DIY Water Chiller

by tinkrmind

This project started as I was looking for water chillers for my laser cutter. The existing solutions are priced 400$+ for active refrigerant based cooling. While passive coolers/Peltier coolers are available for much less, they are very inefficient. I was a little surprised by the lack of commercial products because I could find ice-makers on Amazon for less than $90.

I thought, *if only I could convert an ice-maker into a water chiller - that would be helpful for the maker community.* I really want you to replicate and improve upon this project, so I have placed emphasis on ease of manufacturing over cost reduction.

I really want these steps to be easy to follow, so if you find anything confusing, do let me know. Hope you enjoy this :)

Supplies:

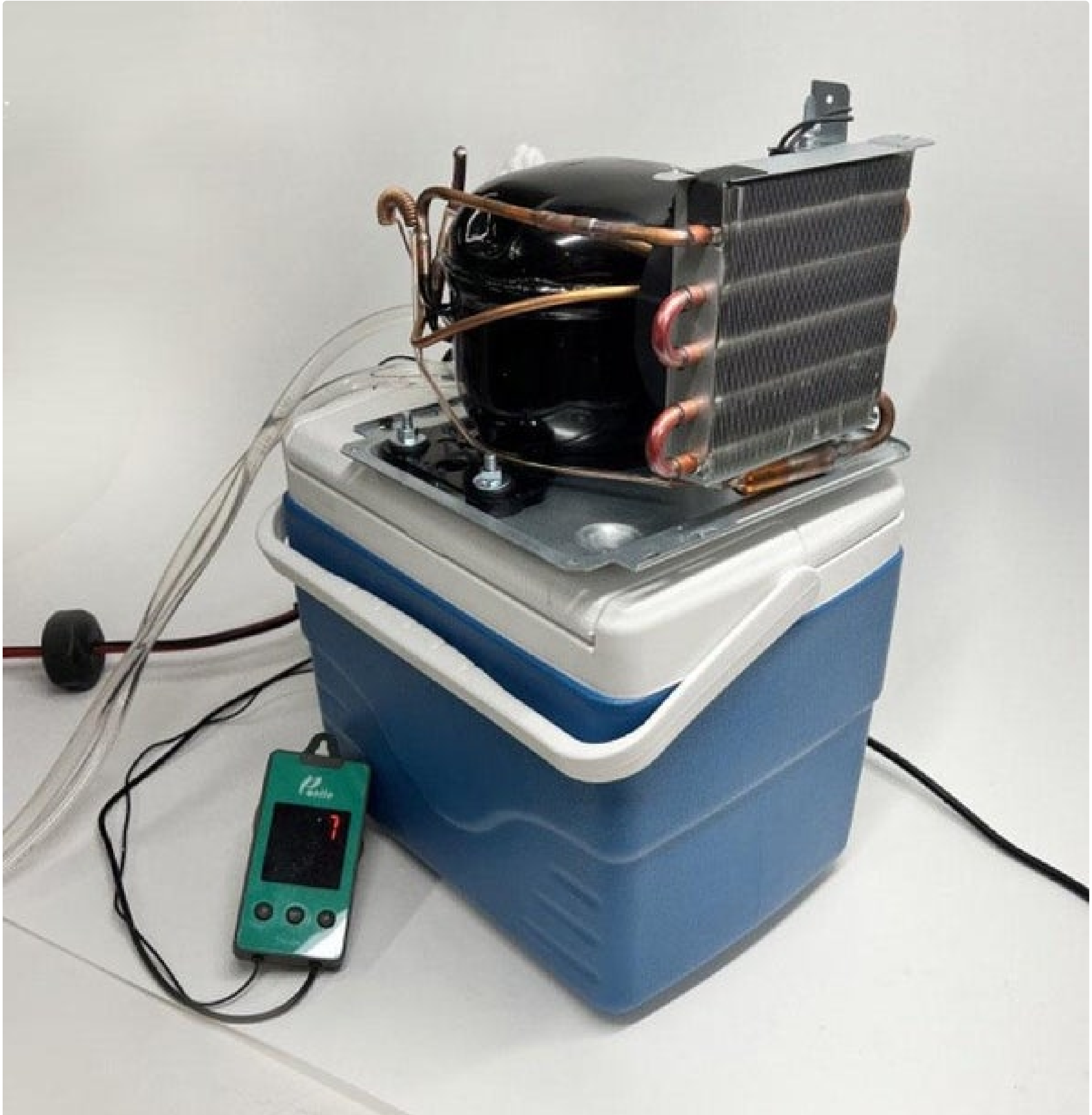
Items:

1. Ice-maker (link; $90)
2. Icebox/cooler (link; $17)
3. Temperature regulator (link; $16)
4. Aquarium pump x2 (link; $13)
5. 12V power supply (link; $8)

Total cost = $144

Tools:

1. Heat shrink solder (link)
2. Hot air blower (link)
3. Wire stripper (link)
4. Hole saw (link) / hand saw / Jigsaw
5. #2 Phillips head screwdriver
6. Mounting screws (link)

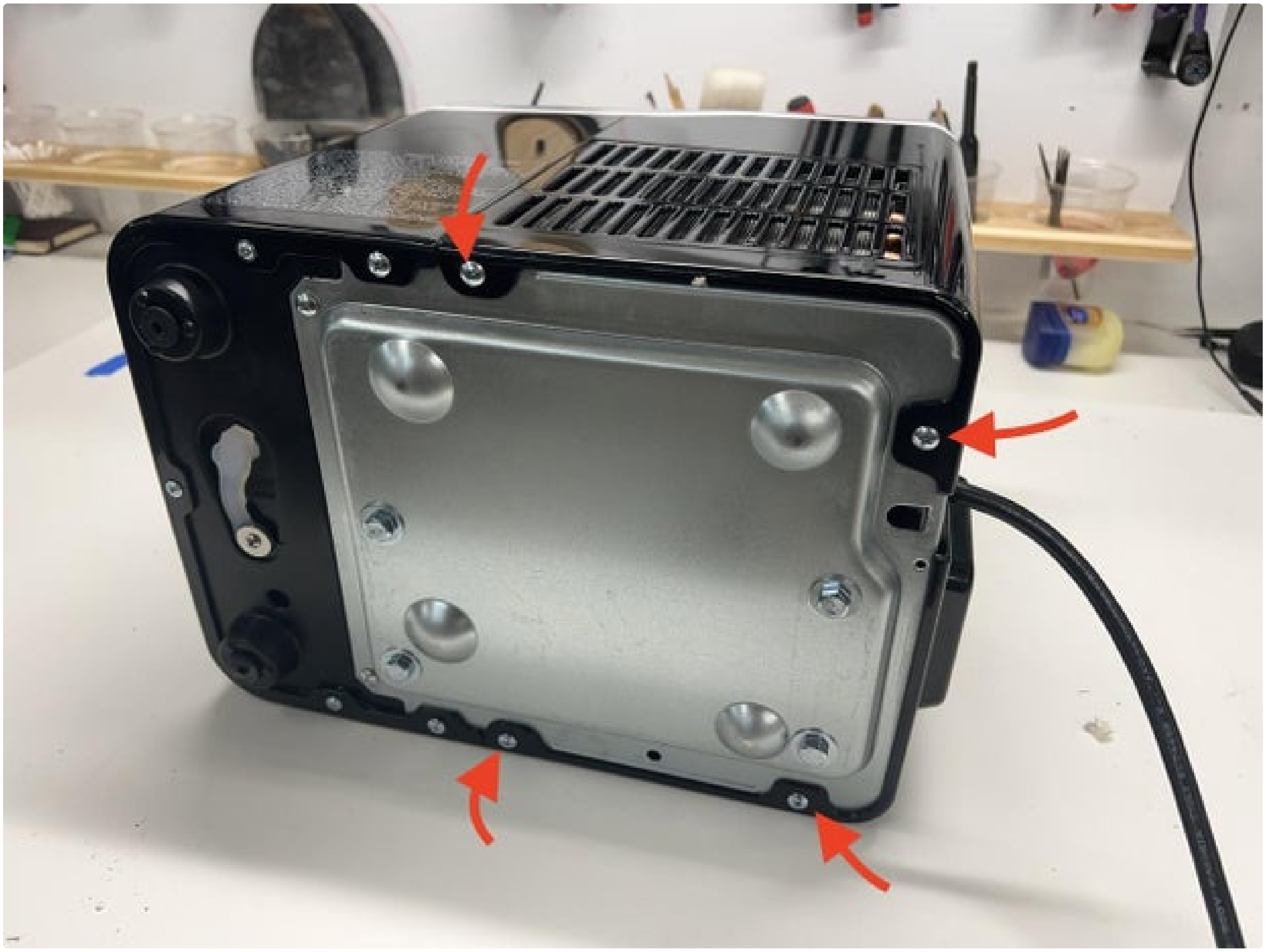


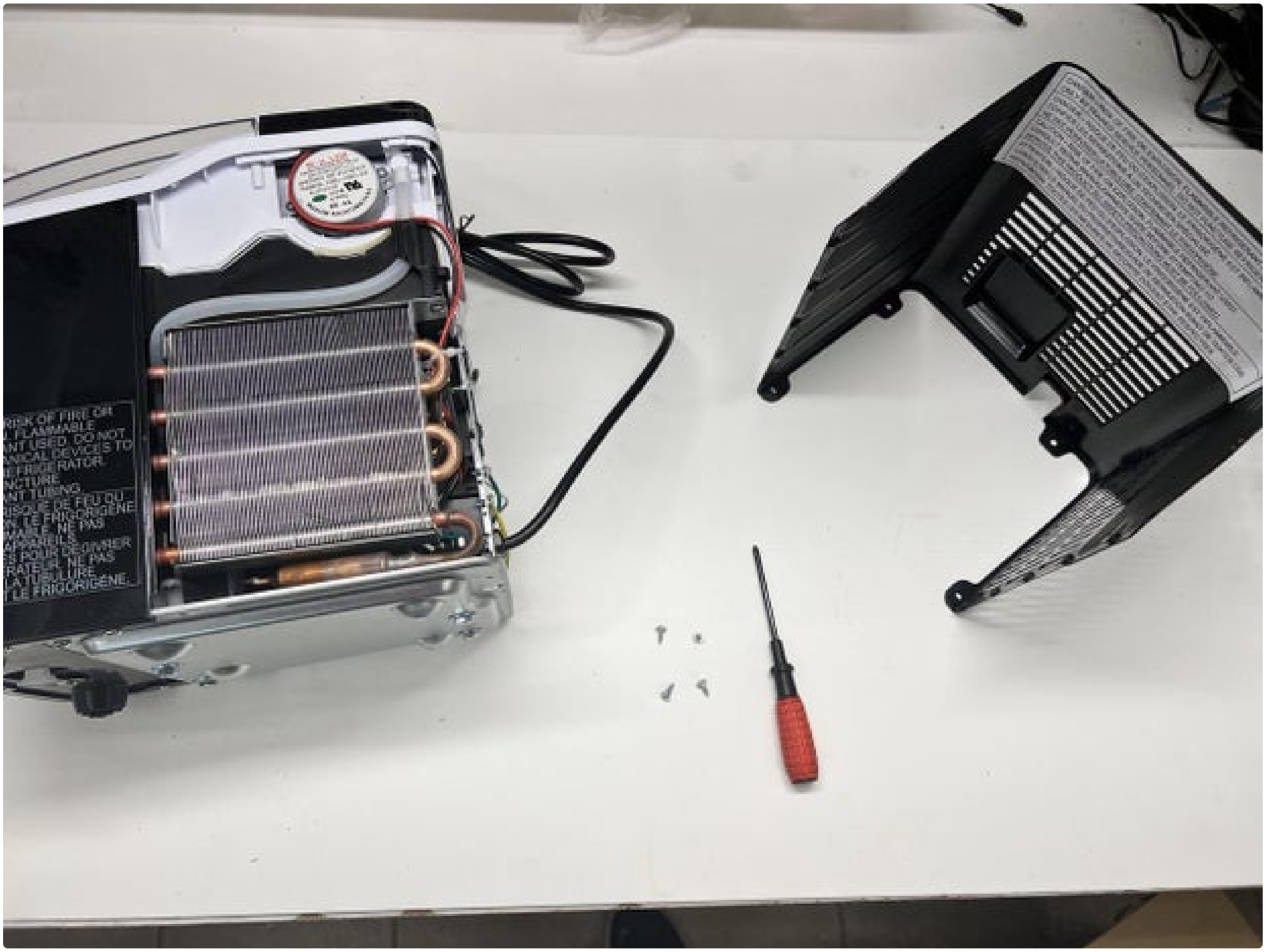
Step 1: Teardown -1

WARNING! The ice-maker is a double whammy of a teardown. Firstly it's a 110V device with capacitors that can store significant charge, and secondly, it contains pressurized refrigerant gas. So be very careful when following these steps in a well ventilated area.

Now that we have that out of the way, the first step is to remove the four screws marked in the second image which will allow the plastic cover to slide out. Thankfully all the screws can be opened with a Phillips #2 screwdriver.

The maze of copper pipe covered in fins will henceforth be referred to as the condenser, since this is where hot and pressurized refrigerant gas condenses into liquid refrigerant, emitting energy in the process. The condenser has a fan to maintain airflow through the fins which transfers this energy into the air.





