INDEXING THE MYFORD SUPER 7 USING A SHERLINE CNC ROTARY TABLE

Background

An ability to index the rotation of a lathe chuck is a very useful tooling asset particularly in clock wheel cutting. Traditionally this would have been done with a mechanical mechanism employing a suitably chosen indexing plate to lock the chuck in place after each incremental rotation.

The advent of electronic rotational indexers such as the Sherline CNC Table makes this task not only easier but also incredibly flexible in the choice of increments. These devices can be programmed to either give numeric divisions up to 999 or similar steps in degrees. The Sherline has backlash compensation included in the design and is a nicely engineered device with a very straightforward controller. The controller has some very useful additional features such as sequential programming of random steps.

My write up describes how to mount the electronic indexer into the rear bore of the lathe spindle using an Expanding Sleeve and a Mounting Plate. A minor modification is made to the rotary table to mount the sleeve.

Before delving into the details of this adaptation I need to emphasise that the idea is not of my making and I am indebted to the late William Smith for sowing the seeds of the idea. I also need to emphasise that my Super 7 is a large bore version with a 26mm ID spindle through bore to accommodate a 1" diameter workpiece. Note that this is the diameter through the spindle as seen at the rear of the shaft. The diameter for the first section at the chuck end of the spindle is larger than this at around 30mm.

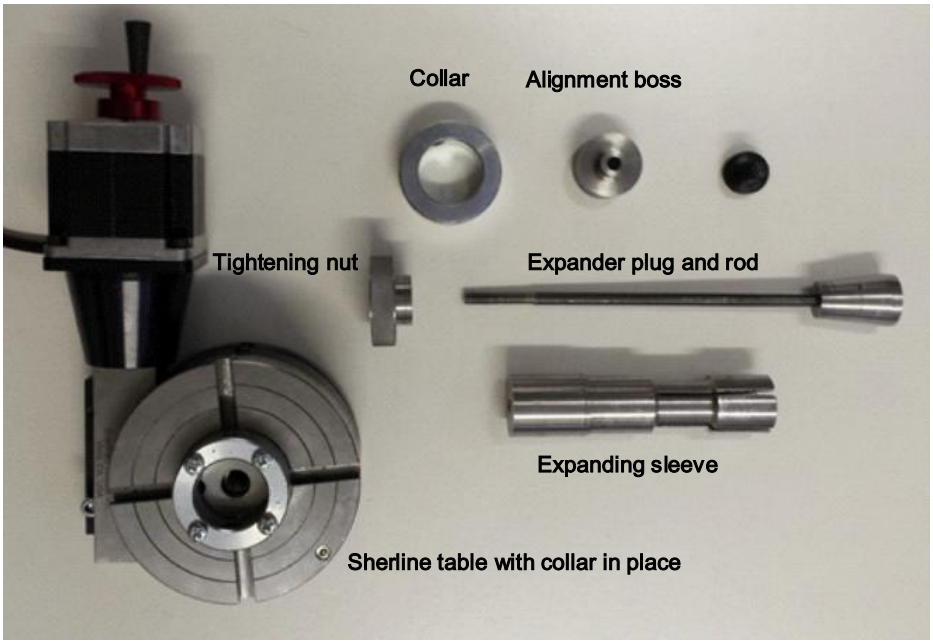
I see no reason why the same style of expanding sleeve adapter cannot be fabricated to fit the standard bore spindle size of the Myford family or indeed any other lathe with easy access to the rear of the headstock spindle bore.

Overview

I emphasise once more that my Super 7 is a large bore so the dimensions that I will give reflect this.

The Expanding Sleeve consists of a quadrant cross cut sleeve that sits snuggly in the inside diameter of the spindle bore. The Sleeve is bored out and has a tapered entry section that matches a tapered expander 'plug'. This Plug is drawn into the cross cut section of the Sleeve by a tightening rod such as to expand the Sleeve and grip the inside of the spindle bore. There is a cross pin fitted to the Tapered Plug to ensure the Plug pulls into the available expansion slots rather than rotating.

Here is a picture of the parts excluding the Mounting Plate. Note that the black object is the supplied central boss that comes with the Sherline table. Note also that a duplicate undrilled collar is shown to complete the picture.



