METAL SPINNING

1. A collection of mandrels, pallets and shells.

Viewed by some as more of an art than a science, Jack Cox lets us into the secrets.

I have found, over the last thirty years or so, that the occasional recourse to the craft of metal spinning has been very helpful to me, both in pursuit of my engineering activities, and rather more so as decorative enhancements to turned objects in wood (actually, the engineering pieces have been mostly in the nature of metal caps and special containers, and I have no photographs available).

So what is metal spinning? Basically it is one of the many ways in which a flat (essentially two-dimensional) sheet of metal (invariably a disc) may be transformed into a three-dimensional object of circular cross-section and elevation profile as desired by the maker, a simple example being given in **Fig.1**. It is the only method of achieving this, which, to my knowledge, requires a lathe.

The following notes can, at best, only provide an introduction to a craft which can become quite complex. Unfortunately, I cannot recommend any further reading, since the craft does not appear to provide as many practitioners (and therefore writers) as, for example, woodturning, although I have recently been advised that Camden Miniature Steam Services do include at least one relevant title in their catalogue. Nevertheless, I hope I can manage to get the beginner off to a reasonable start.

Terminology

The essential procedure is shown in **Fig. 2**. At (a), a flat disc of metal is pressed against a former (normally called a 'mandrel') which is itself shaped to the required internal profile, and is mounted on the headstock of the lathe. If the mandrel is of a removable nature, as is often required, it must be arranged to run truly concentrically at all times. The disc is held firmly against the mandrel by means of a pressure pad of circular cross-section and which also rotates via a live tailstock. Such a pad is, like the mandrel, custom-made to suit the job in hand, and is referred to as a 'pallet'. To complete the terminology, a completed spinning is often (but not always) termed a 'shell'. Photo.1 shows, on the left, a collection of mandrels, on the right, three pallets, and front left a couple of incomplete pewter shells, with a copper shell sawn through the centre-line to show the profile. Mandrels and pallets can be of wood, for the odd one-off job, or can be plastic material (which must be fairly heat-resistant, since spinning does generate some heat. Sorby make a nylon material, sold in rod form, shown being shaped in **Photo. 2**. For my own part, I prefer the stability, precision and permanence of metal, usually brass in my case. Where wood is used, the grain must run axially; if it isn't, there is always the risk that the circular cross-section will become elliptical due to wood movement.

2. A mandrel being made in nylon material.

Procedure

With the lathe in motion, pressure is applied to the rotating disc with a suitable tool, gradually dressing the disc down against the mandrel until it assumes the profile of the latter. The tool is normally of high-carbon steel, shaped as required, hardened and highly-polished

This is of course all very simple _ until one actually tries to do it. There are definitely a few snags but, before going into these, a word about the lathe itself: This needs to be a very robust piece of kit, such as a beefy woodturning lathe, capable of turning a fair size bowl without the bearings complaining. The reason is that the longitudinal and lateral pressures exerted on the work by the tool are very high, and a light lathe would be liable to damage. I have read many times the advocacy of a metal-turning lathe for the task. Personally, I would not use such a machine, for fear of compromising its precision _ which consideration leads me to the lathe toolrest requirement:

Toolrest

The normal woodturning rest is replaced by a special piece of equipment, which can be mounted in the toolrest saddle. It is essentially a horizontal bar carrying a number of holes into which one or possibly two steel pegs may be placed as desired. The pegs may be shouldered or both they and their holes tapered; either way they must not drop though the bar. They are used as fulcrum points to apply pressure to the workpiece from the spinning tool, as in **Fig.3**.

