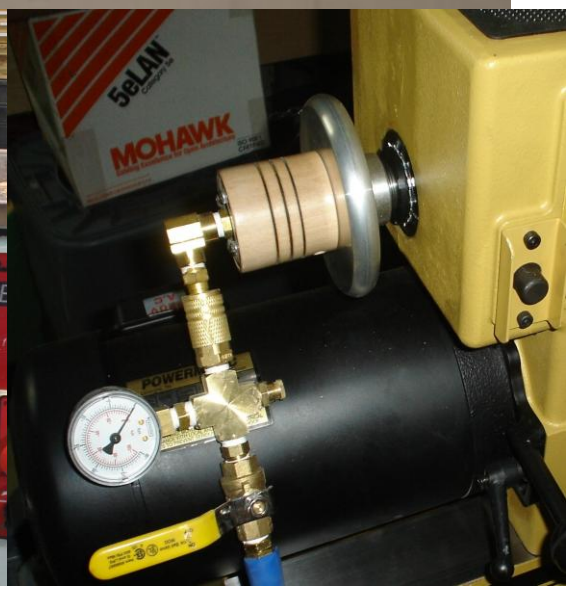
9/12/2010

A Shopmade Vacuum Chuck System



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Introduction

There are numerous methods available to finish the base of a turned object after removing it from a 4-jaw chuck, but one of the easiest, is reverse chucking with vacuum. This method allows you to remove the spigot without having to make custom Jamb Chucks or possibly damaging the lip of the object by gripping it with jaws. It does have its limitations in that very porous objects don't hold well, very thin objects can implode and the object can come loose if you take too heavy a cut, however, for the greatest percentage of turned vessels, it is a very functional and easy to use tool.

This paper will only deal with construction of a Vacuum Chuck system and not construction of the Vacuum Pump itself; however, whenever using a Vacuum Chuck system, it is advisable to have a vacuum Accumulator (tank) in the vacuum line. This can be as easy to make as taking a 30" length of 4" schedule 40 PVC pipe, with a cap on each end, drilling and tapping one end with a ¼" NPT tap and installing a T connection. The accumulator only needs to connect to the line; it doesn't have to go in one end and out the other, but either way works.

This design is a collection of the best features of several systems I have seen, both in production units and shopmade units on the Internet, as well as incorporating some unique features of my own.

This method uses a threaded rod that passes through the hollow spindle in the headstock. If your lathe is not so equipped, this method will not work for your lathe. Also some lathes have a setscrew that protrudes into the spindle. Before starting, check your spindle for obstructions. It would probably be better to resolve any issues with your spindle before starting construction.

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The system consists of four units, the Rotary Unit, the Spindle Adapter, the Header and the Vacuum Drum or Faceplate.

1. Rotary Unit:

   a) The Rotary Adapter consists of a Base Assembly which holds everything together. The Bearing Assembly which allows the Spindle Adapter and Vacuum Drum or Faceplate to rotate separately from the vacuum connection and a pipe fitting with a set screw which allows connection to the Spindle Adapter and keeps the pipe fitting from unscrewing when disconnecting the unit from the Spindle Adapter.

   

   Manufacture of the adapter works best on a mini lathe because the lathe bed is short and there is very little twist in the bed. Larger lathes may be used, however check that the headstock and tailstock meet dead on with a center in the headstock and one in the tailstock, checking that the points meet exactly when pushed together. If there is any twist in the bed, the holes will be oversized.

   b) Tools Needed:
      i) Lathe (Preferably a mini lathe)
      ii) 2 - Jacobs Chucks, at least 1 needs to be ¾" the other can be ½"
      iii) Scroll Chuck:
         (1) Pin jaws.
         (2) #2 jaws

