Tool & Cutter Grinder

The Bonelle Tool and Cutter grinder (based on prof. Chaddock's Quorn) can be used to grind most kind of tools – from lathe tools to end-mills and reamers. I have been grinding my end-mills with an old Emco Unimat and a simple indexer mounted on a X-Y table, and wanted a cutter grinder with a few more options. So I came up with the idea of making just a few of the parts for the Bonelle (or Quorn) and mount them on my present tool grinding equipment. Without any castings I made some changes to the original design so I could use materials I had at hand. The bar bed is 20-mm diameter since I had a spare rod. The various parts are either bolted together or silver soldered. I also decided to use cotter locks instead of slitting. Drawings of the Bonelle can be found on the web, and Duncan Munro and Ron Chernich has good descriptions on building a Quorn.

Materials

The tool holder assembly was made from steel tubing and pieces of 10-mm steel plate from my scrap box, silver soldered together. The bar bed is a piece of 20-mm diameter silver steel, and the spindle was made from 25-mm diameter silver steel. I also bought a mandrel with MT 2 on the inside and 25-mm outside diameter.
For the base I used a piece of 30-mm thick steel plate from my scrap-box. The rotating base is ¾ in. thick in the Bonelle drawings, so I used a piece of 20-mm steel plate for this part, and a piece of scrap steel for clamping the bar bed to the rotating base.

Tool Holder Assembly

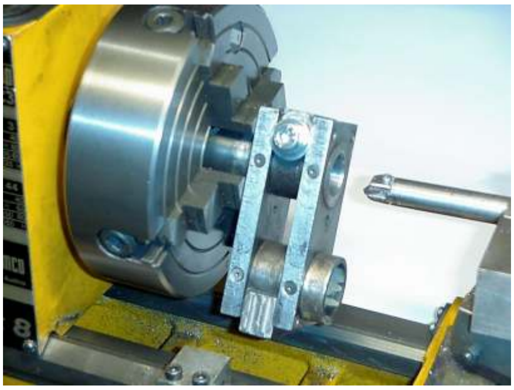
I figured the tool holder assembly might be the most difficult part to fabricate, so I started with it. The tool holder assembly was fabricated from two pieces of 10-mm steel plate and two steel tubes silver soldered together. In addition two rectangular pieces of steel was silver soldered to each tube so I could make holes for the cotter locks.
I started with the pieces I wanted to silver solder to each steel tube, one side must be machined to a close fit to the tube wall. This was done by clamping a long piece of 17 x 20- mm steel to an angle plate attached to the faceplate. By adjusting the angle plate the work could be set at a correct distance from the lathe centre line and a boring bar was used to turn the correct shape. Since the two steel tubes have different diameters I started with the largest. Then the work was moved sideways and shimmed closer to the lathe centre line for the smaller tube. I tried to use counter weights on the faceplate to minimise vibration.

I used a 35-mm diameter steel tube (with inner 27-mm diameter) and a 30-mm diameter steel tube (with inner diameter 19-mm). The two steel plates were clamped together with one M3 screw in each corner and two M4 bolts and all sides was milled to a little over correct size. The two holes were marked 55-mm apart (this would give a size that just would fit my faceplate). The centres of each hole was drilled with a centre drill, I could the use the tailstock centre to push the work against the faceplate when clamping the plates to the faceplate (see picture to the right). I used two pieces of brass as shims between the work and the faceplate and four clamps (in the picture to the right the two last clamps are not yet in place). I bored the holes so the steel tubes would slide in easily (about 0.1-mm clearance for the silver solder). See picture to the left.

I used emery cloth on the inner surfaces of the holes and on the outside of the tubes and steel pieces before soldering. The 30-mm diameter tube was left about 20-mm too long and used for clamping the assembly in the 4-jaw chuck.

While the two pieces was clamped together I drilled a 4-mm pilot hole for the index pin. I made a small distance piece tapped M4 and used this to clamp the two plates together while silver soldering. I put thin pieces of paper around the distance piece and oiled the screws lightly; these turned into carbon during heating so it was easy to remove them when the tool holder cooled down. To make sure nothing moved during the heating process I drilled a few more holed, and used screws or small pieces of wire to keep the various pieces in their correct place. I placed small pieces of silver solder between the tubes and the rectangular pieces for the cotter locks. The assembly was standing when heated so the weight pushed the pieces towards the tubes when the silver solder melted. The holes used for keeping parts together during the heating process was countersunk and tapped M3. I used small Allen screws to keep parts together in case errors in the soldering process.

The next operation was to drill the hole for the bar bed cotter lock. I marked the position carefully and started with a centre drill followed by a 3-mm pilot drill (see picture to the right). The hole was opened up in steps to a diameter of 13-mm. Because the tube used in the lower part was thickwalled I could drill the hole with a 13-mm drill without breaking into the inside of the tube. I used a small diameter end-mill to mill the area around the hole flat.



