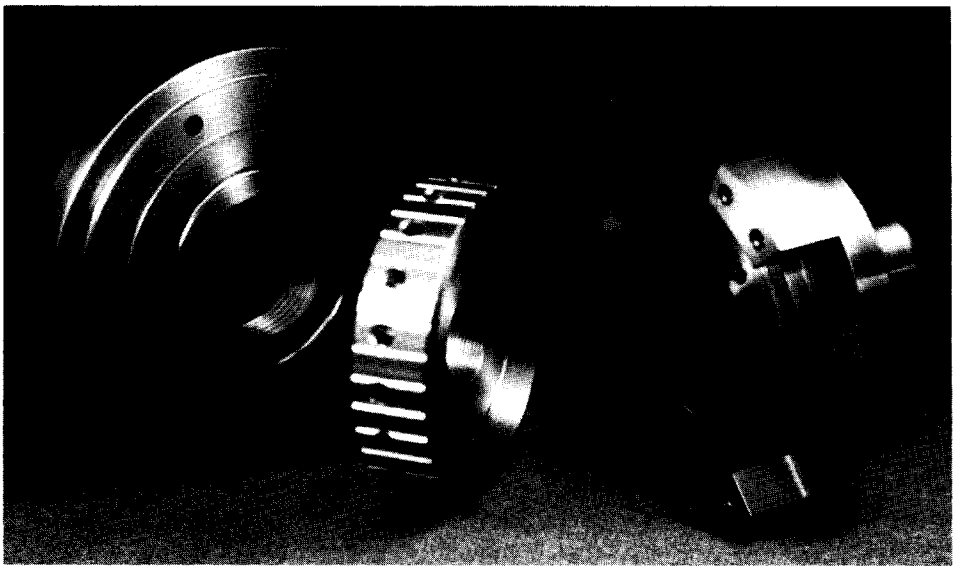


(1)The three major parts of the collet chuck.

Make Your Own Collet Chuck

by Pat loop

Whatever size lathe one might have, when using collets it is desirable to be able to utilize the full bore diameter of the headstock spindle. The chuck described here was designed to achieve that and uses the popular and relatively inexpensive 5-C collets.

As shown by the assembly drawing and ***Photo 1,*** the chuck consists of three major parts: the Nose Piece, or collet holder; the Collet Nut, internally threaded to mate with the thread on the collet and supported in the assembly by two ball races; and the Backplate, which adapts the whole thing to fit your lathe and will dictate the final size of the collet chuck. For those with smaller lathes, the collet chuck diameter could be reduced in size to a more compact unit. The backplate on the drawing and in the photos was included with the 10" lathe that I have along with a three-jaw chuck, a four-jaw, and a faceplate, so it seemed reasonable to use it for this project. The photo shows a rim on the backplate that extends beyond the diameter of the collet holder. I left this on because it is harmless, and I thought that later I might drill a couple of holes in it for a tommy bar or wrench for chuck removal.

So far, I have utilized the collet nut tommy bar by putting it into a hole in the collet nut, placing the bar against the collet chuck, and giving it a light tap with a soft mallet. This is poor practice because someday it's going to be screwed on too tightly, and getting it off will take more than a light tap. There goes the concentricity and zero runout you worked so hard to achieve. I don't recommend it.