Tools

Now for the spinning tools. Most books on the subject will show a selection of as much as twenty different tools, to be used for various purposes. In fact it is possible to do very good work with just one, and this can be home-made. The tool end-profile is shown in **Fig.4(a)** and is in fact featured on one of a pair of tools which I bought from Myford over thirty years ago, but I'm not sure if they still supply it. The tool is shown on the right in **Photo. 3**. As can be seen, it is a simple taper with a domed end, modified by a machined flat on one side. The original Myford tool (the metal part) is 11in. long and ⅝in. diameter, tapered to about ⅜in. diameter at the business end. It is fitted into a 16in. long handle, and is therefore quite a massive hand-tool. For the light work to be described, a similar device can be made from a 12in. length of ⅜in. diameter silver steel. The business end is highly polished, and hardened and tempered to a very light straw, i.e. just below dead-hard. It is fitted into a hardwood handle, to give an overall length of about 18in. – 24in. Under no circumstances must the working area of the tool bear a sharp edge at the discontinuity between the flat and the rest of the tool. Failure to observe the point will turn the tool into an occasional graver, or worse, a parting tool. Just to make things awkward, the photographs do not consistently feature this tool but rather a couple of Sorby tools, notably their 'hook' tool, the end of which is shown in **Fig.4(b)** and **Photo.3** centre, and a general-purpose tool, shown on the left of **Photo. 3** but this is only because I was demonstrating them at the time the photographs were taken. The hook tool in particular is quite handy, given a little practice on the part of the user, but not essential, since it is used in much the same way as the Myford tool. At this point, it may be as well to dispel another myth, in this case regarding the provision of lubricant to facilitate the passage of the tool on the workpiece. Although it is very necessary to lubricate the work to avoid 'galling' or pick-up, particularly with aluminium alloys, it is not at all necessary to buy expensive materials, since a piece of candle-stub will do perfectly. The remaining piece of equipment is a 'back-stick'. This is simply a stick of hardwood, the purpose of which will be described later.

