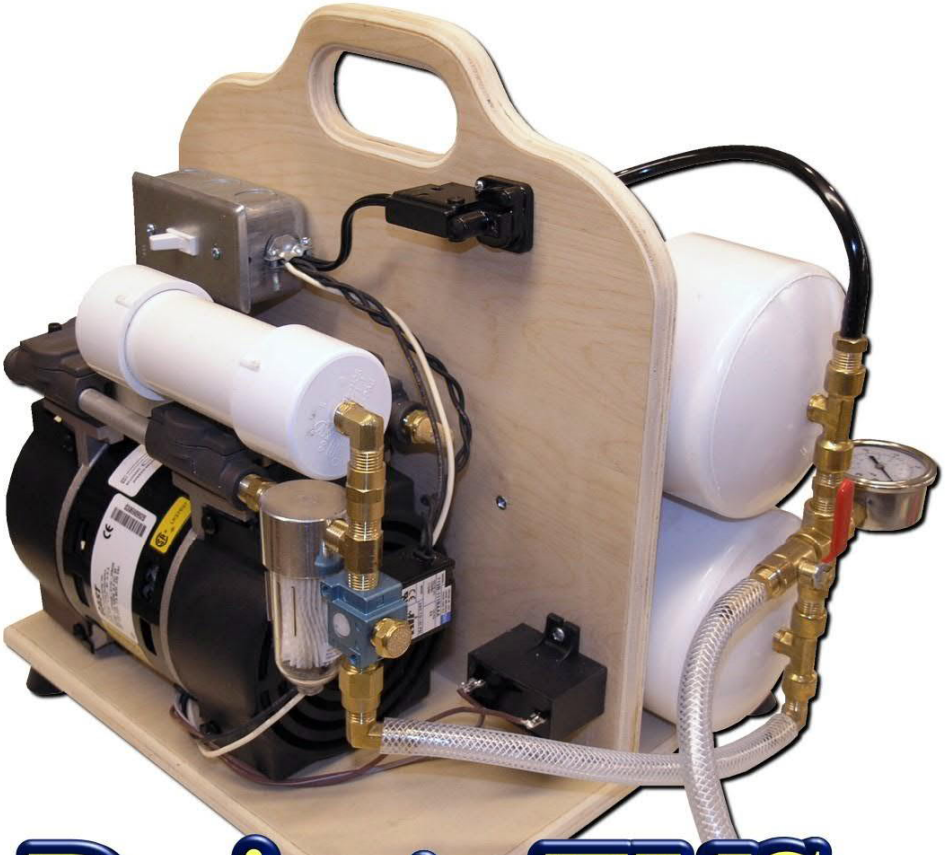

Project : EVS
Electric Vacuum System

Parts Available at www.VeneerSupplies.com
Revision 1.v.3 10/13/20

Welcome

After a year and a half of serious trial and error, and another year of updating and improving, I offer this free plan for building a vacuum veneer press. Make no mistake - this is a heavy duty, durable, and reliable piece of equipment. If you follow the instructions carefully, the press will last for as long as you enjoy the art of veneering.

Most of the veneering books and articles I have read are just too complicated and are geared toward proprietary materials and equipment. The construction method found in the JWW vacuum press article uses standardized parts that can be found on the Internet and at your local hardware store.

I wrote this article to show that you don't need a mega-buck setup to build a professional-level veneer press. I hope you'll agree. I'm always looking for a way to simplify and improve the system which is why it's under continuous revision. As always, you are most welcome to send me email with your suggestions for improvement.

Table of Contents

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The arbitrator shall be agreed upon by the parties and the arbitration shall take place in Harford County, Maryland in accordance with Maryland law.

Procedure
If the parties cannot agree on a mutually acceptable arbitrator, the arbitration will be conducted through the American Arbitration Association ("AAA") and in accordance with its rules. The AAA's rules are available to view at https://www.adr.org. Both parties agree to equally share the administrative expense of the arbitration, unless the arbitrator finds that the claim was brought in bad faith and orders one party to pay the cost of the proceedings as part of the arbitration award. Both parties are responsible for paying the costs of their own counsel, experts, and witnesses. Judgment on the award rendered by the arbitrator may be entered in any court having jurisdiction thereof. Before commencing an arbitration under this Agreement, the aggrieved party will first present the claim or dispute to the opposing party by (certified mail, regular mail). Our notice address to submit claims or disputes is: JWW Services Inc., 217 E. Jarrettsville Rd., Suite 5, Forest Hill, MD 21050. If the claim or dispute is not resolved within 90 days, the aggrieved party can commence arbitration proceedings in accordance with this Agreement.

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All arbitrations conducted under this Agreement shall be conducted only on an individual (and not a class-wide) basis; and an arbitrator shall have no authority to award class-wide relief. Your use of this document indicates your acceptance that this Agreement specifically prohibits you from commencing arbitration proceedings as a representative of others or joining in any arbitration proceedings brought by any other person.

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If any part or any provision of this Agreement shall be finally determined to be invalid or unenforceable under applicable law, that part shall be ineffective to the extent of such invalidity or unenforceability only, without in any way affecting the remaining parts of said provision or the remaining provisions of this Agreement.

More information can be found at https://www.veneersupplies.com/pages/Legal__Information.html

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Understanding How It Works
The Project: EVS system is very easy to build and only requires a minimal understanding of the basic components and the purposes they serve.

1. Vacuum Pump: This is the heart of the system. It removes air from the vacuum bag allowing the atmosphere to exert pressure which results in a clamping effect upon the veneered panel.

2. Vacuum controller: If the vacuum pump is the heart, the vacuum controller is the brain. This critical piece controls the pump and the electro-pneumatic valve (Mac valve). Since no vacuum system can be perfectly sealed, a small leak is always possible. When the vacuum drops, the vacuum controller turns the pump on and engages the Mac valve causing it to direct the flow of vacuum from the pump into the main system.

3. Mac Valve: The Mac valve is a gateway for vacuum flow. It directs air flow to either the main reservoirs when additional vacuum is needed or to an exhaust port when the system cycles off. This exhaust is simply a removal of vacuum from the pump so that it can easily restart on the next cycle.

4. Vacuum Reservoirs/Sub-Reservoir: The main reservoirs in the system hold spare vacuum just like a rechargeable battery. These reservoirs prevent the system from constantly cycling on and off by providing additional vacuum buffer. The sub-reservoir is a small holding tank of free air that allows the pump to achieve full RPM when starting up without back-pressure against the pump intake port.

5. Check Valve: This simple device prevents air from flowing backwards into the pump during the initial stage of the recharging cycle. When the pressure in the sub-reservoir exceeds the pressure in the main reservoirs, the check valve opens and the vacuum from the pump begins filling/refilling the main reservoirs.

Warnings

Not Suitable for Use Near Flammable or Combustible Materials
The individual components of this kit and the completed assembly of these components should not be considered suitable for use in areas where flammable or combustible gases or dusts are present.

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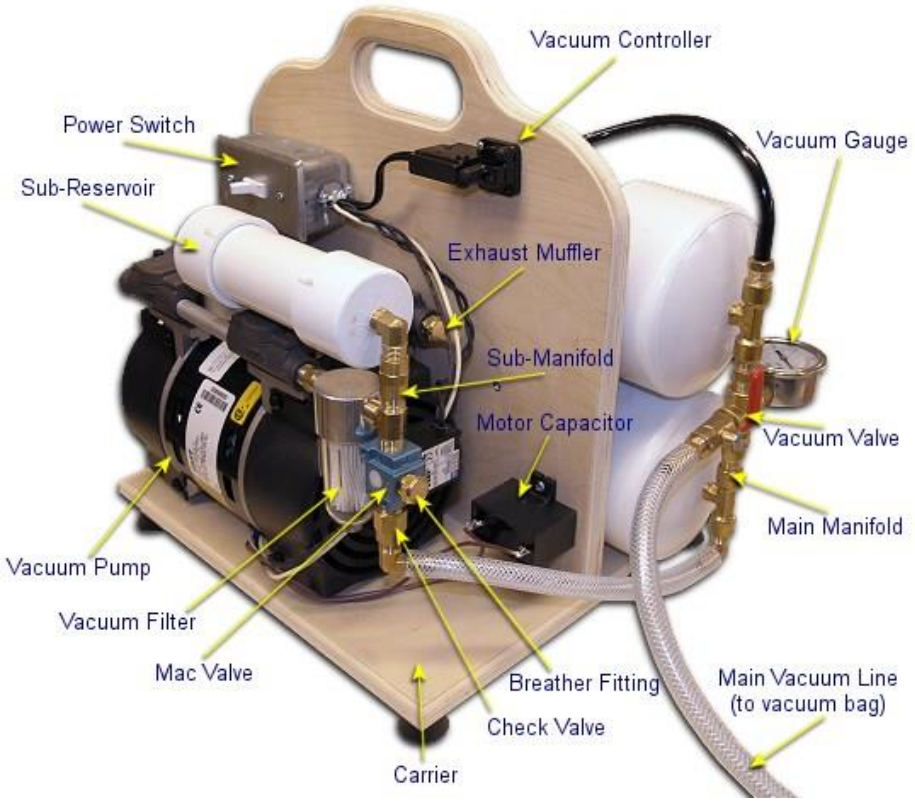
Up Close and Personal: A Good Look at the Vacuum Press



Why does the Project: EVS system need a sub-reservoir, reservoir, check valve, gauge, Mac valve, and all of the other pieces?