The gripping action inside the spindle is not unlike the concept of the Myford produced hand winding handle.

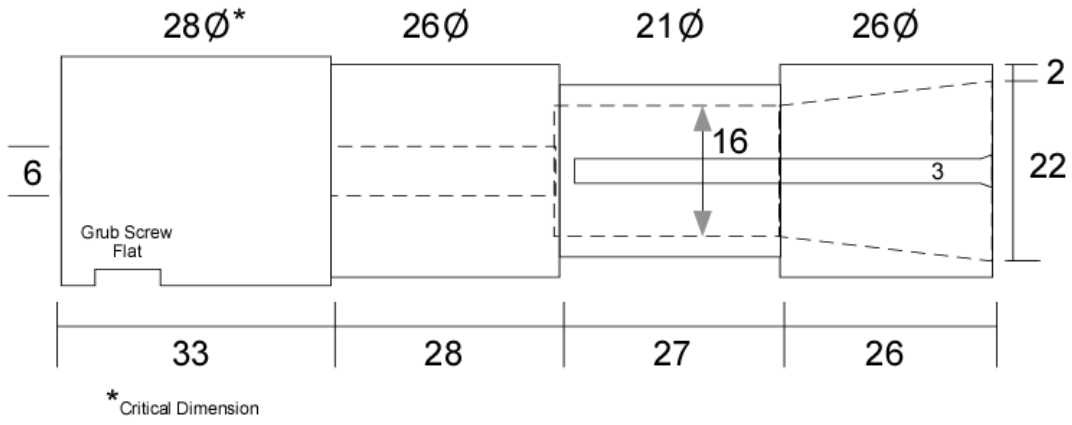
Having mentioned this Myford product it is not out of the question to buy one of these in either small bore or large bore versions and remove the handle to leave the sleeve and expander to be adapted for the indexer concept. The handles for the hand turning handle are held in place with Loctite and readily come apart with the application of heat. If this route is taken some adaptation will be needed to match the resulting diameter of the expanding sleeve assembly to the mounting Collar on the CNC table. This will be better understood after reading these notes.

The Expanding Sleeve

The Expanding Sleeve is made from mild steel stock and which needs to be greater than 28mm diameter but clearly be able to fit into the lathe chuck for machining. As mentioned already the first section of the spindle bore from the chuck end of the Myford is wider than the through spindle bore.

An overall length of 114mm long will be needed for the finished Sleeve.

Expanding Sleeve Details



Turning the sleeve needs some careful thought on the sequence of operations. I suggest the following order : -

1 Hold the stock in the chuck as deeply as possible and turn the face before drilling a centre hole to suit a revolving centre which will support the free end.

2 With support in place, turn the diameter to close to 26mm for a length of 81mm back from the supported tailstock end. This diameter is critical to be a sliding fit in the lathe

spindle bore at the outer end. If you are not confident in your measurements for this then mark the position of the stock in the chuck jaws and remove from the lathe and check for a sliding fit in the rear of the spindle. It should feel like you are pushing a vacuum as you slide it into the spindle. Take iterative cuts to achieve this. It is not ideal to keep removing the work piece as concentricity is the aim hence the marking of the position in the chuck on removal. If you have no run out on your lathe this isn't a problem ….

3 Having achieved the comfortable sliding fit into the spindle rear, reload the stock and the tailstock support centre and turn down the narrow waist to 21mm for a length of 27mm. Again this is not critical so long as the waist is not so thick as to resist the expansion of the end section.

4 Time now to drill and bore the sleeve. Remove the supporting centre and replace it with a fixed steady. Using step drilling techniques, drill into the end of the stock to a depth of 60mm to a diameter of 16mm. I was fortunate to have a 5/8" reduced shank twist drill for this. If you are limited to 12mm drilling capacity then continue beyond this using a boring bar until you achieve the 16mm required diameter. Note it is important to drill deeper than the end of the 'quadrant slots' otherwise when you reverse the stock and through drill, a standard 6mm twist drill will struggle to break out into the 16mm bore.

5 Set the cross slide to a 7 degree angle and with a boring bar cut the taper as shown to leave a 2mm thickness lip at the open end of the stock.

