Electronics Assembly Manual
for the
ElectroSpinner - Whirl-A-Rama

Questions or corrections should be emailed to dougmsbbs@hotmail.com

Note:

This machine can be operated with a variety of HV power supplies and syringes. For that reason, as well as my attempt to put as much information about the machine out as soon as I can, the construction manuals are divided up into individual components. The suggested building order is cabinet, syringe, HV power supply and finally the electronics.

All of the files for this project are available at the projects github page at https://github.com/dougmsbbs/ElectroSpinner.

Table of Contents

Parts List

3D Printed Parts:

Amount	Item
1	Terminal Mount
1	DoorSwitchMount

Purchased Items:

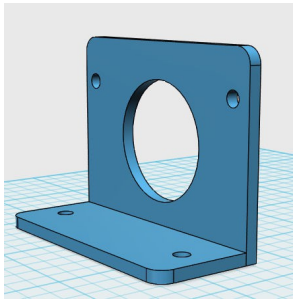
Note: Only items used in the manual are listed. Additional items needed to complete the project will be listed in those manuals (Assembly manual, Syringe manual.)

Amount	Part	Cost
1	gShield Motor Controller	$50.00
1	Power Supply 12v DC Output 29A	$50.00
	Enclosed Style	
1	8 Pin Terminal Block	$2.75
1	USB A-B Cable - 6 foot	$3.95
1	Dual Row 5 Position Screw	$2.50
	Terminal Strip	
1	Limit Switch-Long Arm 2"(50.8mm)	$5.38
	15Amp. uxcell V-153-1C25	
2	M3x12mm Bolt	
2	M3 Nut	
2	M4x16mm Bolts	
2	M4 Nuts	

2	M2x16mm Bolts	
2	M2 Nuts	
4	M2 Washers	
1	24" (610mm) 18awg wire	$1.00
	Duel Conductor.	
24"	18awg hookup wire. Red	$5.00
24"	18awg hookup wire. Black	$5.00
2	18awg Crimp Terminals- Female	$.20
2	Alligator Clips – 1"(27mm) or larger	$1.00
10'(3048mm)	HV Wire – 40kV	$12.48
	This is enough for several machines.	
6	Wire Ties – Small	$.50
2	Pair of Wire Bullet Connectors	$.50
	(two each – male and female)	

Part Identification

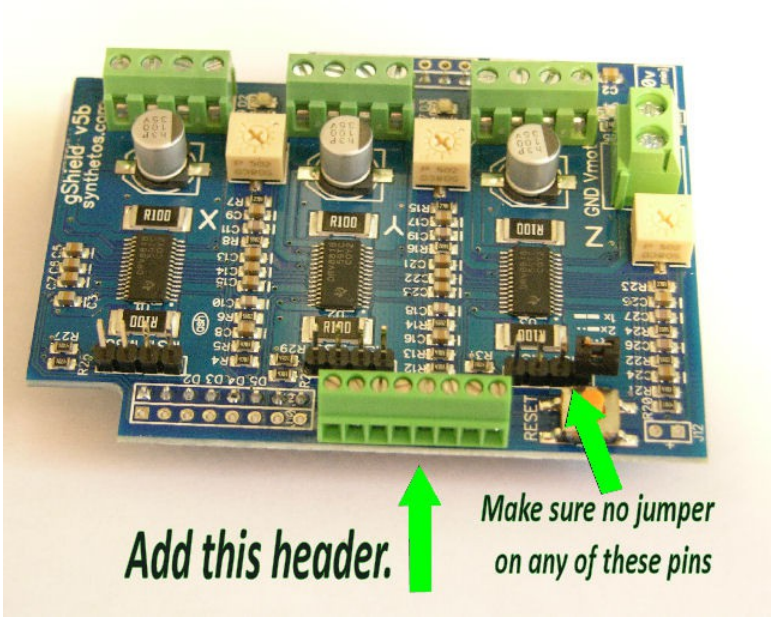
3D Printed Parts:



Prepare The gShield.

