

## HOLLOW TWIST PRINTOUT PAGE

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### INTRODUCTION

The Hapfo series of hydraulic and CNC lathes are well suited for a considerably wide range of specialist turning, and in this section we look at the possibility of employing them to perform the specific technique of hollow twist or core -more correctly called open bine - work. This is relatively straight forward, so long as certain criteria are born in mind.

### FIRST CONSIDERATIONS

It is **MOST IMPORTANT** to remember that a major part of a piece of timbers natural strength is removed by taking away what is, after all, a large percentage of its cross-section. In some instances, too much is removed and renders the work-piece so weak that the finished product has little structural value. It may look good, but simply has insufficient strength to be of much use in a variety of applications.

We may conclude from this that two basic applications are therefore possible in the production of open bine work – structural and artistic. Fortunately, with the Hapfo lathes we can incorporate both, and we shall be discussing this in connection with a variety of products.

For example, a baluster may look elegant, but might be sufficiently weak and so be dangerous. On the other hand, a candlestick may look very fragile, but since it has very little weight to carry is totally acceptable. To enable the operator to arrive at the required design acceptability the following points need to be considered:

### KEY POINTS

the length of the work piece,  
the diameters of the work piece – they are the section which is being twisted, and the minimum being turned and effecting the stability,  
the lead of the actual twist,  
the number of starts or graduations and  
the width or configuration of the cutter being used.

Since the overall length of the work-piece as well as the length of the section being twisted is important, these are the first points to be taken into account, and for our example, we shall consider turning and hollow twisting an ornamental baluster, 50mm square and 800mm long. The lathe used in this exercise is the Hapfo 5000 Hydro King.

For most practical purposes, and to ensure reasonable stability, the maximum length of any section of hollow twist is roughly five times the diameter of the piece. Make it longer than this and a high degree of instability arises. It may well be, that should this twisted length be a section of a longer turning (as in our baluster) some form of support may be required.

### BASIC PRINCIPLES

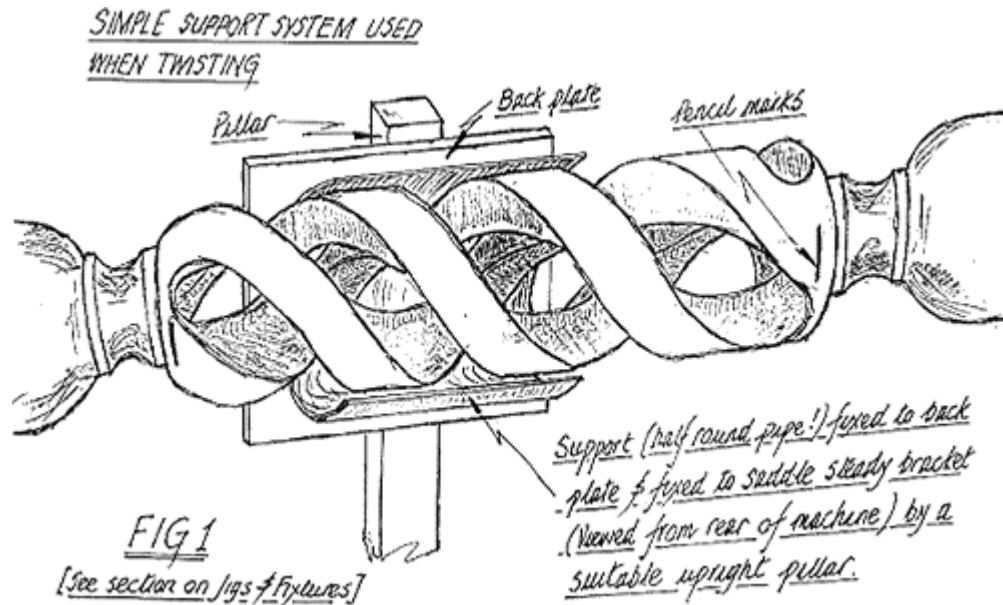
The simple principle of hollow twist work is this – one flutes and twists sufficiently deep enough in order to go past dead centre of the work piece, and do it with a number of starts of appropriate lead in order to break out into the centre of the article being made. Too shallow and the piece does not become hollow, too deep and the exposed bine opposite the cutter gets at least scored, and at worst destroyed.

It is now possible to run through the required steps in order to create a typical hollow twist item.