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iv) Turning Tools
  (1) Parting Tool
  (2) Roughing Gouge
v) Drill Bits (May be Forstner, Brad Point or High Speed Twist Drill depending on size.):
  (1) 7/64”
  (2) 11/64”
  (3) 7/16”
  (4) 5/8”
  (5) 1”
  (6) 1 1/4”
  (7) 2”
vi) Taps:
  (1) ¼” NPT
  (2) 1/8” NPT (1/8 – 27)
  (3) 6-32
vii) Drill Press:
  (1) “V” block
  (2) Bearing Keeper Jig
viii) Miscellaneous:
  (1) Caliper
  (2) 12” ruler
  (3) Countersink
  (4) Files
  (5) Vise
  (6) Machinist’s countersink
  (7) Adjustable wrench
  (8) V Block
  (9) Bearing Keeper Jig
  (10) Center Punch

c) Construction:
  i) Base block:
    (1) Materials:
      (a) 2 1/2” cube of close grained wood or impervious material such as HDPE. (hardwood must be finished after it is made to seal the grain.)
    (2) Construction:
      (a) Complete the handwheel end:
        (i) Chuck the base block in a 4-jaw chuck with the end grain facing towards the end of the lathe.
        (ii) Turn the base block to a 2 1/4”cylinder.
        (iii) With a Jacobs chuck in the tailstock, bore a 7/16” hole through the base.
        (iv) Bore a concentric 2” hole, 3/8” deep.

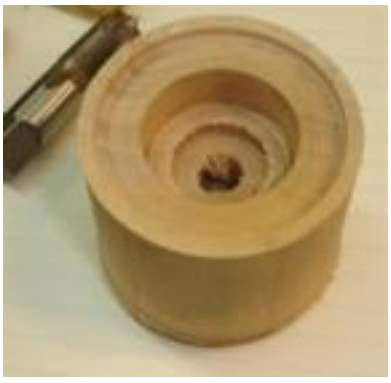
(Don't try to drill the full 2", start with a smaller bit and increase the diameter twice this reduces chatter when cutting.) This allows the adapter to fit over the handwheel on a Jet 1642 or inside the handwheel on the Jet Mini or Midi other lathes may require additional modifications. On a Jet 1442 or a Powermatic 3520, you may want to increase the diameter of the block so that it encloses the handwheel to more easily center it on the handwheel.

(v) Counter bore a concentric 5/8" hole 3/16" deep. This allows the ¼ - 1/8" pipe adapter to thread flush with the surface.

(vi) Tap the 7/16" hole with a ¼" NPT tap chucked up in the Jacobs chuck, grasping the tap on the barrel, not the flats, this keeps it centered better.

(vii) Leave the tap in the base block and remove the base block from the 4-jaw chuck. Remove the Jacobs chuck from the tailstock and remount it in the headstock, using the tap as a screw chuck.

(b) Complete the bearing end:



(i) Complete rounding the Base block, with a live center with the cone on the end, sand and finish.

(ii) Drill 3 concentric holes:

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1. 1" – ¾" deep
2. 1 1/4" – ½" deep
3. 2" – 1/8" deep

(iii) Remove the base block from the lathe and on a drill press with a "V" block, drill a 7/64" hole, 7/16" from the edge of the end that faces the hand wheel. (If your depths aren't exact, measure from the edge to where the flats on the ¼ - 1/8" pipe adapter will be and drill there) tap the hole for 6-32 and drill a ¼" countersink deep enough for the 6-32 screw to be below the surface. Cut the head of the screw off so it is just below the surface of the base unit.

ii) Bearing Assembly:

(1) Materials:

(a) 12 X 32 X 10 mm double sealed precision ball bearing (6201RS) Online from VXB.com http://www.vxb.com/page/bearings/PROD/kit880_1

(b) ¼" brass nipple

(c) ¼" brass pipe elbow

(d) Male Quick Connecter

(e) Teflon tape or pipe thread compound.

(f) JB Weld

(g) Alcohol

(h) 1" stainless steel washer

(2) Construction:

(a) Chuck the ¼" pipe nipple in the 4-jaw chuck

(b) Using a parting tool, turn off the threads on one end of the nipple so that it just fits inside the bearing. The deepest portion of the threads will remain at the end.

(c) Wipe the inside of the bearing and outside of the turned part of the nipple with alcohol. Apply JB Weld to the turned portion of the nipple and the inside of the bearing; press the nipple into the bearing, making sure none of the JB Weld gets on the plastic bearing shield.

(d) Only use JB Weld; regular epoxy or CA glue will not hold sufficiently.

