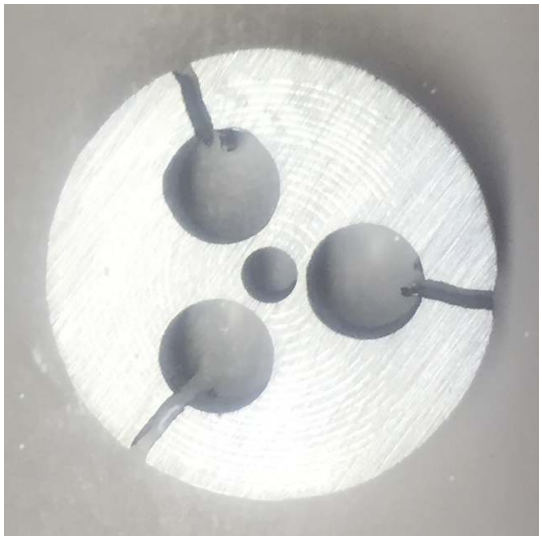
A Crush Collet, version 2.0

By R. G. Sparber

There are many ways to make a machined-in-place collet on a lathe but all of them I've seen require a boring bar[2]. This is because the center hole will not initially be on center so it will be necessary to cut a new hole with a discontinuous cut.

So what do you do if the hole is too small for a boring bar? If you just use a drill, it will follow the off center hole.



One solution is to make what I will call a "Crush Collet". The solution to re-cutting the center hole is to not have it in the first place. Instead, I drilled 3 holes around the center hole and then made 3 saw cuts. This weakened the collet such that the full force of the 3 jaws can distort the remaining metal and slightly close the center hole. With the jaws snug, I can slide the part into the center hole. When fully tightened, the part is solidly clamped.

As with any machined-in-place fixture, its accuracy only persists until it is removed from the machine. This means making all but the center hole ahead of time. Then, when I need it, cut that center hole and use the collet.