In a perfect world, you'd only need to connect the intake of the vacuum pump to a tube which would be connected to a vacuum bag to have a working vacuum press. All of the "extras" on the Project: EVS system might seem a little unnecessary but each has a place and purpose on an auto-cycling system.

The Vacuum Gauge
Obviously, the gauge shows the user the vacuum level inside the system. More importantly, it shows the user if there is a leak. When the system cycles off, the needle on the gauge will move subtly, but it's enough to indicate when a leak is present.

The Vacuum Controller
Without this piece, the system would run continuously. This is fine if you don't mind the 74 decibels of sound being continuously emitted from the pump or if you are not bothered by the waste of electricity from a pump that has to run for the entire duration of the pressing. The vacuum controller monitors the vacuum and cycles the system on and off as needed.

The Vacuum Reservoirs
If you are going to have a system that cycles on and off, you certainly don't want it to cycle too frequently. This is bad for the pump and it's just plain annoying. The reservoirs hold spare vacuum just like scuba tanks hold air for divers. If you have an air compressor in your shop, you certainly understand that a larger tank on an air compressor means that it will cycle on less frequently. The same is true of the vacuum reservoirs.

The Mac Valve/Check Valve/ Sub-Reservoir/Breather Fitting
Once you have established that you need a reservoir system and a vacuum controller, you then find out that the pump will not restart when there is vacuum pushing backwards against the pump's intake port. Dang! Now you need a way to vent off the pressure from the pump when it cycles off. This is accomplished with a Mac valve which directs air flow to either the main reservoirs when additional vacuum is needed or to an exhaust port when the system cycles off. This exhaust is simply a removal of pressure from the pump so that it can easily restart on the next cycle.

The Vacuum Valve
The vacuum valve allows you to pre-charge the reservoirs with vacuum which will give you a short burst of vacuum in the initial pull-down of the vacuum bag.

Assembly Basics
If you read the instructions carefully, you'll find that this system is surprisingly easier to build than previous versions of the press. Each part of the system has detailed instructions. The total average build time is now under 5 hours (down 30% from the previous version). Here's a quick look at how it all goes together.

1. Read the full instructions and review the parts list.
   Time: 45 minutes

2. Build the manifold - This is an assembly of brass hardware that connects and centralizes the main parts of the system.
   Time: 25 minutes

3. Build the sub-reservoir manifold - Another quick assembly of brass hardware that connects the pump, filter, and Mac valve together.
   Time: 20 minutes

4. Build the PVC reservoirs - Two reservoirs are used in the system to hold spare vacuum. A smaller sub-reservoir is also built to provide "free" air to the vacuum pump when it cycles on.
   Time: 60 minutes

5. Make the carrier - A couple of pieces of 3/4" plywood make a simple carrier for the system.
   Time: 30 minutes

6. Assemble the system - This step is an easy one. It's as simple as putting together all of the previously assembled parts.
   Time: 45 minutes

7. Wire the system - You don't need an electronics degree to successfully wire the system. Follow the instructions and your system will be up and running before you know it.
   Time: 35 minutes

8. Testing and adjusting - Test the system for vacuum holding and adjust the cycle pressure.
   Time: 15 minutes

Please note: The build times above are based on average users with a good understanding of how the system works. I highly suggest reading this article from beginning to end before you start building your system so you have a thorough understanding of how the vacuum press parts work together.

Parts List: Hardware Store

The following parts are available at most hardware stores. Warning: Brass products may contain chemicals known to the state of California to cause cancer or reproductive toxicity. Visit www.p65warnings.ca.gov for details.

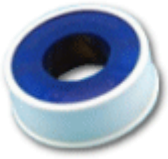
Qty	Item Description	Approximate Cost	Picture
1	8' Extension Cord Cheap: standard two-wire extension cord or Expensive: three-wire grounded extension cord Supplies electricity to the Mac valve and pump	$6.00	
1	Light Switch Controls the power to the system	$.99	
1	Electrical Utility Box or "Handy Box" Houses the switch and electrical connections	$1.49	
1	Switch Plate Cover Covers the handy box and hides the wiring inside	$.99	
2	Romex Connectors Protects the wires entering into the utility box	$.30 ea	
1	3/4" Plywood - 2' x 4' Used to make a carrier for the system	$14.00	
30"	4" Diameter schedule 40 or 80 PVC pipe This must be solid core PVC. PVC is also available at VeneerSupplies.com Holds spare vacuum and prevents the unit from switching on and off too frequently	Varies	
4	4" PVC schedule 40 or 80 pipe cap According to Unibell, all PVC caps are solid core. PVC caps are also available at VeneerSupplies.com Holds spare vacuum and prevents the unit from switching on and off too frequently	$7.00 ea	
6"	1.5" Diameter Schedule 40 or 80 PVC Pipe This must be solid core PVC. Holds temporary free air and allows the pump to achieve full RPM before vacuum is directed to the main reservoirs	$2.00 ea	
2	1.5" PVC Schedule 40 or 80 Pipe Cap	$2.00 ea	
1	PVC Cement Permanently welds the PVC caps to the PVC pipe	$6.00	

4	Rubber "Feet" or Bumpers These are (optionally) used on the bottom of the carrier to isolate any system vibrations. You can find these in most hardware stores in the aisle where cabinet door hardware is sold.	$3.00	
*	Wood Screws 8 of #8 x 1½" For construction of the carrier 2 of #8 x ½" Holds the utility box in place	$.30	
3	Wire Nuts 3 of Red, Yellow, or Orange Securely attaches electrical wires inside the utility box	$1.00	

Parts List: VeneerSupplies.com or Other Internet Sources

You can help to support this article and save time and money by purchasing the following parts through VeneerSupplies.com. A 32-piece builder's kit containing each of these components (not including the vacuum pump) is now available. This kit saves you nearly $40 off the regular website price and $95 off standard retail prices.

Qty	Item Description	Retail Price	Picture
1	Vacuum controller Monitors the vacuum level inside the system and cycles the pump on and off as needed	$26.00-$115.00	
1	Stainless Steel Vacuum Gauge Measures the vacuum level inside the system and vacuum bag	$16.00	
2	Screws: #4 x 5/8" Attaches vacuum controller to the carrier	$.90	
1	Vacuum Valve: 1/4" NPT Allows the system to pre-charge before connecting to a vacuum bag	$8.00	
1	3-Way Mac Valve: 120VAC, 1/4" NPT Controls the air flow in the sub-manifold and unloads pressure from the vacuum pump when the system cycles off	$29.00	
1	Lock-On Vacuum Bag Connector Connects the system to your vacuum bag	$12.00	

1	Vacuum Filter: High Flow (or Low Loss) 1/4" NPT Protects the vacuum pump from debris	$21.50	
1	Hi-Flex Tubing (1/4" ID): 1 ft Makes a soft connection between the vacuum controller and the manifold	$1.50 ea	
1	Brass Check Valve: Female to Male, 1/4" NPT Prevents vacuum from escaping into the sub-reservoir when the Mac valve is opened	$15.00	
1	Breather Fitting: 1/4" NPT Prevents dirt and debris from getting inside the top port of the Mac valve when the system cycles off	$2.60	
2	Brass Elbows: 1/4" NPT to 3/8" Barb An odd fitting that makes it easy to connect the sub-manifold to the main manifold	$2.50 ea	
1	Roll of Thread Sealing Tape Makes the brass connections practically leak-proof	$1.00	
2	Brass Branch Tee: 1/4" NPT Connects the reservoirs to the rest of the manifold assembly	$4.00 ea	
2	Brass Pipe Union (Hex Nipple): 1/4" NPT Attaches the filter to the pump and sub-reservoir manifold to the filter	$2.50 ea	
1	Brass Barbed Fitting: 1/8" NPT-Female to 1/4" Barb Connects vacuum line to vacuum controller	$1.50	
1	Brass Cross: 1/4" NPT The heart of the main manifold	$3.50	
1	Brass Pipe: 1/4" NPT x 2" An important part of the sub-manifold assembly	$2.25	

1	Brass Fitting: 1/4" NPT to 3/8" Hose Barb Connects the braided vacuum tube to the lock-on bag connector	$3.00	
1	Brass Fitting: 1/4" NPT to 1/4" Hose Barb Connects the 1/4" black tubing from the vacuum controller to the manifold	$1.75	
1	Brass Street Tee - 1/4" NPT An integral part of the sub-manifold	$2.95	
1	Brass Street Elbow: 1/4" NPT Another important part of the sub-manifold assembly	$2.95	
2	Brass Pipe - 1/4" NPT (1.5" long) Part of the manifold	$2.00	
1	Braided Tubing: 3/8" I.D, 10 ft Supplies pressure to the vacuum bag; also connects the sub-manifold to the main manifold	$6.00	
1	Brass Fitting: 1/8" NPT to 3/8" Hose Barb Connects the vacuum tube to the lock-on connector	$3.00	
1	Electric Vacuum Pump: 120VAC Must be capable of pulling at least 21" of Hg. The vacuum pump creates vacuum.	$200.00 to $500.00	
1	Vacuum Damper: 1/8" NPT (only used if the pump draws more than 4 CFM) Minimizes pressure fluctuations against the vacuum controller	$12.00	
1	Vacuum Controller Relay: 30 amp contacts 120v relay coil. This is only used if your pump draws more than 10 amps at startup. The relay handles the high-current load of the pump and prevents the vacuum controller from burning up when use with larger vacuum pumps.	$28.00	

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Selecting A Vacuum Pump

Speed and Maximum Pressure
Vacuum pumps are often rated on the flow capacity which is stated as CFM (cubic feet per minute). This references the speed at which the pump is capable of moving *or removing* air and is most often measured at zero pressure. A pump rated at 1 CFM will be fine for flat panel work on vacuum bags up to 4' x 4'. For bags up to 4' x 8' a 3 CFM or greater pump is needed.

