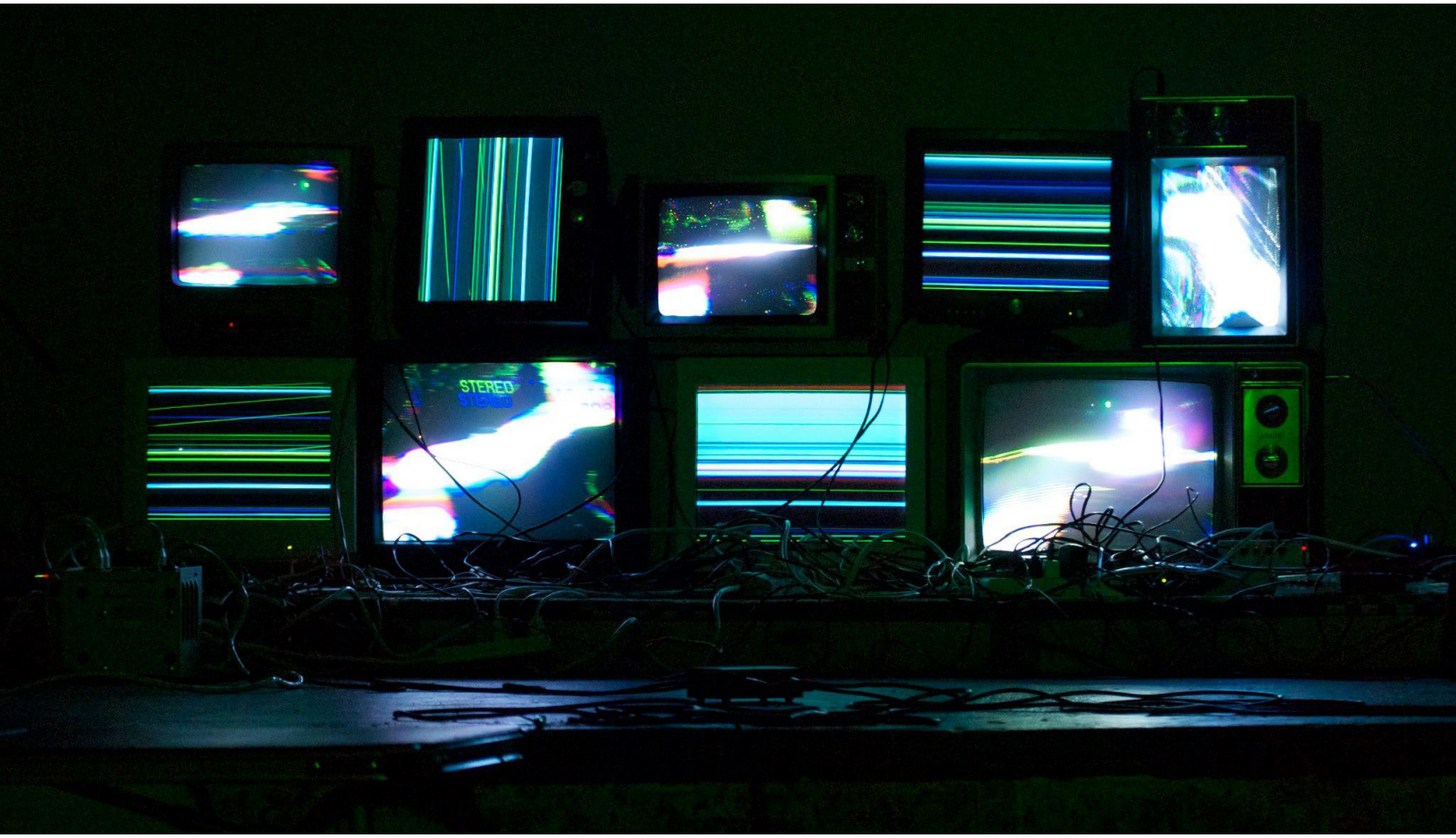
CRACKING RAY TUBES



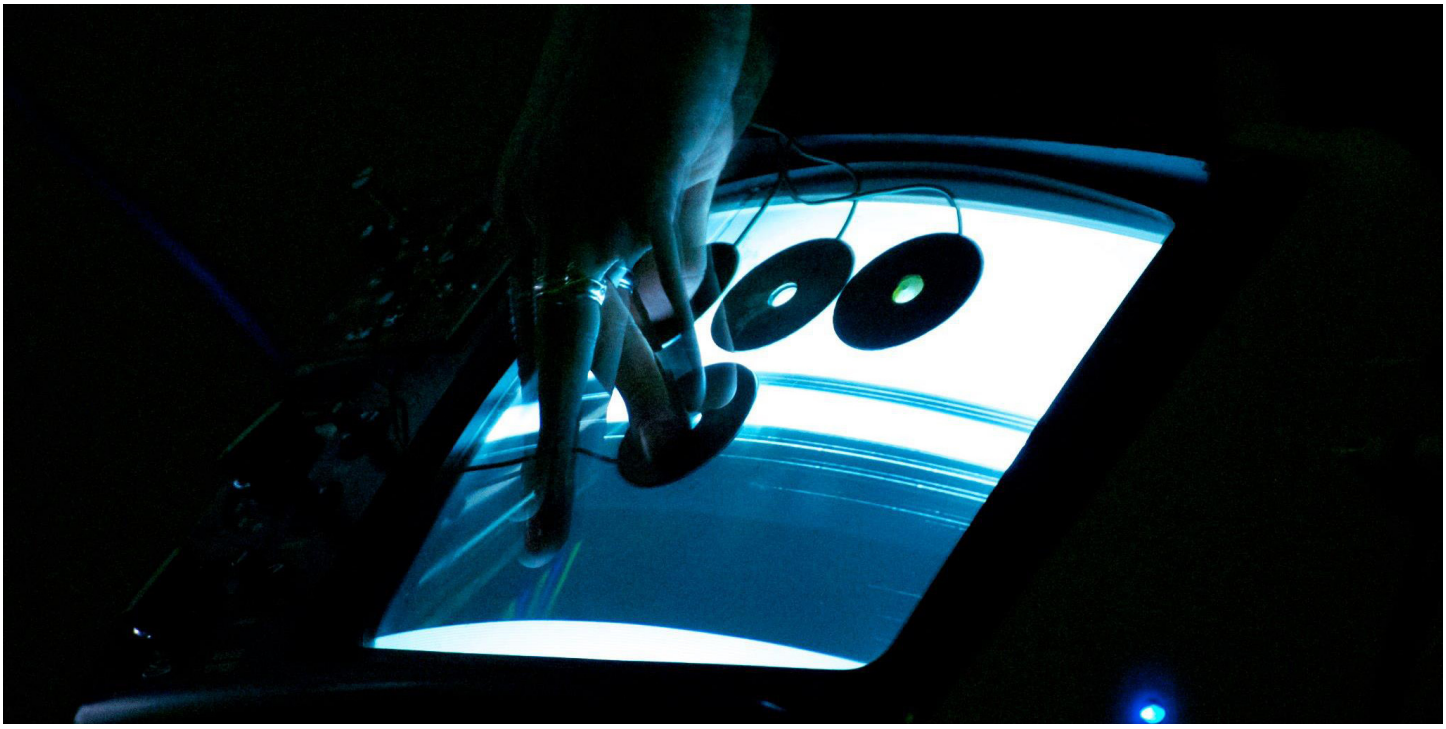
JAMES CONNOLLY KYLE EVANS

Cracked Ray Tube is a collaborative realtime project that breaks and disrupts the interfaces of analog televisions and computer monitors to produce flashing, screeching, wobbulating, self-generated electronic noise and video.

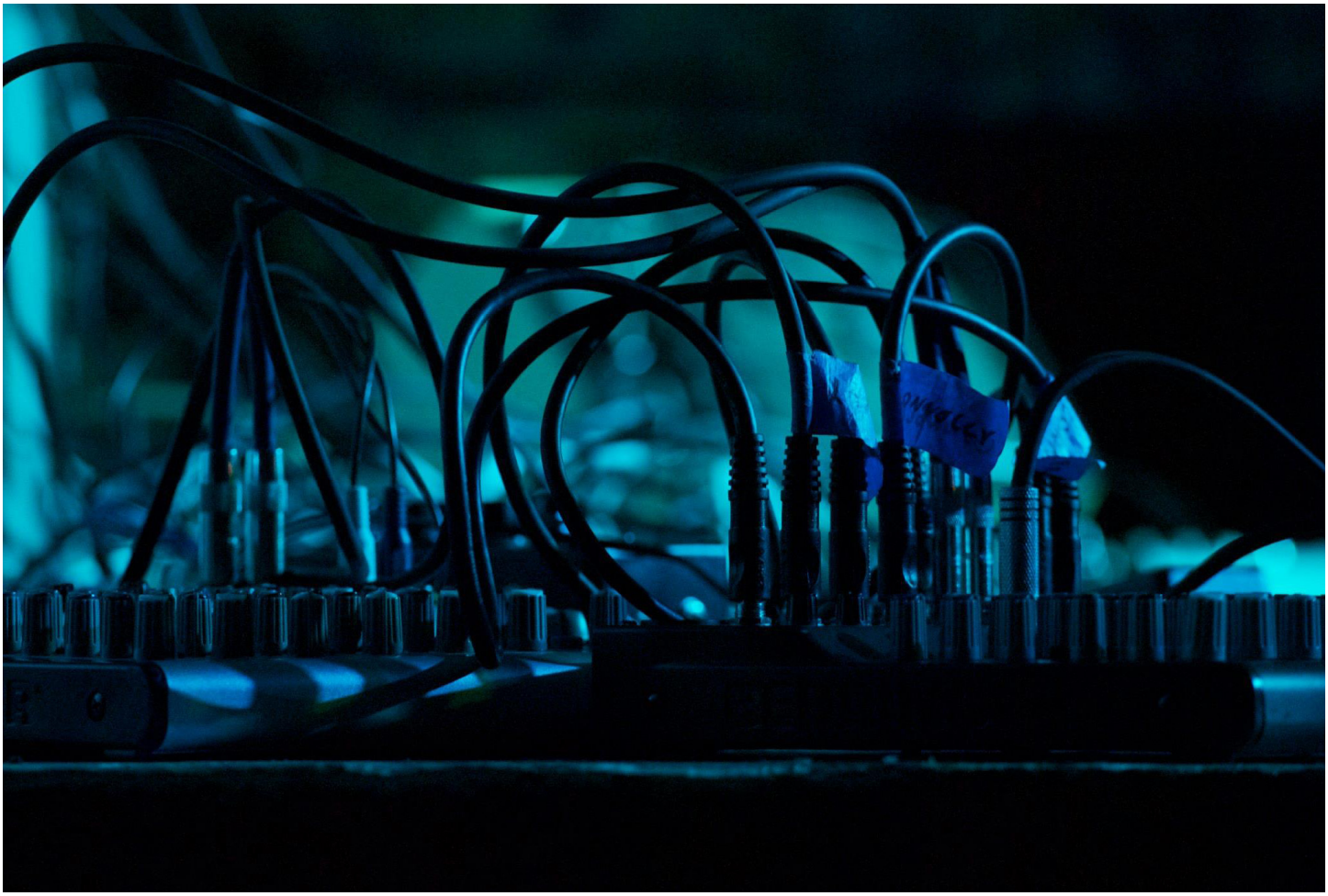
Our audio and video hacks for televisions and VGA computer monitors were first developed as independent projects, and collaboration grew out of their natural compatibility. With the computer monitors, the red, green, and blue video signals of the VGA cable are processed and fed back through a sound mixer simultaneously generating the audio and video information, which is received, deciphered and displayed by multiple computer monitors. On the other side, transmitted video is distorted through both physical contact with handmade circuitry and by electromagnetic flexing and folding of high powered electron beams within modified televisions. In both of our systems, the interfaces of the hardware are hacked, removed, and replaced with structures that function in a far less controlled and more chaotic manner, able to be manipulated through complex instrumentation resulting in unexpected outcomes that differ greatly from their intended use as commodities. Rather than using it to generate signals to be consumed by the viewer, we're interested in examining the cathode ray tube as raw material in itself, as a physical object capable of breaking the viewer's expectations of the familiar act of passively staring at television and computer screens. We're interested in engaging with the methods developed by artists who have examined the cathode ray tube in its own aesthetic qualities including Ben Leposky's Oscillons of the 1950s, the endless experiments of Nam June Paik, the Sandin Image Processor, as well as several artists currently working in the collaborative New Media art world, such as the Chicago group Arcanebolt.

This document describes the way our system works through schematics and tutorials. It explains how to hack the communication networks of these hardwares in order to create new and alternative uses that differ from their intended purposes. This information is presented as a starting point from which your own methods of making, breaking, hacking, and restructuring can follow.

James Connolly and Kyle Evans
crackedraytube.com



CONTENTS



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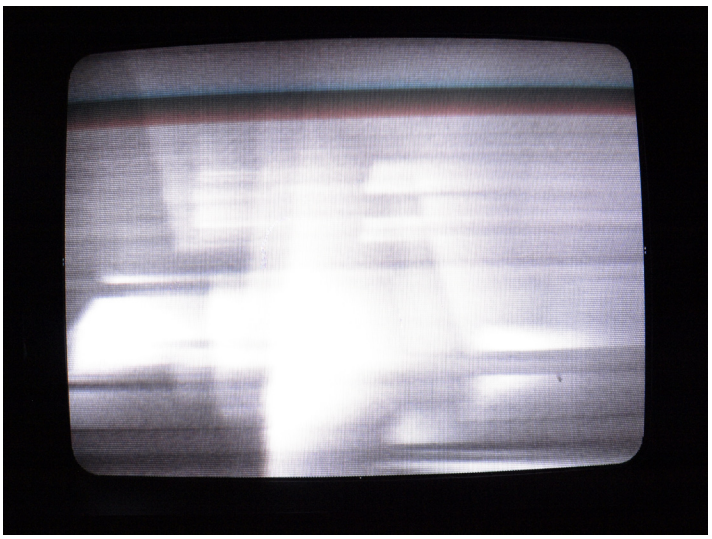
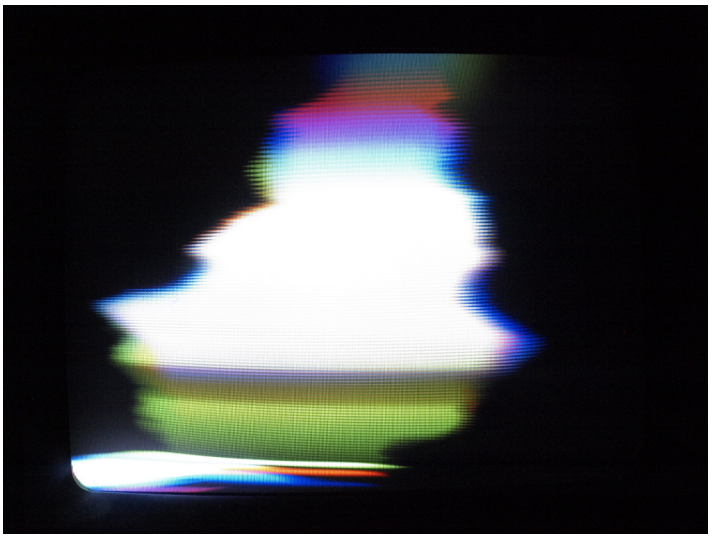
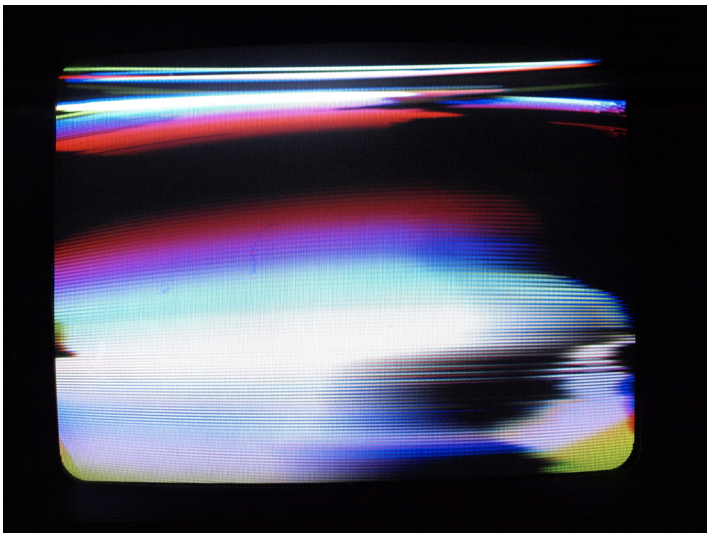
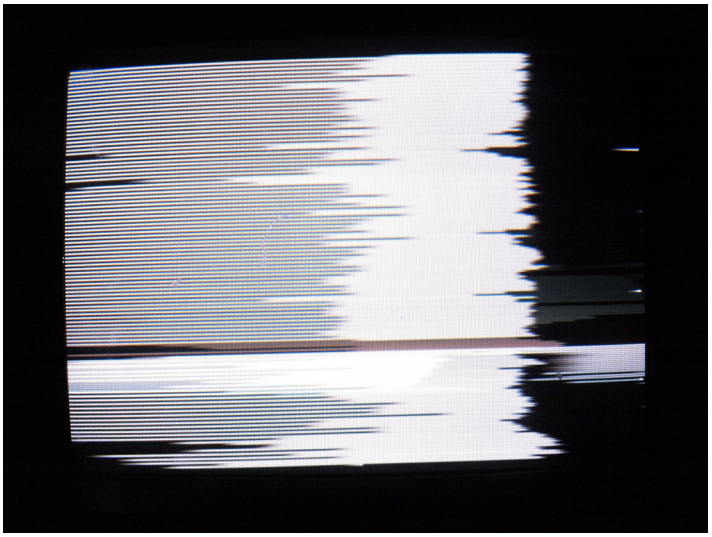
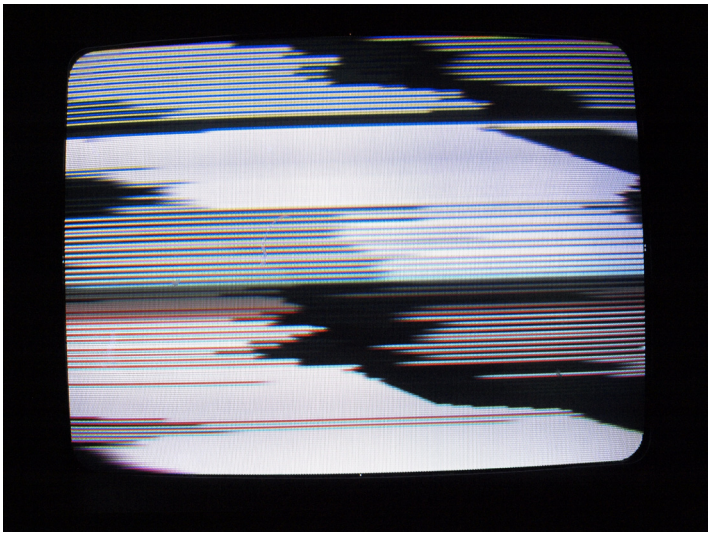
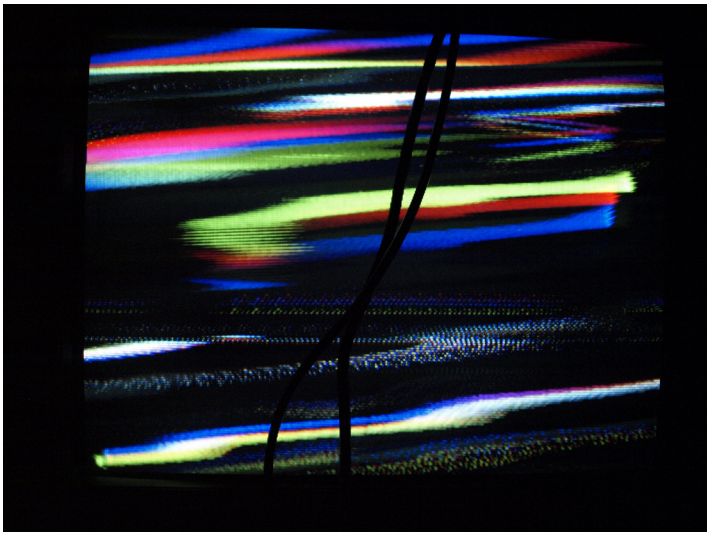


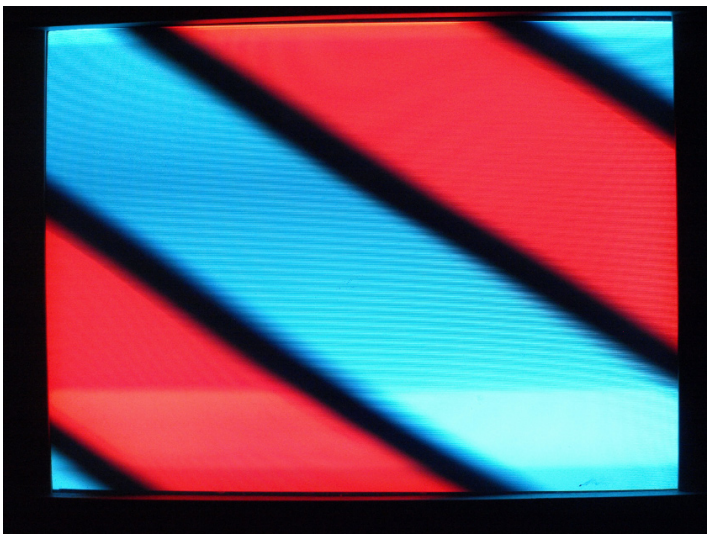


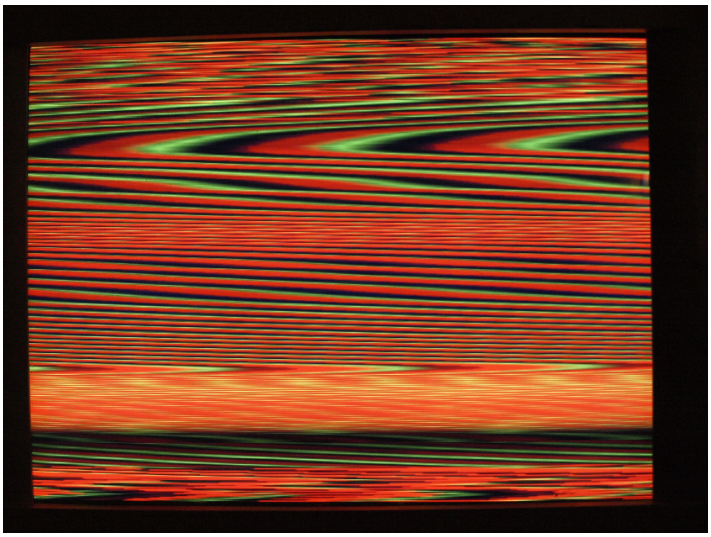


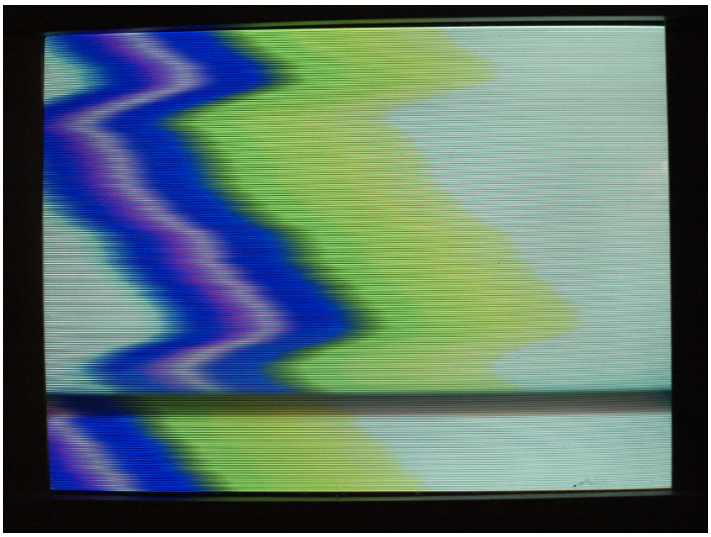


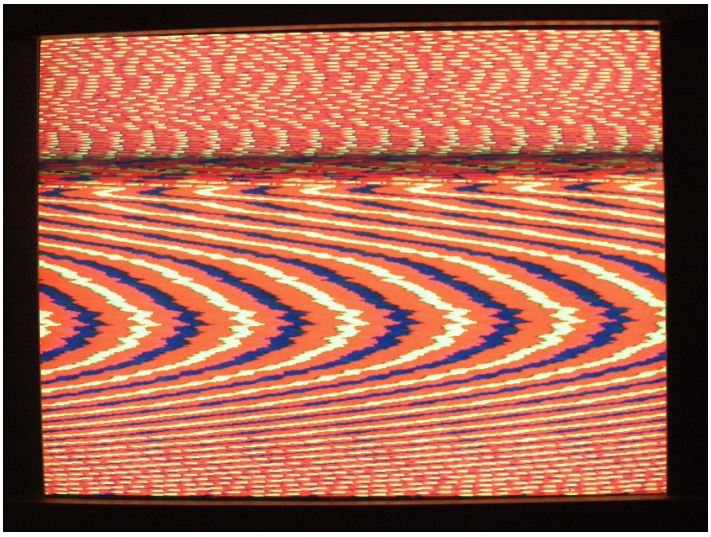


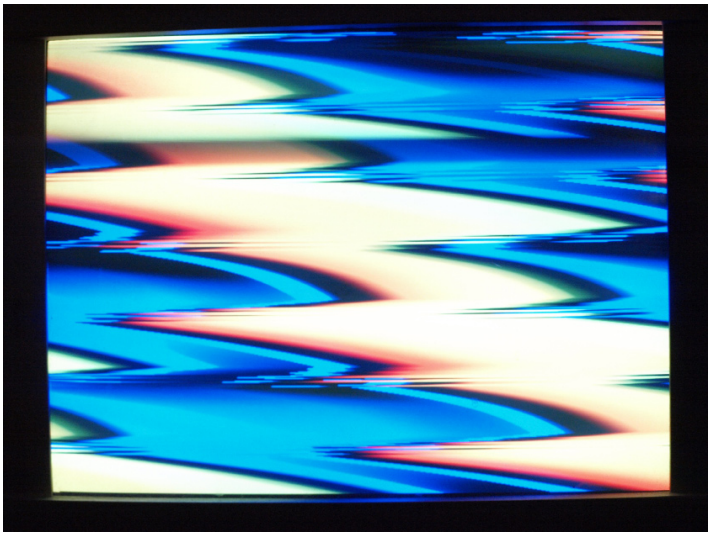




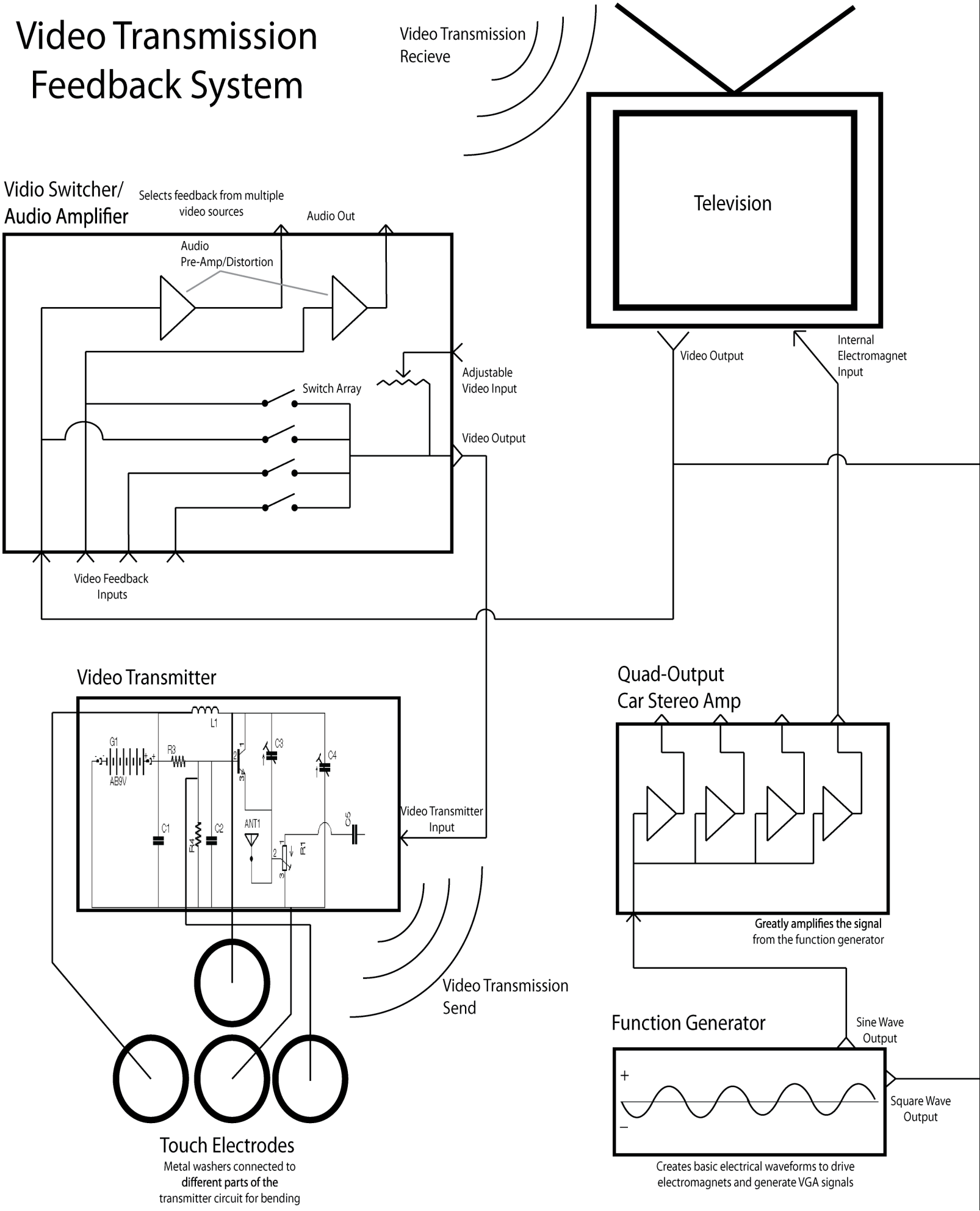




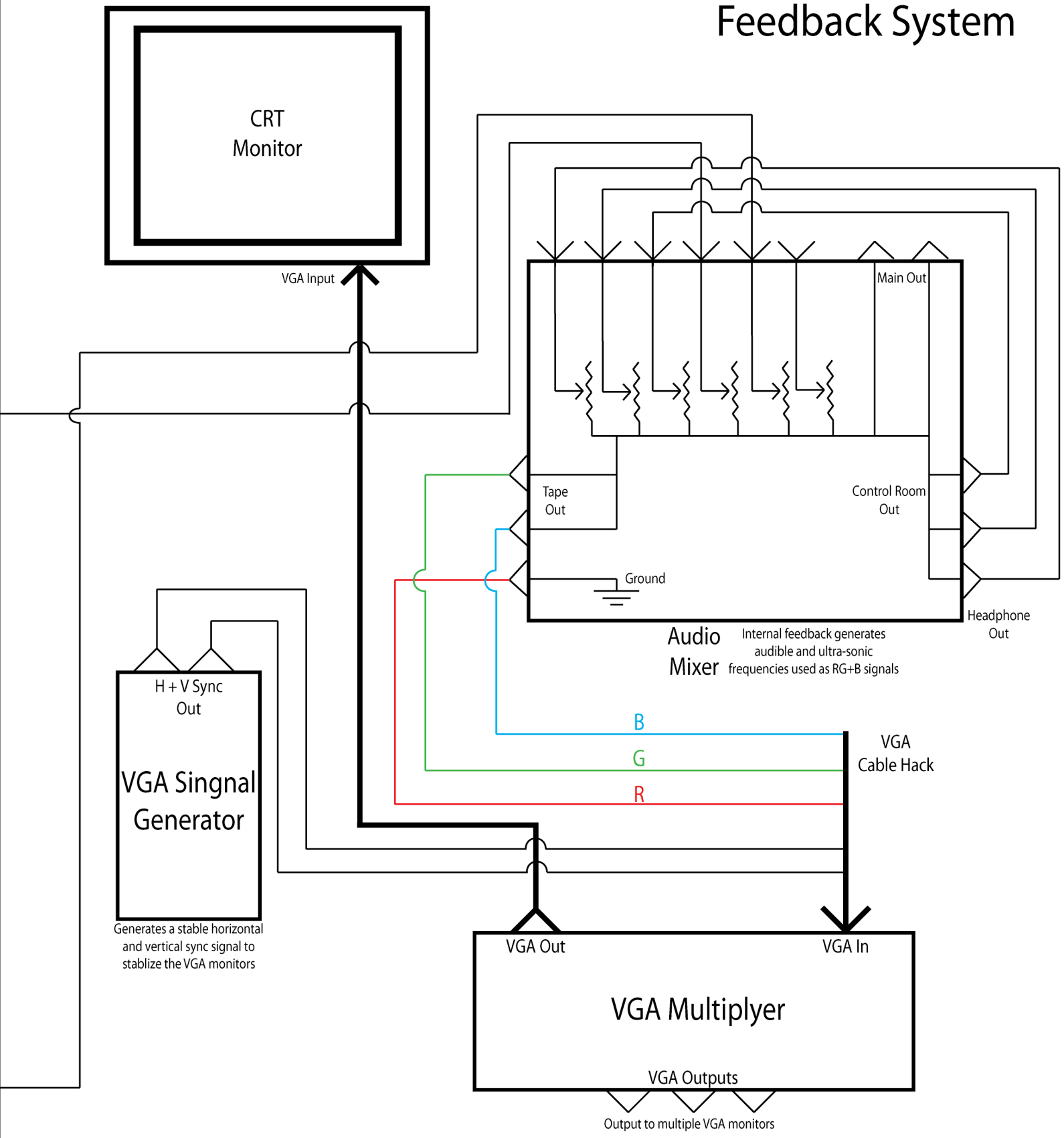




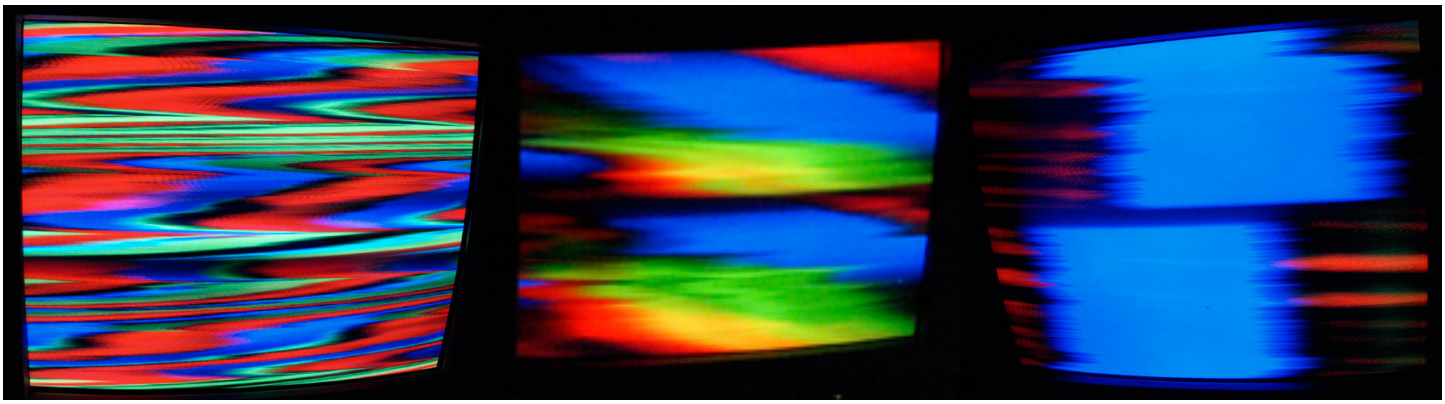
Video Transmission Feedback System



VGA Signal Feedback System



HACKING A VGA CRT TO BEND AUDIO INTO VIDEO



WHAT YOU NEED

-1 male VGA d-sub Connector[1]
-1 female VGA d-sub connector[2]
-Audio cables or jacks (1/4 inch, 1/8 inch, or RCA depending on your ideal output)
-22-gauge single-strand wire (stranded makes it difficult)
-Electrical tape and scissors
-Soldering iron and solder
-Wire strippers
-VGA signal generator or computer with VGA output. (Sending unstable signals can damage computer hardware, so I highly recommend using a VGA signal generator. These are difficult to find, but it I have seen them for less than $20 on ebay.)
-VGA CRT (tube) computer monitor (LCD will not work)