6 Reverse the stock in the lathe and grip in the chuck across the 26mm sections. Face off and drill a 6mm hole through the end face to break out into the bore in the other end of the stock.

7 Next turn down the stock to achieve the 28mm diameter. Now this is important in so far as it must match the 'socket' that you will fit on the CNC table face. I bought a readymade shaft collar from Bearing Boys (Part# CABU28Z) which had a 45mm OD/28mm ID and was 16mm tall. It comes with a M8 socket head grub screw already fitted. I chose to buy this simply to avoid buying a large diameter piece of stock to then only use a narrow section and create a lot of waste material. Having made or bought the collar you can now use the collar to judge a comfortable sliding fit on the 28mm section. There should be no sideways slop and it should feel (just like the 26mm section into the lathe spindle) as if you are pushing a vacuum as it slides on.

8 This completes the lathe work on the Expanding Sleeve but the four quadrant slots now need to be cut to give the expansion flexibility. There is a cross pin in the associated Expanding Boss and this must slide freely in the cross slots. The slots therefore need to match accordingly. I used 2.5mm silver steel for the cross pin and made the four slots 3mm wide. I cut these one at a time in the mill and clearly there will be vibration and chatter associated so care is needed. Alternately the four slots could be cut with a hacksaw with a number of blades mounted in parallel and then filed to finish. I filed a guide chamfer at the end of the slots to allow the cross pin easier location access.

9 Note the grub screw flat is shown in the drawing but is detailed later in the text.

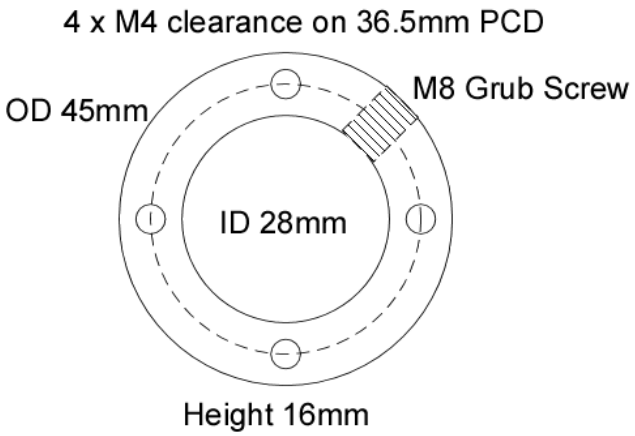
10 This completes the Expanding Sleeve.

Mounting Collar

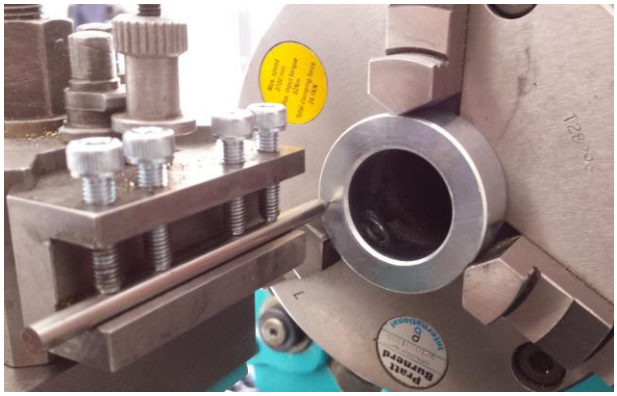
As mentioned earlier, this collar can be made or bought in as a finished item. I opted to buy in. Either way this item needs to be on hand and ready when the Expanding Sleeve is being made.

1 Chuck and face off a section of 45mm diameter mild steel.
2 Very carefully bore out the centre to 28mm. (This has to be a tight fit to the Expanding Sleeve mating diameter).
3 Using a sharpened rod mounted laterally in a grooved QCTP holder, centre mark four holes on 90 degree increments midway on the Collar face (36.5mm PCD). If you have one of the above mentioned winding handles you can insert this in the rear of the spindle and set by eye a 12/3/6/9 o'clock position for the handle. Alternately put a blob of Tippex on the rear spindle end and use this as your clock reference.
4 Part off the Collar to 16mm depth and rotate in the chuck to face and clean off the cut surface. (This side will be the upper most side when mounted on the CNC table).
5 Drill the four centre marks to M4 tapping size only at this stage (3.2mm).
6 Drill and tap a hole midway in the side wall for a M6 or M8 grub screw.
7 Deburr and slightly chamfer the front opening of the centre hole.
8 This completes the Mounting Collar.