### SETTING UP

Since our baluster is 800mm long, and only 50mm in diameter, it follows that support may be required – see **Fig 1** – and equally as important, straight stock **MUST** have been used initially. The details of the baluster are, as normal, turned first, and then the piece reversed between centres, ready to twist. It is **VERY IMPORTANT** at this stage, to stress that the piece needs to be firmly

held between centres in order to obtain the required drive, but not over tightened, since internal stresses and any external ones will come into play as the hollows are developed, and the whole job may "explode" in a rather spectacular fashion if it is unacceptably mounted. It may well be that the actual design of the piece required will need modifications in design in order to be successfully machined.

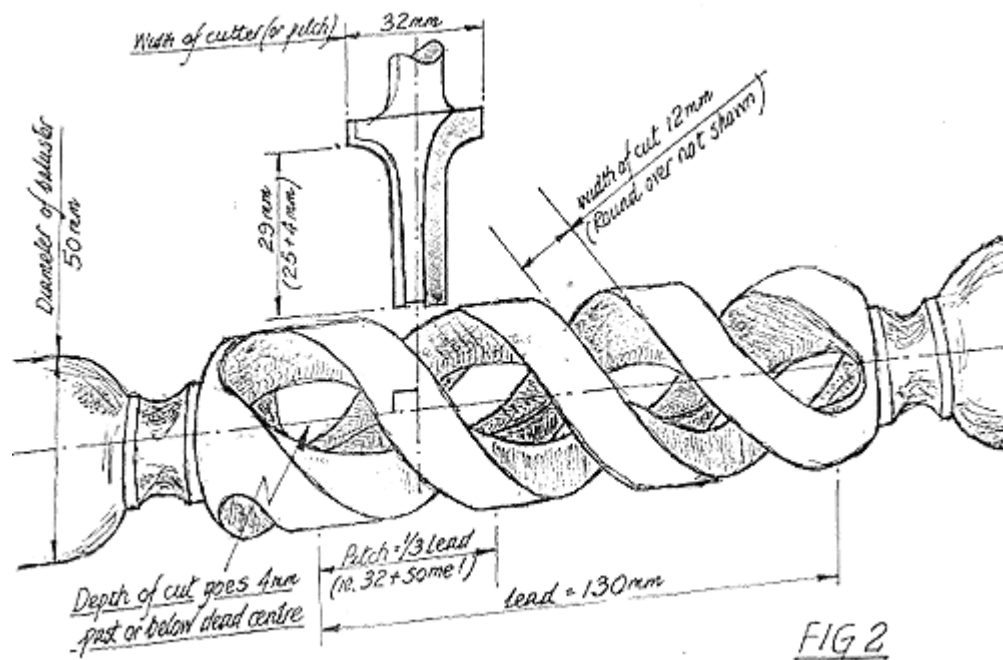


## AVOIDING VIBRATION

Care is required in design to ensure that little or no vibration within the piece is generated during machining. The use of a trial piece, or "rough", to initially test the viability of a design is always desirable. Such vibration is usually caused by either long or small diameter section designs (or a combination of both) and this needs to always be considered. Delays of a few days between turning and twisting are also a disadvantage since some movement will occur.

## HOW MANY STARTS?

In any piece of twisted work, for a given cutter, the longer the lead the more starts will be required. (Note information contained in the Section Barley Twist). It follows that the tighter the twist, the fewer starts are needed until such a condition is reached where the lead and the pitch coincide. With our example it is important to have sufficient starts to look attractive and suit the cutter, but not too many to render the piece weak and unacceptable. For our chosen cutter (see **Fig 2**) the width is about 32mm and from experience, the strength/appearance factor suggests three starts. It is reasonable to add a little and effect the width (an acceptable procedure when working out hollow twist leads) to decide upon a lead of 130mm.



## SETTING THE LEAD

Remember, Lead (**L**) = Pitch or width of cutter (**P**) x No. of Starts (**S**).

The number of starts is crucial, particularly in terms of strength. It is important to appreciate that much of this will come with experience, but it is appropriate for three starts on our 50mm diameter baluster. However, the number of starts (graduations in the CNC machines) is always conditioned by the width of the cutter – again, see the section on Barley Twist.

The way the lead has been arrived at is by taking the width of the cutter – 32mm – and adding a little – say 10mm – then multiplying by the number of starts – 3 – to get 126mm or 130mm

## MAKING IT ELEGANT

Should a more elegant job be required than seems possible to machine, one way is to produce more, slender open twists than is wanted, and physically cut a number out by hand at the completion. For example, cut four narrow open twists on the lathe, and then remove two opposite ones at their roots.

## ROUTER CONFIGURATION

In plan form, we can see in **Fig 2** the configuration of the router cutter required, and it needs to be stated that the type and range of cutters available will limit or condition the work being carried out. The cutter to be used is basically a plunge router bit with a radius at the top of the plunge section and is known as a "pierce & round over" cutter. This is illustrated in **Fig 3**, and the dimensions given (applicable to our example) are for a cutter available from Hapfo Pollards of Salford, Milton Keynes. It is desirable but not essential, to round over the bines, hence the reason for the radius illustrated.