We're going to need to add a few header pins to the gShield before we mount it in the machine. In particular we need to bring out the D8 through D13 and Grd lines. We won't be using all of them, but we'll just add the entire row of pins while we're there, and we won't have to revisit this when we expand the machine in the future.

So go ahead and solder the 8 pin terminal block in place on the gShield.

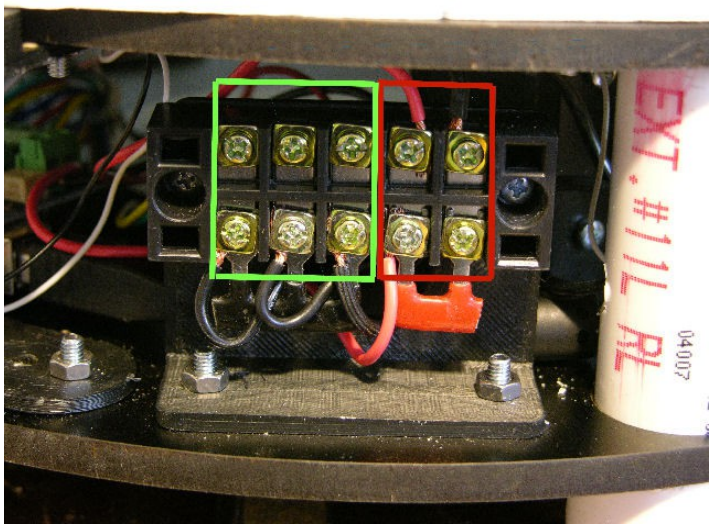


While you're looking at it, make sure none of the jumpers are on the MS1 MS0 pins on any of the axis's. We want micro-stepping on.

Mount The Terminal Strip

We're going to use a terminal strip to distribute power, so lets get that installed now.

Start by cutting one each of the jumpers. Cut each so that you have two pieces of each, one with two spades and one with three. Mount these on the terminal block, with the two spade red one on the lower right, and the three spade one on the bottom left.



From now on all the positive wires we hook up will go on the four terminals within the red rectangle in the photo above. All the negative wires will go under terminals within the green rectangle.

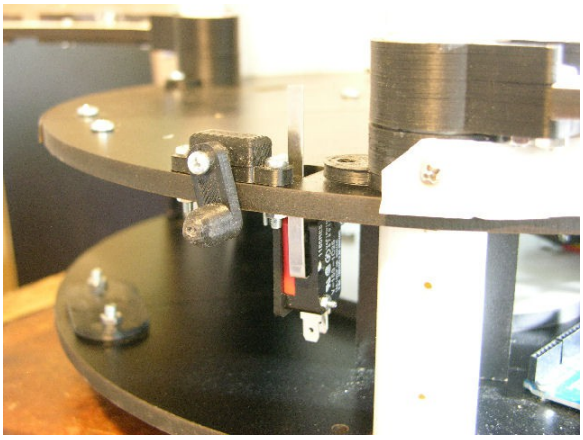
Then mount it to the 3D printed TerminalMount. Use two M3x12mm bolts and nuts.

The assembly then gets mounted to plate B1DuelPost in the cabinet. It goes in the two holes between the posts and arduino. Use two M4x16 bolts and nuts, inserted up from the bottom. Refer to the photo above.

Switch Wiring

Next, install the microswitch with the long arm on it to the DoorSwitchMount 3D printed part. Use two M2x16mm bolts and nuts.

