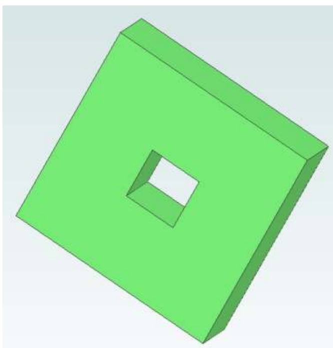
Making Square Holes, version 4

By R. G. Sparber



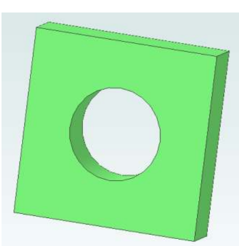
Recently there was a thread on the atlas_craftsman Yahoo site related to making square holes. It compelled me to organize and document what was suggested plus throw in a few tricks I've learned over the years.

I see 4 basic approaches to making square holes

1. Only remove material
2. Remove and add material
3. Only add material
4. Reshape existing material

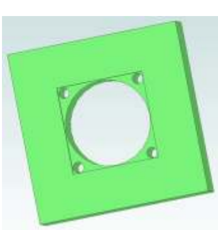
I will give examples of each approach.

Only Remove Material

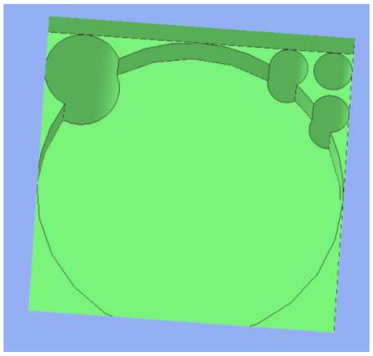


Most of these approaches start by drilling a hole either with a diameter equal to the width of the hole or slightly smaller.

Then you can saw it square, file it square, or

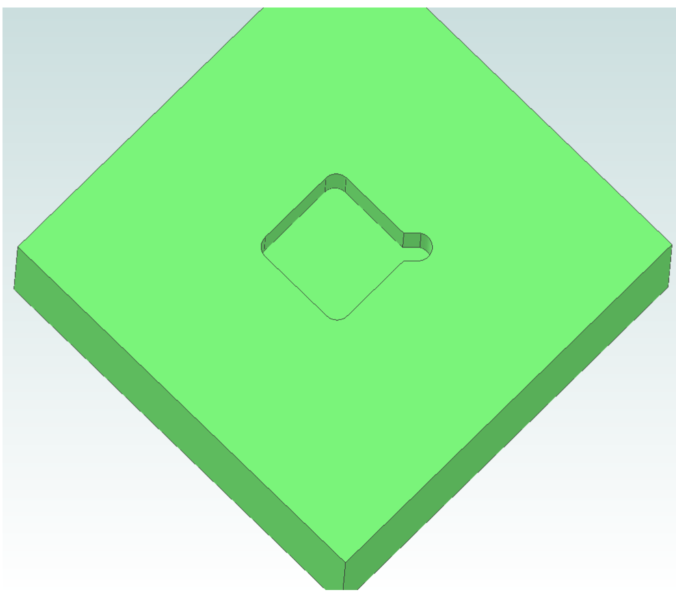


you can first drill small holes that are tangent to the lines near the corners.



Taking the idea of drilling the corners one step more, you can use different sized drills. In the example, I show a ½" square hole. The large centered circle is ½” in diameter. In the upper left corner is a 1/8" hole. By using a 1/16" drill as shown in the upper right corner, we cut the distance from corner to hole in half. The web left between the holes in the upper right is 0.01” thick.

You could also use various sized end mills to cut a square hole. The logic is the same as for drilling. In fact, it would save wear and tear on your end mill to first drill the ½” diameter hole.



If you are milled the hole, the corners can be shaped in two possible ways. You can either have the corners have a radius equal to the end mill or you can feed the end mill into the corner at a 45° angle such that you get corner relief. The example shown here is extreme. You do not have to feed in this much.

One big advantage to milling is that you can make blind holes.

You could also use a shaper to cut in the corners as long as the hole is not blind. Of course, if you have a broach, that will cut a square hole.

If you do use a broach, here is some sage advice from John:

"For a while I was broaching 3/16" square holes in 5/8" square cold rolled stock to mount 3/16" tool bits.