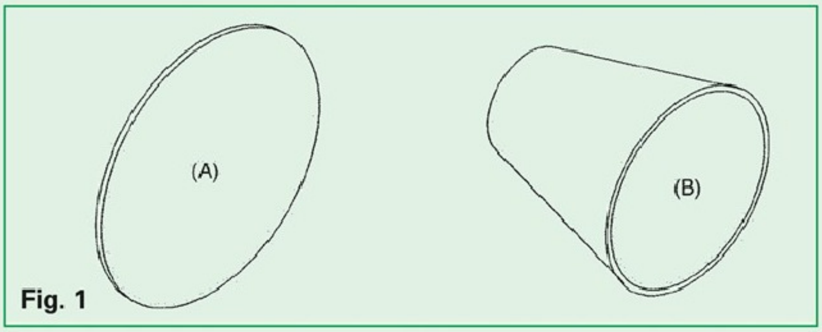


Fig. 1

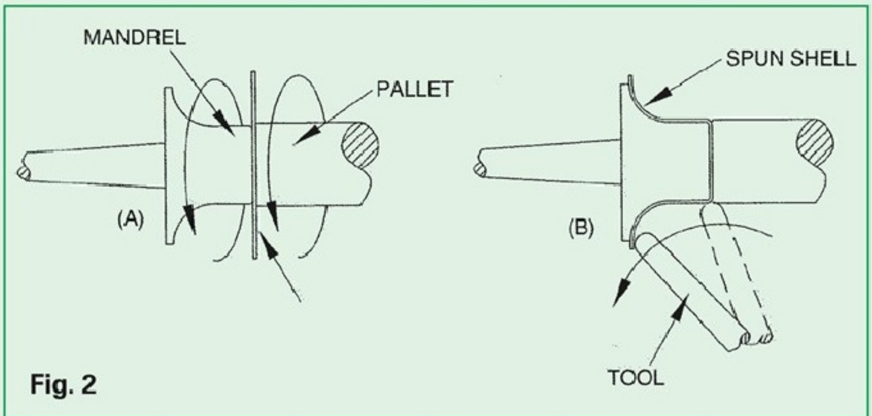


Fig. 2

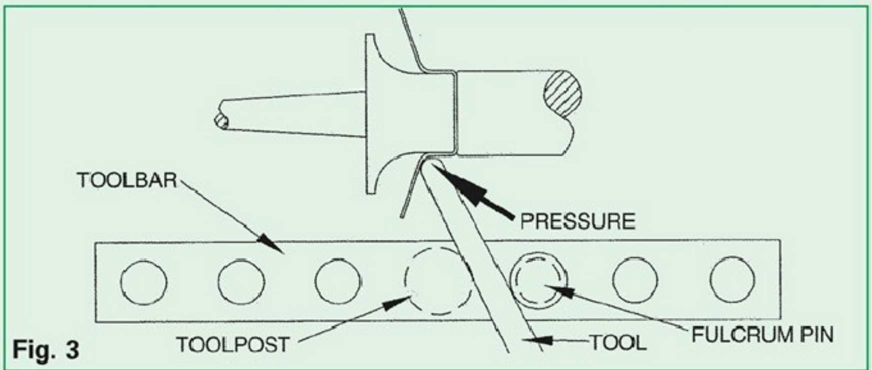


Fig. 3

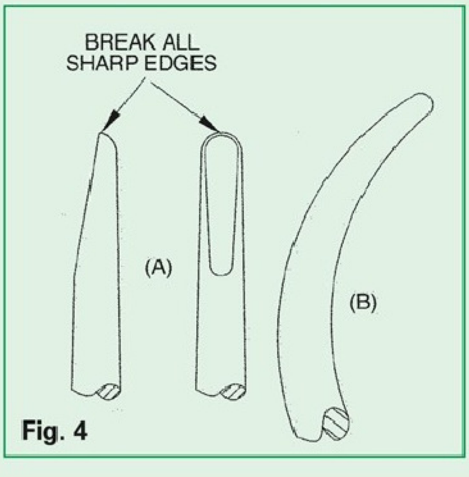


Fig. 4

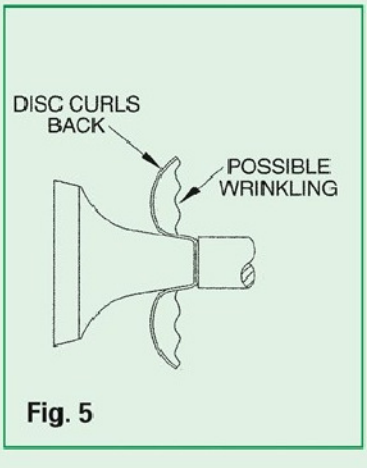


Fig. 5

A complication

The simple diagram of **Fig. 2** does not in fact tell the whole story. For most metals, a very high pressure, combined with a good deal of control, is required, hence the use of long-handled tools and fulcrum pegs. Moreover, even with the aid of such pegs, the operation is not a simple matter of pushing the blank down on to the mandrel. One of the more serious effects is the tendency of the workpiece disc to curl back on itself, and possibly even develop wrinkles also, as in **Fig. 5**. These tendencies must be corrected immediately since, if the corrugations become too pronounced, it is virtually impossible to remove them (although some degree of 'off-the-lathe' correction can be applied in some cases, as will be seen. The preferred method remains however, to catch the problem early, by drawing back the spinning tool, coupled with right-to-left pressure (**Fig.6(a)** and **Photo. 4**) over the incurved surface, to provide a profile as in (b). If corrugation is present (easily detected by 'feel' of work against tool), then the back-stick is brought into play, using it as a pressure pad against the spinning tool, drawing both tools backwards and towards the left as in (c). Note that a second peg will be required to support the back-stick (and the operator must get the feel of independent two-handed working). The back-stick is shown in use in **Photo. 5**, in this case for the somewhat tricky task of rolling a bead. Removal of curling stretches the metal considerably, thereby introducing the topic of 'work-hardening' of metals.

Annealing

All metals that I have worked, with the

3. Three spinning tools.