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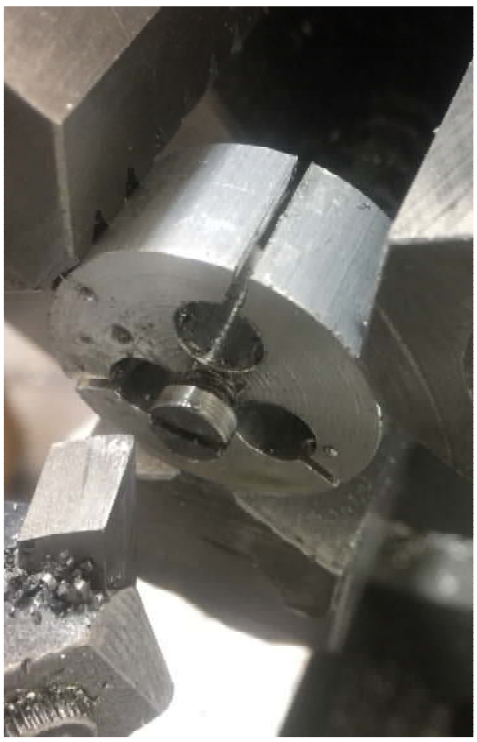
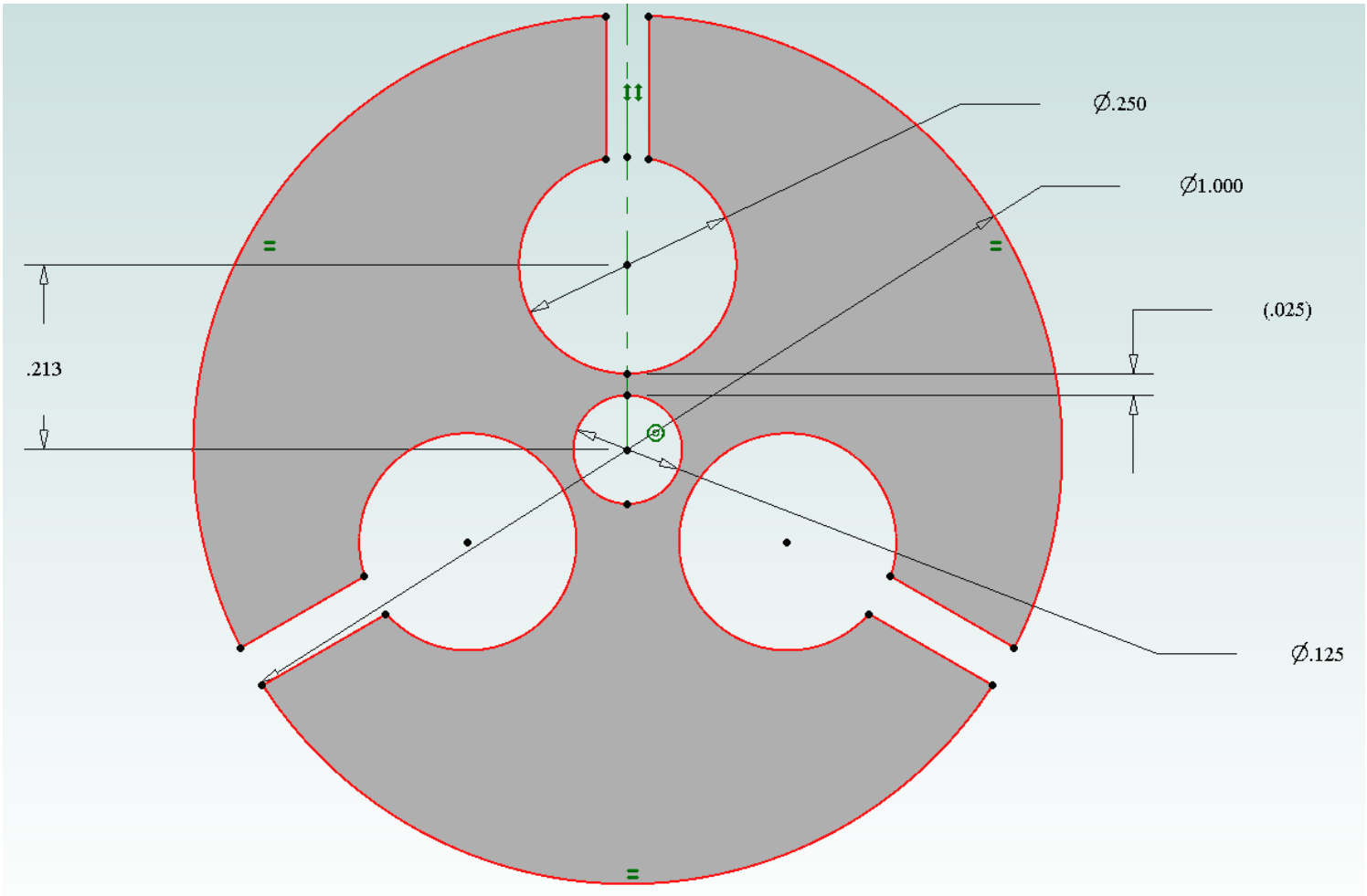
[2] For example, see this excellent video from Joe Pieczynski
https://www.youtube.com/watch?v=gCUkJydSmdA&t=455s



Although my test collets have a smooth hole in them, the real value is when the hole is tapped. It then becomes possible to hold threaded stock like small brass screws without causing damage. Here I have machined the head of an 8-32 screw. It started out with a round head. I saw no unscrewing while machining.

I have been able to get a Total Indicated Runout (TIR) of less than a thou with this collet but it took a bit of doing. Here are most of my attempts. After each one, I measured the TIR, determined the root cause of the poor performance, and then figured out how to avoid the problem on my next attempt.

It should come as no surprise that minimum TIR occurs when each of the 3 jaw segments are identical. Then they all move in the same amount and press on the center hole equally. All of the failed attempts lacked this symmetry.

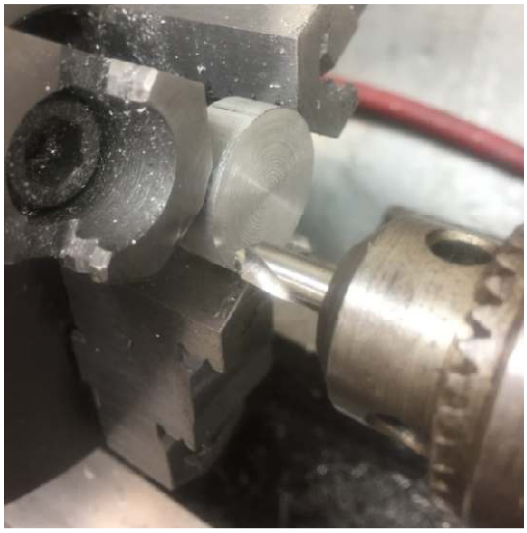


Here is my test crush collet. I used a 1/8" center hole so I could fit it with a 1/8" dowel pin in order to accurately measure TIR. I chose a wall thickness of 0.025" between the nominal position of the center hole and perimeter holes.

