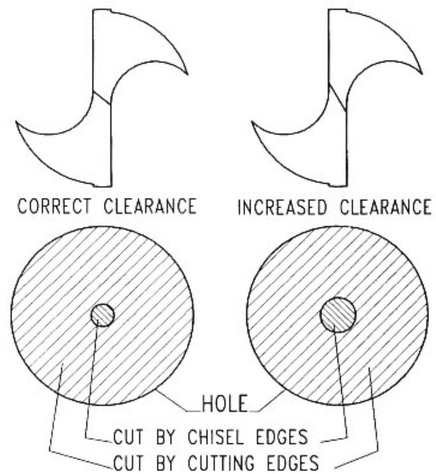
For the very small sizes the jig shown in **Photo 4** will enable smaller drills to be sharpened, at this size most probably after a drill has been broken. The jig is used on a flat stone rather than a rotating wheel. I have used it on rare occasions with some success but have never checked just how accurately the drill drilled. Details for making this jig are included in Chapter 12.

The Jigs in **Photo 2** are relatively easy to use, after a few trial runs, and give

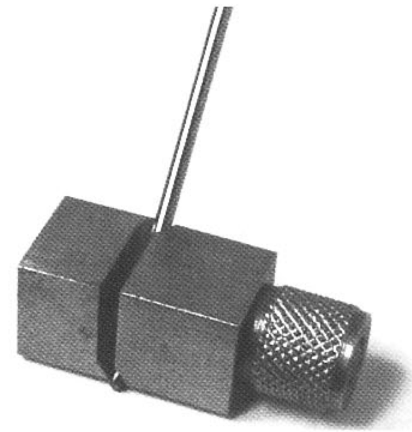


SK1. Chisel edge angle

reasonable results, They are seen being used with the off-hand grinder in **Photos 5** and **6** and show that there is a subtle difference between the two. The modern unit in **Photo 6** rotates about a spindle that



SK2. Effect of clearance angle variation on the chisel point angle and length

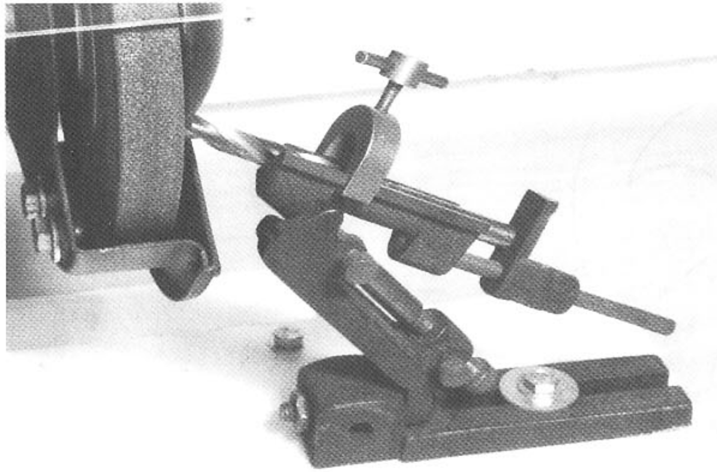


4 Jig for very small drills, this used on a flat stone rather than a grinding wheel.

is almost parallel to the grinding wheel's side whilst the Reliance rotates about a spindle that is at an angle of about 45 degrees to the wheel. Both units present the drill to the wheel at the same angle of 59 degrees but the different axis used with the Reliance causes the clearance to be created differently, more about that later. What the pros and cons of the two methods are I cannot say other than to say that both produce workable results.

As I believe the majority of workshop owners will posses the jig in **Photo 6**, or a close relative of it, I will largely limit my explanations to the method they use to produce the common drill point configuration.