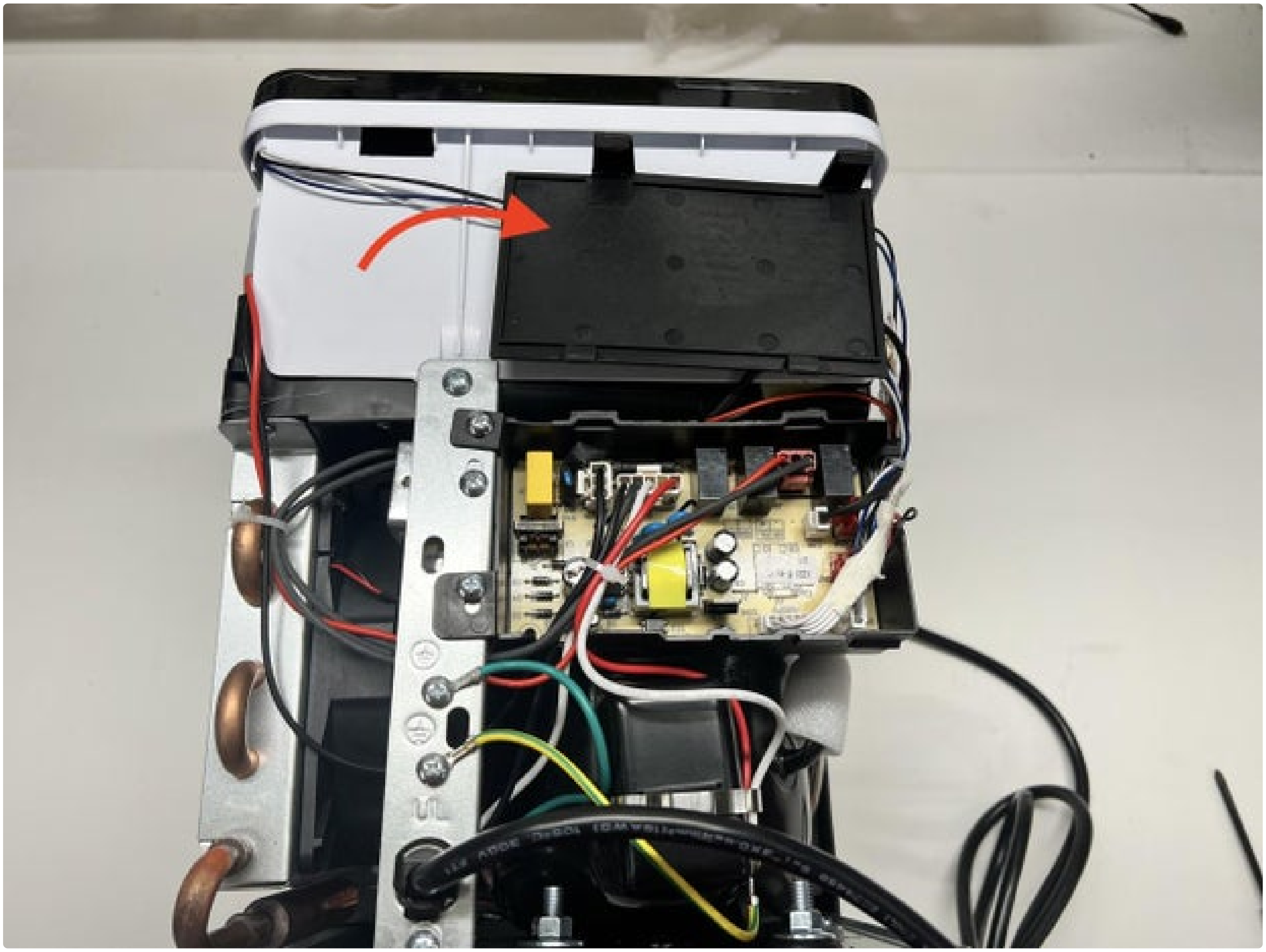
Step 2: Teardown - 2

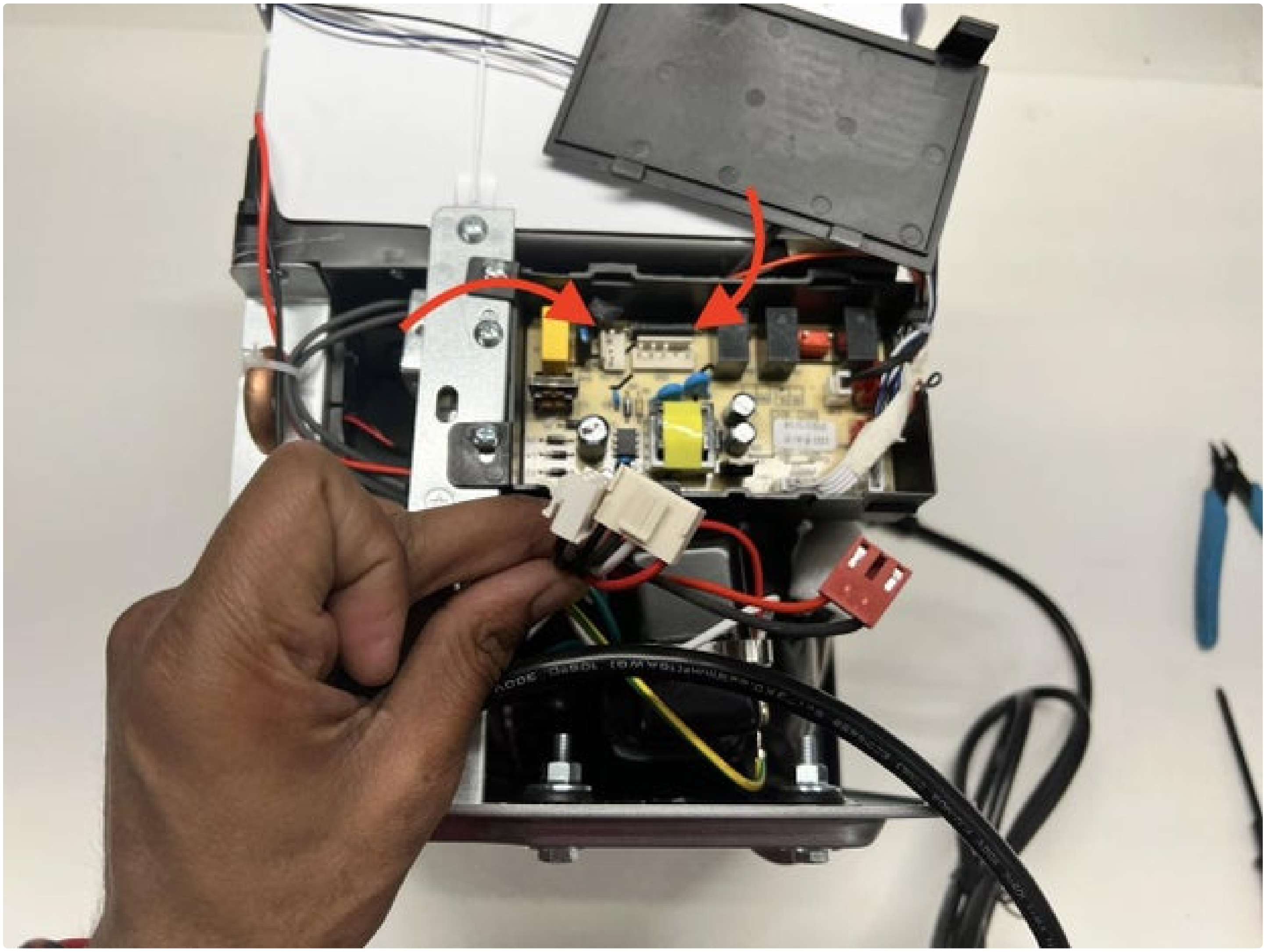
The main circuit board is covered with a black panel which is held in with simple plastic snaps. Remove that panel.

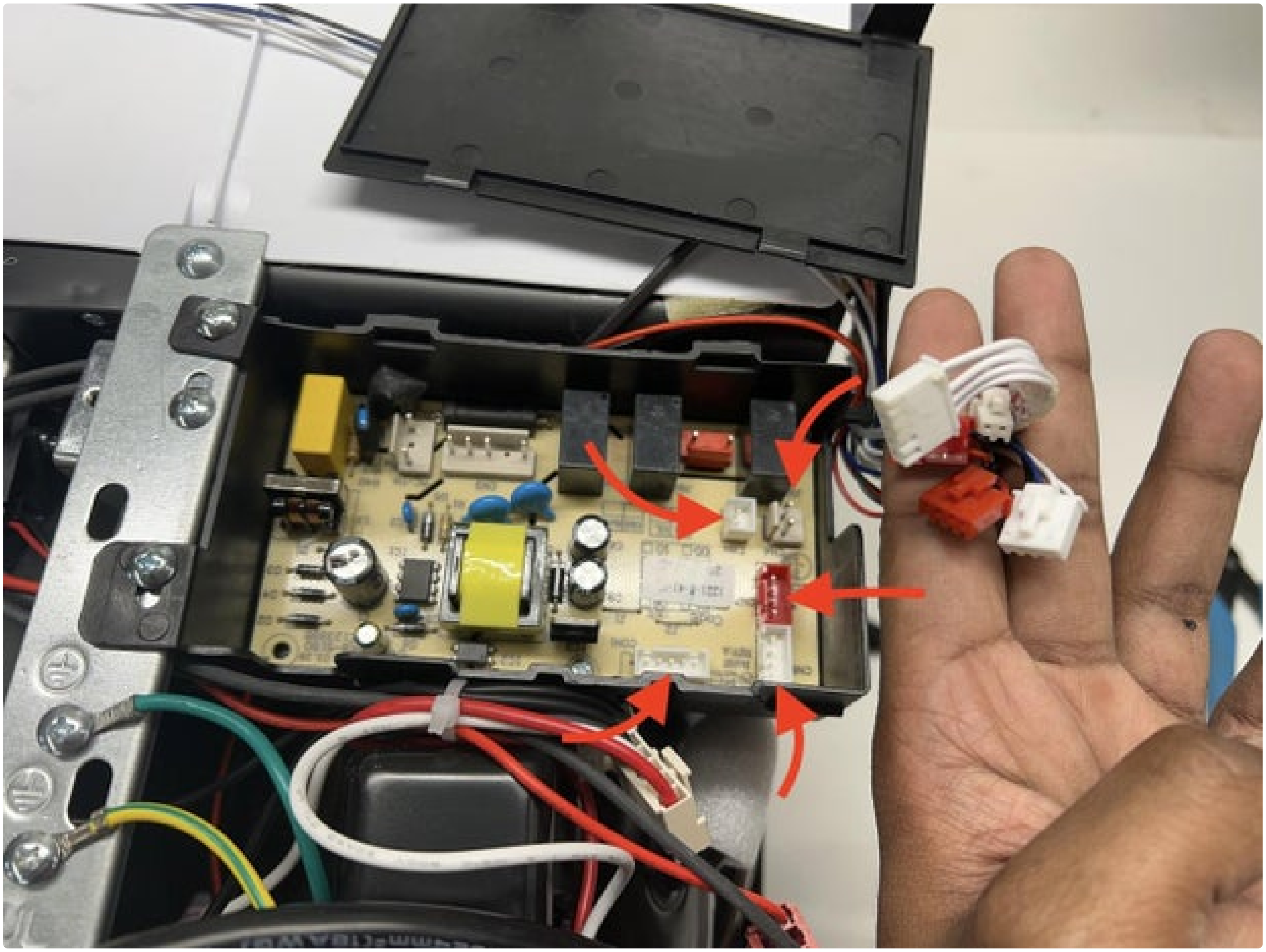
With the panel removed, detach all wires connected to the circuit board.

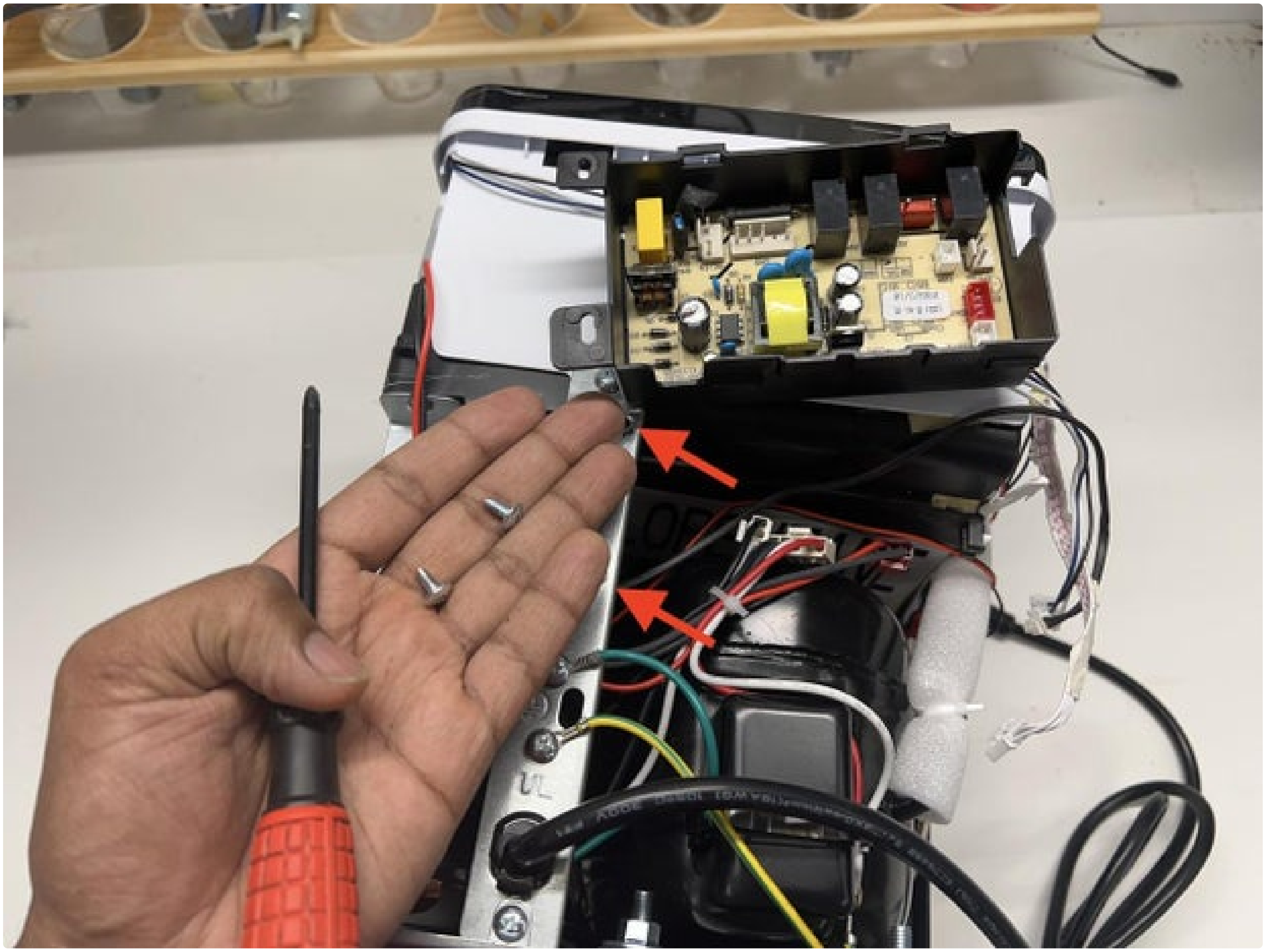
Now that the panel is free of wires, remove two screws marked in the fourth image to remove the circuitboard.

We will not be using any of the original electronics. Relays can be salvaged from this board, or use they can be used to power the condenser fan. However, this will complicate the build, so in this build the circuitboard is scrapped.





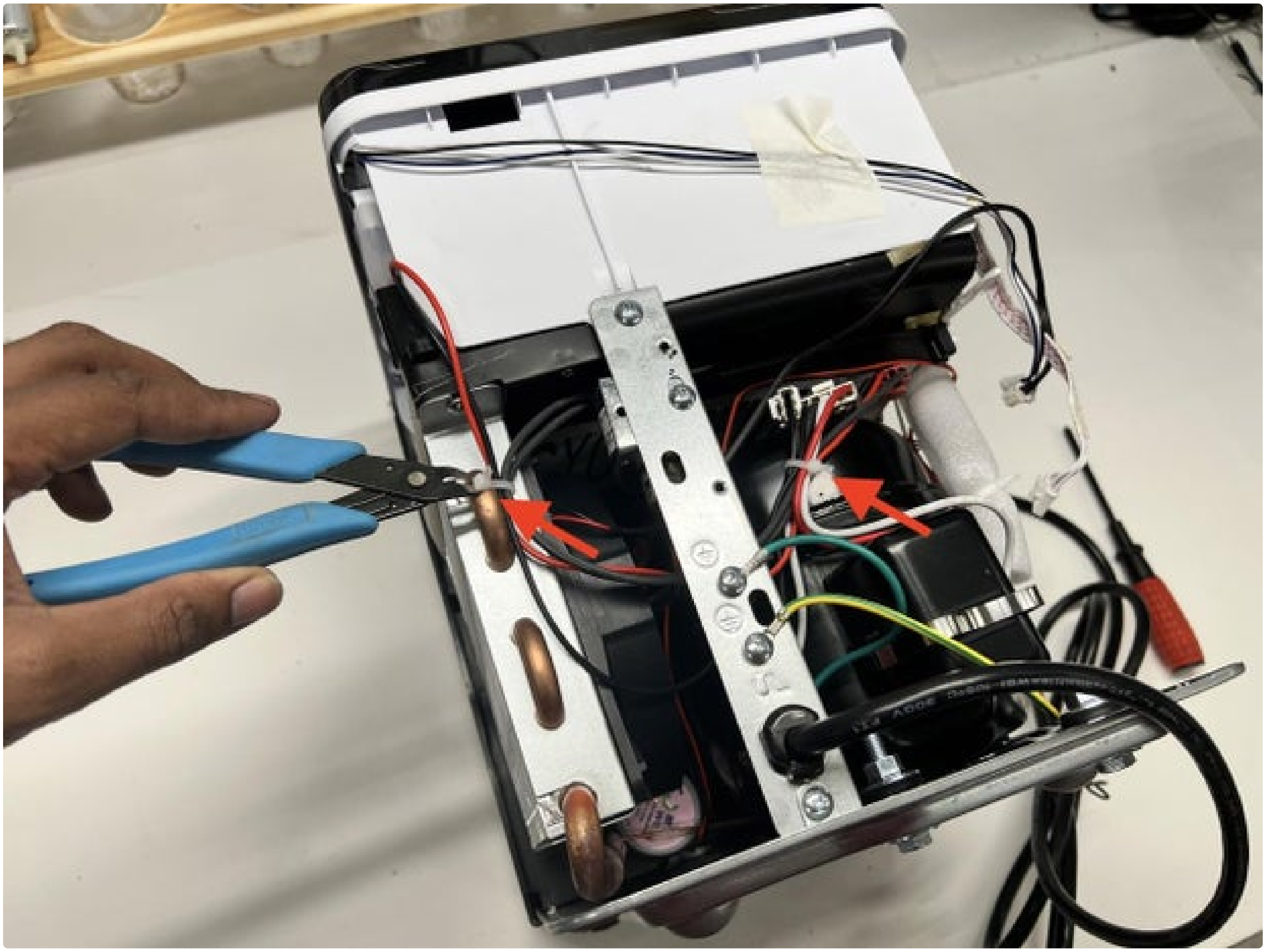


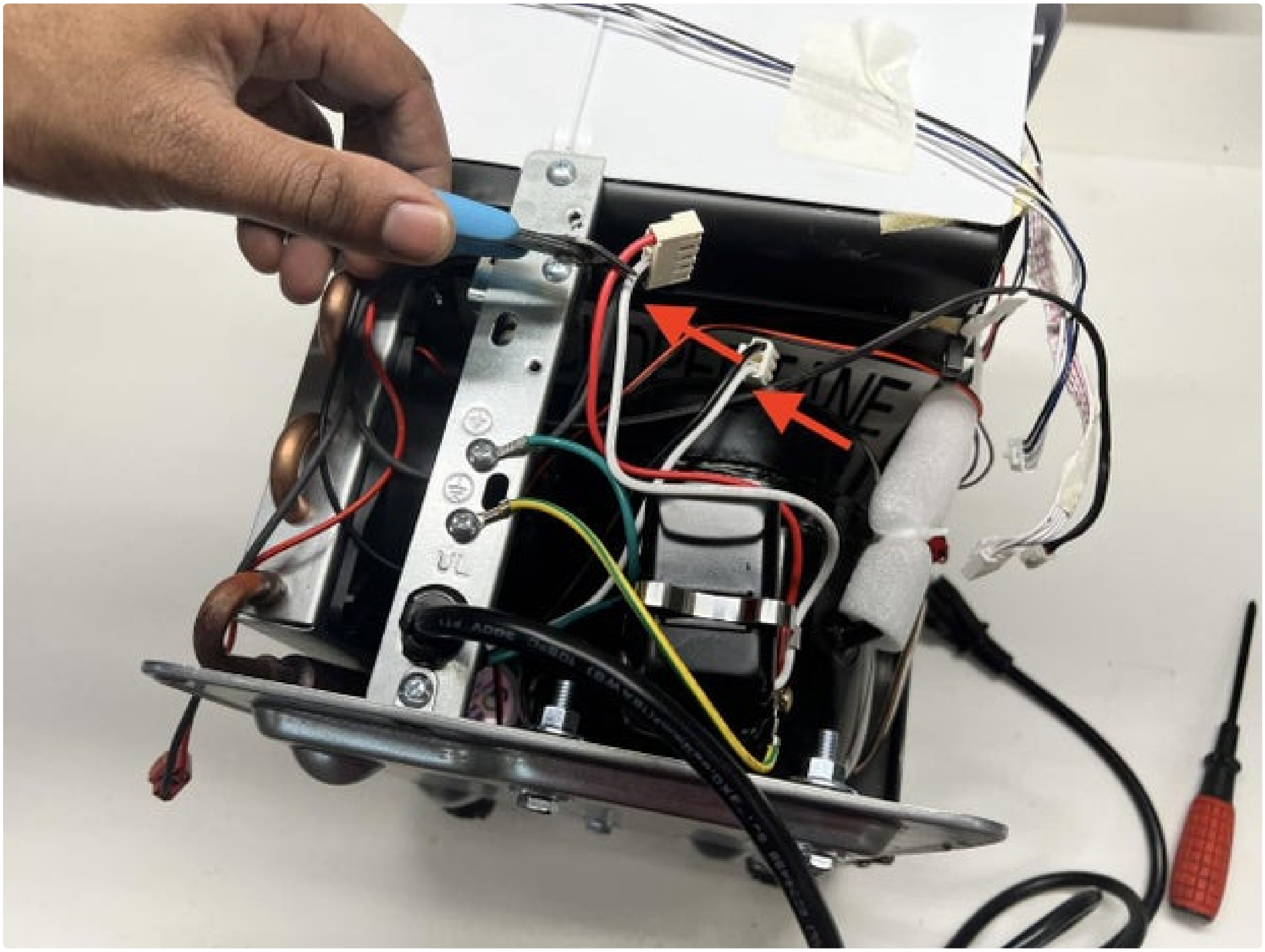


Step 3: Teardown - 3

In the spirit of keeping the electronics simple, feel free to chop up all connectors in sight. Specifically, cut the connectors on thick WHITE+RED and WHITE+BLACK wires.