1 You could also use a male VGA breakout board, or cut into a VGA cable itself, though wire-identification then becomes difficult
2 You could also use a female VGA breakout board, or cut into a VGA cable itself, though wire-identification then becomes difficult

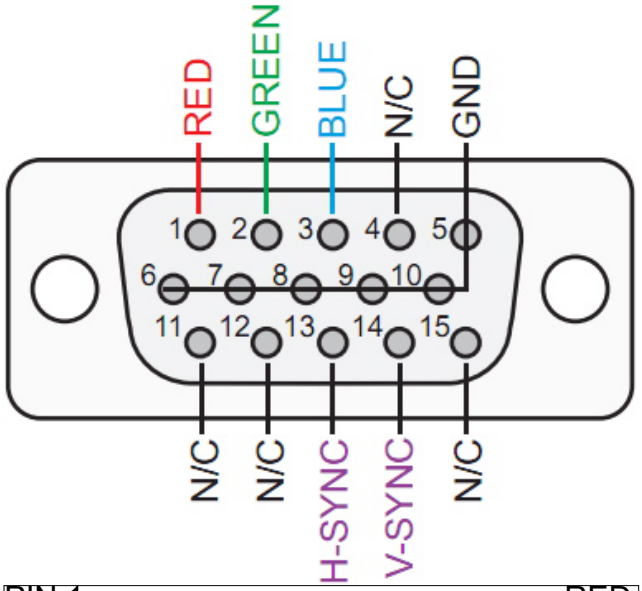
UNDERSTANDING A VGA CABLE

A computer monitor communicates through a **Video Graphics Array** (**VGA**) connector, which is organized into a 15 pin (3 rows of 5) adapter at either end that sends discrete (and, therefore, hackable) **RGBHV** (**R**ED, **G**REEN, **B**LUE, **H**ORIZONTAL-SYNC, **V**ERTICAL-SYNC) analog signals.

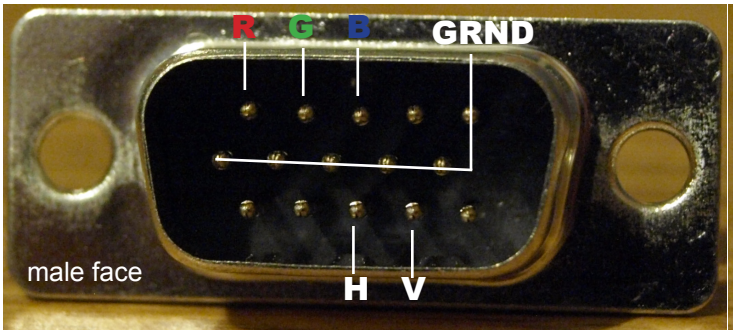
The most useful part of its organization is that the **R**ED, **G**REEN, and **B**LUE (**R**, **G**, **B**) colors of the monitor are controlled by three discrete pins—pins 1-3. These are the pins the stereo audio signal gets sent to. Pin 13 is **H**orizontal-sync, which controls the frame rate and of the displayed image, and pin 14 is the **V**erical-sync, which displays the pixel information. Pin 5 is ground, and pins 6-10 are the ground connections for the **R**, **G**, **B**, **H-SYNC**, and **V-SYNC**.

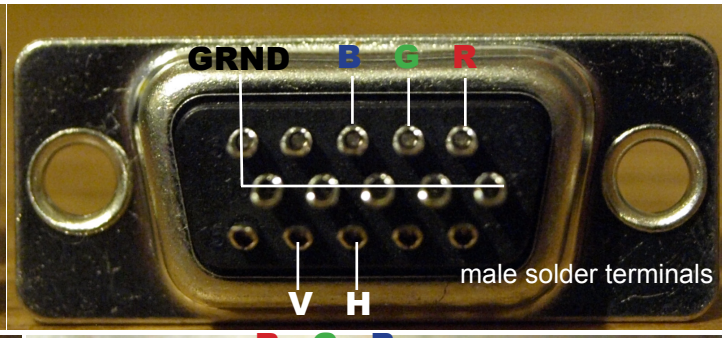
For this hack, wires need to be connection to pins 1 (**R**), 2 (**G**), 3 (**B**), 5-10 (ground), 13 (horizontal-sync), and 14 (vertical-sync)

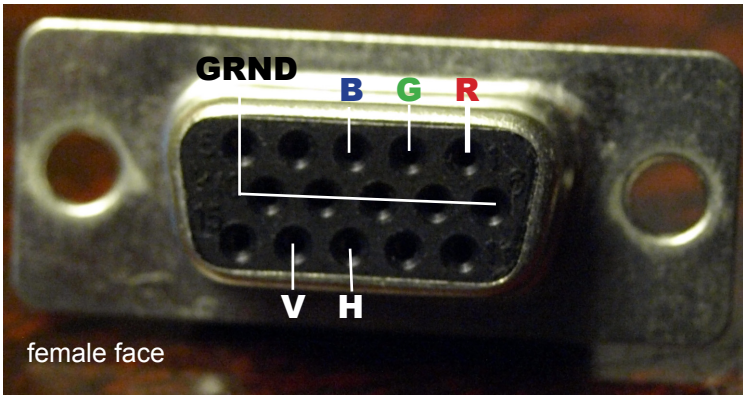
NOTE: D-sub connectors with soldering terminals are labeled with small numbers to ensure you're soldering into the correct holes (this can get VERY confusing, as female soldering terminals are the opposite of male, and on top of that you're seeing them in reverse). To save time and avoid having to resolder, **be sure you're placing the wire into the correct terminal BEFORE applying any solder.**

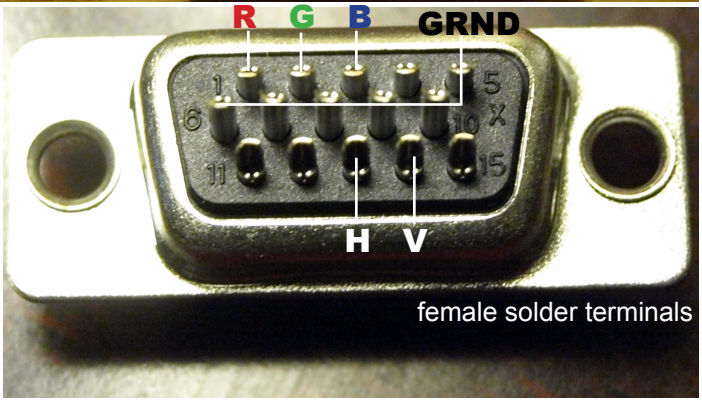


PIN 1:	RED
PIN 2:	GREEN
PIN 3:	BLUE
PIN 4:	-
PIN 5:	GROUND
PIN 6:	RED GROUND
PIN 7:	GREEN GROUND
PIN 8:	BLUE GROUND
PIN 9:	-
PIN 10:	SYNC GROUND
PIN 11:	-
PIN 12:	-
PIN 13:	HORIZONTAL-SYNC
PIN 14:	VERTICAL SYNC
PIN 15:	-









THE HACK

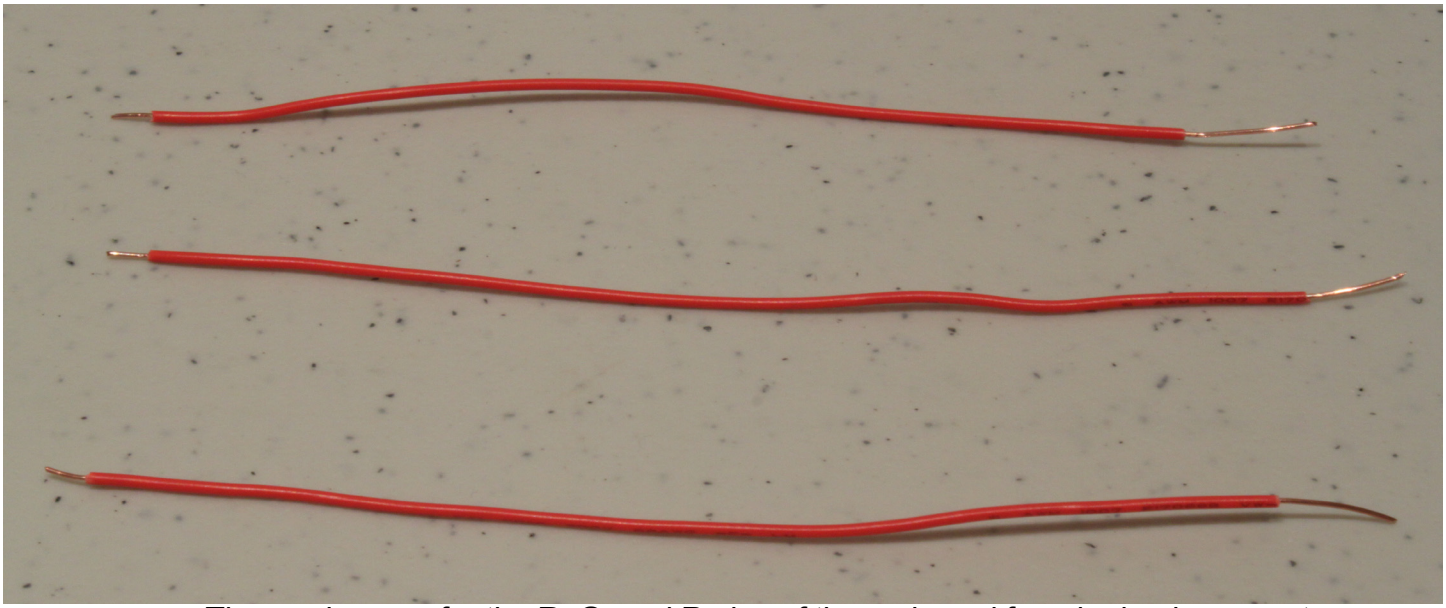
1. SOLDERING THE D-SUB CONNECTOR

This is the most difficult part of the hack. 15-pin d-sub connectors contain solder terminals to connect wires to 15 pins. For the purpose of this hack, only 10 of the 15 pins need to be soldered to.

1.1 PREPARING

-Cut 3 pieces of single-strand wire about 6 inches in length. Make sure that all pieces are as close to being the same length as possible.

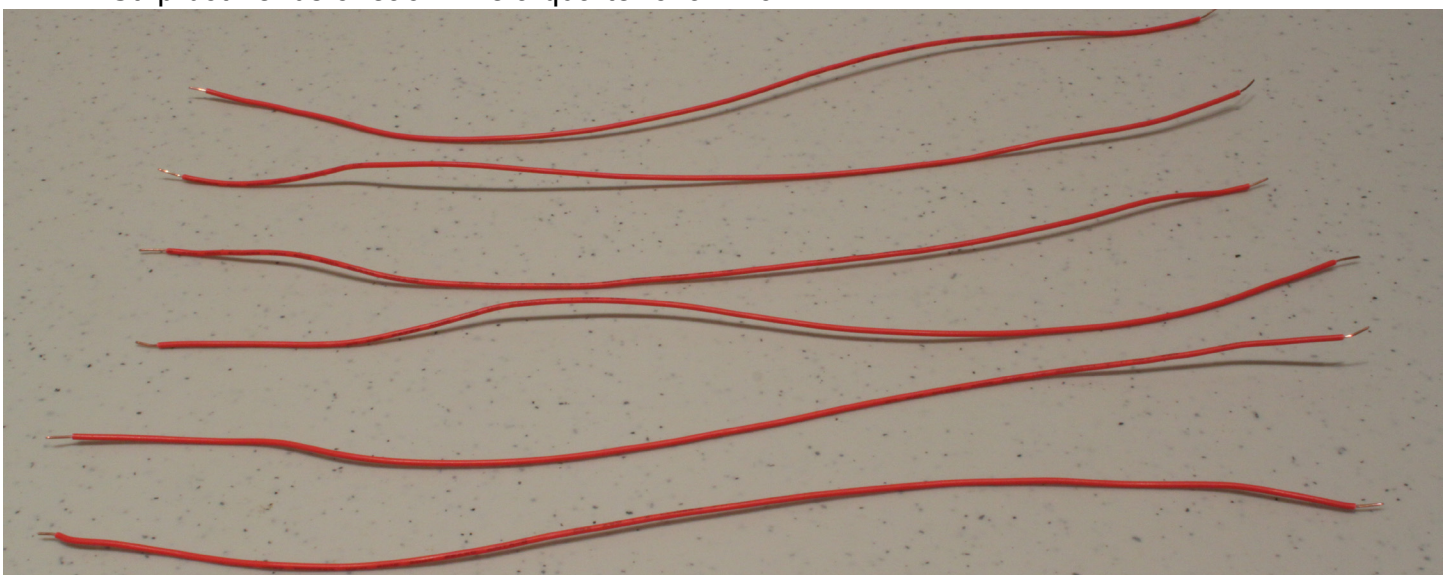
-Strip one end of each 6-inch piece of wire a quarter of an inch (this end will be soldered to the d-sub connector), and the other end half an inch (this will be soldered to the wire connected to the female d-sub connector.



-These wires are for the **R**, **G**, and **B** pins of the male and female d-sub connectors separately.

-Cut an additional **7** pieces of single-strand wire about 12 inches in length, making sure that all pieces are as close to being the same length as possible.

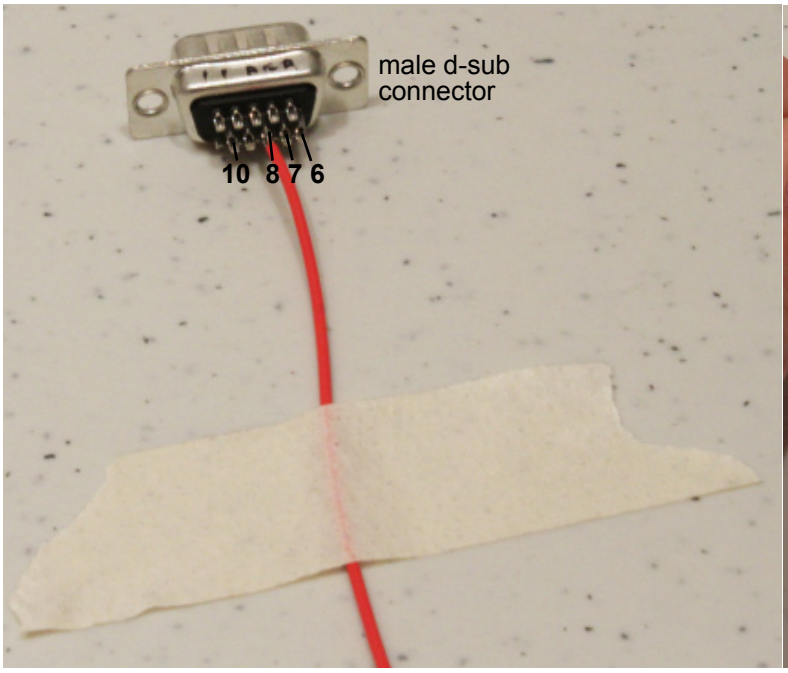
-Strip both ends of each wire a quarter of an inch.

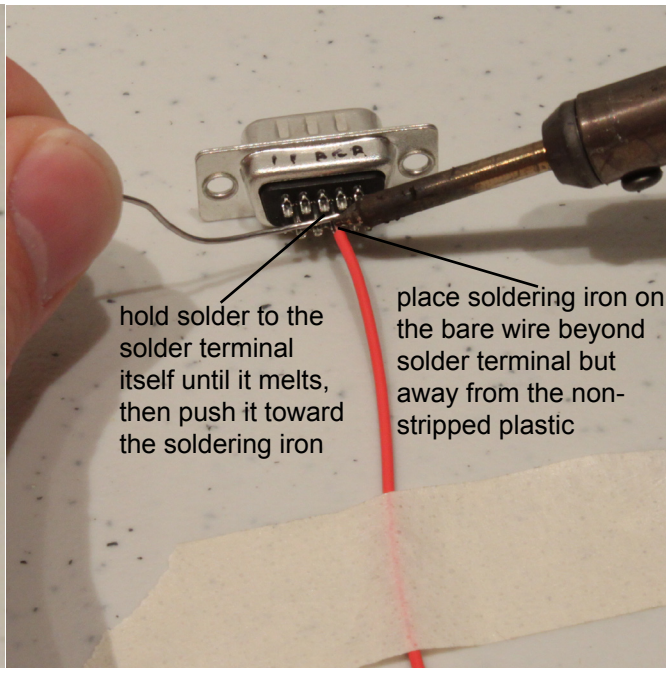


-These wires will connect the ground pins and **H** and **V** sync pins on the male d-sub connector to the ground pins and **H** and **V** sync pins on the female d-sub connector.

1.2 SOLDERING THE GROUND PINS IN THE MIDDLE ROW

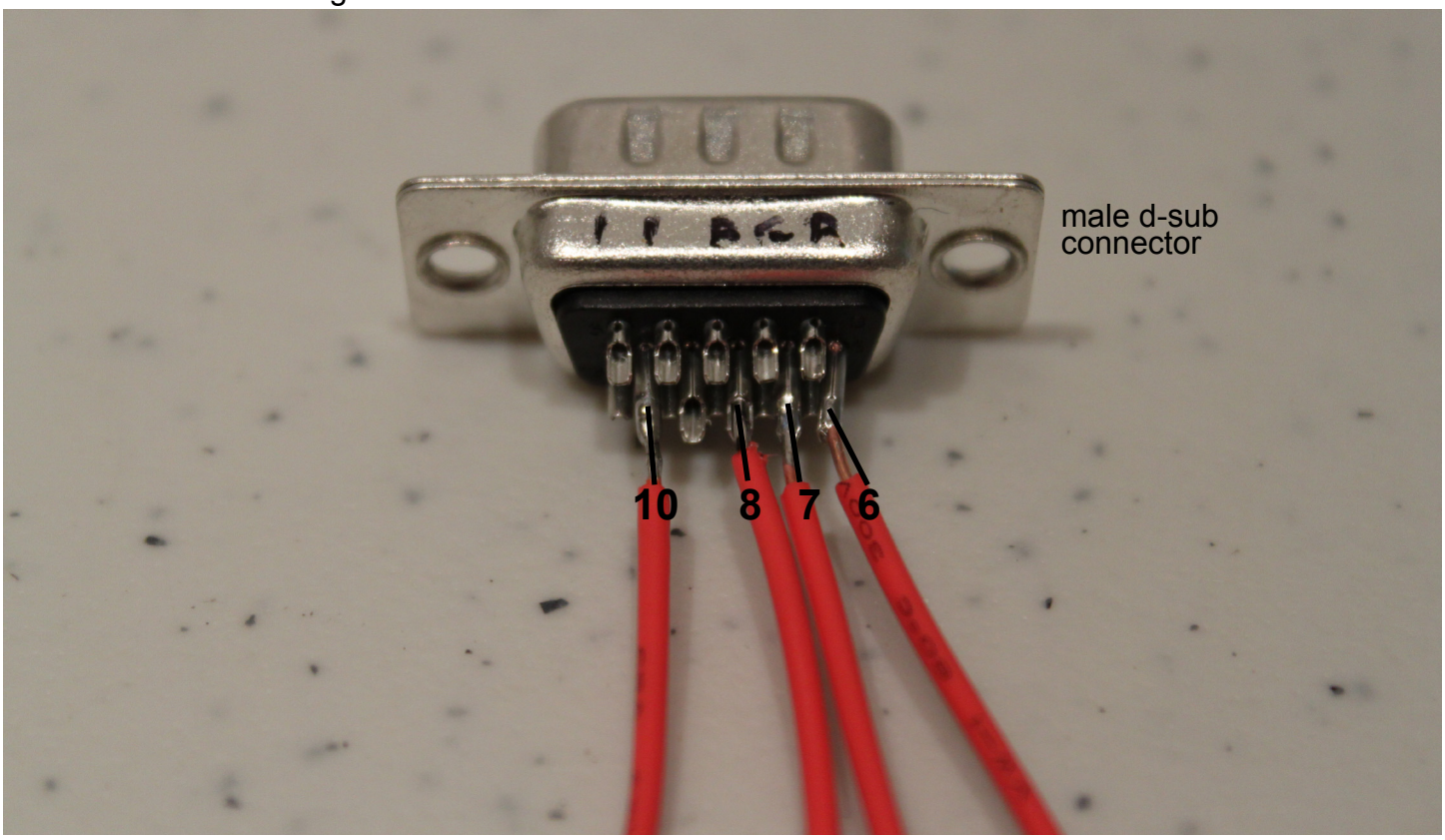
-Solder 4 separate pre-cut 12 inch wires to solder terminals **6**, **7**, **8**, and **10** (note that pin 9 is not necessary to solder) of the male d-sub connector.



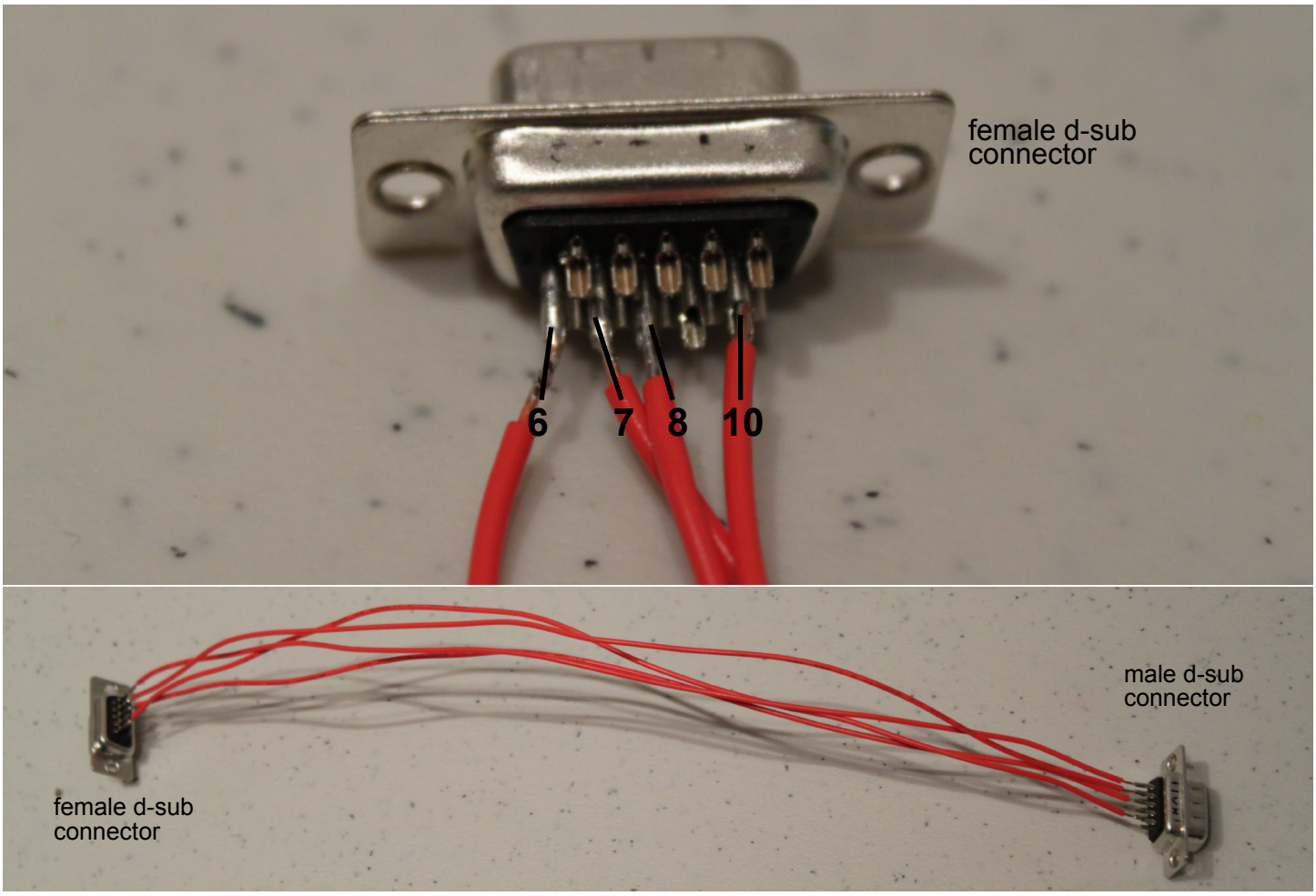


TIP: When soldering into the solder terminals, it works best to slide the wire into the terminal and then tape the wire to the table you're working on to act as a "third hand", holding it in place while you solder the wire.

IMPORTANT: Make sure you solder the middle row of terminals (pins **6**, **7**, **8**, and **10**) before soldering the top and bottom row, or else it will be almost impossible to access those terminals with the soldering iron.



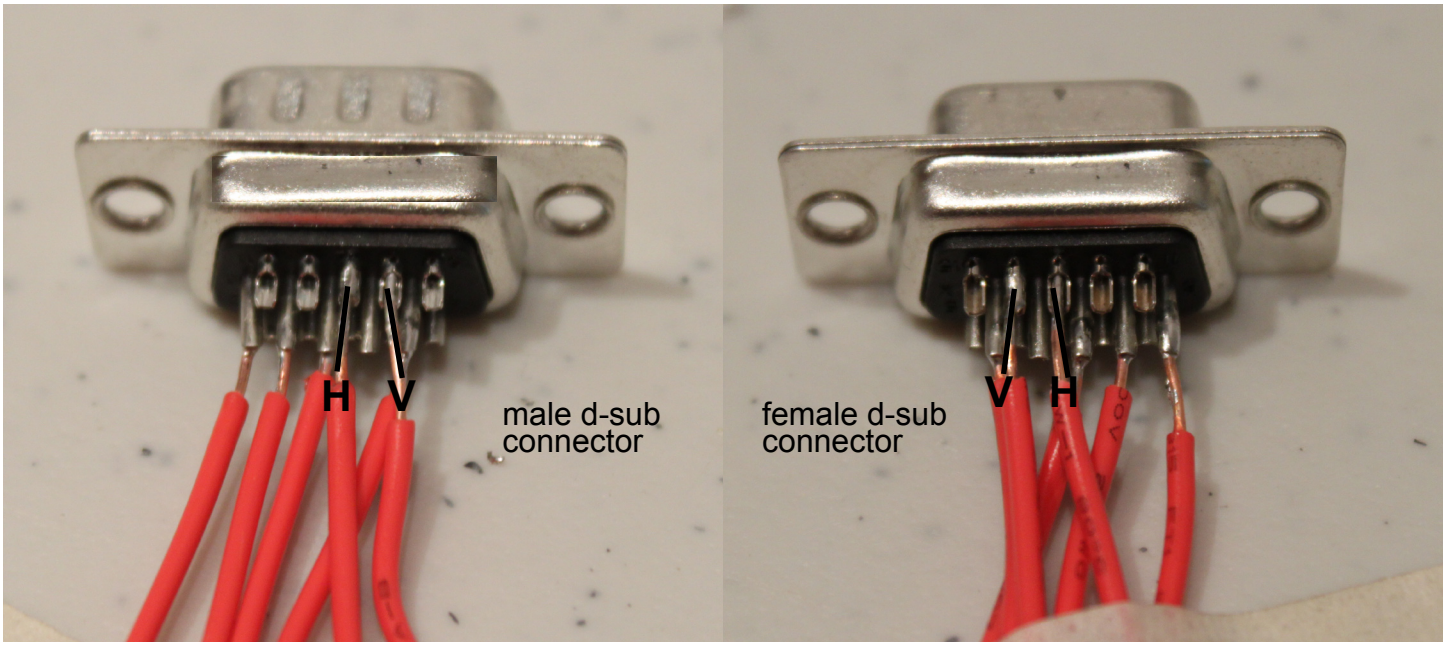
-Solder the other end of those wires into the corresponding solder terminals **6**, **7**, **8**, and **10** on the female d-sub connector.



1.3 SOLDERING THE H AND V SYNC PINS

-Solder 2 separate pre-cut 12 inch wires to solder terminals **13** and **14** of the male d-sub connector.

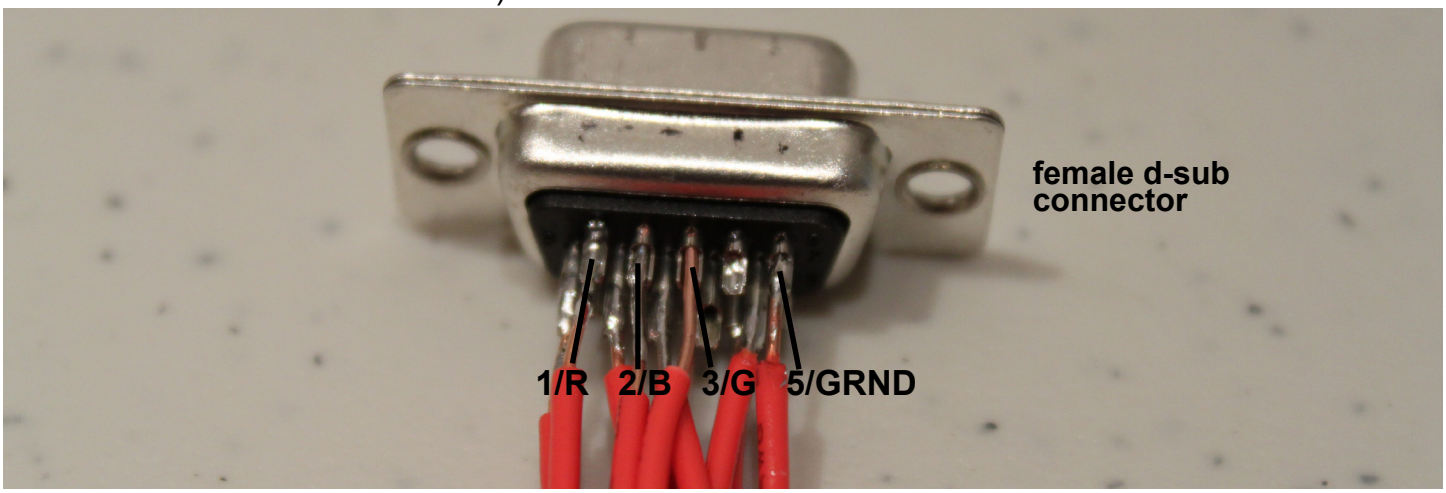
-Solder the other end of those wires into the corresponding solder terminals **13** and **14** on the female d-sub connector.