Mounting Collar



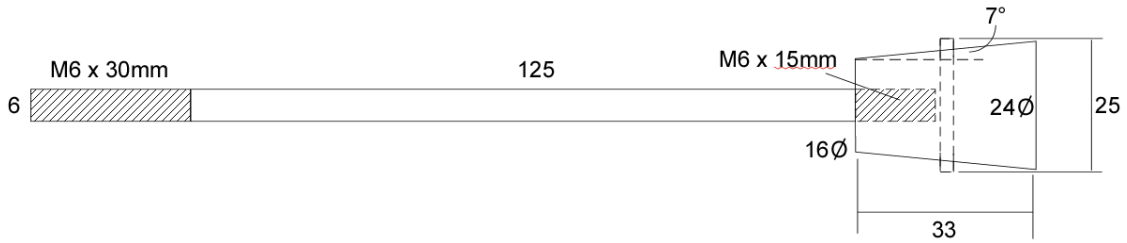
Bearing Boys Part No CABU28Z only needs the four clearance mounting holes added



Expander Rod and Plug

Making this is component is straightforward.

Expander Rod and Plug



1 Take a 170mm length of 6mm steel rod and cut a 6mm thread on each end. This should be 30mm long at one end and 15mm at the other. This is the Expander Rod.

2 Face a 34mm long 25mm diameter section of mild steel in the lathe. This will form the Expander Plug. Face both ends and then drill and tap one end M6 to 15mm depth.

3 Cross drill the stock with a 2.5mm hole at the half way point to accommodate the silver steel cross pin.

4 Screw the Expander Rod into the Expander Plug and Loctite it in place.

5 Once the Loctite has cured, grip the Expander Rod in the lathe to leave the plug available to machining.

6 Set the top slide to the 7° angle and gently shape the Expander Plug to the dimensions show in the diagram and to be a matching fit to the Expanding Sleeve.

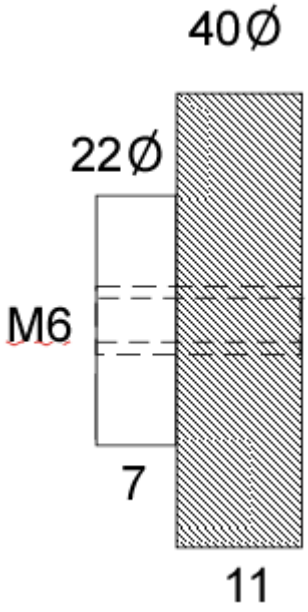
7 Cut a 25mm length of 2.5mm silver steel and Loctite this in place to sit symmetrically in the Plug to stop rotation of the Plug in the taper.

8 This completes the Expander Rod and Plug.

Knurled Expander Tightening Nut

This is non critical straightforward turning.

Knurled Expander Tightening Nut

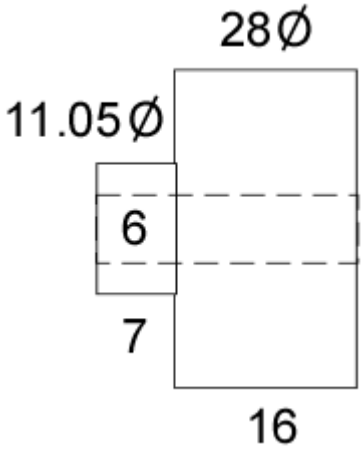


1 Mount and face a 40mm diameter piece of mild steel in the lathe.
2 Turn the 22mm shoulder to a depth of 7mm
3 Knurl the 11mm section and part off.
4 Reverse the stock in the lathe and face the 40mm end face
5 Drill and tap a through centre hole to M6.
6 Chamfer to remove any sharp edges.
7 This completes the Expander Tightening Nut

Centre Alignment Boss

The next step is to mount the Mounting Collar on the CNC table face. In order to ensure this is concentric it is important to make a boss that will mate with the central hole in the CNC table and which has an OD that sits snuggly in the Mounting Collar. This is simple lathe work and details of the Centre Alignment Boss are as follows : -