Later I tried drilling and tapping a 4-40 screw (tap hole 0.089"). The collet did not lock. Next I tried 6-32 (tap hole 0.1066"). It was snug but did not hold. So finally I tried 8-32 (tap hole 0.136") and it was tight. This tells me that a wall thickness greater than 0.025" is too difficult to crush.

Some of my test collets had a lip on them to prevent slippage into the chuck. This was attractive because I wanted to minimize jaw clamping force while drilling and reaming the center hole. On the other hand, it took a lot more steps to form this lip. In the final iteration, I left the lip out. Collet thickness was around ½" but this depends on the application.

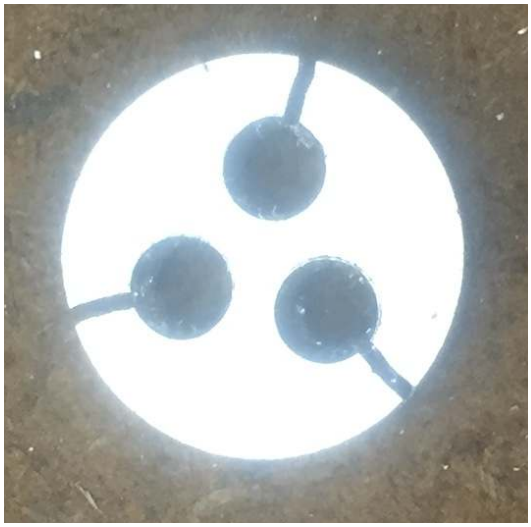
The breakthrough in making the 3 perimeter holes at the same distance from the center was to use my compound mounted drill chuck. I used a line level to set the angle.



In order to avoid backlash, I always moved the spot drill towards myself when setting distance.

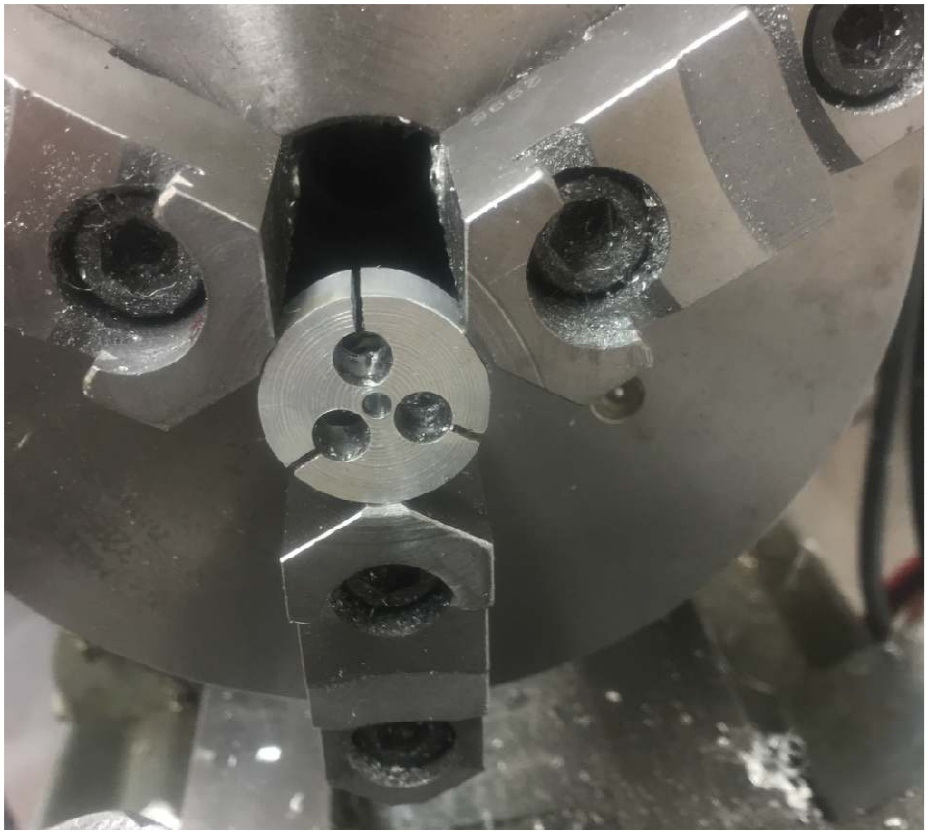
The distance from the center of rotation was set by first moving the spotting drill in from the edge. Then I fed out until the point was at the OD. The crossfeed collar was then zeroed. Next I fed in past the center of rotation. By again moving towards the perimeter until the dial read zero, I reached the center of rotation. It was then a simple matter of moving 0.213" to my final position.