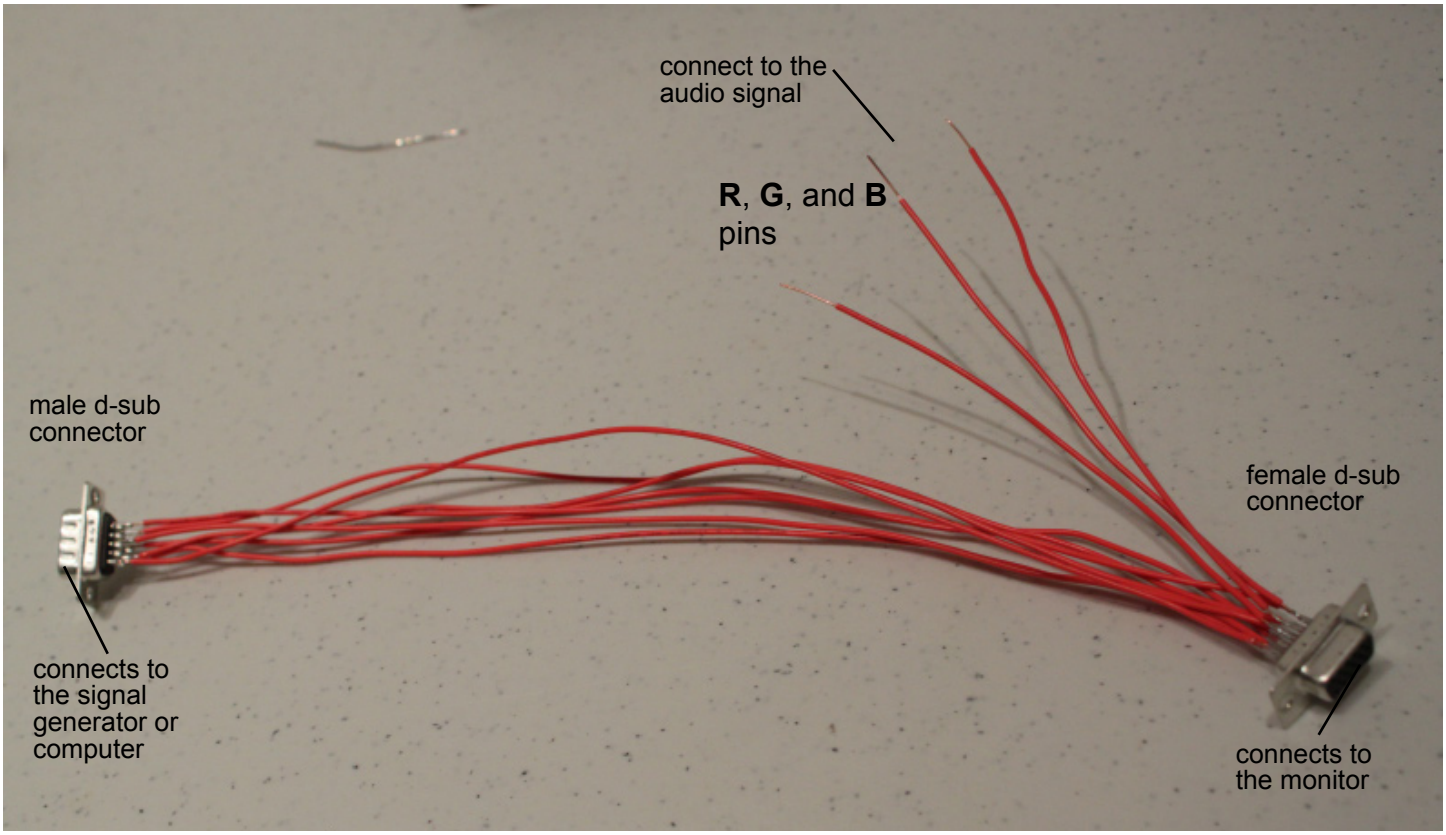


1.4 SOLDERING THE R, G, AND B PINS AND REMAINING GROUND PIN

-Use the remaining pre-cut 12 inch wire to solder terminal **5** of the male pin to terminal **5** of the female pin, completing the ground connection.

-Take the 3 pre-cut 6 inch wires. Solder the end that has been stripped to a quarter of an inch into solder terminals **1**, **2**, and **3** on the **FEMALE** d-sub connector (it is unessecary to solder them to the male d-sub connector).





2. SENDING AUDIO SIGNALS TO THE R, G, AND B PINS

To connect audio to the **R**, **G**, and **B** signals of a VGA cord in a way that shows all colors discretely the three cords have to be connected to the left channel, the right channel, and the ground of an audio signal. The pin connected to the ground signal generates the majority of the visuals, so I prefer to connect the **RED** pin. The left and right channels can be connected to the **BLUE** or the **GREEN** pins interchangably. This tutorial has you connecting the pins to two mono 1/4 inch jacks though, depending on your ideal output, you could also use 1/8 inch jacks or RCA jacks.

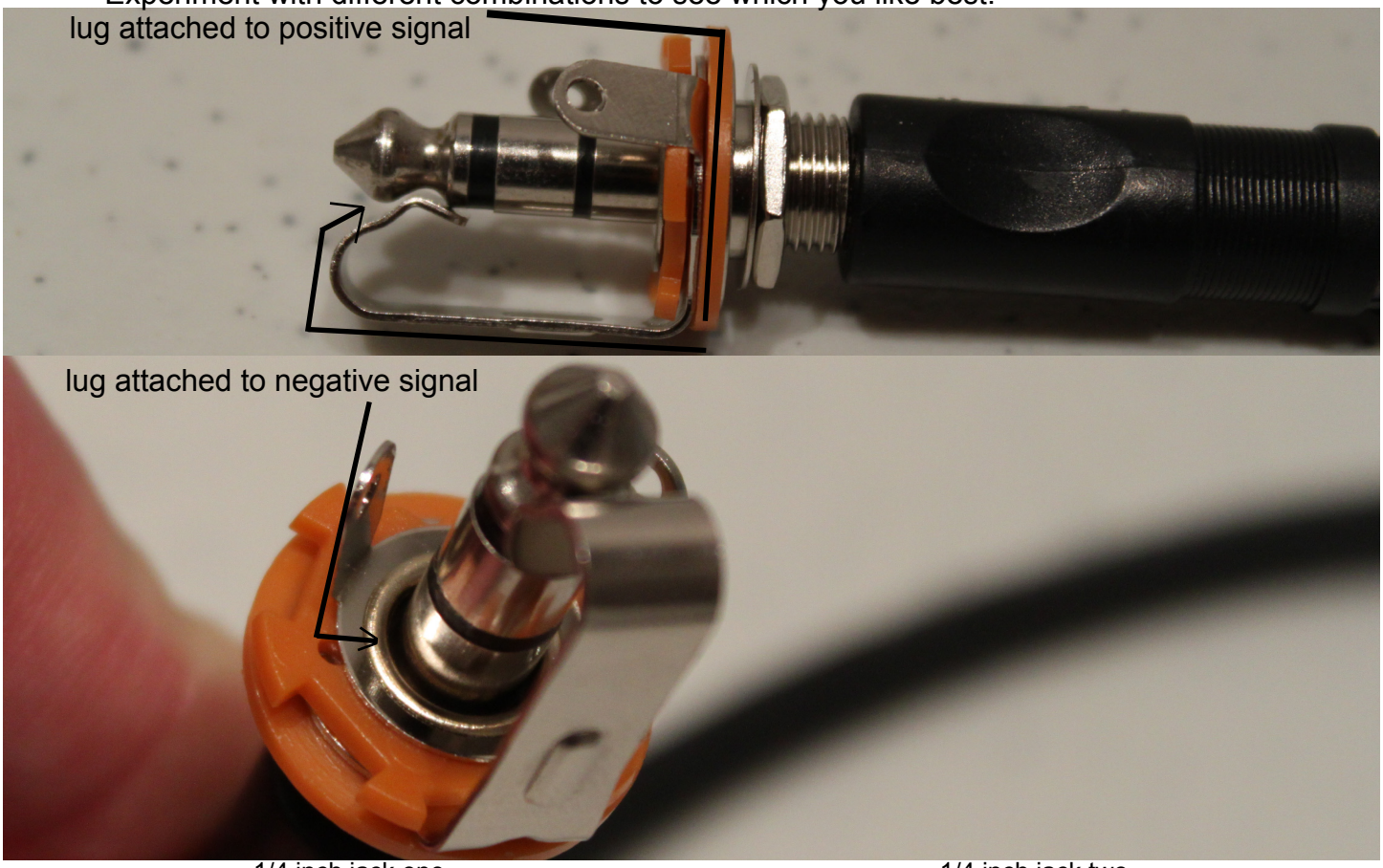
2.1 UNDERSTANDING A 1/4 INCH AUDIO JACK

-Mono 1/4 inch jacks make contact with the audio adapter at two points, one being the positive connection and the other the negative. Both points of contact have their own solder lugs.

-The lug making contat with the tip of the adapter is the positive signal. The positive lug on one jack will be attached to 2 color pins.

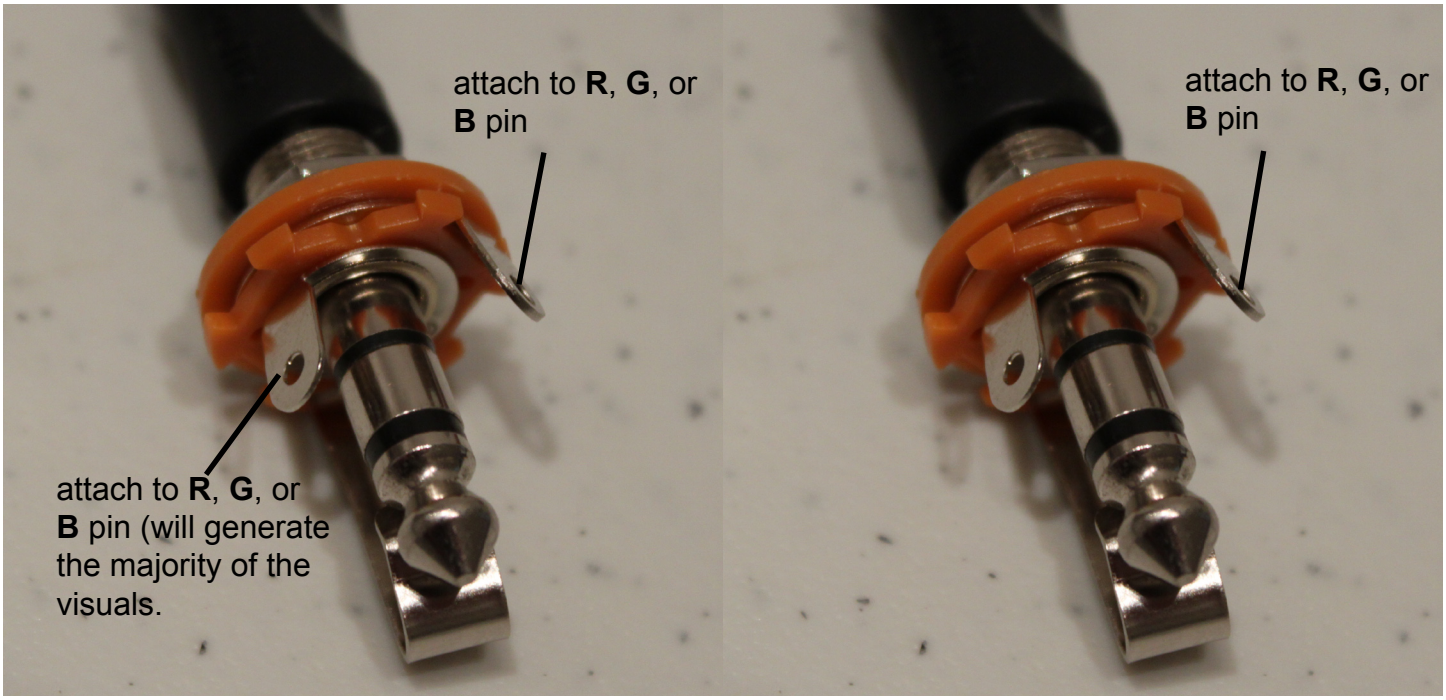
-The lug making contact with the base of the adapter is the negative signal. This lug on one of the jacks will be connected to the one of the color pins and will form the majority of the visuals.

-Experiment with different combinations to see which you like best.



1/4 inch jack one

1/4 inch jack two

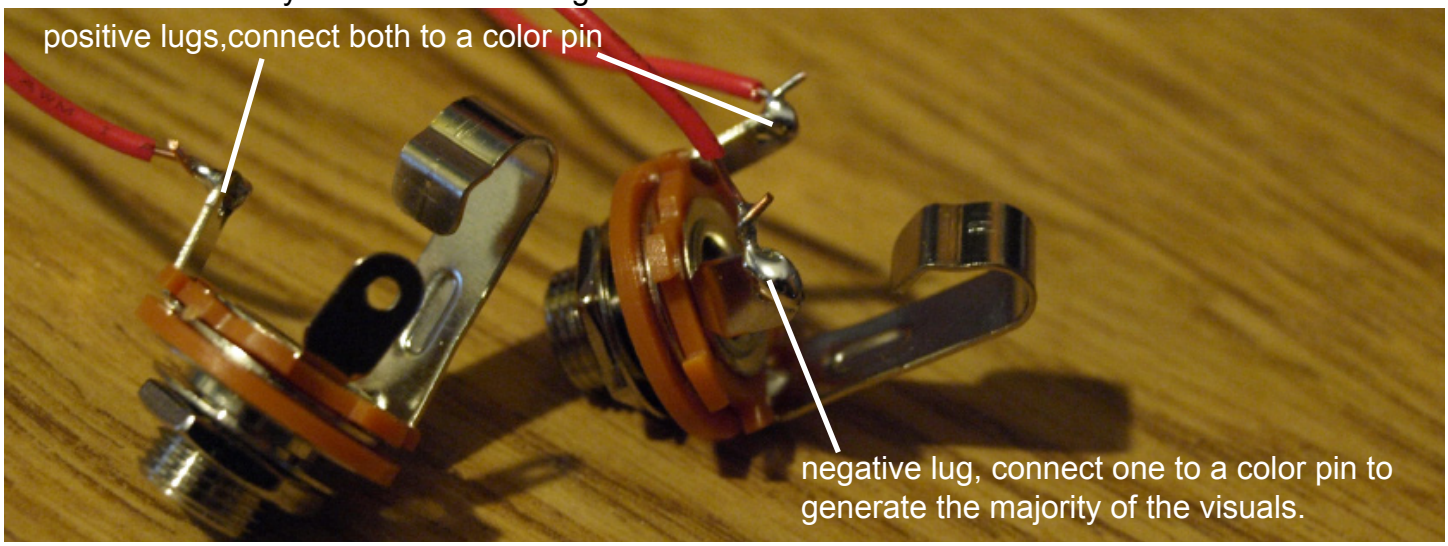


2.2 SOLDERING THE 1/4 INCH JACKS

-Cut three 6-inch wires and strip both ends 3/4 of an inch on all.

-Connect one end of 2 of the wires to each positive solder lug on both jacks by putting the wire half-way through the hole and twisting it to hold it in place, then solder them together.

-Connect one end of the remaining wire to a negative solder lug on one of the two audio jacks the same way and solder them together.

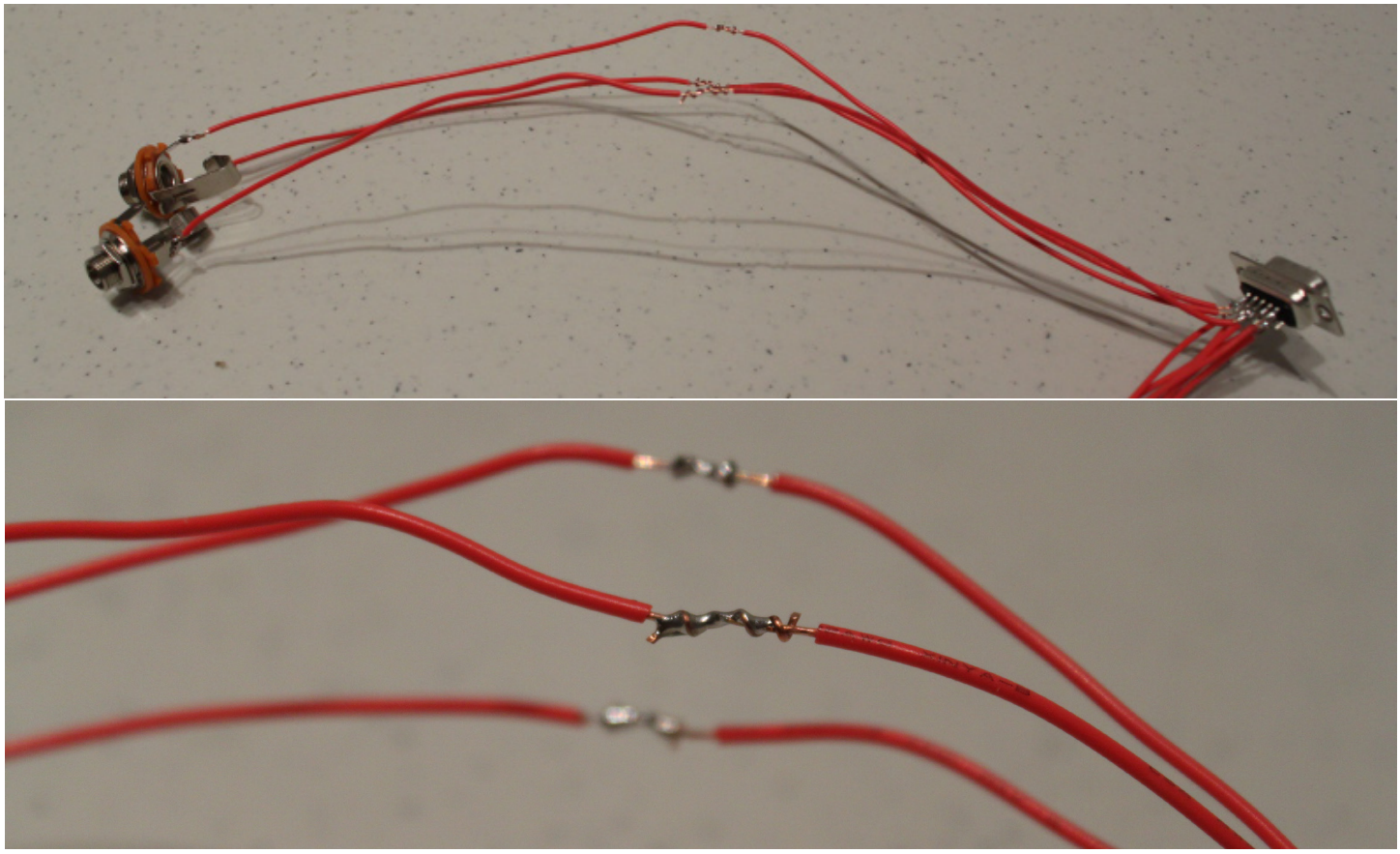


2.2 CONNECTING THE 1/4 INCH JACKS TO THE R, G, AND B PINS

-Solder the other end of the wire attached to the NEGTIVE lug of one of the audio jacks to one of the wires soldered to the color pins.

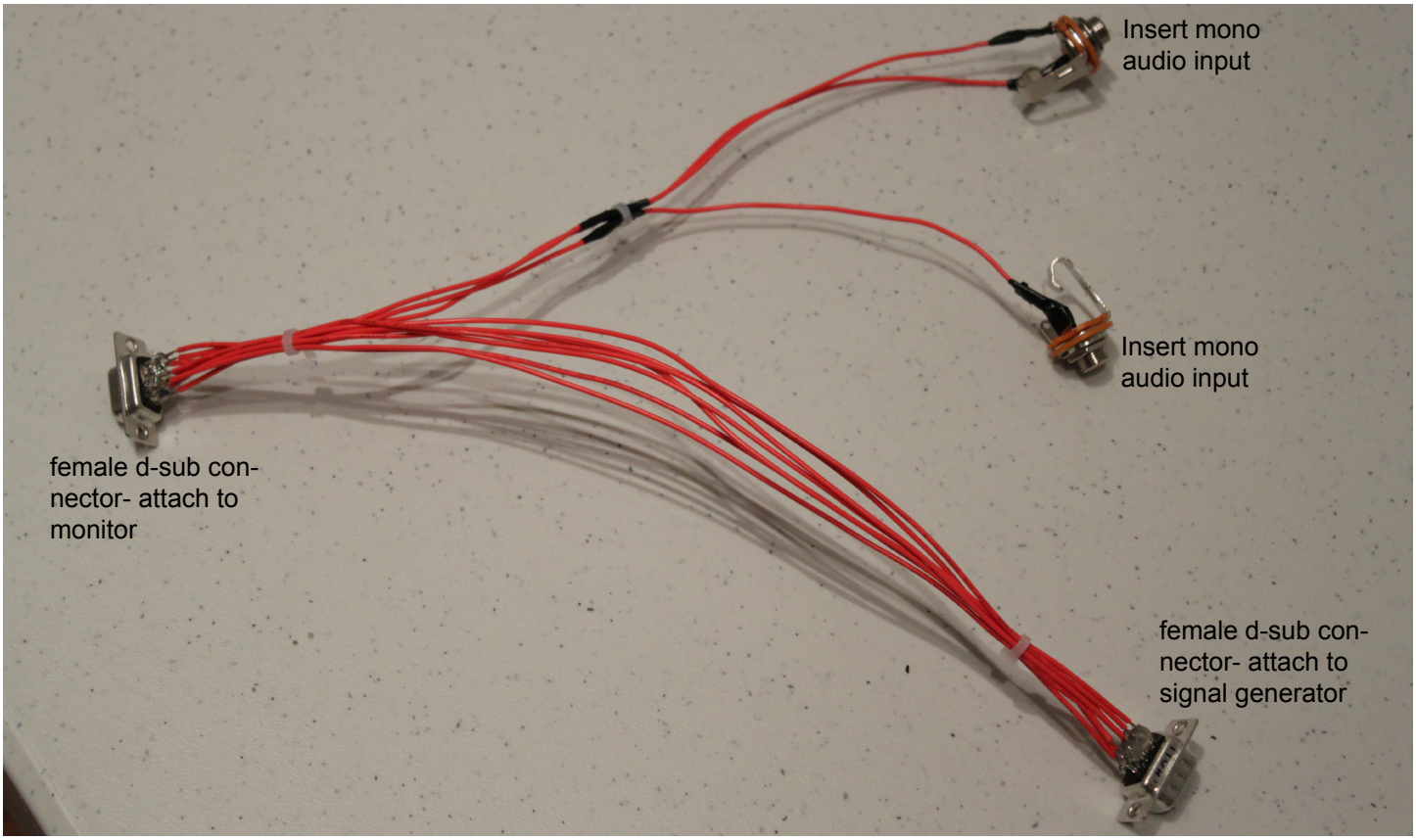
-Solder the other ends of the wires attached to the POSITIVE lugs of each of the audio jacks to the 2 of the wires attached to color pins

-(It doesn't matter which pin goes to which lug, just make sure two are attached to each of the positive signals and one is attached to one of the negative signals).



3. FINISHING UP

-Wrap the connections of the audio cable to the **R**, **G**, and **B** pins with electric tape.
-You may want to apply glue form a glue gun to the solder terminals of the male and femal d-sub connectors to keep the wires firmly in place, especially if you weren't using shrink wrap tubing.
-You may want to use zip ties or electric tape to keep the wires organized and together.



4. CONNECTING THE HACK

-The female end of the hacked VGA cord connects to the VGA cord that goes to the VGA CRT computer monitor.
-The male end of the hacked VGA cord needs to be stabilized by being connected to a VGA signal generator.
-You could also add potentiometers to the connection between the audio and the color pins with switches to control the level of each signal.
-Experiment with the setup. Add additional audio signals to the color pins. Connect multiple color pins to the same audio signal. Plug in a synthesizer or a function generator to have complete control of the visualized waveforms. Try to do more than just send a stable stream of audio into the monitor.

IMPORTANT NOTE: You could stabalize the VGA signal through a computer or a VGA output from a laptop, but the hardware of the computer may be damaged after sending audio into the hacked VGA cord for prolonged periods of time. Because the audio is being sent to the ground of the VGA cable in order to have the red, green, and blue signal of the monitor discretely hacked, it is possible that raw voltage could be thrown back into the computer in a way that could damage the Hardware. Because of this, I highly recommend using a VGA signal generator.

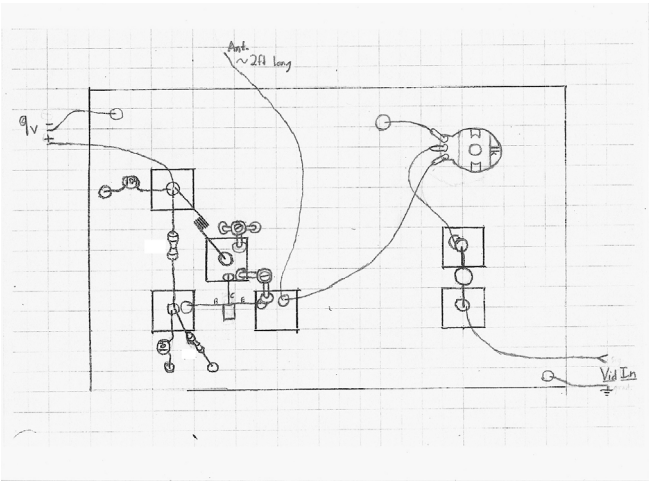
BUILDING A DIY VIDEO TRANSMITTER

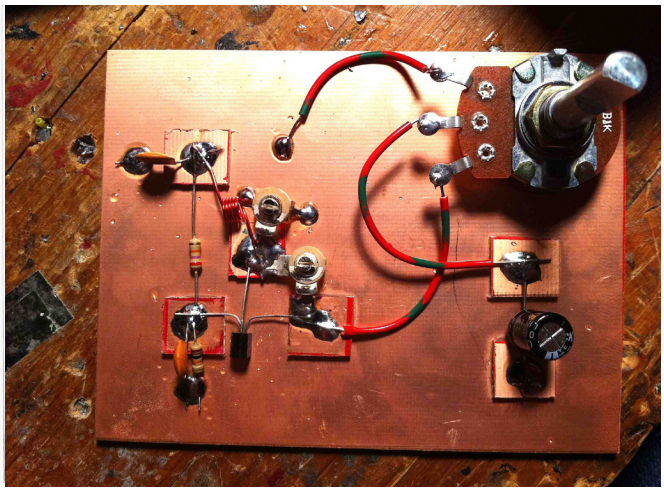
WHAT YOU NEED

- Blank PCB Copper Plate (jameco.com part #169279)
- Capacitors: 2x 0.1uf
  1x 100u
  2x 6-70pf Variable Caps (jameco.com part #32855)
- Resistors: 27kOhm
  10kOh
- Transistor-MPSA18 (jameco.com part #210681)
- 1k potentiometer
- Small amount (~4") of magnet wire 24 AWG or close (jameco.com part #2098419)
- Sand paper
- Stranded hookup wire
- Hacksaw or dremel tool

-Headphones with 1/8" plug (from iPod or MP3 player)

- Hot glue or super glue
- Soldering Iron
- CRT "tube" TV with an antenna (the transmitter won't transmit to newer flat screen TV's)





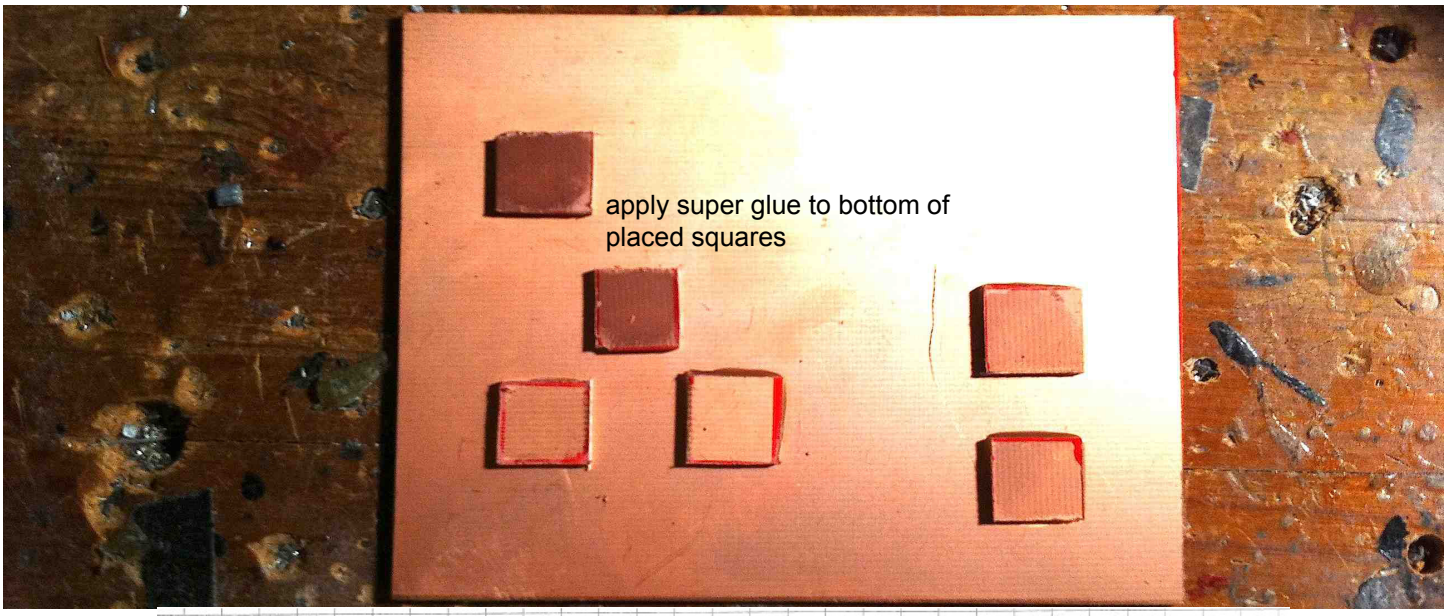
INTRODUCTION

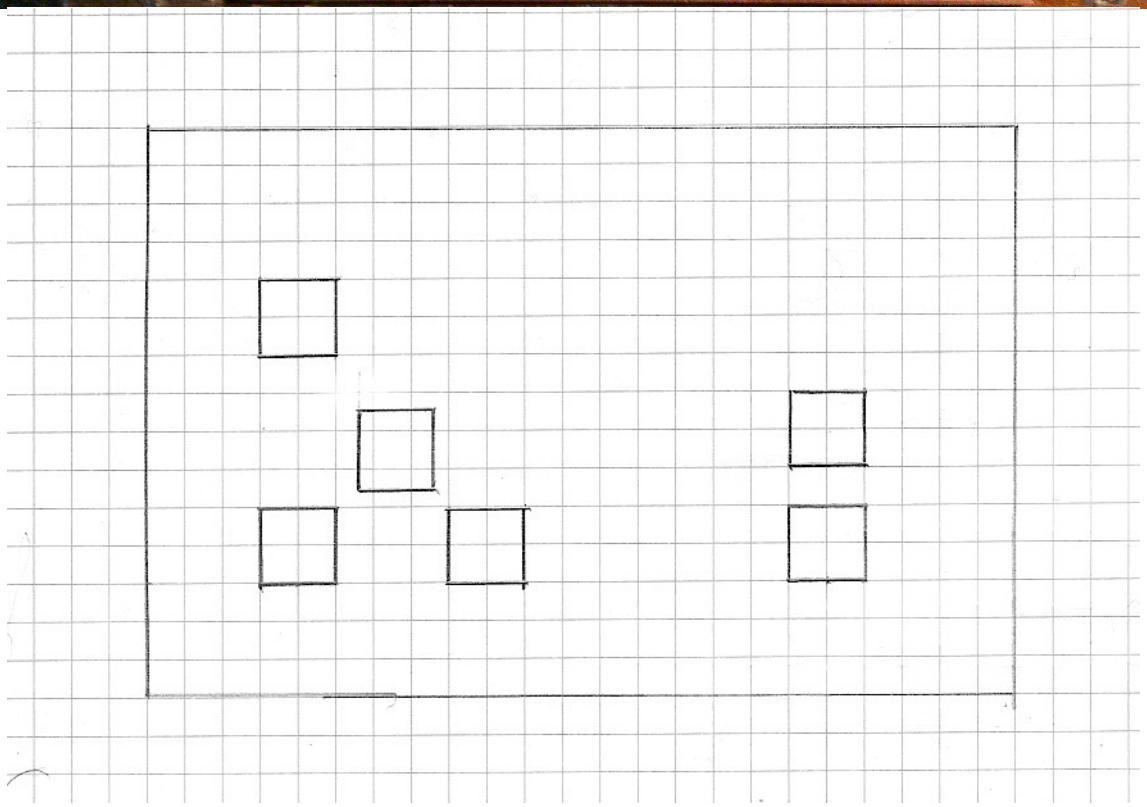
This micro video transmitter was designed by the DIY radio and micro TV artist Tetsuo Kogawa. His website (http://anarchy.translocal.jp/) is full of great info on DIY radio, and all credit for this circuit goes to him.The transmitter can be used to transmit a relatively clear video signal or abstract visualizations, depending on the desired output. It will usually function at a distance of about 20 feet. If you have any previous experience with electronics or circuit building, you will notice that this method of building is different. The circuit is constructed on top of a copper "ground plate" which is common in radio applications. This tutorial uses step-by-step sketches and photos created based on Tetsuo Kogawa's design.