If your vacuum press will be pulling down curved veneer forms or bent laminations, the general rule of thumb is that the pump must be three times faster. This means that a 3 CFM or greater pump is best for vacuum bags up to 4' x 4' for this type of use. Why? Because there is, on average, 3 times more free air inside of a bag containing a bent lamination than there is inside a bag containing a flat panel.

Vacuum pumps are also rated by their maximum achievable vacuum at sea level which is often expressed as inches of mercury or "Hg". For vacuum veneering, the minimum acceptable level of vacuum is 18" of Hg. The ideal vacuum though is 21" of Hg. At the high end, the maximum level of vacuum for veneer work is 25.5" of Hg. Anything over this amount is not only overkill, it's also harder on the pump. Additionally, extreme vacuum levels can cause the veneer to develop small pustules of glue on the veneer face.

Types of Vacuum Pumps

- Diaphragm pumps are very quiet and durable. This type of pump is oil-less and usually has a small footprint. They are ideal pumps for a vacuum system. Typical CFM rating is 1 to 3.

- Piston pumps are not as quiet as diaphragm pumps, but are just as durable. They are almost always oil-less and also work well for a vacuum press. Typical range of CFM is 2 to 5.

- Oil bath pumps are a bit louder and have a tendency to emit a light plume of oil into the air. For some users, this can be a problem. This type of pump requires occasional oil changes and can draw a large amount of amperage. Usually, these pumps range from 3 to 6 CFM.

- Rotary vane pumps Rotary vane vacuum pumps such as the Gast 1023 and 0523 vacuum pumps have been a nightmare. These pumps are difficult to fine tune for vacuum pressing and they draw a tremendous amount of power. There are much better choices. If you are using a rotary vane pump, you will at least need the relay and vacuum damper parts. I offer ZERO support for troubleshooting vacuum press systems built with rotary vane pumps. You waive your right to return this part if you are using it with a rotary vane pump. Typical CFM range for this style of pump is from 5 to 20.

- Refrigerant compressors can also be used for limited runs of vacuum press work. They are quiet, but slow to pull a full vacuum. Typical CFM is less than 1.

Build the Manifold
The manifold creates a hard connection between the reservoirs, gauge, intake, pressure controller and the vacuum source. It's much easier than it looks, so let's get going!

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Parts used in this section:	**Time:**	**Tools:**
Barb fitting - 1/4 NPT-male to 1/4" barb (x1)	25 minutes	Wrenches or pliers
Brass branch tee - 1/4 NPT (x2)		Thread-sealing tape
Brass pipe (1.5" long) - 1/4 NPT (x2)		
Brass cross - 1/4 NPT x1)		
Vacuum valve (x1)		
Vacuum gauge (x1)		
Brass fitting - 1/4 NPT-male to 3/8" barb (x1)		
Brass elbow fitting - 1/4 NPT-male to 3/8" barb (x1)		

1. Place two passes of thread-sealing tape on each of the male threads from the parts list shown above. Wrap the tape clockwise around the fitting.

2. Attach the two brass pipes (1.5" long) to opposite sides of the brass cross fitting.

3. Attach a brass branch tee to each of the brass pipe union fittings. Note the direction of these fittings in relation to the brass cross as shown in the picture below. This is critical.

4. Attach the vacuum valve to the brass cross as shown below. Again, note the orientation of the handle on the valve. It must be aligned correctly with the rest of the manifold.

5. Attach the brass barb fitting (3/8" barb to 1/4 NPT-male) to the vacuum valve.

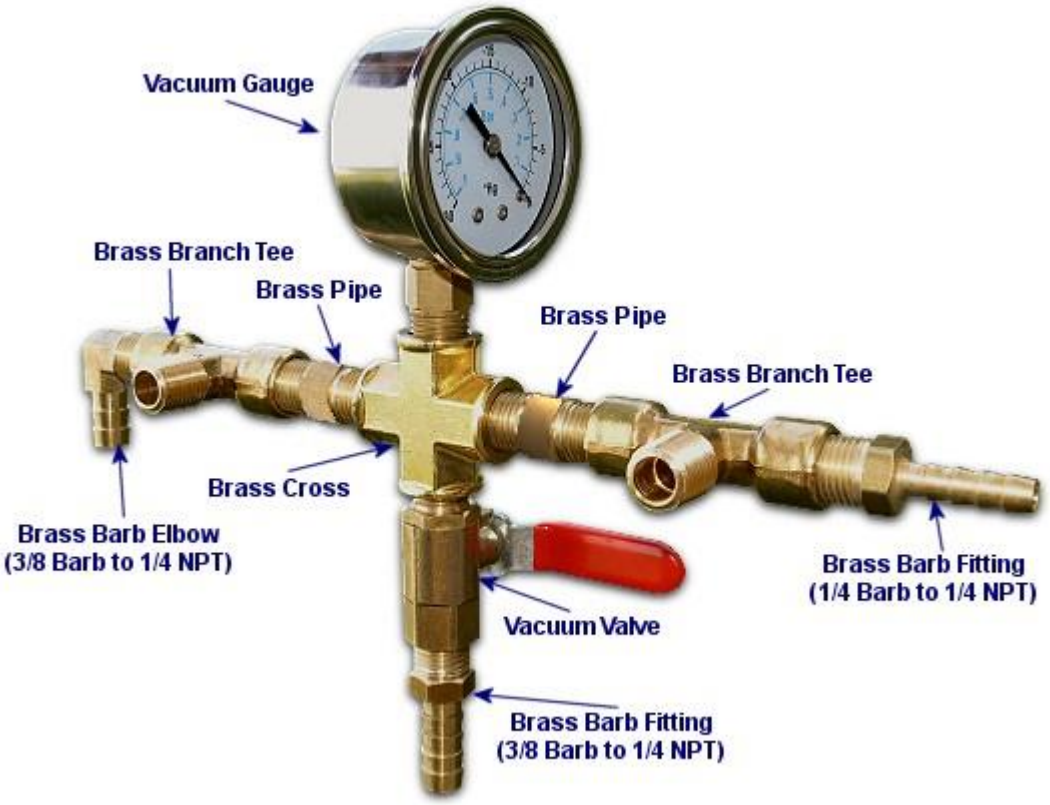
6. Attach the brass barb fitting (1/4" barb to 1/4 NPT-male) to the open end of the branch tee as shown in the picture below.

7. Attach the vacuum gauge to the manifold. Note that the face of the gauge points toward the brass barb fitting in step 6.

8. If the needle on the gauge is not resting at zero, you will need to release the pressure inside the gauge housing. With the gauge in the upright position, use a small flat-tip screwdriver to gently lift the edge of the rubber insert on the top of the gauge. Release when the needle drops back to the zero position. Do not cut off the rubber top of the fitting.

9. Attach the brass elbow fitting (3/8" barb to 1/4 NPT-male) to the remaining open side on the branch tee.

The final assembly should appear as shown in the picture below.
(For demonstrational purposes, thread sealing tape is not shown)



Build the Sub-Reservoir Manifold

Parts used in this section:	Time:	Tools:
Mac valve	25 minutes	Wrenches
Brass street tee - 1/4 NPT		Pliers
Breather fitting - 1/4 NPT		Thread-sealing tape
Brass check valve (female to male) - 1/4 NPT		
Vacuum filter - 1/4 NPT		
Brass pipe (2" long) - 1/4 NPT		
Brass street elbow - 1/4 NPT		
Brass pipe union fitting - 1/4 NPT (x2)		
Brass barbed elbow fitting – 1/4 NPT-male to 3/8" barb		

1. All metal-to-metal connections will require thread-sealing tape. Wrap the tape clockwise around the fittings. Do not apply thread sealing tape to the fittings that will be attached to the vacuum filter.

2. If not already in place, then attach the muffler to the vacuum pump exhaust port. The muffler is not included in the EVS kit because it is part of the vacuum pump. Vacuum pumps purchased at VeneerSupplies.com include an exhaust muffler.

