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VACUUM CHUCKING

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VACUUM CHUCK SYSTEM FOR YOUR WOOD LATHE

At our recent symposium, Turning 2003, I attended a "demo talk" by Dave Hout describing an inexpensive vacuum chuck system for the wood lathe. I had been thinking about putting a vacuum system on my Stubby lathe, but couldn't dig through the confusing information regarding just what kind of pump to use (especially since some pumps were pretty expensive) and the best kind of chucks to make. Dave cut through all the clutter and described a simple homemade system. I now have a vacuum chuck set up on my lathe that cost me about $250 complete -- pump, gauge, chucks and all. This article will describe what I have, where I got it, and how I put it together.

The vacuum chuck opens many new possibilities in the craft/art of wood turning. Probably the most obvious advantage is being able to freely access the bottom of bowls to finish them with style. I'm still learning what the system's capabilities are, but it was gratifying when I finished my first piece that had never been gripped by mechanical jaws. So read on and you too will be able to build your own vacuum chuck system.

The Overall Vacuum System

The vacuum system consists of several interconnected parts: the vacuum pump, vacuum gauge, vacuum relief valve (ball valve), air filters, connecting hoses, lathe hookup and the vacuum chucks (see Figure 1 for a schematic of the set-up). Since the overall operation relies on maintaining a vacuum, it is important that all connections be airtight. To ensure this, wrap Teflon tape around the threads of all fittings before putting them together. Check the system for leaks using the vacuum gauge at each step of assembly. Start with the vacuum pump and be sure you are getting the expected vacuum according to the pump rating. Then