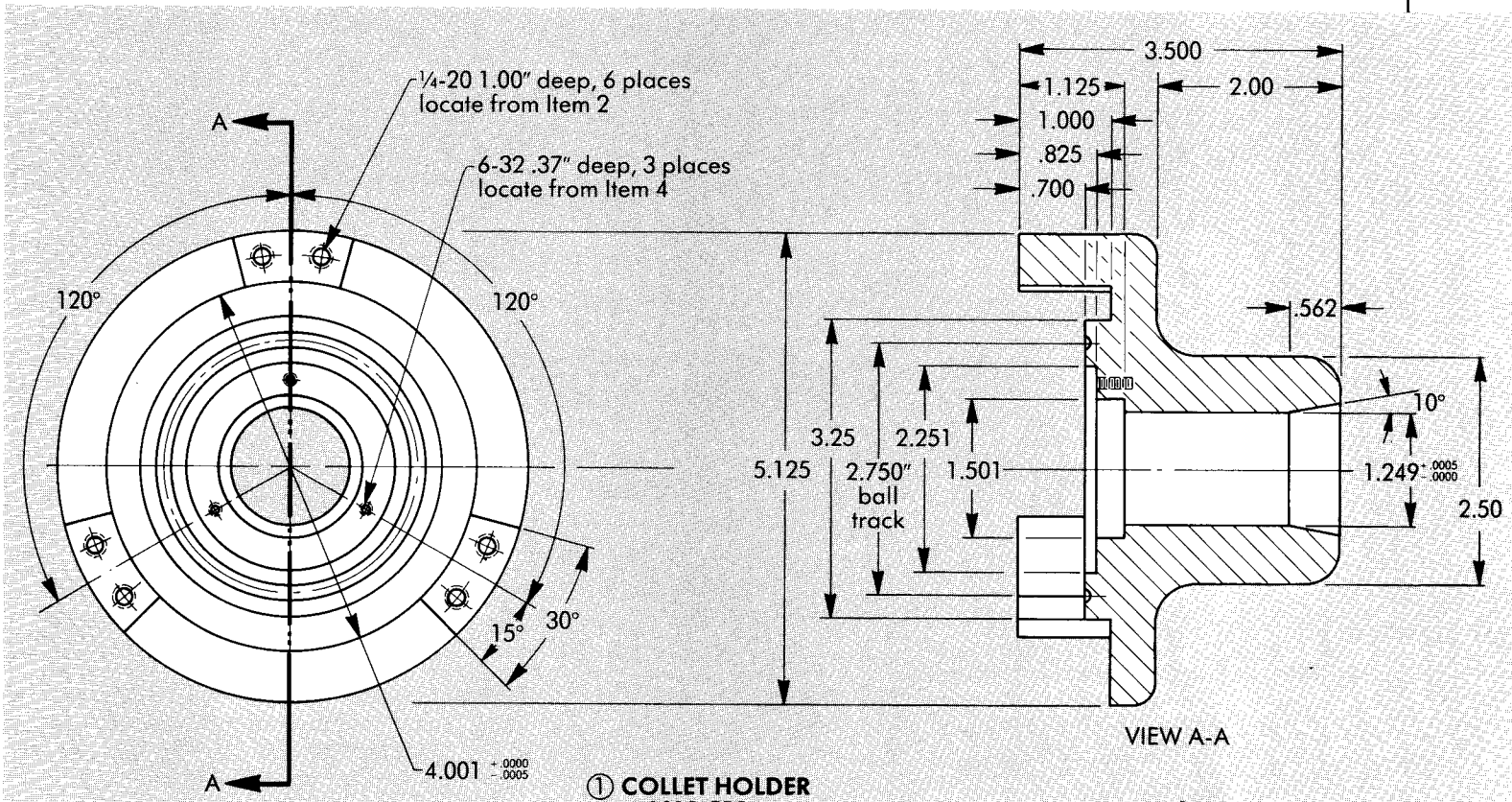
The place to begin is the collet holder. Rough turn the nose down to approximately the 2.5" diameter, leaving enough material for finish turning, including the inside radius, at a later time. The radii shown on the drawing, both internal and external, are purely aesthetic so no dimensions are called out.

