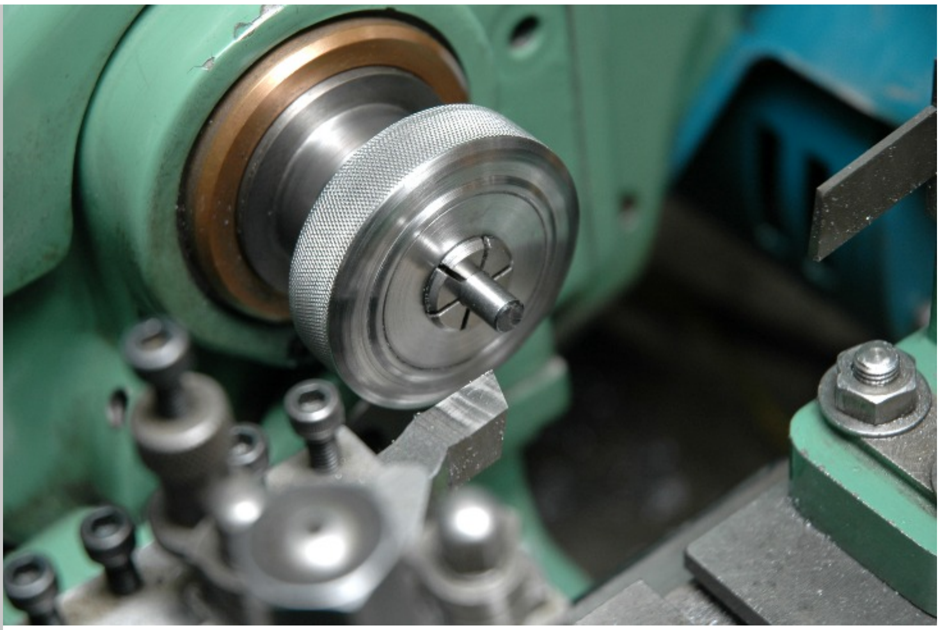
Background

There are many occasions where, particularly with small diameter work, it is nice to be able to rely on the accuracy of a collet system. Some time ago, I obtained a set of 15 ER25 collets giving a gripping range of $^{1}/_{16}$“ to $^{9}/_{16}$“. The set came with a 2MT collet holder, but there was no facility to hold long items as there was no central bore through the collet holder. I therefore set about making a collet holder to fit the mandrel nose of my Myford Super 7B as illustrated in **Photo 1**. and this was a big improvement, allowing long bars to pass through the collet holder and the mandrel. This is similar to the unit described in issue 56 and the constructional article in issue 123 by Harold Hall



Home Made Collet and Closing Nut in Use

Making Two Morse Taper Collets

Getting to Grips with Collets the Myford Way

The Myford System

Myford offer two types of collet equipment for the ML7. The first is a quick release collet adapter which is not the subject of this article. The second is a patented collet (11445) which fits into the no.2 M.T. mandrel of the lathe and is closed and extracted by a closing nut, which screws onto the nose of the lathe. These collets have been unobtainable from Myford for some time, but are now, once again available from Myford, made in the UK. To anyone who has not seen or used these collets, I commend them thoroughly. In my experience, they are convenient to use, extremely accurate and give a far superior grip to my ER25 collet system. Having the shallow taper of the 2MT, they are capable of considerable grip with only hand tightening and the gripping length is much longer than that of the ER25 range. The system gives the shortest possible overhang, as indicated in Photo 2. Typical of Myford they work brilliantly and without fuss.

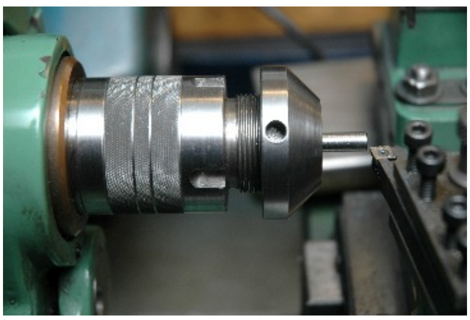


Photo. 1 The ER Collet Holder

There are 2 slight limitations to this Myford collet system. The first is that as the collet pulls into the taper, the work is therefore drawn in as the collet tightens thus moving the work towards the headstock. This has never been an issue with me, but is worth bearing in mind if you have lots of repeat work where length is important. Many collet systems including the “ER” type suffer from this limitation. The short overhang of the Myford system is great advantage, but also gives a slight disadvantage. I like to part off from the rear toolpost. However, the overhang with these collets is so short that I cannot reach the edge of the collet with my rear toolpost as the saddle will not travel far enough to the left.. It may be possible by removing the leadscrew guard from the cross slide, but the cross slide would overhang the bed gap by a substantial amount. Finally there is the matter of the price. At £21.62 each, at the time of writing this article, they are beautifully engineered items but, I am afraid a set of 32 was beyond my budget.