Then a piece of 13-mm diameter brass rod was drilled 6.8-mm to a depth of 41-mm. Then I opened the hole to 8-mm diameter for a depth of 21-mm. The bottom part was then tapped M8, and the rod parted off to a length of just under 40-mm.

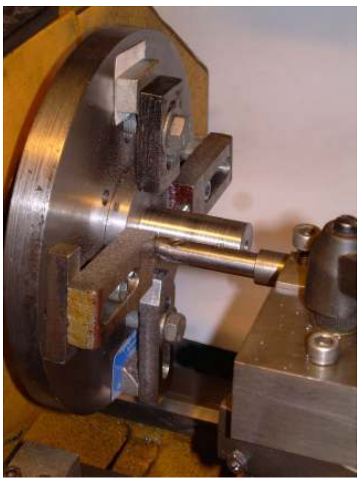
I could then use a 50-mm long M8 Allen screw, a nut and two washers to clamp the brass rod in the hole for the cotter lock so the cotter will be machined when the 20-mm hole is bored.

The assembly was then clamped in the 4-jaw using the protruding part of the bar bed tube (see picture to the right). I used a Dial Test Indicator to centre hole of the bar bed tube; the indicator needle moved just a few hundredths of a mm. The hole was bored to a depth of 42-mm and to a diameter so I could just push the bar bed in by hand.

The brass rod was removed and I used a small hack-saw to cut it into two pieces to make the double cotter.

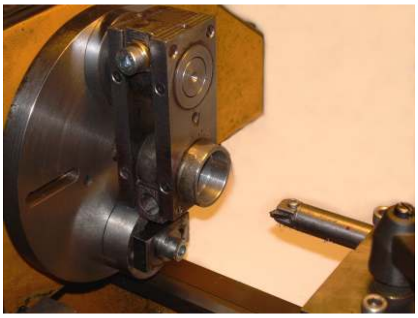
The the hole for the cotter lock clamping the spindle was first drilled with a 3-mm diameter pilot drill, and I used a ½ in. end-mill to open up the hole to final diameter (right picture). Because a thinwalled tube was used I could not use a twist drill over 5-mm without breaking into the inside of the thinwalled tube, so I had to use an end-mill.

This end will have bronze bushes installed so I could not machine the cotter lock installed. A piece of 13-mm diameter brass was drilled and turned as for the other cotter lock, but before parting off the work was mounted in the dividing head in the Mini-Mill. I then used the boring to machine the cotter lock to fit a 25-mm diameter spindle.



To get the hole for the bar bed and the hole for the spindle parallell I followed prof. Chaddock's advice and turned a fixture from a piece of 50-mm diameter steel rod with a 20-mm stub and a truly faced flange. This fixture was made by first chucking the steel rod in the 4-jaw and face one end at high speed with a light finishing cut. A centre hole was drilled and then a 5-mm hole was drilled 20-mm deep and threaded M6. This hole can the be used to clamp the fixture to the faceplate. The rod was turned around and gripped in the 4-jaw and supported by the tailstock centre. The stub was turned to a diameter of 21-mm. The fixture was then removed from the 4-jaw and mounted and centered on the faceplate (right picture). I used a boring tool mounted upside down and the lathe running in reverse to finish the stub to a close fit with the tool holder (The same fixture was later used

to bore the hole for the tailstock center).
I drilled two more 5-mm holes at the flange and threaded them M6. The fixture was then clamped at the periphery of the faceplate with 3 M6 Allen socket head screws. I had a small key that fit between the faceplate and the headstock so I could adjust the tension so the tool holder and the fixture could be knocked around a bit with a plastic mallet. This way I could adjust the position of the spindle tube and get a runout of around 0.1-mm using a Dial Test Indicator (right picture).



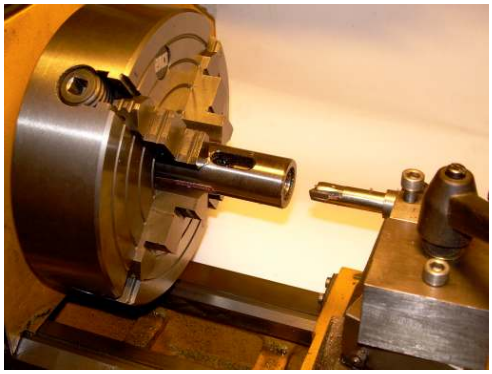
The M6 screws were tightened and I used a boring bar to bore each end (nearly 1-mm, left picture). The two ends was bored in the same setup, the outer diameter of the bronze bushes can later be turned for a press fit.

I purchased two sintered bronze bushes with 25-mm inner diameter. The outside diameter of the bushes was too large to fit inside the steel tube used in the tool holder, so I had to turn them down. First I made a mandrel with a slight taper, one end slighly under 25-mm the other a little over 25-mm. The bush was pressed onto the mandrel, and the mandrel was mounted between centres in the lathe (right picture). This way I could turn the outside diameter of the bush to a press fit in the tool holder.