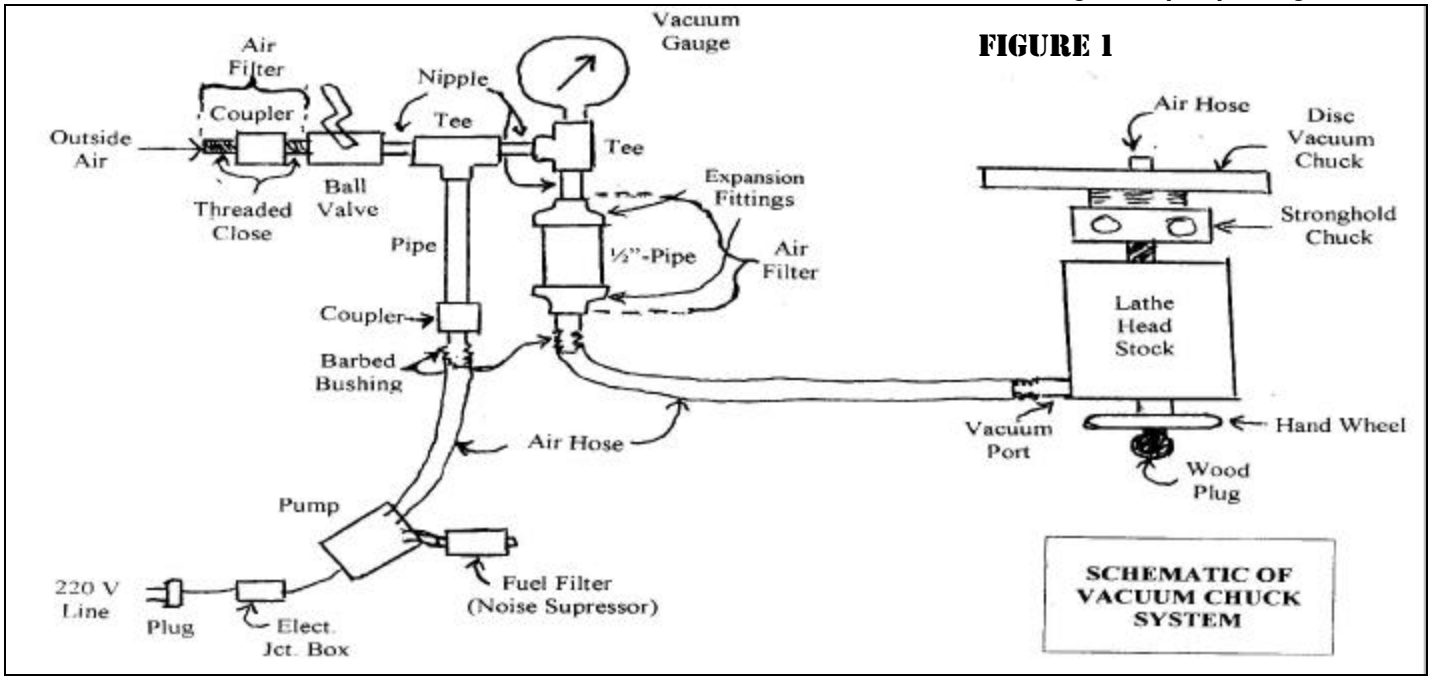

FIGURE 1

SCHEMATIC OF VACUUM CHUCK SYSTEM

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hook the pump to the control system and check for leaks. If you do not pull close to the expected pump rating, back up and make sure all the connections are tight. Once the control system is OK, then connect to the lathe and check again. Next, put a vacuum chuck on the lathe, close

The Stubby 750 with stand.

the end of the air hose with your finger and assess the vacuum. By checking each section of the set-up sequentially, you can find any leaks and fix them before moving on to the next part.

I attached the control system to my shop wall so that the relief valve is within easy reach of the lathe.

The Vacuum Pump

The pump I got is a ¼-horse power, oilless rotary vane Gast vacuum pump. It pulls 4.5 cubic feet of air/min (CFM) at 0 PSI and 3.6 CFM at 10 PSI. The pump came from the Surplus Center (1-800-488-3407; FAX 402-474-5198; www.surpluscenter.com), W "O" Street, P.O. Box 82209, Lincoln, NE 68501-2209 (Item # 4-1540). The delivery cost at my home was $106.10. The pump does not have built-in filters, so I added my own to the control system (described below).

This pump pulls more than enough vacuum to hold things on the lathe as long as your system isn't really leaky. It operates on 220 volts and draws 1.5 amps. Since my Stubby lathe requires a 220V line, I simply changed the single plug 220V outlet on the wall to a two-plug outlet and wired a 220 V plug onto the pump. (An electrician told me that as long as the amperage I was drawing on a line was not more than 80% of the maximum amperage rating, I wouldn't risk overloading the line.) Make sure the junction between the wires coming from the pump and the line to the plug are protected from sawdust and wood shavings to prevent fires; I made this connection inside a closed electrical box. My electrical supplies came from Becker Electric Supply, 11310 Mosteller Rd, Sharonville, OH, 513- 771-2550. Note: If you don't have a 220V line available, there are Gast vacuum pumps on the market that operate on 120V. Some pumps also have built-in filter systems. I recommend you start with the Surplus Center and see what they have available; their supply continually changes.

When you buy your pump, the Surplus Center sometimes carries an inexpensive noise suppressor (~$3) that is well worth the money. They didn't have them when I ordered, so instead I bought an in-line automobile fuel filter and screwed it onto the outlet port (Napa Auto Parts, 225 Northland Blvd., Cincinnati, OH 45246, Part # 3265 Fuel Filter ; $15.33). I bought this particular filter because I wanted to maintain a 3/8-inch opening throughout my system and this filter had the proper fitting.

The Vacuum Control System

The vacuum control system is made up of standard plumbing fixtures, except for the vacuum gauge (see Figure 1). I attached the control system to my shop wall so that the relief valve is within easy reach of the lathe. To connect the control system to the vacuum pump, I bought a compressed air hose (orange) from Home Depot (~$10) that has a 3/8-inch internal diameter. The vacuum gauge came from McMaster-Carr, 200 Aurora Industrial Pkwy, Aurora, OH 44202 (330-995-5500; FAX 330-995-9600; www.mcmaster.com) and is specified as an ABS Case Compound Gauge, 2% Mid-Scale Accuracy with a 4" Dial and a Bottom Connection, 0 to –30" HG/0-30 PSI ($15.69 including shipping). They have other gauges, but the 4" dial makes it easy to read when you're standing at the lathe. I bought all of the plumbing fittings, including the ball relief valve, from Ferguson Enterprises, Inc., 11860 Mosteller Rd. (right next to the I-275 exit), Cincinnati, OH 45241-1569 (513-771-6000). Other stores had some of the fittings, but Ferguson gave me one-stop-shopping and help finding what I