3. Carefully attach a brass pipe union fitting to the pump's vacuum intake. Be certain you attach this part to the vacuum port. The exact location of this port will vary from one pump model to another. Do not assume that the pictures in this article are showing the vacuum port location for your pump as it can vary from one model to the next. Read the directions that came with your pump to determine which of the ports is for vacuum.

4. Connect the vacuum filter to the brass pipe union. Vacuum filters have an arrow indicating flow direction. Note that the direction air flow should be toward the pump. Remember that the filter head is made from a composite plastic and is soft. Avoid over-tightening the filter. When the filter just becomes snug, then continue tightening until the filter is in the vertical position.

5. Attach the breather fitting to port 3 on the Mac valve.

6. Attach the check valve to port 1 on the Mac valve.

7. Attach the brass barbed elbow fitting to the check valve. Note the direction that the barb is pointing as shown in the picture below.

8. Attach the brass street tee to port 2 on the Mac valve. Note the final position of this fitting on the Mac valve as shown below.

9. Attach the 2" brass pipe to the straight side of the street tee.

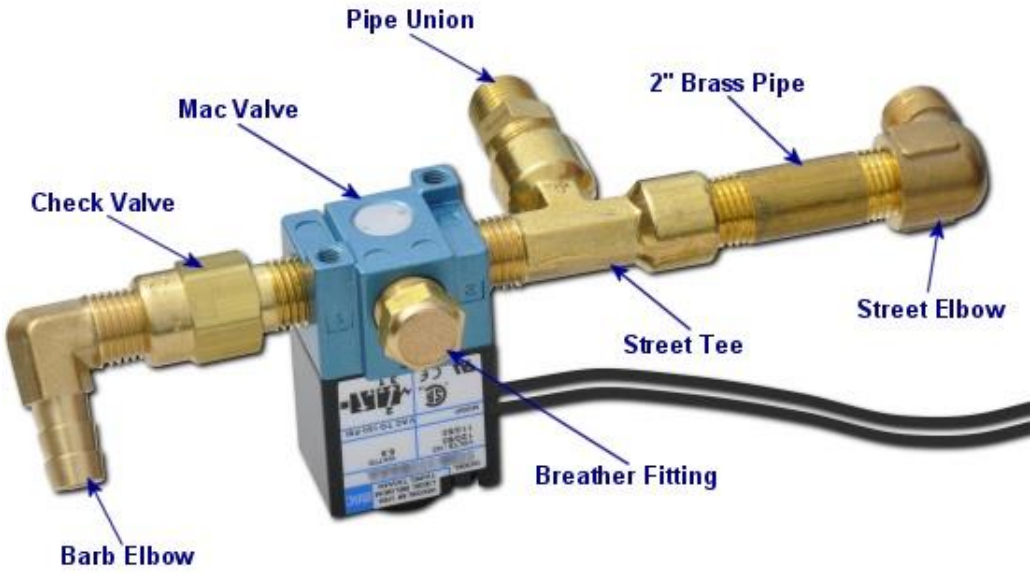
10. Attach the another pipe union fitting to the remaining open port on the street tee.

11. Attach the street elbow to the brass pipe. Note the direction that the elbow fitting is pointing when tight. It should be pointing in the same direction as the pipe union fitting.

12. Check to make sure your final assembly looks like the one shown below.

13. Attach this assembly to the vacuum filter. When the assembly is snug, the street elbow fitting will be at the top of the pump and the barbed elbow will be at the bottom.

The final assembly should appear as shown in the picture below.



Build the PVC Reservoirs
There are three PVC reservoirs that need to be built. This is another easy part of the system and it shouldn't take more than 60 minutes to assemble. The first two tanks, which we'll call the "main reservoirs" are made from 4" solid core schedule 40 or 80 PVC which can be found at most plumbing shops. The reservoirs are used to hold spare vacuum. They prevent the vacuum pump from having to cycle on and off too frequently.

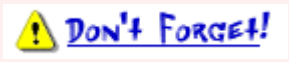
Parts used in this section:	**Time:**	**Tools:**
4" PVC Pipe (2 at 15"L)	60 minutes	Drill press
4" PVC Caps (4)		7/16" Drill bit
1.5" PVC Pipe (1 at 6"L)		1/2" socket & ratchet
1.5" PVC Caps (2)		Tape measure
PVC Cement		
Pipe Tap (optional)		

Check your local plumbing supplier for the PVC pipe. If they have one or two small pieces sitting around, they might give them to you for free. If they don't have any in stock, I've found this grade of PVC at Home Depot (oddly, Lowes does not carry it). Be sure that it is solid core schedule 40 or 80 PVC. If you cannot find this type of PVC, ask your local plumbing supplier to order it for you. Do not substitute any other type of PVC. Foam core PVC and black ABS pipe reportedly collapse under negative pressure.

For the main reservoirs, you need 2 pieces that are 15" long. With more available reservoir space, the less the unit has to cycle on and off. This minimizes the wear and tear on the Mac valve and pump. The 15" lengths of PVC will make an adequate reservoir system that will give you the right amount of vacuum reserve without making the overall system too heavy. Two schedule 40 or 80 end caps are used to make the reservoir ends.

This system also uses a "sub-reservoir" to maintain proper life of the vacuum pump valves. For the sub-reservoir, a 6" piece of 1.5" schedule 40 or 80 PVC is used. You'll also need two 1.5" PVC caps to complete this piece.

Tap the Caps
There are two ways to tap the reservoir caps. The first involves the use of a dedicated pipe tapping tool. This is the easiest method and produces the cleanest threads. The second method involves using the fitting itself to cut the threads and requires a bit of strength and patience.



Only tap 2 of the 4 caps for the main reservoirs and one of the sub-reservoir caps!

Method #1
The easiest and most reliable way to create the threads is with a dedicated 1/4" NPT tap. Note that pipe tap sizes do not refer to diameter. The actual outside diameter of a 1/4" NPT pipe thread is .54 inch. Most hardware stores carry pipe taps for about $9 but you can save a couple of bucks and pick one up at VeneerSupplies.com.

To create the threads use a drill press and a 7/16" bit. It is critical that the hole be drilled straight through the top center of the cap. To do this, be certain to drill into the cap from the top as shown. If the cap is drilled off-center, it will not fit the manifold and carrier correctly. I've also had excellent results drilling the caps on my lathe.

Use a pair of Vise-Grips or a ratchet with a 1/2" socket to hold the tap. Carefully screw in the tap using about 3/4 of the tap length. Then test the threads with a

brass fitting. If it is too snug, re-tap the hole and screw it in a bit further to slightly widen the hole. Be sure to tap only two of the four caps in the system.

If you don't have a tap, you can make your own using an old 1/4" NPT brass fitting. Simply bevel the leading threads and then cut an angled groove in them with a hacksaw so you have something similar to what is shown in the picture to the right. The sharp brass edges won't last long but will hold up for a couple of uses.

Method #2
If you prefer to tap the caps with the brass fitting itself, you can drill a 31/64" hole into the cap and create the threads with the ¼" pipe thread of the fittings.

To create the threads in the cap, use a wrench or socket to insert a brass fitting. Any fitting with 1/4 " NPT threads and a hex nut on the top will work fine. Remember, you will be threading the fittings into unthreaded plastic so work slowly. A small amount of light oil will assist in the threading process. After you have inserted the fitting completely through the hole, remove it and repeat the process on the other cap. Be sure to tap only two of the four caps in the system.

From Mike Lonchambon of Houston, TX
After I drilled the caps out at the drill press, I chucked a brass fitting into the press and lowered it down to the cap. I gave the chuck a few twists by hand to get it started straight and true and then removed it from the press and continued with a wrench. This ensures that the fitting goes in perfectly straight which is difficult to do by hand.