Two things to pass along here:

1. I drilled a #7 hole as the pilot for the broach as I didn't need a perfectly defined square hole. It essentially just nicked in square corners which were adequate to register the 3/16" tool bit that I didn't want to rotate. It took less pressure from the arbor press and did the job.
2. I learned the hard way that the 5 or so inch length of the broach to be pressed through the stock could easily "cock" and break if I attempted to press the cutting tool through in one stroke. I think the broach was $78 at the time. I had better luck pressing the replacement broach an inch or so, raising the ram which allowed the broach to straighten up, and then another inch, and so on until I was through."

A low cost broach can be made by shaping a High Speed Steel blank to have a sharp end and then use a mill with the spindle locked to drive it up and down while moving the table. Malcolm has a good video on this:

http://www.youtube.com/watch?v=RxX6b1VBV0I

This approach can also be made to work on a lathe by moving the tailstock in and out or by setting up a lever on the tool holder to drive the cutter in and out.

In industry it is common to use a punch press and hardened dies to make all shapes of holes.

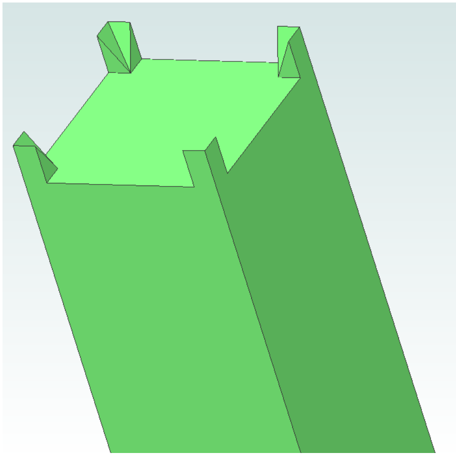
It might also be possible to use abrasives to slowly grind a square hole.

If doing casting or 3D printing, a square hole is very simple.

You could also try your hand at making a rotary broach.

This example can be seen at mikesworkshop:

http://mikesworkshop.weebly.com/rotary-broaching.html

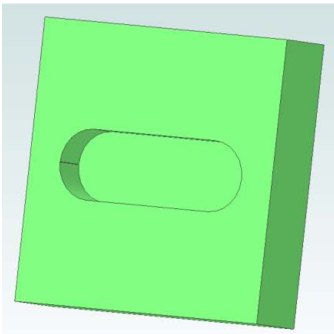


You can also take a block of High Speed Steel of the desired cross section. Grind a recess in one end so you end up with the corners as cutters with relief. You drive this though the hole with a large hammer to broach the hole. I call this “bash broaching”. To make the tool go into the hole easier, counter sink first.

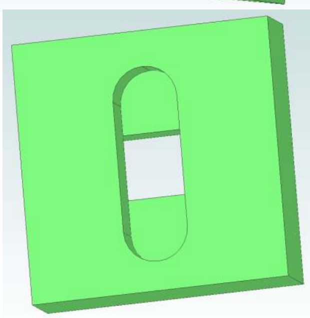
Note: although “doc” does this all of the time, Corey did not get away with it. When struck with a hammer, the HSS shattered and embedded shards in his hand. Using a press would avoid the shock load and probably be safer. Even then, put a shield around the tool to stop and shards that may be produced.

Alan Lapp suggested using a re-ground allen key to make the bash broach.

An example of “out of the box” thinking is to form a square hole by milling two slots. This idea came a Ken Gentry of Houston, TX which was from the book “Practical Ideas…”[2]. This book is packed with great ideas.



First mill a slot half way through the work piece that has straight sides at least as long as the square hole will be wide.

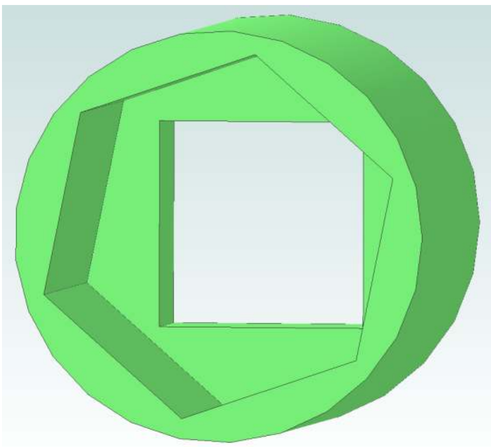


Then flip the work piece over and cut a perpendicular slot on the other side. You then end up with a hole that has vertical square sides through half of the hole and horizontal square sides through the other half. I have used this type of hole to enclose a cutter and it works well.