This is a good time to drill a 1" diameter hole through the piece while you have a good grip on it. Remove and rechuck on the smaller diameter, face off the back, and turn the OD. Machine the inside to the ,700" depth and slightly less than 4" diameter. Now you'll have to change bits so you can machine out the annulus used to clear the lip on the collet nut. At this time, bring out the inside diameter to the finished dimension. This is called out at 4.001", but all we have to do is make certain it's a nice fit with the lip on the backplate, which will be turned later and made to fit whatever diameter you choose. Machine the cavity that accepts the keyway ring. Here again the dimensions aren't as critical as my drawing implies because you can turn the ring for a nice fit when it is being made. The reason for the ring is to make easier the installation of a key for the collets and to replace the key if it gets damaged.

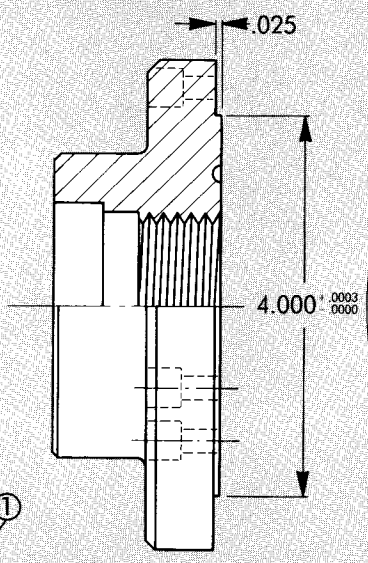
Now comes the fun part where the dimensions are important: the ball tracks. The depth of the groove and the diameter are important to each mating pair. I have a 1" travel dial indicator on the lathe that works against the carriage, so depth control was easy. The mean diameter of the groove can be eyeballed with dividers or a template can be made. The drawing shows a detail of the ball track that indicates the groove is slightly larger than the ball diameter. This is to allow a little radial tolerance in movement of the nut to assure alignment with the collet thread. Grind a lathe bit to a radius of about .075" to .080" and stone the cutting edge smooth so the groove will also be smooth. Take light cuts at slow speed. Cut the groove to a depth of ,055" to .056" so mating parts will have about .O 15" clearance when the 1/8" diameter balls are installed.

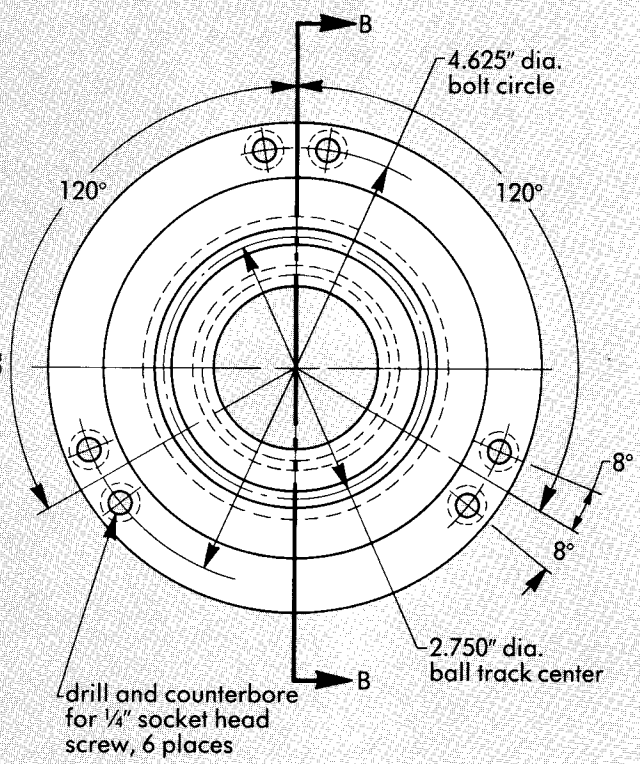
The ball track can be cleaned up by polishing out with a piece of 1/8" wood dowel and abrasive. Don't worry about a mirror finish. This isn't exactly a high speed bearing, anyway. All you want to do is keep it from growling too much when rotated.