exception of pewter, have exhibited work-hardening and require annealing, a simple process of heating to dull red (rather less for aluminium alloys) and either allowing to cool in air or quenching in water. I suggest the latter cooling method since, apart from the time saved, the thermal shock tends to throw off the black scale caused by the heating process, particularly with copper. After annealing, the remaining scale is (in my case at least) removed by abrasives and the spinning continued. It is possible to remove scale by 'pickling'. This comprises immersion of the piece in a boiling solution of some aggressive chemical or other, such as 10% sulphuric acid. I personally regard all chemicals as nasty insidious things and want no part of any of them sloshing about in my workshop, therefore my knowledge of pickling is non-existent.

When annealed work is returned to the lathe, it is sensible to re-dress that part of it which has already been put down hard against the mandrel, to re-assert contact, always working from right to left. This is because the heating process can cause some local distortion of the workpiece. It may be necessary to anneal more than once, dependent usually upon the depth of the spinning. The operator can also be a factor, since undue timidity may give rise to several passes over the work where one will do, and work-hardening will occur more rapidly as a result. As experience is gained, it is possible to become quite brutal, and to put down a shell of the type illustrated in **Fig. 6** and **Photo. 6**, even in copper, in one rapid session, comprising three passes at most, starting with stock material and no annealing at all. This can be a great advantage, since scale removal is a nuisance, and can make finishing and polishing rather difficult at times. Annealed material becomes very soft indeed, and it is often possible to salvage a badly wrinkled part-spun shell by annealing, and hammering the wrinkles out on an anvil, although further annealing may then be required before returning the piece to the lathe.