The Project Takes Shape

I had by this time acquired 3 genuine Myford collets and began to think about how I could make some myself. The collet is a Myford patent and like most things Myford, seems to work better than the competition. However, as I understand it, the patent system allows us to make items for our own use, so I set about attempting to make my own.

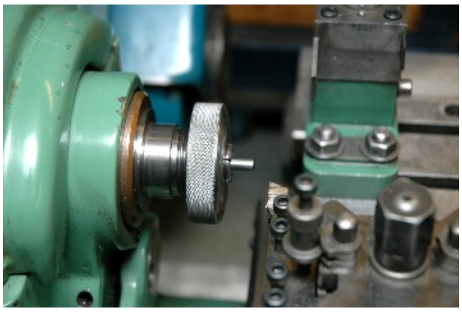


Photo. 2 The Short Overhang of Myford Collets

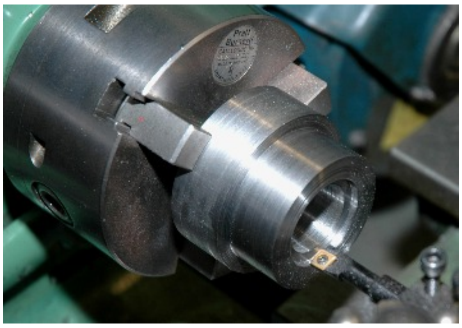


Photo. 3 The Part Finished Collet Closing Nut

Turning the collet presented little difficulty, but was wasteful in materials. Slitting the collet, however was rather problematic as there was nothing to easily "get hold of" on a tapered item that had to have 6 longitudinal slots cut into it. Some time ago, I met Alan Hopwood of York M.E.C. who said that he had been considering making these collets in pairs, face to face and he sent me a drawing (which I have since lost). However experimentation proved that this idea of making two collets back to back (or face to face if you prefer) was very valid.. I describe my method of making these which has proved very successful indeed. I have made some in mild steel, which seem to be quite adequate for our type of intermittent use, and I have made some in silver steel, thinking that I would harden and temper them – more of this later. In mild steel they cost pence to make and in silver steel it is possible to make 5 out of a 13" length of ¾" dia. bar which works out at about £1.30 each.

Making a Start

In order to use Myford collets, you need to have three pieces of equipment which you should either buy from Myford or make yourself. These are :-

1. **A Closing Nut** – which screws, complete with inserted collet, onto the lathe mandrel nose.

2. **An Extractor Sleeve** – for closing the collets in order to insert them into, or extract them from, the Closing Nut.

3. **An Extraction Push Bar** – to extract the collets from the extractor sleeve.

These 3 items are illustrated in **Fig.1.**
Thus the method of use is to push the collet, tail first, into the extractor sleeve, closing the collet and leaving the compressed head sticking out of the sleeve. The closing nut is then placed over the groove in the head of the collet and the collet is pushed out of the sleeve with the extraction push bar to leave the collet captive on the nut. The nut and collet are then screwed onto the lathe nose as one unit, ready for use. After use the collet is removed from the closing nut in similar fashion.
I had previously bought these 3 genuine Myford items, but I made an additional closing nut so that I can use the collets in more than one machine at once. You may like to consider making (or buying) these items first as you will need them to test your success when you make the collets. The extractor sleeve and the push bar are straight forward turning jobs, although the extractor sleeve is a very deep bore and should probably either be bored from each end or bored on the cross slide, using a boring bar between centres, using the cross slide as a boring table. The extraction push bar should be made in two parts and either Araldited or Loctited together. I shall describe the collet closing nut in more detail.