Tailstock

The tailstock was made from a piece of 15-mm thick steel (95x30), to this I silver soldered two 10-mm pieces of steel. The position of the hole for the bar bed was marked and centre drilled, and a hole for the cotter was drilled nad a piece of brass clamped in place. I then used the tailstock center to press the work against the faceplate so the work could be clamped to the faceplate. Then a hole was bored so the bar bed was a push fit.

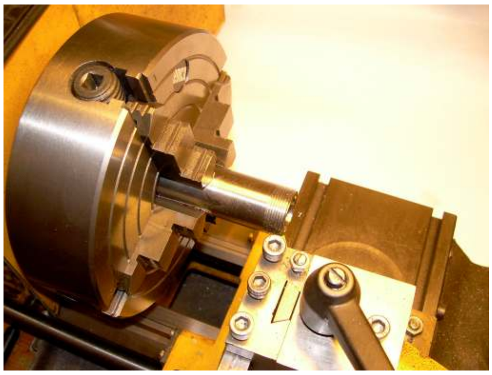
Spindles



I wanted three spindles. One spindle with an internal Morse taper #2, this was purchased ground and hardened, with MT 2 on the inside and 25.0-mm outside diameter. One spindle for the collets I use to grind four facet points on twis drills, and a spindle with a 10-mm square hole for grinding lathe toolbits.

MT 2 Spindle

The MT 2 spindle I purchased was hardened and ground all over. It was a nice push fit in the bronze bushes, but there was no through hole for a drawbar. And the nose was not threaded for the closing nut needed for the Myford collets I have.



The first operation was to mount the spindle in the 4-jaw rear end outwards and centering it with a dial indicator. There was already a centre hole at the rear end so I decided to try to drill a hole with an ordinary HSS twist drill 4-mm in diameter. I used slow speed and plenty of cutting oil and managed to drill through, the drill was rather dull when it broke through. The hole was then opened up in stages to nearly 10-mm and my collection of dull drills increased. I then used a small boring bar to open up the hole to 10.5-mm. It was now possible to use MT 2 finger collets and a 10-mm draw bar in the spindle.

Next I mounted the spindle with the MT 2 part outwards and centred as before. I then used a carbide tipped tool to cut a M25 x 1.25 thread on the outside of the spindle (right picture). A piece from a 38-mm steel rod was used to make a closing nut for the Myford collets, and a 7-mm thick collar with a 25-mm diameter hole. The collar is split and a M4 socket head screw is used to clamp it around the spindle. The closing nut was knurled on the outside and two holes drilled on the front. The two holes in the front are used by a small spanner.The nut was heated and treated with vegetable oil to give it some rust protection.

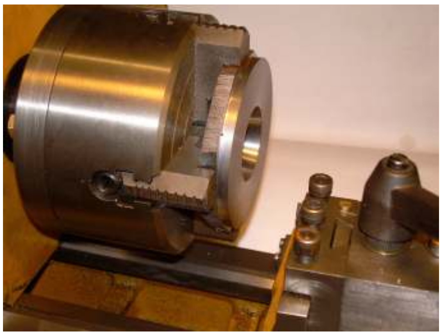
When I tested this spindle with a 8-mm end mill the runout was between 0.01 and 0.02-mm.

Spindle for grinding twist drills

The second spindle I wanted is for the collets used to grind four facet points on twist drills . This spindle (and collets) was made after Ron Chernich's webpage ("Drill Sharpening on the Quorn"). I started with a piece of ground steel shaft (0.45% carbon) 25-mm in diameter and a length of 75-mm. The work was carefully centered in the 4-jaw using a dial indicator. I drilled a 5-mm pilot hole through, and opened up to a diameter of 12-mm right through. The hole was then opened up to 15-mm diameter for a depth of 64-mm. I then used a boring bar to bore the 64-mm deep hole to 16-mm (a push fit for the collets). The rear part of the hole was threaded (with 1-mm pitch). How I made the collets is described in "Grinding Jig for Bench Grinder".

Universal Index Plate

The index Plate was made from a rusty piece of steel around 13-mm thick. The centre was marked and the corners cut before I mounted it in the 4-jaw. The work was faced and turned round about 1-mm oversize as close to the jaws as possible. The hole was turned with a taper slightly less than used on the Bonelle or Quorn.
After finishing the tapered hole the work was turned around and turned about 1-mm oversize. For the final turning the index plate I will use the 25-mm tapederd mandrel and mount the index plate with the collet and lock nut.



The collet was turned from a piece of 40-mm diameter steel rod about 20-mm longer than required. The extra length was used as a chucking piece. After centering the hole was bored to 25-mm and the outside turned slightly oversize on the tapered part (right picture). The part to receive the thread was turned to size and threaded with a 1.25-mm pitch. The collet was then partly parted off and I used a hacksaw to cut through to the hole for a little over halfway. The collet and chucking piece was transferred to the milling machine and the collet was slit. This will cause the collet to close up a bit so I transferred it back to the lathe, centered it an opened up the bore so I sould just push it onto the spindle by hand.