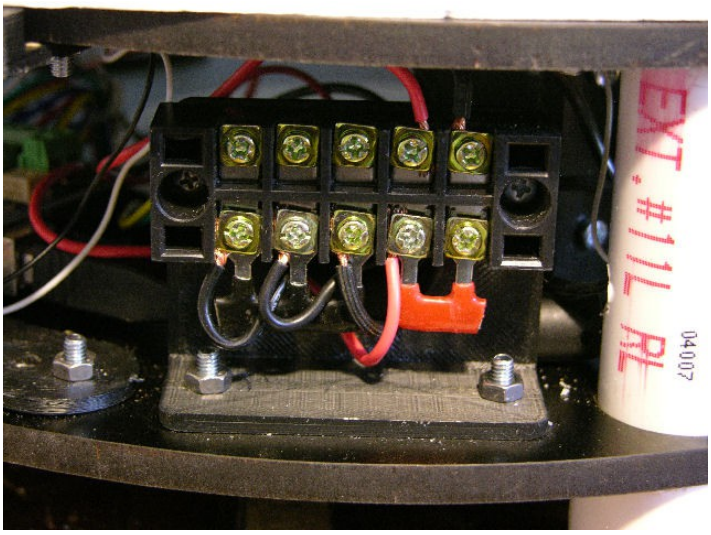
Now install the DoorSwitchMount by the slot in part B1DuelPost. Use two M2x16mm bolts, two M2 nuts, and four M2 washers. Adjust the switch in the slot until the switch is tripped when the door is in the closed position with the latch holding it in place.



Power-In Wiring

Run the 24” (610mm) 18awg dual conductor wire in between the duel posts between decks B1 and B2. Route them so they come out from behind the terminal block, with the ground wire going to the black side, and the positive to the red side.

Like this:



Fasten them both in place under the screws terminal.

Next, locate the two wires you ran up the right side rear post when you put the cabinet together. This will be the thicker wires coming out of the hole in the post.

These are the power going to our HV power supply, and they run all the way up and out the top of the machine.

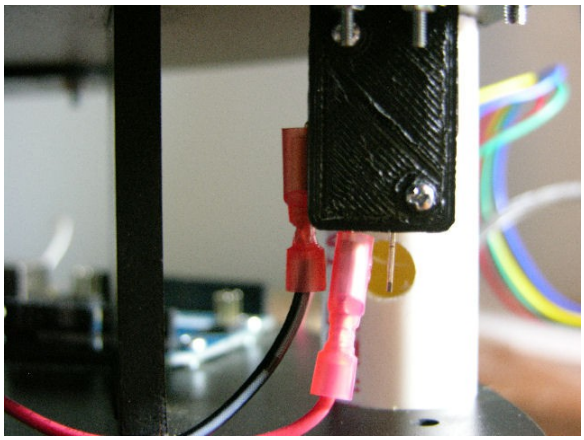
Feed one of the wires (which is up to you, but if one has a stripe on it I'd use it for positive) into the back of the terminal block and out the front and fasten it to the negative strip. Fasten it down to the screw terminal.

The other of that pair of wires goes to the door switch center terminal. Install a female crimp terminal on the end of the wire and push it onto the switch.

Take another 12 inch (305mm) piece of 18awg wire and install a female crimp terminal on one end. Put that end on the normally open terminal on the door switch.

Run the other end to the terminal block, insert it from the rear, and fasten it down to one of the positive screw terminals.

That's it for the power to the HV power supply. It will only come on when the door is closed.



Arduino Power

Since we will be controlling the machine from the serial port connected to a computer, we don't need to power the arduino separately. So we can skip it. Go us!

gShield Wiring

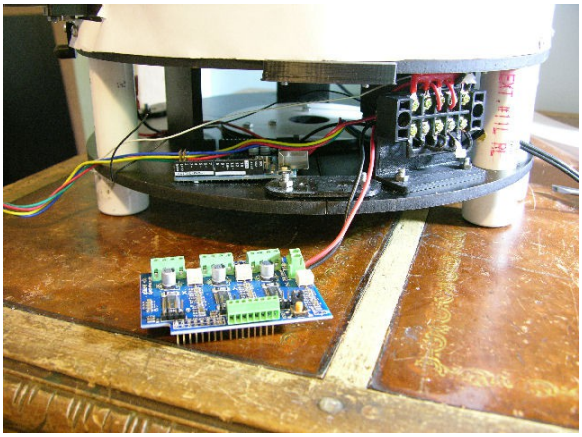
The gShield *does* need power. So lets do that next.

Take two eight inch (203mm) lengths of the 18awg wire and fasten them to the next available screw terminal on the terminal block, black to negative, red to positive. Stay with our plan by sticking them in from the rear of the terminal block. Keeps everything all nice looking that way.