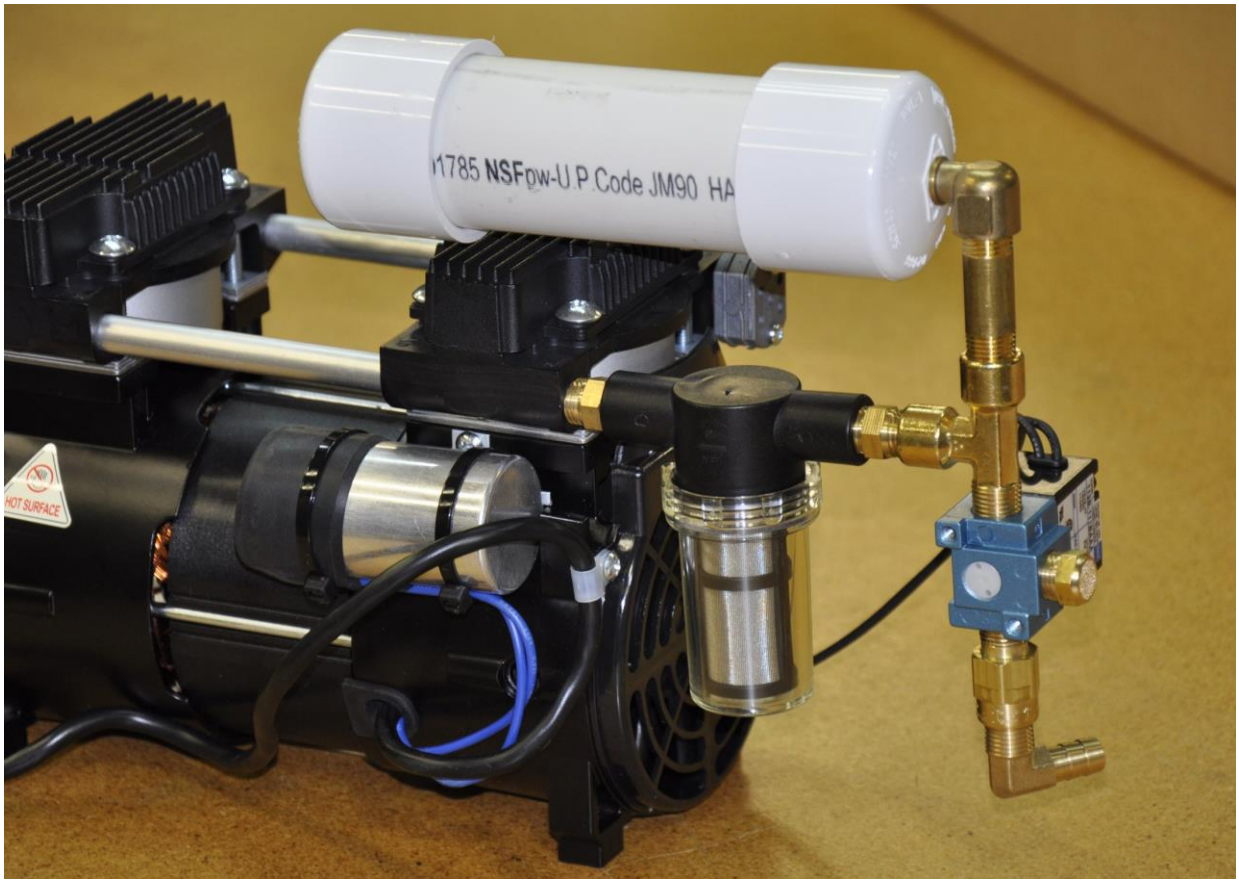
Build the Main Reservoirs
Cut two pieces of 4" PVC to 15" in length. They must be the same length. This will make it easier to attach them to the carrier.

You can now cement the top and bottom cap to the PVC pipe to make one of the reservoirs. Remember to use one tapped and one untapped cap on each of the two reservoirs. Use regular PVC cement and apply it generously to both sides of the mating areas. Give the cap a slight twist (1/4 turn) as the parts slide together. For goodness sake, do this in a well-ventilated area.

Before assembling the second reservoir, measure the length of PVC pipe between the two caps on the first reservoir (on my system, the measurement was 10.5"). Now, attach one of the caps to the second reservoir using the cement. Measure from the edge of this cap to the length you just measured on the first reservoir and mark the PVC with a pencil. Apply cement and attach the last PVC cap. Slide it up to the pencil line to ensur that both reservoirs are the exact same size. This is critical. Otherwise they will not attach correctly to the carrier.

Assemble the Sub-Reservoir
Cut a piece of 6" length of 1.5" diameter PVC. One cap should have a hole drilled in it. The other cap should be solid (no holes). Use regular PVC cement and apply it generously to both sides of the mating areas. Give the caps a slight twist (1/4 turn) as the parts slide together. Again, be sure do this in a well-ventilated area.

Attach the Reservoirs
Be sure that you have applied thread-sealing tape to the male threads that are remaining on the tees. Then screw the PVC reservoirs onto the main manifold system. Attach the sub-reservoir to the upper brass fitting on the sub-reservoir manifold as shown in the following picture.



Assembled Sub-Reservoir Manifold

Build the Carrier
The carrier is made of 4 pieces of wood and consists of three assembly steps.

Parts used in this section:	**Time:**	**Tools:**
3/4" Plywood (2'x4')	30 minutes	Saw
1 Board ft. of hardwood		Tape measure
#8 x 1.5" Wood screws (8)		Drill
		3/16" Drill bit

Step 1: Build the Main Carrier Section
You will need to do some measuring to make the carrier. You will need to adjust the measurements based on the size of your pump (with the pressure-release assembly attached) and the size of the main reservoirs. The measurements below are for the vacuum press system that I built for my shop.

There are only two pieces of 3/4" plywood needed for the main part of the carrier. The bottom piece is 13" wide and 14" long. The upright piece is 14" wide and 14" long. I centered the upright piece over the bottom and glued and screwed these two pieces together. Since the whole system is well balanced on the carrier, it doesn't need much more support than this.

Step 2: Build the T Clamp
The simplest way to attach the reservoirs to the carrier is with a basic "T" clamp made from two pieces of maple or other hardwood. When made correctly, the clamp will securely hold the reservoirs to the carrier.

Measuring for the T clamps is an easy process. There are two parts to the T clamp. We'll call these pieces a "top" and "bottom". Use the measuring instructions below to build a T clamp that will fit your reservoir system.

Top

Width: The distance between the top centers of the reservoirs (when attached to the manifold) plus 1/2". This is an important measurement. Check out the picture.

Length: The distance between the ends of the PVC caps on a reservoir.

Thickness: 3/4" will work fine.

Bottom

Width: The measurement between the top of the PVC body and the bottom of the PVC cap minus 1/16". There is an easy way to measure this accurately. See the picture on the right.

Length: The same as the top piece length.

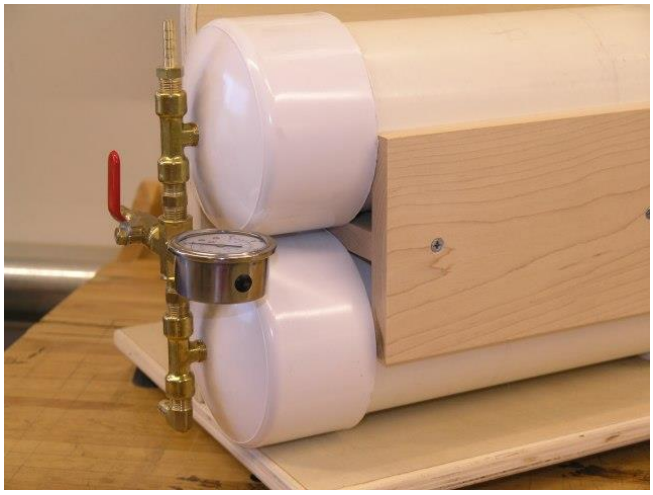
Thickness: 3/4" will work fine.

Screw the top and bottom of the T clamp together.

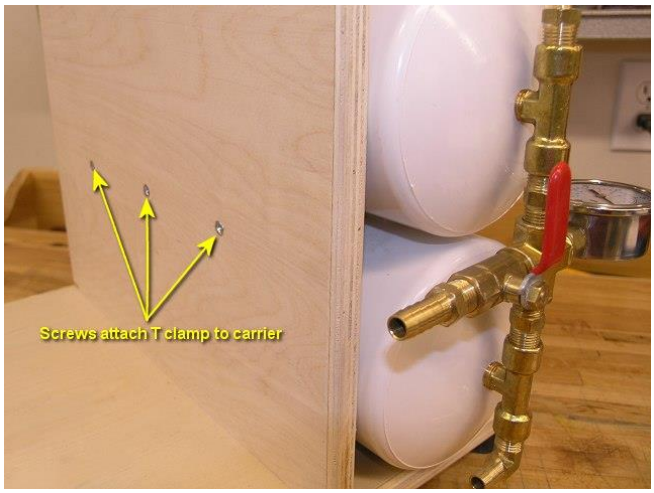
Step 3: Attach the Reservoirs to the Carrier

Rest the reservoirs and manifold assembly against the upright piece of the carrier. Insert the T clamp between the two PVC bodies and centered between the PVC caps. The bottom of the T should just touch the main upright on the carrier. If the fit is too loose, you can trim the bottom of the T clamp. On the other hand, if the fit is too tight, you'll need to make another piece of the bottom of the T clamp.

You can now attach the T clamp to the upright on the carrier by screwing through the upright into the bottom of the T clamp. This takes a bit of careful marking and measuring but it only takes a minute to get it down right. The reservoir and manifold system should now be securely residing on the carrier (held snugly against the carrier upright).



T Clamp Attached
(shown from reservoir side)



T Clamp Attached
(shown from pump side)

The picture of my carrier shows four rubber feet attached to the bottom. These feet came with my vacuum pump. Since I couldn't use them on the pump, I simply drilled four 7/32" holes in the bottom of the carrier and screwed them in. They are not needed to make the system run smoothly but I thought it was a nice touch.