[2] Practical Ideas… for metalworking Operations, Tooling, and Maintenance by the editors of AMERICAN MACHINIST, Penton Publishing, ISBN 0-932905-05-6

In the spirit of "if you can't solve the problem, change the problem", it may be that you want to cut a square hole because you can't find one readymade. For example, say you have a 14 mm square drive on your bench vise and want to make a handle. Note that 14 mm equals 0.551" . So you could mill the shaft down so it is 0.500" square and then use a ½" square drive from a socket. You can see an example of this kind of drive at

http://rick.sparber.org/rwa.pdf



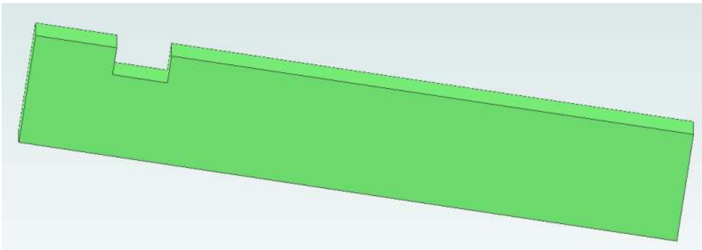
You could also start with a square hole like in a socket with a ½" drive hole. Anneal to return the metal to its soft state. File the square hole until it fits.

If you have an Electrical Discharge Machining (EDM) machine, you can cut any shape hole.

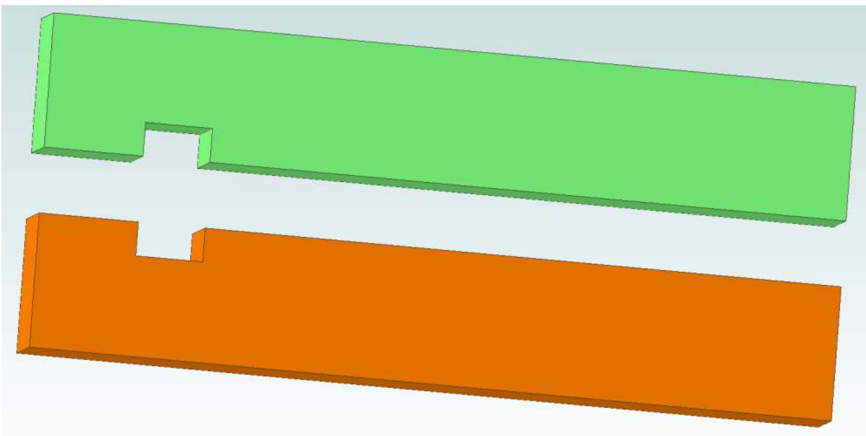
If the work piece is thin enough, you can use a cold chisel and a hammer to cut the square hole or just about any other shape.

In all of the above cases, we have only removed material.

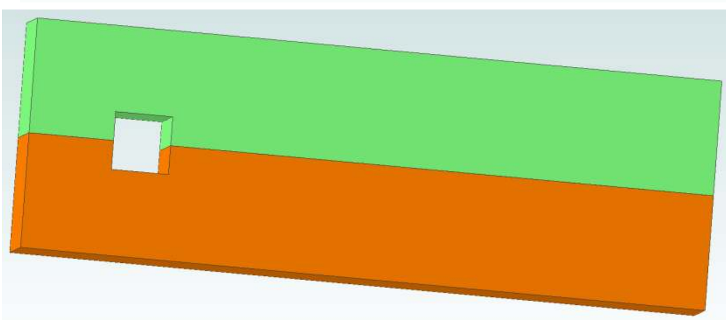
Remove and Add Material



In this first example I cut a slot in a piece of bar stock that is the width of the square hole but only half as deep. Then I cut a second bar with the same feature.