Base

The base is just a rectangular piece of 10mm thick steel plate with a hole in the centre and one 6mm hole in each corner for clamping to the grinding table. Both sides were faced in the lathe and I drilled an 11mm hole in the centre and tapped MF 12x1, I also drilled four 5mm holes and tapped M6 for clamping the rotating base to the base.

Rotating base

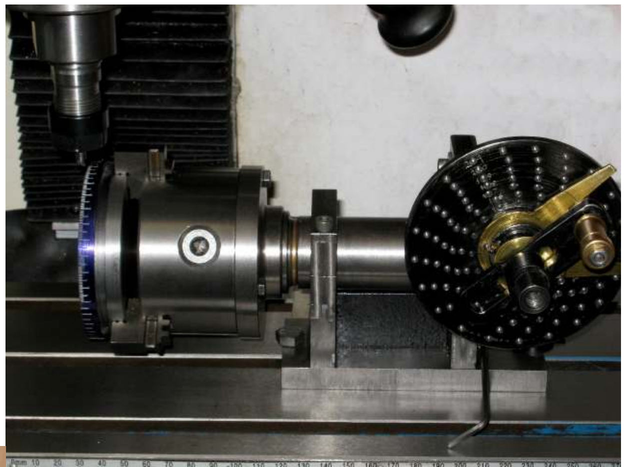
The rotating base started as a piece of steel plate a little over 20 mm thick. I used a hacksaw to cut off the corners and mounted it in the 4-jaw and rough turned the piece to a diameter a little over 80-mm. Both sides were faced and a hole drilled through the centre, the hole was bored to 11.8mm and reamed 12mm. On the top surface the 12mm hole was bored to a diameter of 20mm to a depth of just over 5mm. This hole will take a bolt that is threaded MF 12 x 1 and screw into the Base, and the Rotating Base rotates on this bolt. This is not according to the drawing and not the way the Rotating Base is clamped on the Bonelle/Quorn. I think using just a bolt is simpler to make and if it wears and become sloppy I could just make another bolt with a slightly larger diameter.

The work was mounted in my 3-jaw and I used a parting-off tool to make a groove about 6mm deep and almost 5mm wide. I then used a broken 3mm drill to make a kind of long ad thin knife tool and used that to make the groove wider at the bottom. When one side was finished, the work was turned around and the other side of the groove turned wider in the same manner. On the Quorn Prof. Chaddock turned a T-slot, I found this a bit easier to do. This T-slot is used to clamp some stops.

The work was then mounted in my dividing head and 360 divisions cut with a V-shaped tool mounted in the milling chuck. I made the 10 degree marks the longest, the 5 degree marks a bit shorter and the 1 degree marks the shortest.

I used 2mm high punches to mark the Rotating Base as adviced by Prof. Chaddock:

0 – 10 – 20 – 30 – 40 – 40 – 30 – 20 – 10 – 0

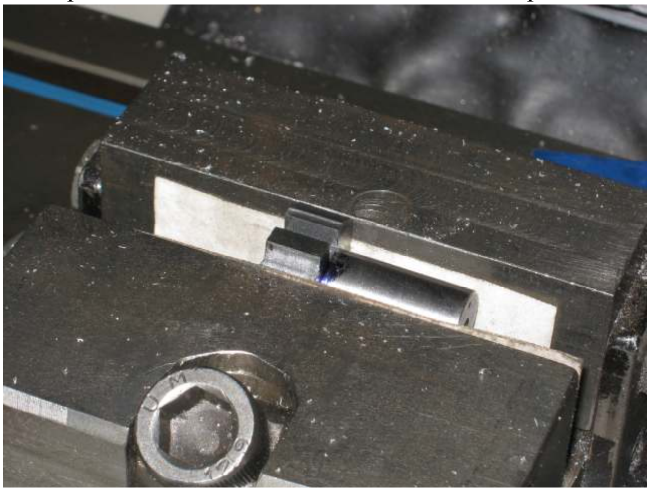


The various parts were mounted together – see left photo – and I ground the end teeth on an 8mm endmill.

Using a cheap X-Y table and my old Unimat SL work well, I tried the newly ground cutter on a piece of light alloy and it gave a nice finish. Not quite as nice as a new cutter but now I can grind my old cutters and use them for roughing cuts and use the new ones for a light finishing cut.

Grinding small lathe HSS tool bits

As mentioned earlier I made a spindle with a 10mm square hole for grinding lathe HSS tool bits. 10mm turned out to be far too large for the small 1/8" square tool bits I use for my small boring bars, so I wondered how to clamp them for grinding. I could of course, make another spindle with a smaller square hole, but then it occurred to me that I could turn down a larger bar to 12mm diameter for a length that gave a good grip in an ordinary 12mm collet, and mill a 3.2mm slot in the other end. A couple of M3 set screws could be used to clamp the tool bit. This would probably be easier than to make a new spindle with a small square hole.