Lay the gShield on the table in front of the cabinet, with the two wires you just installed coming out from behind the terminal block. Fasten those wires to the gShield. Pay **very close** attention to the polarity as you install them. Make darn sure you have the red wire on positive and the ground on negative!

You can ruin the gShield if you get this wrong!

Be careful not to bend the pins on the gShield, but it's rather nice to be able to wire up the gShield outside of the cabinet. When it's all ready we'll mount it on the arduino.

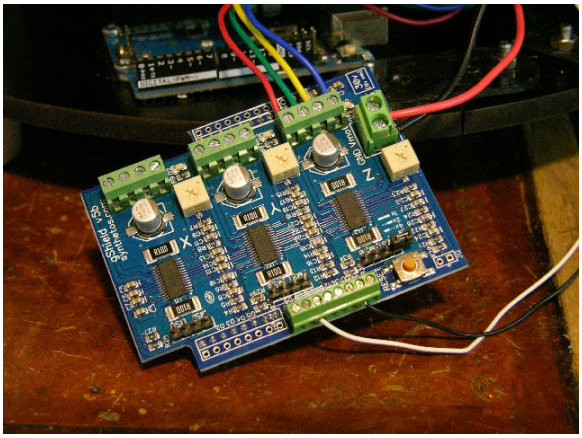


Stepper Motor Wiring

Time to wire up the stepper motor. Pull the wires from the stepper motor out, lay them beside the power wires going to the gShield, and trim them to about the same length.

Wire the four wires to the terminals for Z axis. If your stepper came with the wires in a plug-in connector wire them to the gShield in the same order. If there was no connector you'll have to find the order yourself. If you can't get that information from the manufacturer, there are plenty of web sites showing how to determine the order they

need to go. Here I knew the order of mine was red, green, yellow, blue.

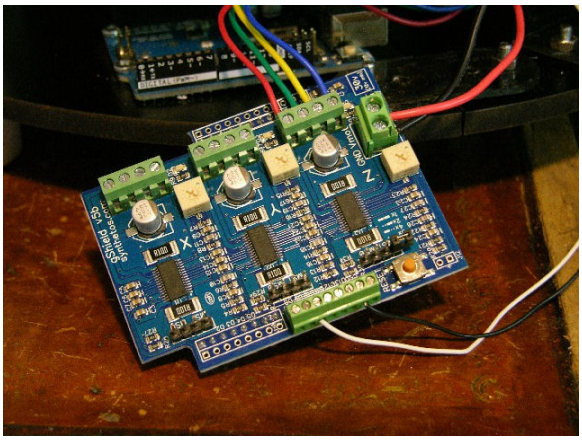


Top Limit Switch

Find the two signal wires you ran up inside of the rear post and fastened to the top limit switch. Run them behind the terminal block and out to the gShield.

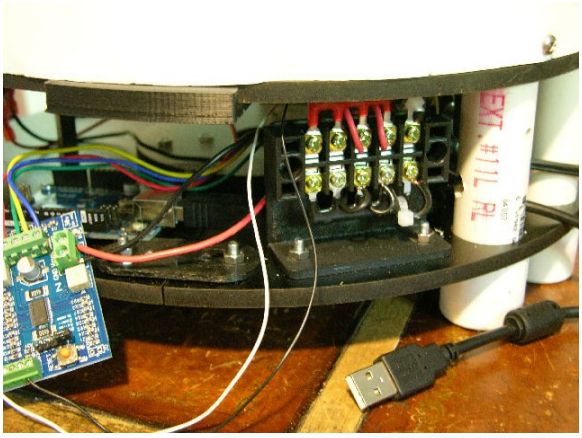
Fasten one of the wires to the header screw terminal's you soldiered to the gShield way back at the start. It goes on pin 10. Wire the other one to the ground pin on the header. If you're not sure what the pin numbers are hold the gShield in place over the arduino, and it's printed on the side of the arduino header.