BUILDING THE TRANSMITTER

1. PREPARING THE COPPER PLATE

- Take the bare copper plate and cut off 1inch of material using a dremel tool or hacksaw.
- Use this material to cut out 6 square ½ in. x ½ in. pieces.
- Arrange the 6 pieces on the larger copper plate as shown in the image below…



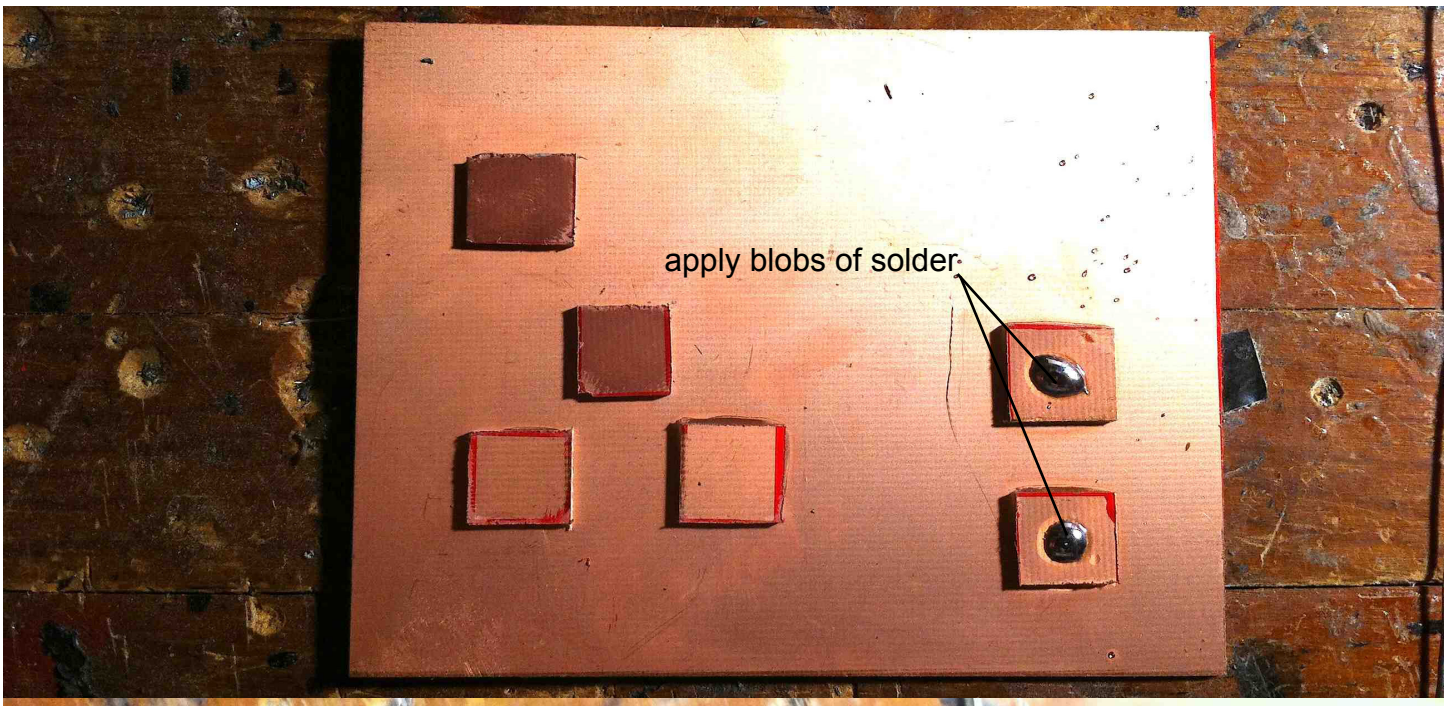


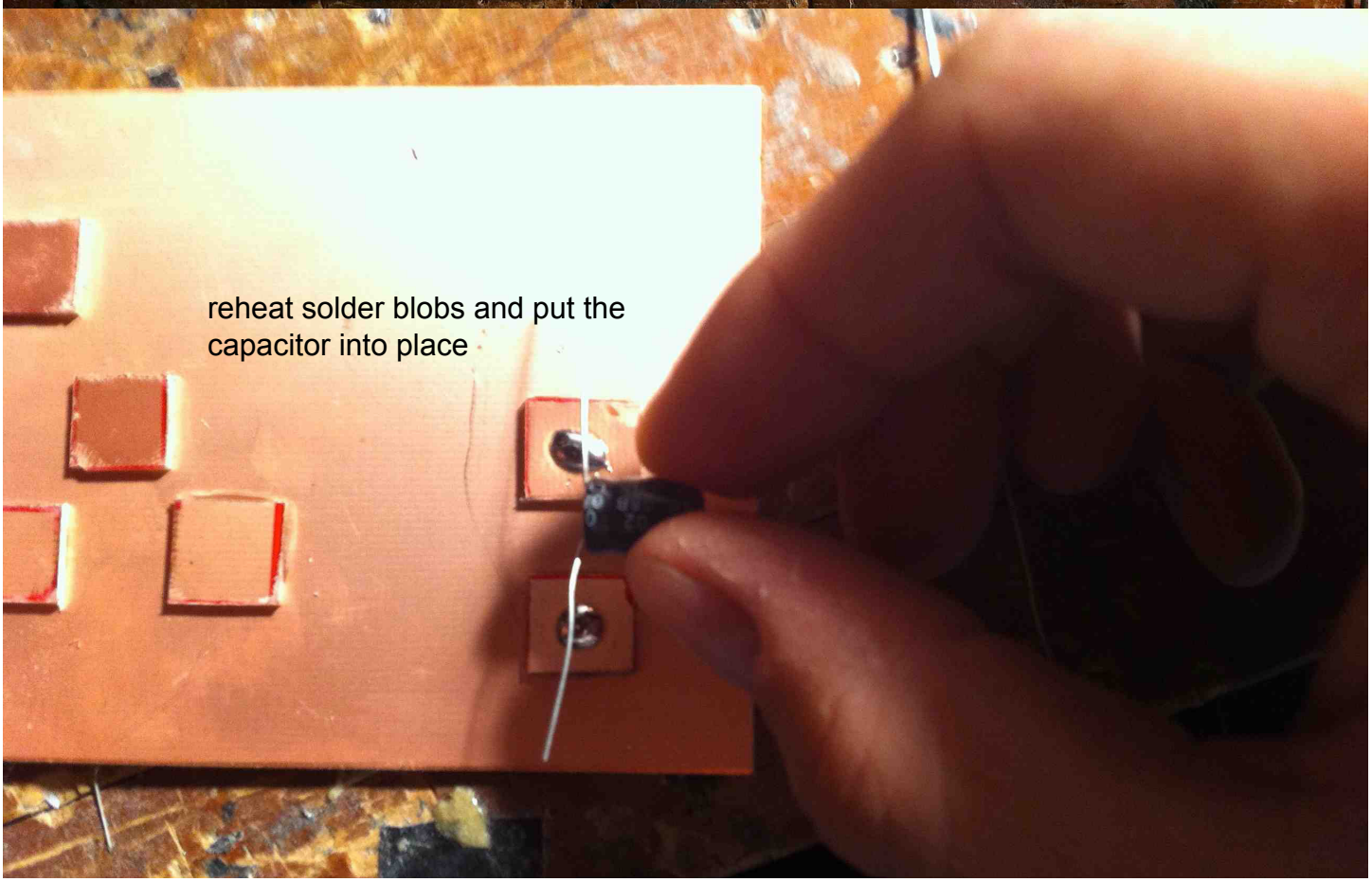
****NOTE**** Be sure to arrange them so that all the component leads will be able to reach the squares. Look ahead to see what components will go where so you know exactly how to space them.

- Once you have them arranged, put a dab of hot or super glue on the bottom of each square and stick them in place on the copper plate.

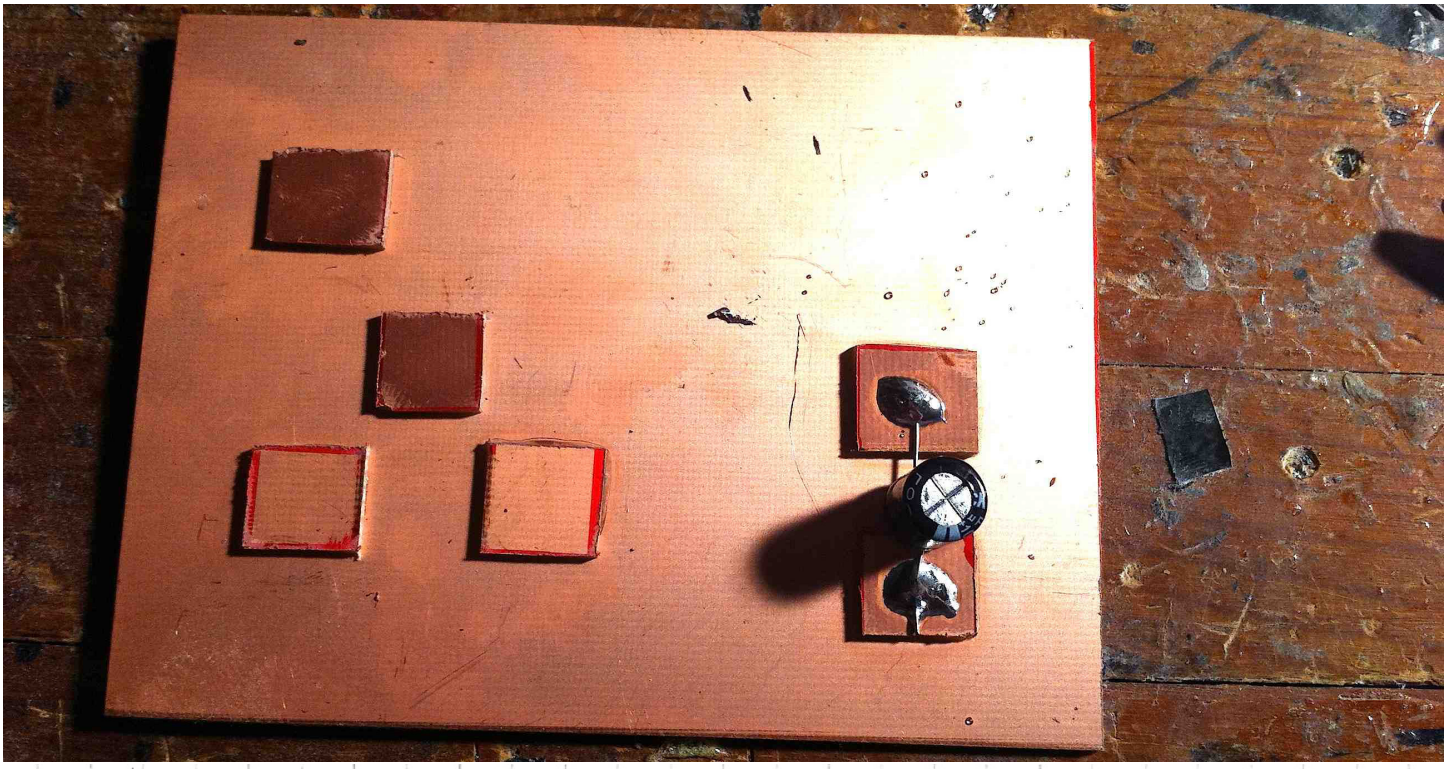
2. ADDING THE 100uF CAPACITOR (the cylinder with “100uF” written on the side)

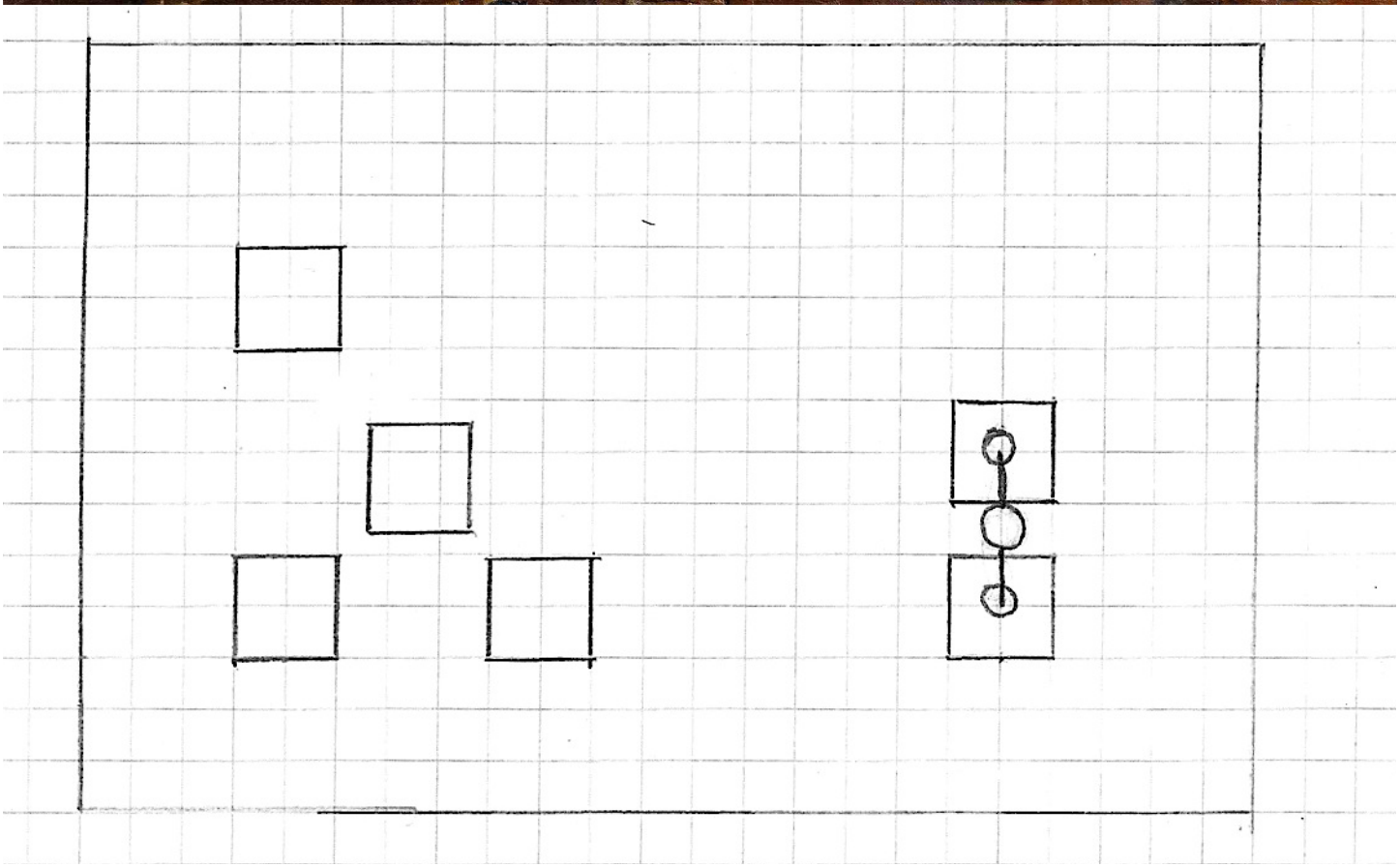
- Melt a blob of solder onto the two squares furthest to the right. To do this, apply your iron to each square to transfer heat for an extended period of time until the solder flows onto the surface.





- Bend the legs out of the 100uf capacitor and straddle them between the two squares making sure that the leads are only touching the two small squares (not touching the ground plate).
- Cut the excess off of the leads.
- One at a time, re-heat the solder blobs and place the capacitor leads into them, allowing them to cool down until they stay in place.

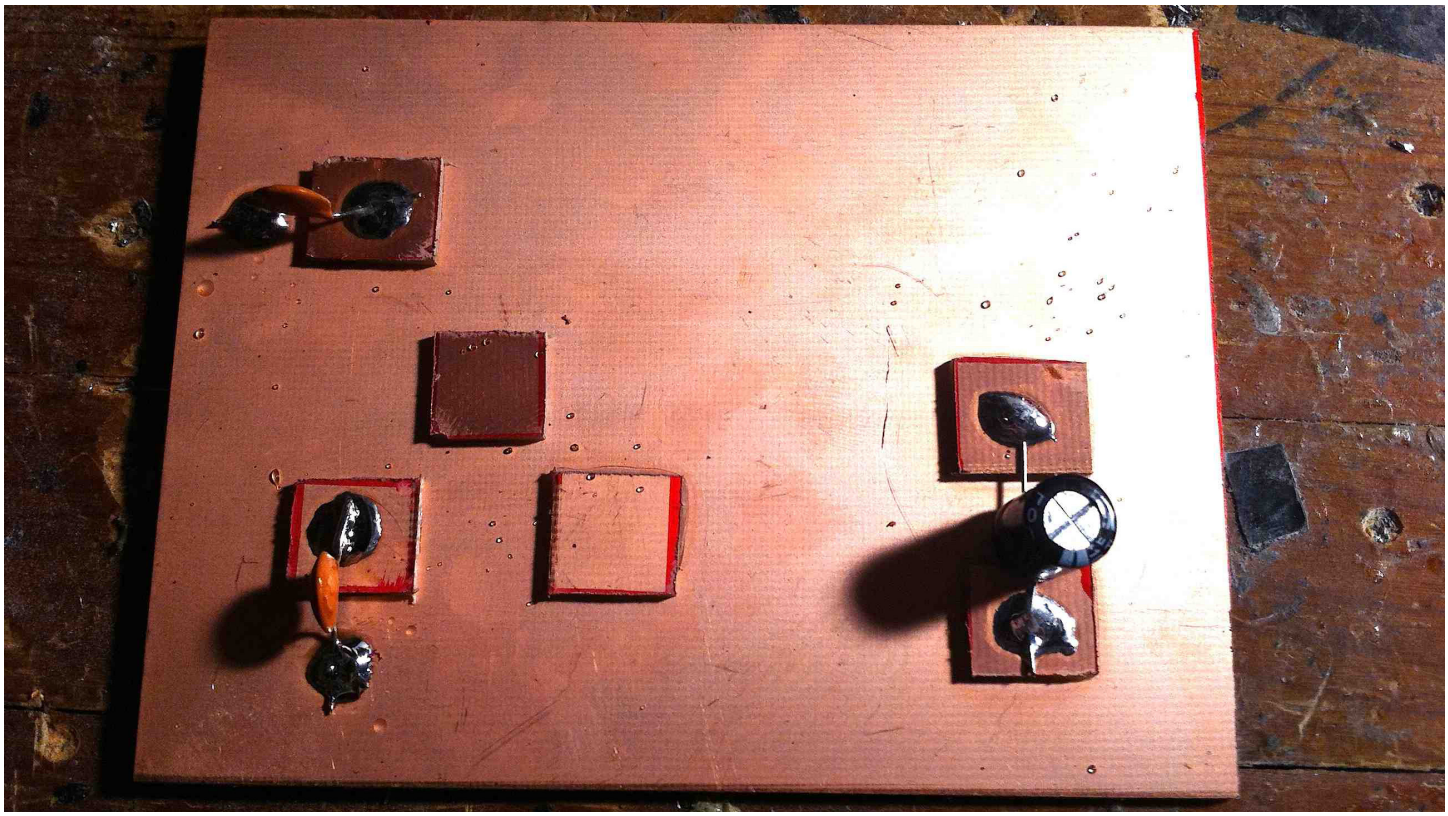


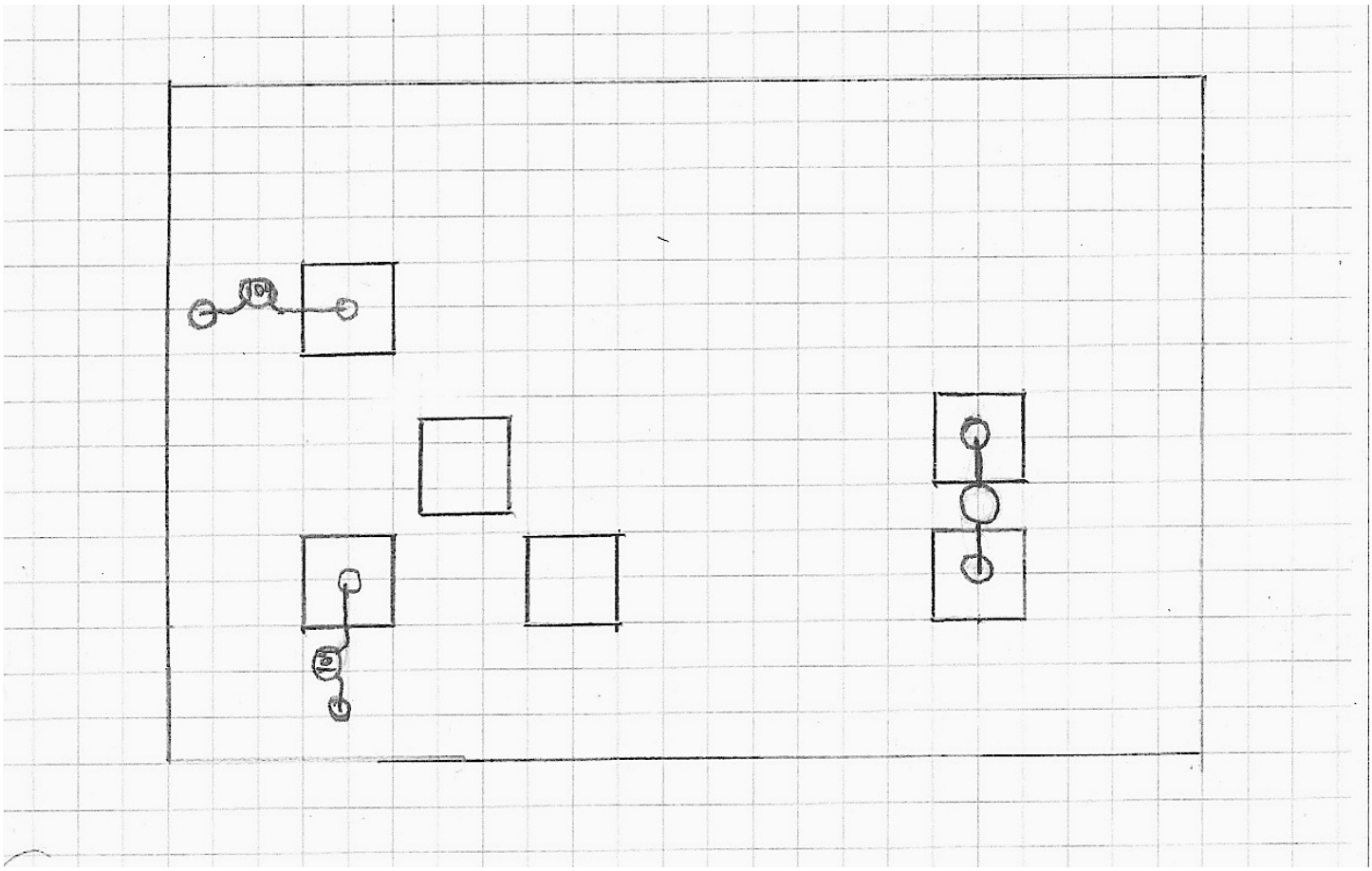


NOTE - This capacitor is polarized meaning that it has to be facing in the appropriate direction. Make sure you solder the NEGATIVE lead to the LOWER of the two squares. The negative side has the shorter lead and a vertical stripe along the side of the capacitor.

3. ADDING THE .1uF CAPACITORS (the two discs with “104” written on them)

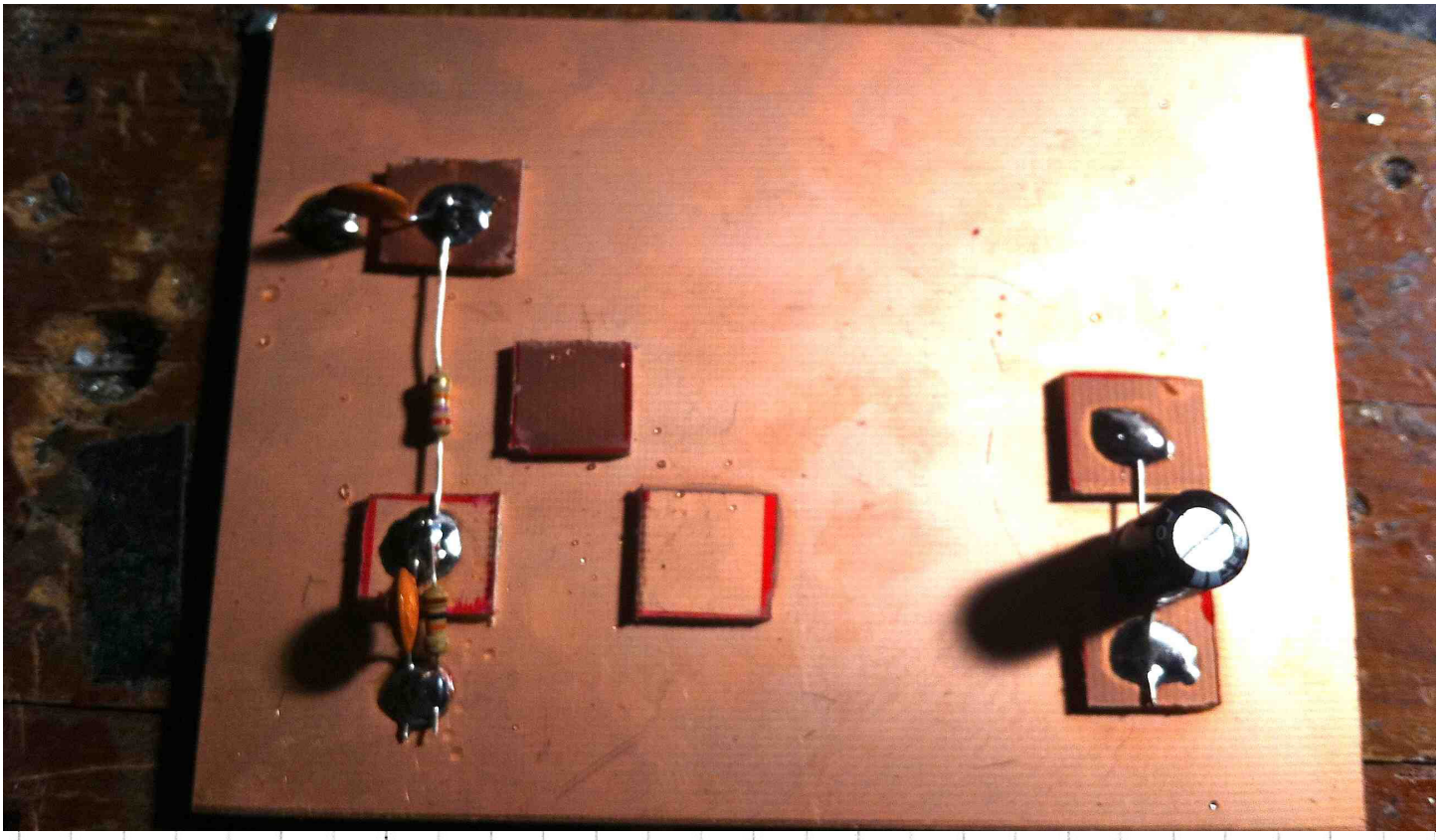
- These capacitors will be positioned between the upper and lower left most squares and the ground plate. Melt a blob of solder on these two squares and two blobs on the ground plate beside each. (Reference the pictures for exact positioning).
- Re-heat the blobs and position the capacitors accordingly as in step 2.

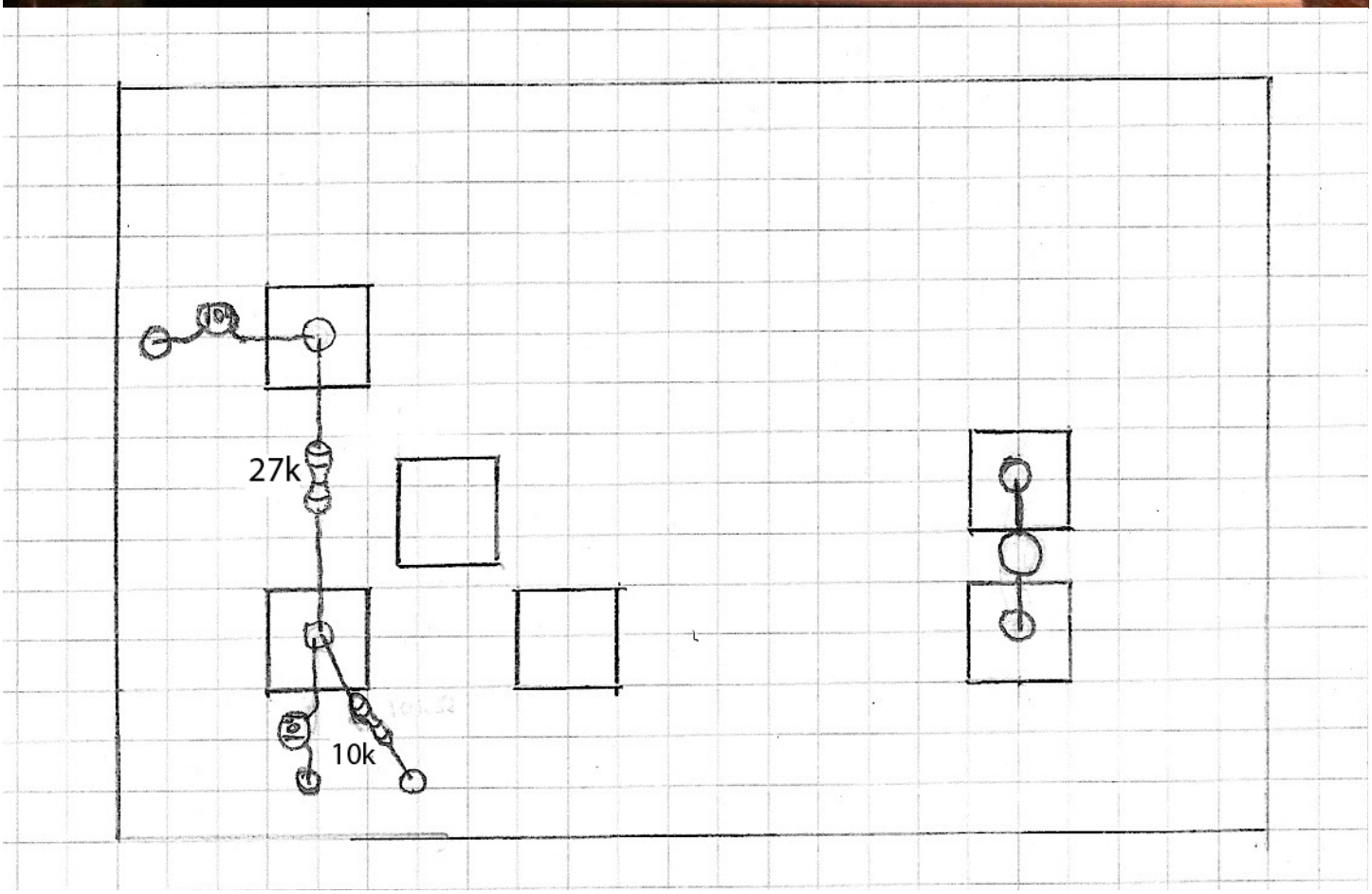




4. ADDING THE RESISTORS (10k and 27k)

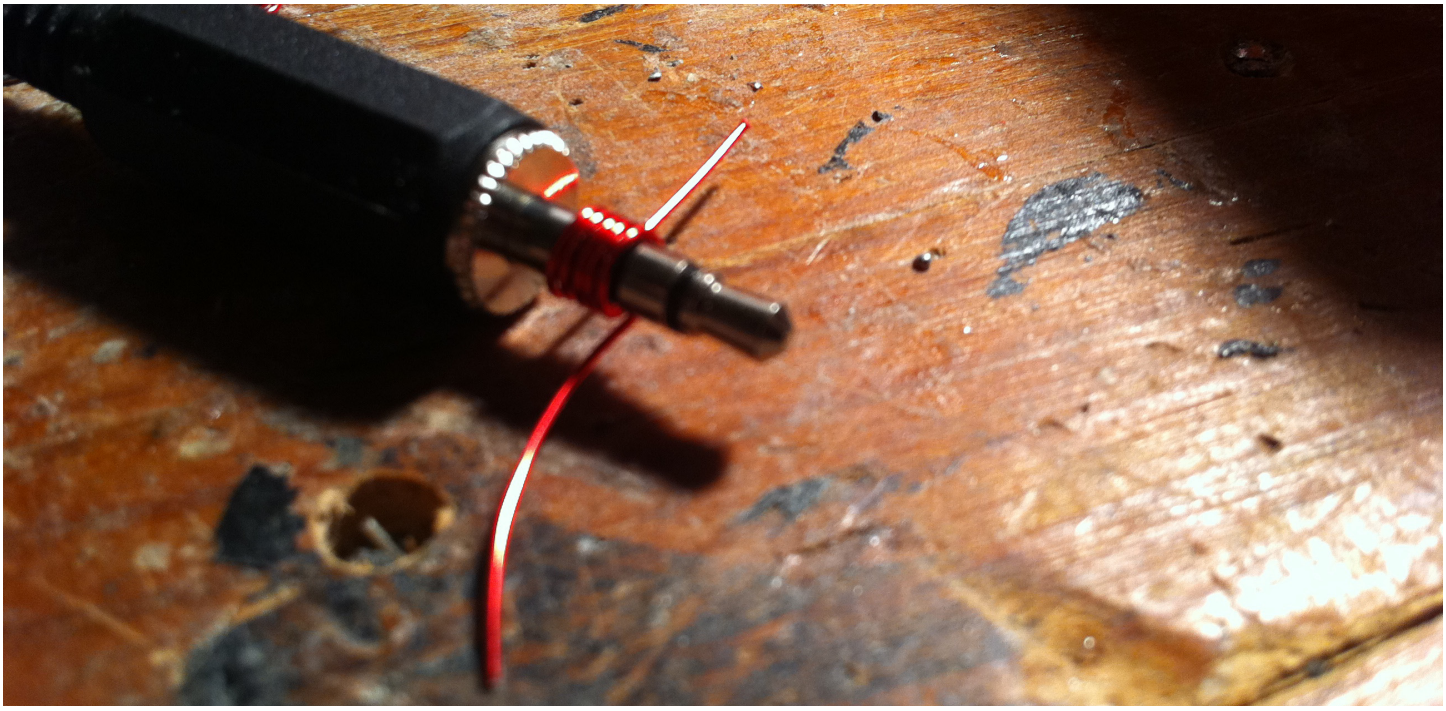
- Solder the 10k resistor (brown, black and orange stripes) between the bottom left square and ground.
- Solder the 27k resistor (red, violate and orange stripes) between the two left squares.