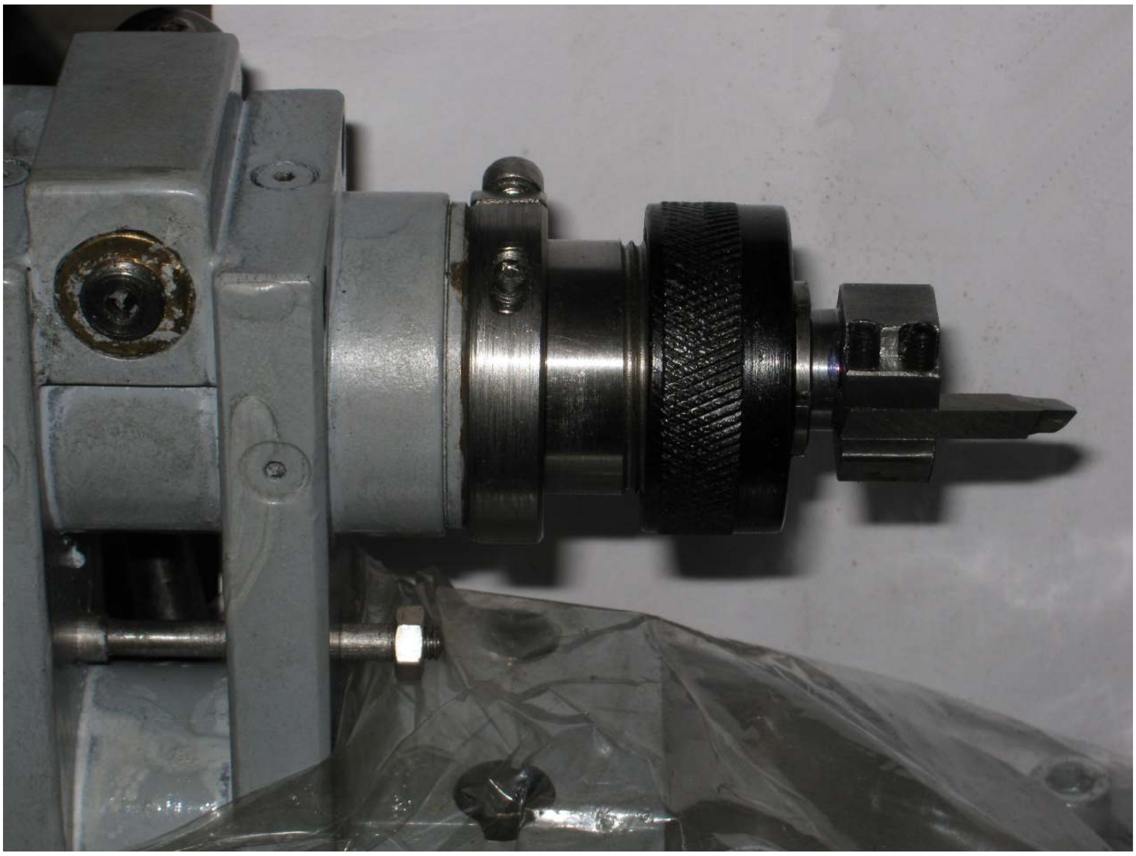


I had a piece of hexagonal free-cutting steel (17mm AF) and mounted a piece about 45mm long in the 4-jaw. Two opposite corners were filed flat for a length of 16mm, so the jaws had a flat to grip on. The work was clamped slightly eccentric in the 4-jaw so the periphery of the 12mm shaft would almost touch two of the flats. I drilled a small centre hole in the end closest to the tailstock and supported that end with a centre while turning the 12mm diameter shaft.

The work was then transferred to the milling machine and the 3.2mm slot milled for a sliding fit of the 1/8" HSS tool bits – right photo.

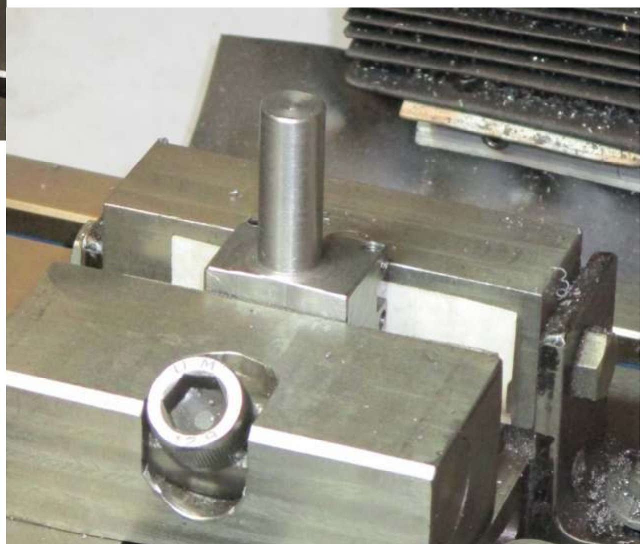
I also milled on the outside of the slot for the two M3 set screws.