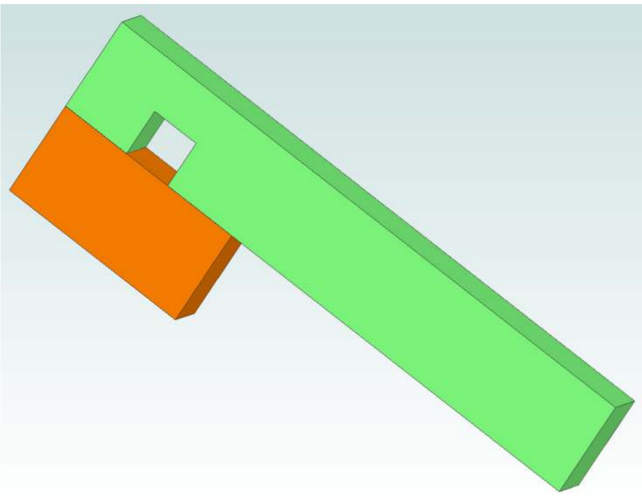


Flip one bar over,

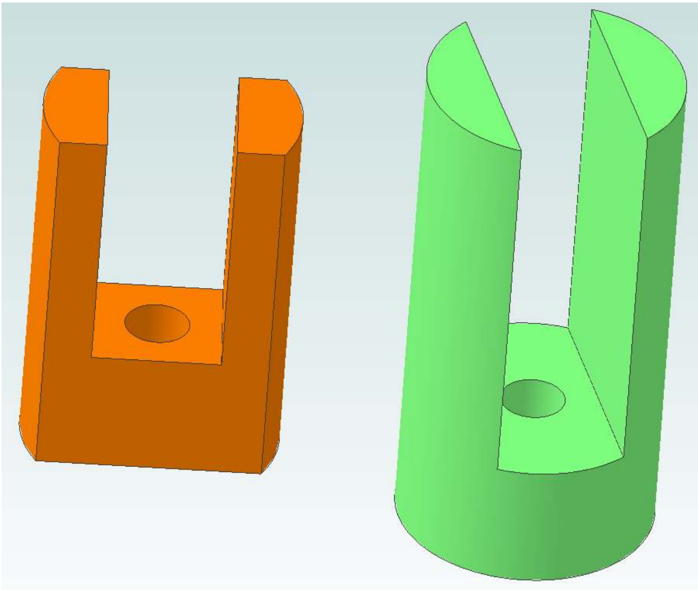


and bolt or weld them together.

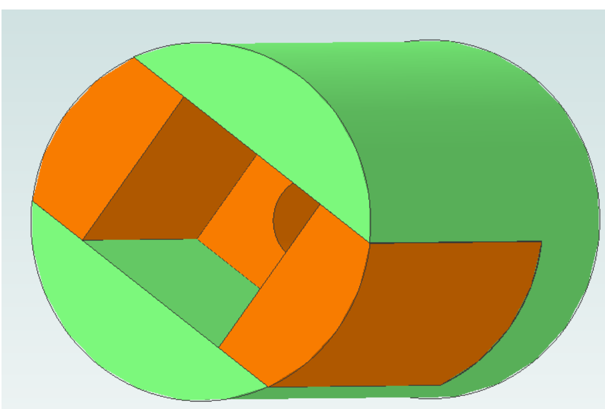
A variation on this approach would be to mill the full depth



and then bolt or weld a piece of bar stock across the opening.



You can also take round stock and mill in slots.



Then assemble the pieces and run a bolt through the bottom, and/or pin the sides, or weld the parts together. This structure might not be as strong as the bar stock approach but, if necessary, you could add a sleeve to hold the sides together.