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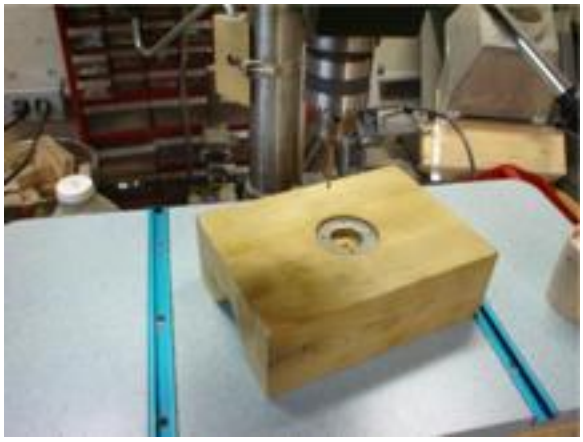
iii) Bearing keeper:
(1) Make a jig consisting of a block of wood with 2 concentric holes 1 ¼" and 2" in diameter. The 1 ¼" hole should be ¾" deep and the 2" hole should be 3/8" deep.
(2) Using a center finder, scribe two perpendicular lines on the 1"washer. Set a combination square at ¼", mark the center of each line and centerpunch.
(3) Place the washer in the jig and drill 4-11/64" holes.



d) Base block assembly:
(1) Materials:
(a) Base Block
(b) Bearing assembly
(c) Bearing keeper
(d) 3/8" - ¼" pipe adapter
(e) 6/32 X 1" screw
(f) Silicone caulk (RTV)
(g) 4 - #6 x 1/2" sheet metal screws
(2) Apply a small amount of silicone caulk to the outside of the bearing assembly and to the shoulder inside the 1 ¼" hole, making sure that none, including the squeezout, gets on the plastic bearing shield.
(3) Place the bearing keeper over the bearing assembly and into the 2" recess. Drill 4 11/64" holes to receive the #6 screws.
(4) Put silicone caulk on the threads of the 3/8" - ¼" pipe adapter and screw it into the opposite end of the base block so it is flush with the surface.
(a) Insert the 6-32 screw for the setscrew, checking that it is below the surface of the base block. The set screw should seat against one of the flats on the pipe adapter. If the screw head is above the surface, cut it off so it is recessed.
(b) Put the Teflon tape or pipe compound on the threads and assemble the nipple to the elbow and thread the quick connector into the other end of the elbow.

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e) Spindle adapter:

i) Materials:
(1) ¼" Threaded rod (Lamp Rod)
(2) 1" x 1" brass rod
(3) 11/16 X ½ X 3/32" "O" ring.

ii) Construction:

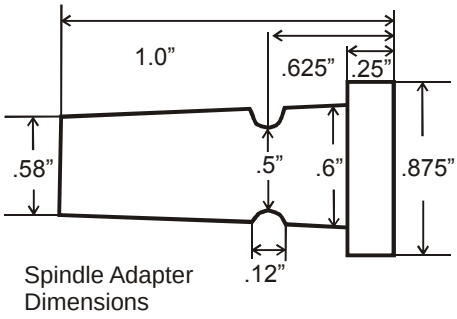
Cut brass chips are hot! Wear a long sleeved shirt and a leather glove while turning this piece or you'll end up with a bunch of small burns on your hand and wrist.

(1) Chuck the 1" X 1" brass rod into a 4-jaw chuck with a set of pin jaws. Turn the lathe on to see if it runs true, adjust if necessary.

(2) Use the Machinist's countersink to start a pilot hole in the center of the bar.

(3) Bore a ¼", then a 3/8" hole through the center of the rod to engage the live center.

(4) With the 1/8 NPT tap chucked in the Jacobs Chuck, in the tailstock, cut threads inside the bar, as far as you can go. Grip the sides of the tap, not the flats, to ensure the tap runs true.



Spindle Adapter Dimensions

(5) Release the bar from the scroll chuck, Remove the Jacobs chuck from the tailstock and remount it in the headstock, using the tap as a screw chuck.

(6) Place the cone on the live center and support the end of the rod, to keep the Jacobs chuck from coming out of the Morse taper..

(7) Using a parting tool, turn the rod down to .875" diameter and face the end by the live center. Smooth out any roughness with a file.

(8) Mark the rod at ¼" from the live center.

(9) At 1/4" from the unthreaded end, turn the rod down to .6" taper to .58" at the end of the rod.