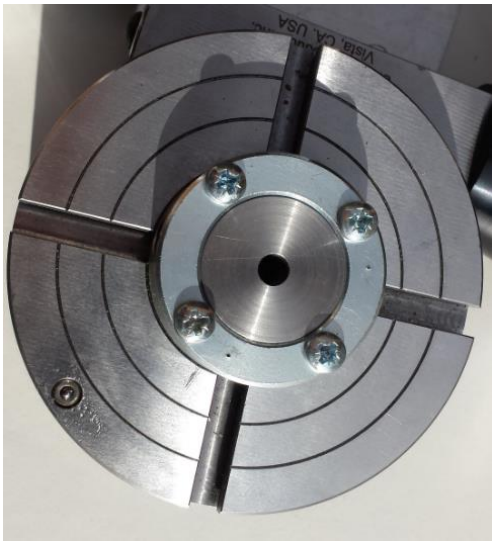
Centre Alignment Boss

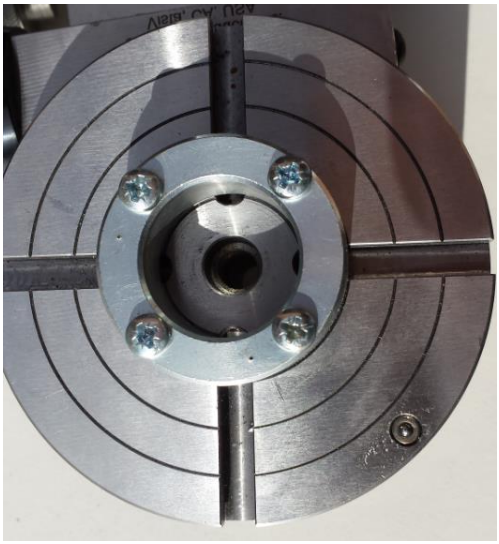


1 Chuck and face off a 30mm diameter section of mild steel.
2 Turn down a shoulder to 11.05 diameter and 7mm deep. The 11.05mm diameter is critical to mate with the hole in the CNC table centre.
3 Turn down the wider section to 28mm such that it smoothly fits inside the Mounting Collar with a nice vacuum sliding action.
4 Centre drill and then drill a 6mm though hole.
5 Part off the 28mm section to 16mm.
6 Apply a small chamfer to all edges.
7 This completes the Centre Alignment Boss.

Attaching to the Indexer

Having produced all the components these now have to be fastened to the indexer table and it has to be accurately concentric.





1 Fit the Central Alignment Boss to the top of the CNC table by dropping it into the central hole and retain it with a through M6 nut and bolt.
2 Place the Mounting Collar over the Centre Alignment Boss and make sure it is seated flush with the face of the table. Make sure you put the face that was faced off first of all towards the table as this is concentric with the outer diameter of the Boss.
3 Rotate the Collar such that the four holes in the Collar sit central in the four quadrants of the CNC table between the T Slots. Tighten the grub screw in the Collar such as to hold the Collar in place. Don't overtighten it.
4 Using a centre pop make a pair of witness alignment marks on the Collar and the table so the orientation of the Collar and the table can be maintained in the future.
5 Using the M4 tapping holes in the Collar as guides drill through these into the face of the table to a depth of 5mm. Not knowing what was below the surface meant I kept this depth conservative.
6 Remove the Collar and the Boss from the table.
7 Tap the four holes in the table surface M4.
8 Drill out the four holes in the Collar to now be M4 clearance.
9 Reinsert the Centre Alignment Boss on the table and then re-mount the Collar on the table with the marked face upwards and synchronised with the witness marks. Secure in place with four M4 x 20 screws.
10 Remove the Centre Alignment Boss.
11 This completes the preparation of the table for use with the other components.

Grub Screw Accommodation

Before final assembly there is one final action : -

1 Fit the Expanding Sleeve into the Collar such that is perpendicular to the table and seated home to the table surface.
2 Gently tighten the grub screw sufficient to leave a witness mark in the Sleeve surface.
3 Loosen the grub screw and withdraw the sleeve and file or machine a generous flat to match the impact area of the grub screw. (Without this the grub screw will deform the outer surface of the sleeve and lead to difficulties inserting and withdrawing the Sleeve from the Collar.