Machine a backplate to fit your lathe spindle. Fasten it to the spindle and turn the ,025" lip to a nice fit with the collet holder. This is used to locate these two parts and, therefore, should be a good fit. Turn a ball track in the backplate just as you did in the collet holder. Now the holes for the 1/4" socket head screws should be drilled and counterbored. **you** don't possess a rotary table, the holes can be located right on your lathe. With a pointed bit, such as a threading tool, a light cut can be made to establish the bolt circle. The bolt circle doesn't have to be a precise diameter because the other holes in the collet holder are going to be match-drilled to the backplate anyway. For this same reason, the hole positions may be established by placing the backplate in a three-jaw chuck and blocking each jaw in turn against a bar placed across the ways. Using the pointed tool and the cross-feed, scribe a line across the bolt circle mark which will give you the



① **COLLET HOLDER**
1018 CRS

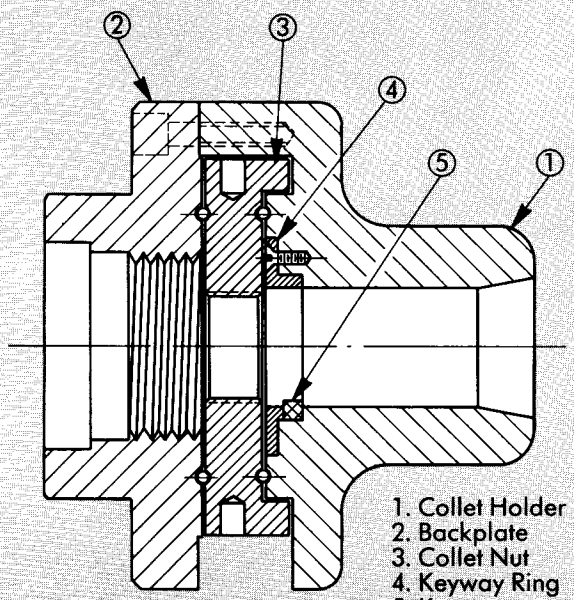




② **BACKPLATE**
cast iron

BILL OF MATERIALS

ITEM	REQ'D	DESCRIPTION
1	1	5⅛" dia. × 3½" mild steel
2	1	5⅛" dia. × 1¾" mild steel (or cast iron)
3	1	4" dia. × 1" mild steel
4	1	2¼" dia. × ½" mild steel
	138	⅛" dia. steel balls
	6	¼-20 × 1" socket head screws
	3	6-32 × ¼" flathead machine screws
	1	¼ × ¼ × ⅛" mild steel



1. Collet Holder
2. Backplate
3. Collet Nut
4. Keyway Ring
5. Key

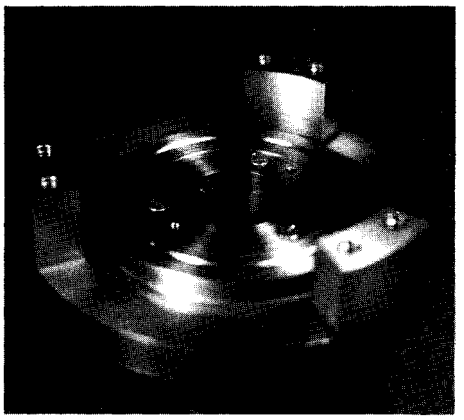
COLLET CHUCK ASSEMBLY

120'. Now set a pair of dividers to ,325" and, using the 120" line and bolt circle intersection as a center, scribe a mark on either side. Where it crosses the bolt circle is where you punch mark for the screw holes.

The backplate and collet holder can be clamped together, the holder match drilled, and the holes then tapped for the screws. It would be a good idea to put a pair of alignment marks on both pieces near a set of screws to assure they always go together the same way. Deburr all the holes in the backplate and set it aside.

The removal of material from the back of the collet holder (to form the slots for your finger to rotate the collet nut) is a milling machine operation and, since the slot or segments removed form a 90" angle, the X and Y axes can be used directly, milling to scribed lines. The collet holder can be clamped to the milling table by using the T-slots and clamps, but to make the affair stable, I used a short length of 4" OD heavy wall tubing to clamp against. I didn't mill all the way to the 1" depth of collet nut annulus because it was easier than trying to make it all blend.