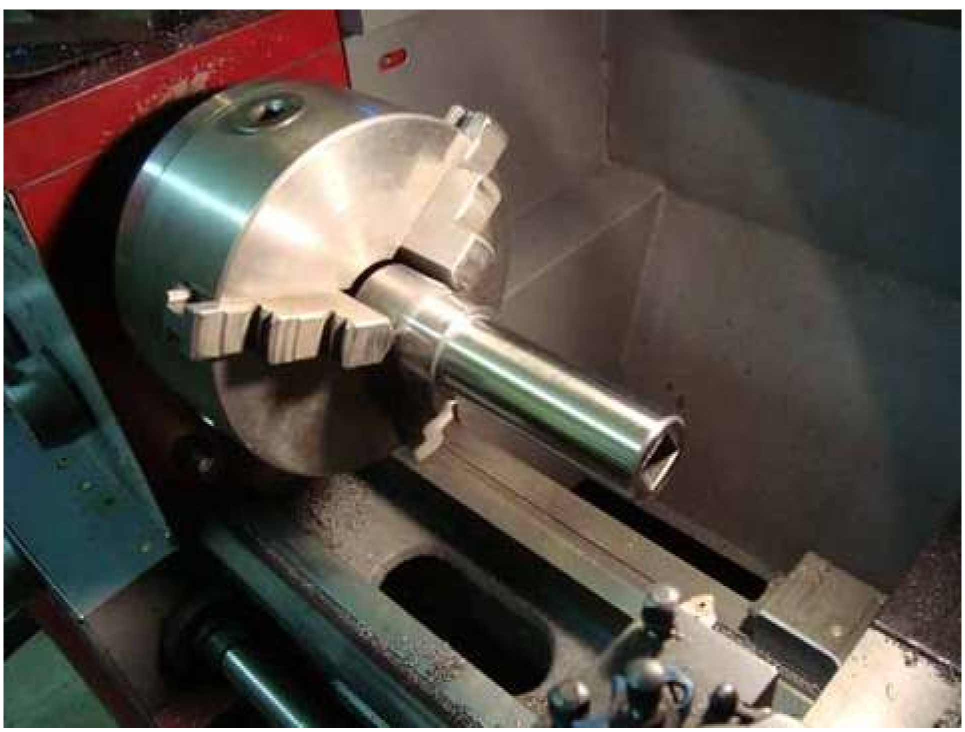
Combining the last two ideas, you can cut a full depth slot in the side of the round stock, fit a bar in the slot to form the square hole, and weld it up. Then turn the OD to hide the weld.

Gerard Emonds provided the following pictures of how he made an insert with a square hole.

He first cut a slot in the round work piece and also a flat on top so the resulting square U cross section is the correct size for the square hole.

Then he milled a second piece of steel for the cover.

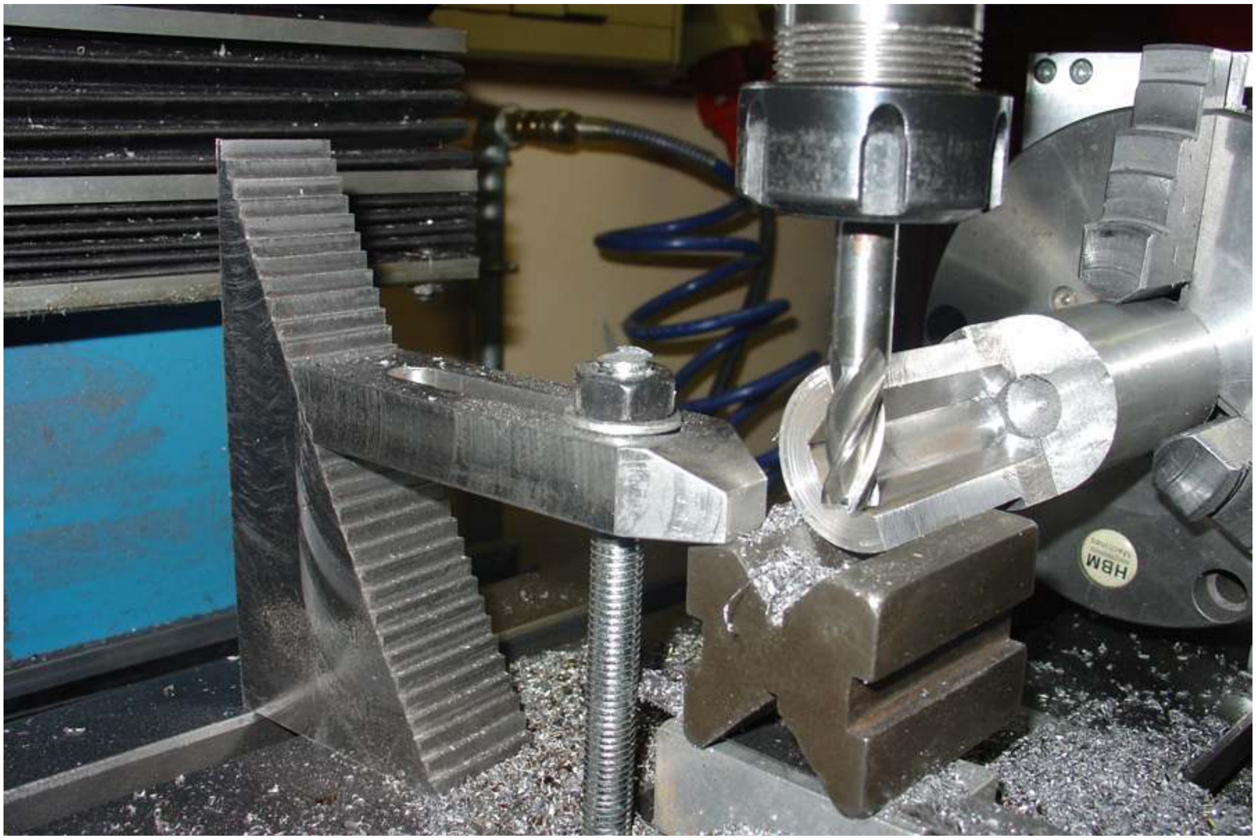
The two parts were clamped together in preparation for welding. Note that alignment was not critical here. The cover just has to span the opening enough to be welded.