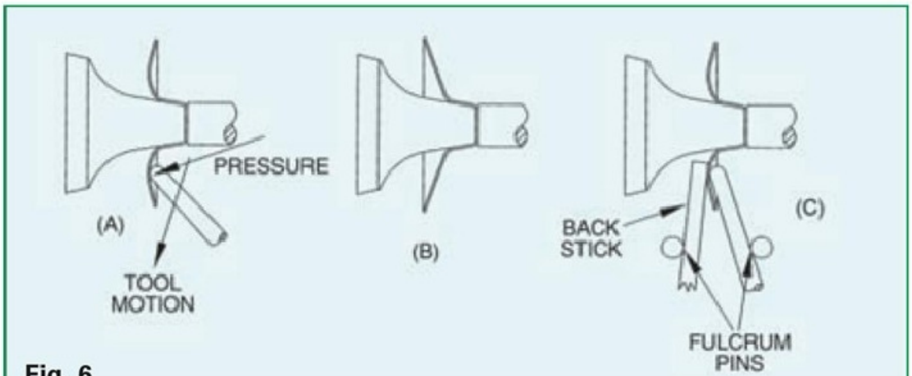


Fig. 6

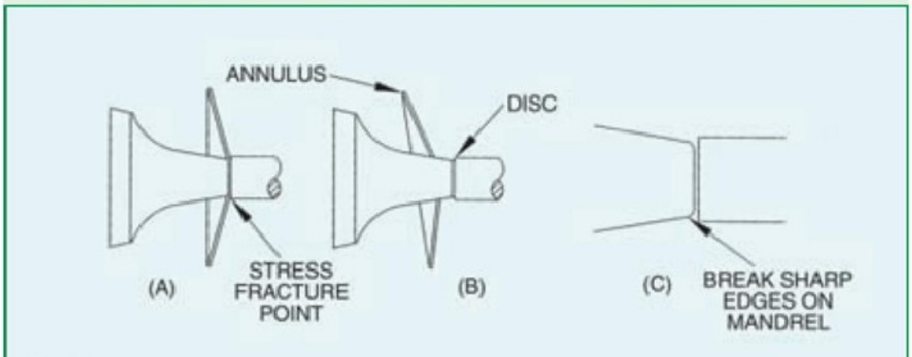


Fig. 7

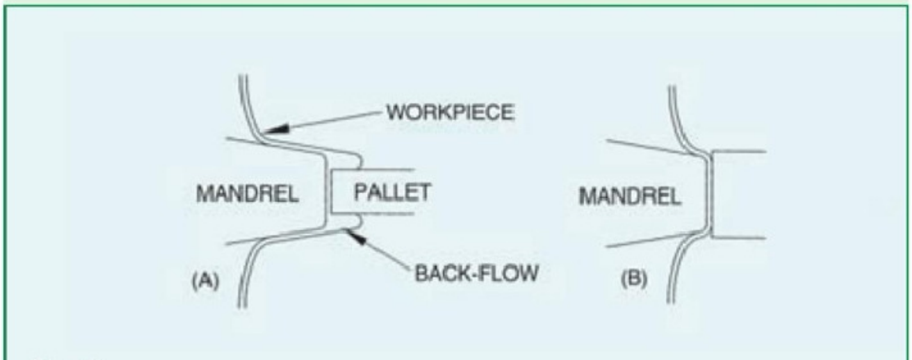


Fig. 8

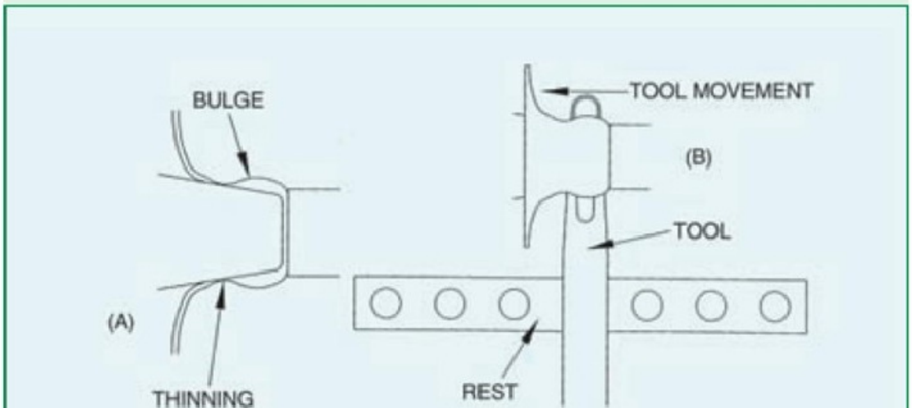


Fig. 9

Beginner's Metal

Pewter doesn't work-harden, and requires no annealing, which is as well since its melting point is about that of soft solder, and the mere act of waving a blowtorch at it will reduce it to a blob of molten metal (which should be saved, as it is a very easy casting material for certain types of decorative work). Modern pewter is totally lead-free, comprising (I think) 92% tin, 2% copper and 6% antimony. Despite the fact that it is relatively expensive (due, I suspect, to the tin content), I strongly advocate it as a beginner's material, since it is very easy to work _ which is itself a slight snag, in that it can lull the newcomer into thinking that copper, for example, is just as easily worked _ which it isn't! Although pewter doesn't work-harden, it can develop stress fractures, and is no different from other metals in this respect. Such fractures usually (but not always) occur at a sharp discontinuity on the mandrel, particularly at the start of the spinning. This is, in my experience, a major cause of the newcomer throwing all tools and equipment out of the window and going off to do something else. Referring to **Fig. 7**, too timid an approach will produce a stress fracture at the discontinuity (a), resulting in the production of a small disc and large annulus, neither of which is a fat lot of use to anybody. The mandrel should always be made with fairly gentle transitions from one part to another, to help reduce the problem (c).

Pallet size

Another major source of annoyance is making the pallet the wrong size for the job. The ideal pallet diameter is that of the end-diameter of the mandrel plus twice the thickness of the sheet being spun. All drawings thus far show precisely this relationship. If the pallet is made too large, there may be problems of tool access. The really disastrous situation however, is making the pallet diameter too small. The temptation to pick a pallet out of the box, rather than make one correctly is very strong, but is a sure path to producing 'wasters', for the following reasons:

Firstly, there is an increased tendency to rock the work as the spinning is started, and this will take place against the smaller diameter (i.e. the pallet) which will increase the local stress on the workpiece. Even if this hurdle is surmounted, as the work proceeds, the metal will tend to flow backwards towards the pallet. A pallet of the correct size will tend to arrest the flow, but a small pallet will produce the result shown in **Fig. 8**. It is generally a waste of time to try applying correction, since this serves merely to loosen the spinning on the mandrel, with subsequent fracture somewhere. **Photo. 6** actually shows a mistake in progress; here a small pallet was used (due to laziness on my part), with the result that the pallet is more or less burying itself in the workpiece, producing (eventually) a waster.

Given the correct size of pallet, the first (and absolutely essential) requirement is to turn the disc over the end of the mandrel for a short distance, as in **Fig.8(b)** and **Photo. 4**. Apart from positively locating the work, this serves the purpose of avoiding stress fractures due to rocking against the end of the mandrel. When this is achieved,