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needed. Since my connecting hose had a 3/8-inch internal diameter, I tried to maintain this diameter throughout the system, so I stuck with 3/8-inch fittings. Remember to use Teflon tape when putting the fittings together to avoid leaks. My system contains two homemade air filters since the pump didn't have built-in filters. Each filter consists of two smaller diameter fittings with a short length of larger diameter pipe between them. To make the filter, I cut a small piece of window screen (or a faucet filter screen) that would just fit into the pipe, but would not pass through the smaller fitting. Put a small fitting on one end of the pipe, put in the screen, pack the pipe loosely with some cotton, and then put on the second small fitting -- instant air filter. The filters are important to keep dust and small wood chips out of the pump; such debris could lower pump efficiency or cause it to seize. When connecting the control system to the compressed air hose, I wrapped the very end of the barbed bushing with Teflon tape before pushing on the hose to ensure a tight fit. I also used a hose clamp over the outside of the hose to help secure it.

The Lathe Hook-Up

Fortunately for me, the Stubby has a built-in vacuum port that accepts the standard fitting on the end of the compressed air hose. I simply wrapped the hose ending with Teflon tape and screwed it into the port. Because the vacuum port leads directly to the center opening in the drive shaft, it is necessary to plug the hand-wheel end of the spindle when drawing a vacuum. The hand-wheel opening can be plugged with a small rubber stopper, or in my case, I turned a small wooden peg to fit the hole and coated the larger end of the peg with cyanoacrylate glue to seal the pores (I could also have used varnish or sanding sealer). If you don't happen to have a built-in vacuum port on your lathe, you can still hook up a vacuum system by making your own vacuum adapter (for details see the article by Ralph Tedeschi that will appear later in another article).

The Vacuum Chucks

I made vacuum chucks of two different types that fit directly into my Stronghold chuck. This eliminates the need to remove the Stronghold every time I want to use a vacuum chuck. The first type of vacuum chuck is basically a flat disc that will accept and hold the smooth rim of a bowl. The second type consists of an open cylinder that will hold a bowl from either the inside or outside. This latter chuck makes it possible to hold a natural edge or rough edged bowl, or alternatively, to seat the rounded base of a bowl or other vessel. These chucks are manufactured in the following way.

The Flat Disc Chuck

This chuck is made from a piece of ¾-inch thick medium density fiberboard (MDF, Home Depot). Draw a large circle with a slightly smaller diameter than the swing on your lathe on the MDF with a compass (mark the center) and cut around the outside edge of the circle with the band saw.

Mount this on your lathe, with the drawing toward the tailstock, against a flat waste block with some rubberized material over the interface to help drive the MDF. Put the point of the tailstock at the center of the circle you drew on the MDF and tighten down the tailstock. Cut a groove in the MDF about ½-inch deep and ½-inch wide that will later accommodate the jaws of the Stronghold chuck; in my case about a 4-inch outside diameter for the groove was sufficient. Make this cut with the tip of a standard parting tool used like a scraper and make sure the bottom of the groove is flat. Once the groove is cut, remove the MDF from the lathe, turn it around and remount it in the Stronghold chuck. True up the outer edge. Take the MDF off the lathe and drill a hole in the previously marked center. Use a drill bit that produces a tight fit to the compressed air hose (make sure this hole is

The filters are important to keep dust and small wood chips out of the pump.

A relatively inexpensive gasket can be made from a fender pad sold by Harbor Freight.

drilled perpendicular to the flat surface of the disc). Remount the MDF in the Stronghold chuck and push a short piece (~ 6 inches) of compressed air hose through the chuck and into the Morse taper on the lathe spindle shaft until it fits snugly in the drive shaft. This fit between hose and shaft creates your vacuum seal to the lathe, so be sure to cut the end of the air hose square. Once the hose is pushed snug, cut off excess hose at the face so you leave only about ½-inch sticking out of the disc. Hot-glue the hose in place or use some other suitable adhesive. When the glue is hard, remove the disc from the lathe and add more glue around the hose on the back of the disc.