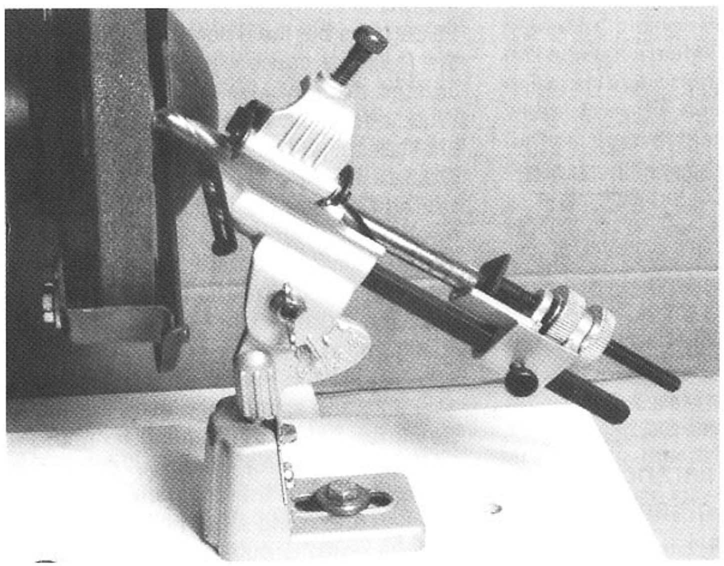
Four factors make up the drill point geometry, the angle, the cutting lip length, clearance behind the cutting lip and the angle and length of the chisel point. The internal angle of the common drill is 118 degrees and using a jig will easily ensure that the angle is equal on both sides (59



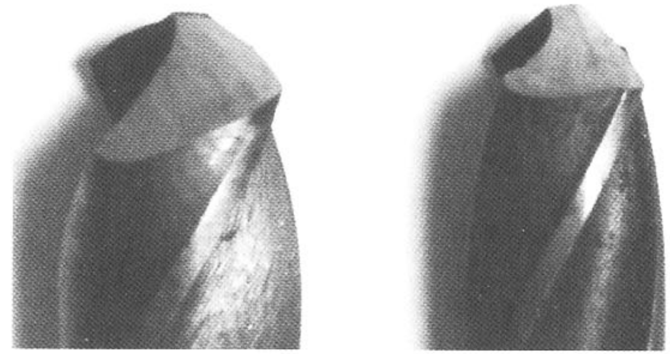
5 The Reliance jig in use.

degrees) so will not discuss the effect of unequal angles. Similarly, having got equal angles the lip lengths should also be the same though this is not guaranteed unless care is taken. What can easily vary is the clearance angle behind the cutting lip and the effect this has on the chisel point. **SK1** shows the end view of an accurately sharpened drill.

It may come as a surprise that even



6 The Modern jig in use.



7 Two drills sharpened with the wrong projection from the drilling jig. That on the left having too little projection the clearance is too great, whilst that on the right has too little clearance having been sharpened with too much projection.

using the type of jig suggested, where it is quite easy to get both the cutting edge angle correct and both lengths equal, the chisel angle needs much more attention. Sketch **SK2** shows the end view of a drill with an increased chisel angle. The increased angle in the drawing shows the effect is, to lengthen the chisel and shorten the cutting edges.

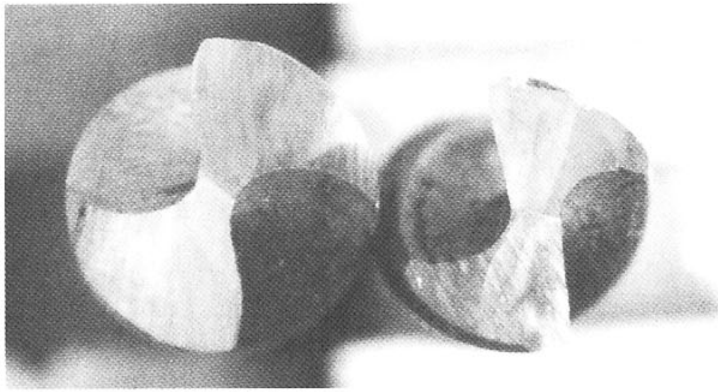
Looking at the end of a twist drill it becomes obvious that the cutting lips are less than the radius of the hole being drilled. Because of this the chisel has to remove the centre of the hole with what can only be termed a scraping action. This is the case even with a perfectly sharpened drill. Ensuring the chisel angle is correct is therefore of considerable importance, as a longer chisel will considerably increase the pressure required to force the drill through the workpiece. Another important point to consider is that if attempting to start the hole from a centre punch mark the longer chisel will find it more difficult to centralise itself on the mark.