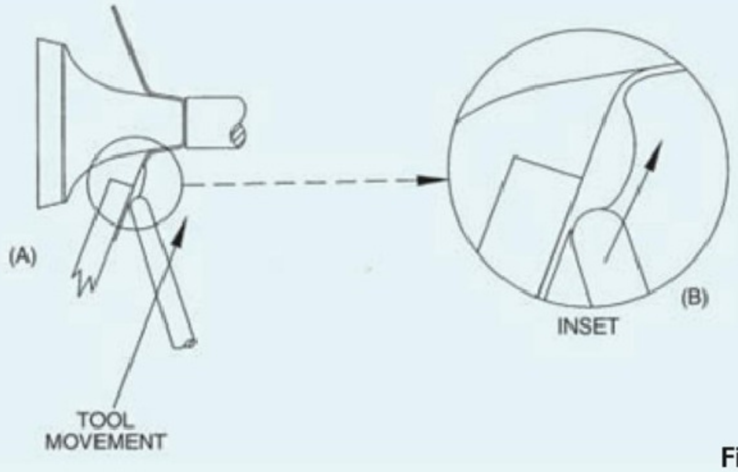


Fig. 10

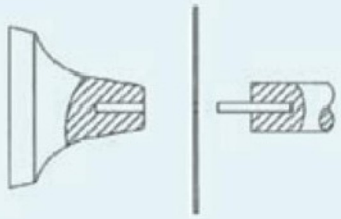


Fig. 11

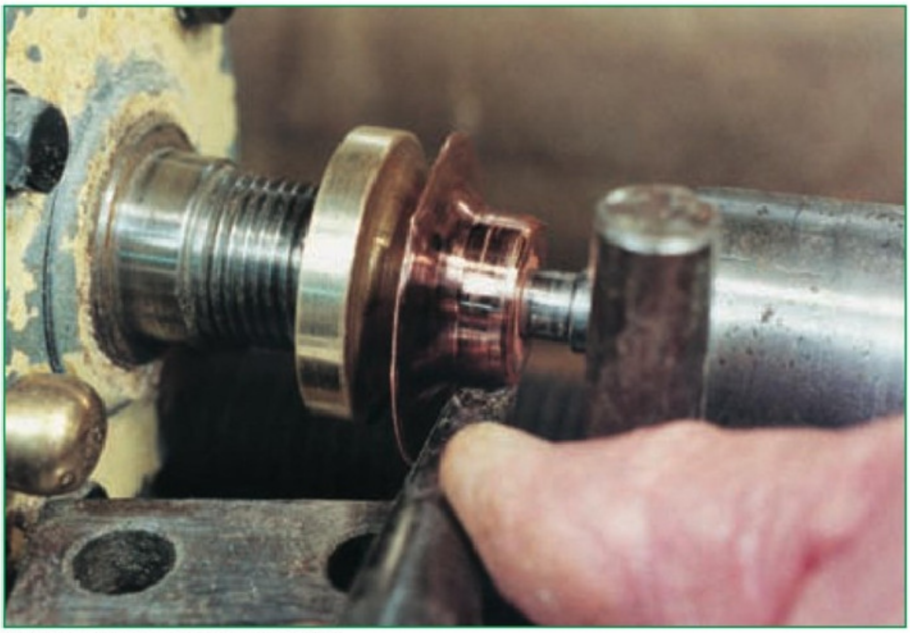
one can more or less forget stress fractures at this point. It is possible however, to become too confident, and produce them elsewhere, as in **Photo. 7**. In this case, the top flange was lost due to pushing too hard against the discontinuity at the top shoulder of the mandrel. The correct procedure is to rotate the flat edge of the tool over the corner, and turn the flange before dressing it down against the mandrel. The general task is however, one of dressing the shell hard down against the mandrel, following the procedure outlined in **Fig. 6** and shown part-way through a project in **Photo. 8**. Note that mandrel design must always feature a slight taper or 'draw' on any 'axially parallel' parts, to allow the shell to be removed from the mandrel when completed (even with a taper, this can be a little difficult at times.

Problems due to technique

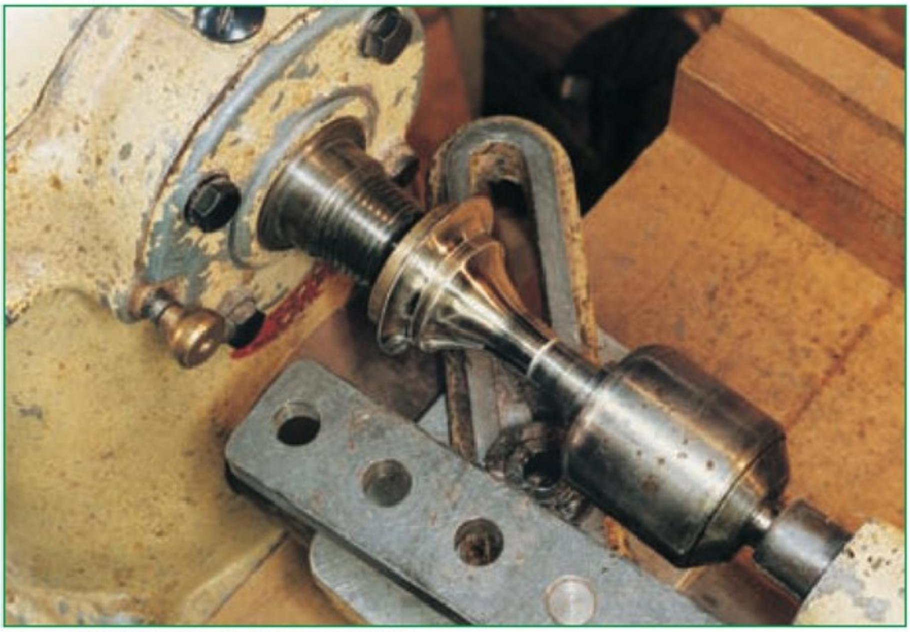
Two further problems may occur: Firstly, it is possible to produce a swelling near the end of the spinning as in **Fig.9(a)**. This is unquestionably faulty technique, and is often followed by a thinning of the shell to the left of the swelling (metal behaves in odd ways at times, and the thinning is invariably due to an apparent momentary increase in softness and ductility _ no, I can't explain why, but severe damage often results, as in **Photo.9**). It may be possible to iron-out the swelling by using the flat part of the spinning tool beneath the workpiece, using the toolrest itself as a fulcrum (**Fig.9(b)** and **Photo.10**), and gently dressing the surplus material towards the left. This only works if the thinning is minor: otherwise expect wrinkling and fracture at the thinned portion, and another waster. Generally speaking, the deformation attendant upon creating a spinning can result in a great deal of thinning of the metal in other areas also, largely due to the (mainly) stretching effects, and the amateur spinner can well end up with a finished shell of varying thickness, mostly rather less than the original. On the other hand, the clever, experienced spinner (that lets me out) can produce a really deep shell which is of