After welding, the part is chucked up and turned to the final OD. It is then parted off.

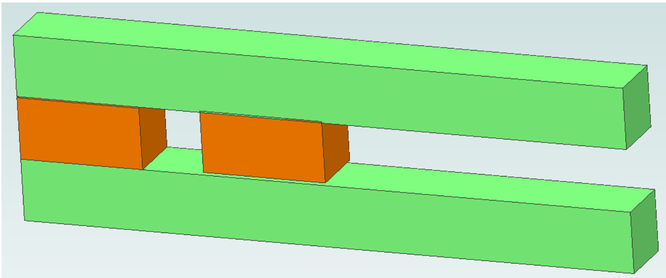
The result is nothing short of amazing.

And here Gerard was making a hexagonal hole.



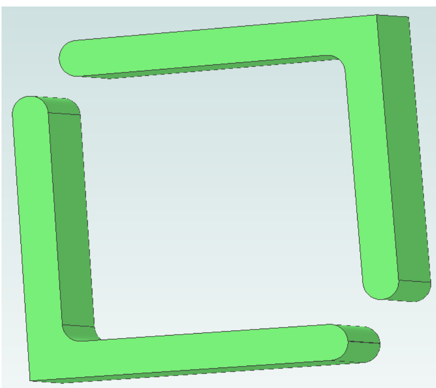
In this case, the other half of the hole must be carefully aligned before welding.

Only Add Material

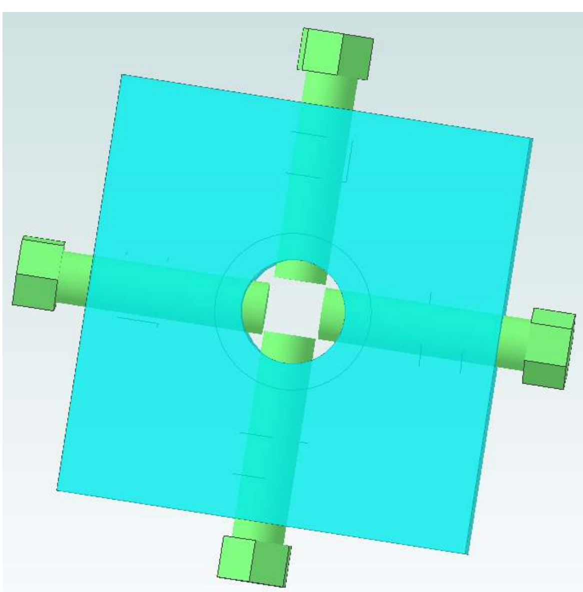


The square hole is formed by bolting or welding together bits of square stock.

If strength is not important, you could coat the square shaft that will engage the square hole in oil, then secure it in the center of a close fitting round hole. Fill the void with a metal epoxy like JB Weld®. If more clearance is needed, put some tape on the flats instead of oil.

