

Click! A Vacuum Pick From Bic!

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Feb 28

For three years ago I decided to try to make a vacuum pick for surface-mount work, and began by turning an aquarium pump into a vacuum pump (See Part I). The second part of the project was to fabricate a wand, and do it cheaply. An example of a very nice commercial vacuum wand, the Weller WVP, is shown below:



We have one of these in the lab at IPFW (Indiana University-Purdue University Fort Wayne), and I prefer it over tweezers for everything from resistors and capacitors to large ICs in quad flat-pack (QFP, TQFP, etc.) packages. I considered buying one for the Lazy Dog Engineering lab in my basement, but the lowest price I found was \$65. I thought I could do better, so I tried making one out of some aquarium tubing and a syringe. That worked out well enough that my teaching assistant actually liked it, but I didn't like it nearly as well as the Weller wand. Then I found a source for Luer fittings, the kind found on syringes, IV tubes, and vacuum wands, so I decided to try making a wand out of aluminum tubing, aquarium tubing, and a luer fitting. That didn't feel right, either, so I went back to using tweezers. When you're doing hand assembly with surface mount parts, ergonomics are very important, and my DIY vacuum wands just weren't good enough ergonomically.

Recently, I decided to try again. I had realized that one of the big problems with my picks (compared with the Weller pick) was that the tubing Weller uses between pick and pump was EXTREMELY flexible, much more so than the aquarium tubing I had used, so I would have to find some tubing that was as flexible as Wellers, or nearly so.

The other big problem was the wand itself. You hold it like a pen, of course, and control it using a small hole in the side of the wand. Cover the hole with your fingertip, and a vacuum appears at the tip of the wand. Remove your finger from the hole, and the vacuum at the wand tip disappears. When you release the part you're placing, you need to move your finger

off the hole with as little disturbance as possible, and the well-designed Weller wand makes this easy. It's flat around the hole, and it's very comfortable to hold like a pen.

My first thought was to try to make a wand similar to the Weller wand from scratch, using aluminum tubing. I would have slipped the aluminum tubing inside some surgical rubber tubing, and drilled a hole in the right place through the rubber and aluminum tubes.

But then I had a better idea: You hold the wand in your hand like a pen, and it needs to be comfortable. Pen manufacturers have been making pens that are comfortable to hold for years, so just get a pen with a good ergonomic design, remove the inner parts, and turn it into a wand!

Next, the tubing. A quick trip to the local hobby shop was all it took, because they sell model airplane fuel line tubing in a variety of sizes and materials. I quickly discovered that silicone tubing is by far the most flexible, very close to the tubing Weller uses. I also found that small-diameter tubing is more flexible than large-diameter tubing. The tubing I chose has an outside diameter of about 0.17 inch.

Next stop: the local Walmart store, for a pen. There are a lot of good choices, but I settled on a Inc Trio, sold in packages of two for \$1.49. Inc seems to be a Walmart private label, so if you want to use one exactly like it you'll have to go there. It has a rubber padded grip, padded on three sides. There are many, many similar pens that would do as well.

I already had some Luer fittings, male barbed Luer adapters, actually. You can get a package of 25 for \$6.80 from Cole-Parmer.com

You'll also want one or more vacuum pick tips, which I found at Howard Electronic Instruments. They're a good source for a lot of products related to soldering and electronic assembly, reasonable-priced, and they ship quickly. The tips aren't very expensive, and you'll probably want several different sizes. The smallest are good for 0805-size parts, maybe even smaller.

Finally, you'll want a glue gun (or a tube of silicone adhesive /sealant), and a few inches of aquarium tube. Here's a photo of the parts, and the finished pick:



The unmodified pen, aquarium tubing, Luer adapter, and suction tips are on the right.

Now, to get started. First, take the pen apart so you can remove the filler, spring, etc. On this pen, the first step is to unthread the tip piece:

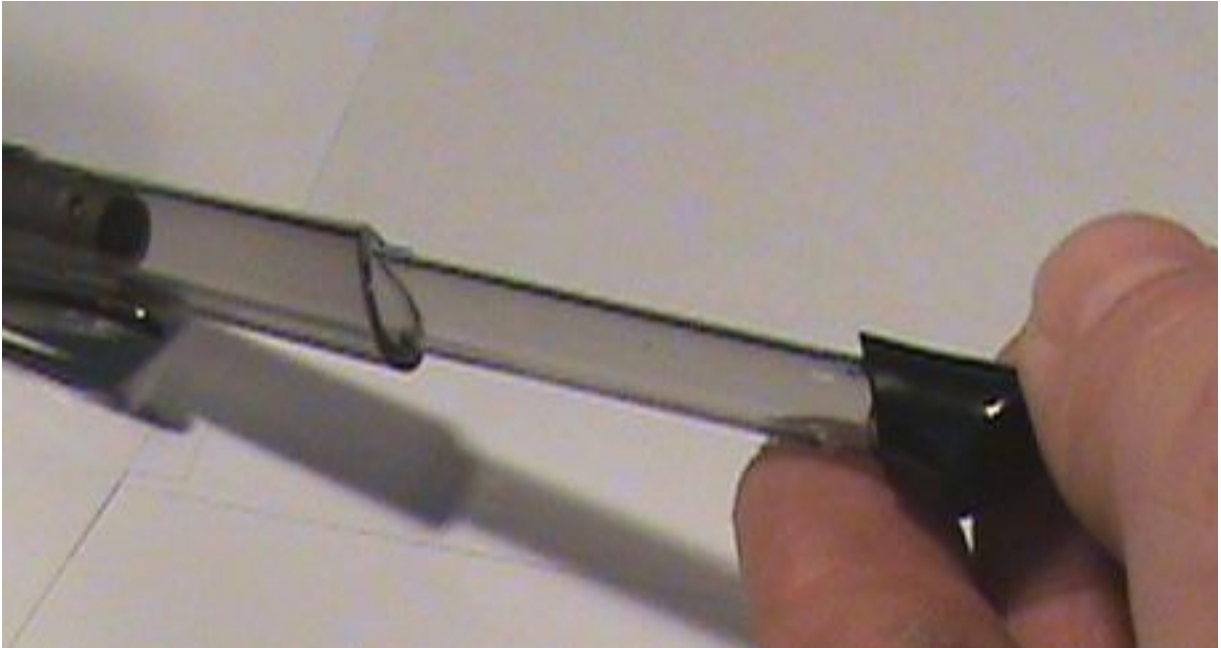


Remove and discard the filler and spring:

Slide the rubber grip off the barrel:



Slide the plastic trim off:



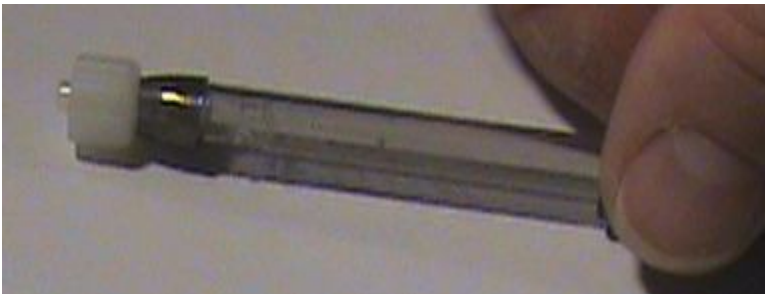
Pull the top off. This may require a little force!



Remove and discard the clicker button, clicker, and any other internal parts:



Thread the tip piece back onto the barrel, and cut or grind just enough of the end off so you can get the barbed end of the Luer adapter in:



Slide the rubber grip back onto the barrel. Drill a small hole, perhaps $\frac{3}{32}$ " in diameter, in the place where you would like to rest your forfinger while using the pick. Drill through the grip, and one side of the barrel only:

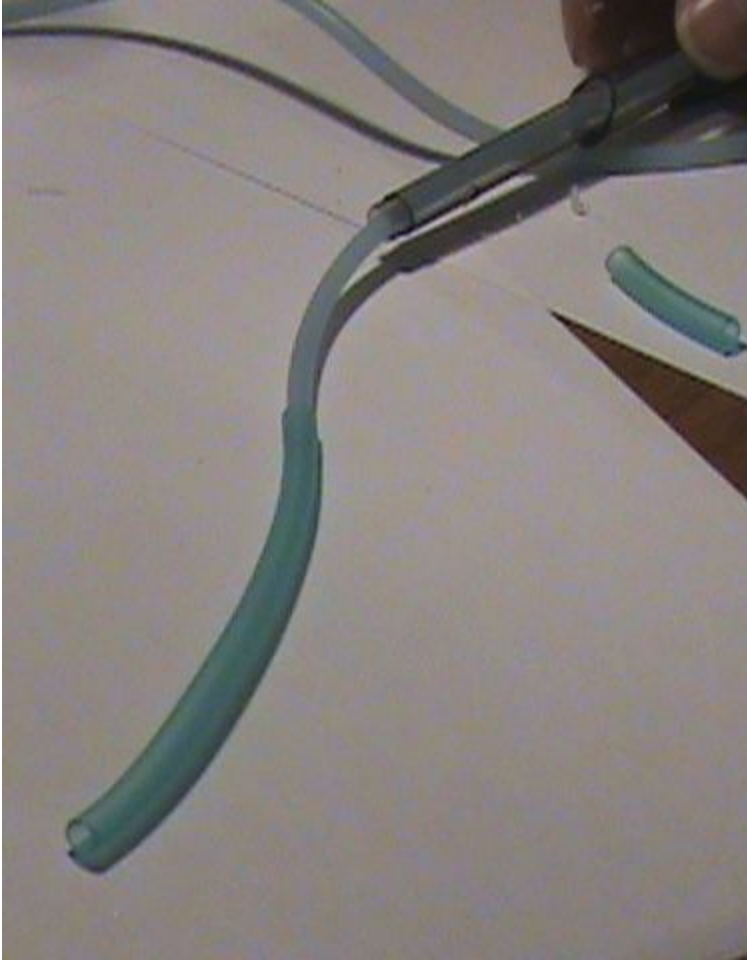


Remove the grip again, and replace the top. Cut a piece of the aquarium tube long enough to extend from a centimeter or so above the finger hole out the top end of the pen, but only a

centimeter or so past the top end:



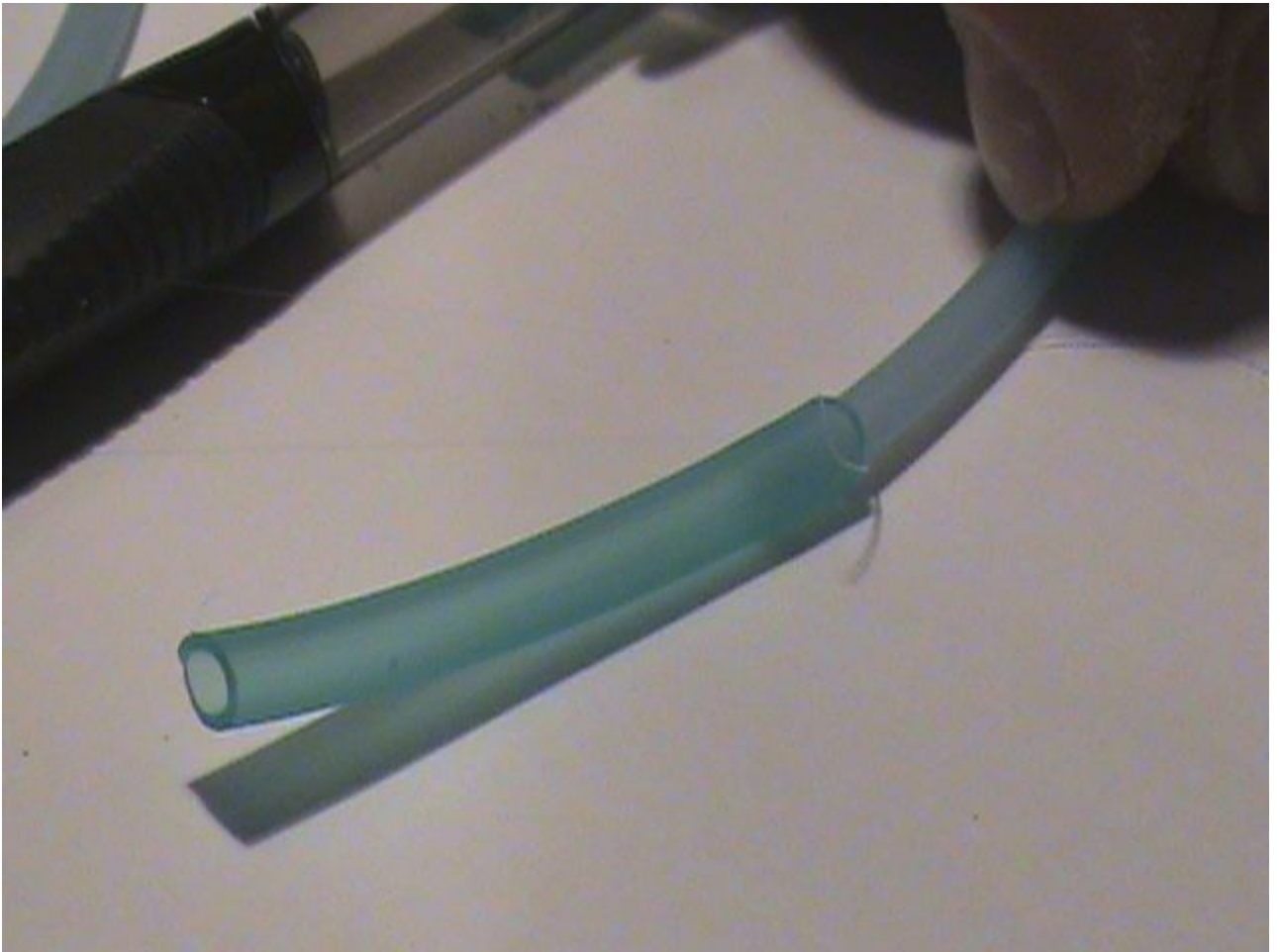
Thread the small-diameter silicone tubing through the barrel of the pen, and push the end about 1/8 inch into the piece of aquarium tube as shown:



Work quickly during this part. Get a nice, healthy gob of hot glue all the way around the aquarium tubing, about 1-2 centimeters from the end, then push the aquarium tubing up into the pen barrel so its end is above the finger hole. The aquarium tubing / silicone tubing joint should now be above the pen barrel, and the gob of hot glue should form a seal between the tubing and the barrel, above the finger hole. Make sure the finger hole is free of hot glue, then slip the grip back on, thread the tip back onto the barrel, and seal around the Luer adapter with hot glue:



Cut another short piece of aquarium tube, perhaps 2 inches long, and push the free end of the silicone tube into it. This piece of aquarium tube will fit over the nipple of the aquarium pump:



You now have your vacuum pick. Twist one of the suction cup tips onto the Luer adapter, connect the tube to the pump, and try it out!

For picking up 0805-size resistors, you don't even need the suction cup:



To release the part, just move your index finger off the finger hole:



That's it! The pen cost \$0.75, the silicone tubing was \$1 per foot (four feet seems about right), the Luer adapter cost about \$0.30 each, Three suction cup tips about \$4.00, and the aquarium pump cost \$10. The total cost was less than \$18.00!

I don't think I'll be going back to tweezers.

From Aquarium Pump to Vacuum Pump in 5 Minutes

Feb 27

Okay maybe 10 minutes.

When it comes to picking and placing surface-mount parts, a good pair of tweezers works pretty well. A good vacuum pick can be easier to use, but tweezers beat a poor vacuum pick. You can get a vacuum pick on the internet for anywhere from \$40 on up to several hundred, but I'm going to show you how to make one for a fraction of that. In this post I'll show you how to turn a \$10 aquarium pump into a vacuum pump in 5 minutes. Tomorrow, I'll show you how to make a nice, comfortable, controllable wand. Ready? Here goes:

I start with an "Aqua Culture" brand pump which currently sells for \$10 at Walmart. This particular model has two outputs (the little white nipples visible in the photo). It's really two diaphragm pumps in one housing. It's just fine to start with a single-pump unit, and slightly less work:

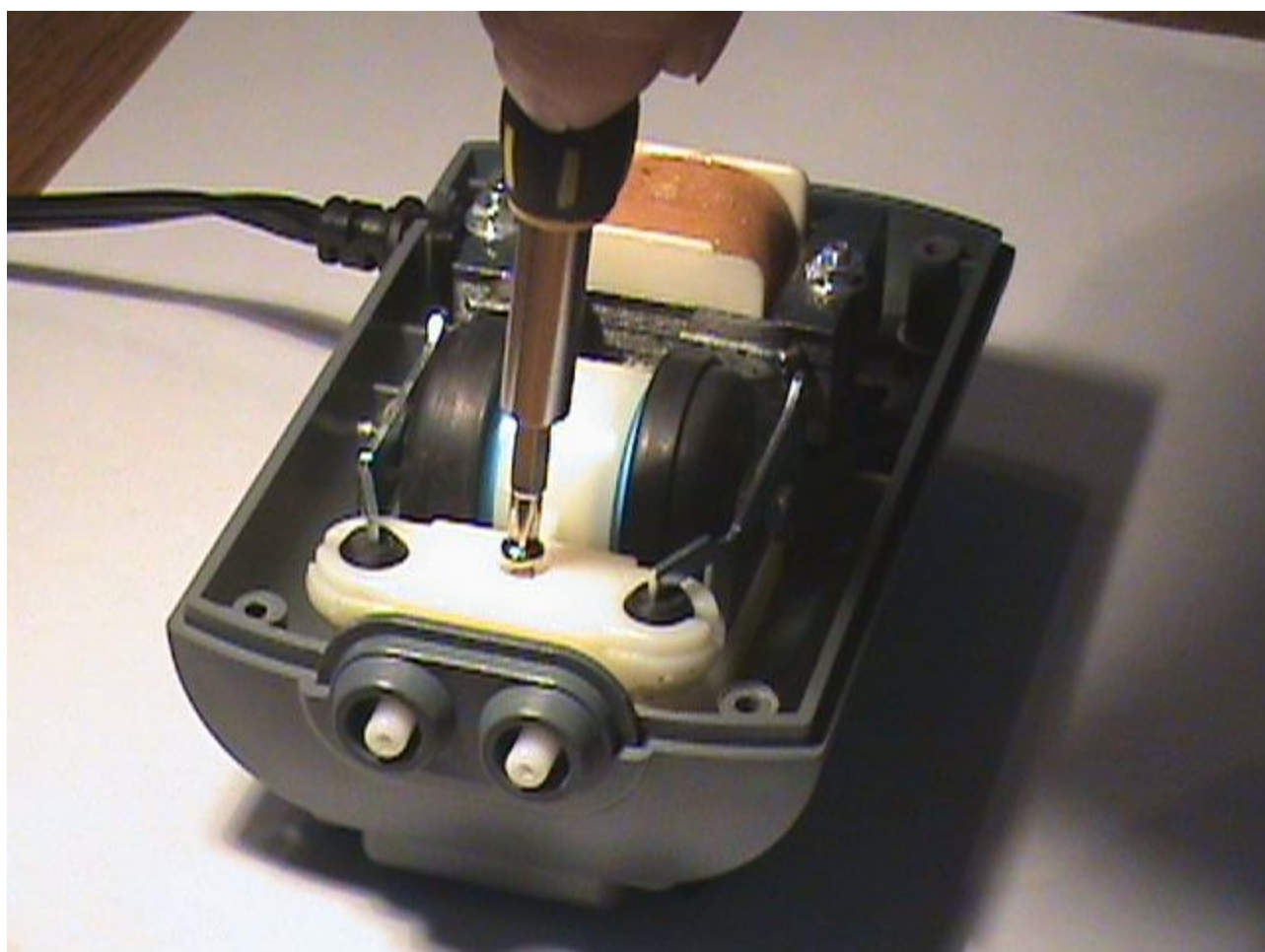


As far as I know, all aquarium pumps are simple diaphragm pumps, and work the same way. All are probably put together pretty much the same way, too, so the following procedure should work (with a little adaptation) with just about any aquarium pump.

First, remove the screws that hold the plastic enclosure together. On this one, there are four of them, found in the corners of the bottom half of the enclosure:



Turn the pump over, and lift the top of the enclosure off. At one end, you'll see something that looks a bit like a power transformer. At the other, you'll see a plastic base (the one here is yellowish white). Attached to this are two metal arms, with a magnet on the end of each arm. There should be a screw holding the base to the bottom half of the enclosure. Remove the screw:



Lift out the plastic base, with the metal arms, magnets, black rubber diaphragms, etc.
attached:



On this pump, there is a plastic trim piece over the two nipples. No jokes, please. Remove it:



Gently loosen and release the black rubber diaphragms from the blue plastic piece, and fold the metal arms back exposing the blue plastic pieces:



There is a screw in the center of the blue plastic piece. Remove it:



Then remove the blue piece, remembering how it was oriented:



This exposes a black rubber piece. Notice the small hole on the right, with a small plastic protrusion poking through it, and the larger hole in the center:



Remove the black rubber piece:



Use a pointe instrument of some sort to make a small hole, about the size of the smaller of the two original holes, on the opposite side of the center hole and the same distance from the center as the original small hole:



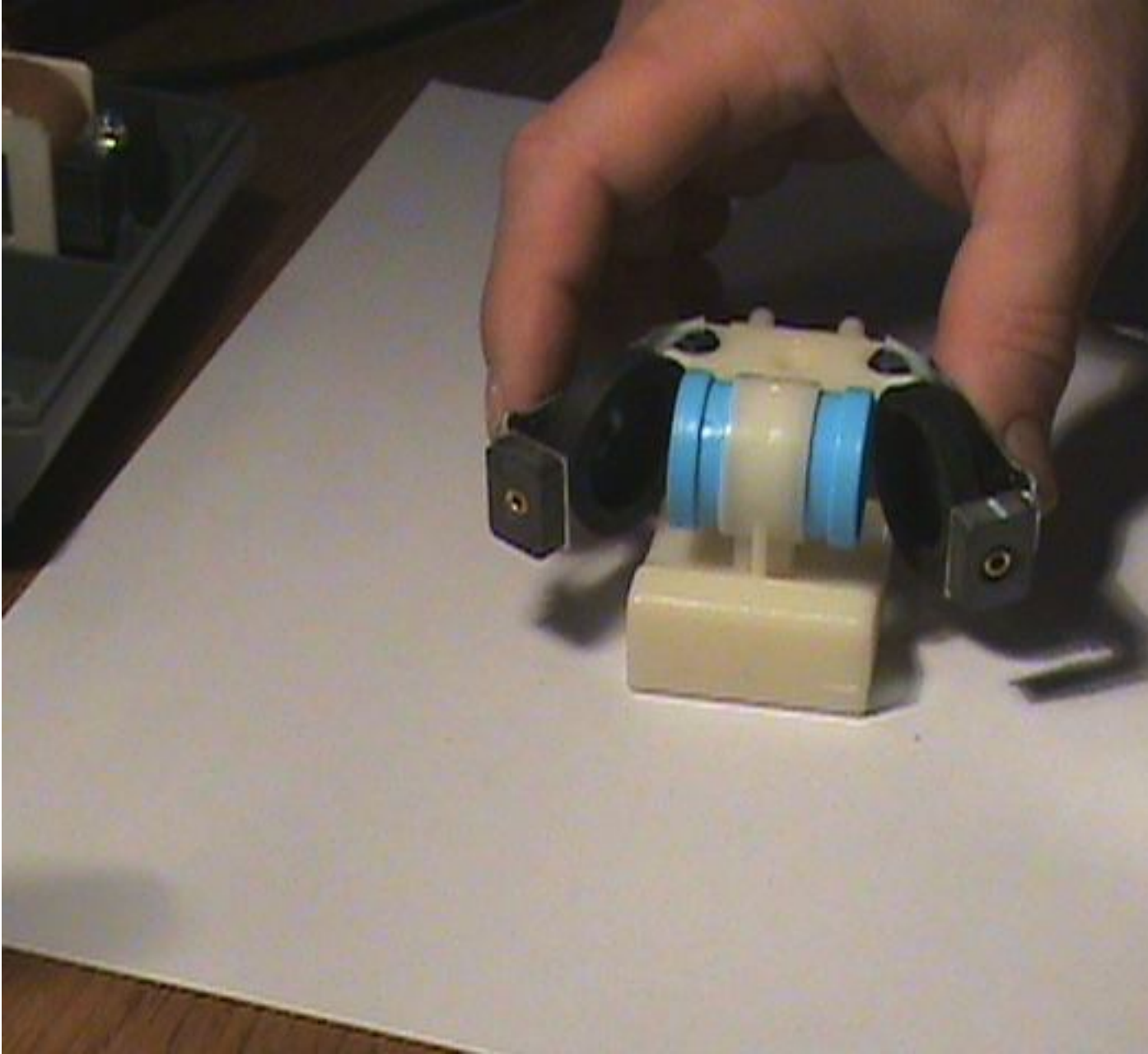
Replace the black rubber piece as it was, but turned 180 degrees from its original orientation so the new small hole fits over the small plastic protrusion:



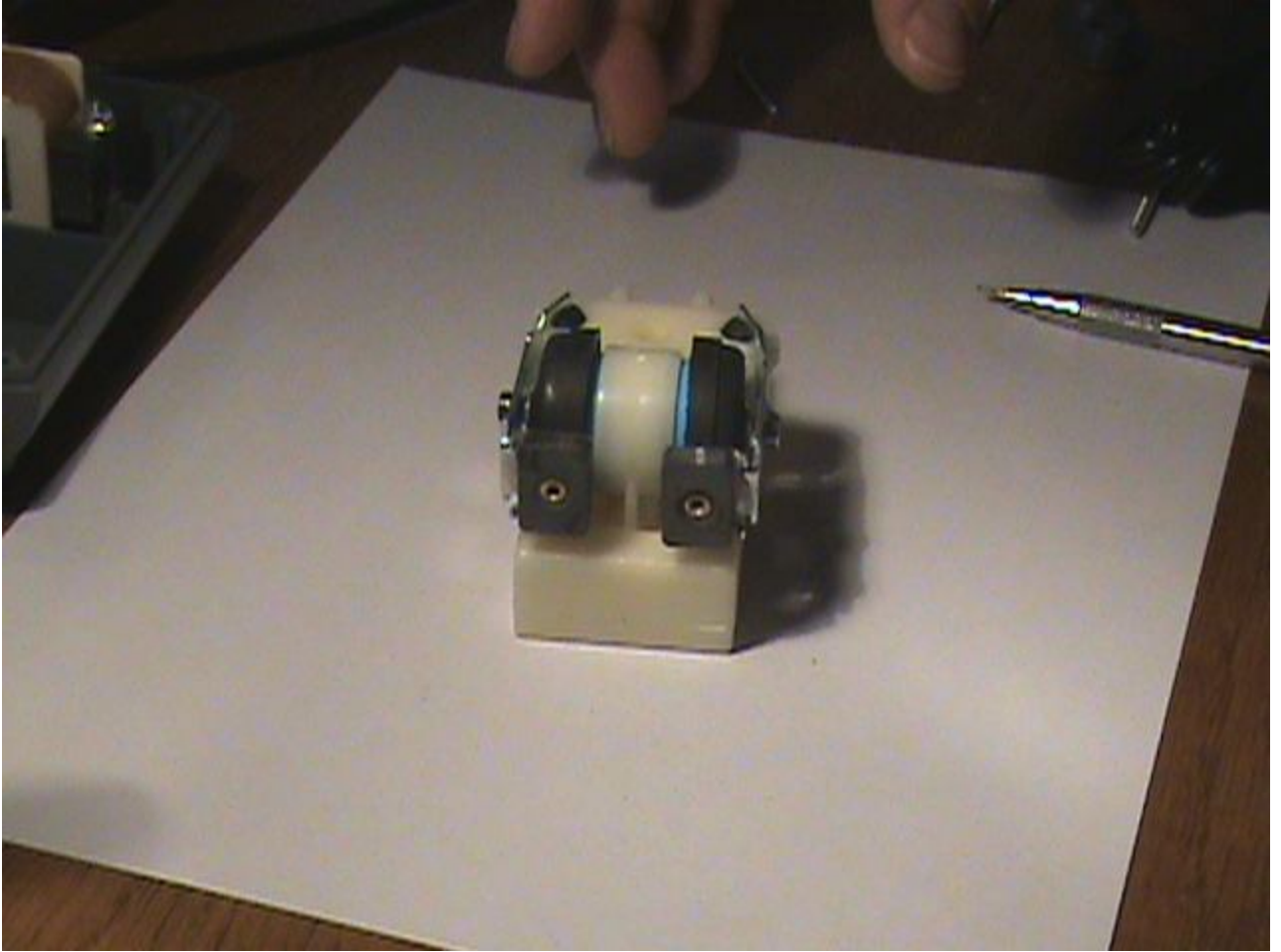
Replace the blue plastic piece, oriented as it was before. Replace and tighten the screw:



Remove the other blue plastic piece, make the hole in the black rubber piece, replace it turned 180 degrees, replace the blue plastic piece, and tighten the screw. Then, swing the two arms back to their original position:



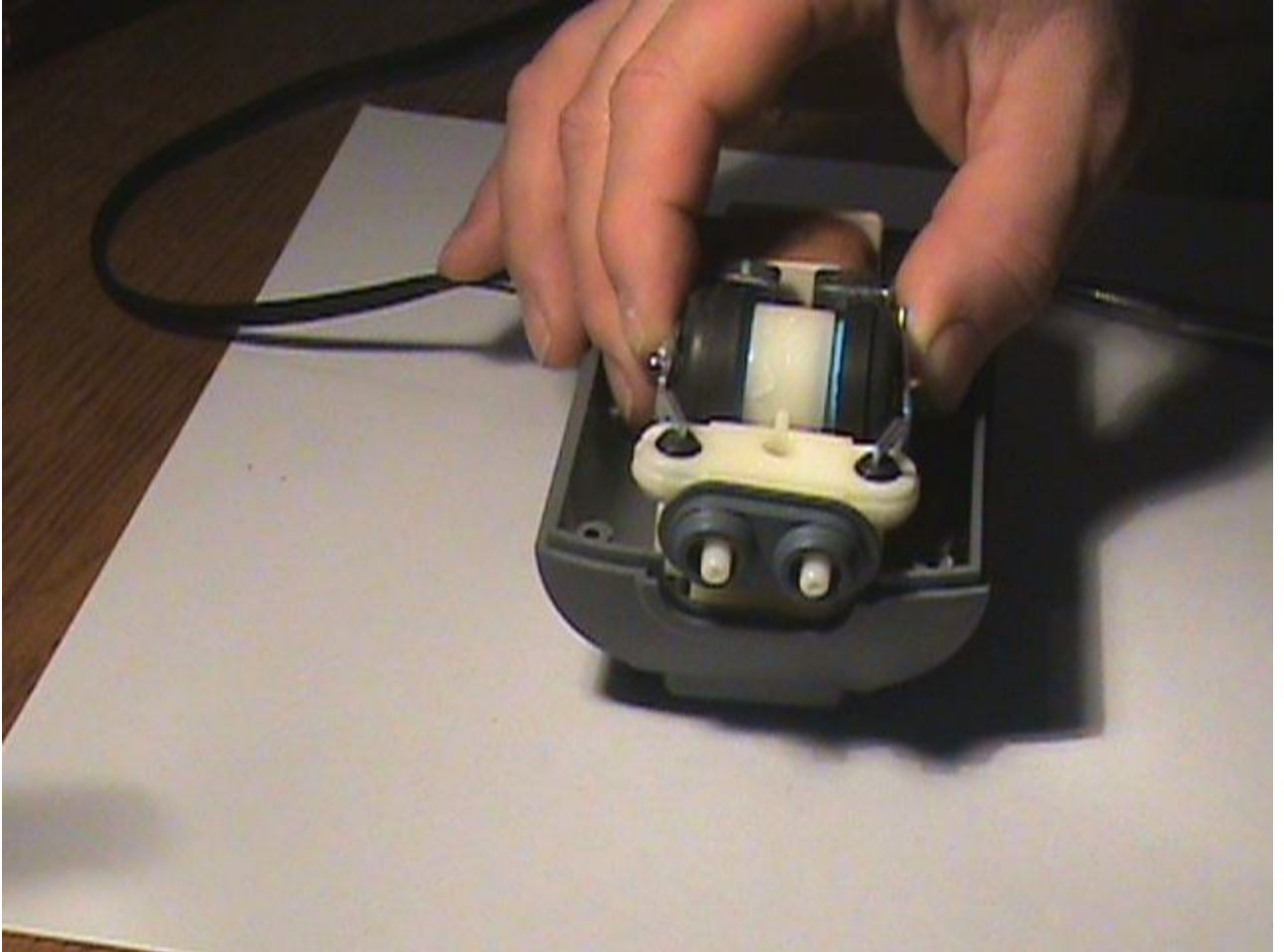
Gently fit the two rubber diaphragms back over the blue plastic pieces, as they were originally.