The next operation is to make the keyway ring – which is quite straightforward, but it too should be a good fit in the collet holder. In fact, the two 6-32 threaded holes diametrically



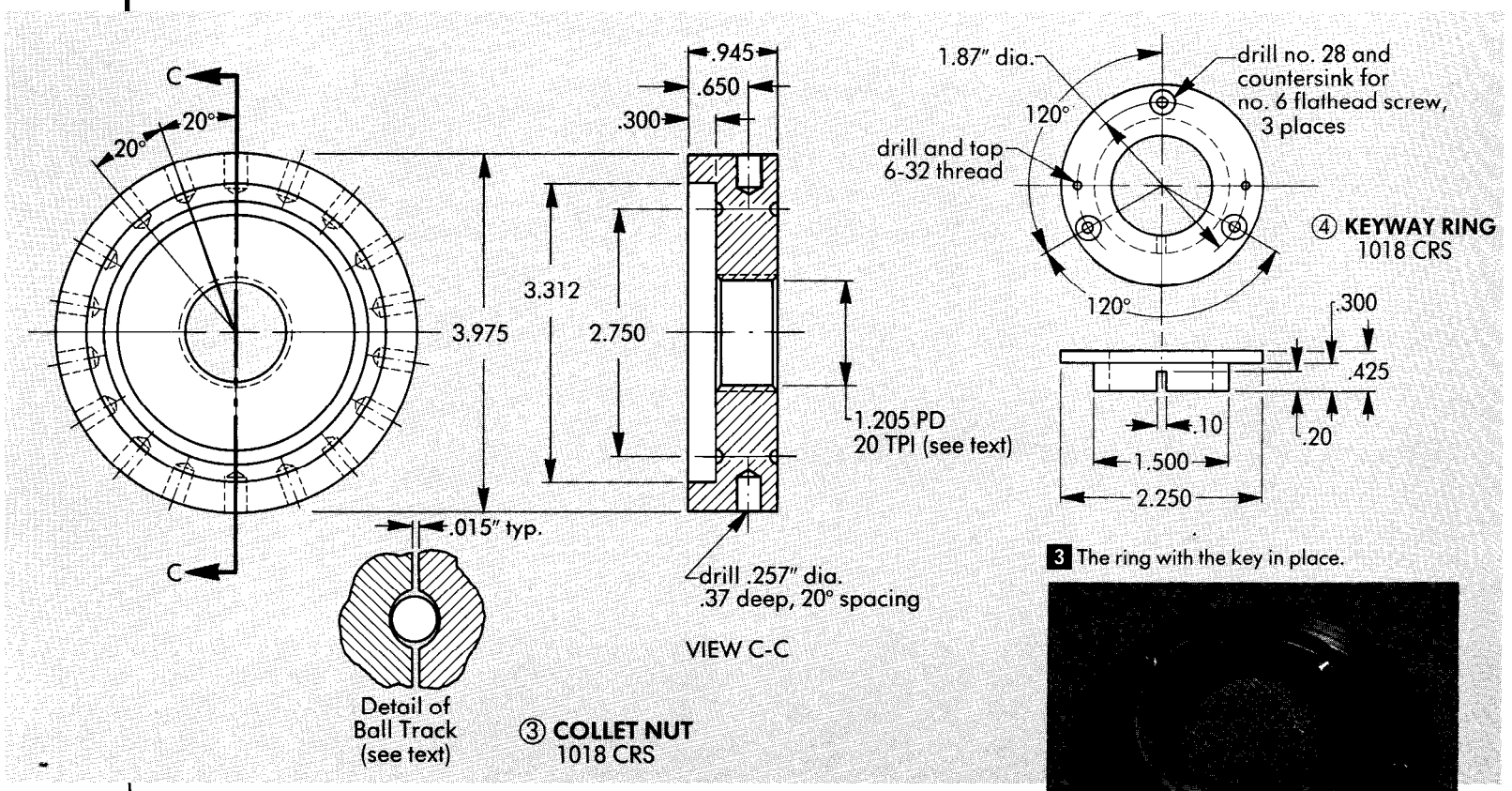
(2)The collet holder with the keywoy ring installed.