(10) Using the very end of a ¼" rattail file cut a round .12" groove .625" from the unthreaded end, so that the "O" ring spins around in the groove with moderate resistance (Sneak up on the fit by placing the "O" ring over the base of the tap. Roll it up to the groove to check the fit. As you get close to .5", remove the tap and adapter and check the fit on the headstock. The fit wants to be snug and the head wants to be against the face of the Morse Taper. The Spindle adapter should fit inside the Morse Taper with no slop and light pressure should seat it against the face of the Spindle.)

(11) Flatten opposite sides of the head with a file to allow

grasping with a wrench. (Flatten one side then rotate 180° and use a bench level to make the flat level on the bottom. Flatten the top and check for level again. You should end up with 2 parallel flats.)

(12) Put Teflon tape or pipe compound on one end of the lamp rod threads and thread it onto the adapter.

(13) Place the "O" ring in the groove.

(14) Cut the lamp rod off 1" beyond the handwheel, then place the Adapter and lamp rod through the Head stock and screw the Rotary adapter on the other end firmly. Push the Rotary adapter firmly against the Hand wheel and measure the distance between the face of the Morse taper and the head of the Spindle adapter. Remove the Rotary adapter and Spindle adapter and cut the measured amount off of the Lamp Rod.

(15) Screw the Rotary Adapter onto the Lamp Rod; it should fit snugly against the Handwheel. If it is too long, file the end off until it fits.

2) Vacuum Manifold:
   a) Materials:
      i) Vacuum Gauge
      ii) ¼" pipe X
      iii) ¼" Ball valve
      iv) ¼" Bleeder valve (In the Air compressor section at Lowes or Home depot)
      v) 8' length of ¼" hose
      vi) 2 – ¼" hose barbs
      vii) 2 – ¼" hose clamps
      viii) Male quick connector
      ix) Female quick connector

   b) Construction:
      i) Install both hose barbs in the hose using the hose clamps.
      ii) Connect one end to the male quick connector
      iii) Connect the other hose barb to the ¼" Ball valve and the valve to the X with the ¼" nipple.
      iv) On the 2 adjacent branches of the T, connect the Bleeder valve and the Vacuum Gauge
      v) Connect the female quick connector to the remaining branch.
3) Vacuum Drums and Faceplates:
   a) Materials:
      i) Vacuum faceplate construction using a metal faceplate: (for normal rimmed vessels)
         (1) Materials:
            (a) 3" metal faceplate
            (b) 4 - #10x1" sheet metal screws
            (c) MDF (Buy a stair tread instead of a full sheet of MDF they are 1" thick)
            (d) 11 X 14 X 1/4" Craft foam (available at Michael's Arts and Crafts)

(e) Nylon washer or 11 X 14 X 1/8" Craft foam (available at Michael's Arts and Crafts)
(f) RTV
(g) Spray on contact cement

(2) Construction:
(a) Apply RTV to the front of the metal faceplate and then screw it to the center of a MDF rough cut disk. Don't use drywall or hardened construction screws; they have a tendency to shear off.
(b) Mount the faceplate to the lathe and true up the edge of the MDF. Use a dust collector to keep from breathing the dust, it can be harmful.
(c) Drill a 3/8" hole through the center of the faceplate.
(d) Paint all surfaces of the MDF with 2 coats of 2# cut shellac, including the inside of the hole.
(e) Spray the face of the faceplate and one side of the 1/4" craft foam with the contact cement wait until tacky and press together.
(f) With the lathe running at low speed, using a Sharpie permanent marker, draw a radius every 1/2" starting at 3". The Sharpie ink will slightly attack the foam and leave indentations which assist in centering.

ii) Drum Construction Using a Metal Faceplate: (for deep, natural or irregular edged vessels)
(1) Materials:
(a) 3" metal faceplate
(b) 4 - #10x1" sheet metal screws
(c) HDPE or MDF (Buy a stair tread stair tread instead of a full sheet of MDF they are 1" thick)
(d) 11 X 14 X 1/8" craft foam (available at Michael's Arts and Crafts)
(e) RTV
(f) Spray on contact cement
(g) Nylon washer to seal between spindle and faceplate.