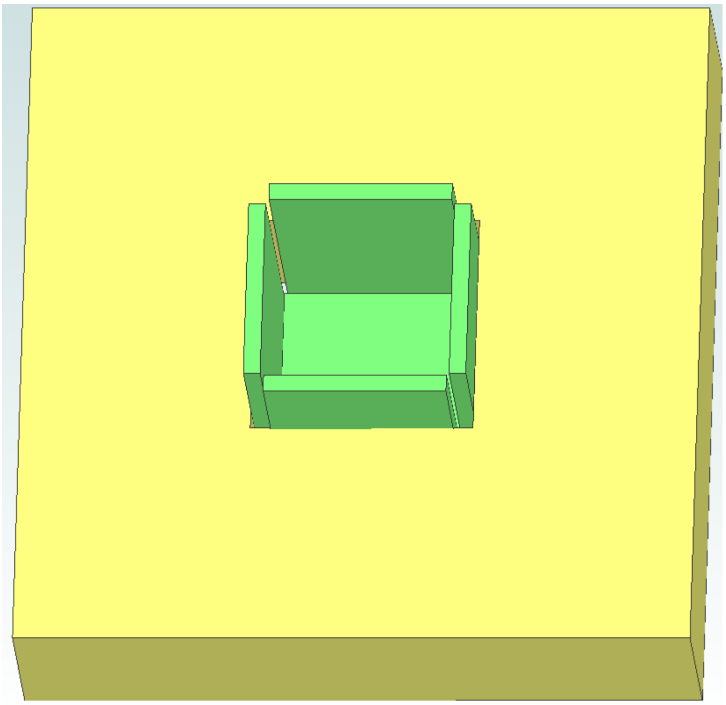


If you can weld, taking two pieces of angle stock might do the trick. Just run a bead down the outside.



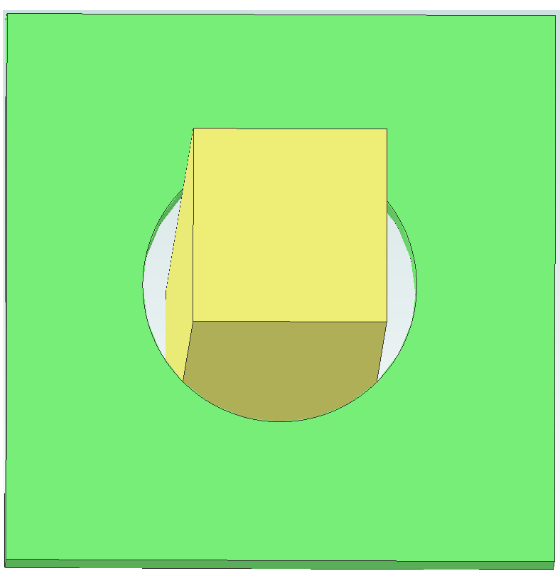
Doc suggested forming the square hole by using 4 bolts screwed into a block with a round hole in the center.

The support block has been drawn translucent so you can see how the bolts are arranged.



L. Garlinghouse wrote:

"Because I don't want to damage any part of the vise, if I could find a socket or better yet a U-joint drive with a 3/4" drive, because 3/4"=12/16" and I want to end up with 9/16" my hole is only 3/16"too big, so If I can decrease two sides by 3/32" I'll end up with my desired size. Thus I could bend an "L" shaped piece of maybe some steel strapping that was close to 0.090" thick and end up with a square hole pretty close to 9/16" or 14mm. I could then epoxy the "L" shaped piece in place and I would have a hole close enough to what I wanted. The 0.045" or so of eccentricity could probably be lived with. After everything cures I can file or grind off any of my "L-shim" that sticks out beyond the face of my piece."



My good friend Ed C said:

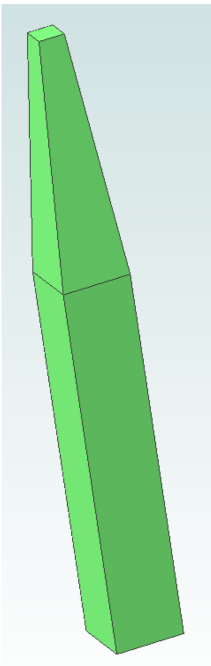
"If you have a copper bar with the desired cross section, you could fit it inside a hole The use an additive welding process like MIG or stick to fill the gap."

Christopher Locke points out that you can buy square hole sleeves. Then just press it into your round hole.

Weld or silver solder to secure the insert.

This web page is from the Sturdy Broaching Service Company. You can also find these sleeves on eBay.