Having considered the above, we can further develop the hollow twist process, and the following is applicable to most aspects of such work. It should be noted that this type of operation is unsuitable for tapered work when carried out on copy machines and must be used on parallel pieces. Should the operator be using a CNC machine, the required elements are naturally added to the programme.

## MARKING OUT

Since the work piece has been mounted between centres (see **Fig 1**) the first operation is to mark in pencil on the section of the work piece to be hollow twisted, the range of the cut. Next, the traverse speed should be set (say at point 4) and kept at that position. It is **VERY IMPORTANT** that this is not moved at all during the total operation, as serious problems will result as will be seen later.

The router bit is now mounted in the King unit (for as previously mentioned, this is the model we are using in this example) and the plunge face brought to within 1mm of the work face of the baluster by using the precision setting device (PSD/depth stop).

The slide stops are now set at both right and left hand by traversing the saddle forwards until the stop is effected at the left hand pencil mark, and backwards until likewise, the saddle stops at the right hand pencil mark. This is the range of the saddle movement and is **NOT** altered during the operation, since passing cuts are taken in stages and in sequence, in order to ensure the work piece is in balance and an appropriate amount of timber is removed each time thus causing minimal stress overall.

## RECAP

At this point it is important to recap that the lead is set (at 130mm.) and three starts selected, the traverse speed is fixed (at "4") and the depth stop so adjusted to ensure the tip of the cutter's plunge face is 1mm from the work piece. With the rotational speed of the King unit set to maximum (17,000 RPM) and the cutter rotating anti-clockwise, it is now possible to commence with the operation noting that the indexing head selector should be in the zero (or "24") point and remembering that the slide stops are in the required position.

This operation is not possible with the 5000M lathe with cantilever arms, since the geometry does not accommodate such movement, except, and unless, the conventional router support has been replaced by a specially adapted type of cross slide mechanism.

It should also be remembered that the twist function must be kept in gear (in our example "left") throughout the operation of producing each piece, as it is very difficult to re-engage the exact gearing position if, at any time, this is lost.

## STARTING TO CUT

To commence the actual cut for the hollow twist, switch on the router and wind in the depth stop 10mm (Each turn of the depth stop wheel reduces or increases the distance travelled by the cross slide by 1mm). Turn the mode switch to "1" and wait for the router cutter to plunge into the work piece, then immediately press the "forward" button engaging the forward movement of the saddle. The work piece will rotate slowly and the first helix will be produced. The saddle will stop when the left hand slide stop is reached, and the mode switch is then immediately turned to the "0" position, ensuring that the router will disengage from the work piece and take up its original position. At this moment, the "backward" button is engaged and the saddle returns to its original position when the right hand slide stop is reached.

## THE SECOND HELIX

To produce the second helix, move the indexing head selector to "8" (Remember, for three starts, divide 3 into 24 – the index plate hole number size – to get the answer 8) and repeat the above procedure. After the second helix is produced and the router cutter and saddle have been returned to their original positions, move the indexing head selector to "16" and once again, repeat the above procedure, to produce the third and final helix.

Between the cutting of each helix, and immediately after the router has returned to the "start" position, it is **MOST IMPORTANT** to take out the slack in the gear train (always apparent in any gear train to a greater or lesser degree) by pulling the index head plate from the top, towards the operator – push it away from the operator if a right hand helix is being cut – and holding it firmly until the router cutter has been activated and the plunge has taken place. If this is not done some distortion of the groove being cut will result and render the work piece imperfect and unacceptable.

After a little practice it becomes quite straightforward to hold the indexing plate, turn the mode switch and press the traverse button all in one smooth, easy fashion.

At this stage in the production of our hollow twist, the depth stop is now turned to allow the router to come IN a further 10mm, and the whole of the above procedure repeated using only the 24 (or 0) 8 and 16 hole positions of the indexing head. After this a further 10mm deep cut will be required and the procedure repeated yet again, and so on, until the rounded section of the router cutter comes into action, and the hollow of the twist has been machined.

The reason for cutting in only 10mm deep cuts, and taking each helix in turn is to ensure the stability of the work piece, since any undue vibration can destroy the job. It may also be necessary to take the last one or two passes in only 2 or 3mm deep cuts to ensure the radius of the cutter is developed to the correct profile.