Collet Closing Nut

Cut a piece of 2¼ " diameter bar of F.C.M.S. to 1.5" length. Hold in the 3 jaw SC chuck using the outside set of jaws. Face the outside end and centre. Turn the outside diameter down to 2" for a length of about ¾". You could simply clean up a length of 2" bar if you wish, I just happened to have lots of 2¼ " bar to hand.
The Myford nose is threaded 1.125" x 12 T.P.I. so the next process is to bore out the bar ready to screw-cut this thread. The thread will pass straight through the nut until we fit the washer.
Drill a hole down the centre to a depth of 1" and then increase the diameter of the hole with successive drills until it is better to use a boring tool. Bore the hole out to 1.018" diameter for a depth of 1" ready to screw-cut the thread.
Whilst you have the boring tool in the toolpost, it is a good time to bore the recess which will take the washer to hold the collet. Therefore bore a recess 1.3" diameter to a depth of 0.125". **Photo 3.** shows the item at this stage. We shall, later, make a washer 1.3" Dia. and 0.122 thick to go into this recess.
The nut could be made in one piece, with difficulty, but Myford appear to make it in two parts and if it is good enough for Myford, then it is certainly good enough for me.
Cut a recess at the internal end of the bored hole for about 1/4" axially and taking the internal diameter of the recess out to around 1.170" to give a good run-out for cutting the internal thread. Set up your lathe for cutting 12 T.P.I. Whitworth form thread and cut the internal thread. I have a DRO and set the Cross Slide travel (Z Axis?) to zero where I want to stop the thread. Cut the thread either on

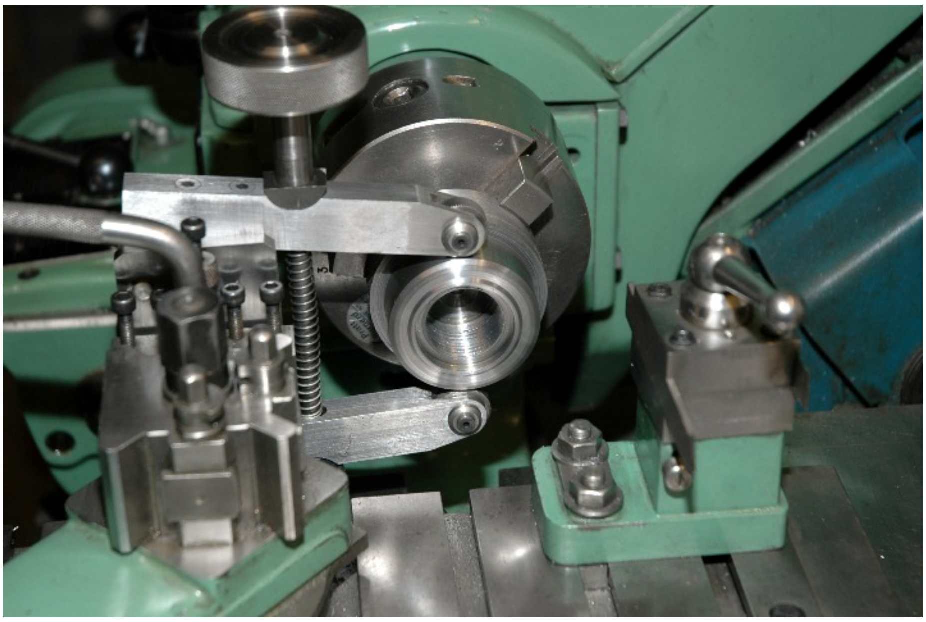


Photo. 4 Knurling the Outside of the Collet Closing Nut

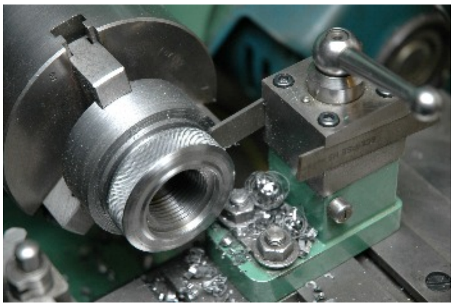


Photo. 5 Parting off the Collet Closing Nut to Length

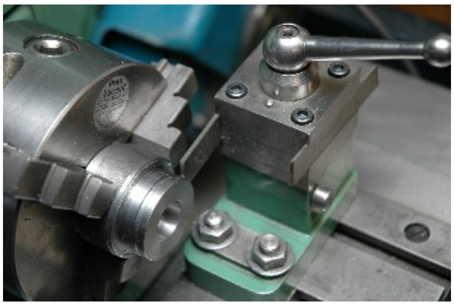


Photo. 6 Making the Washer for the Collet Closing Nut.