While you're at it, also remove the white foam insulation around a copper pipe that is held with two white zip-ties.

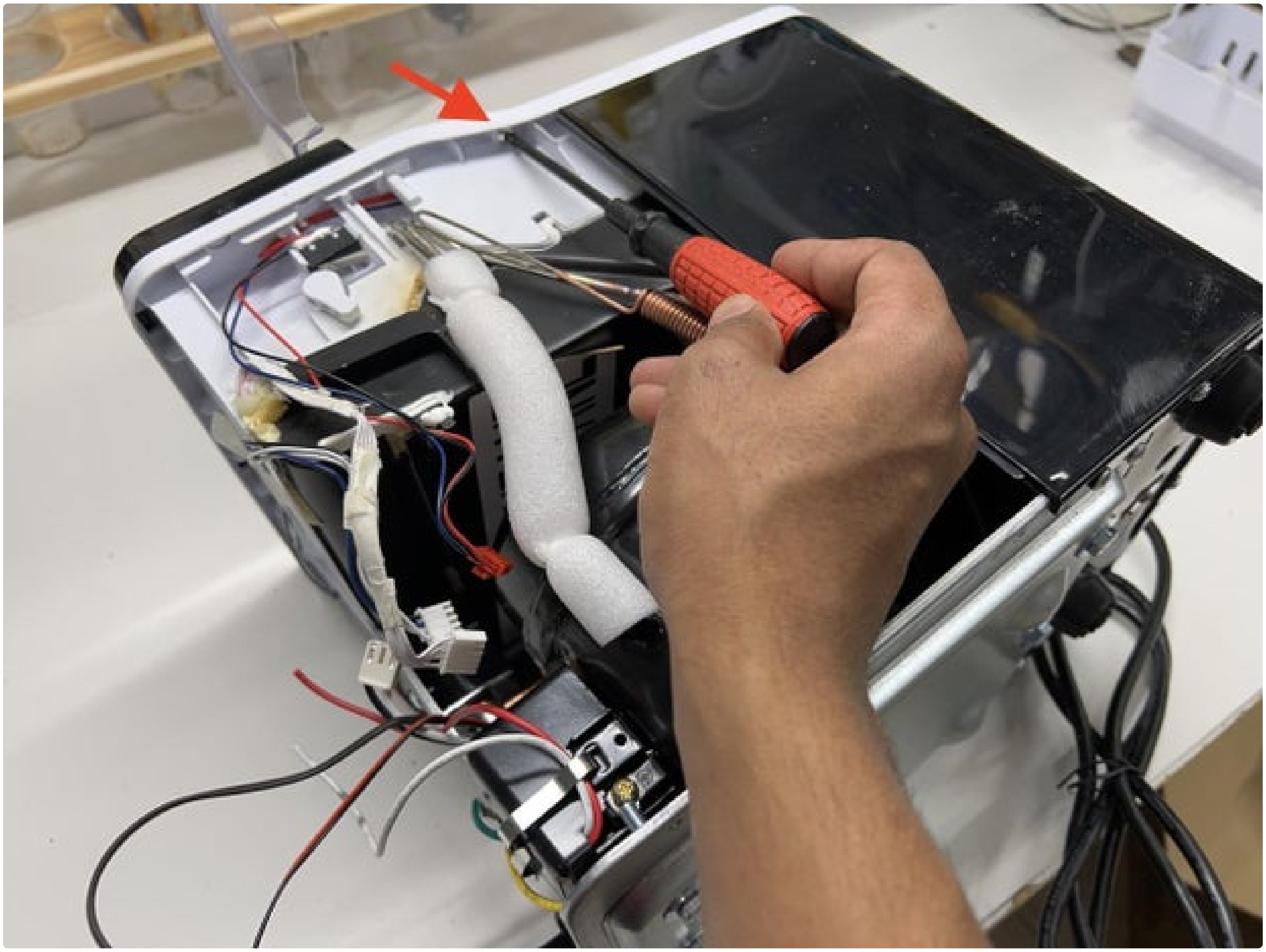


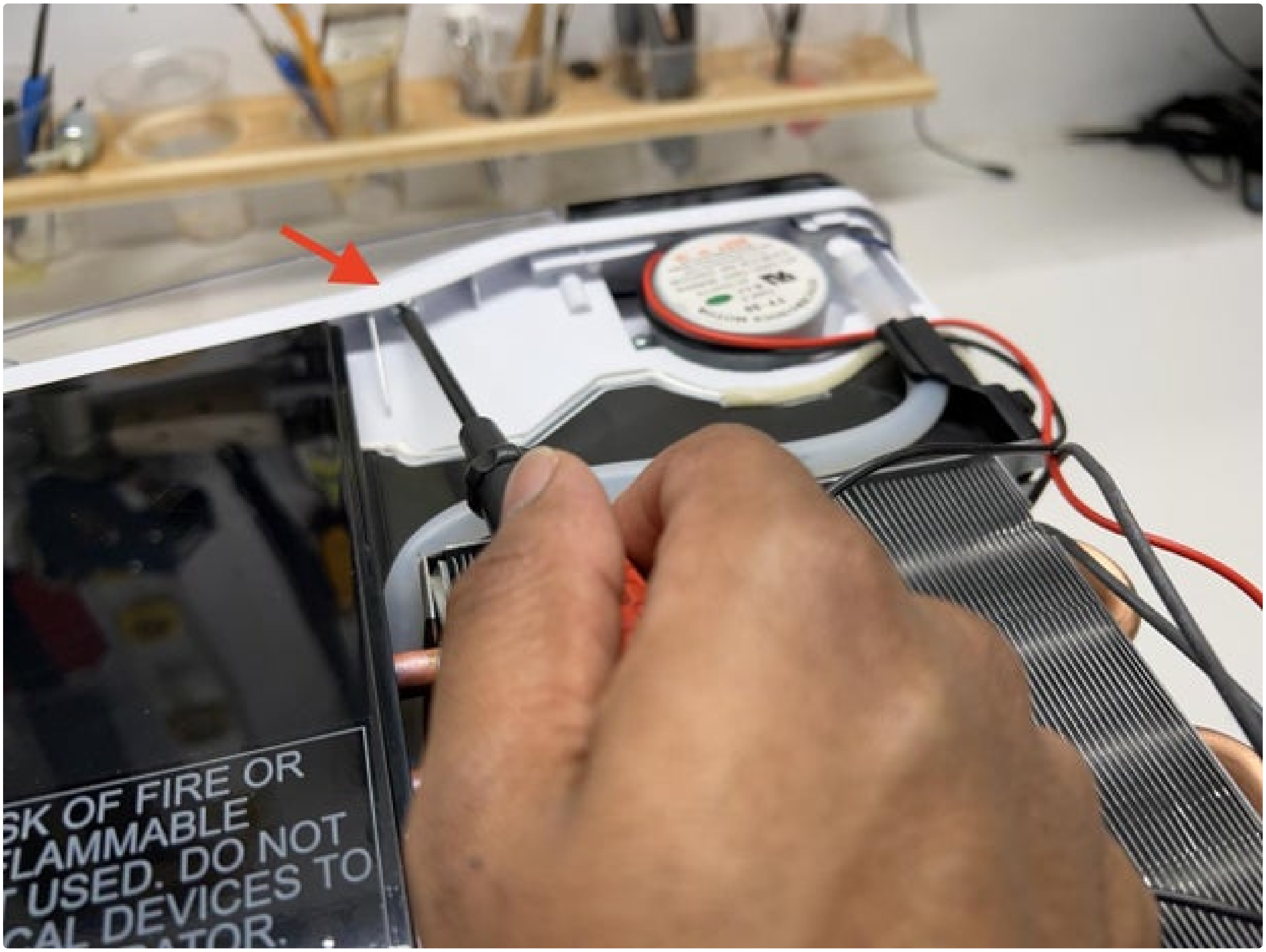


Step 4: Teardown - 4

Remove the two screws marked on either side and then the three screws on the top. We will then be able to remove the scooping mechanism and plastic panel on the top side.

The chrome plated piece is where ice forms. This will henceforth be referred to as the evaporator, since this is where the refrigerant evaporates by taking in energy, thus cooling down the metal pipe.

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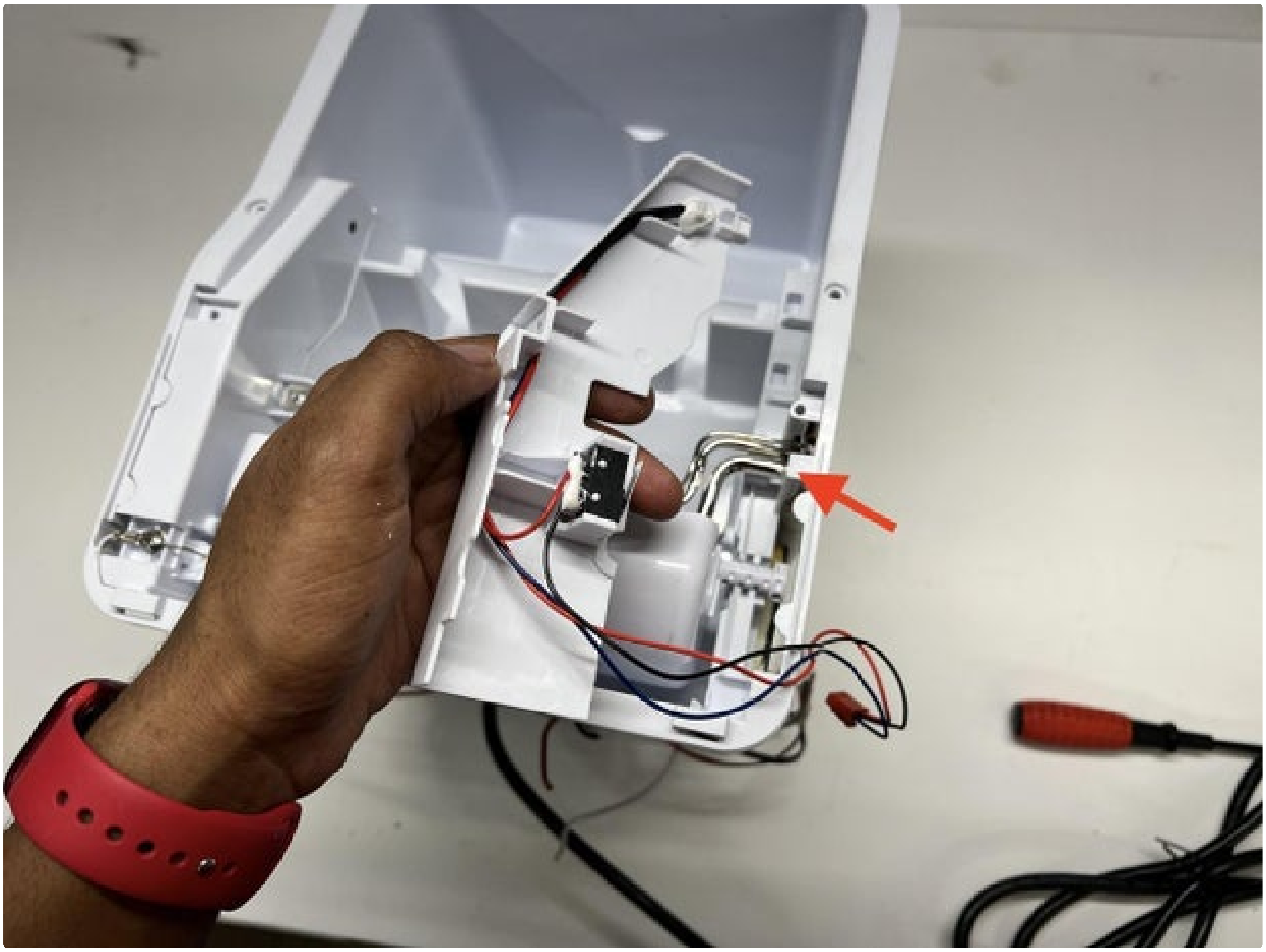
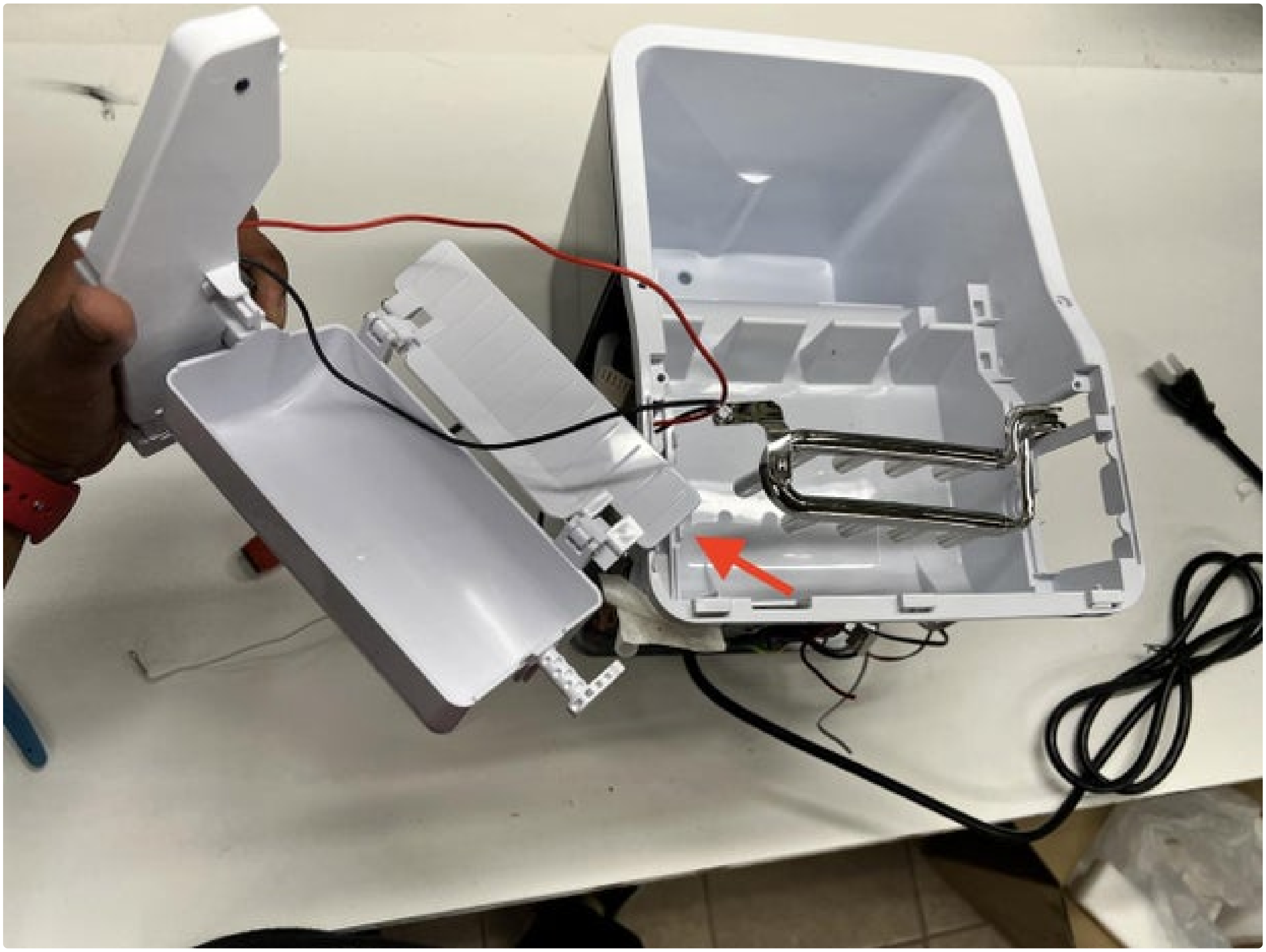
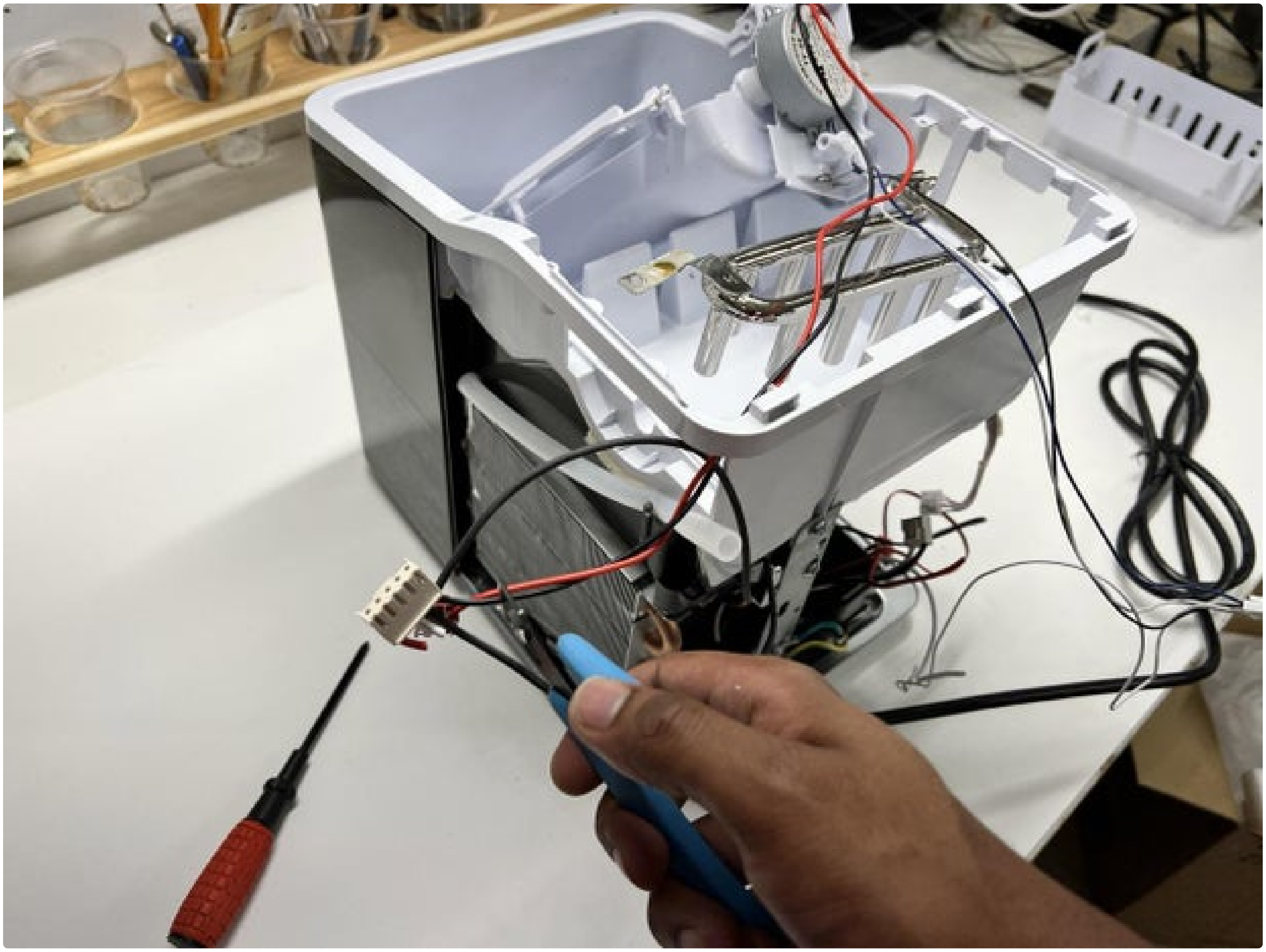