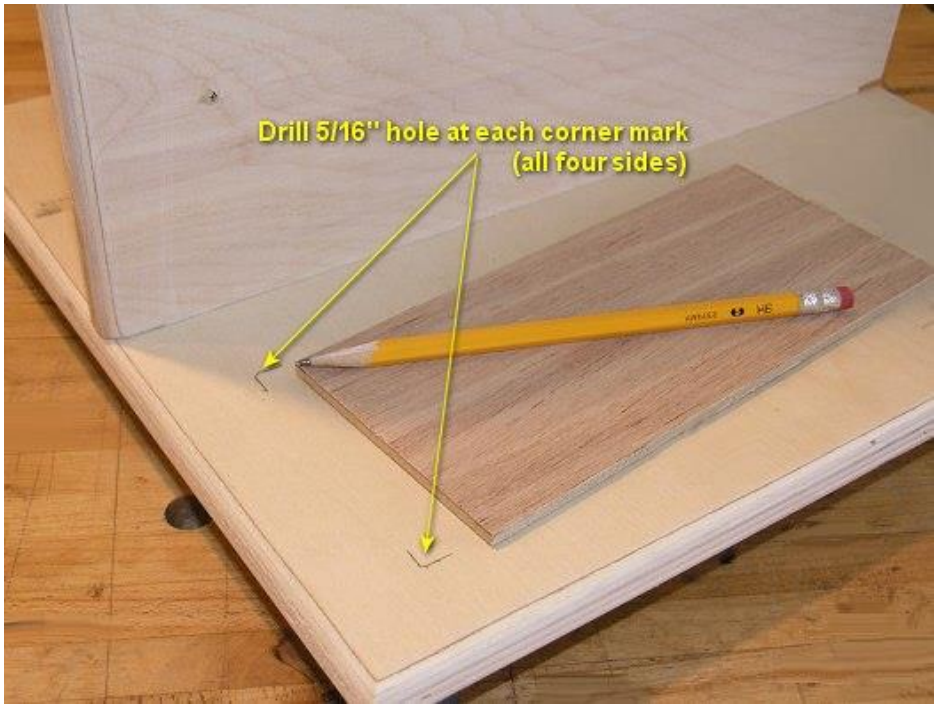
Attach the Pump and Pressure Release Assembly To the Carrier
There are two factors to consider before attaching the vacuum pump. First is the location. This should be as close as possible to the upright on the carrier to help balance the weight of the whole system. Second, it should be placed on the carrier bottom in a way that keeps the core parts of the pressure release assembly within the boundaries of the carrier.

Parts used in this section:	**Time:**	**Tools:**
Machine screws 1/4-20 by 1.25" (4) (size may vary)	15 minutes	Drill Drill bit Screwdriver

Nearly all vacuum pumps have mounting holes on the bottom. These holes will be used to attach the pump to the carrier. For the rebuilt 3.15 CFM pumps at VeneerSupplies.com, four mounting screws (1/4"-20 x 1") are needed. The 5 CFM pumps at VeneerSupplies.com use four screws as well (6mm x 1mm x 25mm).

The spacing for the holes should be measured on the underside of the pump. Measure the distance from each mounting hole on the pump. To get the holes to line up easily, cut a piece of 1/4" plywood to same size as the distance between the mounting holes and then lay this piece on the carrier and mark two lines at each corner. The corner of each set of lines is where you'll drill the four mounting holes with a suitably sized drill bit.

Finish up this part by attaching the pump to the carrier with the machine screws. Do not over-tighten the screws. If the screws are too tight or the carrier holes are off center, the motor housing will flex and the pump may not start.



Attach the Vacuum Controller and Project Box

The vacuum controller regulates vacuum in the system and cycles the pump on/off as needed.

Parts used in this section:	**Time:**	**Tools:**
Vacuum controller	30 minutes	Wrenches or pliers
Brass barb fitting: 1/8 NPT-female to 1/4" barb		Screwdriver
Plastic project box with attached cable gland		Drill
Screws: #10 by 3/4" (x4)		5/8" Drill bit
Black vinyl tubing: 1/4" ID x 12"		Scissors
Braided vinyl vacuum tube: 3/8" ID x 12"		
Thread sealing tape		
Vacuum damper (if required)		

1. Remove the four screws and lid from the project box.

2. There is a short piece of insulating cord inside the box. Use gentle finger pressure to install the cord into the recess in the lid. At the end of this process, the insulation cord will need to be cut with scissors since the manufacturer provides more cord than is needed. Do not stretch the insulation cord while installing it.

3. Remove the plastic nut from the vacuum controller and set the vacuum controller into the box so that the threaded extrusion is inserted into the pre-drilled hole on the bottom of the box. Then reinstall and hand-tighten the plastic nut.

4. Wrap the visible threads of the vacuum controller with two layers of thread sealing tape.

5. A vacuum damper must be used if the vacuum pump draws more than 4 CFM. If the pump is rated for 4 CFM or less, then please proceed to step 6 below.

   Apply thread sealing tape to the threads on the vacuum damper. Then use two wrenches to attach the 1/4" barb to 1/8" NPT-female fitting to the vacuum damper with firm force.

   Now attach the vacuum damper fitting to the vacuum controller. Do not over-tighten the fitting. The maximum torque for the plastic body of the vacuum controller is 4 inch-lbs. The plastic threads will break off if this fitting is over-tightened. Damage caused by excessive force on the vacuum controller is not covered by any warranty, so proceed with care. In most cases, slightly more than hand-tight is adequate.

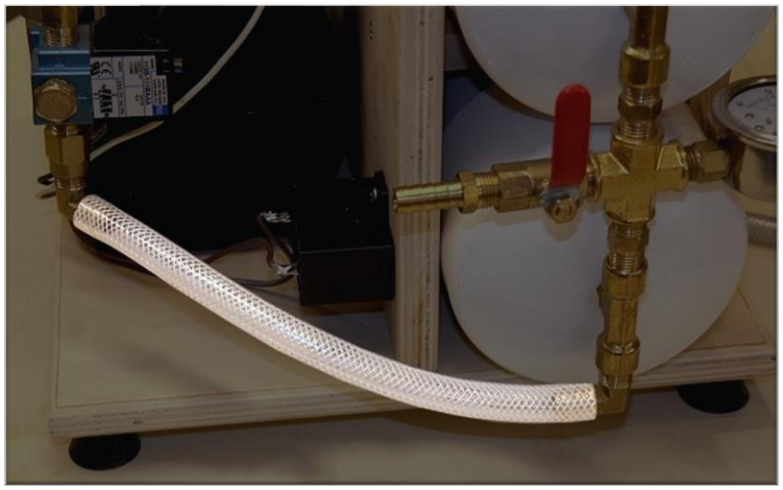
6. A vacuum damper fitting is not required if the vacuum pump draws 4 CFM or less. Attach a 1/4" barb to 1/8" NPT-female brass fitting to the threads on the vacuum controller. Do not over-tighten the fitting. The maximum torque for the plastic body of the vacuum controller is 4 inch-lbs. The plastic threads will break off if this fitting is over-tightened. Damage caused by excessive force on the vacuum controller is not covered by any warranty, so proceed with care. In most cases, slightly more than hand-tight is adequate.

7. The project box is mounted on the upright portion of the plywood carrier. Find a suitable place on the carrier to mount the project box keeping in mind that the barb fitting on the vacuum controller is connected to the reservoirs with only a 12" length of tubing. Drill a 5/8" hole through the carrier so that the barb fitting (and vacuum damper, if required) on the vacuum controller fits through this hole.

8. Use four #10 x 3/4" screws to attach the project box to the carrier so the brass fitting is pointing toward the reservoirs. Do not over tighten these screws as this could break the mounting tabs on the project box.

9. Now attach a piece of 1/4" ID vinyl tubing to the barbed end of the brass fitting and connect the other end to the barbed fitting at the top of the manifold on the reservoirs.

10. Finish up this section by connecting a short piece of the 3/8" ID braided tubing between the barbed elbow on the sub-reservoir manifold and the barbed elbow fitting on the main manifold.



Additional Notes

The wires that attach to the vacuum controller should be inserted through the plastic "cable gland" fitting on the project box. Then hand-tighten the nut on the fitting to seal and secure the wire.

Do not reinstall the lid on the project box until after you have completed the "Testing and Adjusting" section of these instructions. At that point, the lid can be attached and the four lid screws can be installed and gently tightened.

Attach the Electrical Box

Parts used in this section:	**Time:** 5 minutes	**Tools:**
Wood screws #8 x 5/8"		Wrench or pliers
Electrical Box		Screwdriver
2 Romex connectors		

1. Remove two of the "knockouts" from the electrical box to allow for the wiring of the unit. You can remove any two of these knockouts depending on where your wires are running. In this example, I removed the two that are at the far ends of the box.

2. Attach the romex connectors to the utility box where the knockouts were removed.

3. Attach the electrical box to the upright on the carrier with two to four wood screws as shown in the picture below.

Wiring Preface: Warning!
Working with 120v AC is inherently dangerous. You must be aware of the essential practices and principles of safety when working with 120 volts before continuing. The wiring information described herein is a rough guideline. The information provided here and as shown, it is not intended to meet local and national safety codes and should not be considered a safe way to complete the wiring on this system/kit. Do not proceed to wire this system without the help of a certified electrician who can be relied upon to address and remedy any safety issues with the information provided.

Be sure to read the disclaimer near the beginning of this article before proceeding.