## ON THE OTHER HAND

It will be appreciated that the above method was for a left hand hollow twist. It should be remembered from the section on Barley Twisting that right hand twists do not give such a perfect result (due to vibrations generated by the cutter and the nature of timber generally as cuts are made, in effect, across end grain) and this must be born in mind. Some timbers will shatter (certain exotics such as hard, close grained bubinga) and great care must be exercised. Cutting clockwise with an opposite handed cutter helps.

Finally, some cleaning up may be required, but in general, this will be minimal if care has been taken and clean, sharp tooling used. A Fladder type sanding disc can be of help.

Applications for open bine work are considerable, and besides the baluster in our example, lamps and candlesticks are obvious examples. Other items of possible interest will include newels, standard lamps, bedposts & rails, pilasters, and jardinairs, but a whole range of items will come to mind once this type of work is taken on and completed.

On our Hapfo lathes, what originally took a considerable time by hand takes a relatively short time and can lead to not only pleasing and satisfying items, but profitable ones as well.

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### **NOTE:**

Should larger diameter work be required (for example a 4 or 5 inch diameter newel post) it must be appreciated that the longer the cutter, the larger the diameter that is essential to ensure no breakages are possible.

It follows that the larger the work piece the greater the cutter diameter needs to be and the number of starts could be increased to, say, four. The lead will also need to be increased in order to retain proportion. The requirements, in this case, work with us, but should there be any problems it is always helpful to obtain a second opinion and the folk at Hapfo Pollards Limited will always do their best to be of assistance.

However, remember it is always best, if at all possible, to complete a "rough" first. If this turns out badly it proves the point of preparing such a piece, and if perfect, one has a fine example to show future customers.

Hollow twist is invariably great to look at, is satisfying to produce and commands good prices. If owners have not produced such work to date it's definitely worth a try and may well open up other areas of profitable pieces one will be proud to have manufactured. It's certainly quicker than doing it by hand!!!

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## **Example Hollow Twisting Job 1**

In this particular instance, the customer required a custom designed baluster blank, which was then hollow twisted, the various balusters being from 820mm to 1130mm in length. This meant that the twisted lengths varied between 150mm and 450mm and whilst the short lengths gave no problems at all, the longer ones gave, as will be realised from our earlier comments, problems of a peculiar nature.

The fact is that the longer balusters would become unstable, since the timber size was 50 x 50mm square, giving a maximum turned diameter of 50mm, and this well exceeds the suggested maximum length of five times the diameter. Instead of 250mm of hollow twist, we were asked to provide 450mm.

However, as all experienced turners will know, one is always asked, at some stage, for something which is either difficult or downright impossible! – the customer being just that and NOT a turner. Since all Hapfo owners do their very best to please and tend to say "yes" to a request first and then consider how best to execute the request second, this was such a job.

However, since we are working with a Hapfo lathe (the AP5000 hydro King) the request was not impossible, but simply technically difficult and needed to be thought out. As should be appreciated, the following tends to go against what has been previously stated under the Hollow Twist section, but is this not the nature of a wood-turners lot? It may be a difficult request to complete, but if certain jobs were that easy, everyone could do them and where would that leave the experienced Hapfoman?

### **MAIN POINTS**

The following points were the salient ones to consider:

- a. The diameter of the baluster,
- b. The overall length of the baluster,
- c. The total length of hollow twist,
- d. The configuration of the actual bine, and
- e. The type of timber.

Since the maximum diameter was 50mm over a total length of 1130mm some form of support was required. The photographs show how this was achieved. This accommodated the cutter and ensured the timber did not flex at all – most important.

Since the overall length well exceeded the recommended, and the length of actual hollow twist was 450mm this meant that the degree of vibration would be excessive irrespective of any support or the shape or design of the cutter. This was simply due to so much timber being potentially removed and the pressure exerted by the tailstock, making the whole piece become unstable in the machine.

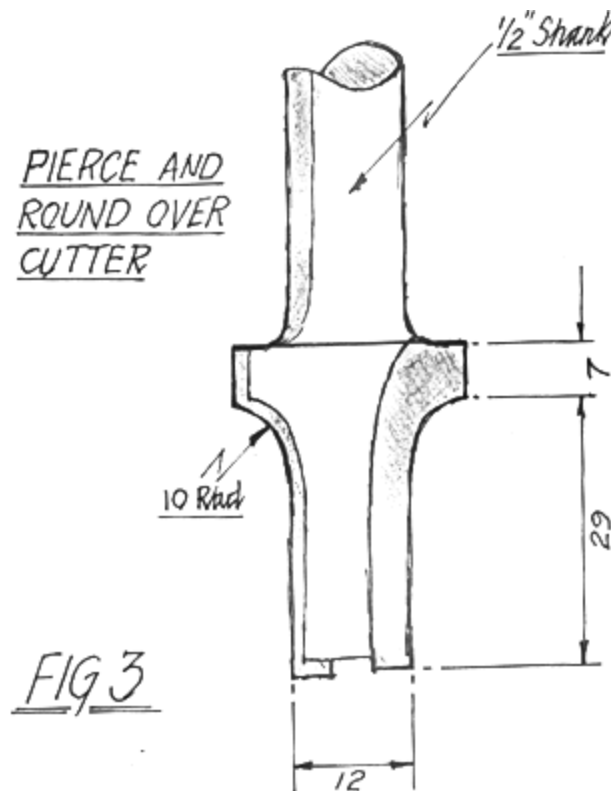
This required a rethink about such pressure, and the tailstock needed to be so modified in order that the job could be held by the tailstock and simply supported at the other end to maintain the central position of the work-piece.