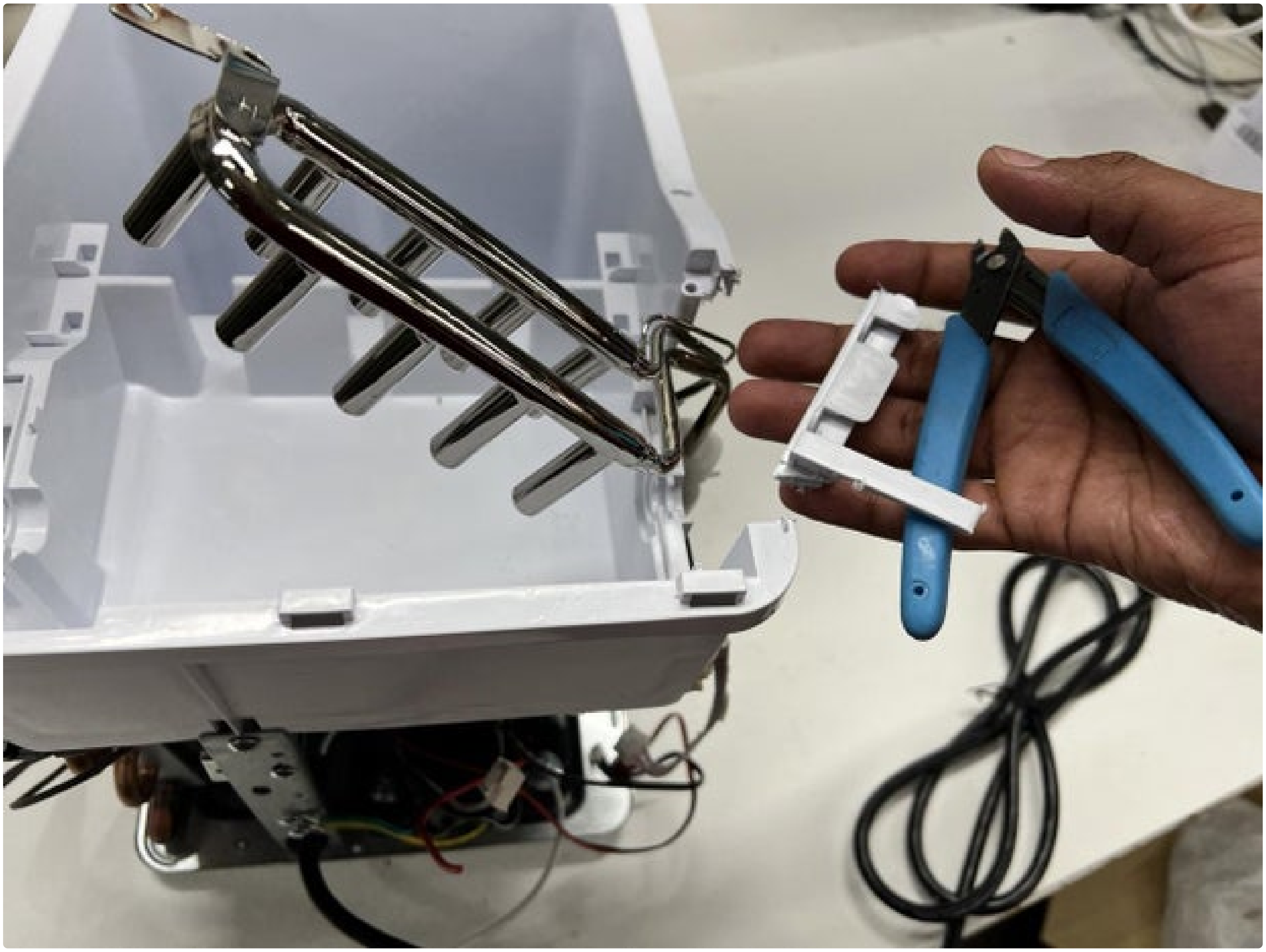


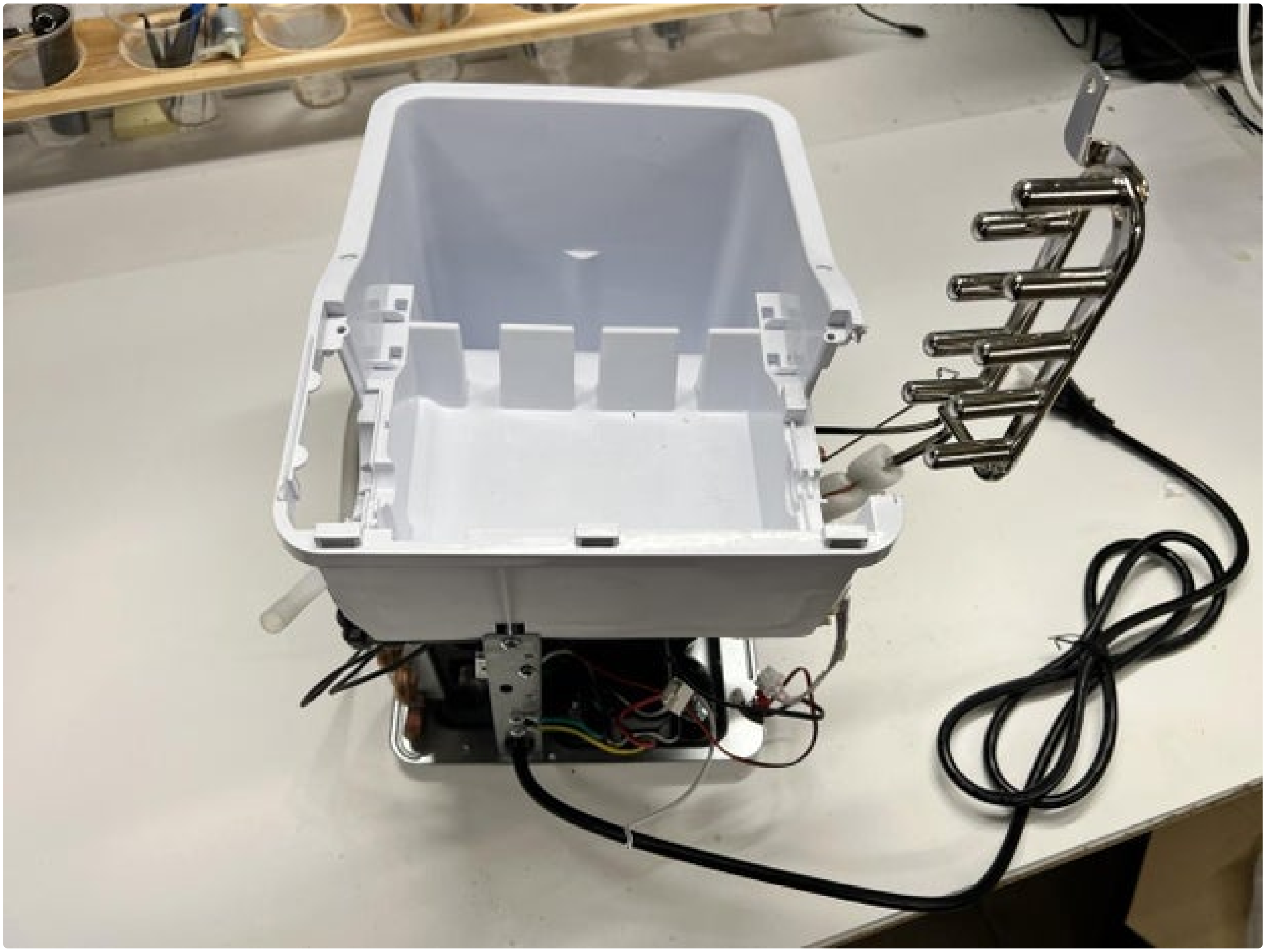
Step 5: Teardown - 5

Grab those wire cutters again because it's chop-chop time! To remove the scooper assembly, several wires need to be cut. Don't worry, we won't need them. Also disconnect the silicone tubing connected to the case, we won't need the wire cutters for that.

Next, cut the plastic piece shown in image 2 to allow the evaporator to be lifted up and out of the plastic casing. This is needed to remove the plastic casing entirely in the next step. Be **verycareful** not to kink the copper pipe while bending it.