(2) MDF:
(a) Rough cut 4 disks of MDF to the desired diameter.
(b) Draw a circle 1" inside the edge of 3 of the disks and cut the circles out with a jigsaw.
(c) Glue all 4 pieces of MDF together to make a rough hollow vessel. They can be clamped by placing them between the metal faceplate and the tailstock with a piece of scrap across the mouth. Allow to setup over night
(d) Remove the rough vessel and the metal faceplate from the lathe, apply RTV to the face of the metal faceplate and screw it to the center of the bottom of the MDF vessel.
(e) Drill a 3/8" hole through the center of the faceplate.
(f) True up the inside and outside of the vessel, leaving ¾" wall thickness. Gently round the top. Use a dust collector to keep from breathing the dust, it can be harmful.
(g) Paint all surfaces of the MDF with 2 coats of 2# cut shellac, including the inside of the hole.
(h) Cut a disk of Craft foam that will cover the lip of the Drum.
(i) Spray contact cement on the lip and one side of the Craft foam. After the adhesive is tacky, apply it to the lip of the Drum.

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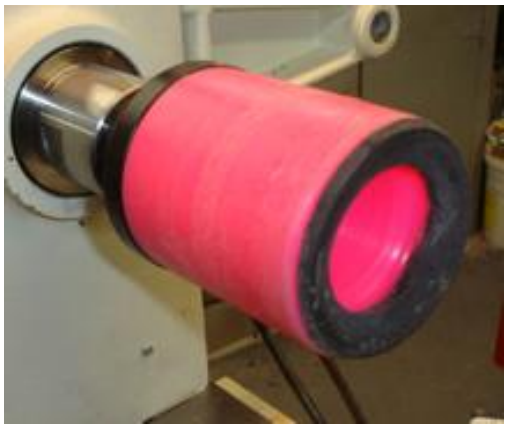
(j) For deeper Drums, add additional layers of MDF. If the height is greater than1.5x the diameter, reinforce each layer with 4 countersunk flat headed screws; Offset their locations on each layer so they don't hit one another. When turning with longer Drums, use the tailstock for additional support.



(3) HDPE construction:
   (a) Turn a piece of HDPE to the appropriate length and diameter.
   (b) Cut a disk of Craft foam that will cover the lip of the Drum.
   (c) Spray contact cement on the lip and one side of the Craft foam. After the adhesive is tacky, apply it to the lip of the Drum.

iii) Drum or Faceplate Construction Using A Tapped Wood Base:
   (1) Materials:
      (a) MDF (Buy a stair tread stair tread instead of a full sheet of MDF they are 1" thick)
      (b) 1" thick hardwood disk of the desired diameter.
      (c) 11 X 14 X 1/8" craft foam (available at Michael's Arts and Crafts)
      (d) RTV
      (e) Spray on contact cement
      (f) Nylon washer or gasket made from Craft Foam
   (2) Construction is similar to that using the metal faceplate, only use a wood tap that matches the thread in the headstock instead of the metal faceplate.

   (3) After the threading is complete, true up and face the base plate.
   (4) Use a piece of 1/8" craft foam as a gasket on the back of the Drum or faceplate to seal it at the spindle.

iv) Alternate Drum Construction using schedule 40 PVC pipe:
   (1) Materials:
      (a) 1" thick hardwood disk of the desired diameter.
      (b) 11 X 14 X 1/8" craft foam (available at Michael's Arts and Crafts)
      (c) RTV
      (d) Spray on contact cement
      (e) Nylon washer or gasket made from Craft Foam
   (2) Make a 1"hardwood base of the outer diameter of the desired piece of PVC pipe, using either the metal faceplate or tapped base plate method.
   (3) If making a threaded wood baseplate, after the threading is complete, true up and face the baseplate.
   (4) Turn a ½" rabbit on the outside edge of the baseplate to achieve a friction fit for the PVC pipe.
   (5) Glue the pipe into the rabbit with RTV or epoxy
   (6) True up and round the lip of the pipe.

(7) Spray contact cement on the lip and one side of the Craft foam. After the adhesive is tacky, apply it to the lip of the Drum and trim to fit the lip. An alternate method is to cut the foam large enough to wrap over the sides of the drum and use a nylon wiretie to secure it to the outside of the drum.

Resources:

www.joewoodworker.com
AAW forums