What then causes the chisel angle to be incorrect and how can this be corrected. The cause is too much clearance angle. If the face behind the cutting lip falls too rapidly it will result in the chisel being skewed round. I think this will be better understood if you observe an actual drill, a large size preferably.

It can be seen by reference to **Photo 6**, showing a jig in position for sharpening a drill, that the jig rotates about a bearing in the base of the unit. Sketch **SK3** shows how this grinds a cylindrical surface onto the end of the drill. Of greater significance is that the radius of the cylinder will vary with the amount that the drill is projecting from the jig as the sketch illustrates. For a reduced projection the radius becomes less and the curvature greater, as a result the clearance behind the cutting edge increases. This will have the effect of increasing the chisel angle and its length.

I should add here that in the case of the Reliance, and other similar jigs, that the jig rotating about an angle to the wheel's side that the ground face is conical rather than cylindrical. However, all my comments regarding chisel angle variation and the reasons for this are equally applicable.

Photo 7 shows two drills sharpened with differing projections from the jig. The



8 The effect of too much clearance has resulted in too great a chisel angle whilst with too little clearance the chisel angle is too small. See text regarding the curved cutting edge on the left hand drill.

one on the left has been sharpened with too little projection and the rear clearance is far too great. The other with more projection the clearance is less. **Photo 8** shows how this has caused the chisel angle on the left to increase compared to that on the right. However, this photograph, set up with two old drills taken at random, has served to show another feature of drill sharpening.

The wrong angle

It can be seen that the drill on the right has straight cutting edges, as it should have, whilst those on the left have a pronounced curve. This is because, whilst it was sharpened at the standard angle of 118 degrees, this was the wrong angle for the type of drill that it is. Whilst drills purchased for general use (by far the majority of the drills sold) are intended to have a point angle of 118 degrees some, for special reasons, are intended to have another angle. Typical of this are drills specially made for drilling thinner materials. These have a flatter point so that more of the drill is in contact with the workpiece before the point starts to break through. The effect of the wrong angle is that with too flat a point then the cutting edges become concave and if too pointed, convex, see **SK4**. The drill in the photograph should have been sharpened at greater than 118 degrees (flatter) and is obviously a drill intended for thin materials. For this reason, the 118 degree angle, or more or less for special drills, is relatively important but not an absolute requirement, a variation of a few degrees will not be a problem. There is therefore no need to check the angle, if the cutting edge looks straight all is well.

Using the jig

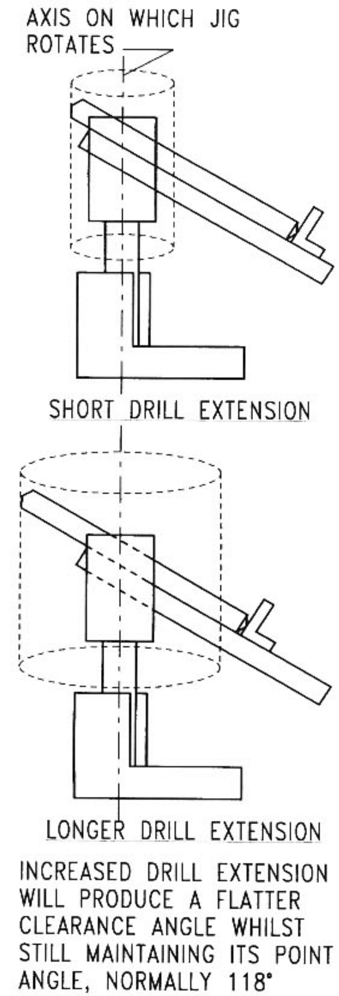
It would be nice to give a detailed explanation of how to use the type of jig seen in the photographs, especially as the instructions supplied often leave a lot to be desired. However, jigs purchased from different sources are likely to have differences and similarly also the instructions supplied. I am therefore giving the essential basics and would suggest that you arm yourself with a few old drills in the larger sizes, say 8mm to 12mm and spend an hour or so attempting to put the jig through its paces.

Three things are important when positioning the drill in the jig. These are the projection, the orientation of the cutting edge and rotating the drill 180 degrees after having completed the first edge.