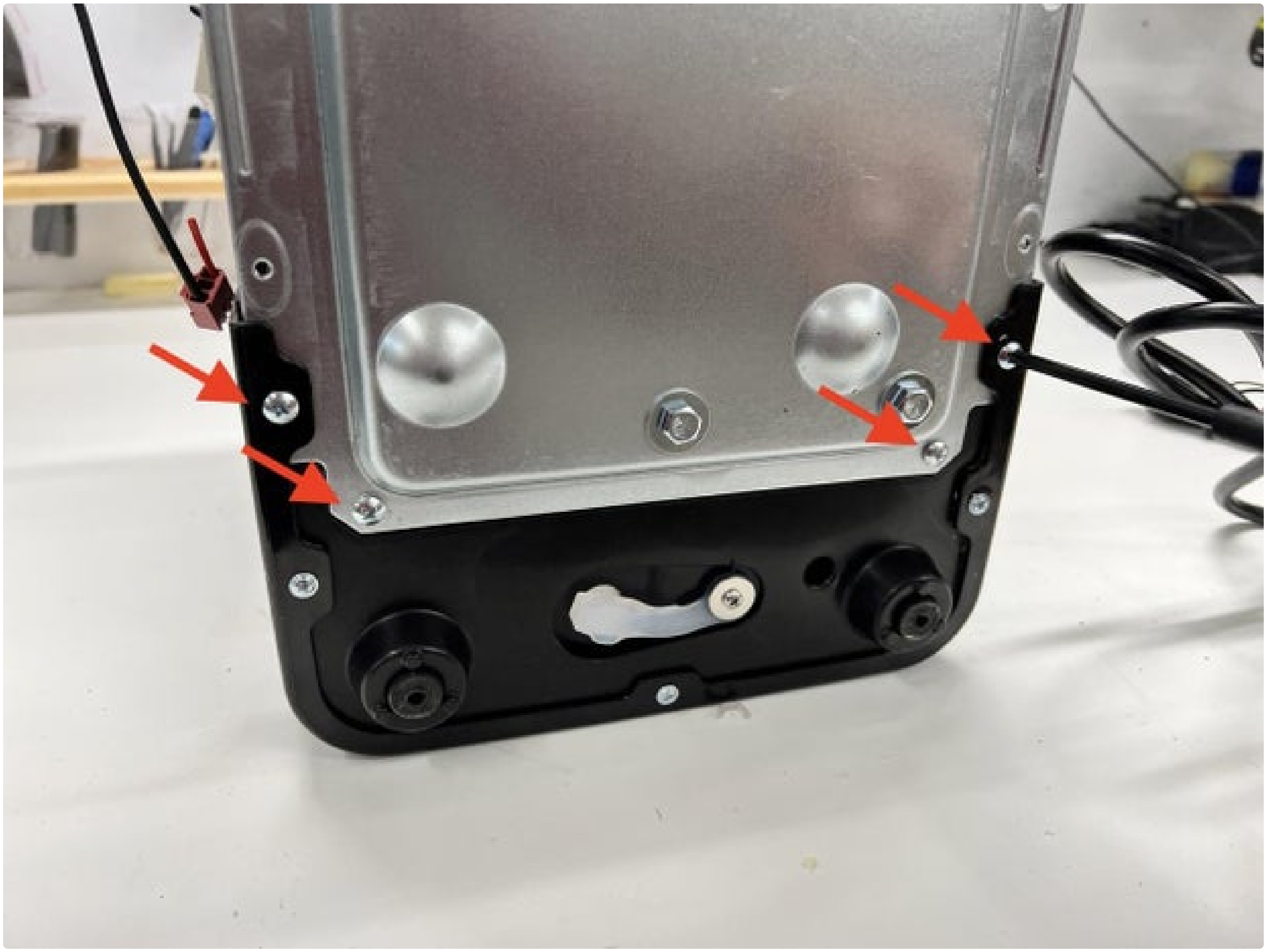


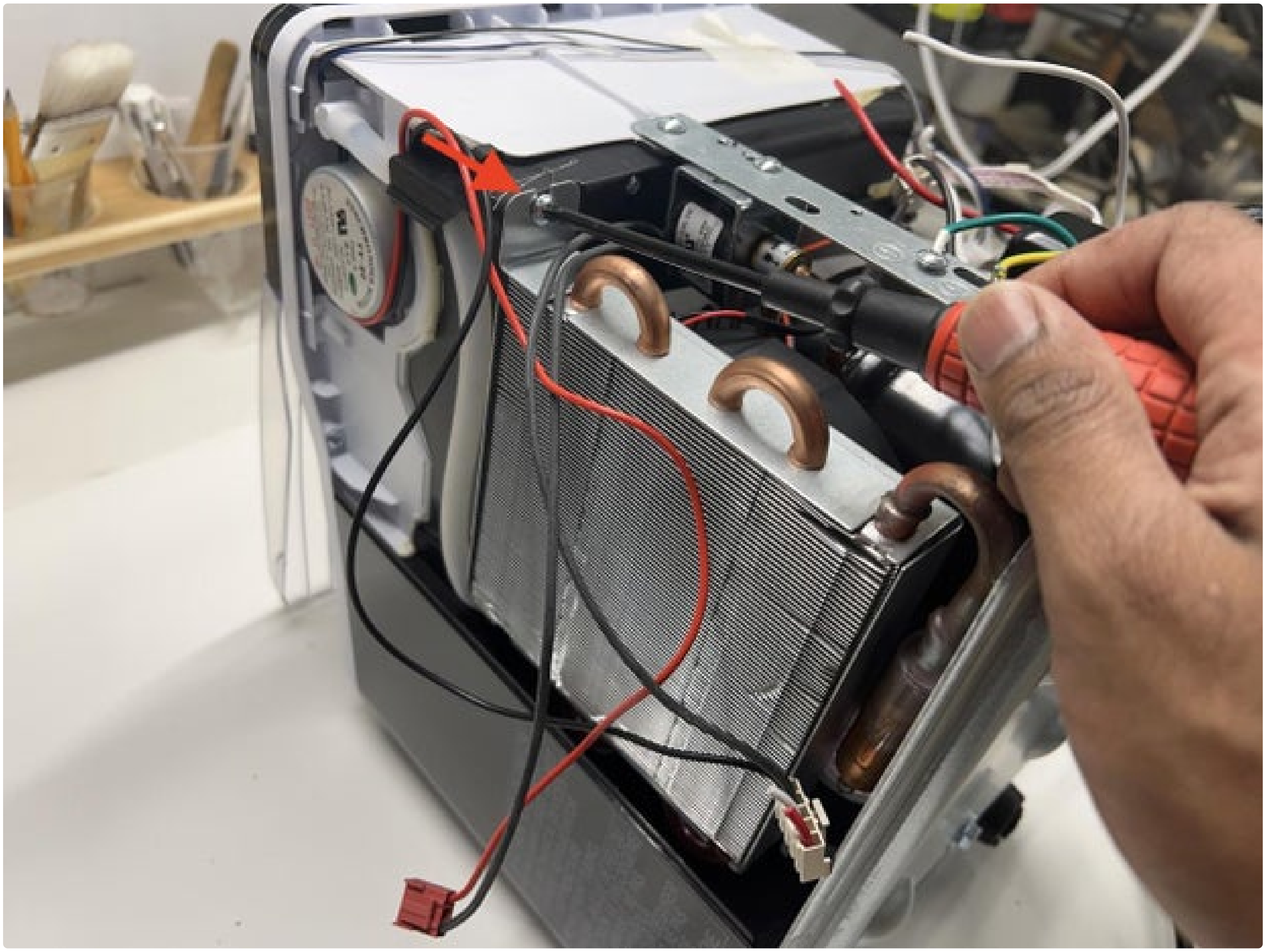


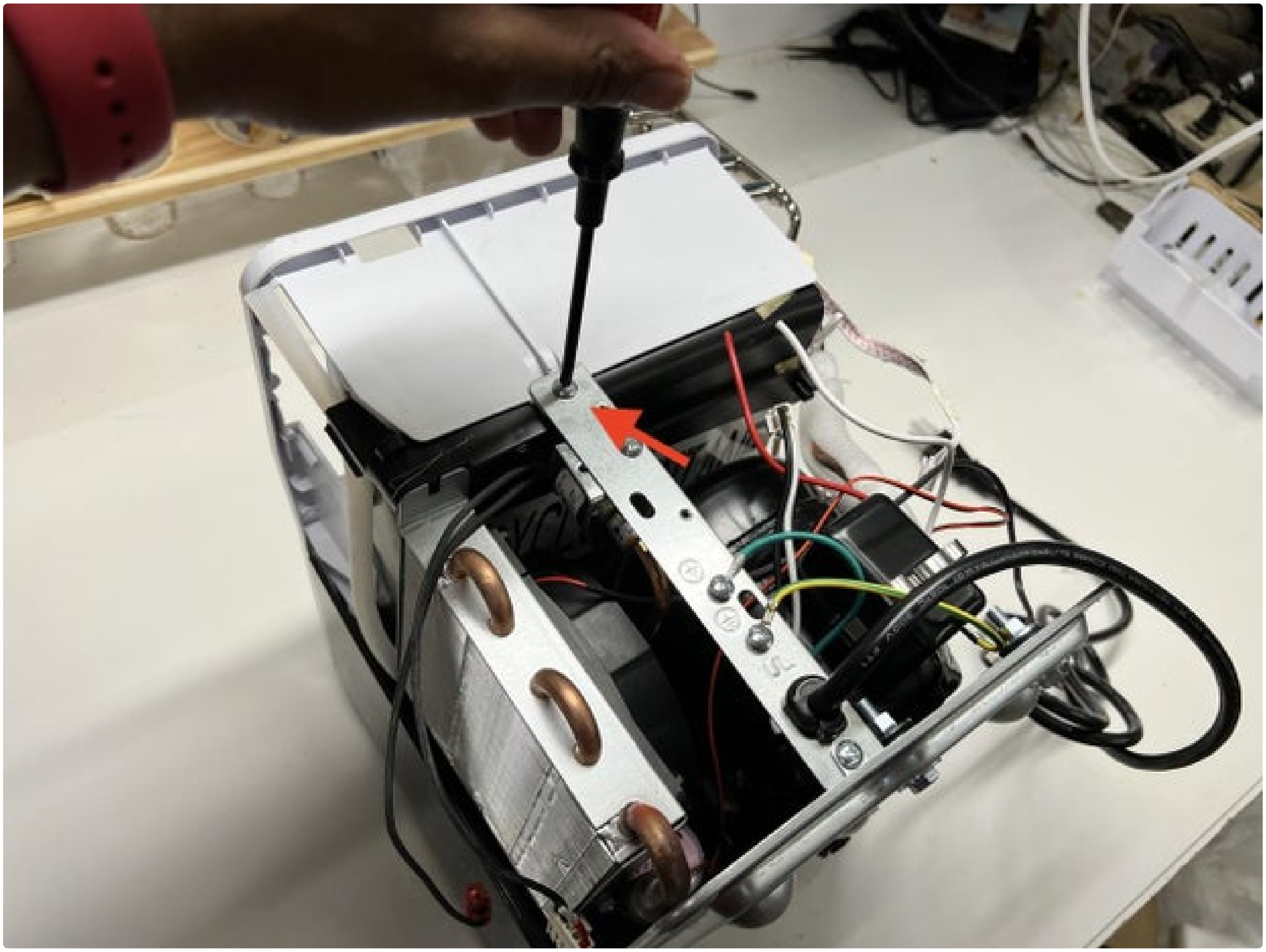


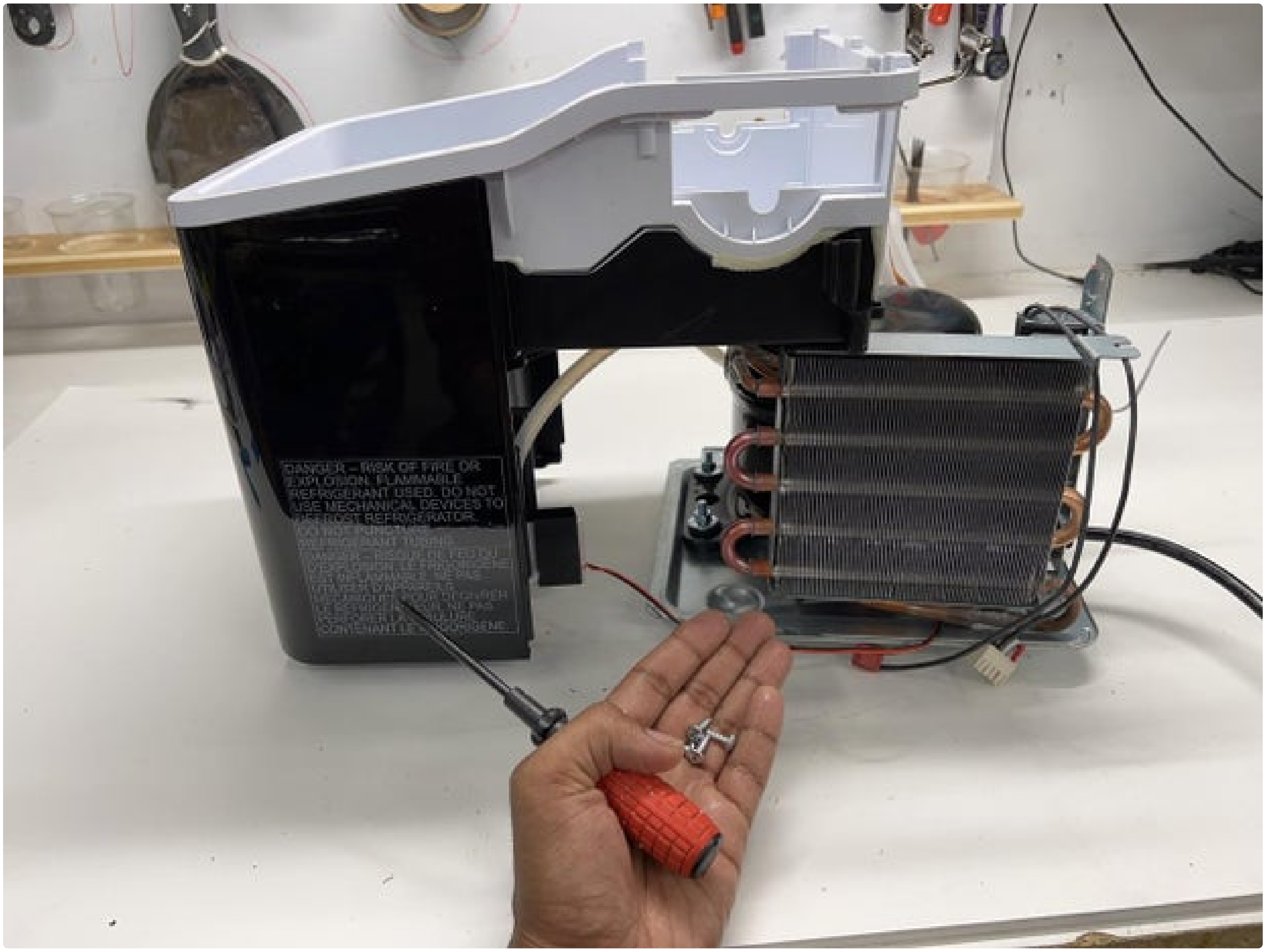
Step 6: Teardown - 6

Remove the six screws marked in the images above to slide out the refrigeration assembly from the plastic casing.



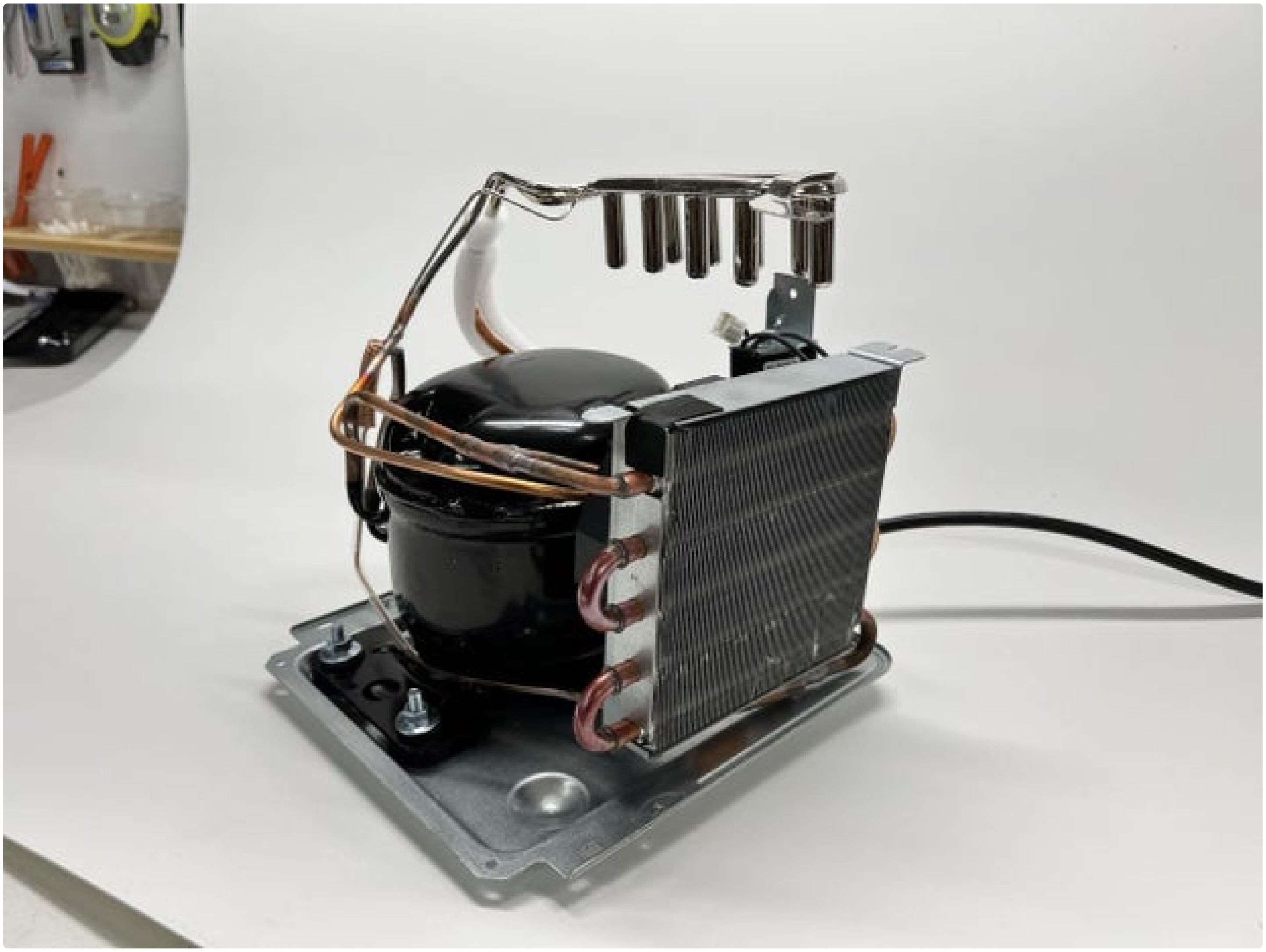


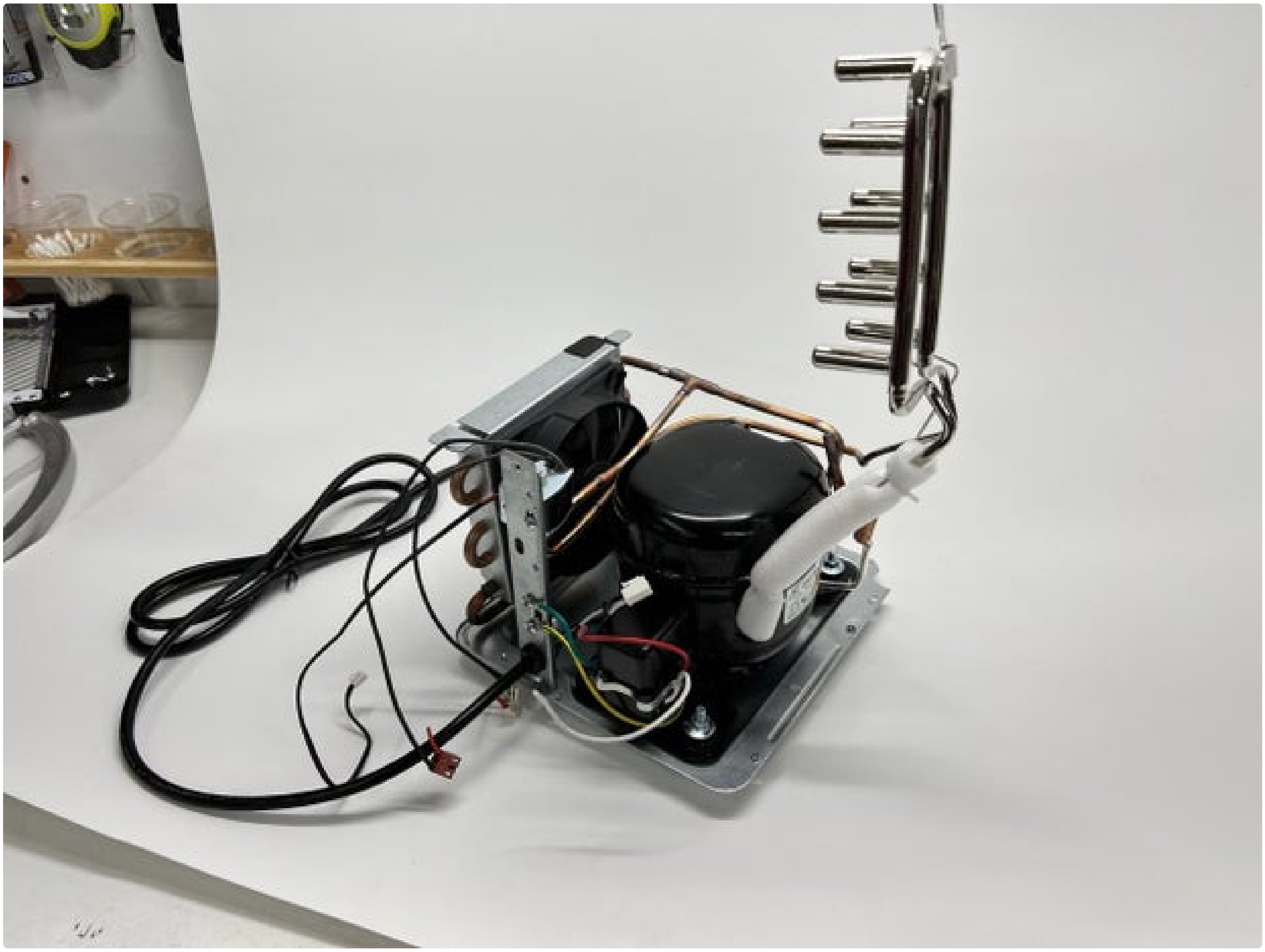




Step 7: Phew! Take a Step Back

Take a look at the refrigeration loop in all its glory! Really take the time to follow the maze of copper pipes. Forgive me for being a little poetic, but this is a piece of engineering beauty. Units not unlike this keep your fruits fresh and drinks cold. Yet, very few people understand how they work, even on a surface level. Hopefully by the end of this you'll have a better understanding of that process.