slow back gear or by hand. A 1" travel on 12 T.P.I. happens very quickly !! If, like me, you have a 2 M.T. false nose with a Myford thread then use this as a test for size, otherwise you may have to remove the chuck, reverse, and try the nut on the mandrel, making sure that you do not disturb the screw-cutting gear train and that the chuck goes back into the same place **exactly.** Once happy with the thread, clean up the bottom of the washer recess with a boring tool as it will have been burred over during screw-cutting. Finish the shape of the face of the nut to suit you preference and knurl the outside diameter. I used a knurling tool made from a Hemmingway kit, as in **Photo.4** but I have made an extended pair of arms to allow the tool to knurl to around 3" diameter. Part off the nut to a length of 0.65" as in **Photo 5**

The washer is made from a piece of 1.5" dia. FCMS. I wondered about using silver steel and hardening, but intended to silver solder the item into the nut, so hardening would be difficult. Face off, turn down to 1.3" dia. using the closing nut as a test to get a good fit. Drill and then bore a central hole to a diameter of 0.629" and a depth of at least 1/4". I bored mine to a depth of ½" to be sure. De-burr and part of to leave a washer of 0.122" thickness as in **Photo 6**. I left mine 0.125" thick and cleaned up the reverse face. Please use outside jaws and do not over extend inside jaws as in the picture.

Now you should degrease the two items and silver solder the washer carefully into the nut, taking care not to let the solder run into the threads. I cheated and, being a great fan of Araldite epoxy resin, I clamped it up with (non rapid) Araldite and cooked it at 60°C for 3 hours. Despite the fact that the washer exerts considerable sideways pressure on the collet, the Araldite adhesive method has proved perfectly serviceable. You should now have a closing nut similar to the one shown at the head of this article.

Making the Collets

First you must set up either your cross slide or your taper turning attachment to exactly the correct angle for a no. 2MT. This is approximately 3° and if you have a DRO and a taper turning attachment it is easy. A no. 2MT has a taper of .04995" on diameter per 1" of travel. Therefore with your taper turning attachment set up, move your cross slide to the right, then to the left a bit to take up the backlash and zero the DRO. Wind the cross slide left for 2" using the DRO as a guide and the reading on the X scale should be 0.499. Keep adjusting until you have got it right. The whole success of this project depends on getting this accurate. If you do not have a DRO or a taper turning attachment, then set up as follows:- Chuck a scrap of bar in the chuck and centre it. Support a no.2 MT centre between this female centre and the tailstock centre. Then place a dial test indicator (DTI) in the toolpost, pressing the foot against the no.2MT centre suspended between centres, and wind either the cross slide if you are using a taper turning attachment, or the top slide if you are using that, back and forth, adjusting the settings until the DTI maintains a constant reading on the scale. **Photo 7.** shows the setup. If setting up this way it is imperative that the foot of the DTI is EXACTLY at centre height.