4. Applying right to left pressure.

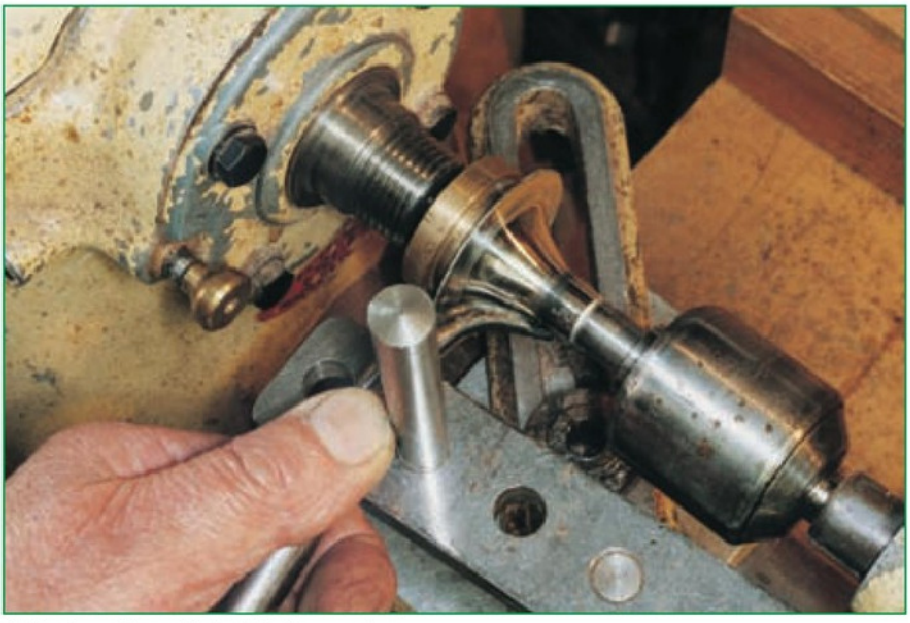
5. Using the back stick (and a second peg)



6. Three passes and no annealing.



7. ...... and produce a fracture elsewhere.



8. Partway through the Fig.6 procedure.

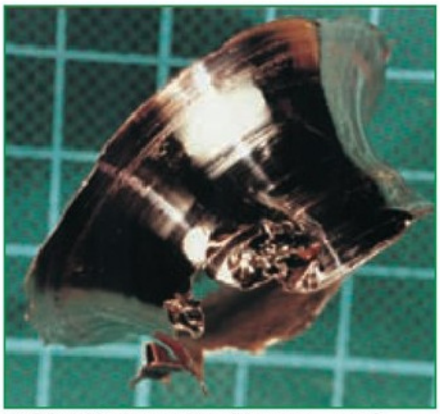
constant thickness at or very near that of the original disc. **Fig.10** shows the general idea. The tool is pushed from the periphery of the shell towards the centre, carrying with it a small bulge of metal which can, by careful variation of pressure, be made to flow to restore the wall thickness depleted by thinning. This is not really a technique for the beginner. Despite being fairly easy with pewter, it can be very difficult with less ductile metals. It requires back-stick support, at least to begin with.

Setting up

Placement of the disc on the mandrel end prior to spinning requires thought. For many applications a small central hole may be permissible. In such cases, I strongly advise making use of it to locate the disc. If the lathe headstock and tailstock are not in perfect alignment, a non-located disc is quite likely to fly out of the lathe on start-up, with some attendant danger to the operator. **Fig.11** shows a suitable method. If a central hole is not permissible, the disc should be clamped in position via the pallet, and nudged into concentricity. The lathe is then run slowly whilst the initial shoulder is turned over as in **Fig.8(b)**. It can also help to apply a dab of superglue between disc and pallet prior to spinning, since this is easily broken when required, but superglue on the end of the mandrel is a bad idea since, once the spinning starts to follow the mandrel profile, it may be impossible to remove it without damage. I read many years ago that professional metal spinners sometimes 'hop-in' a disc blank with the machine running. I imagine that this would be a very good way to lose a finger or two.