The earlier explanations have detailed the effect of the wrong projection from the jig but I found the instructions supplied with my jig were somewhat vague. The real important value is the distance from the jigs axis as **SK3** attempts to illustrate. This though is difficult to measure and it is normal to take a measurement off the end of the channel in which the drill rests. However, this is not a constant and varies with the diameter of the drill being sharpened. Actually, the larger the drill the greater the required projection.

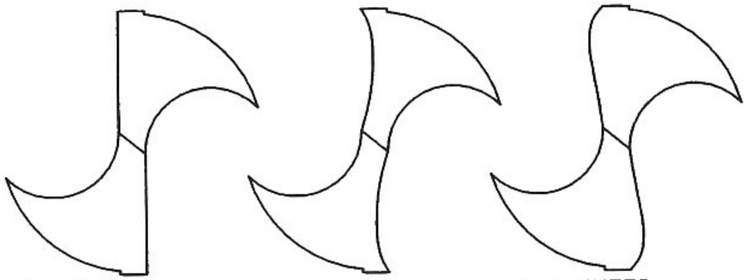
I can therefore, only suggest that initially you follow the instructions with the jig and observe the results. If this gives a chisel angle of approximately 130 degrees then all is well, if more or less then adjust the projection and re-sharpen. The angle can be checked by comparing the drill being sharpened against one of similar size that is still in the state supplied. Alternatively, a small piece of card marked at 130 degrees can be placed alongside the drill's cutting edge as a reference.

Next important requirement is the orientation of the drill, that is, does the cutting edge have to be vertical, horizontal or some angle between. For this the cutting edge should be set so that both ends arrive at the wheel at the same time, for the type of jig being considered this will be vertical. If the error is appreciable then one end of the cutting edge will arrive at the grinding wheel before the other causing the cutting edge to be domed as illustrated in **SK5**. However, this situation is more theoretical



SK3. Result of change in drill extension.

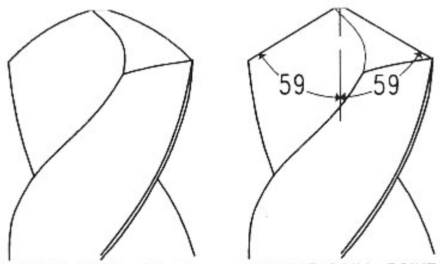
than actual, as the error would have to be large for it to become apparent. Of more importance is that, whilst the cutting edge has been rotated in the jig, the chisel produced will still be produced in largely



SK4. Effect of drill point angle variation on the cutting edge.

the same position relative to the jig. Rotation of the drill will therefore result in a change in the chisel angle. Orientation is though not critical and a few degrees either way will not cause undue errors.

Having sharpened the first side, it is very important that the drill is rotated as close to 180 degrees as is possible. Only if this is done will the two sides be the same. The jig has a small finger that is set to locate into the flute on the first side and is then used to replicate the setting on the second. I found this difficult work with so where the drill is long enough I made a short bar to fit



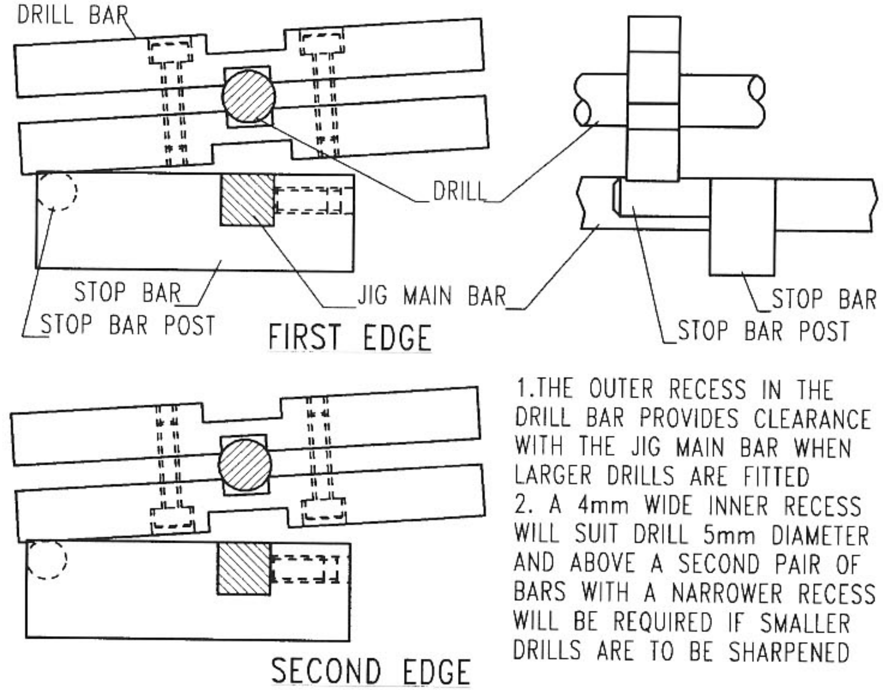
SK5.