Below is a photo of the holder mounted in a 12mm collet and with a 1/8" HSS tool bit.



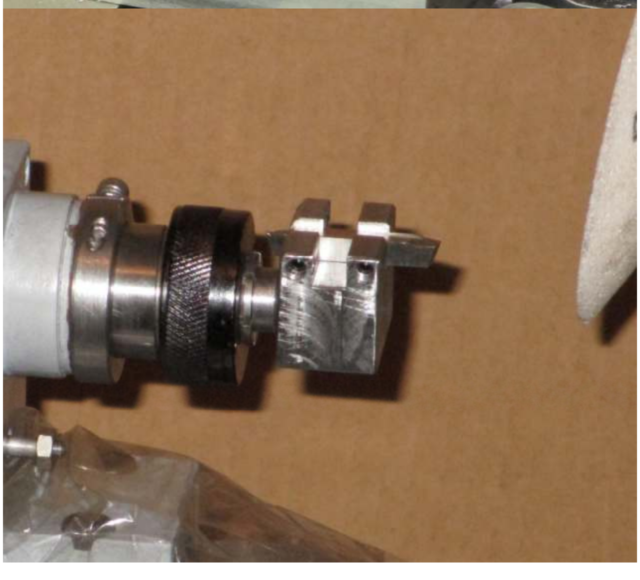
The holder for the 1/8" HSS tool bits worked so well that I decided to make a similar holder – though a bit larger – for the 5mm square HSS tool bits I use in my small lathe. I found a suitable piece of mild steel in my scrap box and first squared it up in the milling machine, and then mounted it in the 4-jaw so I could turn the 12mm shaft – right photo.

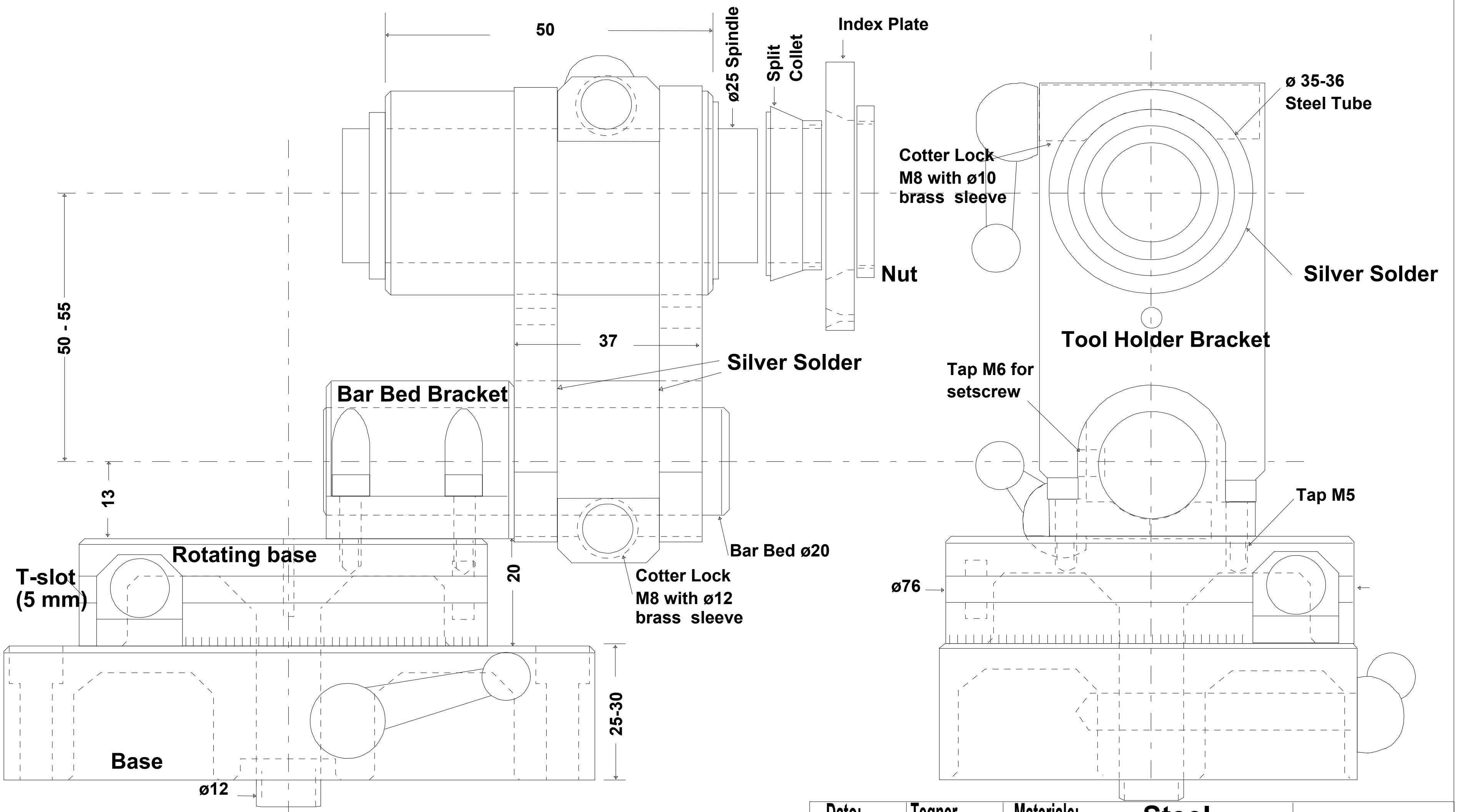
After turning the 12mm shat the work was again transferred to the milling machine and I milled two 6mm wide slots at 90 deg. With 6mm wide slots I can also clamp and grind the 6mm tool bits I use in the tangential toolholder for my larger lathe – see photo below.