To provide a good seal between the bowl and the disc, some type of closed cell gasket material is needed. A relatively inexpensive gasket can be made from a fender pad sold by Harbor Freight (Super Cushion Fender Mat Plus, 2 ft x 3 ft., $8.55, available at Harbor Freight Tools, 5710 Harrison Ave., Dent, OH 513-598-4897). This material is thin enough so that the bowl can be pulled tight to the solid MDF undersurface. This keeps it stable for turning, but it still holds the vacuum well. I cut a round piece of the fender pad to fit my MDF, put a hole in the middle to accommodate the compressed air hose end, and attached it to the MDF disc using a spray adhesive (3M Super 77 Spray Adhesive, Home Depot; I sprayed only the MDF). Once the glue was dry, I put the assembled disc on the lathe and marked concentric circles separated by about ½-inch on the surface using a black magic marker. These circles act as a guide to help center a bowl for turning.

The Cylindrical Chuck

The cylindrical chuck is made essentially the same way as the flat disc chuck, except the disc is smaller and a groove is cut into the front face to accept a PVC pipe coupler. The coupler is a short thick section of PVC pipe and can be purchased from Home Depot in various diameters for less than $2 each. I made 2, 3 and 4-inch chucks. Once the small disc is prepared to be gripped by the Stronghold chuck as described earlier, the MDF is mounted in the jaws of the chuck and a groove to accept one end of the PVC coupler is cut into the face with a parting tool. When making these chucks, it is important to (a) maintain a flat surface on the back side of the MDF disc so that the Stronghold chuck jaws have a flat surface to mate to for consistent chuck alignment, and (b) make sure that you don't accidentally create a weak spot in the MDF disc by overlapping the grooves on the front and back of the disc.

After the section of compressed air hose is glued into place, the PVC is glued into the front groove with hot-glue or medium viscosity cyanoacrylate glue, both on the inside and outside of the coupler. Once the glue is dry, put the vacuum chuck in the Stronghold chuck and true up the exposed end of the PVC coupler with a scraper. Make this upper edge rounded to both the inside and outside. The gasket material is the same as described previously, but cut to fit the end of the coupler. I attached the gasket material with the 3M Super 77 Spray Adhesive by spraying a "puddle" of the adhesive on a piece of paper and immediately spreading it on the end of the coupler using a cotton swab. Once it became tacky, I pressed the gasket material onto the surface. To relieve stress on the PVC-gasket interface when round objects are placed on the chuck, after the glue dried I cut 8 equally spaced radial slits in the gasket inside the rim.

The way my system is set up, I can open the relief valve with the pump running and get 1 to 2 inches Hg. This low vacuum enables me to shift and reposition the vessel with minimal effort. Once it is adjusted, I can then close the relief valve partially to apply sufficient vacuum for turning.

THE FINAL WORD!

Cautions

There are some watch-outs and principles that you need to be aware of in working with vacuum chucks. First, one can pull enough vacuum to implode thin-walled vessels. Only pull enough vacuum to hold the piece securely and wear a face shield for your protection. Second, the amount of vacuum holding the piece on the chuck depends upon the surface area exposed to the vacuum –the larger the area, the greater the holding power. With the PVC chucks, the holding power is about the same for all vessels, because the area exposed to the vacuum is determined by the diameter of PVC pipe. It is a different story on the flat-plate chuck. The holding power is related to the diameter of the vessel. For additional discussion on vacuum chucks and some things that might go "bump" in the night, I highly recommend reading the following American Woodturner articles:

American Woodturner, Winter 1998, Vol. 13, No. 4, pg.32-35
Vacuum Chucks, by Ken Keoughan

American Woodturner, Spring 1999Vol. 14, No.1,28-31
Vacuum Chucks, by Ernie Showalter

American Woodturner, Summer 1999, Vol. 14, No. 2, pg26-27
Sealing the System, O-Ring Materials Improve the Vacuum, by John Hill

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There are many variations of my system that would result in a reliable vacuum setup, but this is the way I did it. You're welcome to use all or part of what I've described. If you think some modification might work better for you, give it a try. Just remember to have fun and stay safe.

Happy turning,

Bruce Gibson