to the drill to control the rotation. This is best understood by studying **SK6**, and **Photo's 9** and **10**.

Sharpen the first side with the drill bar against the stop bar post, then having completed that edge rotate the drill once more ensuring that the bar is against the post and sharpen the second edge. When fastening the drill bar to the drill the two halves of the bar should of course be parallel. At smaller diameters just a visual check should suffice but at larger diameters check the gap at each end with a rule.

Having sharpened your drill you can of course use it to drill its first hole. Do though before arriving at that stage check the appearance of the drill against a new drill of similar size, in particular, the chisel angle but also the clearance behind the cutting edge. This is important for even if these are wrong the drill will probably still drill a reasonable hole. If the sharpened drill shows major differences from a new drill adjust projection and grind once more.

With the first drill sharpened correctly make a note of the drill size and the projection used. Do this with other drills, remembering that larger drills require a greater projection, until you have a range



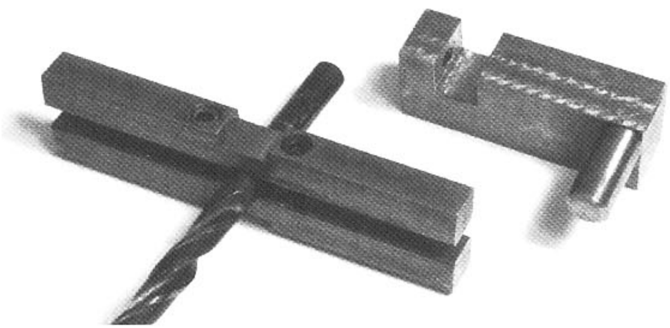
SK6. 180 degree rotation device.

of values. From this point it will only be necessary to interpolate from these values for drill sizes that fall in between. You will soon realise that the amount of projection and the orientation of the drill are not that critical and some variation from the ideal will still give workable results. Getting close to 180 degree rotation between edges is though more important.

Having set the drill in the jig with the required projection, the complete jig is moved towards the grinding wheel until the drills edge almost touches the wheel. The slot in the jig's base permits this adjustment to be made, as can be seen in **Photo 6**. The jig then provides a fine feed to set the amount being ground off, do set this to remove very little or overheating of the drill may result. If the drill is badly worn take a little of each side in turn until you make the final pass on each edge. The feed must not of course be further adjusted when making the final pass over the second edge. Should you be re-establishing a cutting edge on a broken drill then reshape the end by hand before using the jig.

Four facet

I suspect the term "Four Facet" when applied to drills will be new to some readers, it is though, as the term implies, a drill sharpened with four faces rather than the normal two. This should not be confused with the drills available commercially which



9 Parts to assist in accurately rotating the drill by 180° for sharpening the second edge.

are known as having a "Split Point Geometry" even though there are similarities both in terms of shape and advantages, more about these later. It is an alternative method of sharpening drills in which each cutting lip has two flat surfaces, being primary and secondary clearance angles, similar to the cutting edges of an end mill.