Pin ten should be the third pin from the left on that header, and ground is the second from the right.



USB Cable

Slide the USB cable in between the rear posts, behind the terminal block, and into the arduino.

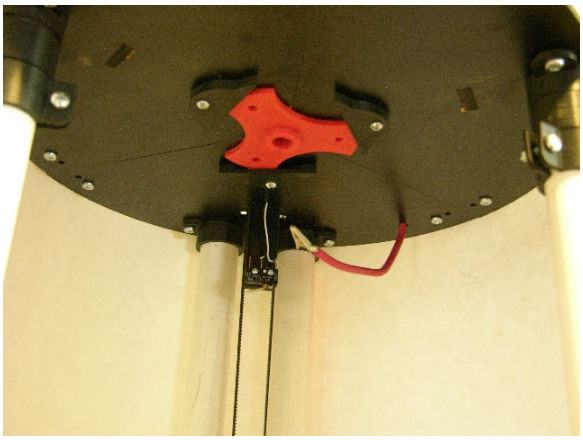


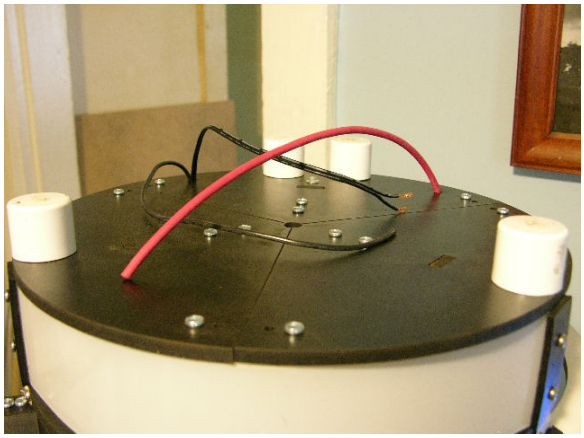
HV Wiring

Cut a piece of the HV wire to a length of twenty inches (508mm) and insert it down through the hole on the right side of piece T2DuelPost. See the picture below to locate the hole. Then feed it down through the matching hole in T1DuelPost and into the work chamber. Feed enough down so that you can comfortably reach it to attach an alligator clip.

Crimp one of the alligator clips onto the end in the chamber, then soldier it in place. Seeing how important this connection is to the functioning of the machine, it's best to both crimp and soldier it. Then hold the alligator clip up to the center of the chamber right below the hole in the center. Pull any excess back up on top of the machine.

Leave the extra on top alone for a bit. We'll fasten that to the HV power supply when we get that far.

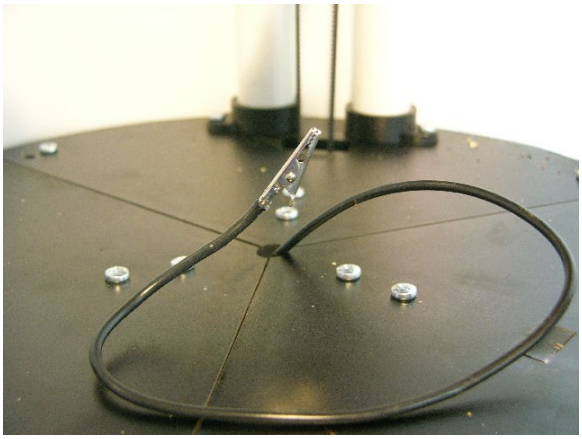




Chamber Ground Wire.

Attach another alligator clip to the ground wire that's coming up through the center hole in the bottom of the chamber. Same as above, crimp and then soldier in place.

This wire will be attached to the collecting plate when we run the machine.



Syringe Wiring

Assuming you have already built the syringe for this project, or you have another

one from a different source you would like to use, it's time to get it hooked up.

Any syringe pump that operates off of a four lead nema17 stepper motor should work just fine.