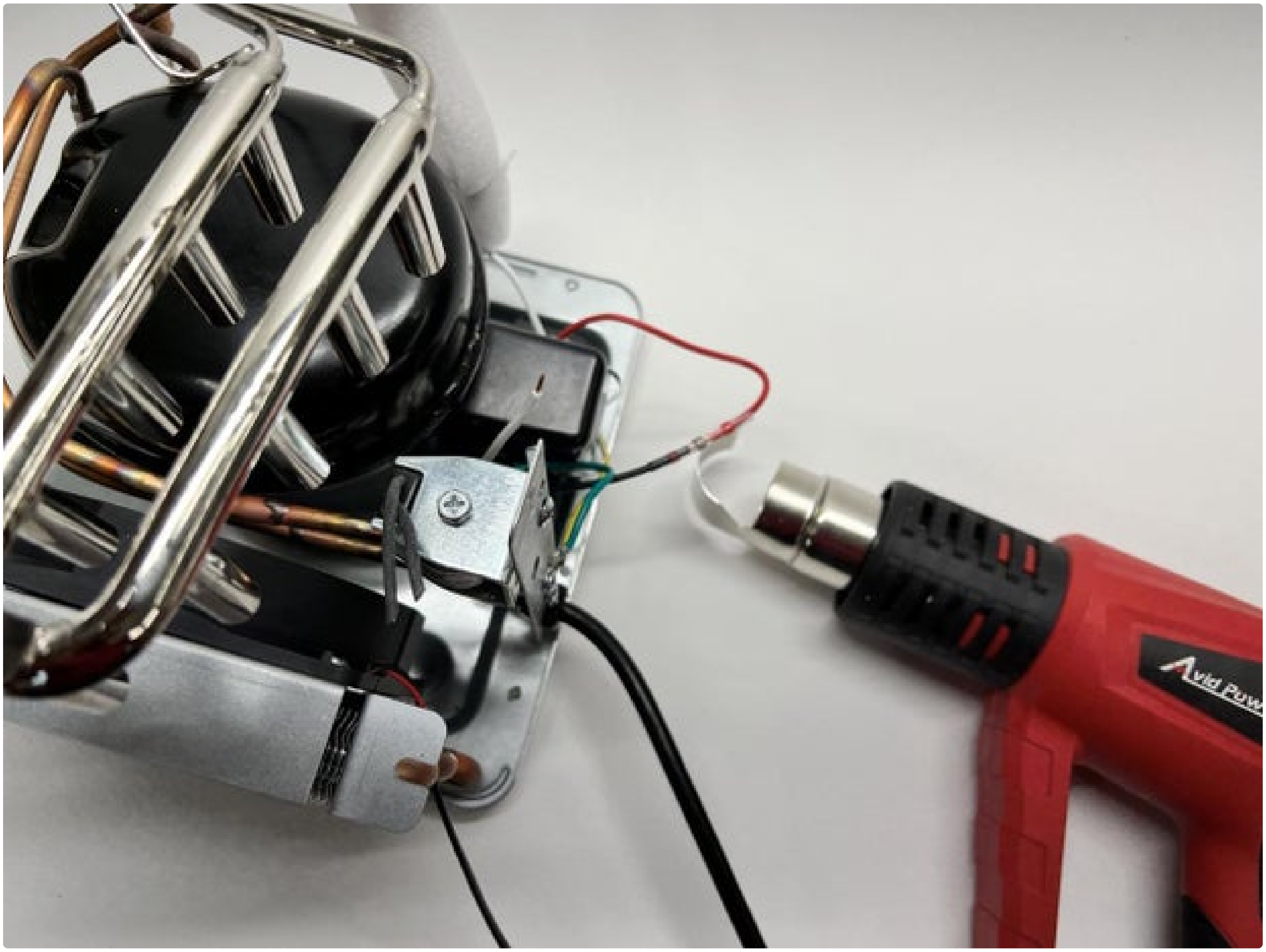


Step 8: Wire It Up - 1

In the spirit of keeping the build as simple as possible, we'll do away with the soldering iron and used Solder Heat Shrink instead. These have a bit of solder inside the heat-shrink along with a glue lining to make a waterproof seal. All we need to do is strip the wires, push them in from either side of the tube, and heat using a heat gun until the solder melts. We'll also see the glue melt and bind to the plastic, making a waterproof seal. Give it a tug test to make sure the connection is solid, as sometimes oxidized copper leads to a weak solder joint.

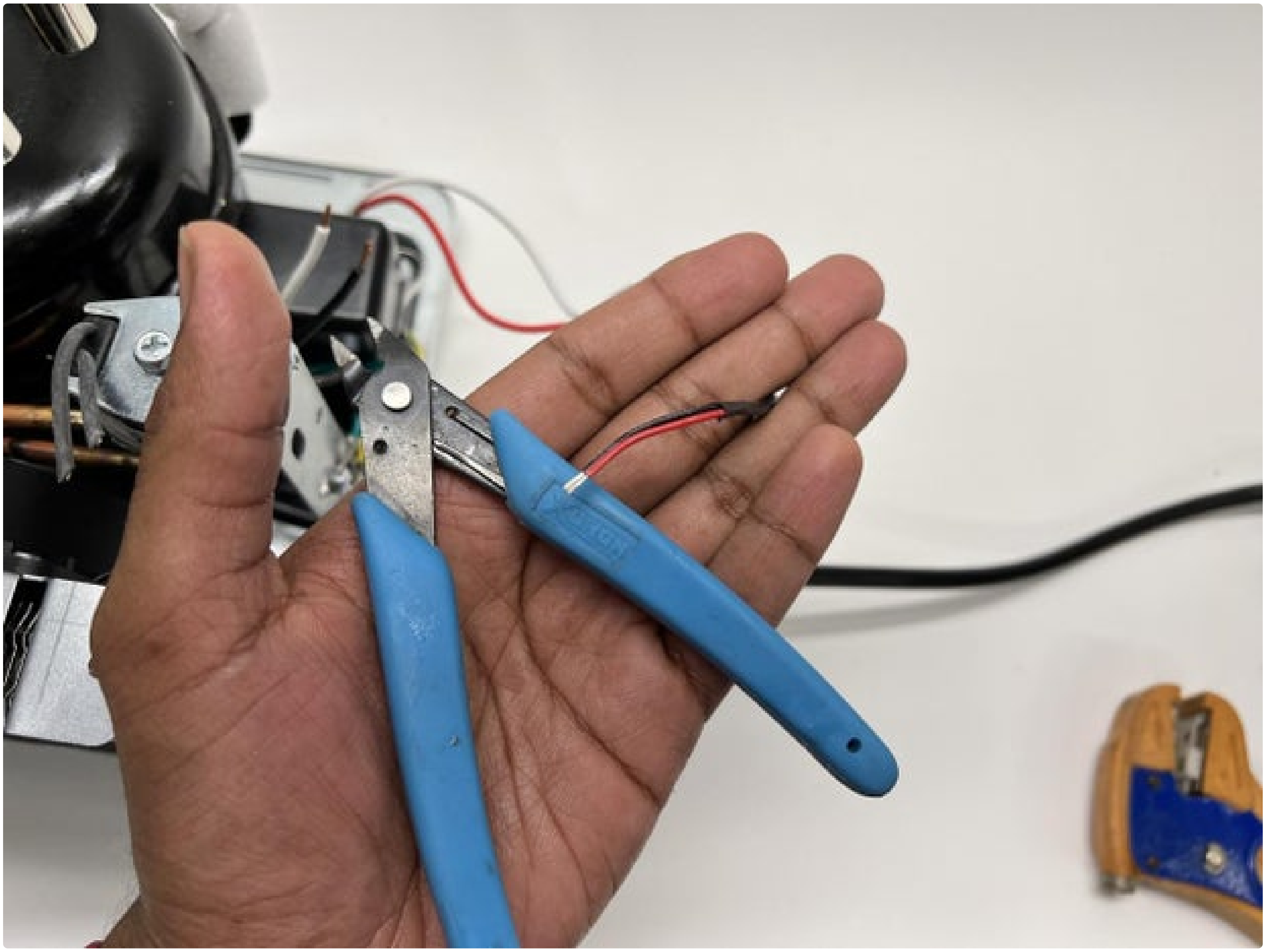
Connect the thick RED wire to the BLACK wire, and the two WHITE wires together. With this setup, the 110V AC line is directly connected to the compressor. We will next connect power to the condenser fan.

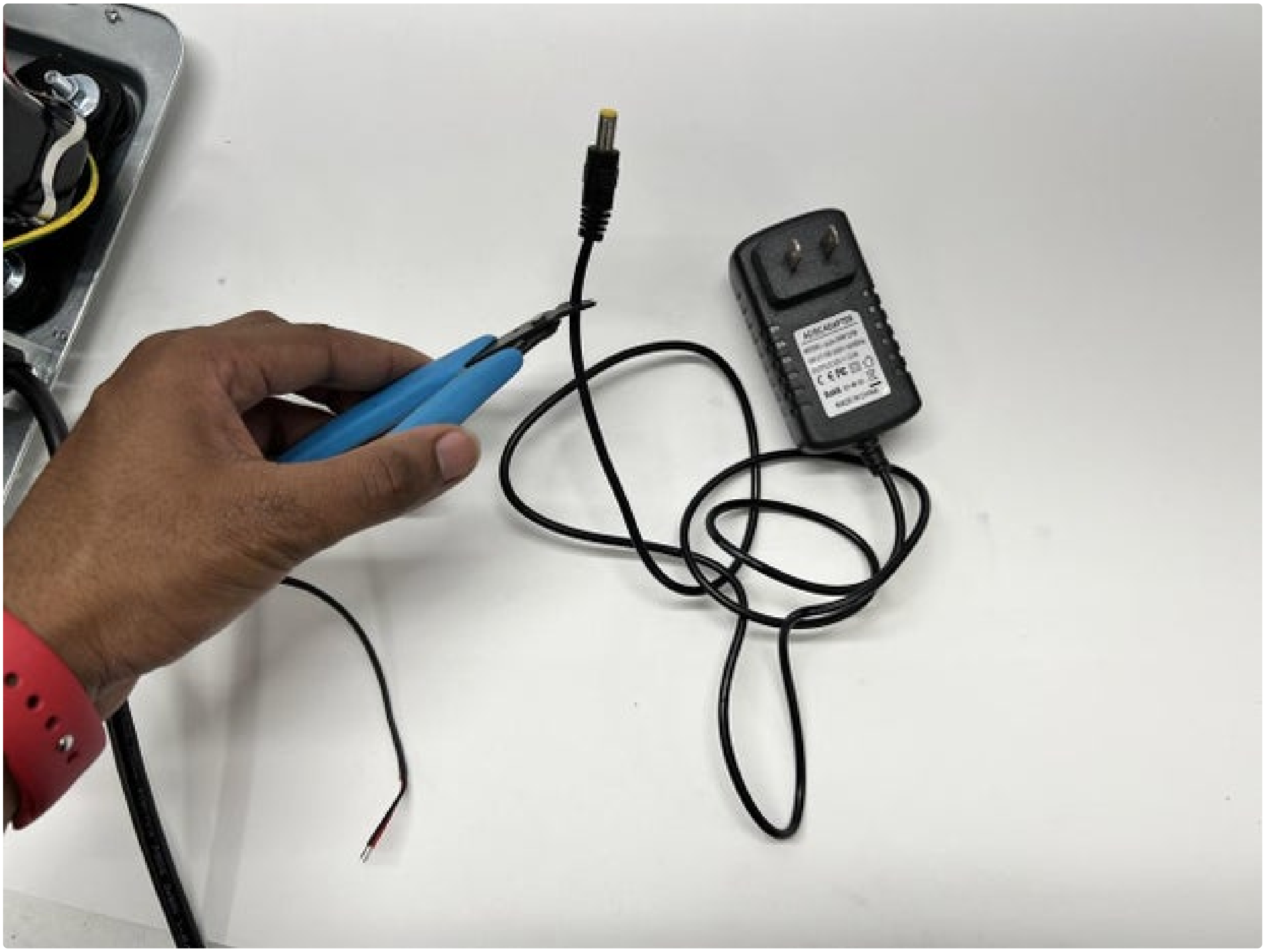

DESIGN REGD
MULTITEC

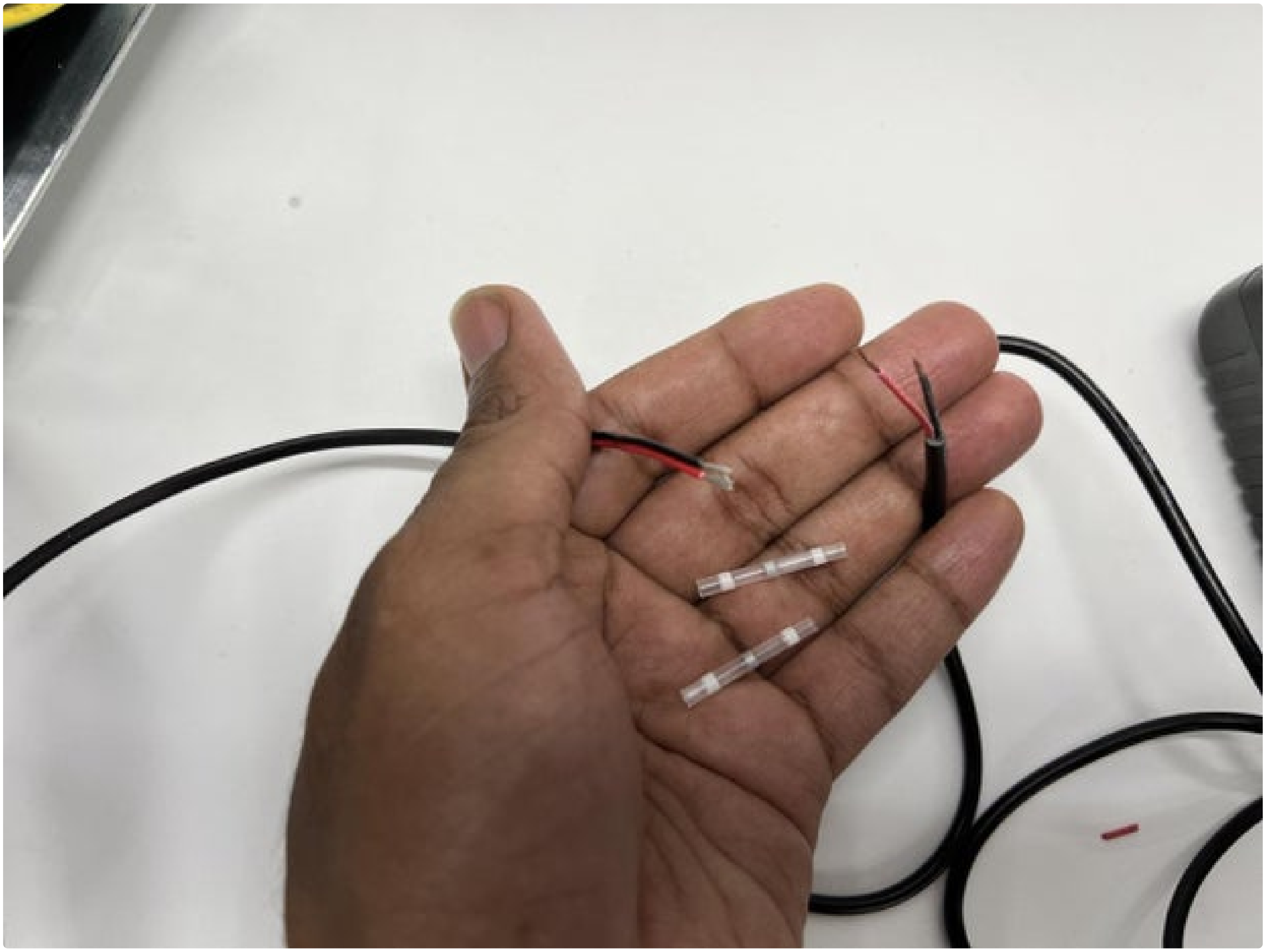


Step 9: Wire It Up - 2

Cut and strip the wires going to the fan as well as the output wire of the 12V power supply. Connect RED to RED and BLACK to BLACK. It's a good idea to test the connection by twisting the wires together first just to make sure the polarity is correct. Some black electrical tape can be added for additional waterproofing, strength, and aesthetics.