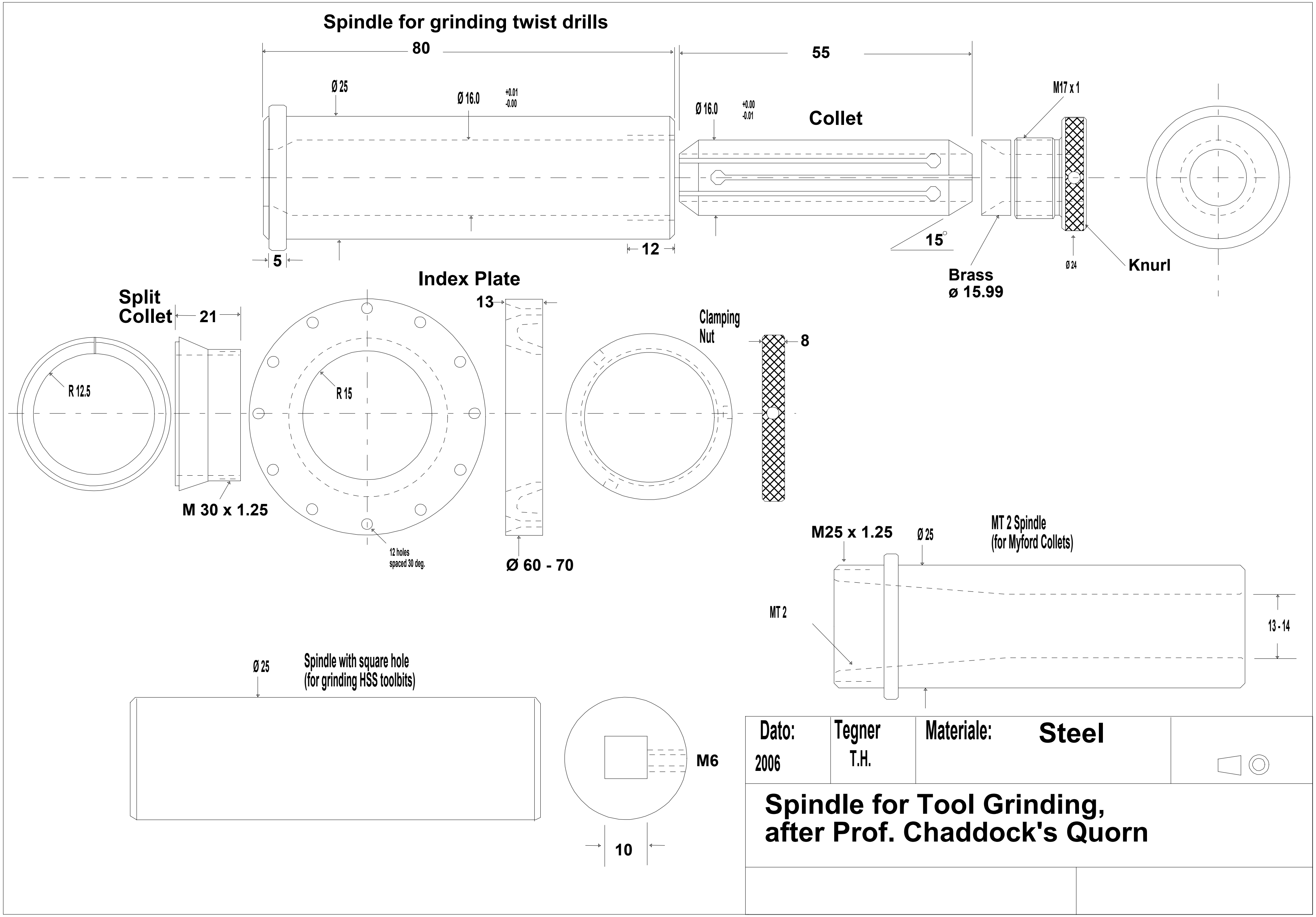
Since I milled two slots, two of the tapped holes for the set screws used to clamp the tool bits, had to cross. I drilled a small pilot hole first, then used a larger 3.3mm drill for the cross-hole. After tapping the large hole M4 the small hole was opened up to 3.3mm and tapped M4. This seemed to work fairly well and the holes ended up where I wanted them. After tapping the last hole I cleaned up the previous hole the remove swarf.