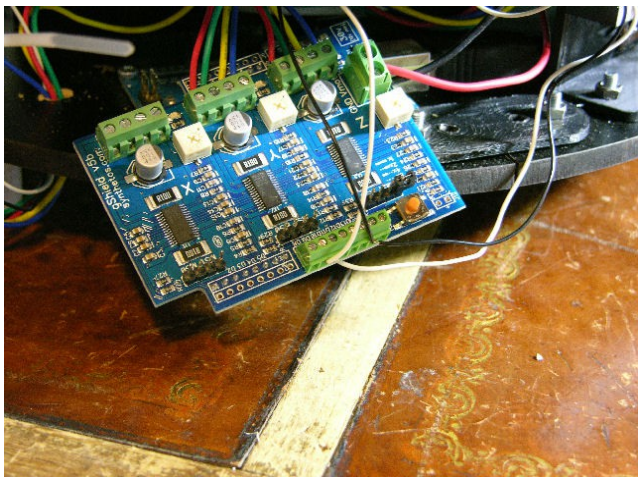
Start by routing the wires from the syringe pump into the cabinet. Wire tie the wires up neatly on the run from the stepper motor and along the lower swing arm. Then run them under the machine and up into the hole between the arduino and the front right post. Wire tie in enough places to keep the wires under control and looking neat. I like to add one just inside the cabinet where they enter and leave a little tail on it, to prevent the wires from getting pulled out.

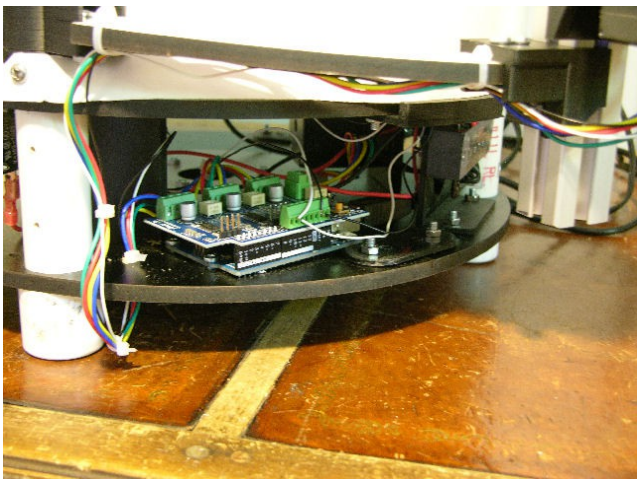
Pull the gShield off of the arduino if you have it sitting on it, and pull it out of the cabinet a bit.

Wire the four stepper wires to the Y axis on the gShield. The order they go depends on the stepper motors you have. Check the manufacturers web site, or search the web to find out how to determine the correct order for your stepper motor.

Wire one of the wires coming from the syringe pumps limit switch to pin nine on the gShield header we soldered in place.

Connect the other wire coming from the limit switch to the ground terminal on the gShield right along with the cabinets limit switch ground.





Carefully aligning the pins, place the gShield back onto the arduino and press down into place.

We Need Power!

You have several choices for a power supply. An ATX computer power supply is a

popular choice, but takes a bit of work to get it ready. An enclosed type power supply is pretty much ready to go right out of the box.

The choice is yours. If you want my opinion, I'd say if you're spending money to buy a new supply, go for the enclosed one and avoid the extra work.

ATX Power Supply

Enclosed Power Supply

If you have the enclosed style, skip this next section and go right to wiring it up.

Modifying an ATX Style Power Supply

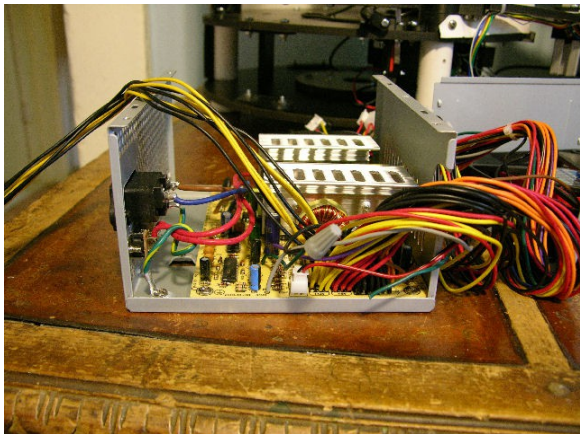
We need to make sense of that tangle of wires coming out the back of the power supply.