opposite each other are there for jack screws just to be able to remove it. Bore a 1" diameter hole through the center as you did with the collet holder. When the ring is complete with the three countersunk holes, it can be used to locate the threaded holes in the collet holder and fastened in place. Make sure it is flush with the back of the collet holder and that the screw heads do not protrude. There isn't going to be much clearance here with the collet nut. It's a good idea to put a pair of reference marks on the ring and collet holder so they go back together the same way each time.

Now you're ready to bolt the backplate and collet holder together again and mount it on your lathe spindle. The hole to accept the collets can now be bored through the holder and ring. Bore out to about 1.20" diameter, then change to the largest boring bar you have that will go through, to reduce chatter and make a smooth cut.

My concern about achieving a smooth finish and perhaps having to do a honing operation to bring it to a linal diameter was unnecessary. The cutting tool I used was slightly radiused and had considerable top rake. It cleared the chips nicely and left a smooth finish that required no further work. When nearing the linal diameter, it's best to use a collet as a plug gage to get a nice slip fit in the hole. I found that the collets I have are quite consistent in their diameters but varied in length on the cylindrical portion from the threaded end to the transition point of the taper by as much as 1/16" Because of this, the ,562" depth of taper is a nominal figure, and you'll find that some collets will be flush on the end and some will protrude. The entrance lip of the taper should be slightly rounded to prevent a ding or burr from interfering with the collet seating properly.

After you've sweated over achieving a good fit for the collets, now is a good time to linish turning the outside of the collet chuck and bring it to final diameter and finish.



3 The ring with the key in place.

The next to be made is Item 3, the collet nut, which also becomes a tolerance absorber for final fit on the ball races. Machine the front side of the nut with the lip first. Bore a hole 1.175" diameter and, using a 60" threading tool, cut 20 threads to the inch to match the collet thread. Here again use the collet as a gage, but inspect the thread on the collets very carefully. I found that over half my collets had bad threads where the keyway intersected them. There was a row of burrs that would have chewed up the threads on the nut in a very short time. They were easily removed with a three-corner Swiss file, but it was a nuisance. Make a chamfer on the nut thread to assist in alignment with the collet and part off the nut about an inch long. Don't worry about the ball race on the front side; we'll get to that later.