If you are soldering the wires to the vacuum controller, be careful not to damage the vacuum controller by over-heating the tabs. Allow the soldering iron to reach full heat before you begin. Then apply solder to the common and normally closed tabs. Next apply solder to the wire ends. Lastly, reheat the wire ends onto the tabs. This last step should not require any additional solder. Be sure to adequately insulate any exposed wire near the terminals. Some users install the vacuum controller in a plastic "project box" suitable for the dimensions of the vacuum controller.

If you opt to use crimp-on connectors, simply strip off 1/4 inch of insulation and insert the wire into the connector and crimp the plastic area of the connector with wire crimpers.

Important: The terminals on the vacuum controller are covered by a removable plastic lid. Remove this piece for easy access to the tabs by pulling upward on it. Be sure to attach the wires to the correct terminals. The lower terminal is not used.

Vacuum Pump Amperage
The vacuum controller included with the EVS kit can handle up to 10 amps at 120v AC. The label on most vacuum pumps will display the running amperage but not the start up amperage. The spike in electricity when the pump starts up can greatly exceed the running amperage. In fact, rotary vane pumps can require three times more amperage at start up over the running amps. Damage to the vacuum controller will occur if the start-up amperage exceeds that which the vacuum controller can handle.

There are several possible wiring options based on the type of vacuum pump you are using.

- 120v AC Vacuum Pump Drawing Less Than 10 Amps at Start Up
  For use with the 3.5 and 5.0 CFM vacuum pumps on the VeneerSupplies.com website

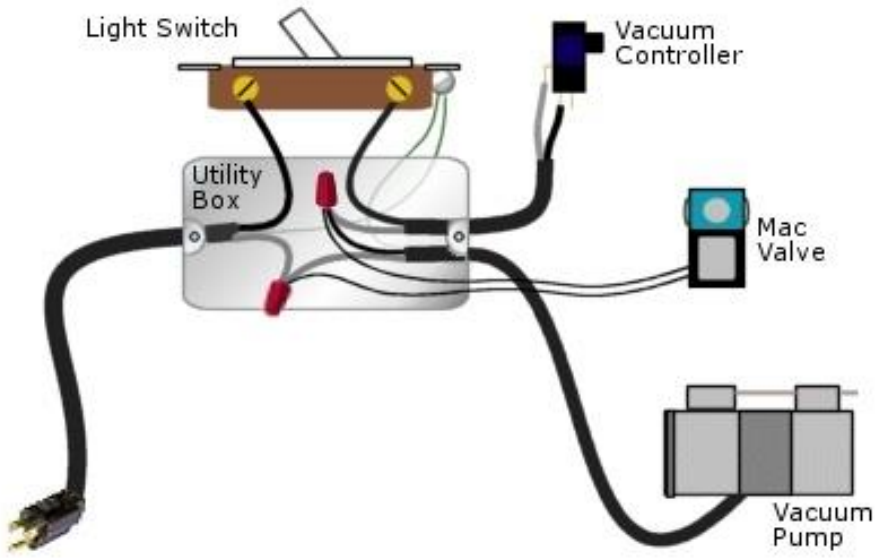
- 120v AC Vacuum Pump Drawing More Than 10 Amps at Start Up
  Requires a relay with a 120v AC coil and contacts rated for at least 30 amps @ 120v AC

- 240v AC Vacuum Pump
  Please consult your local electrician before building a 240v system.

Wiring Option 1
120v AC Vacuum Pump Drawing Less Than 10 Amps at Start Up
For use with VeneerSupplies.com vacuum pumps

This wiring method is specific to the 3.5/5.0 CFM vacuum pumps offered on the VeneerSupplies.com website but may also apply to others.

Parts used in this section:	**Time:**	**Tools:**
Solder or crimp-on connectors	30 minutes	Wire strippers
Wire nuts/caps		Screwdriver
Light switch		Soldering iron
Light switch plate		
Power cord		



1. If your pump has a power cord and plug-end attached, the easiest way to proceed is by cutting the cord leaving enough wire to reach from the vacuum pump to the utility box (plus 6 inches).

2. To access the individually insulated wires inside the power cord, remove 3 inches of the black insulation on the wire end that remains attached to the pump. Insert this stripped section of wire into the utility box so that the 3 inches of individual wires are easy to connect to the rest of the system. Do not tighten the screws on romex connector that holds this power cord in place yet.

3. Measure the distance between the vacuum controller and the utility box. Add 6 inches to this measurement and cut this length from the left-over power cord that was cut off the pump in step 1. Set this piece of wire aside. It will be used in a few minutes.

4. Remove 3 inches of the black insulation from the remaining piece of wire from step 1 (the wire with the plug end). Insert this stripped section of wire into the utility box so that the 3 inches of wire are easy to connect to the other system wires that will be in the box.

5. Pull one of the wires from the Mac valve into the utility box through the romex connector mentioned in step 2 above. The Mac valve wires are non-polarized so either wire is fine to use for this step.

6. Attach this wire and the white (neutral) wire from the pump to the white wire on the main power cord with a wire nut. Remove 1/2" of insulation from each wire to do this.

7. For this step, you will need the short piece of power cord from step 3. Remove 3 inches of the black power cord insulation from both ends of this wire. With solder or a crimp-on connector, attach the black wire to the normally closed tab on the vacuum controller. Remove the plastic lid on the vacuum controller to get to the tabs.

8. Attach the white wire to the common tab on the vacuum controller with solder or a crimp-on connector.

9. Insert the other end of this small section of the power cord into the utility box.

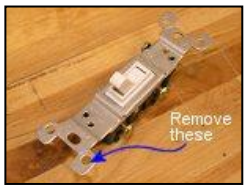
10. Insert the remaining wire from the Mac valve into the utility box. Attach this wire and the black wire from the vacuum pump to the white (switched hot) wire from the vacuum controller. Twist these three wires together and attach a wire nut.

11. Now tighten the screws on the romex connector.

12. Attach the remaining black wire from the short section of the power cord to one of the terminals on the light switch. Do not use the ground terminal.

13. Attach the black wire from the main A/C power cord to the remaining terminal on the light switch. Again, do not use the ground terminal.

14. If your power cord comes with a ground wire, you can attach it first to the light switch on the electrical box. Then route this wire to the grounding screw or wire on the pump (if the pump has one).



15. Remove the "ears" from the light switch and attach the switch to the utility box. Then attach the light switch plate.

16. Take a second look at what you have completed so far. Make sure the wire is coming from the light switch is attached to the middle tab of the vacuum controller (marked as 'normally closed') and the other wire is attached to the common tab just above it. The bottom tab on the vacuum controller ('normally open') is not used.

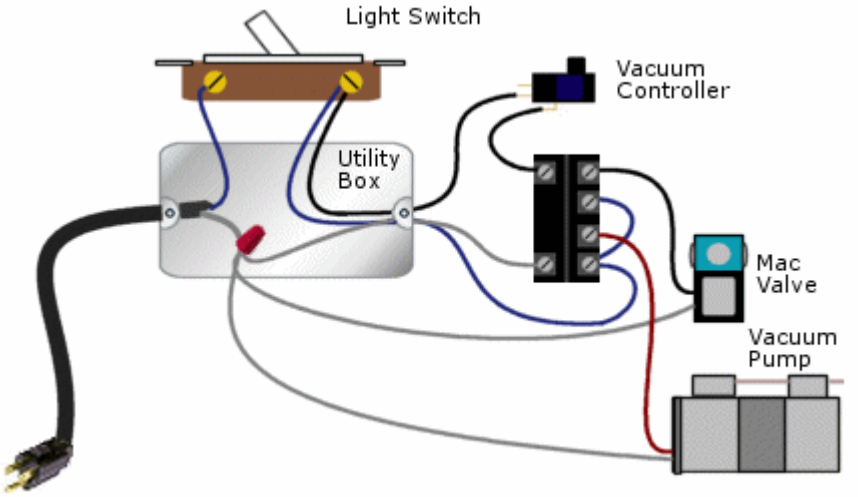
Wiring Option 2
120v AC Vacuum Pump Drawing More Than 10 Amps at Start Up

If your vacuum pump draws more than 10 amps at start up, you will need a relay with a 120v AC coil and contacts rated for at least 30 amps at 120v AC. There are only three differences between this wiring situation and "Wiring Option 1" shown above.

Also note that you will need a power cord suitable for the amperage drawn by your vacuum pump.

1. The vacuum controller is now controlling the relay only.
2. The vacuum pump and Mac valve are now powered through the relay. The relay gets its power feed from the hot wire on the light switch (see the blue line shown below).
3. If you are using a vacuum pump that draws more than 15 amps, you will need to upgrade to a heavy-duty light switch.

IMPORTANT: It is your responsibility to safely insulate and protect the exposed terminals on the relay after the wiring has been completed and before the system is given power.



Option 3: 240v AC Vacuum Pump

Due to safety and liability issues associated with 240v electricity, I do not support this type of configuration. I can not provide assistance, instructions, or diagrams for building a high voltage system. Please consult a certified electrician before purchasing and/or building a 240v system.

Several surplus centers are offering inexpensive 240v pumps. The Gast 0522 and 0523 pumps are notoriously troublesome with the EVS system. You have to ask yourself if it's worth saving $35 for the hazard of a system wired for 240v.