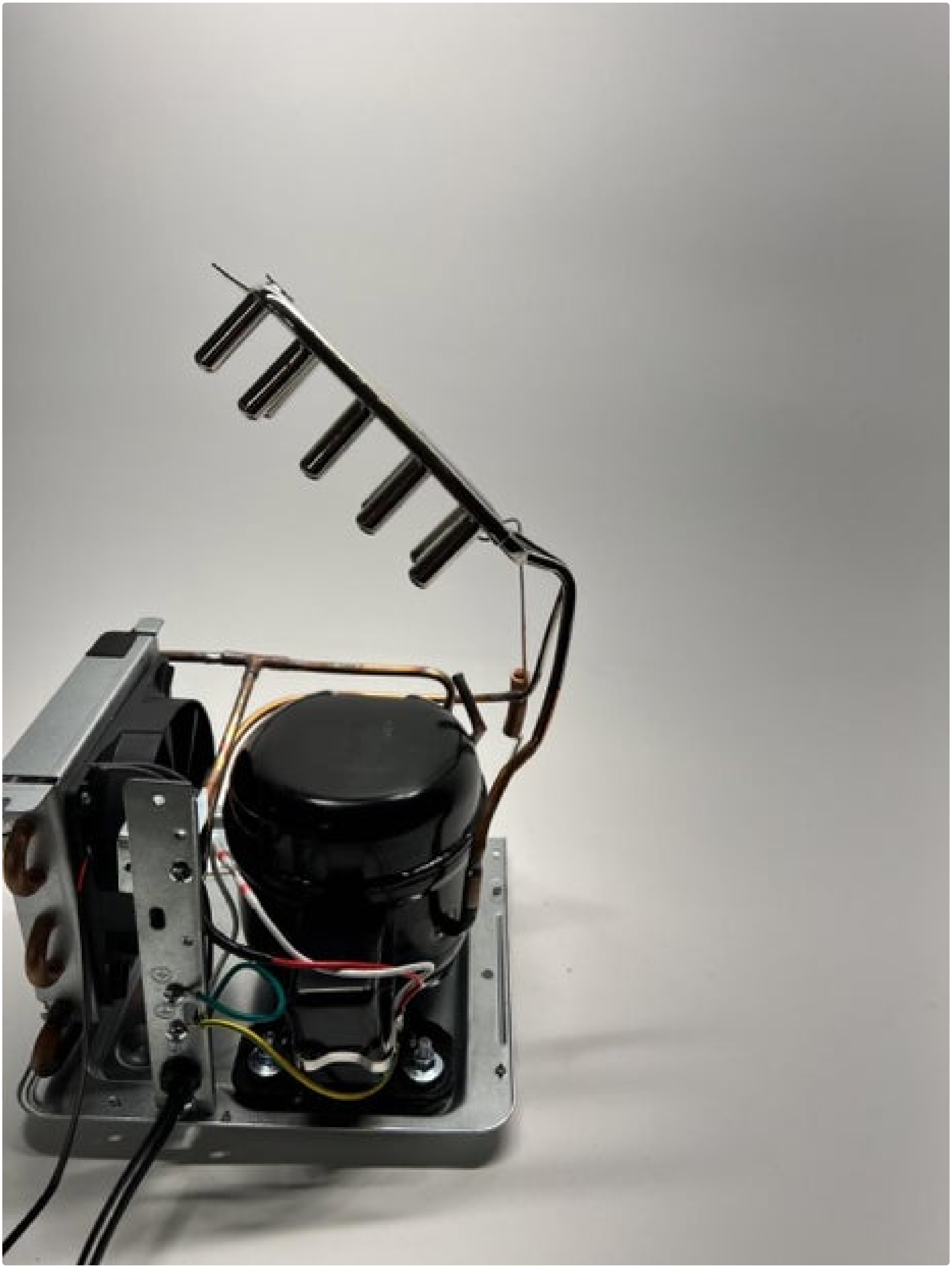

AC/DC ADAPTER
RoHS
MADE IN CHINA

Step 10: Bending Refrigerant Lines

The whole chiller assembly will be placed above the icebox filled with water. So, the evaporator needs to be bent down to be submerged in the water.

This is the step that gave me the most trouble and it's also the step I can give the least advice on. Copper pipe loves to get kinked when you try to bend it. And it's very difficult to straighten a kink. Any kinks are a rupture risk. So, my method was to go slow, and support the pipe I was bending at the point of the bend using my finger. There are pipe benders, like this one or this one, which could be helpful, but I found it easier to work with my hands. Thankfully, the pipes are longer than needed which makes things a lot easier.

Once we have bent the evaporator pipes down to resemble photo two and three, we can proceed with mounting it to the icebox.



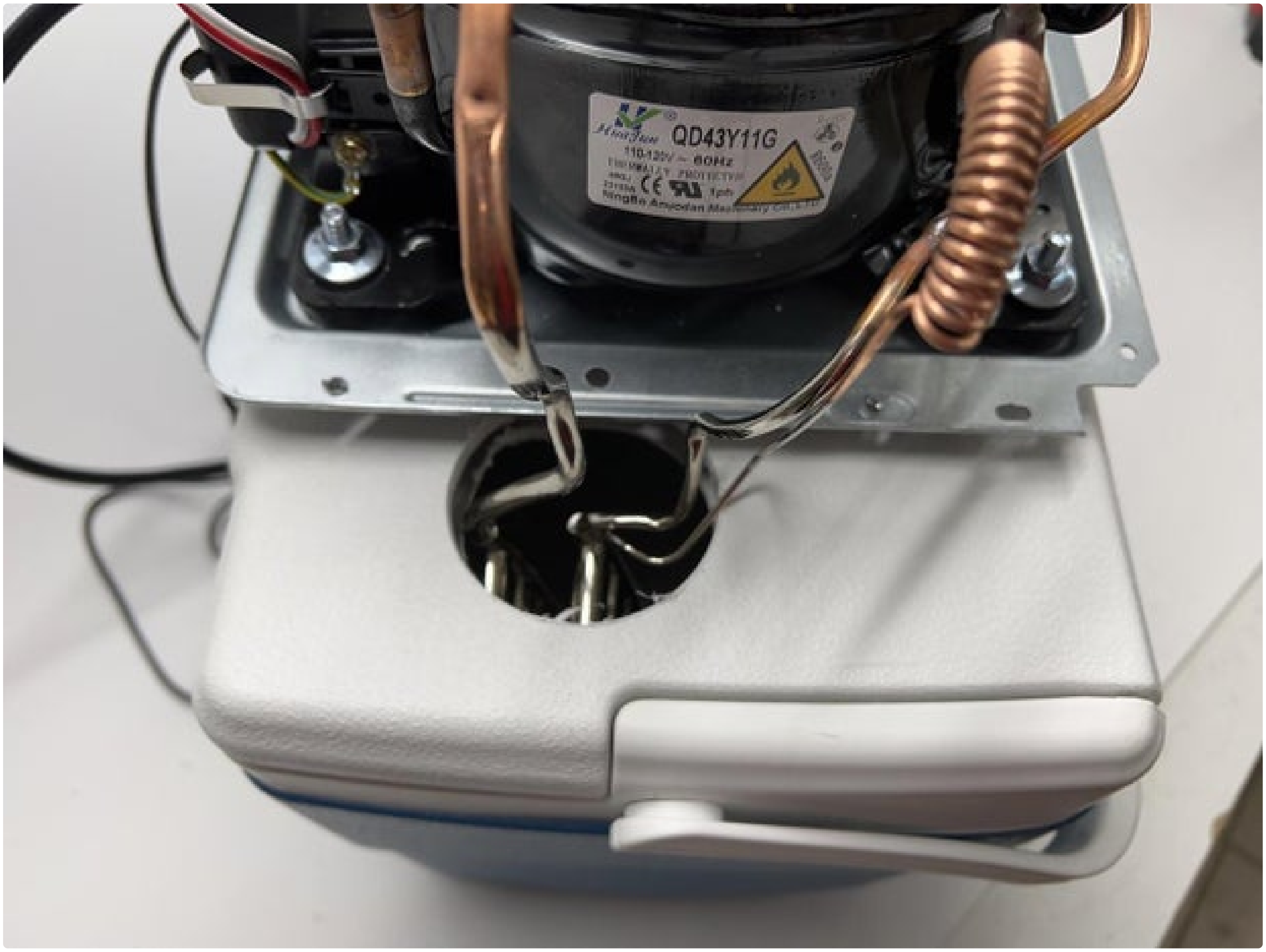

CHILLER

Step 11: Making the Hole

We'll use a 2.5" hole saw to drill out the hole in the lid of the icebox for the evaporator. You can also use a hand saw or jigsaw instead. Interestingly, the lid is hollow, not filled with foam the way that was expected. It could be filled later with gap filler for added rigidity.

The evaporator should slide in easily and there should be just about enough space for the base of the chiller assembly.


Coleman
CHILLER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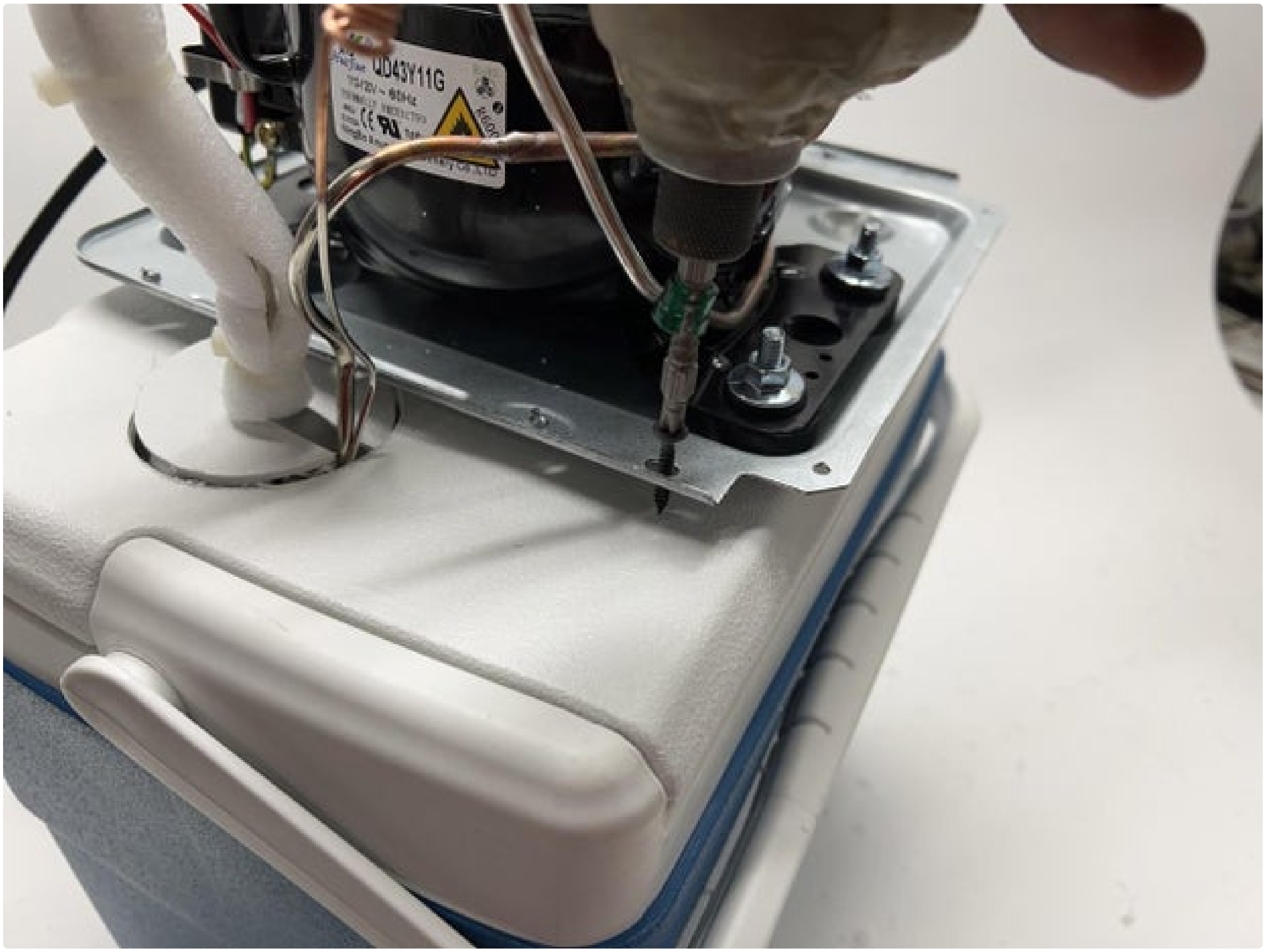
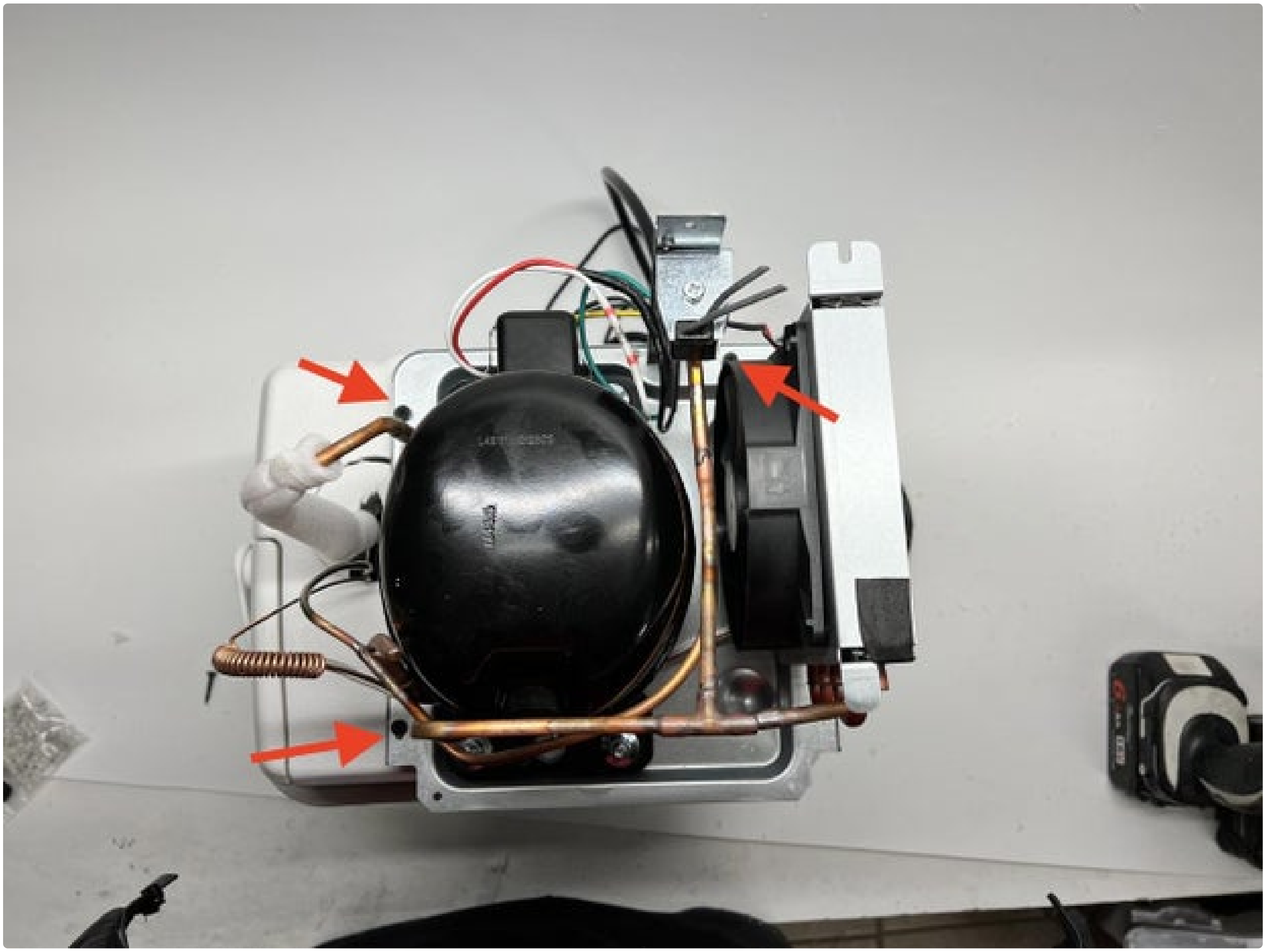
DEER PARK