You may be tempted to say "so what" as the end away from the cutting edge is only clearance anyway. There is though a surprising effect of this method of sharpening and that is, the chisel edge is replaced by a point, see **SK7**. Advantages of a drill sharpened in this way is that the pressure required when drilling is reduced and with care will start without the need for centre punching the hole position. On the downside the drills can be drawn into the

10 The parts in photograph 9 in use on the sharpening jig.

material being drilled. This especially so with materials that tend to draw the drill into it, some grades of brass typically.

Whilst relatively easy to visualise, in practice it is more difficult to create and attempting this free hand is certainly a non starter as accuracy is more critical than with the conventional drill form. Sharpening drills to this form is best done on a full function Tool and Cutter Grinder such as the Quorn, (Photo 4 Chapter 1) However, jigs have been developed which enable them to be sharpened using the simpler Worden grinder (Photo 6 Chapter 1) or similar.

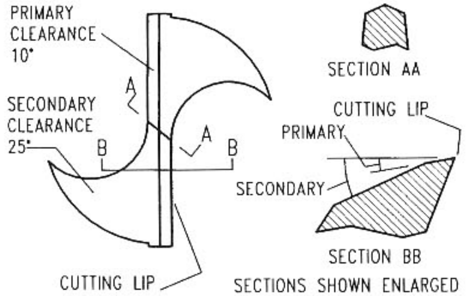
The method most often put forward for sharpening drills in this way is to create the point using four flats. Having ground the first secondary angle it is then essential that the drill be rotated 180° and the second face ground at exactly the same depth. The primary angle is then ground in the same way, and again, both sides must be ground equally. There is though more to it than that as not only must the two faces be ground at the same level this must also be chosen so that the four facets meet centrally at a point. It is therefore essential that both sides are ground equally but also that the amount removed produces the required point. This necessitates a little being removed from each side in turn until the required point is achieved. The process will therefore need some precise positioning to achieve the desired result.

The angles for the two facets for each edge should be around 10 degrees for the primary clearance and 25 degrees for the secondary, though like most things in metal cutting activities these values are not critical. I would though suggest that the secondary angle should be no less that 25 degrees, values between 25 degrees and 30 degrees being more appropriate. The other factor is how the secondary facet is positioned in relation to the primary. This should be done so that primary facet is a constant width from the centre of the drill to the edge rather than triangular. For this to be achieved the drill is not rotated, to produce the second clearance, only the angle to the wheel being increased. An accessory for carrying out this method of drill sharpening is detailed in Chapter 12 that also gives more technical data regarding this method of drill sharpening.

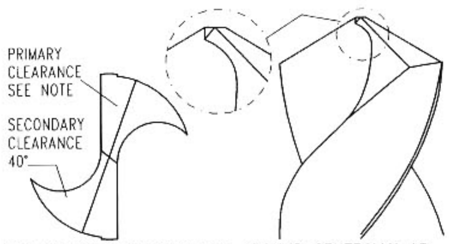
Split point geometry

This is a form of drill that is now commercially quite common and has similarities with the four facet form, having both primary and secondary clearances. However, there are differences, one being that the primary facet has a triangular rather than a rectangular form. This can be seen by comparing **SK8** with **SK7**. Another difference is the secondary clearance has a much steeper angle of around 40°. It is also much more difficult to produce the secondary clearance. In the case of the four facet method the drill can be just wiped across the flat face of a grinding wheel. This is not so in the case of a split point drill, as the secondary clearance must go only as far as the chisel edge so as to create a cutting edge on this as **SK8** attempts to illustrate. The corner of the grinding wheel must therefore be used to produce this and it should be obvious that very accurate positioning is necessary. Also, the wheel must be dressed to have a sharp corner making it necessary to use a fine grit wheel especially if attempted to sharpen smaller drills.

The primary clearance can be



SK7. Four facet drill format.



THE PRIMARY CLEARANCE IS GROUND GENERALLY AS FOR A STANDARD DRILL FORM BUT WITH A GREATER EXTENSION FROM THE SHARPENING JIG SO AS TO PRODUCE A CHISEL ANGLE OF 110° PRIOR TO CREATING THE THIRD AND FOURTH FACETS

SK8. Split point drill form.

produced using a conventional drill grinder but set to give a smaller chisel angle than normal of around 110 degrees. There is still yet another factor that must be observed when producing the secondary clearance. It can be seen from **SK8** that the primary facet has a triangular form. However, the angle of this cannot be chosen at random as it must rotate the chisel round to the standard angle of about 130 degrees, and yet there is more. The two secondary faces must not pass one another else you will end up with a forked point, it is advisable to avoid this by leaving just a small portion of the original chisel untouched, say about 0.1 mm to 0.2 mm wide.