Making the Double Collet Blank

Cut off a length of either ¾" FCMS or Silver steel according to

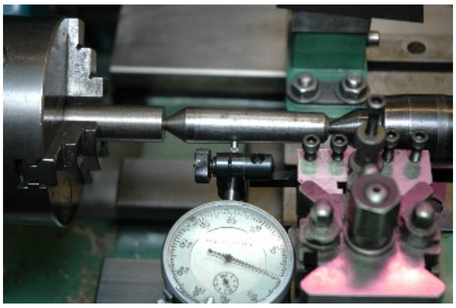


Photo. 7 Setting Up to Turn The Morse Taper

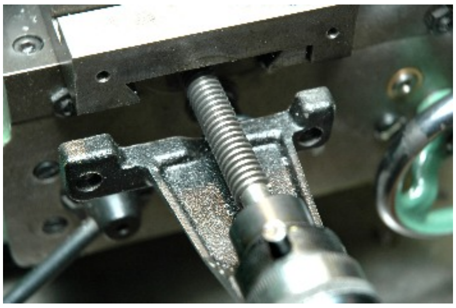


Photo. 8 Disconnect The Cross Slide Feed Screw

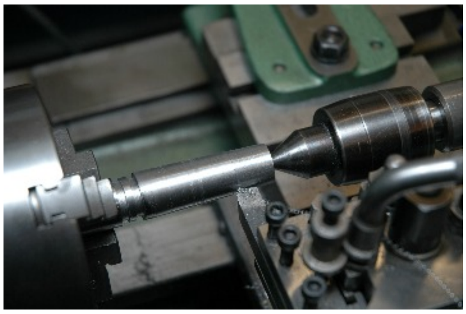
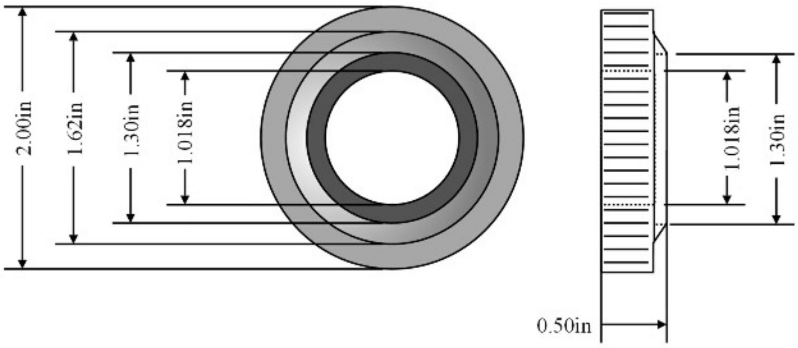


Photo. 9 Turning The Number Two Morse Taper



Collet Extractor Sleeve

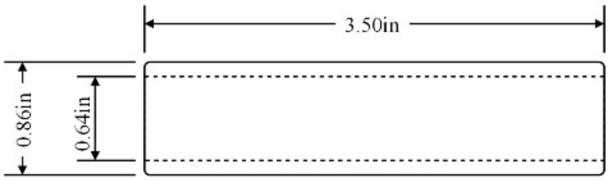
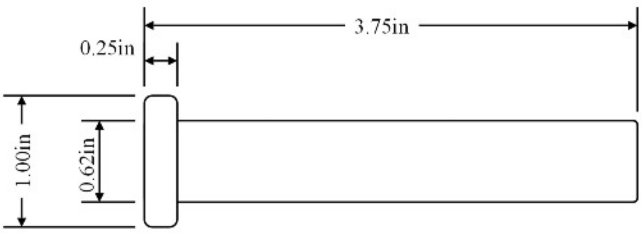


Fig. 1

Collet Extraction Push Bar



your preference, just over 4.700" long. This will make 2 collets face to face as shown in **fig. 2** Chuck the piece of Steel in the 3 jaw chuck leaving about 2.5" protruding. Clean up the end, centre it and bring up the tailstock. Measure 2.07" from the end and using a parting tool of between 0.125"and 0.130" width cut a groove to reduce the diameter to 0.590" for the width of the tool. Move the carriage left for the width of the tool using the dials / DRO and then move the carriage a further 0.09". Cut a further groove at this setting which will be the waste part in the middle of the double collet. Note – if the bar is longer than 4.7" there is no problem. If it is shorter, then you may be cutting into the head of the second collet. After turning the two grooves, reduce the intermediate part between the grooves to 0.068" diameter which is to become the head of the collet. Deburr the edges of both grooves. Now set up for taper turning using the previously set settings. If you are using a taper turning attachment (TTA), then do not forget to disconnect the cross-slide leadscrew, as shown in **Photo 8.** before clamping the cross-slide to the taper turning nut. If you forget to disconnect this then serious damage may occur.

If you don't have a TTA then use the cross-slide to put on the cut and the top-slide to traverse the cut. If you have a TTA then use the top-slide to put on the cut and the self-act to traverse the cut. I set the top slide to 30° so that if I put on 0.010" on the top-slide dials, then this would reduce the diameter by 0.010". (Sine 30° = 0.5 therefore 30° reduces the effect of the top slide dials to 50%). Turn the taper until the diameter at the largest point (next to the groove) is 0.704". This dimension is critical if the collet is to work correctly and **Photo 9.** shows the process. If you are wanting to judge the progress before the taper reaches the groove, you can try temporarily fitting a no.2 MT socket and noting how far it goes on to the taper. Taking a cut of 4 thou i.e. reducing the diameter by 8 thou will allow the socket to move forwards by 0.160 "

When you have reached the diameter of 0.704 at the big end, the taper is finished size. However Myford reduce the diameter of the