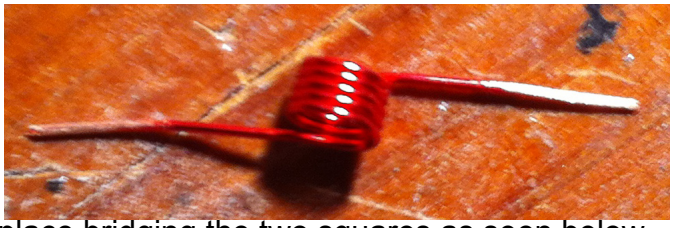


5. ADDING THE COIL

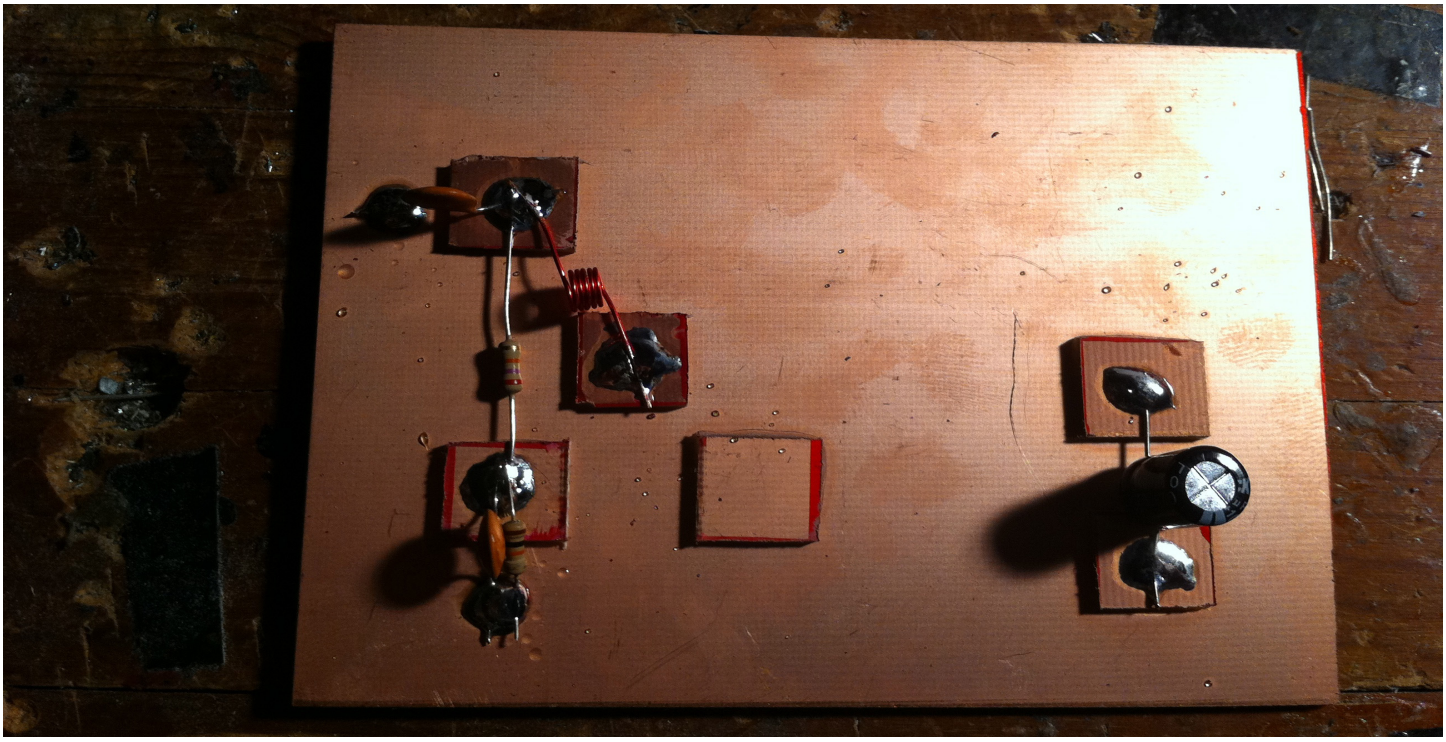
- Cut about 4” of the magnet wire (24 AWG or close)
- Use the plug from your headphones to wrap the wire around. Make 5 turns.

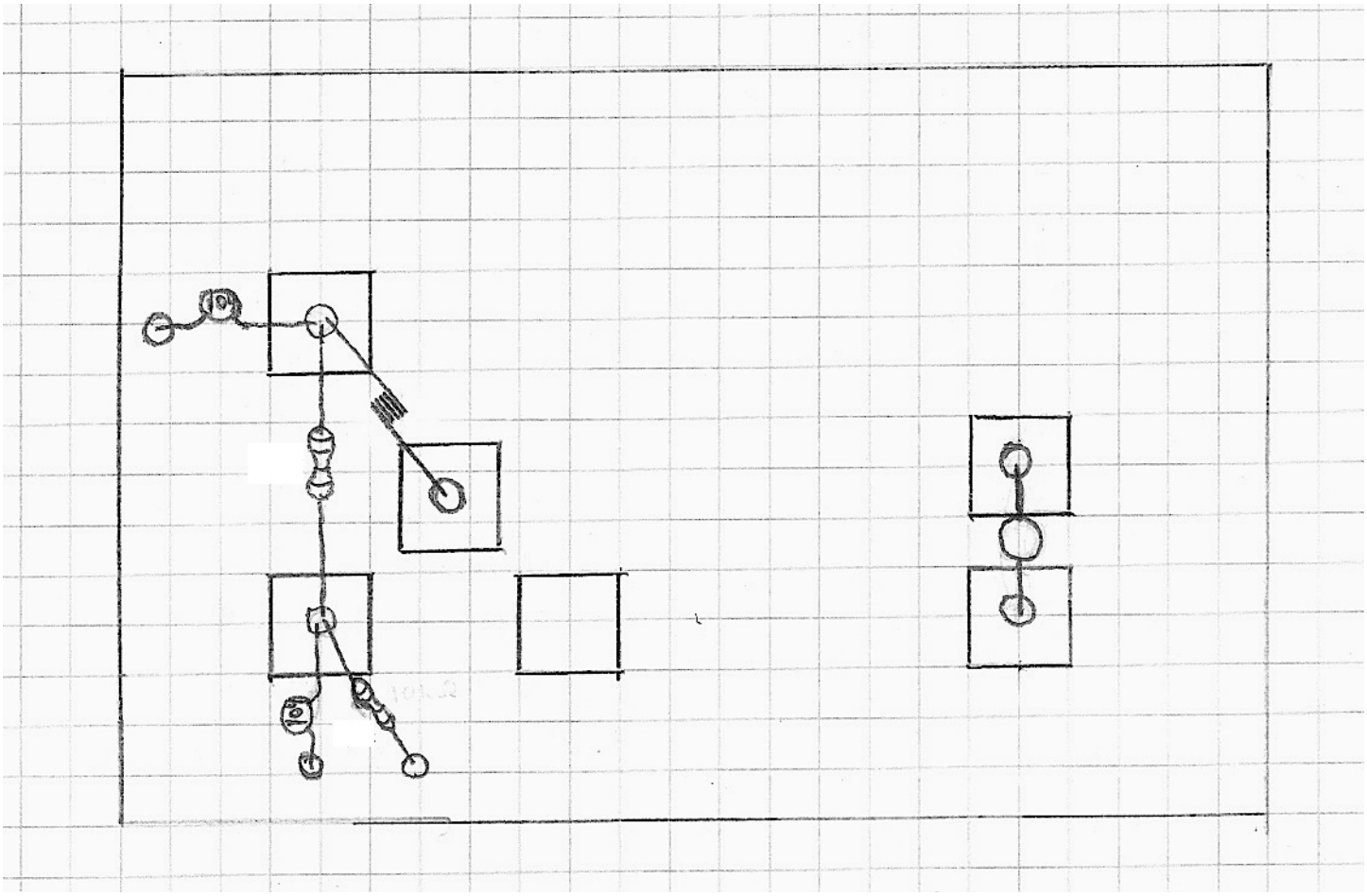


- With the wire still wrapped around the headphone plug, take a small piece of sand paper and rub off the colored insulation of each end until the bare copper is exposed (If the copper is not exposed, you won’t be able to make a connection).



- Solder the coil into place bridging the two squares as seen below





6. ADDING THE VARIABLE CAPACITORS

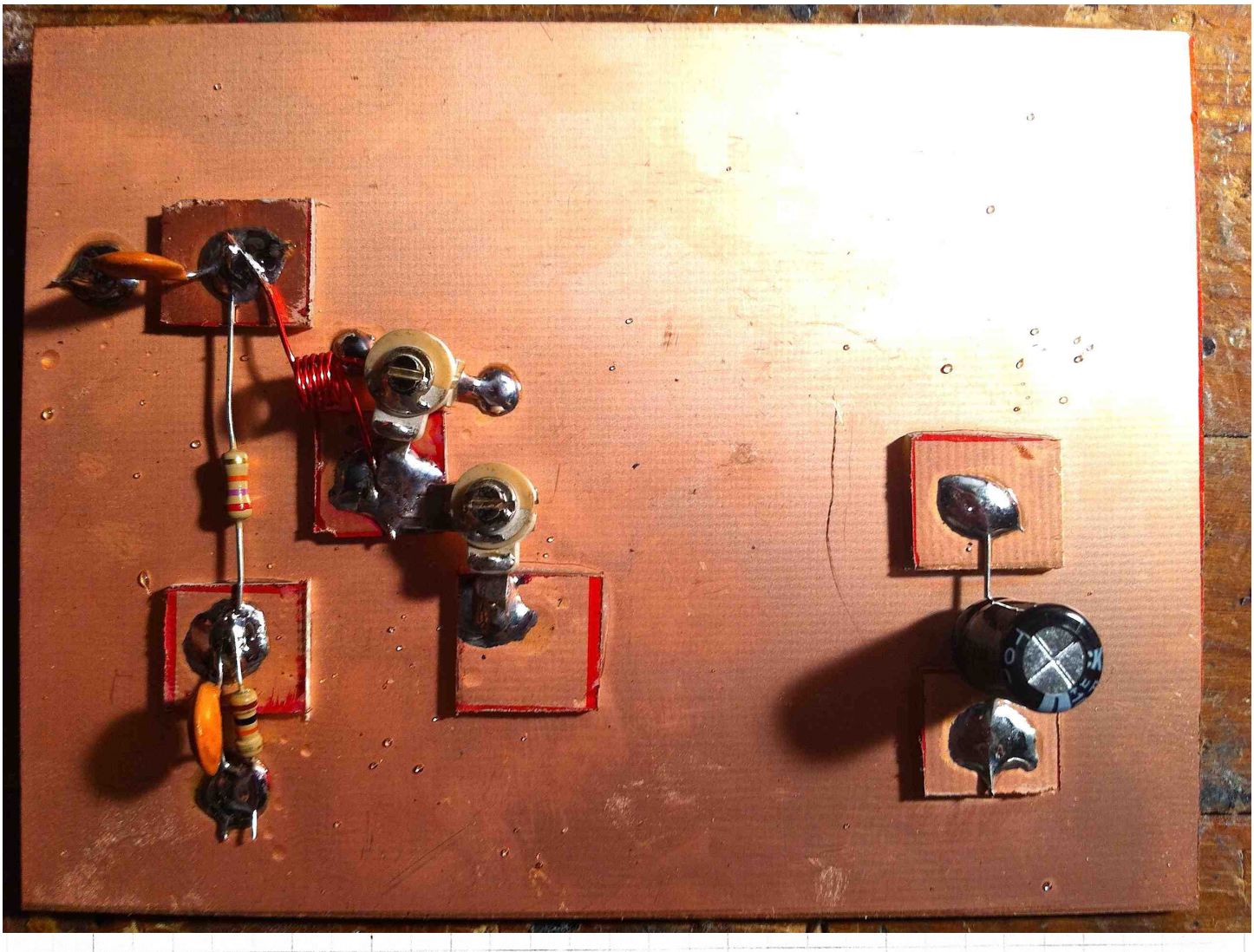
NOTE Once the component leads start to pile up on each other on each square, it helps to add additional solder.

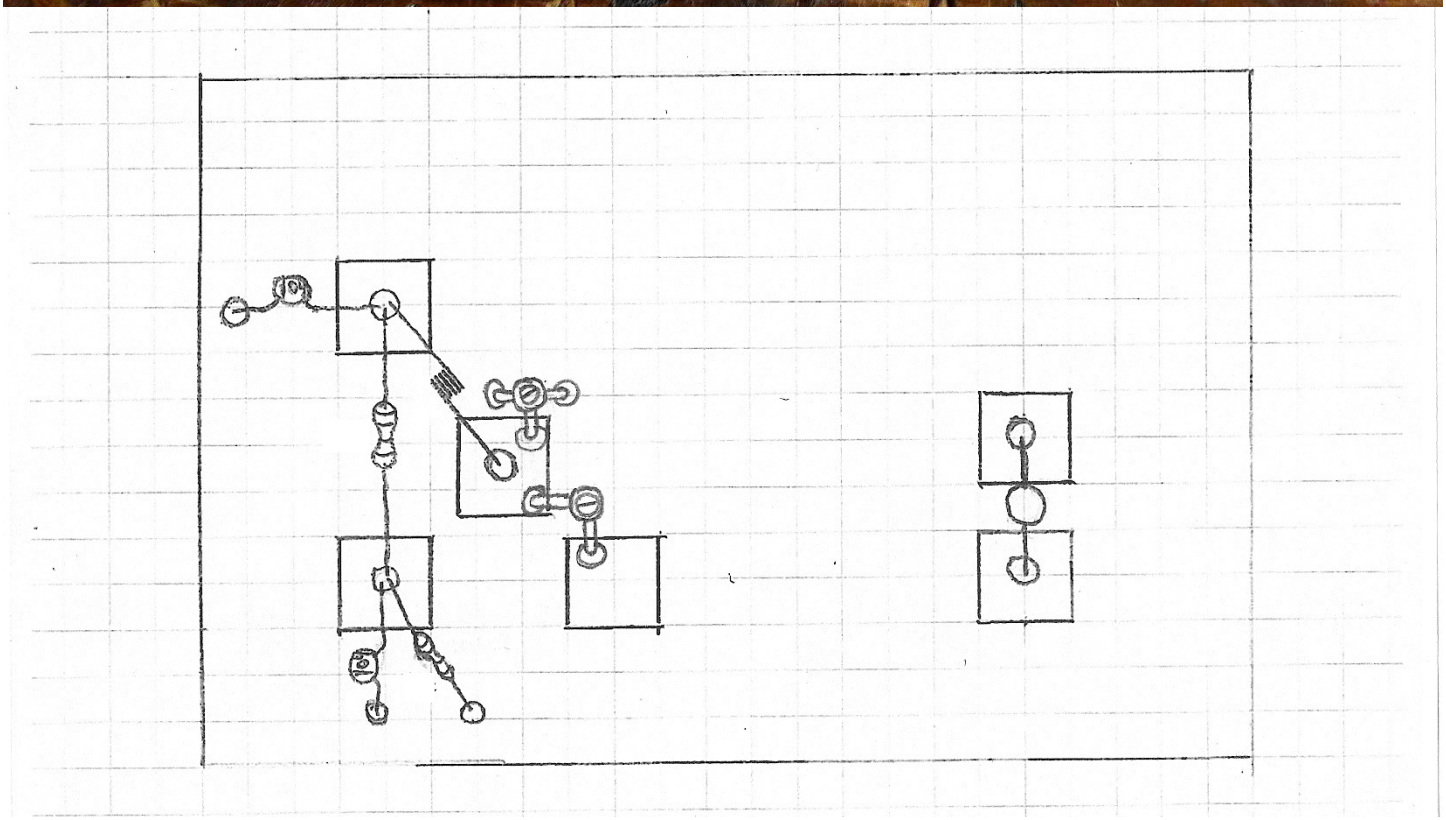
- The first variable capacitor will be soldered between the top square of the three that make up the bottom triangle and the ground plate.
- Solder the “nose” of the capacitor (the lead that is different from the other two) to the square, and the other two side leads to the ground plate.

NOTE You will have to bend the leads in a certain way in order to get everything positioned properly. Just play around with it till you get it.

- The second variable capacitor will bridge between top and right squares of the triangle. Only two leads are needed here so use your clippers to remove one of the side leads, leaving the nose and only one side. (See the pic below)

The variable capacitors soldered into place…



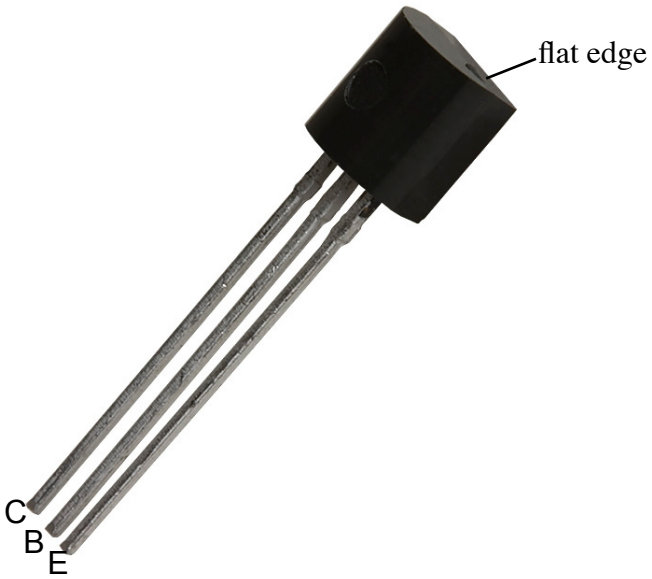


7. ADDING THE TRANSISTOR (MPSA18)

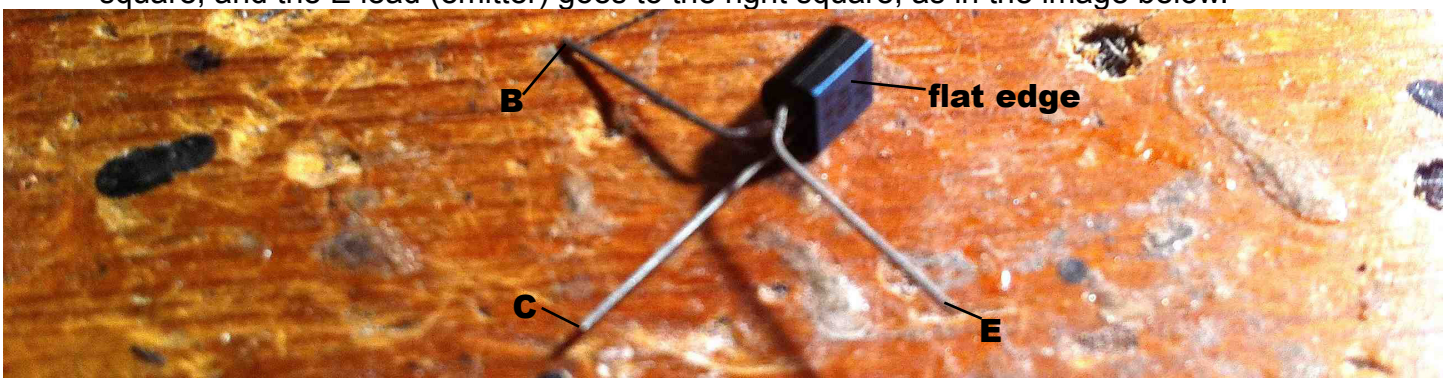
NOTE This transistor is sensitive to heat and can be destroyed by the heat from your iron. Be sure to follow the necessary precautions below. But don't worry if you do kill one, they are only ~$.10 a piece.

- The three leads of the transistor all do specific things and must go to the appropriate places. Here is a pic of the orientation of this transistor…

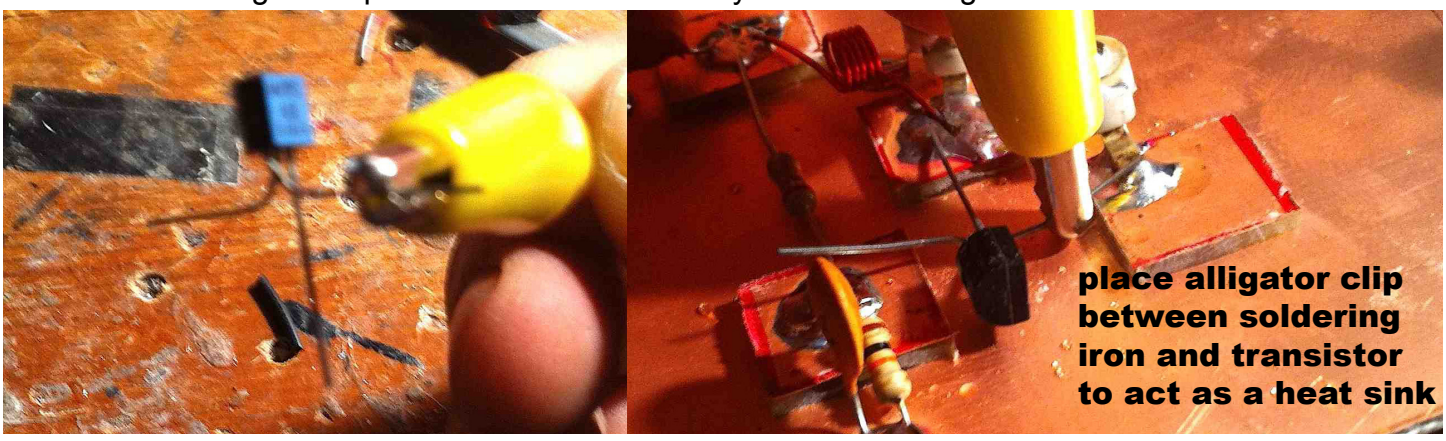
C=Collector B=Base E=Emitter



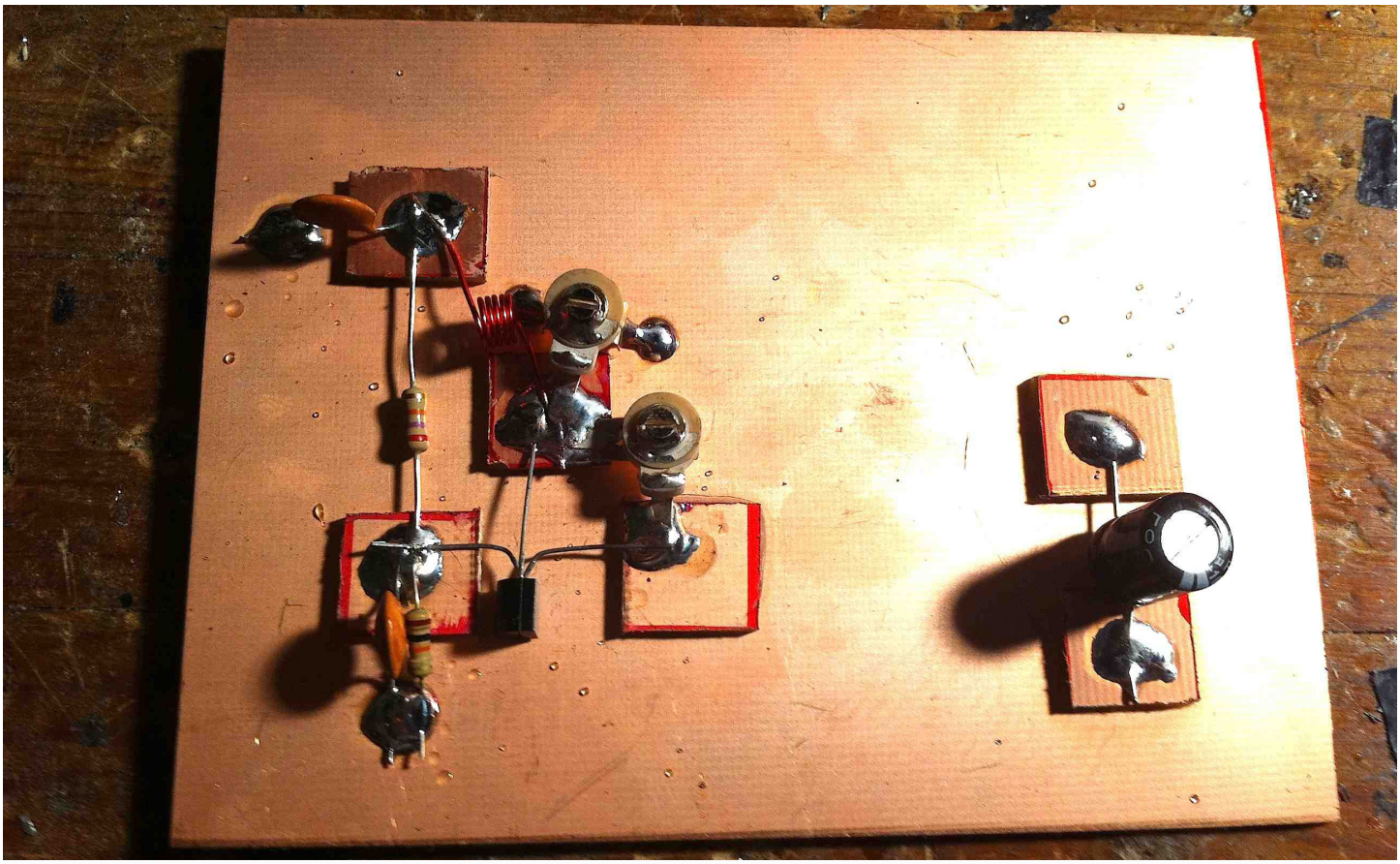
- Each lead from the transistor will be soldered to the three different squares that make up the triangle, so you will have to bend the leads accordingly.
- The B lead (base) goes to the left square of the triangle, the C lead (collector) goes to the top square, and the E lead (emitter) goes to the right square, as in the image below.

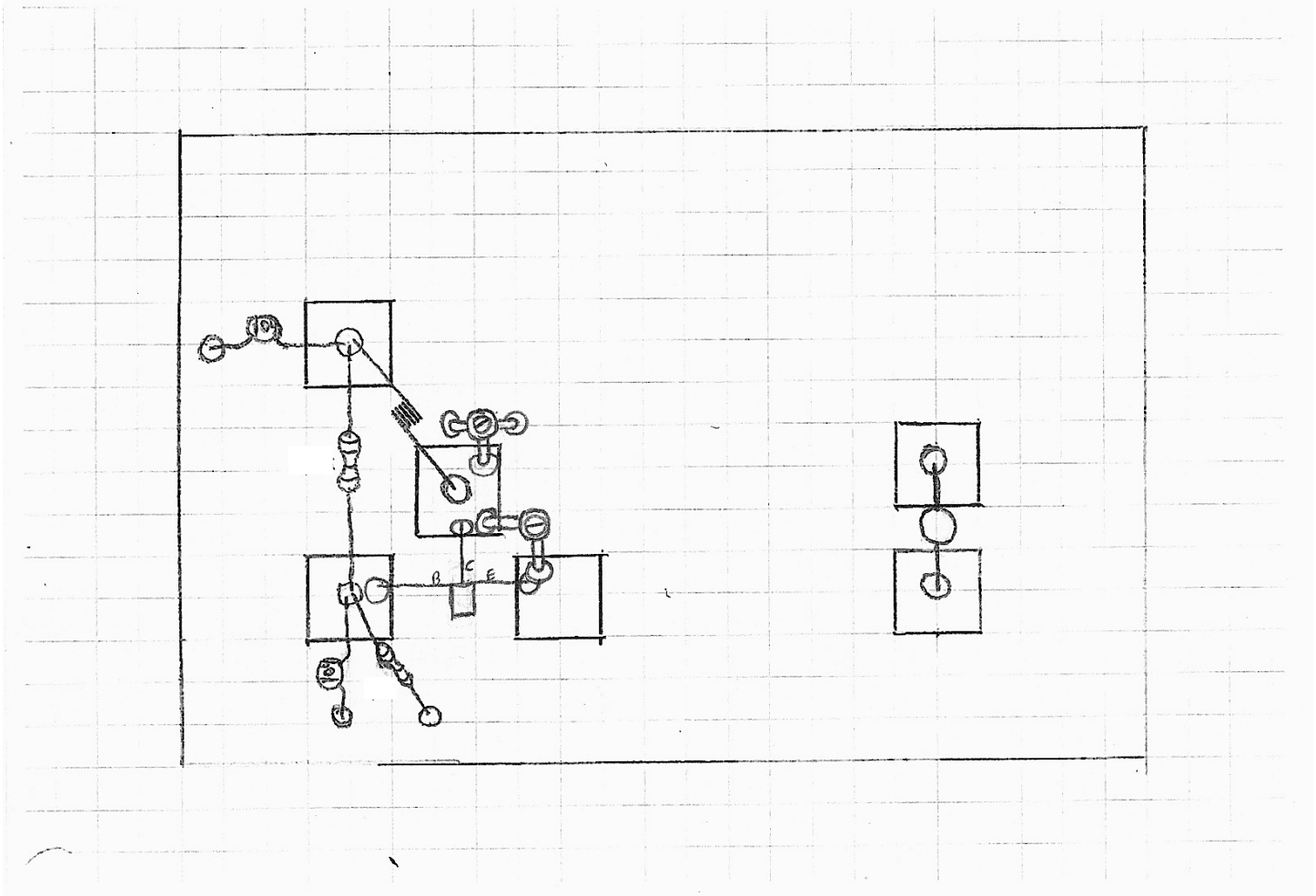


- Before you solder the transistor in place, you need to have a "heat sink" attached to protect it. This will draw some of the heat from the transistor to something else. To do this, simply take an alligator clip and attach it to the lead you are soldering…



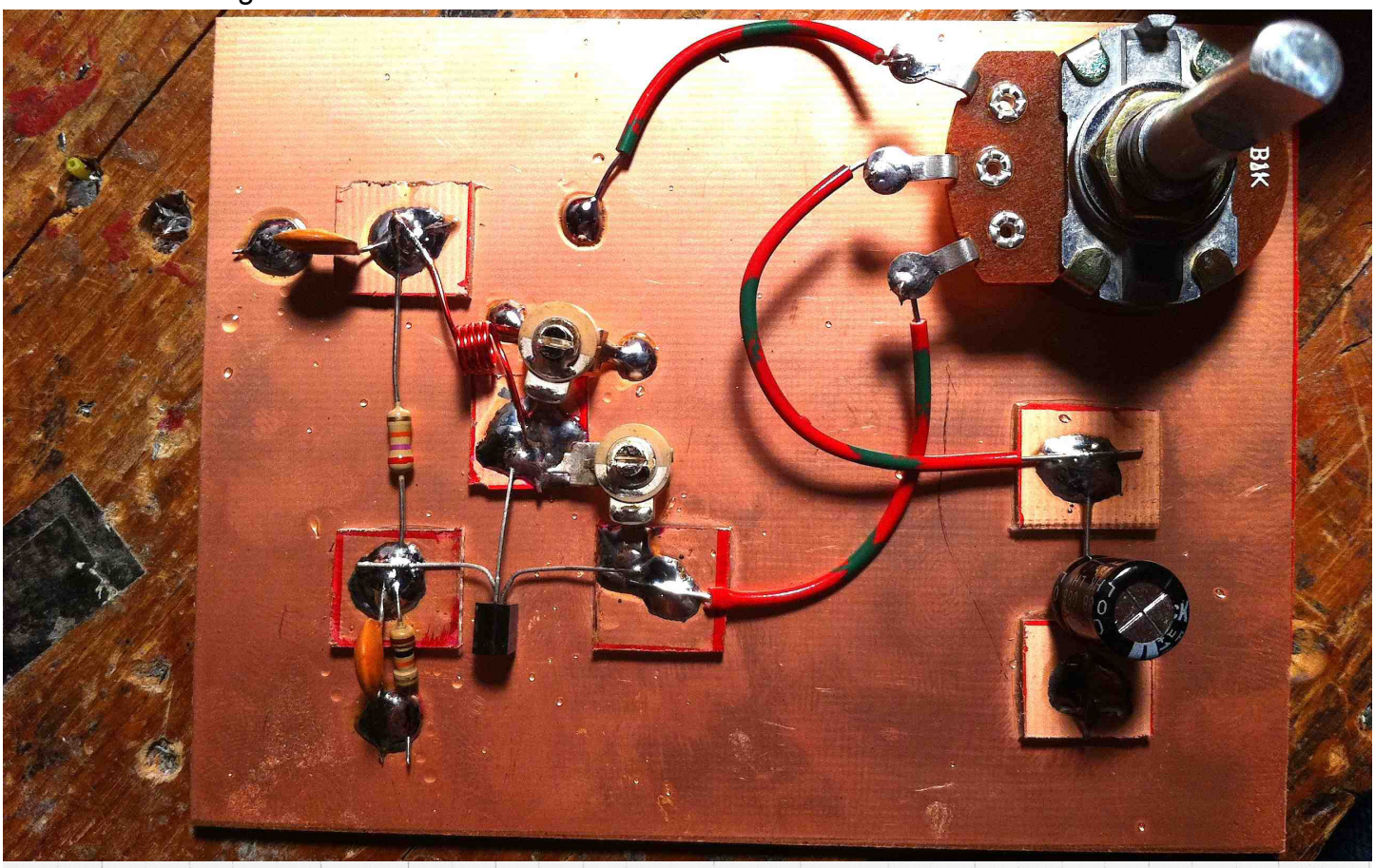
- Solder each lead in place attaching the clip lead to each one before doing so.