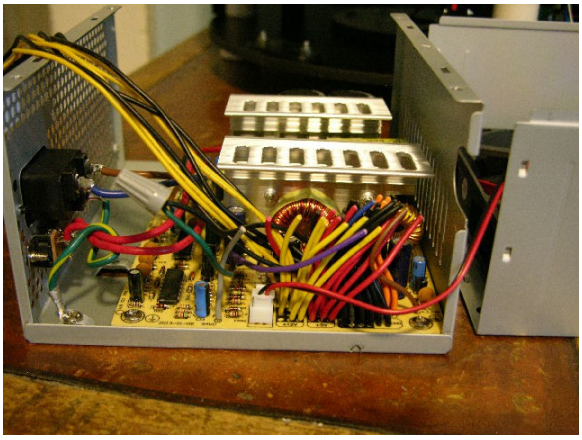
Start by taking the screws out of the top of the case. There is normally only four of them.

Take the top off and swing it off to aside. Most of them have a fan in the top piece, and you'll need to be sure and leave those wires intact.

Now find the wires you want to save. You need four of the yellow wires and five of the black ones. You also need the green wire.

Pull the ones you want to save off to one side, and cut all the others wires off.





Tie the green wire and one of the black wires together with a twist on wire connector. That's the 'power good' signal that will let the power supply come on.

Take the four yellow and four black wires you pulled aside and trim them down to the same length, leaving them as long as you can. Strip the ends off and twist them together, all black in one bundle, all yellow in the other.

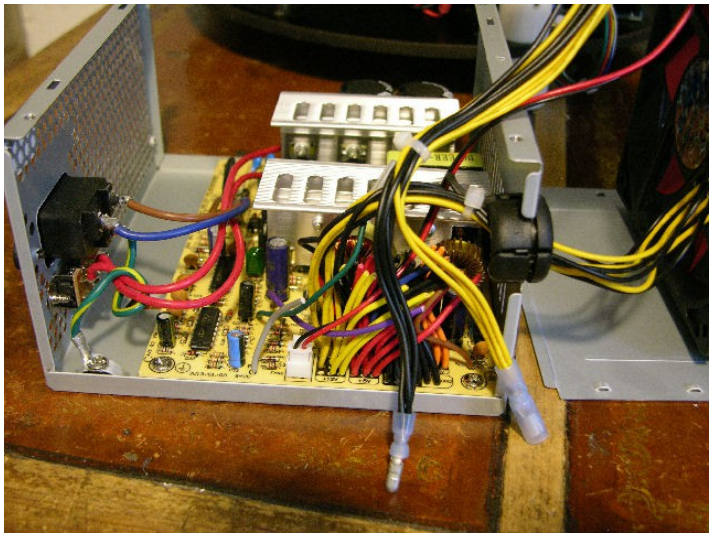
Install a *female* bullet connector on the yellow wires, and a *male* on the black wires. That way you can disconnect the power supply from the cabinet, and still be sure to plug them back in correctly.

Now we need to install the bullet connectors on the 24” duel conductor wire. This time you will put the *male* connector on the wire that will be our positive lead, and the *female* on the ground wires.

Leave this unplugged for the moment. We'll want to test the supply first.

Pull that duel conductor wire out the rubber grommet in the power supply's case, and wire tie it so it can't get pulled out the back. My power supply had a loop in the rubber grommet just perfect to hold the wire tie in place, so I used that. If yours has no such thing put two wire ties on, pointed in opposite directions, and don't trim them down all that much. See if that will keep them from being pulled out. Whatever you come up with that works, great. As long as they can't be yanked out of the supply, it's all good.

Yours should look something like this:



Put the cover back on the power supply and install all four screws.

It's time to test it out. Hook up a meter to the output wires, and plug in the power supply. The fan on the power supply should come on and the meter should read around 12 volts. If yours does, great!