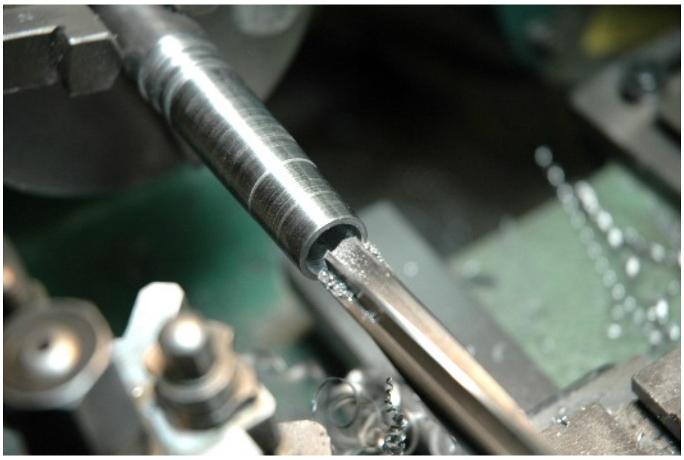


Photo. 10 Reaming the Back of the Collet

Photo. 11 Finishing a Collet Bore to Size

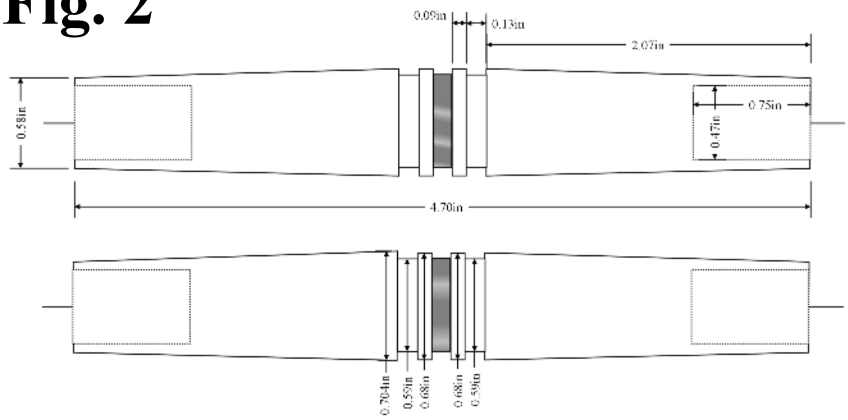
first 0.75” at the small end by 12 thou so you should take a final cut of 6 thou for ¾”. This reduced diameter is useful as you can stamp the size here without destroying the taper fit. Now proper engineers look away for a moment. – *I finished off the taper by covering the lathe bed and finishing with fine emery paper. – sorry experts !!*

Photo. 12 Finished Collet showing the manufacturing Stages

Finally Drill the end of the taper to a depth of ¾” in increasing sizes, until you arrive at 29/64” Then ream 12mm to the full 0.75” depth as shown in **Photo 10.**. Sorry for the mix of metric and imperial, I just happened to have a 12mm machine reamer. Myford seem to use 15/32” which is 11.9mm. Deburr the end both inside and out.
Now reverse the bar and cut the second taper in the same way. To do this, remove the bar from the chuck, remove the chuck and insert the taper that you have just created into the headstock mandrel, after first scrupulously cleaning it, and the mandrel socket of swarf. Lightly tap home with a soft hammer and if you have got the taper correct, this will give ample drive to cut the second collet on the remainder of the bar. If not – then recheck your taper settings and go back to GO as they say in Monopoly!! As a further check, Myford collets, when inserted in the taper, uncompressed and with the bore filled by a bar, stick out of the taper giving a distance of 0.240” from mandrel to collet groove on my lathe. My embryo collets varied up to 20 thou about this standard, which is equivalent to 1 thou on diameter.
When you have cut the second taper, reduced the small end and drilled / reamed the end of the bar, you can part off the collet and finish the front face, chamfering the edge. The profile of the front face is not important but Myford’s collets look like the one on the **Header Photo.** Tap the collet gently from the mandrel using a $^3/_8$” bar down the mandrel bore and which will fit into the small end of the collet so as not to damage the end. Put this blank on one side and finish the second collet in the same way. Decide what size each collet should be then drill and bore or ream to size as shown in **Photo 11. Photo 12.** shows the various stages of production and shows a genuine Myford collet for comparison.
Now – before you forget which size you have bored, stamp the reduced part of the taper with the size of the collet. I used 3/32” number stamps to do this which seemed to be about the right size. Perfectionists will – no doubt –

Double Collet Blank - 2 Morse Taper

Fig. 2



For reasons of clarity, the above Drawing does not show the 12 thou diameter reduction at the small end of the taper The taper should be reduced in diameter at the outside end by 0.012" for a distance of 0.75"