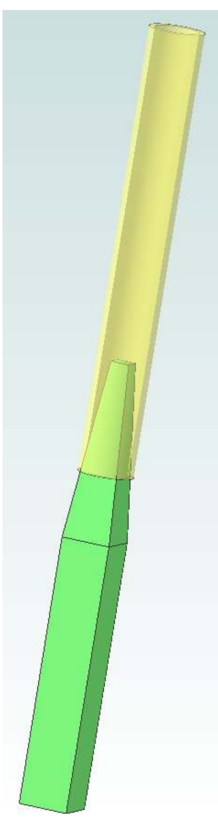
Reshape Existing Material



L. Garlinghouse wrote:

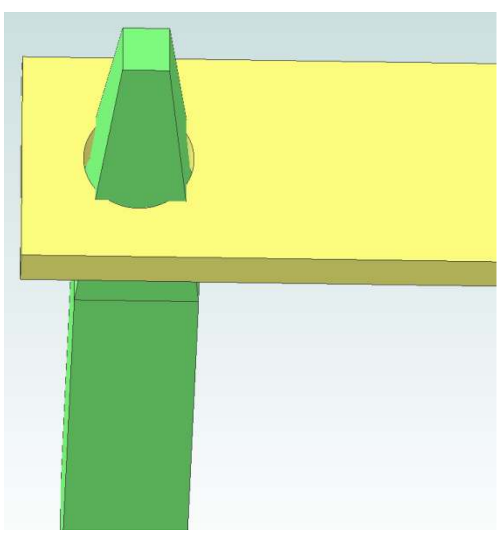
First I would find a piece of stock, ideally already square, maybe even 9/16" square, or 14mm or something bigger, or a piece of round big enough to give me a square section the right size. Next I would make it square for about and inch starting about 3" from the end. [Grind, file, whatever].
Then I would taper it down to let's say 1/2" cross section or less from my nicely sized square along the remaining 2" or so to the end. I would probably let the tapered portion evolve from a square into an octagon along the way. The result would be a drift that could be used to form square holes.

(RGS: You might even be able to use a drift from your toolbox if the cross section is right.)



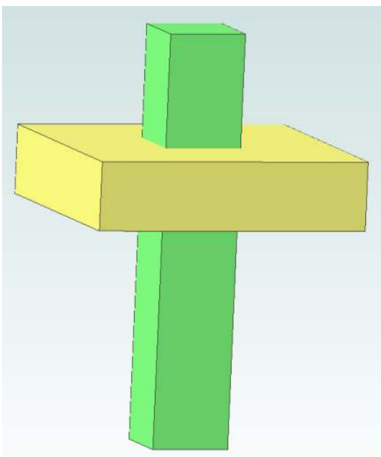
Note: This rendering shows the pipe as translucent so you can see how the mandrel fits inside.

Then, and it doesn't make any difference whether my handle is



going to be out of flat bar or if I'm using a piece of pipe, I would heat the pipe or the end of the flat, that already has a 1/2" hole in it, to red-orange-yellow hot in my forge, or if I can't find my forge, on my hibachi, in my barbecue, in a pile of charcoal on the dirt. If there is electricity I would use the exhaust from my shop vac, or a hair dryer as a blower, otherwise I could just fan with a piece of old fiberboard box. And then pound my drift into it with a large hammer. If all goes well, I end up with a nice square hole.

Even though the drift is probably from mild steel, it will work a couple of times in red hot steel. 1/2" schedule 40 pipe might work, schedule 80 might work better if I'm making a socket out of pipe, and I think 3/8" flat might work if I'm not. If I wanted something thicker than 3/8" I might use 2 pieces formed to size.



Alan Lapp added: A corollary to your internal drift would be to forge a round hole smaller over a square mandrel in order to form a square hole.

George Brent sent in:

“an adjustable, cheap tap handle of the right size that could be set screwed or epoxied in place for a certain application could be a fast way to get a simple handle. If it’s too long I'm sure it would cut pretty easily and using glue or set screws you could get rid of most of the slop in the jaws for a relatively solid wrench.

This was from Shars and goes up to about .53" square. 1/4-3/4x15L Tap & Reamer Wrench. Your Price: $7.60

Acknowledgements

Thanks to Keith Mc who posed the original question, Fred Townroe, jerdal, doc, Ray Waldbaum, Charlie Gallo, pbgd3, Corey Renner, Paul Finell, GreggK , Matthew Tinker, L. Garlinghouse, Alan Lapp, Gerard Emonds, Jerry Durand, Rexarino, johnviejo68, Bruce, George Brent, Glenn N, Ed C, Christopher Locke, Rob B, and Gary in AZ.

These generous people again demonstrate that "all of us are smarter than any one of us".

I welcome your comments and questions.

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