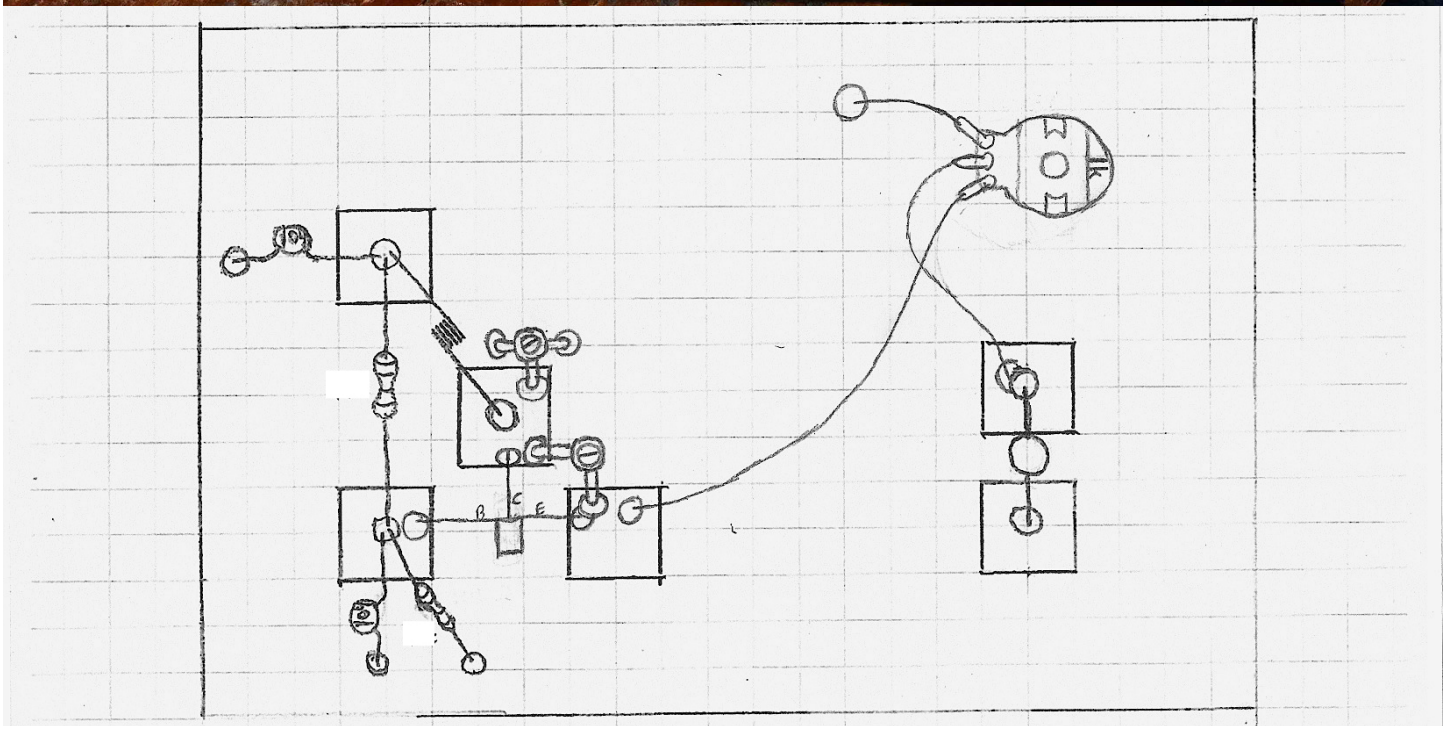




8. ADDING THE 1k POTENTIOMETER

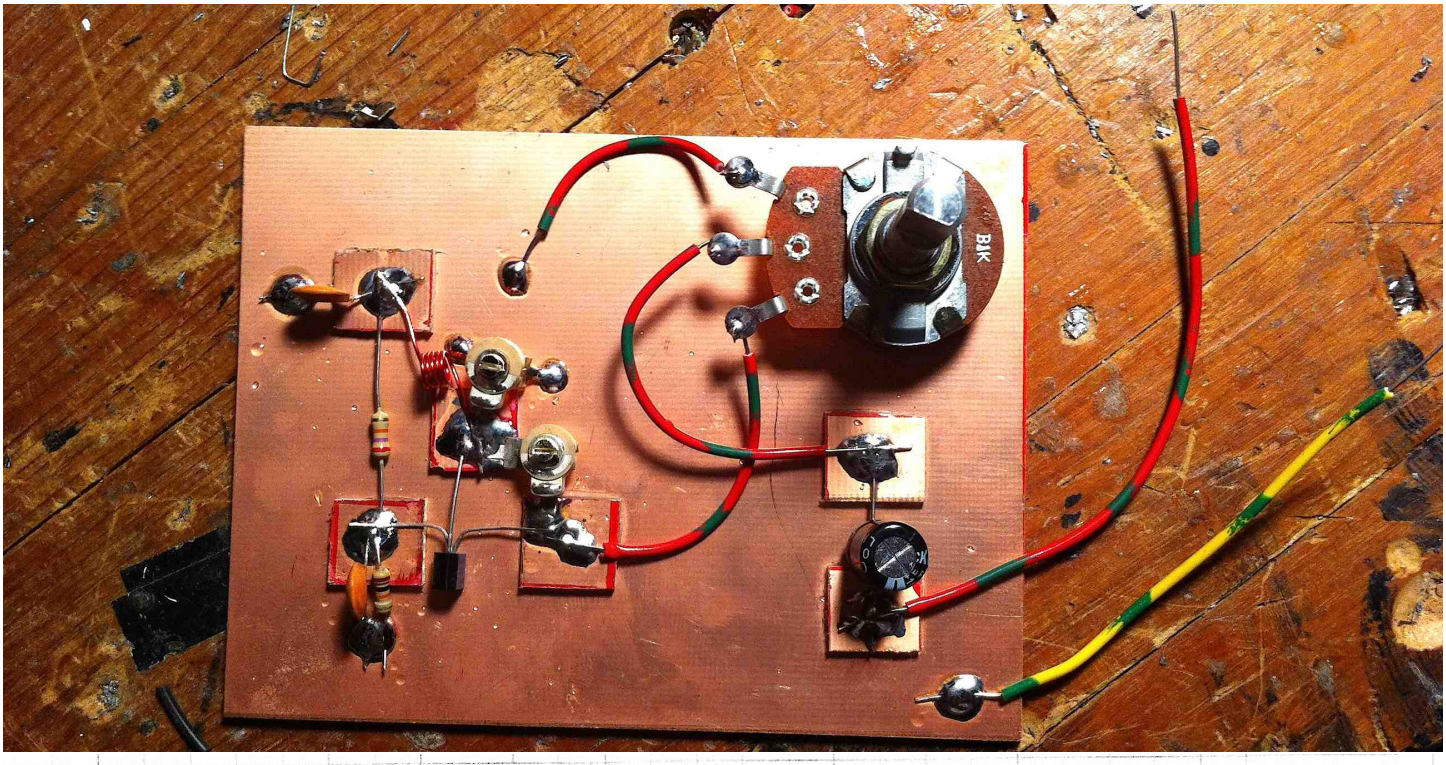
- Put a bit of super glue or hot glue on the bottom of the potentiometer and stick it to the upper right corner with the leads facing towards the left of the plate.
- Take a small amount of stranded hookup wire and strip both ends. Solder one side to the upper most lead and the other side to the ground plate.
- Repeat the process by connecting the middle lead of the potentiometer to the upper most of the two right squares. Then connect the lower lead of the potentiometer to the right most square of the triangle.

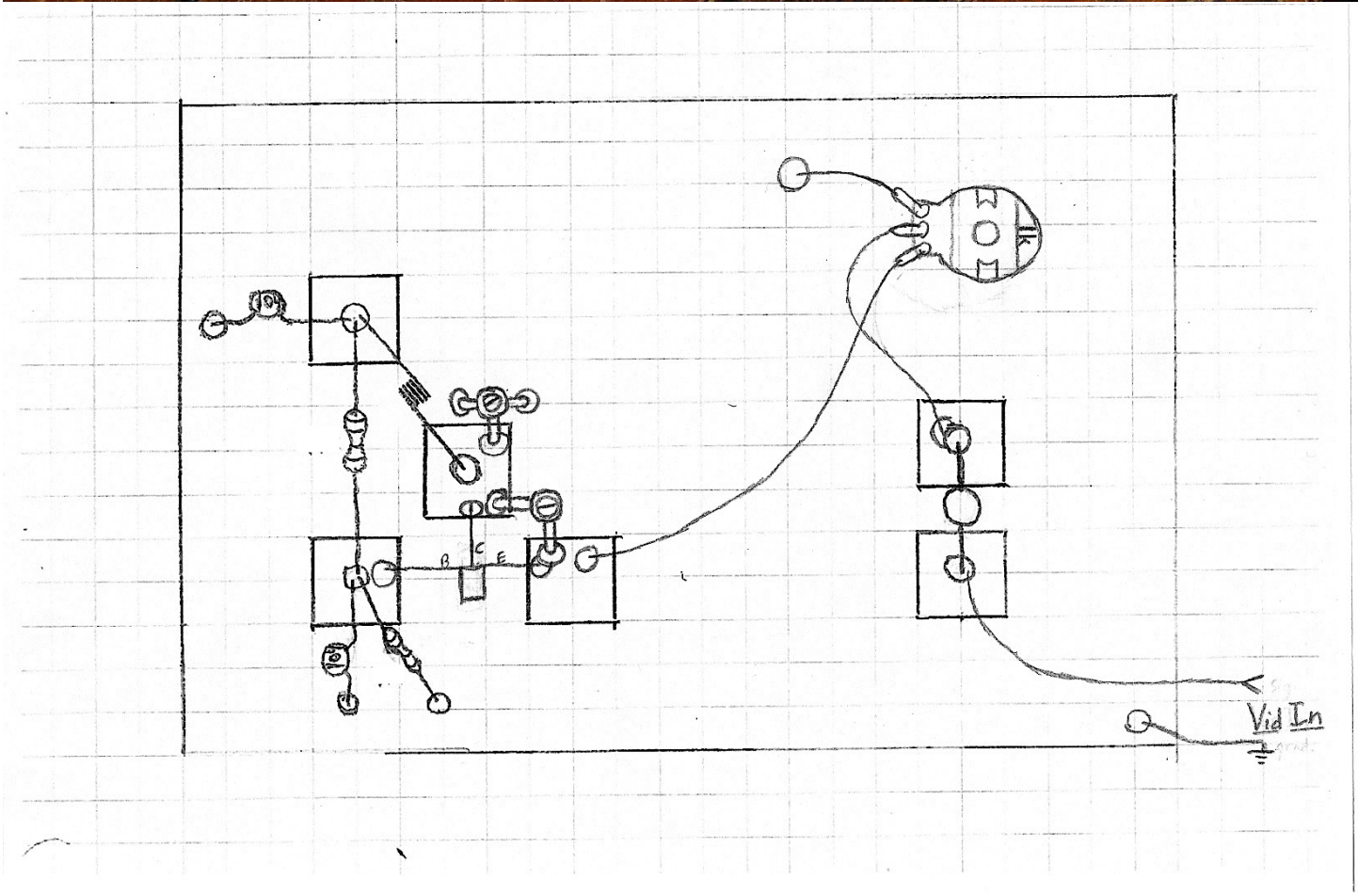




9. ADDING THE INPUT WIRES

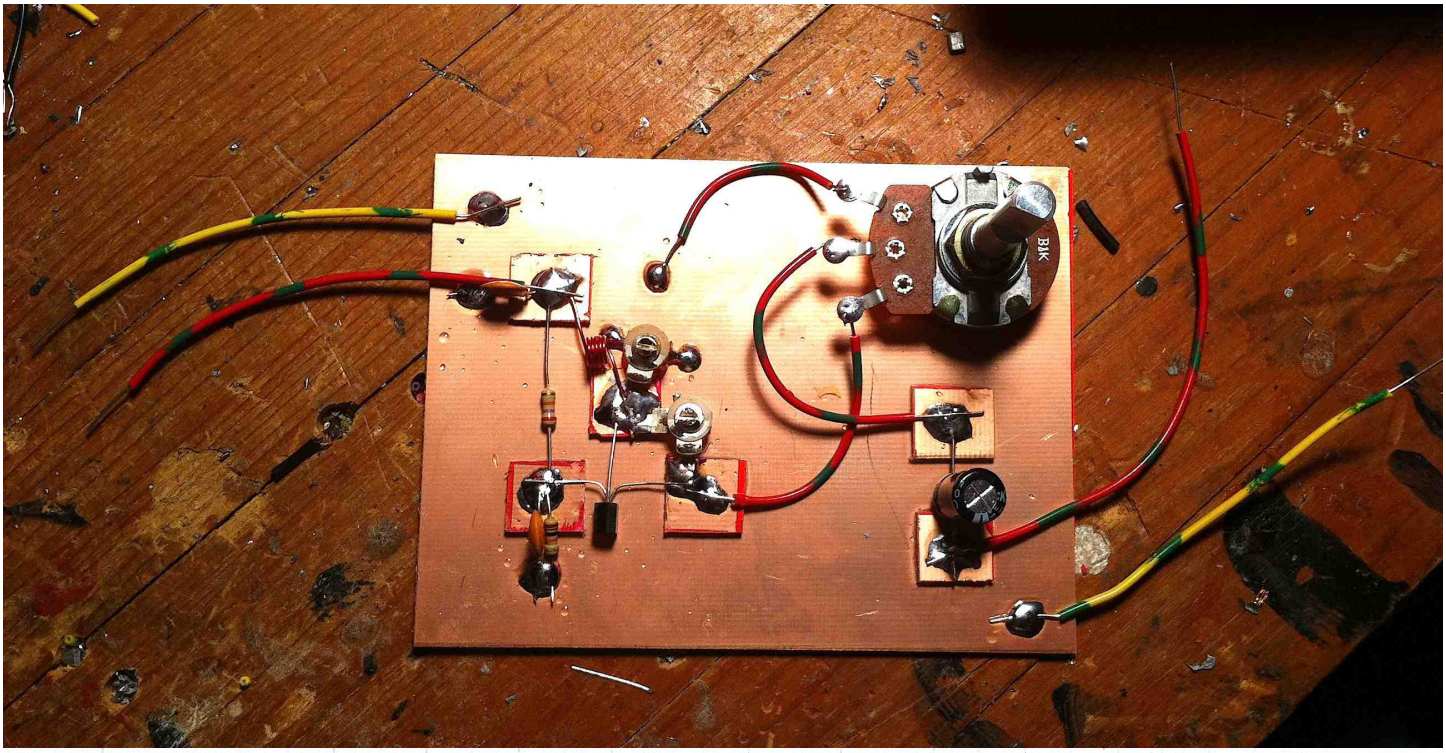
- Cut two small lengths (~4-5”) of your stranded wire and strip both sides
- Solder one of the wires to the ground plate (this will be the ground input from your video source)
- Solder the other wire to the bottom square of the two right squares. (This will be the signal input from your video source)

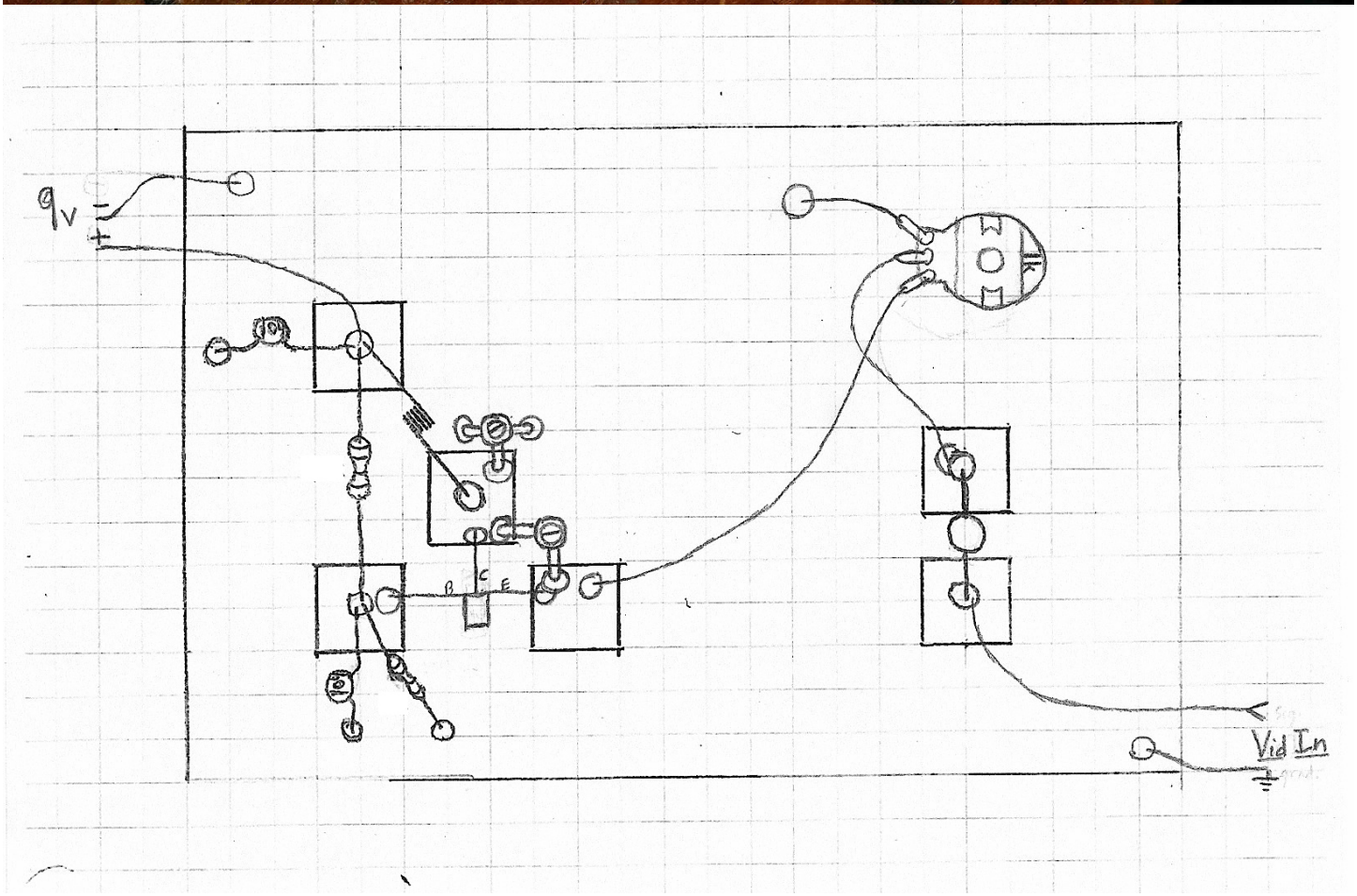




10. ADDING THE BATTERY INPUT WIRES

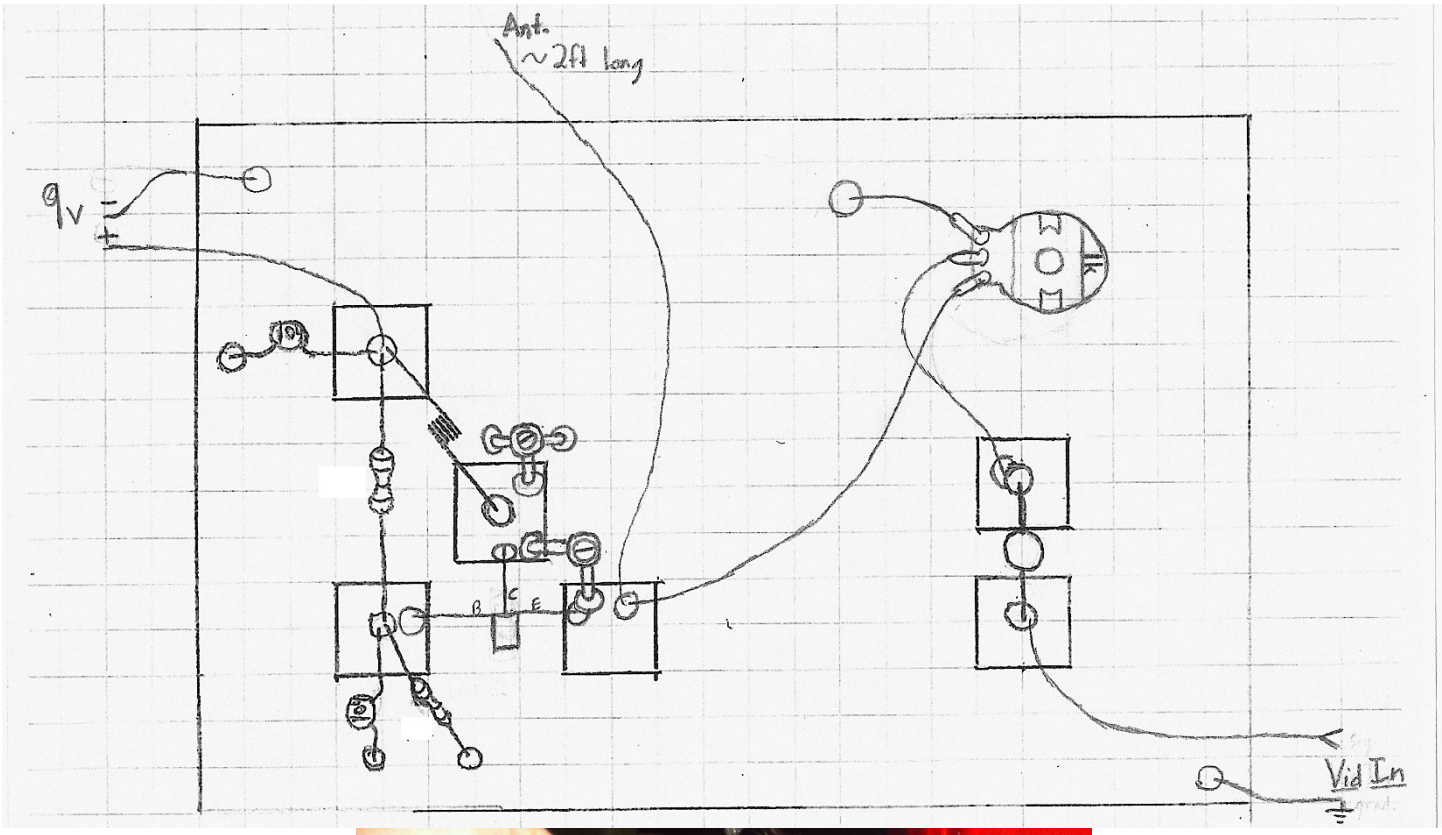
- Just like the last step, cut two shot pieces of wire and strip both ends.
- Solder one of the wires to the ground plate (this will be the negative input from your 9volt battery).
- Solder the other wire to the upper left square (this will be the positive input from your 9volt battery).

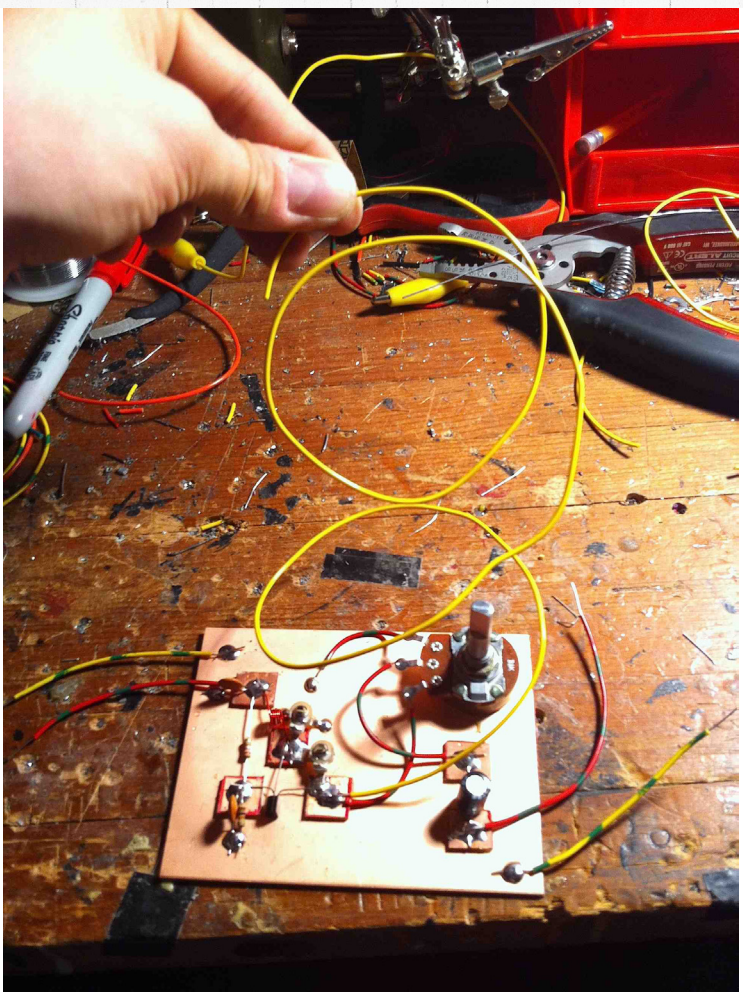




11. ADDING THE ANTENNA

- Cut about 2 feet of wire and strip one end.
- Solder the wire to the right most square of the triangle.

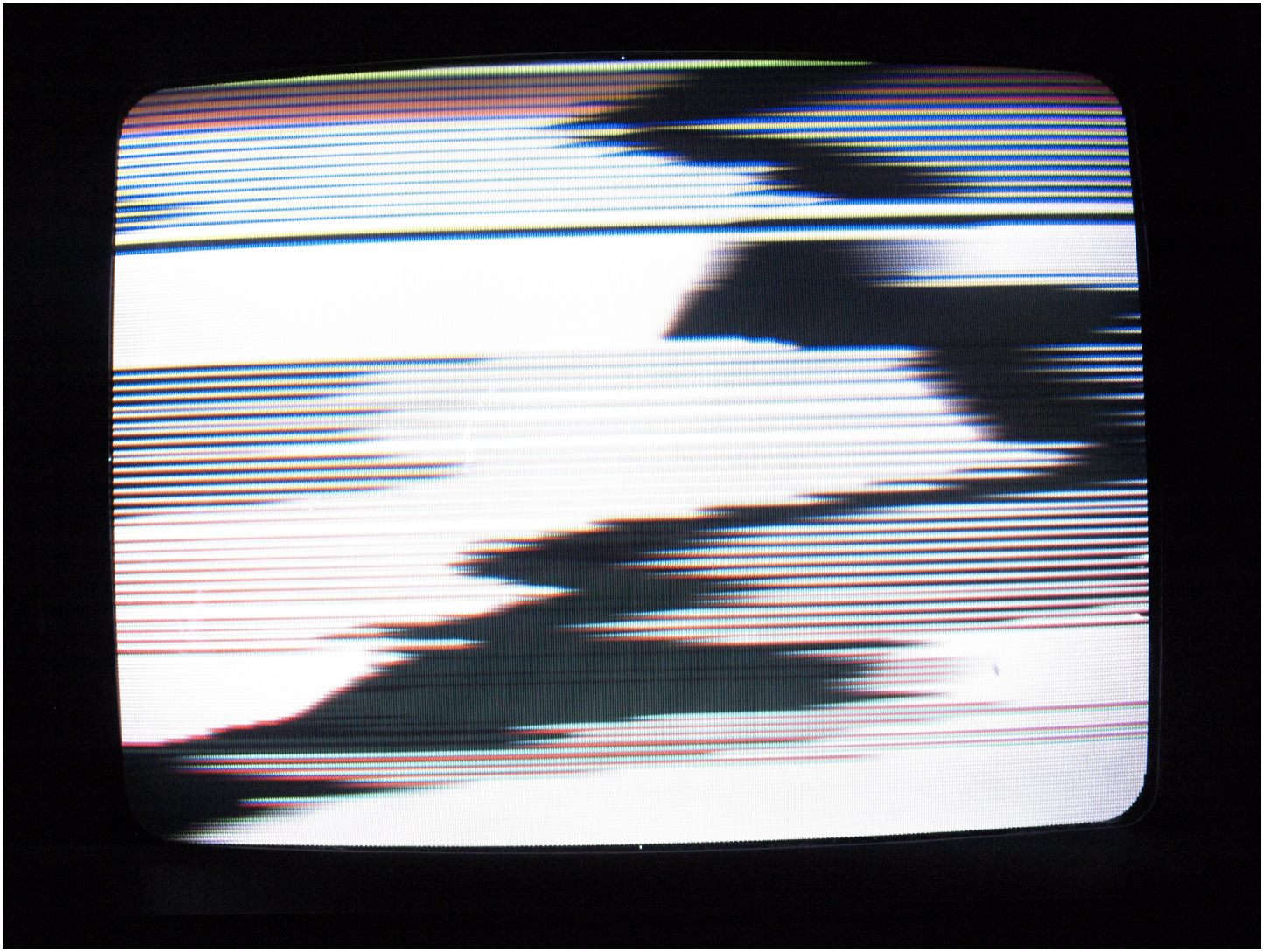




OPERATING

- Find a video source (DVD player, VHS player, iPod etc.) that has a composite video output.
- Use an alligator clip lead to connect the ground from your video source to the ground input of the transmitter. Using another alligator clip lead, attach the signal output from your source to the signal input of the transmitter.
- Use two more alligator clips to connect the positive and negative of a 9v battery to the positive and negative battery inputs of the transmitter.
- Turn on a CRT “tube style” TV and tune it to channel 2 or 3.
- Turn your potentiometer to somewhere around 50%
- Using a small screwdriver, tune the upper most variable cap slowly until you see the TV make a flicker or change.
- Tune the second variable capacitor until you start to see some strong signal coming through
- Tune the potentiometer and the two variable capacitors until you get the imagery you wan

Send any comments, questions or suggestions to yaktronix.online@gmail.com



BUILDING A DIY ELECTROMAGNET FOR TELEVISION HACKING

WHAT YOU NEED

-3/8” diameter STEEL dowel rod (length depends on how many E-mags you want to make)

-Steel works good, but it at least hast to be a ferrous (magnetic) metal.
(If your not sure, bring a fridge magnet to the hardware store and see if it sticks to it. If it sticks, you know its ferrous.

