Shop-made Vacuum Chuck

By Al Crandall

This article will enable you to build a shop made vacuum chuck. I will list the materials I used, where I found them at Lowe's, and give you step by step instructions to lead you through the maze I foundered in while constructing my own unit. I believe this design to be about as simple as it can get in so far as machining parts is concerned, and is mostly just a matter of buying the parts and assembling them into a workable unit. Foremost in the design was a desire to seal as many potential vacuum leaks as possible. I am very happy with the results I've received from the first couple of units and feel that my goal has been achieved. I found all the parts at Lowe's, so for the sake of simplicity I will use their part numbers to identify the components and tell you where to find them. Lets go shopping!

1. A-776 Brass Reducer Bushing 3/8-mip X 1/8-fip Aisle 13, Plumbing. $1.03 ea. Need (1) for every chuck body you make.

2. 30 " long 1/8-ip Threaded Steel Pipe, Angelo brand, part number 70270. Lighting section, short cross aisle between aisles 7 and 8. $3.58 ea. Need (1)

3. Angelo 70162 Couplings 1/8-ip thread. Same location as above. Need (1) pkg. $1.07 ea.

4. Angelo 70621 Brass Lock Nuts 1/8-ip thread. Same location as above. Need (1) package of 6. $.58 ea.

5. #8 "O" Ring 9/16 X 3/8 X 3/32 Aisle 13, Plumbing. Need (1) $.25 ea.

6. 5/16 Bright Flat Washer Lowe's item # 63307 Aisle 16, Hardware. Need (3) pcs. $.03 each.

7. #48 "O" Ring 5/8 X 3/8 X 1/8 Aisle 13, Plumbing. Need (2) pkgs. $.25 ea.

8. 5/8 X 3/8 Rubber Grommet, Lowe's # 139356 Aisle 16, Drawer K4, Specialty Fasteners. Need (1) pkg. $.71 ea.

9. Bearing, 99502-H .625 Bore. Double Seal for Ace Pump. Aisle 16, Drawer K10, Specialty Fasteners. Need (1). $5.47 ea.

10. 1" Adapter, Fem. Sch 40, white PVC Lowe's # 23864 Aisle 14, Plumbing. Need (1). $.41 ea.

11. 1" X ½" Bushing, Threaded. Sch 40, white PVC. Lowe's # 51323 Aisle 14, Plumbing. Need (1). $.75 ea.

12. A-223 ½ Compression X ½-mip Brass Elbow Aisle 13, Plumbing. Need (1). $2.94 ea.

13. ½ Outside Diameter X 3/8 Inside Diameter Milky White Polyethylene Tubing Lowe's # 22268 Aisle 13, Plumbing. Length to suit. (I used 8 feet.) $.17 per foot.

O.K., let's put some of these parts together. To this date, I have built four chucks and I find that using a piece of ¾ inch thick mdf super glued into the chuck is an easy and leak proof way of getting the brass bushing (my Item # 1 in the shopping list) installed into the chuck body. Just drill a 9/16-diameter hole on the centerline of the lathe spindle and tap it for the 3/8 bushing to screw into. A little c.a. glue in the threads just prior to installing the brass bushing will insure a leak proof joint. Screw quickly and don't stop or the c.a. glue will lock up before the bushing is seated all the way. Don't ask me how I know this. If you drill the mdf in assembly on the lathe, be sure you tap from the proper side. You want the brass bushing to install from the spindle side, not the tail stock side.

Because the threads inside #1 are tapered and the threaded pipe (#2) has straight threads I was fearful of a leak for two reasons. First, this type joint has a minimal number of threads engaged. I also feared future slop and wear due to repeated screwing and unscrewing of the steel pipe into brass threads when mounting the vacuum chuck assembly. I thought an "O" ring would give a better seal than the threads.

Cut Item #2 to length. This length will be determined by several factors. You will need about 3" sticking out the left end of your lathe spindle, plus enough to get through the spindle and into Item #1. How you intend to mount the body onto the lathe will affect the distance of Item #1 from the right end of the spindle, which in turn will change the length of the threaded rod. A body screwed directly onto the spindle will place Item #1 closer than if, for instance, a Talon or Nova chuck were used to hold the vacuum body.

Next thread one of Item #3, the coupler, and one of Item #4, the nut, onto the rod. Temporarily leave about ¾ inch of threads exposed beyond the nut. Using moderate hand torque only, screw #2 into #1 and back it out. Do this several times until the threads feel like they are tightening up at the same place each time. No need to over torque because the "O" ring will be doing the sealing. Place Item #5 on the rod and next to the nut. Screw the rod in again and run the nut up so as to squeeze the "O" ring somewhat and form a seal. Apply two or three drops of Lock Tite to the threads next to the nut and screw the coupler tight against the nut. Unscrew the rod from Item #1 making sure the nut and coupler do not move on the rod, and that they are still jammed tightly against each other. The main purpose of the coupler is to "square up" the sloppy fitting nut upon the rod, and to add more threads for the Lock Tite to act upon. The chuck end of the rod is now finished.

The threaded rod needs to be held on center of the spindle bore where it exits the spindle on the left, or outboard, end. I solved this problem by turning a tapered plug from wood. The small end fits into the spindle bore, and the length and taper combine to cause the large end to stick out past the end of the spindle. Mine is about ½ inch long. Drill a 25/64 hole through it while it's in the lathe and cut it off. Drill out the three flat washers, Item #6, to 25/64 and slide the wood plug (small end first) and one of Item #6 onto the end of the rod which we haven't worked on yet. Using c.a. glue, carefully glue the large end of the wood plug to Item # 6. Do not let either become glued to the rod. I applied a thin layer of glue to the outside of the taper to add some durability to the plug.