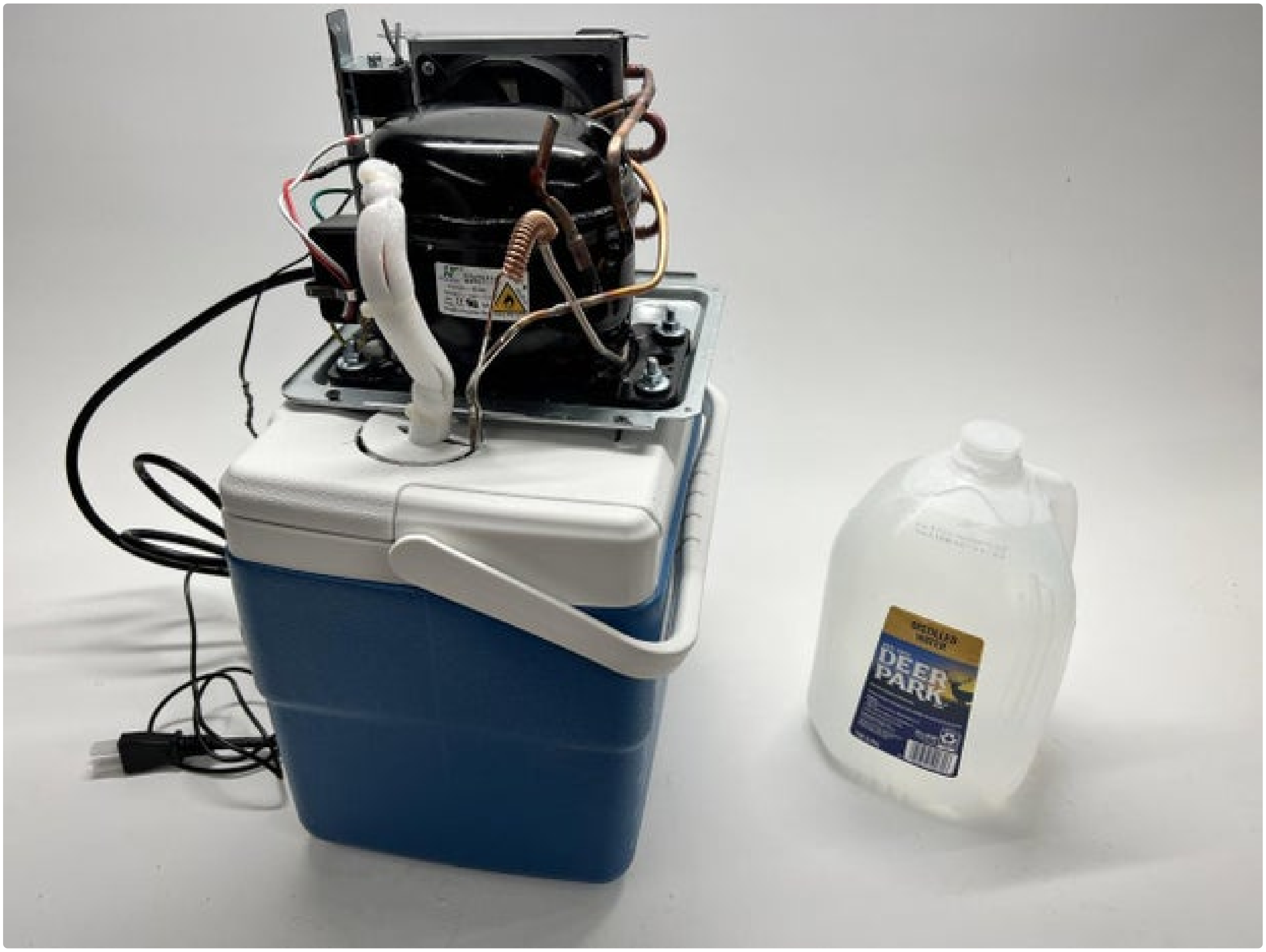
Step 12: Mounting

We can mount the chiller assembly to the lid of the icebox with three #6-#10 plastic tapping screws. The optimal mounting locations are marked with a red arrow in the second image.

Next, you can also zip-tie the insulation foam removed in Step 3 to the return pipe from the evaporator to the compressor.





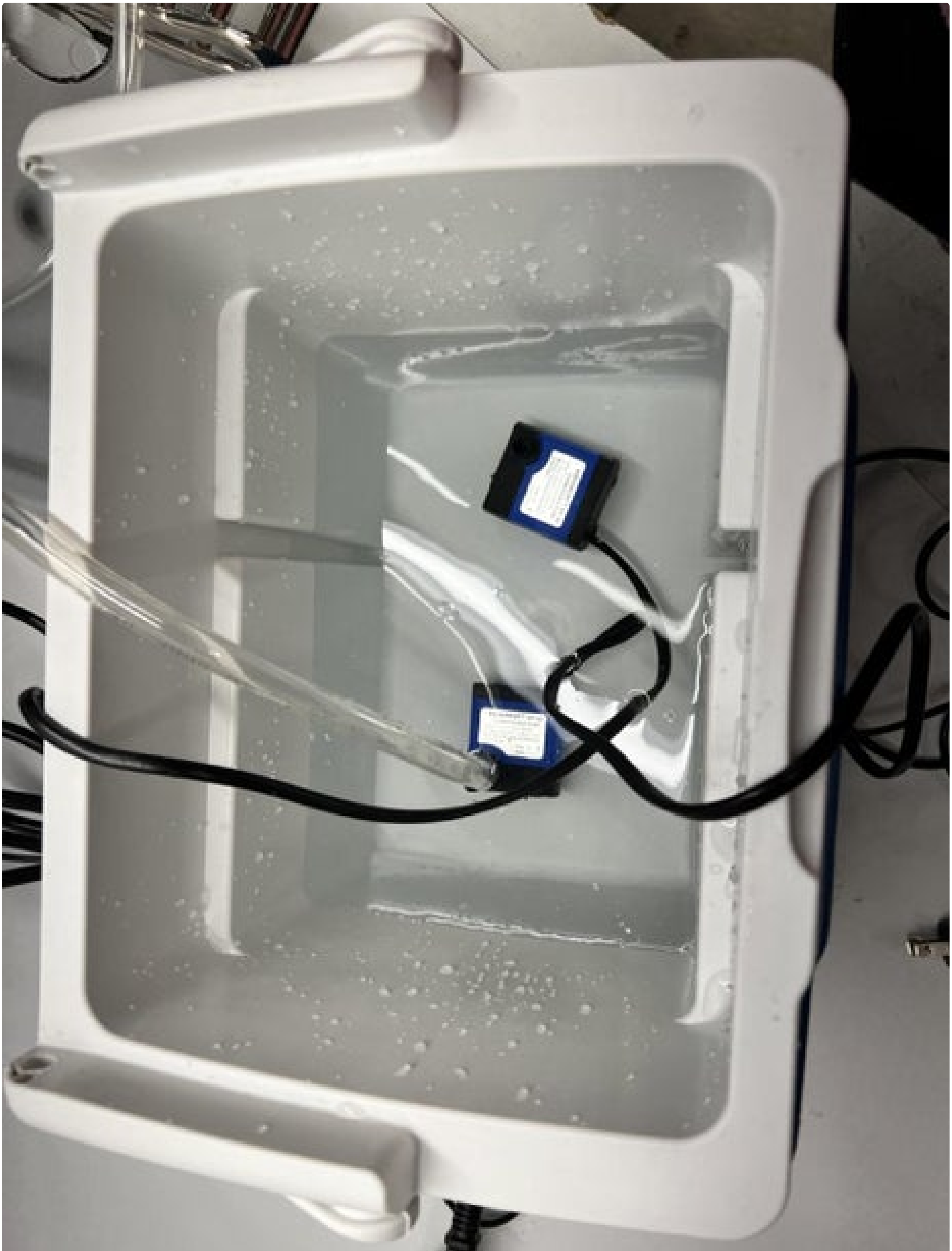

DEER
PARK

Step 13: Final Assembly

We're using two aquarium pumps inside the icebox. One to simply circulate the water, keeping the temperature homogeneous throughout and the second to actually pump the chilled water into whatever needs cooling.

In this case, I'm using distilled water because I want to cool the CO2 tube of my K40 Laser Cutter. This is a challenging application because any additives like anti freeze might cause arcing in the laser tube. Most applications like GPUs, terrariums, tooling are not sensitive to anti freeze, in which case it is highly recommended.

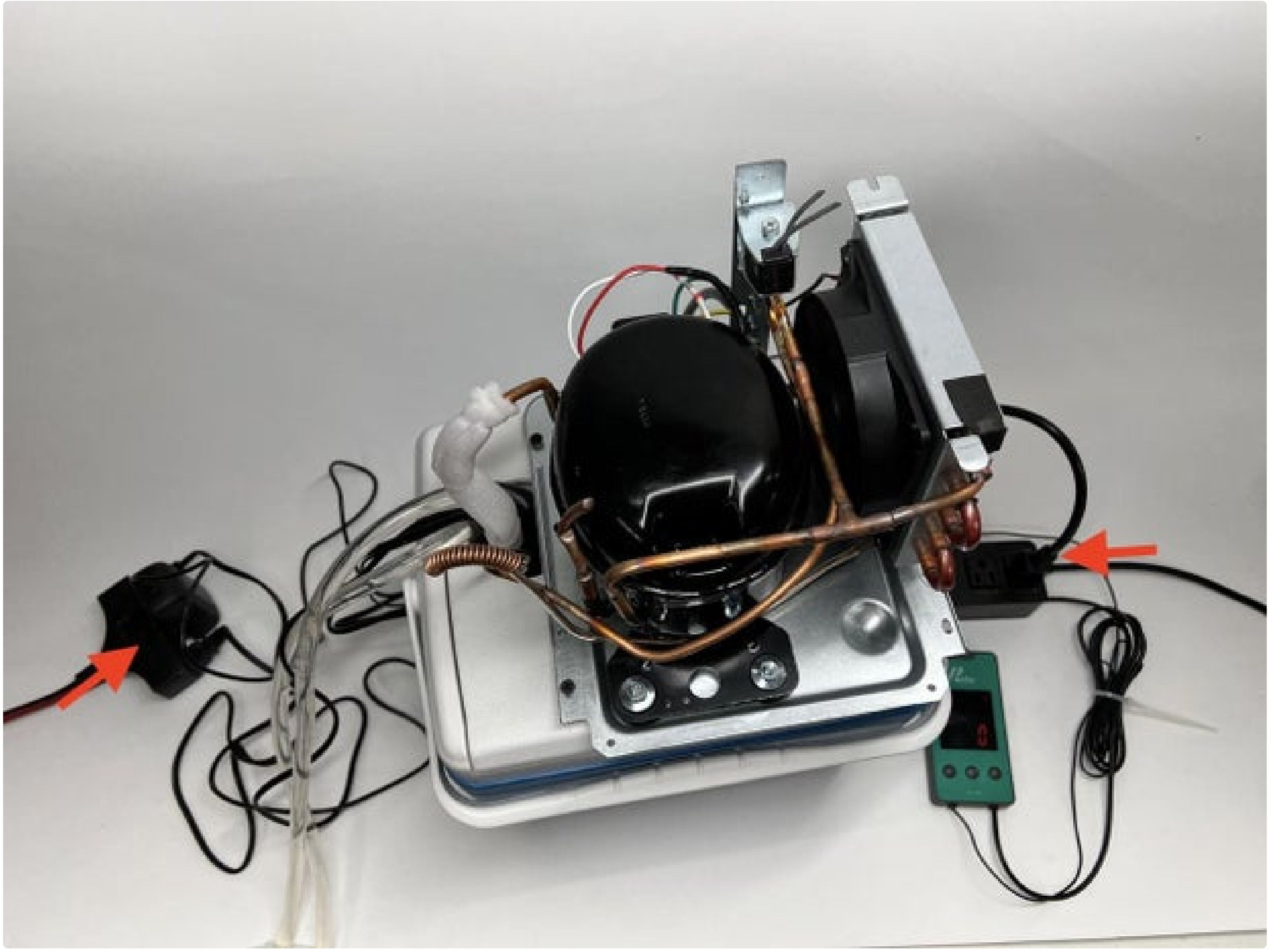
The power cords of pumps and cooling inlet and outlet pipes can be passed through the hole for the evaporator.



Step 14: Thermostat

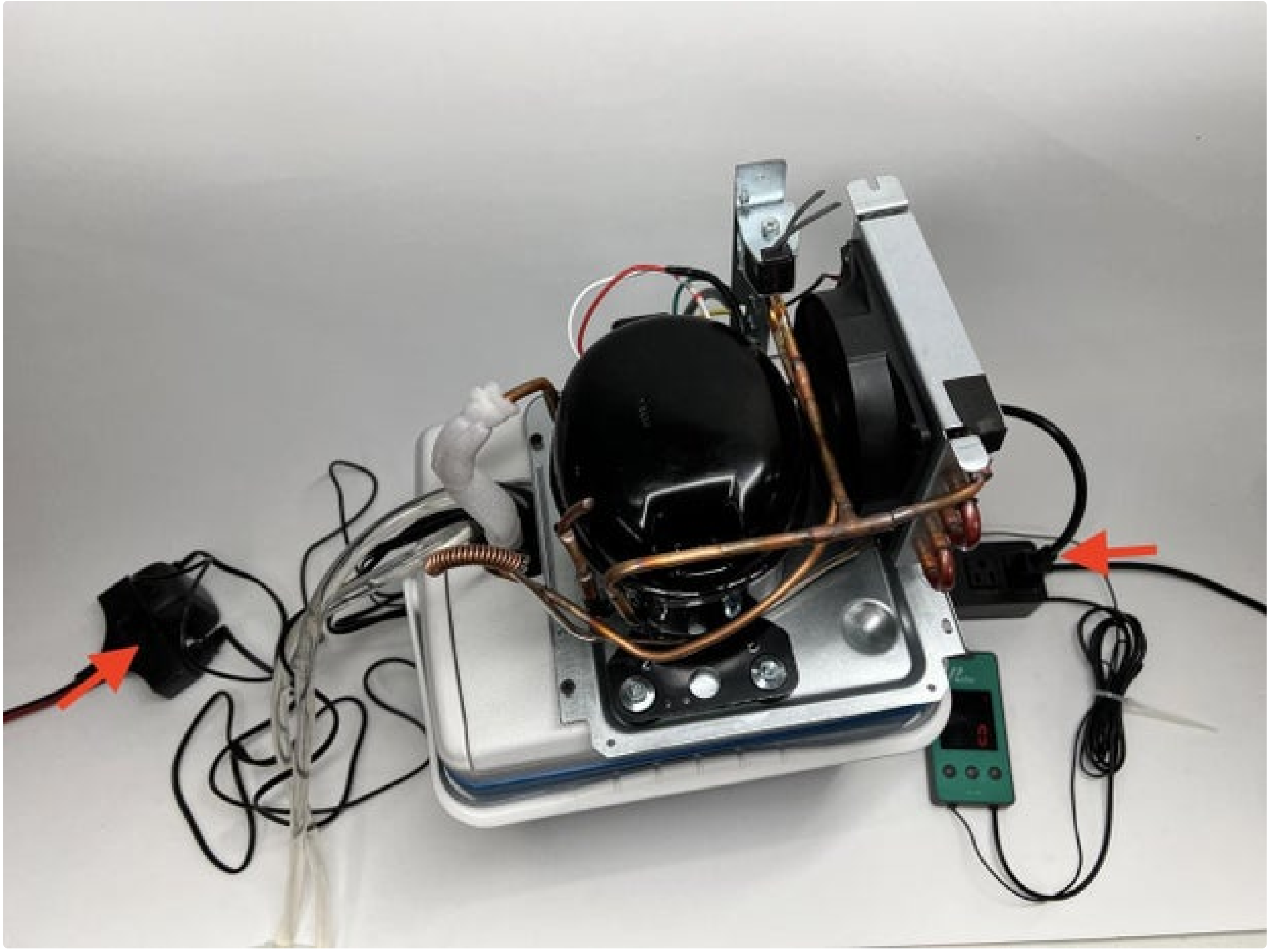
Since we have removed the original electronics, we need an external temperature regulator. Luckily, aquarium thermostats are cheap and easy to get. It already comes with a waterproof temperature probe, which we'll put all the way on the floor of the icebox, away from the evaporator. We'll plug in the compressor to the cooling plug on the thermostat. If your thermostat has only one plug, make sure to change the setting from heating to cooling.

We'll set the temperature to 7°C, with a max of 10°C, (i.e. the thermostat will cool the water until it hits 7°C and wait for the water to reach 10°C before switching on the compressor again).



Step 15: Plugging It All In

We now have four things that need to be plugged into power, two plugs of the aquarium pumps, one plug for the 12V supply, and one plug for the thermostat to which the compressor is already plugged in. Any easy way to manage this wiring mess would be to plug everything into a singe power strip, then switching the strip on and off will control the entire water chiller.



Step 16: Conclusion

The total cost for the project is easily **<$150**. I cannot find any 'real' water chillers in this price range. If you know of anything that is in this price range, I'd love to hear about it! The closest comparison I found was CW-5000 which is often priced $400-$500+ or this water chiller priced at $330.

CW-3000 for example is simply a radiator without a refrigeration circuit. Similarly, many chillers are Peltier based which is a horribly inefficient way to cool anything. Many small drinks coolers and fridges are Peltier based.

This project could use several improvements including: adding a case, attaching a larger heatsink attached to the evaporator, using 12V pumps and connecting them to the same 12V supply and generally integrating everything tighter. As it is though, the system works reliably, and I'm going to focus on getting some performance characteristics next.

I'll add more details about the project to Refrigediro.org.