The result of all these requirements is that sharpening this form of drill is far from straight forward and the four facet method that will cut almost as well will be the easier option. It is my understanding that the drill flute arrangement is identical to the standard drill. Therefore, if you come across any of these drills you can when blunt eventually sharpen them in the conventional form should you not want to attempt the split point geometry. **Photo 11** shows split point drills in close up.

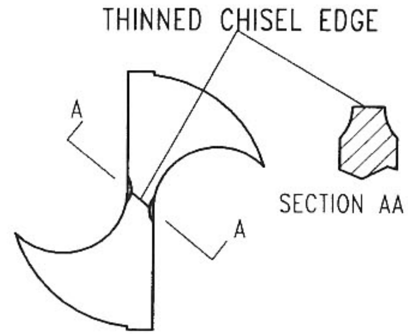
Point thinning

Point thinning, seen illustrated in **SK9**, is useful on larger drills as it reduces the pressure required making it less of a strain on lightweight drilling machines. It can also be of help with drilling difficult materials, even when using smaller drills. You will need a wheel with a very thin edge to do this even with drills of say 12 mm diameter, how practical it is to do this at smaller diameters will depend on the equipment available for carrying out the thinning. Thinning should be carried out equally on both flutes and central to the chisel, reducing the chisel to about 60 to 70% of its normal length.

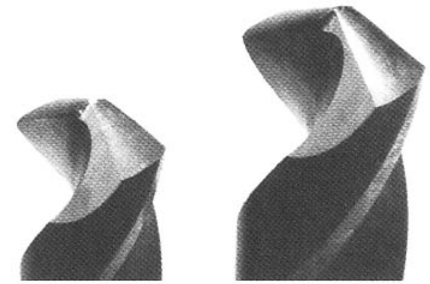
For strength, the core thickness of a drill increases toward the drill shank, because of this a much shortened drill, maybe having been broken, may also require to have its point thinned.

Drilling brass

Having said that four facet drills will tend to draw themselves into some grades of brass, the effect is not totally eliminated by the use of drills sharpened in the standard



SK9. Chisel edge thinning.



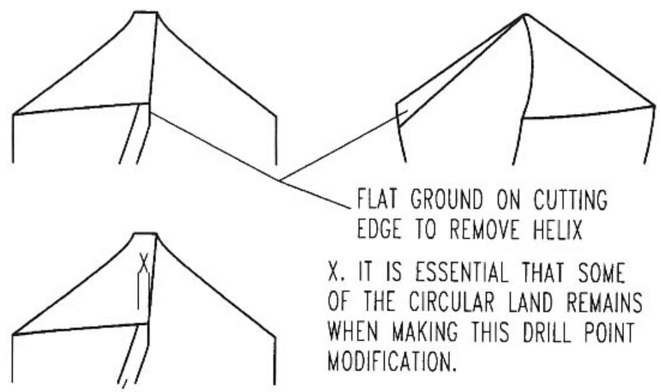
11 Split point drills.

manner. To overcome the problem fully it is practice to remove the helix at the cutting edge by grinding a small flat as shown in **SK10**.

Other materials

Whilst other forms of drills are supplied, typically slow spiral, and will work marginally better than the standard for some materials, the difference is small and the standard drills will suffice for the type of work likely in the home workshop.

One area where there just may be an advantage in diverting from the standard is if you have a reoccurring task is for drilling thin materials where the drill can start to break through before the hole has reached size on the front. Sharpening the drill with a flatter point will help to avoid this situation. The modified drill will though have the problem of a curved cutting edge as mentioned above. However, the curved edge can be removed whilst still maintaining the helix angle using a wheel with a narrow edge, see Chapter 1 Photo 9. It will though, not be a task to be carried out free hand.



SK10. Drill modification for drilling difficult materials.