If the fan does not come on and you get no voltage reading at all, it's most likely a problem with that 'power good' line. Unplug the supply and open it back up to see what's going on.

If the fan works but you get something other than 12 volts, you likely used the wrong wires. It would be a rare thing to not have the 12 volt being on the yellow wires (I've never seen it), but I guess it could happen.

Given that you have the 12 volt output, unplug the power supply, and plug in the

wires coming from the back of the cabinet. They're the ones with the matching bullet connectors we installed above.

Now double and even triple check that the polarity is correct by checking for continuity between the bullet connectors and the terminal block in the cabinet. Make sure that the 12 volt line coming out of the power supply is hooked to the 'red' section on the terminal block, and the ground from the power supply is connected to the 'black' terminal block section.

Incorrect polarity can destroy the gShield. Make darn sure it's correct!

One more little detail to take care of before we move on. Those wires going up to the top of the cabinet to power the HV supply are hanging in the wind up there. If they were to touch each other it wouldn't be a good thing. Make sure they are separated, or better yet put a wire cap on them. Just taping them off would work too.

If all is well, you're ready to test it out. With the bullet connectors firmly together, plug in the power supply. You should see the blue LED glow on the gShield.

Ain't that a grand sight!

If you see the light (pun intended), move your meter to the two leads on top of the machine. Plug the power supply in. Open and close the door a few times to make sure it's working okay. You should get 12 volts when the door is closed, and zero volts when it's open.

If there is a problem with any of that, unplug the supply and track the wiring back until you find the problem. It's in there somewhere. And you'll find it in short order, I'm sure.

At this stage, you can replace the side covers on the cabinet. With all that working, the only thing missing as far as wiring goes is the HV power supply.

We'll get to that next.

High Voltage Time!

Assuming you have the high voltage supply sitting there staring at you, we can wire it up now.

The HV supply for this project works well, but it's not your only option. If you have another one, feel free to use it. It needs to be powered by 12 volts, but that's about all you need to worry about. Whatever you use should have an adjustable output, and go

up to 30kV.

The HV supply sits on top of the machine, where's it close to the nozzle, giving us as short a HV voltage path as we can get. So go ahead and place it up there.

Wire the two 12 volt leads up to the input of your HV supply, paying close attention to the polarity.

The ground output from the HV supply goes to the ground wire running down the left duel post.

The high voltage output goes to the HV wire going down the small hole on the right side, and leads to the alligator clip hanging at the top inside the cabinet.

That's it for the wiring.

All you need now is the firmware uploaded to the arduino.

Uploading the Firmware

To upload the firmware you will need the arduino IDE, the firmware for the electrospinner, as well as the library AccelStepper.

The arduino IDE can be downloaded here:

https://www.arduino.cc/en/Main/Software

The electrospinner software is available on the projects github page:

https://github.com/dougmsbbs/ElectroSpinner.

And finally, the AccelStepper library can be found here:

http://www.airspayce.com/mikem/arduino/AccelStepper/AccelStepper-1.51.zip1

Follow the directions to install the arduino IDE. Then install the AccelStepper library. Instructions to do both are included in the IDE download, or can be found all over the web.

Plug the USB cable coming from the electrospinner into your computer. Load

up the electrospinner firmware in the arduino IDE, and tell it to compile and upload.

When it's done uploading, you can use the arduino IDE's serial monitor screen to send commands that will run the electrospinner. Instructions on the best techniques and all the commands will be in the Operations Manual (as of 7/7/2016 not yet completed). Keep checking the projects github page to see when it's ready for release.

Also in the works is a windows 8.1 or greater GUI for the electrospinner. It will also be released on the projects github page.

That's about it. Your machine is put together and ready for a run. The how's and why's of that will be in the Operations Manual when it's ready for release. There is a lot to try with this machine, and I'm sure I won't be the one to discover all of them. I look forward to any and all knowledge you gain from using this machine, and sharing it with the rest of us.

It's going to be an interesting few years, while we explore all that is possible with a hobby level electrospinning machine about anyone can build. I can't wait to see what you come up with!