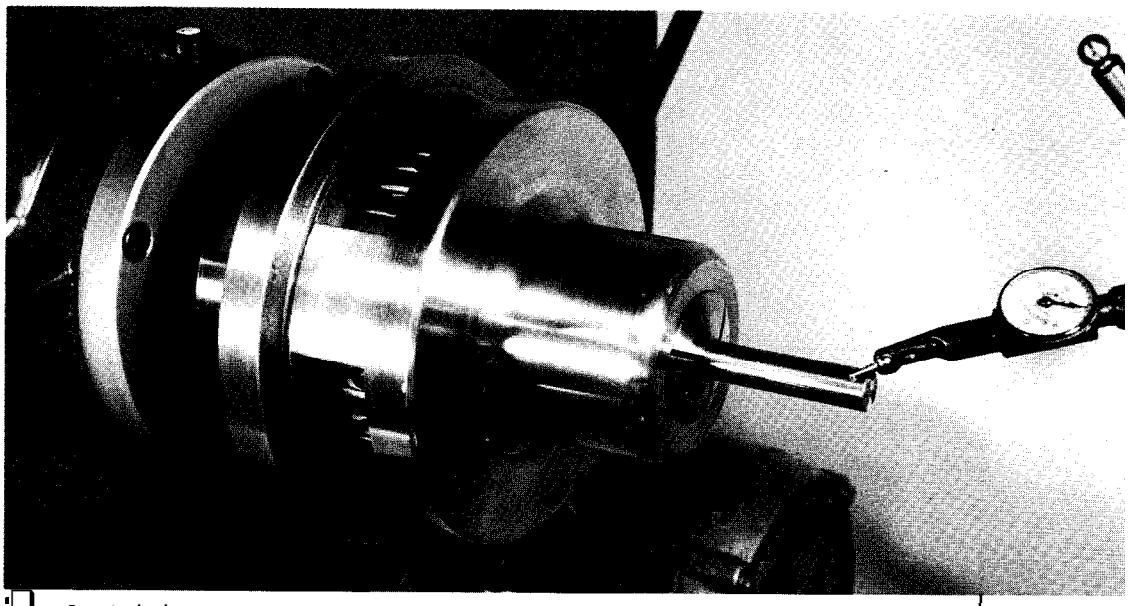
Make a threaded mandrel with a shoulder to hold the nut. Screw the nut on the mandrel and face off the back side to bring it down to the .945" dimension, and the outside diameter to 3.975". Now the nut should be removed from the mandrel and turned around so the ball track on the front side can be machined. When the groove is almost deep enough but not quite, stop.

Place the collet holder face down on your bench and put a few bearing balls in its ball track; spread them around evenly. Remove the nut from the mandrel and place it face down on the collet holder. By using a depth mike or vernier calipers, check the distance between the back surface of the nut and the backplate mounting pad on the collet holder. If there is not **enough** to clear the ,025" lip on the backplate plus the .O 15" clearance, it will have to go back on the mandrel and have the ball track made deeper until there is. When you're satisfied with the way it fits, you can screw the nut back on the mandrel and turn the fourth and last ball track to mate with the backplate. Do a fit check by placing the nut in the collet holder as before and spreading some balls around the ball track on the nut. Put the backplate in position and check the nut for tightness. It should rotate freely with just a little axial play. When the nut is rotated it will probably emit sounds of protest, but that will be improved later by the addition of more balls and some grease during final assembly.

The holes around the edge of the nut can now be drilled. As can be seen in the photos, I used an 1/8" diameter ball end mill to produce a fluted edge for rotating the nut with my finger. Once the nut is finger tight, a short piece of 1/4" drill rod can be used to cinch the collet tight.

4. The collet holder and nut with bearing balls, ready for assembly to the backplate.

Using a piece of rod to tighten the collet.



Runout check.

Remove the ring from the collet holder and mill the slot for the key, which is made from a piece of mild steel and pressed into the slot. If it is a little undersize, it can be soft soldered in place. The collet keyways measured a consistent width of. 12 5", but the depth varied from ,054" to .065", so the protrusion of the key was made .050". Knock off the sharp corners with a file so it will enter the slot in the collets nicely and you can put everything together for a final assembly.

When placing the balls in their respective tracks, resist the temptation to crowd in that last ball. It's best to leave room for them to move around. Don't forget to put a little grease in the ball track.

This is a project that was designed empirically -which is a nice way of saying, 'You keep doing it until you get it right!"

Improvements can still be made, such as substituting a superior material for mild steel, although mild steel will surely outlast me. If the collet holder should ever become sloppy, it could be bored and a hardened sleeve shrunk in and ground to size. The nut seems to have an overabundance of holes; I must confess the recent purchase of a horizontal/vertical rotary table.. I had so much fun using it that I got carried away with the holes and the fluting.

I'm sure you'll find the chuck a pleasure to use because of the speed of chucking and unchucking. When you remove a part you're working on for some other operation and then rechuck it, you don't have to put a mark on it to align with number one jaw. It's nice to put a dial indicator on a part and read its surface texture rather than eccentricity.

Photos by Fritz Bruning