-Hand Drill
-Hack saw
-Wire clippers
-Electrical Tape and Scissors
-Small piece of sand paper
-Patience and Dedication
-Multi-meter (optional, but it helps to have one)

-Insulated Magnet Wire (jameco.com part #2098419)

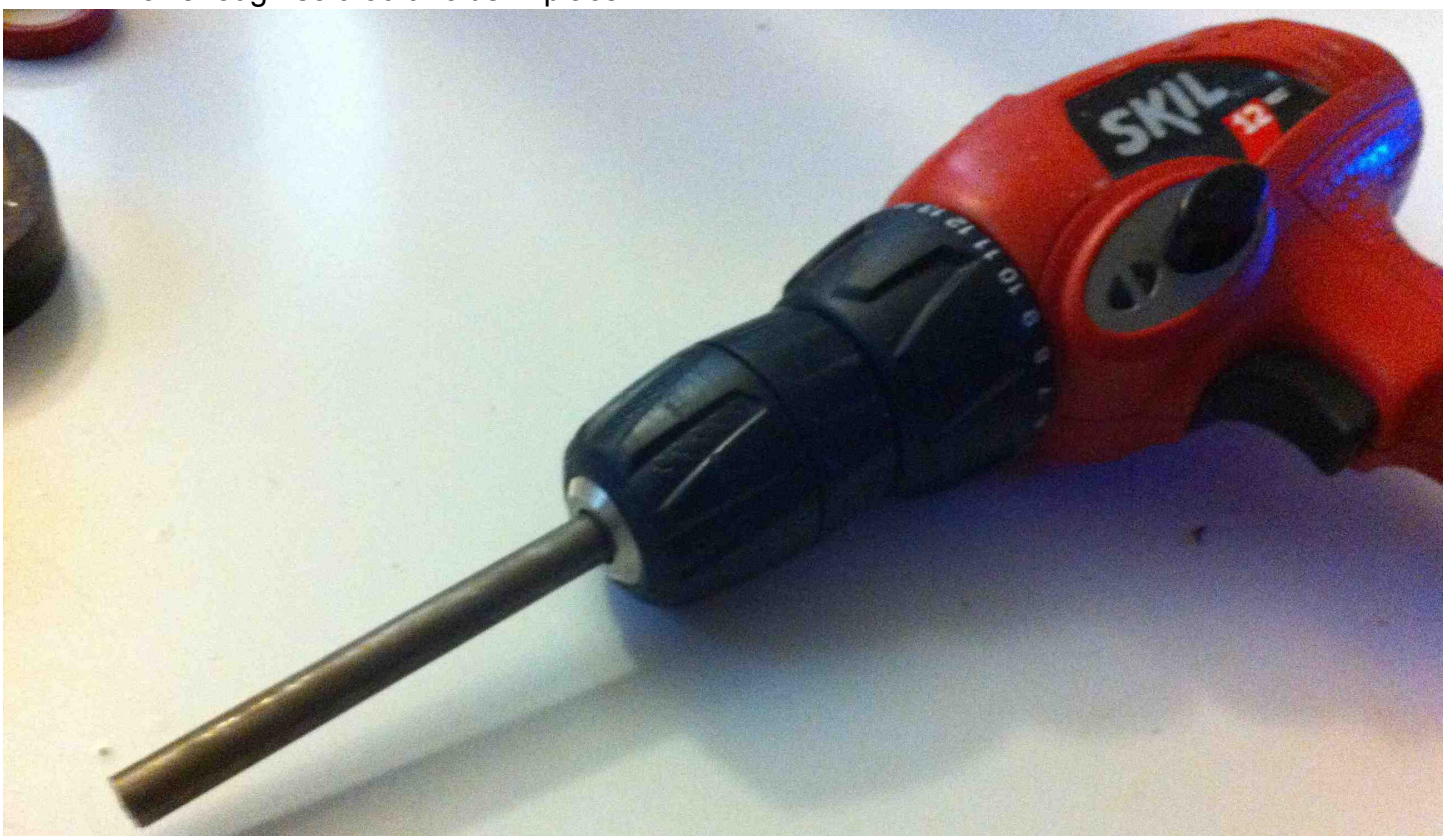
24 AWG seems to work best
(AWG=American Wire Gauge, standards for wire thickness)

BUILDING THE ELECTROMAGNET

1. Use your hack saw to cut off a ~4” length piece from your dowel rod.

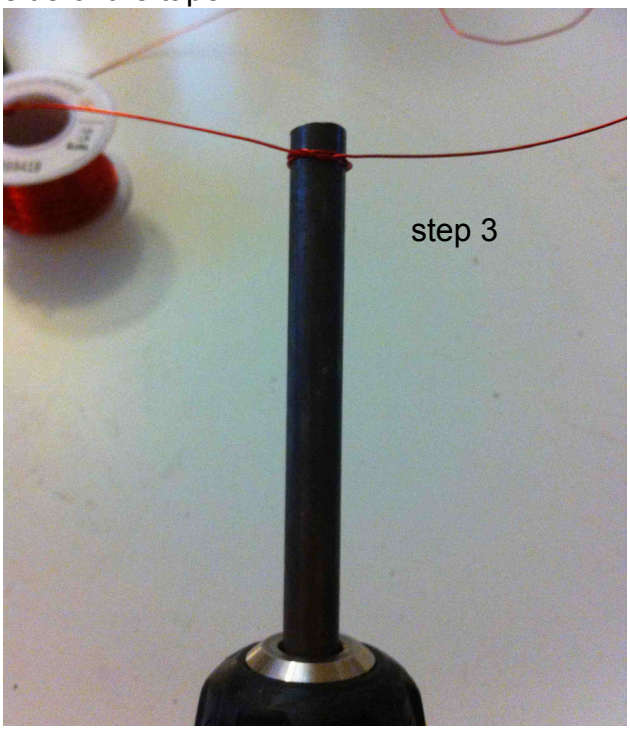
2. Fit the small rod into the chuck of your drill, as if it’s a drill bit.

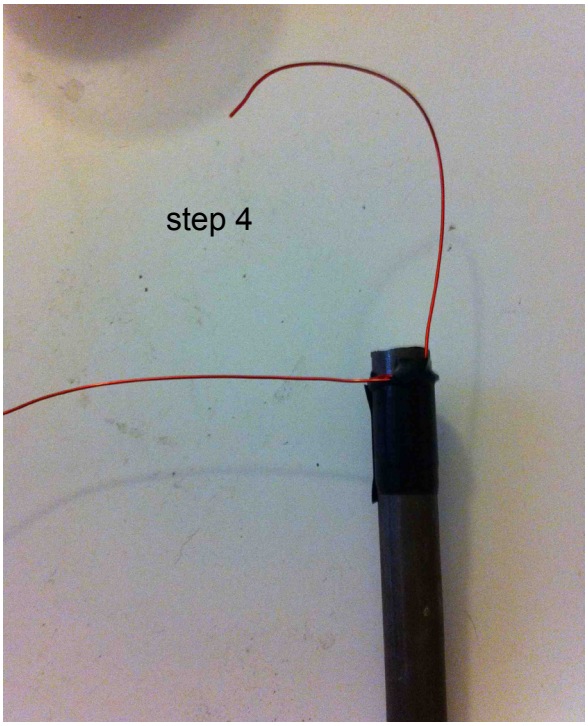
Note: You need as much of the rod as you can outside of the chuck so only put it in far enough so that it holds in place.



3. With the magnet wire, tie a knot around the top of the rod leaving about a 4” tail of wire. Tie the knot about ½” from the top.

4. Wrap electrical tape around the knot to secure it. Make sure both sides of the magnet wire are outside of the tape.

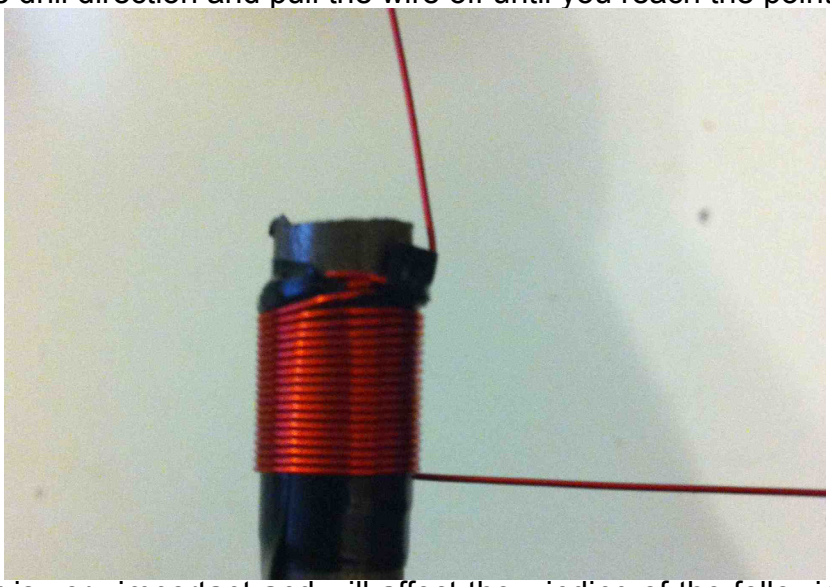




5. Hold the magnet wire taught to one side of the rod and slowly begin to spin the drill.

-You can hold the wire however feels most comfortable and use whichever rotation direction for the drill you like, just be sure to keep it tight.

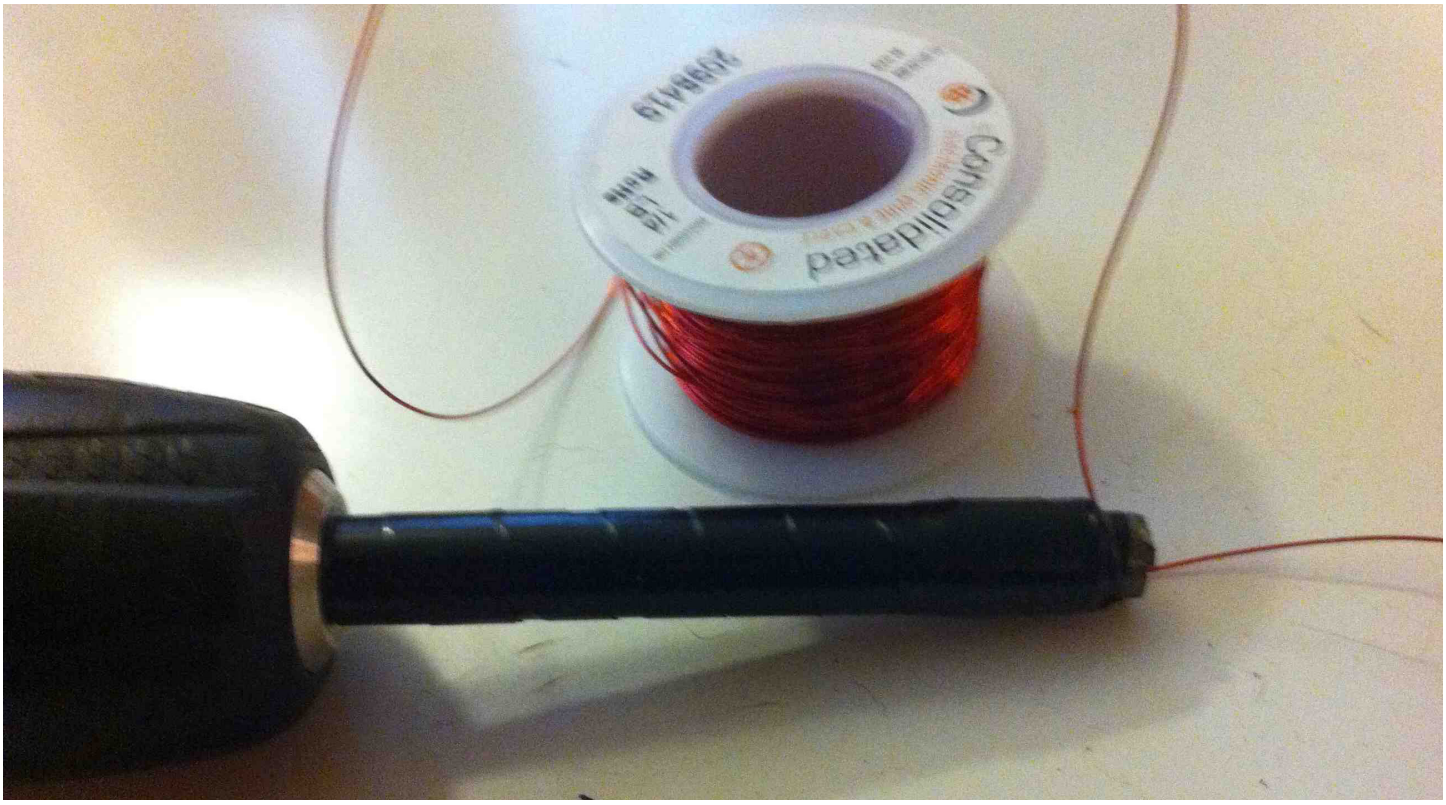
-The wire will start to stack one on top of the other as you guide it into position. If you mess up, just reverse the drill direction and pull the wire off until you reach the point of your mistake.



-This first layer is very important and will affect the winding of the following layers, so try to be as clean as possible. Also, the closer the windings are together, the more powerful the magnet will be.

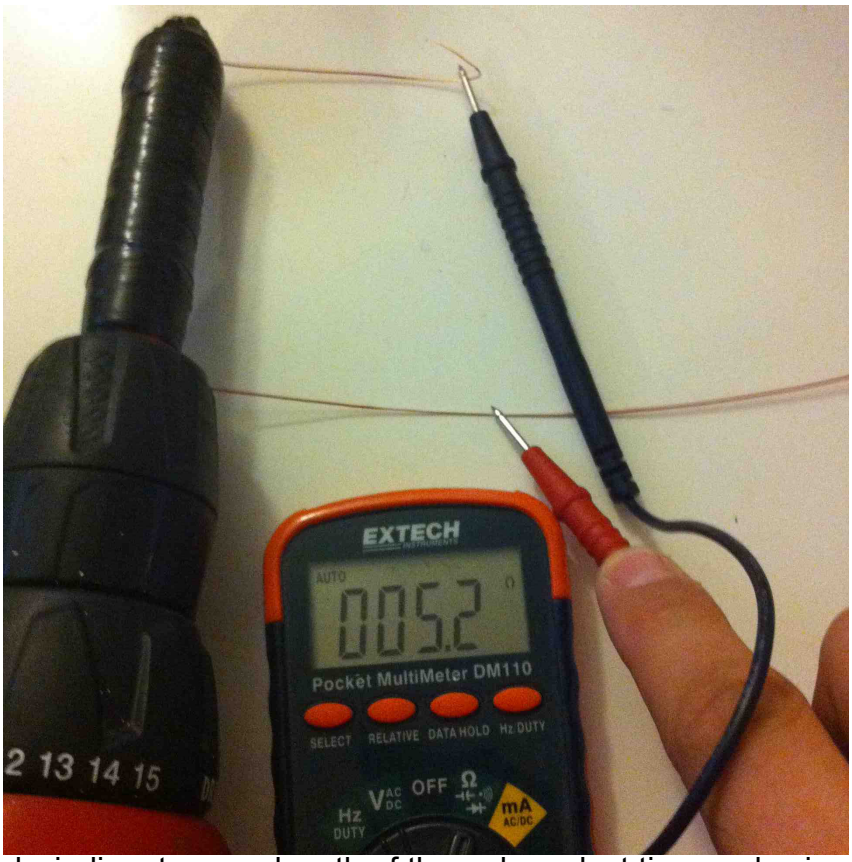
6. Continue winding the wire making sure that you hold it tight. Once you reach the bottom, the top of the cuck will force the winding in the opposite direction and do the same process all the way back up.

7.Once you reach back to the top, hold the wire tight and wrap electrical tape around the whole length of the rod. Don't cover up the very tip of the metal rod with tape, and be sure to leave ¼" to ½" exposed.

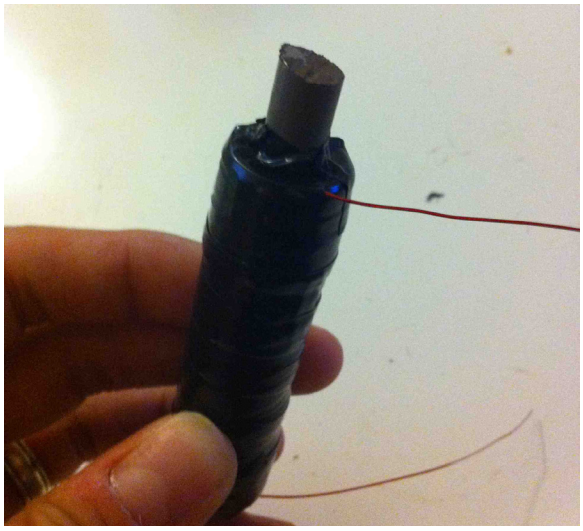


8. Repeat this process a few more times. The more wire you wind will result in a more powerful magnet but greater overall resistance. I usually wind my mine until I reach 5 Ohms of resistance. A good rule of thumb is that each up and down wind = 1 Ohm. So going up and down about 5 times is usually sufficient. But anything around 4 – 8 Ohms is good. If none of this makes sense, don't worry and just experiment.

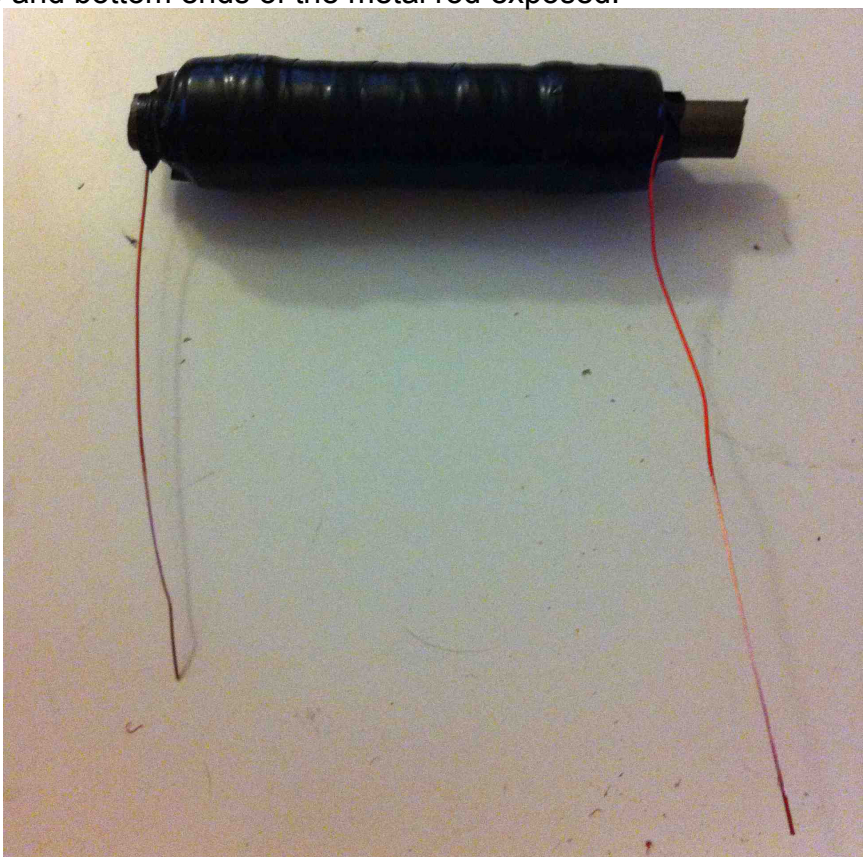
To test the resistance of your magnet so far, find a stopping point at one of the ends and tape down the wire. Take your sand paper and rub off the insulation on both ends of the wound wire. This removes the colored insulation and exposes the bare wire. Take your multi-meter and test the resistance between the two points. If it is sufficient then snip off your wire, but if it's not, keep on winding.



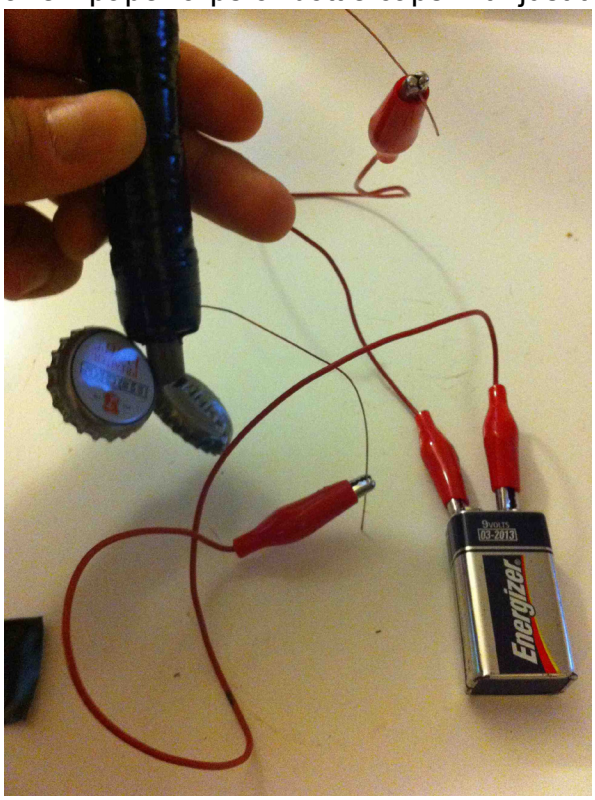
9. When your finished winding, tape up length of the rod one last time and snip off the remaining wire leaving a few inches for a tail. Remove the magnet from the drill chuck and turn it over. You may notice that the bottom side closest to the chuck is not very well secured. Place some tape around the bottom covering the exposure to secure it.



The finished magnet should look something like this. Make sure everything is secure with tape, but be sure to leave the top and bottom ends of the metal rod exposed.

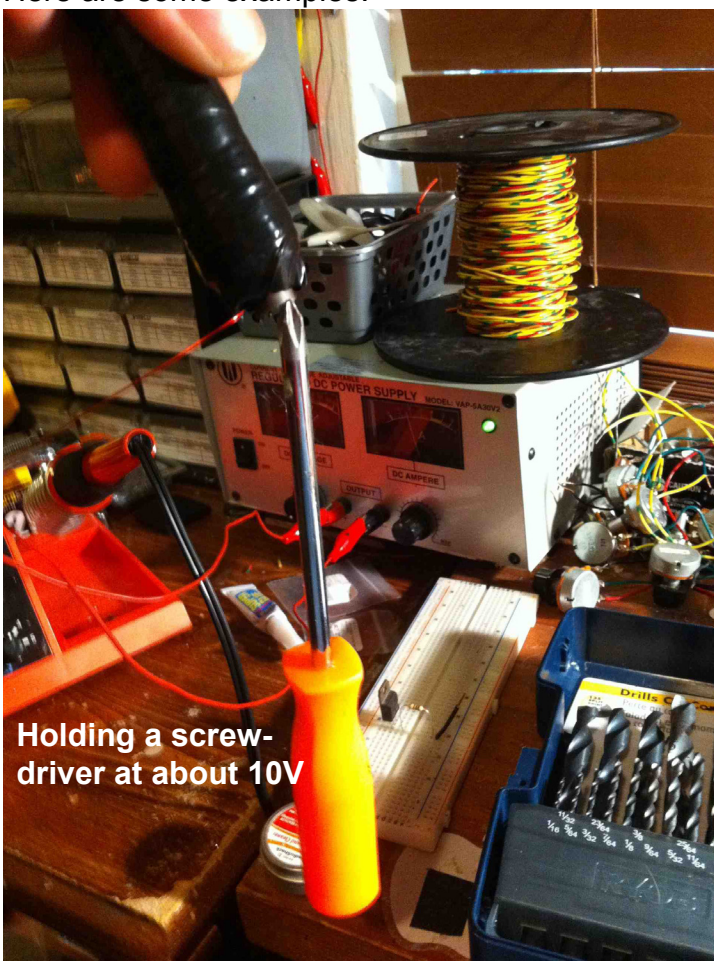


10. To test out your magnet, first make sure you have sanded off the insulation on both sides of the wire. Use some clip leads or some wire to attach the + and – of a 9v battery to the two leads of magnet wire. It doesn't matter which side goes to + or – at this point. (Changing that will switch the north and south polarity of the magnet).
You should be able to pick up a few paper clips or bottle caps with just the 9v.



For more power, use more electricity. Try hooking it up to a DC power supply. The increase in available amps will increase the power of the magnet dramatically. But it will also increase the heat it generates. Sometimes it can be hot to the tough so be careful.

Here are some examples:



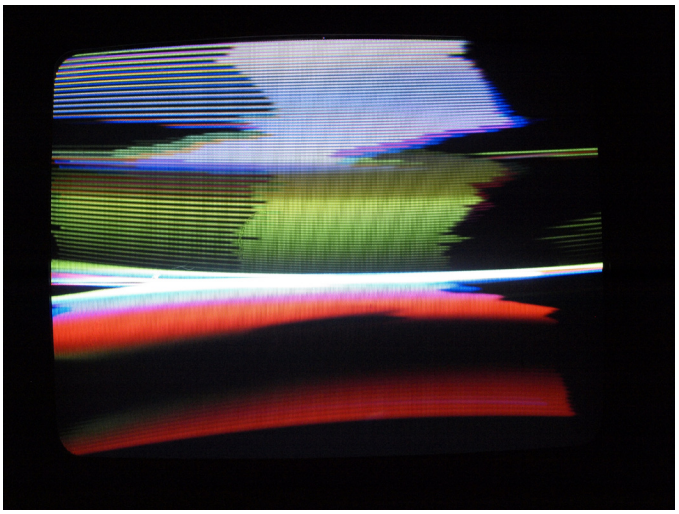
A lantern battery would also work much more efficiently than the 9v. If you're comfortable you can also try a moderately powerful DC wall wart, but don't play around with plugging stuff into the wall unless you are more experienced. **Remember: Batteries can't hurt you, but wall power can!**

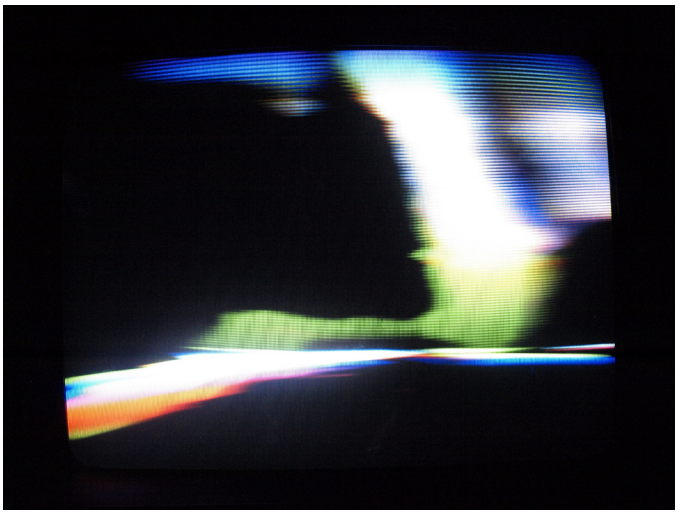
INTRODUCTORY INFORMATION ON USING AN ELECTROMAGNET FOR TELEVISION HACKING

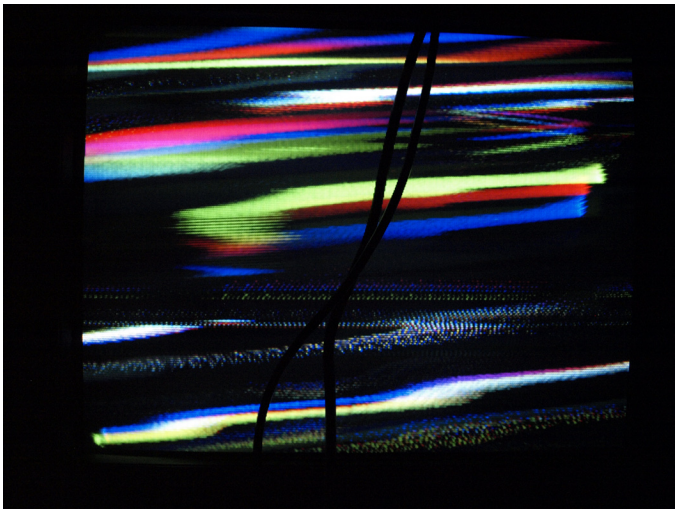
Though this will all be covered in the next tutorial, here is an explanation on where all this is going in regards to video hacking.

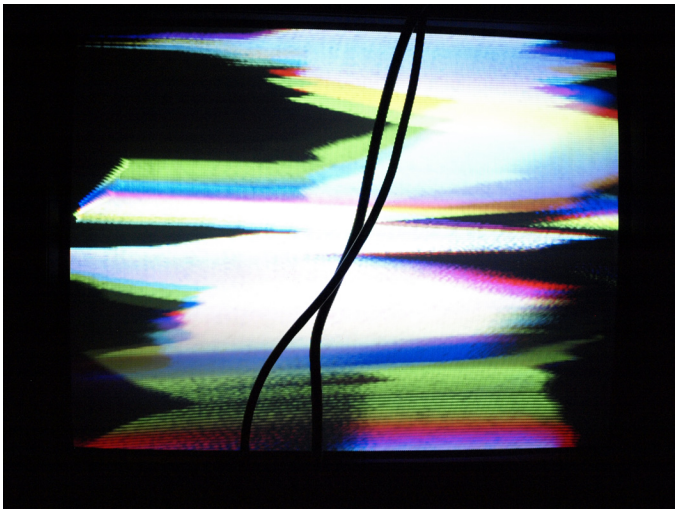
If you have ever stuck a magnet on a CRT, you know how it alters the colors and images on the screen. Doing this internally makes for some very interesting and dramatic imagery.

The electromagnet needs to be between 4 and 8 Ohms because this is around the same resistance of an audio speaker (or impedance when you're talking about an alternating current signal like audio). If you amplify an audio signal, such as a sine wave, and replace the speaker with the magnet, you have a magnet that is rapidly switching polarity. This is useful over a stationary magnet because you can make an image wobble over time rather than just a still distortion. If none of this makes sense, don't worry, it doesn't have to in order to make it work. Here are some example results of the process:

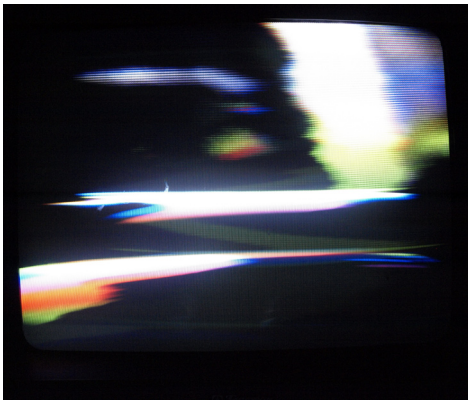
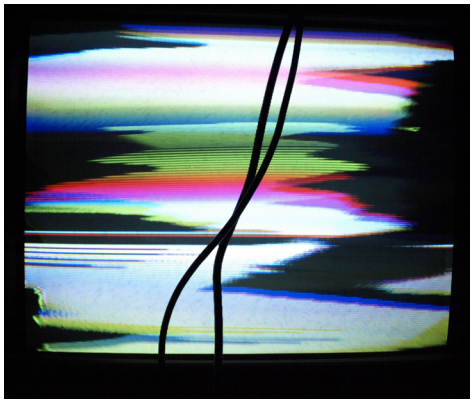
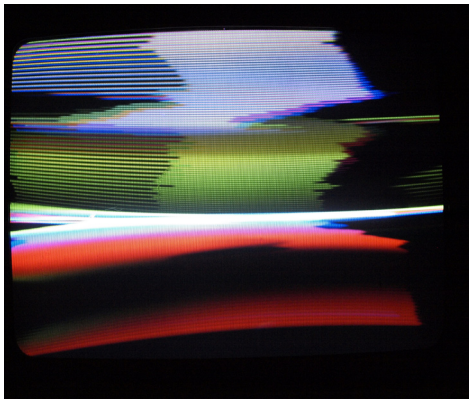








HACKING A TELEVISION WITH A DIY ELECTROMAGNET

WHAT YOU NEED

- DIY electromagnet from previous tutorial
- Either a ¼" audio jack, RCA jack, or terminal mounts (whatever you have on you)
- Wire (stranded or solid)
- Large flathead screwdriver
- Clip leads (alligator clips)
- Hand drill
- Electrical tape
- Hot glue gun
- Stereo receiver or audio amplifier
- Signal generator
- CRT (tube style TV)

NOTE: The signal generator is for creating basic audio waveforms (such as sine waves). I have created a program for Mac computers that will work for this (yaktronix.com/tvhack) or you can find an equivalent for free online. A hardware function generator will work as well. This will all be covered in further detail later in the tutorial.