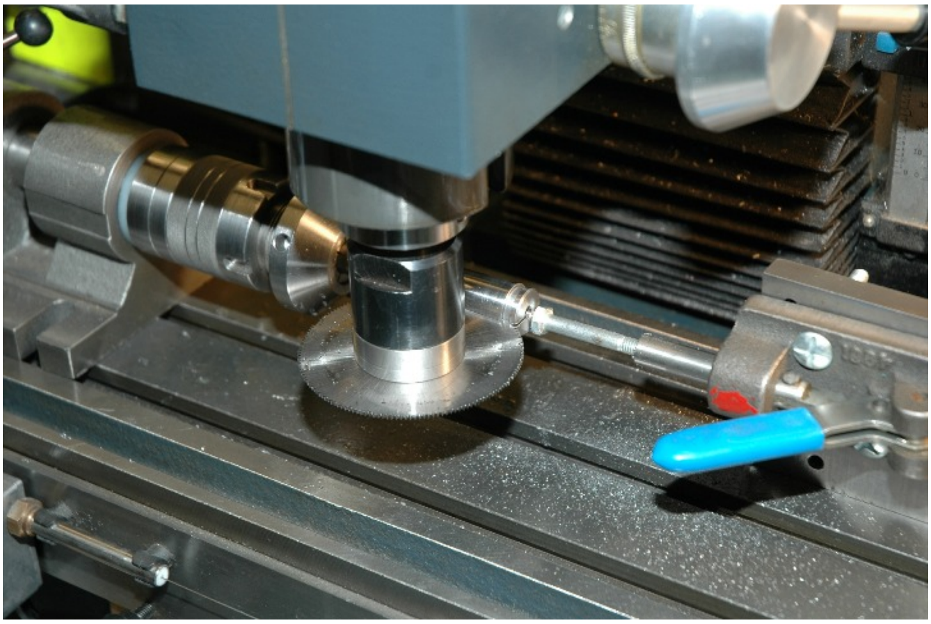


Photo. 13 Slitting the Collets in a Mill.

make up a jig to hold the number punches in absolute alignment. I simply took a short length of 1" bar and turned ¾" axially at one end down to 15/32"diameter. I held this mandrel horizontally in the bench vice and placed the large bored tail of the collet onto the reduced end. I found that with care I could adequately stamp the size on the reduced diameter of the collet. ONE sharp tap with a hefty hammer should do it – you do not get a second chance.

Slitting the Collet

This really is the most difficult part of the whole process as you are trying to index 6 slots around a tapered object with holes at each end. The 6 slots in the collet should start ½" from the tail end and travel completely through to the nose, going right into the bore of the collet. These slots should be 0.040" or 1mm wide. At first glance there seems to be no way of holding the object for slitting. I made a mandrel to fit into the rear 12mm hole at the back of the collet. This was made from a ½" bar of mild steel and I put a very gradual taper on the end down to 12mm dia. I mounted this horizontally on the milling machine table using a dividing head. The back of the collet can now be tapped onto the tapered mandrel holding it for slitting.

The vibration of slitting the collet would undoubtedly shake the collet loose, so I mounted a toggle clamp to push the collet onto the mandrel as in **Photo 13.** I tried various methods of slitting these collets but owners of a good milling machine with a powerful slow speed may find it easier than I did. I have a Wabeco mill, with an electronic speed control, which is great, taking the spindle speed down to 180 RPM. However at this low speed, the electronic speed control gets very "lumpy" when using a large slitting saw.

My first attempt was to mount the collet to the right of the saw and saw into it from the left. However when several slits have been cut, the "fingers" of the collet can move and pull outwards into the teeth, with the stress of sawing. This leads to a situation similar to "climb milling" with a vicious jab of the saw, so I decided to reverse the set-up as shown in **Photo.13**.

The method that I used was to saw a shallow groove for the full length required (axially). The table traverse is then returned and the saw moved deeper (radially) before traversing the table for the full slot again. This worked well, although, after making the first collet, I purchased 2 small slitting saws, 30mm dia by 1mm thick. These worked much better on my mill.

After slitting, you need to sit down with a set of needle files and carefully de-burr the edges of the slots, both on the bore of the collet and on the outside taper. Myford collets are black around the rear reduced portion of the taper. I blacked mine with some gun black – obtained from the local gunsmith. It makes not a scrap of difference to the functionality, but so much more satisfying to see that they look just like "the real thing" !! **Photo. 14.** shows the finished article.