Here is a photo of the finished holder mounted in a 12mm collet and with a 5mm square tool bit.

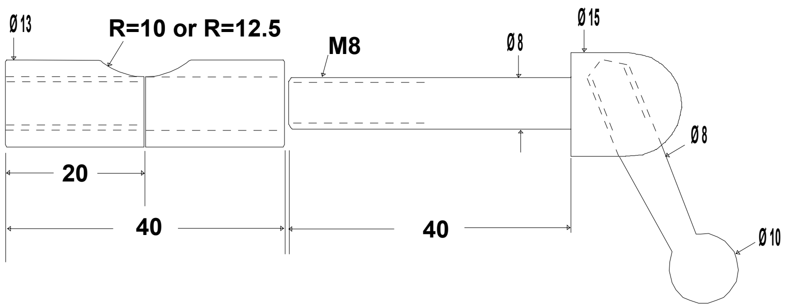


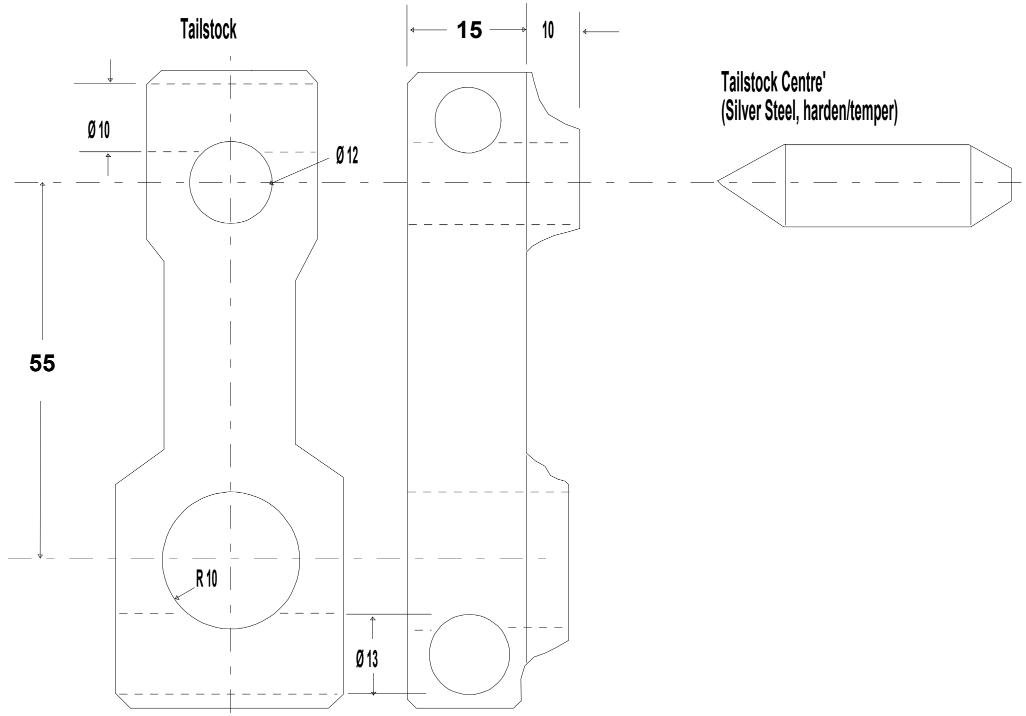


Dato: 2006	Tegner T.H.	Materiale: Steel	
Holder for Tool Grinding, after Prof. Chaddock's Quorn			


Spindle for grinding twist drills
80
55
Ø 25
Ø 16.0 +0.01 -0.00
Ø 16.0 +0.00 -0.01
Collet
M17 x 1
5
12
15°
Brass
ø 15.99
Ø 24
Knurl
Index Plate
Split
Collet
21
13
R 12.5
R 15
Clamping
Nut
8
M 30 x 1.25
12 holes
spaced 30 deg.
Ø 60 - 70
M25 x 1.25
Ø 25
MT 2 Spindle
(for Myford Collets)
MT 2
13 - 14
Ø 25
Spindle with square hole
(for grinding HSS toolbits)
M6
10
Dato:
2006
Tegner
T.H.
Materiale:
Steel
Spindle for Tool Grinding,
after Prof. Chaddock's Quorn

Cotter Lock (brass) and Ball Handle (steel)





Dato:	Tegner	Materiale:	Steel
2006	T.H.		

Spindle for Tool Grinding, after Prof. Chaddock's Quorn