Testing and Adjusting
Close the vacuum valve on the main reservoir. Plug in the AC cord and turn the system on. The pump should turn on and air should begin moving through the system. If the pump does not start or only runs briefly, be sure to adjust the vacuum controller (see next paragraph) before you re-examine the wiring.

Notice that there is a small plastic cap on the vacuum controller just in front of the "common' tab. Under this cap is where the adjustment is made for setting the amount of vacuum inside the unit. You can pop of the cap with small flat screwdriver.

For the next stage of testing, you will want to carefully adjust the vacuum setting to 21". With the system powered up, use a small flat screwdriver to slowly turn the adjusting screw counter-clockwise until the unit creates 21" of vacuum and turns off. Do not touch the tabs or bare wire on the vacuum controller while the unit is plugged in.

Remember: Counter-clockwise turns of the screw will increase the amount of vacuum required before the controller will turn off the system. I've found that most often, 21" of Hg is when there is about 1/8" of thread showing above the adjustment screw. Re-attach the plastic cap to the vacuum controller when the desired vacuum level adjustment is set.

The system will automatically cycle on again when the vacuum has decreased. The manufacturer of the vacuum controller claims that the unit will cycle back to the "on" mode within 4" of Hg decrease. This 4" amount of differential is not adjustable.

During normal operation of a tightly sealed unit, it is common to have the unit cycle on every 15 minutes for 10 - 30 seconds. The length of time depends on the size of the vacuum bag, pump and reservoirs.

After the system has automatically turned off, watch the needle on the vacuum gauge to see if it shows signs of a leak. It's not uncommon to have a small leak show up. The fix for this is simple.

Got A Leak? No Problem!
First, remove the manifold system from the reservoirs and tighten all of the brass joints. While it is possible to over-tighten the fittings, it is more common to find that the fittings are not tight enough. Re-assemble the system and test it again. I've found that this solves 99% of leak problems.

If the leak persists, leave the system charged with vacuum and apply a small amount of silicone to each of the brass fittings and gauge where they attach to the PVC caps. If a leak does exist, the vacuum will pull the silicone into the void area causing the leak to seal itself. Also consider applying silicone to the area around the edge of the PVC caps on the pipe.

After you have applied the silicone, turn the system off and let the air back into the PVC pipe by opening the vacuum valve. Allow the unit to sit overnight so the silicone can cure.

Finishing Up

Parts used in this section:	Time:	Tools:
Braided vinyl tubing (3/8" ID) - 10 ft. Lock-on connector Brass barb fitting - 3/8" barb to 1/8" NPT-male	5 minutes	Wrenches/Pliers

1. You can now attach the 10' piece of 3/8" ID braided vinyl tubing to the vacuum valve.
2. Apply thread-sealing tape to the 3/8" barb to 1/8" NPT male fitting.
3. Attach the barbed fitting to the lock-on connector.

4. Slide this assembly onto the end of the tubing.

Your Project: EVS Vacuum Press System Is Now Complete!

The EVS system is very easy to set up and put to use. The steps below outline the standard process to veneer a simple panel.

1. Connect the power cord to a 120-volt AC outlet.
2. Set the vacuum valve handle to the "off" position.
3. Turn on the power switch to pre-charge the system with vacuum.
4. Set up the vacuum bag with a bottom platen inside.
5. Apply glue to project substrate and set the veneer in place.
6. Put the project in the vacuum bag and place breather mesh on top of the project.
7. Close the vacuum bag.
8. Attach the lock-on connector to your vacuum bag by pulling back the sleeve on the lock-on connector and sliding it onto the brass stem on the vacuum bag. Release the sleeve while gently pushing the downward to snap the lock-on connector into position.
9. Open the vacuum valve in the EVS system.

I've written a short but helpful article that explains what else you will need to use your vacuum press. The article also includes a step by step guide to using your system for vacuum pressing a veneered panel. Follow the guide carefully and your first veneer project will turn out perfectly.

Check it out here…
www.JoeWoodworker.com/veneering/getting-started.htm

Reminders

- The system is set to turn off at 21" of Hg. This is the ideal vacuum level for most veneer projects. The system will turn on again when the vacuum level drops by 2" to 5" of Hg.
- The on/off cycling of the Project: EVS system is harmless. It is not uncommon for it to cycle on and off every 10 minutes for 5 - 8 seconds with a vacuum bag connected. Systems that are assembled exceptionally well may hold vacuum for many hours without cycling on.
- The odor of PVC cement may be present during the first few uses of your system.

Warnings

1. Do not allow the vacuum press system to run unattended.
2. Disconnect power from the system when not in use.
3. The vacuum gauge is a sensitive instrument and will be rendered inaccurate if dropped or struck with a hard object.
4. The vacuum pump and other parts of the system may be hot during and after use. Exercise care when handling the vacuum press system.

Mods and Options for the Project: EVS Vacuum System

Cord Storage

If you plan to move your vacuum press around frequently, you might find it convenient to store the power cord on the back of the press. To do this, I picked up a pair of coat hooks from the hardware store and mounted them on the vacuum press as shown below. When I need to carry the system from place to place, I wrap the power cord around these hooks. Then I coil up the vacuum tube and place it over the handle on the carrier.

Vacuum Chucking

With a vacuum chuck, you can use the vacuum press to hold small bowls onto the lathe so you can finish up the bottoms without showing any machine markings. One nice thing about this add-on is that it allows you to easily monitor the vacuum on the work piece. When the needle on the gauge is above 18" of Hg, you know that the project is ready to be turned. And with the vacuum valve and bleeder, it also allows you to pre-fit the work piece with light vacuum so you can center the project on the jig easily without having to have an extra set of hands to control the vacuum source. So I spent a few weekends trying to figure out how to do it.

Learn more here:
www.JoeWoodworker.com/veneering/vacuumchucking.htm

Vacuum Clamping

I've wanted to adapt the vacuum press system for vacuum clamping for quite some time. Of course, it's not too difficult to hook the vacuum line from the system directly to a clamping board but I wanted something more durable and easier to use. The biggest restriction from making this adaptation a reality was the on/off control of the vacuum to the clamping jig. I wanted to build something that could shut off the vacuum without depleting the vacuum reservoirs.

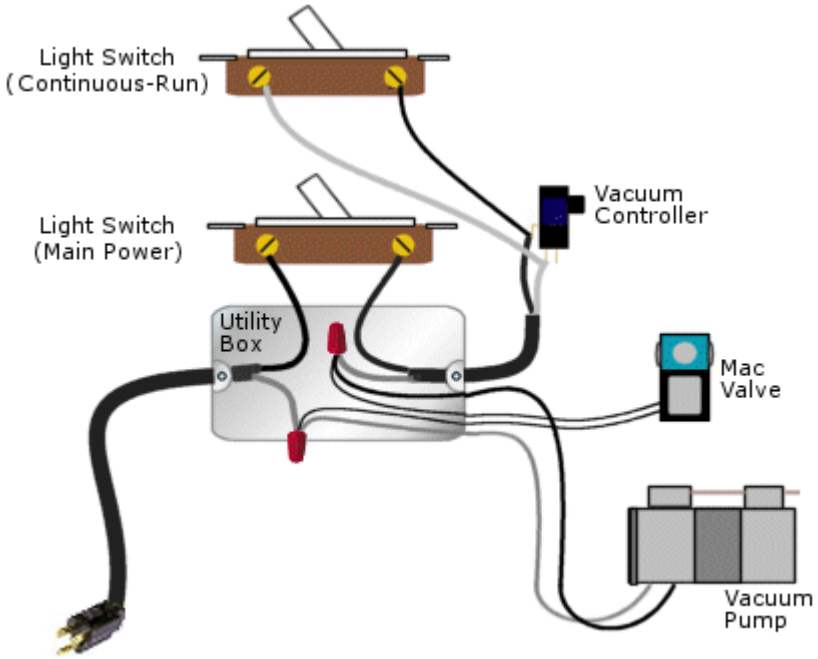
Learn more here:
www.JoeWoodworker.com/veneering/vacuumclamping.htm

Quick Conversion to Continuous-Run

It's easy to make a cycling vacuum press run continuously. You'll need a light switch and some suitable wire to complete this modification. Simply connect a wire from the normally closed tab on the vacuum controller to one of the terminals on a light switch. Then connect a wire from the common tab to the other terminal on the light switch.

That will by pass the switching ability of the vacuum controller so the pump runs non-stop. When engaged, the light switch will bypass the vacuum controller's switching and allow the electrical current into the system regardless of the vacuum in the reservoirs. When disengaged, the system will return to auto-cycling on and off to maintain the vacuum level set by the vacuum controller.

Why would you want this option? Unnecessary stresses are placed on a pump if it cycles on and off too frequently. If you are using the vacuum press system for vacuum chucking or vacuum clamping and the system is cycling on and off very often (every 30 seconds), you might wish to consider this option.



What Are You Doing with Your Vacuum Press?

Feel free to send me pictures and a brief summary of what you are doing with your vacuum press. I'd be happy to post it here. Share your vacuum success stories and you'll make this vacuum press even more helpful to other woodworkers!