Considerations for Collets with Small Bores

As you make collets in the smaller sizes, it is necessary to reduce the number of slits, as otherwise you destroy all the gripping surface of the collet. For example :-

A 1/8" collet has an internal gripping surface of 0.125 x 22 ÷ 7 = 0.392" circumference.

Six slits of 0.040" width would remove 0.24" of the gripping circumference, and it would be prudent to reduce the number of slits

Photo. 14 A Finished Collet Ready For Use

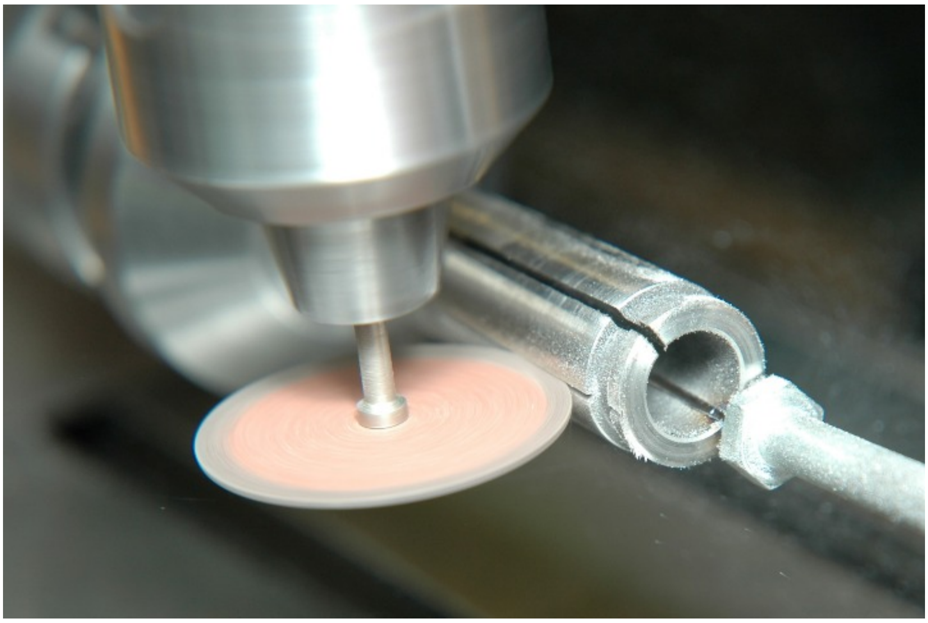


Photo. 16 Slitting a Hardened Collet With a Grinding Disc

to four. Reducing perhaps to three for the smaller sizes.

Silver Steel and Hardening

I personally have decided to stick with Free Cutting Mild Steel for all my collets. They seem perfectly serviceable and are easier to make than Hardened Silver Steel collets. Making them in Silver Steel and leaving them soft may prove to be a little stronger. I do not have suds coolant on my machines as I do not like the rust-making properties when left for long periods in the slideways. If you have suds facilities and can flood the work with coolant, then you may have more success than I did, but I will document my findings.

Making the item in silver steel proved no problem up to the point of slitting. I had to be careful of my machine speeds so as not to heat up the work too much and to be careful of work hardening the item. Slitting the item proved to be very hard on the slitting saw, but would probably be much easier with suds coolant.

I heated the finished item in a kiln to 770° C and quenched vertically in cold water. Unfortunately there was considerable distortion, most probably aggravated by picking up the item with tongues. In the second attempt, I hardened the collet after boring to size but before slitting. After quenching, the item was tempered at 230° C in the domestic tempering device (oven), prior to using it for the Sunday lunch. The lunch was great and the collet looked good also. After cooling (and lunch) I mounted it on the mill and proceeded to slit it using a 38mm grinding disk obtained from Proops. **Photo. 15.** shows the process. It works, but takes a desperately long time, especially without coolant, as I had to keep letting the job cool so as not to soften it. I was grinding 0.75mm deep on each pass and was using a powered feed of 18mm per minute. VERY slow. Sorry for the mixture of Imperial and metric measurements, but my mill has Metric dials. Other, more experienced, engineers may have much better methods of doing this, but I have decided that I shall stay with mild steel.

Conclusion

A challenging, and time consuming, project to make, but leaving me with a useful set of collets that I could not have afforded to buy. As always with tools that you have made yourself it is a joy to use them.