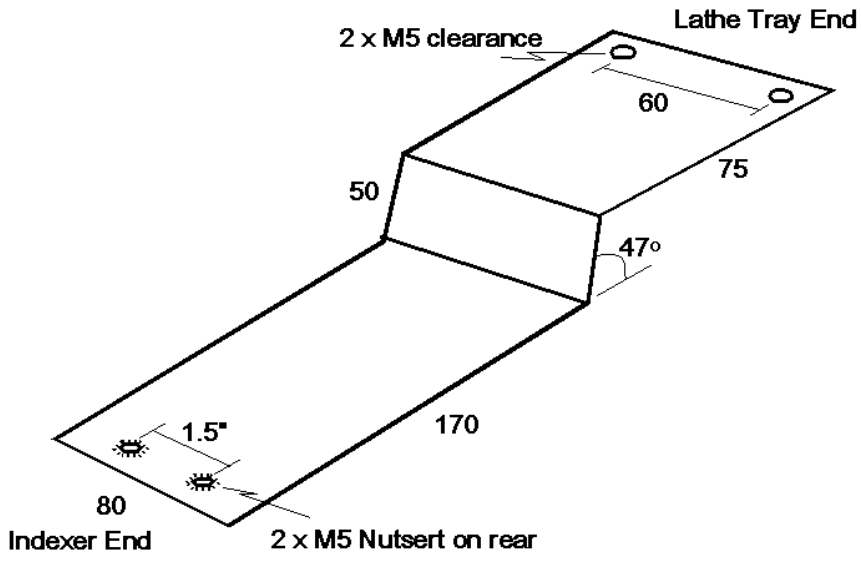
Assembly

1 The Expanding Sleeve is fitted into the Collar and the Expander Rod and Plug assembly is inserted into the end of the Sleeve and down through the table centre hole.
2 The Knurled Expander Nut is wound onto the thread protruding through the lower surface of the table but not heavily tightened.
3 The Sleeve is rotated to ensure the grub screw is aligned with the mating flat on the Sleeve and the grub screw tightened.
4 With the Expanding Sleeve in place on the table, it should be located into the lathe rear bore and the Knurled Nut tightened to grip the sleeve inside the bore. The whole assembly is now tight in the lathe bore and will rotate with the lathe spindle.
5 The assembly now needs to be rigidly fixed to the lathe body to stop this rotation. The following section describes a solution for this.

Retaining Plate

There are various ways that this could be achieved and this is my solution.