This was achieved by manufacturing a new back-plate for the standard four-jaw chuck, and welding this to a modified morse taper (MT) – in our case a No.3. This then allowed the job to be mounted in the four-jaw chuck, simply supported at the other end with the live centre and thus ensuring that NO end pressure was transferred to the job, eliminated one source of guaranteed vibration (see photograph).

Further vibration could be generated by using tooling that was not pristine sharp, or by the use of “inappropriate” timber. Timber should be of a more stable nature, and suggests hardwood. In our case we were using ash.

## **ROUTER AND LEAD**

Perhaps the key to this job was the type of router-bit employed (this is shown in **FIG 3**) and the lead, together with the number of starts employed. From experience the number of starts should be three, as this gives the more pleasing appearance, and still retains reasonable stability.



The lead is crucial since this, coupled with the type of router bit used, gives the nature of the hollow twist produced. The customer had requested that the bine be round, with no flat at the top. The radius of the cutter used was 10mm with a cutting diameter of 12mm, thus giving an overall cutting width of 32mm at full depth. This meant, as previously discussed under the Hollow Twisting section, producing a lead of 96mm. (3 x 32) plus "a little" to ensure such a round bine. The extra (again from experience) needed to be about 10mm or so, and using the formula already explained we would require a top toothed wheel of 12 and a bottom one of 22.

$$\text{Lead} = Gt / Gb \times C$$

$$= 12 / 22 \times 200$$

$$= 109$$

The router cutter used was the pierce & round over type, and the above lead gave the correct shape required by the customer. The actual depth of the cutter was 29mm and therefore gave a width of timber behind the cutter of 21mm (50 – 29) and hence a reasonable amount of timber to ensure the baluster was relatively stable. It must be stated however, that the finished product was insufficiently stable for a balustrade on its own, but at least the customer was supplied with the product requested!

Once the blank was mounted in the lathe by the modified tailstock and between centres, it was important to ensure that the support was just in contact with the 50mm turned section to be hollow twisted and that no undue side pressure was pushing the baluster out of line.

The stops were then set as previously outlined, and the procedure commenced as already mentioned, the only difference being that cuts ought only to be 5mm deep since more than this could have the tendency to destabilise the job and thus cause the vibration that great care has been taken to eliminate. The traverse speed was set to 7.

The final cuts will need to have some form of dampening since the individual bines that are now beginning to be formed will yet again begin to vibrate if not all is very carefully centralised and equally stable.

The final two cuts are best at 2 and 1 mm depths respectively as this cleans the radii and yet again minimises the possible vibration inevitably induced.

Some final clean up with paper may be required off the machine, but the finished baluster is most pleasing and a product not possible on the majority of copy lathes.

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## Example Hollow Twisting - Job 2

This request was very straightforward and comprised a simple form of furniture foot as outlined in an accompanying diagram. It will be remembered from the previous section on hollow twisting that the statement was made that this type of work is not suitable for tapered turning. However, this referred to traditional work which is rounded over and is carried out with the pierce & round over type of router cutter.

The use of straight plunge router cutters opens up other possibilities and allows tapered and contour work to be contemplated. The only consideration different from those already discussed is that the cutter should not be too long, as too great an unsupported length may cause stresses that will eventually cause possible breakage of the bit.

It should also be appreciated that such a bit will only give square shoulders. As a rough guide the maximum diameter of such work ought to be no more than about four inches, and this will require a cutting length of approximately two and a half inches, as the cutter will be required to travel at least half an inch past dead centre.

The diagram gives the drawing for the template and indicates the length of hollow twist required.

All other operations are as previously given, and it should now be clear that the basic instructions and procedures are similar for the majority of open bane work, care be taken to ensure that leads are acceptable and any undue pressures are not being exerted onto the cutters being used.

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