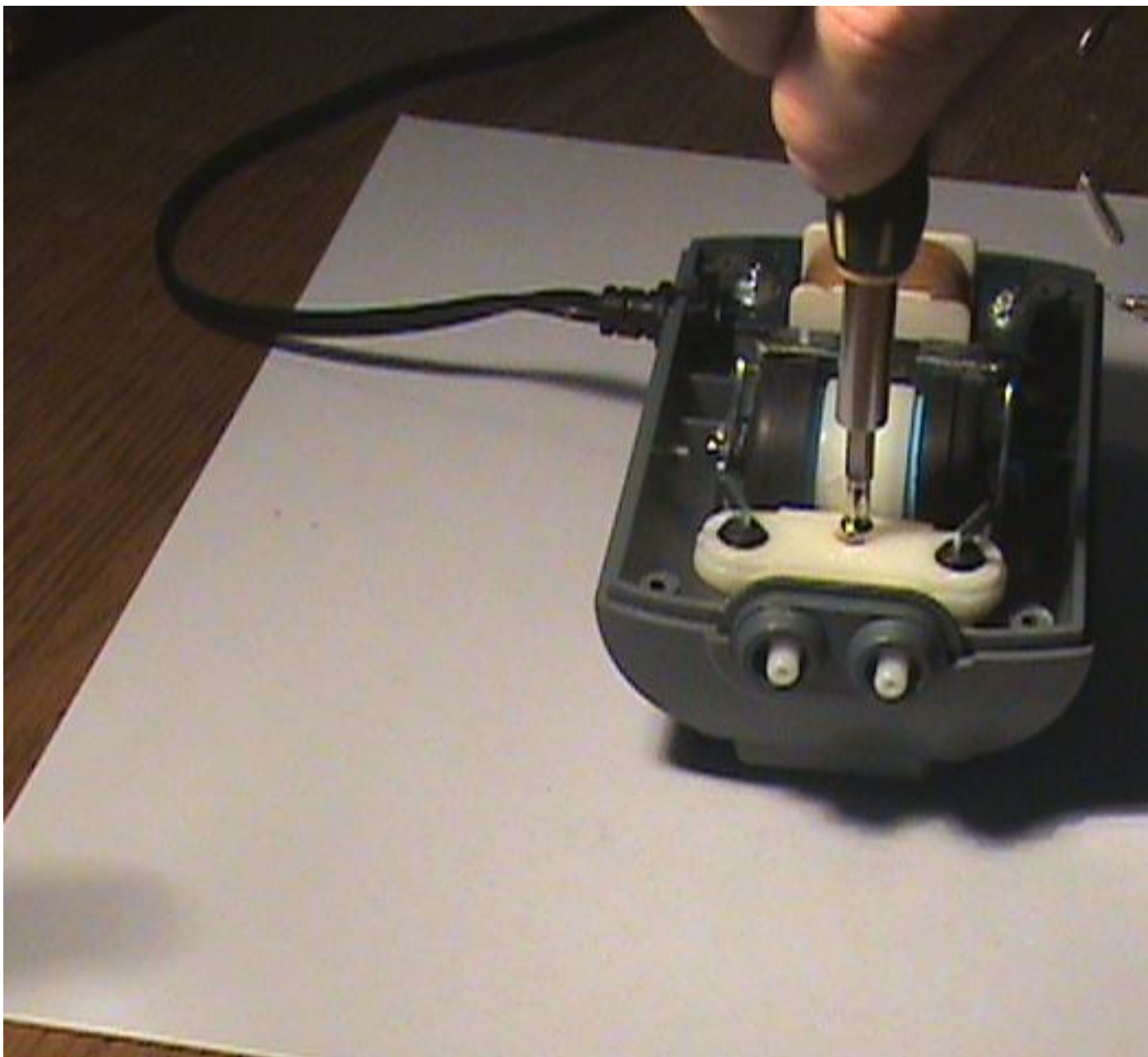
Replace the trim piece:



Put it all back into the bottom half of the enclosure:



Tighten the screw:



Replace the top half of the enclosure:



And replace and tighten the four remaining screws. You've just reversed an aquarium pump.