Blank size

There is of course the question of how big a blank disc should be in order to achieve a given shell profile. This is a very difficult one to answer _ there isn't even a decent rule of thumb to my knowledge, since diameter, profile and depth of shell are all factors, along with initial disc thickness and operator skill. For the kind of profiles forming the bulk of the illustrations given, I would perhaps suggest a disc diameter increase of about 25% on that of the largest required shell diameter to begin with, to be modified after a trial or two. Disc thickness is also a consideration.



9. Metal behaves in odd ways.... and severe damage results.

10. Ironing out the swelling using the tool beneath the work piece.

11. Parting off pewter.

Messrs. Robert Sorby supply a range of metal-spinning equipment, included in which are packs of pewter, brass and copper discs, of 5in. and 3in. diameter, and thickness approx. 0.027in. The pewter in this thickness is easily worked, but the other two would be found very hard work indeed. For copper (my own favourite metal for this type of work) I would suggest a thickness no greater than 0.022in. i.e. 24 SWG (it is surprising how much difference a few thou' makes in terms of brute force). As in most lathe work, peripheral speed of workpiece is a major factor but, for the small-diameter work discussed (up to 3in. approx.) I would suggest a beginning spindle speed of around 800 rpm. This can subsequently be modified to suit individual jobs _ once again, 'feel' is far more important than hard-and-fast rules.

Parting off

Finally, the most difficult (and potentially dangerous) job of all, that of parting-off and trimming: Actually pewter is (once again) a very easy material to work, on the spinning lathe with hand tools. Any straight-ground side and face scraper or parting-tool as used for woodturning will do the job (**Photo.11**), producing delicate ribbon swarf which is of no danger, other than being trodden into the floor. Other metals are much less forgiving, and I strongly advise goggles, thick gloves and a low spindle speed if one is obliged to use the spinning lathe, since the swarf tends to be very sharp and inclined to lash about somewhat. If at all possible, the work should be transferred to a metalworking lathe to obtain the benefit of fixed tools and fine feeds. Whatever the method, the work should always be held to the mandrel via the required shell. If held by the waste portion, there is some risk of buckling the shell as it leaves the waste. For all spinning quality metals (other than pewter) a generous top-rake is required on the cutting tool.

Finishing

A very brief word about finishing, perhaps. My dislike of chemicals compels me to use entirely abrasive methods. Woodturning abrasives of about 240 – 400 grit are good to begin with, followed by wet-and-dry up to about 1000 grade, used wet or dry as preferred. This is followed by applying a stick of polishing 'soap' (Sorby do quite a good one), and polishing off with a soft cloth. This is usually sufficient, but a final polish with Duraglit wadding, or Brasso can also be beneficial. Finally, to avoid tarnish, the application of a cellulose lacquer, formulated for metal, may be given, preferably by spray but, with care, by sable-hair brush, with the lathe running slowly, to even-out the 'ribbing'.

Conclusion

The foregoing notes, although somewhat lengthy, can only serve to give a general idea of the spinning process for small work, and cannot hope to comprehensively cover all aspects of the craft. Many other interesting avenues are open to exploration, not the least of which is 'spinning on air' i.e. creating part of a spun profile without a mandrel to define the profile. As a matter of interest (with no attempt to explain the techniques), **Photo.12** shows the top of a salt-cellar being spun with no mandrel support other than a short wood cylinder at the point of attachment to the lathe. It is also possible to create swages, bead rolls, and even design mandrel systems to produce incurved vessels and still manage to get the mandrel out (and a few extra tools are required). All this however, is a little beyond the scope of the present article.

Suppliers:

Turret Brazing Products,
Unit.3 Meadowbrook Park,
Halfway,
Sheffield. S21 2EA
Tel: 0114 248 8570 Suppliers of non-ferrous metals, sheets, discs etc.

Robert Sorby,
Athol Road,
Sheffield. S80 PA
Tel: 0114 225 0700 Suppliers of brass, copper, pewter discs. Spinning tools, materials.

12. "Spinning on Air"