Find two Item #4 nuts which, when jammed together on the rod, have their flats aligned with each other. These two nuts will be bonded together in assembly as though they were one nut to provide a wider nut for a wrench to fit on. Set them aside for the moment. Install another nut, Item # 4, on the rod next to the washer and plug. In use, this nut will be tightened only finger tight to keep the plug against the outboard end of the spindle.

Now you are ready to position the two "paired" nuts onto the rod. Run them down the rod maybe ¾ inch. Put a washer, Item # 6, on next followed by one of the Item # 7 "O" rings, then one of the Item #8 grommets followed by the last Item # 7 "O" ring. Next slip Item # 9, the bearing, onto this stack of rubber donuts and follow that with the last # 6 washer and a # 4 nut.

Using a pair of wrenches, tighten the nuts against the washers until the bearing is firmly squeezed by the washers. When everything is tightened firmly and there are about three threads showing beyond the single nut on the end of the rod, you have found the proper position for the "paired" nuts. Without moving the "paired" nuts remove all the bearings and washers and assorted rubber things outboard of them and if the flats still line up with each other, then bond the nuts in place with Lock Tite.

The adapter, Item # 10, must be machined to allow the # 9 bearing to fit into the glue socket end. I fit mine with .003 "press" or interference between the pvc fitting and the bearing o.d. and pressed them together using the drill chuck in my lathe tail stock to apply the needed pressure and insure that the bearing was being kept square to the bore. Open the jaws of the drill chuck all the way and use a flat board against the bearing to keep the pressure on the outer race. I used a large socket from a tool set to finish pushing the bearing into the recess of the fitting. If you lack the equipment to do close tolerance boring then I suggest you drill out the fitting with a 1 3/8-diameter Forstner bit and use c.a. glue to effect a tight seal around the bearing. As a last resort the pvc may be bored out using ordinary turning tools in a cut and fit manner. I believe this joint between the bearing and the pvc adapter to be the most likely to cause major vacuum loss if not done with great care and attention. Seat the bearing against the internal flange in the middle of the adapter and cut off the excess length of the fitting to within about 1/8-inch from the face of the bearing. This will leave enough of a wall to flow a small bead of c.a. glue against and get the necessary seal at this critical joint. It also exposes the "paired" nuts when assembled so that getting a wrench on them is easier.

When the marriage of the bearing and the pvc adapter is complete and the glue is dry, the threaded rod may be installed permanently. Stack the washer, "O" ring, grommet, and "O" ring against the "paired" nuts as before. Slip the bearing onto the "donut stack" again with the threaded end of the pvc adapter pointing away from the "paired" nuts. Working through the threaded end of the adapter, drop the last washer onto the threaded rod and torque down the last nut.

All that remains to do is to screw Item # 11 into # 10 and Item # 12 into # 11. Use pipe joint dope instead of Teflon tape to seal these last two joints. Small shreds of tape might come loose and get sucked into your vacuum pump. I break the system apart at the compression nut on Item # 12 when swapping from one threaded rod to a different one of another length. The poly tubing, Item # 13, goes from # 12 to a brass tee into which I added a vacuum gage and a brass ball valve so I could cut back the holding power of the chuck while positioning a workpiece. The gage came from McMaster-Carr Supply Co. for a very reasonable cost of $7.23 plus shipping. It's part # 3935K32. I bought on-line at www.mcmaster.com after doing a search for "vacuum gage". Phone is 630-833-0300. I put a brass nipple between the tee and the ball valve to separate the valve from the gage and to get clearance for the lever handle on the valve. The other piece of poly went from the ball valve to my vacuum pump. There is nothing really magic about this part of the set-up so I am going to let you fend for yourselves here.

Now lets talk a little about the actual chuck bodies. I wanted to turn large platters or large shallow bowls in the gap between my spindle end and the beginning of the lathe ways. I started with a 6-inch diameter faceplate and mounted a 7-½ inch diameter piece of ¾ thick mdf to it using "furniture bolts" from the specialty fasteners drawers at Lowe's and "O" rings. A gasket made from a mouse pad and attached using spray adhesive from my 12" disc sander completed the assembly. Next came three chucks made from pvc plumbing fittings. One started life as a 4" to 2" reducer bushing and another was a 3" to 2" bushing. The last is a floor area drain assembly. It was designed to attach inside a 3" pipe or over a 2" pipe. Glue in an mdf plug, throw away the plastic grate, and it's almost done. It still needs to have a gasket attached to it. All of these fittings cost less than $5 each and make good starting places.

All four chucks mount on the lathe in different manners. One uses a commercial face plate as a base so it just screws on. One uses a pvc fitting with 1" pipe threads inside. I re-tapped it with a 1"-8 tap so it just screws onto the spindle also. A flat washer glued to the fitting assures that it seats the same place every time. Another chuck uses a 1"-8 steel nut welded to a 1" flat washer, which in turn is bolted to the body using six ¼-20 hex head bolts. Still another has been re-enforced with a plug of mdf and a 1" steel washer so it can resist the crushing forces of my Talon chuck jaws. I just chuck it up like any piece of wood. I match a mark on the chuck to the #4 jaw so it runs true each time I mount it. Chuck bodies are everywhere you look. Just use your imagination and happy vacuuming. Al Crandall