Pictorial View of Retaining Plate

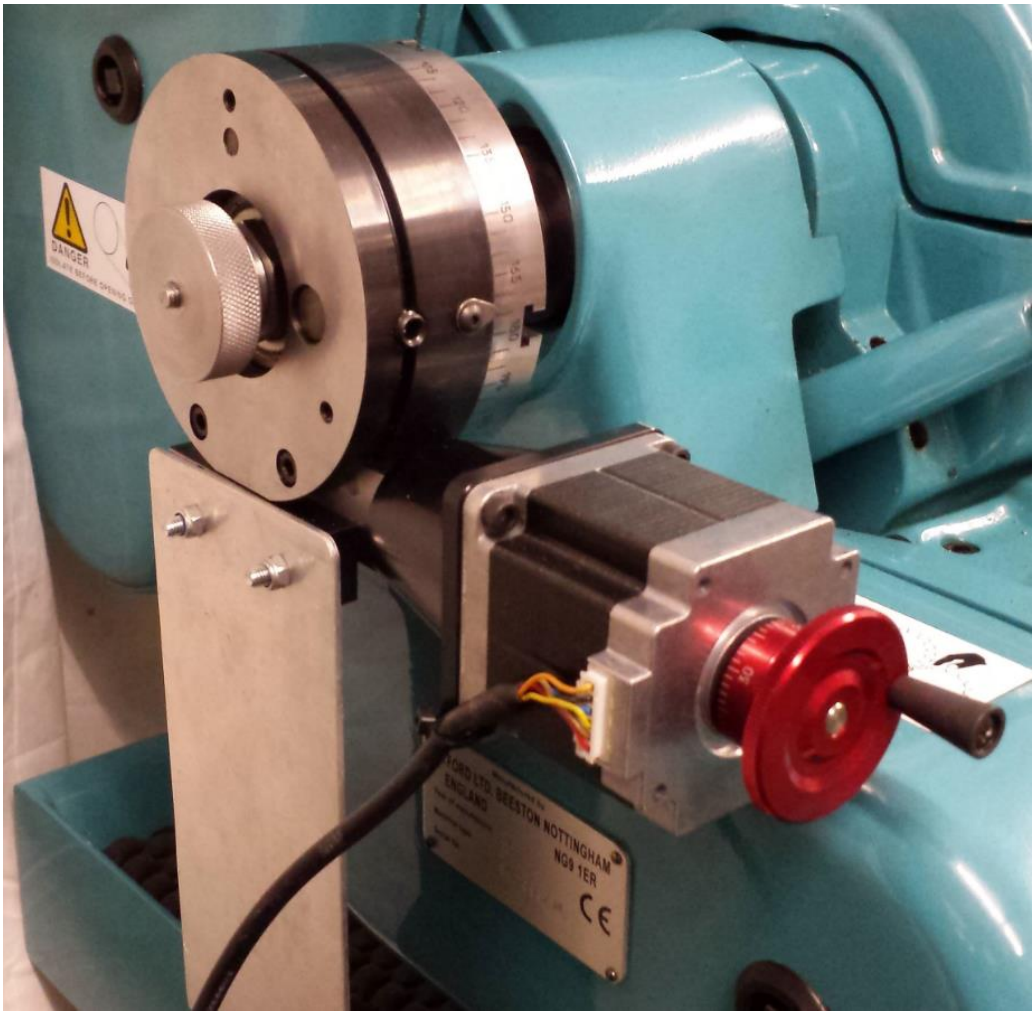


I bent a piece of 2mm x 80mm wide x 295mm long aluminium sheet with an offset bend as per the drawing above.

The offset is to align the table when mounted in the spindle end to match the lathe tray edge. The sheet is fixed onto the indexer body via the two empty holes on the table body. These are 1.5" apart and will take M5 screws. I put two M5 captive nuts (e.g. Nutserts/Hankbushes or Rivet Nuts) in the mating holes in the plate to make mounting and dismounting easier.

The sheet is bent as shown to bring it in-line with the lathe tray outer surface on the Super 7 where it was temporarily held in place with a couple of toolmakers clamps. Two holes were then drilled through the aluminium and through the lathe tray wall. The holes in the lathe tray wall were then enlarged to take two more captive M5 fasteners.

Here is an image of the plate in position on the indexer (note this was before I fitted the captive nuts).




Motion Controller

Using the Indexer

1 Mount the Sleeve in the Collar and rotate the shaft until you align the flat/notch in the sleeve with the grub screw in the collar. Tighten in place.
2 Mount the anchoring plate on the indexer using 2 off M5 x 20mm cap head screws.
3 Push the sleeve into the lathe spindle outer end to a depth that allows the anchoring plate to sit vertically in line with the lathe tray edge. Fasten in place with a further pair of M5 screws such as to hold the assembly rigid to the lathe tray wall.
4 Tighten the Knurled Nut to expand the Sleeve until it grips the inside of the spindle.
5 All is now ready for action – note the indexer is always used with the belt drive to the chuck free running so there is no resistance working against the indexer action.

Remote Indexing

If you read the User Notes with the Sherline CNC Table you will see that there is a pin on the interface table that is called SENSE. If you short this pin to the interface GROUND pin it will initiate a 'NXT' command to increment the table by whatever division is programmed. This is useful to have as a manual remote switch close to the job being worked. As an alternative a push switch could be mounted on the milling table which can be depressed by the milling spindle (preferably with the milling spindle stopped …) after an appropriate XYZ command as part of an automated milling program

Storage

I had a nice Berry Bros & Rudd Port presentation box that nicely accommodated all the parts for storage …..

Disclaimer – This write up is designed to assist fellow hobbyists and as such I have no commercial, financial or other association with Sherline Inc and its products and I acknowledge their patents and copyrights in this and other write ups.