I drilled a starter hole, rotated 120° and drilled the next one. This guaranteed the best possible symmetry.



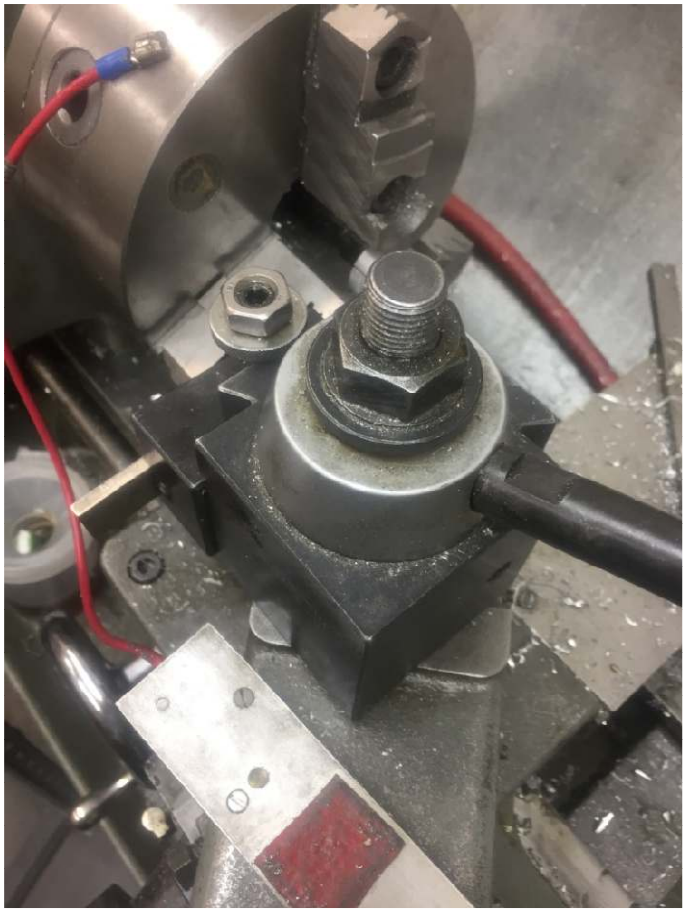
Next I removed the part and drilled through using a ¼" drill on the drill press. The 3 cuts were made on my bandsaw. It is essential that the saw not slip and cut the far side of any hole. I spoiled one part that way. This caused excessive TIR.

Deburr and put back in the 3 jaw chuck when needed. Remember, this collet is only accurate from the time the center hole is cut in place until it is removed from the chuck.



The crush collet has been spot drilled, drilled through with a #32 drill (0.116" diameter), and then reamed to 0.125".

My 1/8" dowel pin smoothly slid into the hole. Then when I tightened down on the chuck, the pin was solidly locked in place.



I measured TIR by using my parting tool as a probe. My Electronic Edge Finder[3] told me when the tool contacted the dowel pin. I took readings at 0°, 120°, and 240°. The crossfeed dial told me movement. Then I checked at 60°, 180°, and 300° to verify I had found maximum and minimum.

With a TIR of less than a thou, I felt it was time to write up the idea and wait for comments from those smarter than me.

[3] See http://rick.sparber.org/ReadMeEEF.pdf

Acknowledgments

Thanks to John Herrmann for a number of things. He posing the original problem. His need is long since passed as he found an acceptable solution. But as he well knows, once I get interested in a problem, I don't usually give up. John suggesting I could drill and tap the hole to hold threaded stock like tiny screws. And finally, he found a few typos.

Thanks to Peter Bready for finding typos.

I welcome your comments and questions.

If you wish to be contacted each time I publish an article, email me with just "Article Alias" in the subject line.

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