INTRODUCTION

This tutorial demonstrates how to use a hand-wound electromagnet to bend the electron beam of a television, causing the image to distort and "wobble". This method is highly influenced from Nam June Paik's video instrument/processor, the Wobbulator. You can find the info and build instructions for the Wobbulator on the Experimental Television Center's site here: (http://www.experimentaltvcenter.org/raster-manipulation-unit-operation-and-construction).

This method of image bending employs many of the ideas created by Paik, such as using a sinusoidal (sine) wave to drive the electromagnet. This is what gives the image its unique "wobble" characteristic. As the sine wave (or any other basic waveform) continuously alternates the polarity (north and south) of the magnet, the three electron beams of a color TV (RGB) are deflected causing the image distortions to move back and forth. Changing the frequency of the signal also greatly affect-sthe image.

This tutorial will cover the step-by-step process of how to modify your own CRT. But before we start please take note of this **very serious** safety reminder…

<u>OPENING A CRT TELEVISION IS A VERY DANGEROUS PROCESS</u>. You will be handling a device that stores MANY times more electricity than what comes out of the wall. Though this tutorial explains how to properly discharge a TV so it is safe to use, if you feel uncomfortable with this <u>DO NOT CONTINUE</u>. If this is your first time opening up a CRT, it can be a little frightening, but this tutorial will give you the step by step to safely working inside of one.

THE HACK

1. FINDING THE RIGHT CRT AND OPENING IT UP

It must be a CRT (tube style) TV, no flat screens will work for this. You can find these at all thrift stores around the world for dirt-cheap. Though almost any CRT will work, it does make a difference if you use a color or B+W TV. Using a color TV will result in the rainbow effect as the RG+B beams are deflected to the wrong points on the phosphorescent screen. A B+W TV will just give you the image distortions.

When picking out your CRT, take into account the type of hardware holding it together and make sure you have the tools to open it. Also make sure that the screws are not challenging to get to. You can open up any TV, just some are more difficult than others.

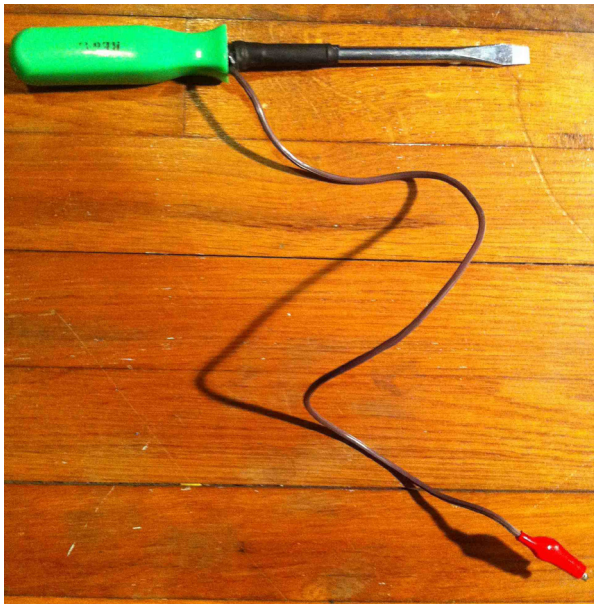
Before you open up the TV, make sure it is unplugged from the wall. Remove all the screws and set them aside. The big back part of the TV will be loose and can now be slid off. Sometimes older TV's will have extra latches in the casing that you may have to use a screwdriver to detach. Be sure not to touch stuff in there until you really know what your doing. A CRT will hold a very powerful charge for a very long time. The TV is not safe to operate within until it has been properly discharged.

2. DISCHARGING THE CRT

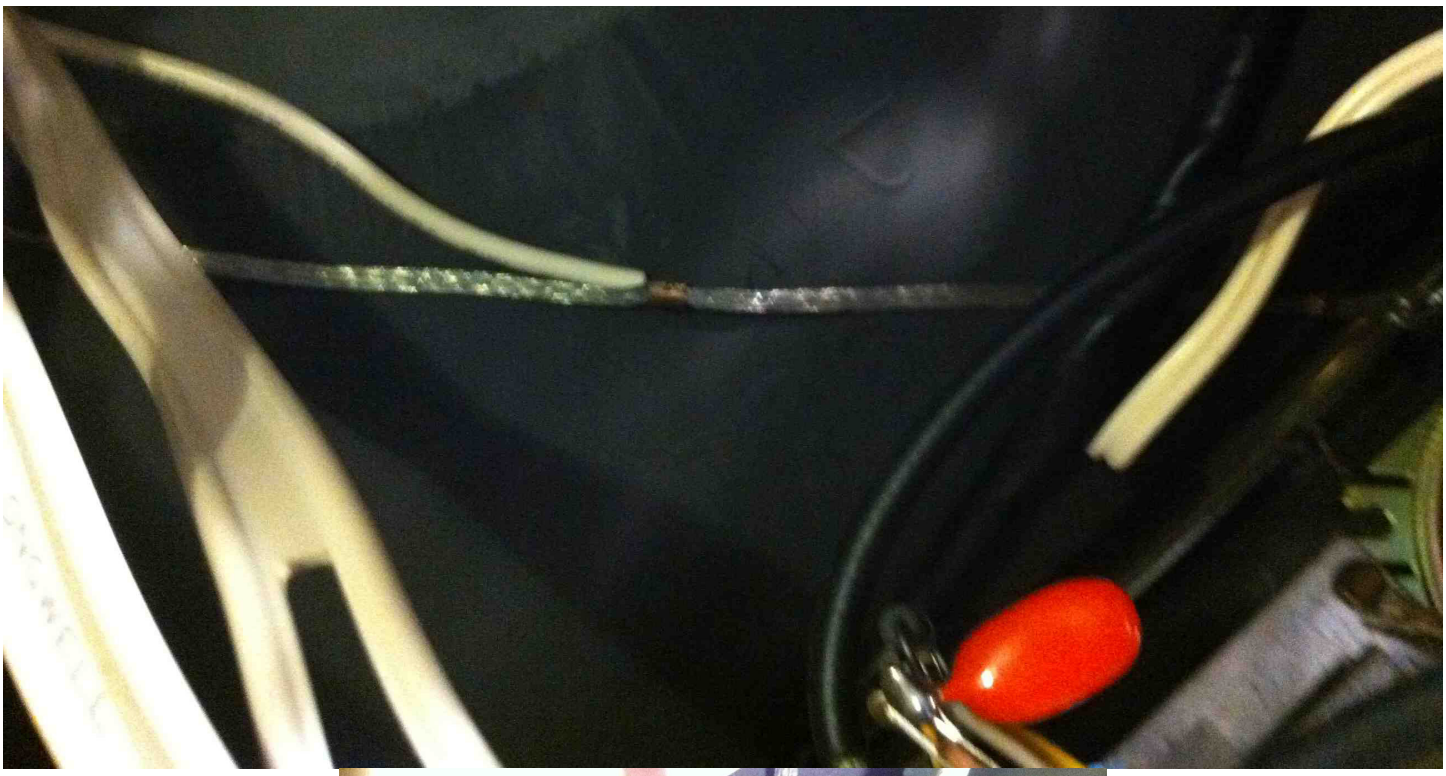
***NOTE* It is important to follow basic electrical safety measures when dealing with high voltages. Where rubber sole shoes to keep yourself insulated and work on wood floors if available. Always keep one hand behind your back when discharging, as this will prevent the electricity from moving through your body from one hand to the other.**

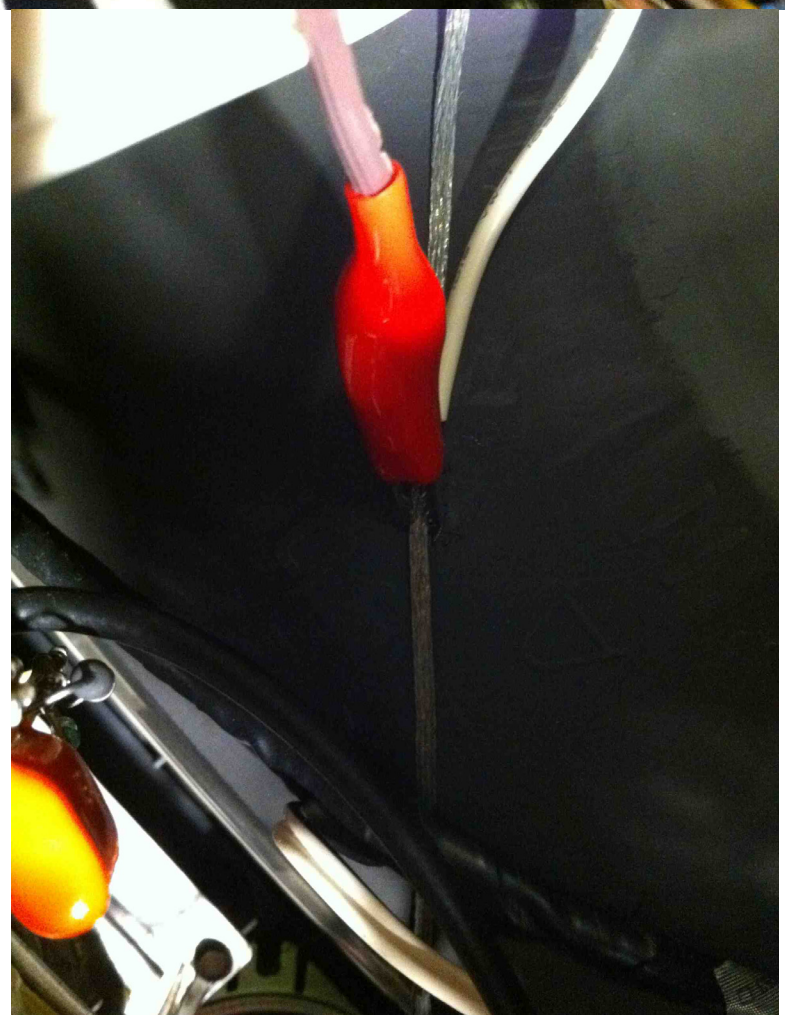
For this step you will need to make a discharging tool using a big flathead screwdriver with an insulated handle (rubber or plastic) and a clip lead (alligator clip). Attach one side of the clip lead to the base of the metal of the screwdriver. The image below shows the tool I use to discharge TV's that is attached to a clip lead that has been stripped on one side and wrapped around the screwdriver and held in place with heat shrink tubing.

I would suggest using some electrical tape to make sure that the clip is secured to the screwdriver.

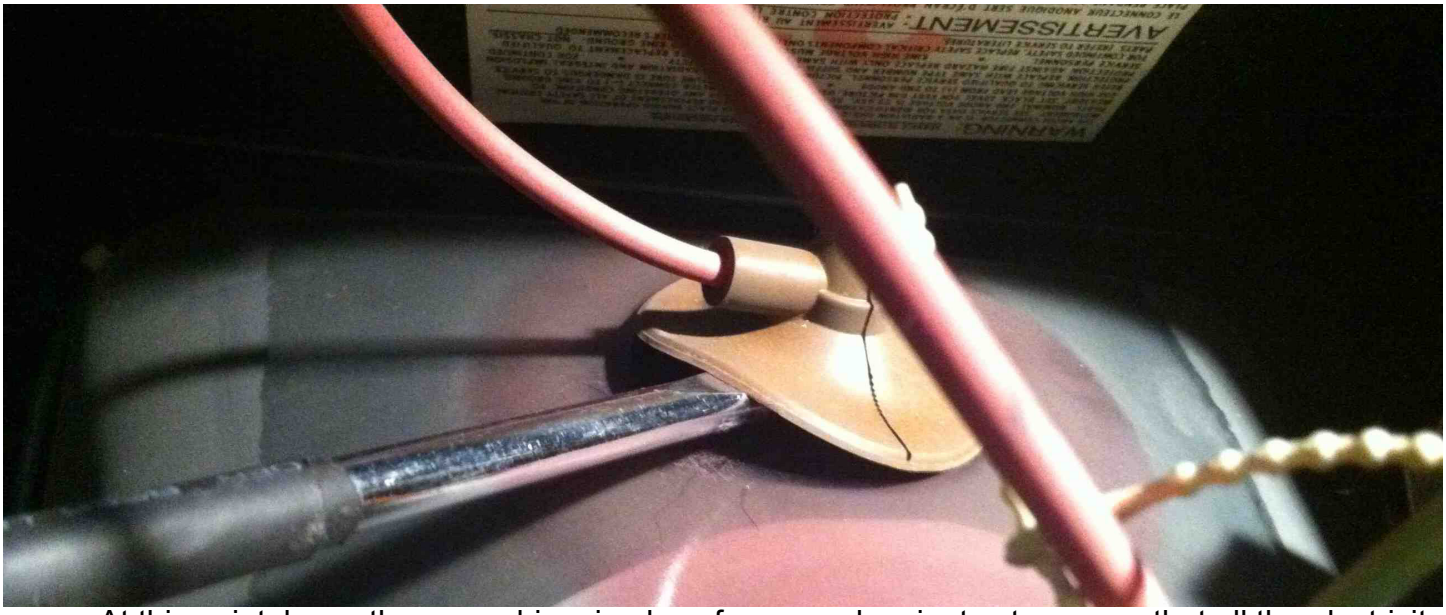


Now attach the other end of the clip lead to the grounding wire or plate of the CRT. This will most likely be an exposed wire that runs around the outside of the tube. It looks like picture hanging wire. If that is not there then it is the metal frame surrounding the tube. The images below show the ground wire and how to attach the clip lead…





Now locate the anode. The anode usually sits on the top of the tube and looks like a suction cup with a thick (usually red) wire coming out of it. With one hand behind your back and while wearing your rubber sole shoes, slide the screwdriver head underneath the rubber of the suction cup. There is a piece of metal underneath the cap that you want the screwdriver to make contact with. Once it touches it, you may hear a loud snap or a quick sizzle, but don't worry because this is a good thing. That means the electricity is discharging. If you don't hear a pop, don't worry. Some CRT's don't hold as much of a charge so you may not hear it, but make sure the screwdriver is coming in contact with the metal under the rubber cap and that the clip lead is attached to the screwdriver and the ground wire.

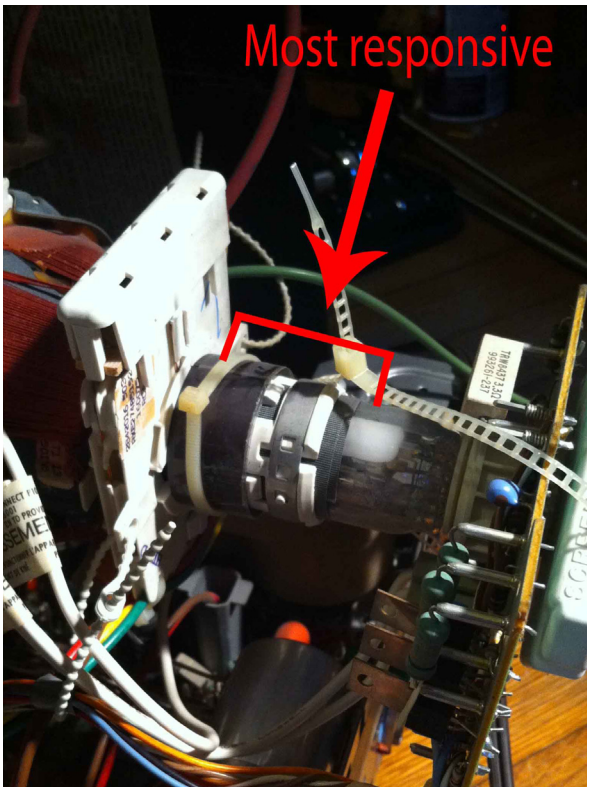


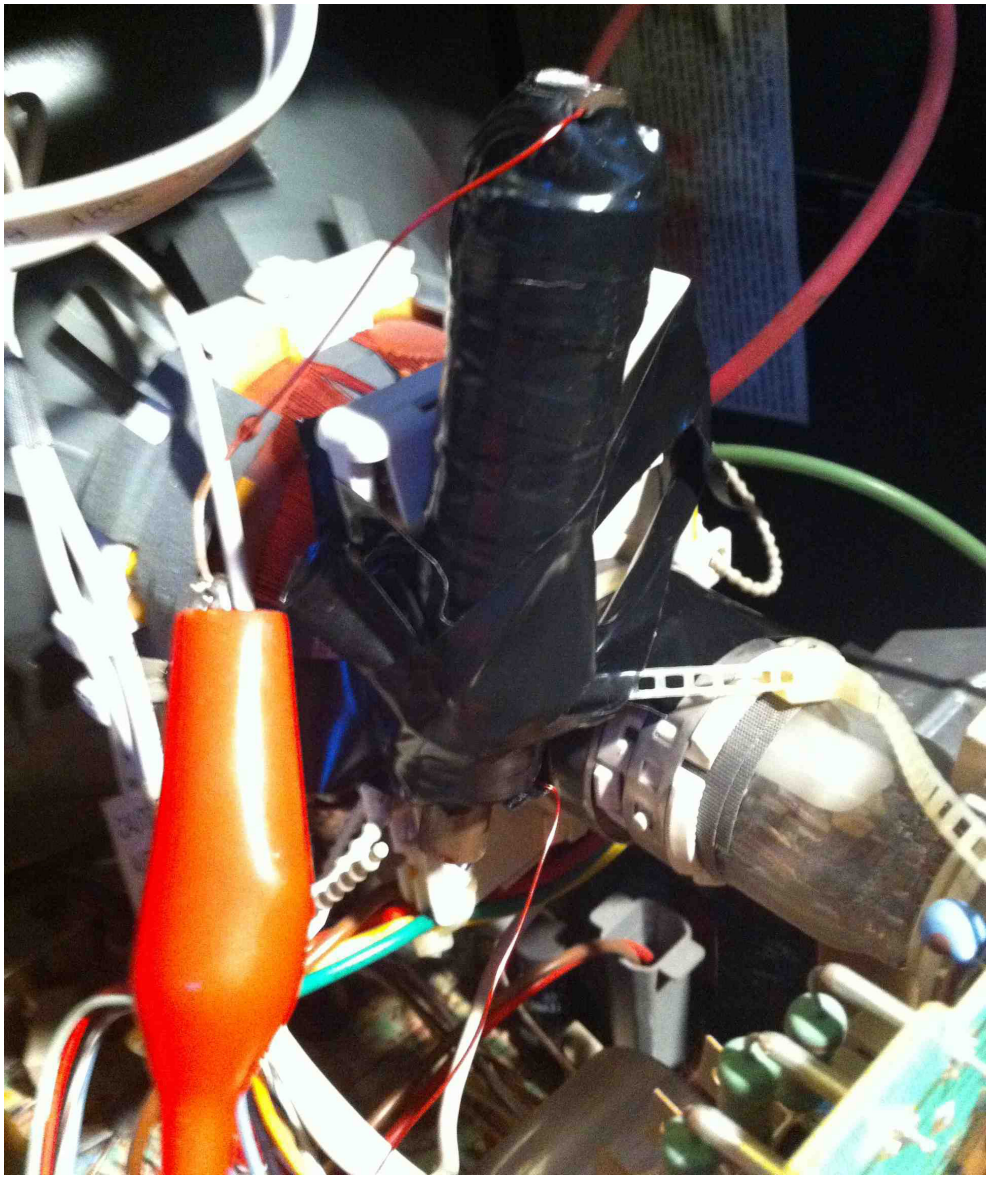
At this point, leave the screwdriver in place for a couple minutes to ensure that all the electricity has been discharged. After that, try discharging it one more time just to be safe. Now you have a safely discharged TV to work with.

***NOTE* Even though the TV is safe to work with now, you should probably still stay away from the anode cup and the fly-back transformer that the red wire leads to. They are not used in the process and it's best to be extra safe and just leave them alone.**

3. PLACING THE MAGNET

In order to find the appropriate positioning to your liking, you will have to go through a process of temporarily securing the magnet in place then testing it out and repeating if necessary. Using Some electrical tape, strap the magnet to the area of the CRT shown in the picture below. I have found that the most responsive method of placing the magnet is by making sure one of the ends (poles) of the magnet is right next to the tube. There is less activity happening in the middle of the magnet so it is less responsive. But experimentation is key here.





4. TESTING AND READJUSTING

To test the magnet you will need to set up your stereo and a signal source. Your signal source can be anything really, but to get the most response out of the magnet some sources work better than others. Here are some things that work best…

- Software I made for this at yaktronix.com/tvhack (Mac only)
- Any other signal generator or test tone software (plenty of free ones out there. Google “free signal generator software”)
- Test tone from your DAW like Logic or Pro Tools
- Recordings of test tones played out of QuickTime, iTunes or an iPod
- iPhone/Android app signal generator
- Hardware function generator
- Synthesizers (software of hardware)
- Homemade synths (Ex. Nic Collins 7C14 square wave synth. Book: “Handmade Electronic Music”)

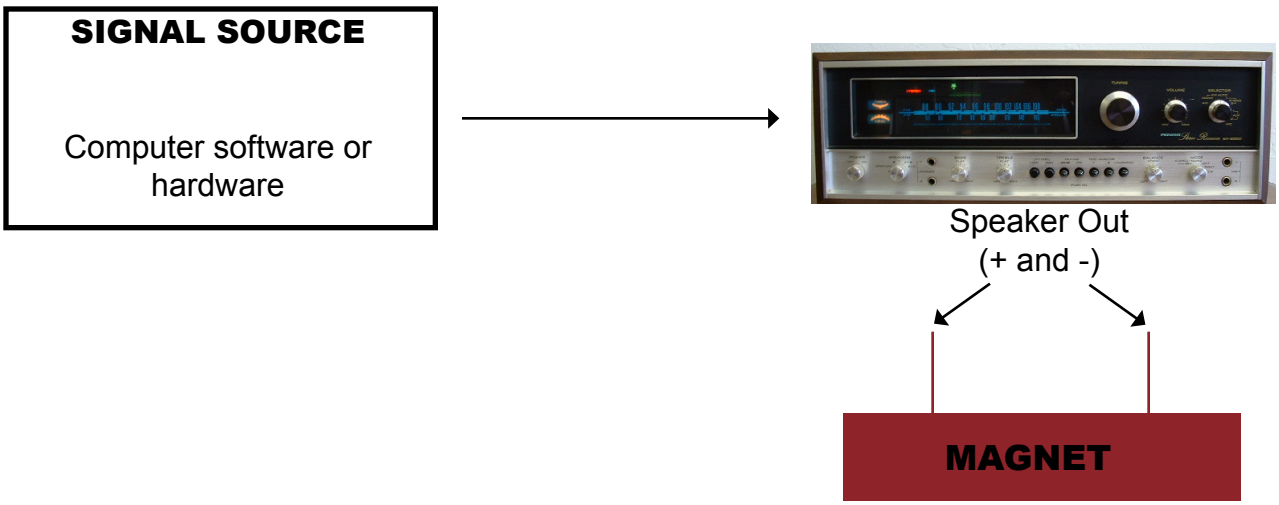
NOTE The best range of frequency for magnet response is ~1Hz - ~300Hz. But experimentation is the best way to figure out what works best for you.

The setup is as follows:

- Plug your selected signal source into your stereo receiver's input.
- Connect speaker wire (or any wire) from the positive and negative terminals of one of the speaker outputs
- Using clip leads, connect the two exposed wires of your magnet to the + and – of the speaker output. (This is the reason why, as said in the DIY magnet tutorial, the magnets should measure around 4-8 Ohms. This will trick the stereo into thinking the magnet is a speaker because speakers measure around the same impedance. It doesn't have to be perfect to trick the stereo.)

Make sure that no exposed wires are touching any parts of the insides of the TV. Cover all exposed wire in electrical tape.

- Plug in a video source to your TV. It can be a DVD or VHS connected to the video input of the TV or, if it's older, find one of the rare last remaining broadcast channels with some rabbit ears or build the DIY transmitter in the previous tutorial. Also, an FM modulator (Radio Shack) will convert a composite video signal from an RCA to a usable signal for an old TV with only an antenna input. If none of this, just use the static and find a video source later.
- Plug in your TV and turn it on. **Stay away from the inside when it's on.**
- Make sure the volume to your stereo is turned down before you power on your signal source. This will be turned up gradually.
- Turn on your signal source and tune it to around 60Hz. If your source is not tunable like this or if you have no idea what this means, just find a low to medium pitched sound. I would suggest starting with a sine tone and then experimenting with other waveforms after.
- Turn up your stereo slowly until you start to see some reaction on the TV screen.



If you don't see much happening, then try repositioning the magnetby following these steps:

- Turn off the TV and unplug it
- Discharge the TV again
- Reposition the magnet and tape it down

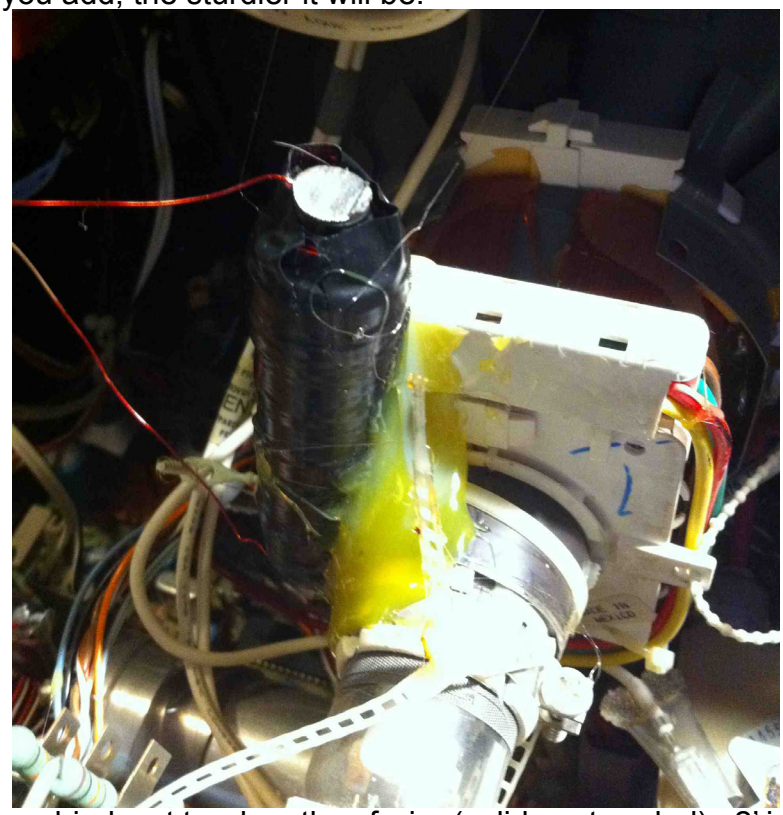
This part will take some experimentation on your part until you find the perfect positioning.
If that is still not fixing the problem, here are some troubleshooting techniques…

Test your magnet by removing it from the TV and hooking it up to the stereo independently. Double-check your stereo settings to make sure you have the proper inputs and outputs selected. Turn up the volume on the stereo with your signal source playing and place your screwdriver at the end of your magnet. It should vibrate the screwdriver at the frequency of your source signal. If you get no response out of it, it could be a problem with the stereo or your magnet.

5. FINISHING

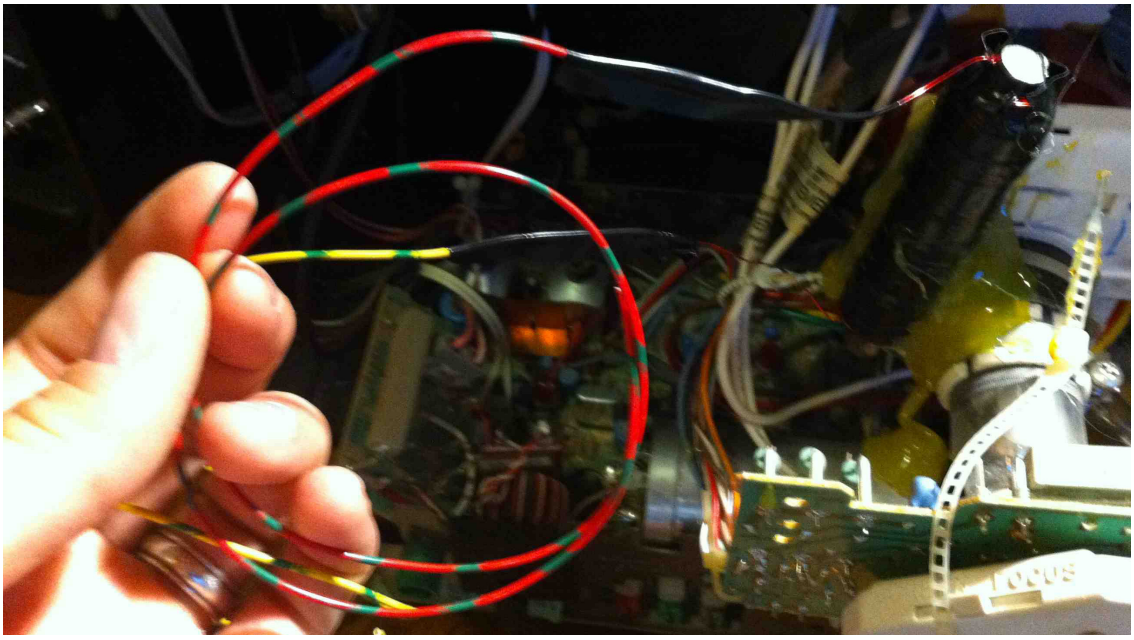
Once you have found the perfect positioning for the magnet, its time to install it permanently and create a way to “plug in” to your magnet from outside the TV after you close it up.

- First, turn off, unplug and discharge your TV. Remember the location and positioning of the magnet and remove the tape holding it in place. Now hold the magnet positioned the way you want and apply large amounts of hot glue. Be generous with the glue and apply a few coats because the more you add, the sturdier it will be.

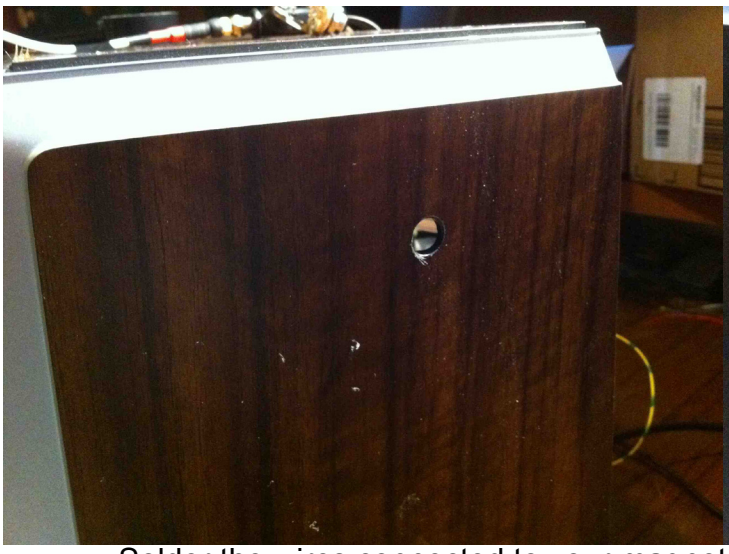


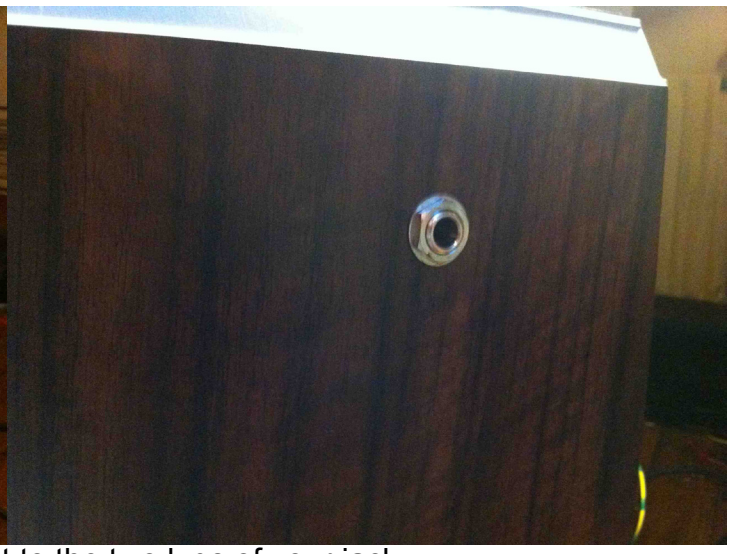
- After the glue has dried, cut two lengths of wire (solid or stranded) ~2’ in length. Strip both ends and solder each wire to the two leads coming from your magnet. Wrap the connections with electrical tape when you’re done.

NOTE – Do not leave any wires exposed. You want to be **COMPLETELY ISOLATED** from the internal electronics of the TV.

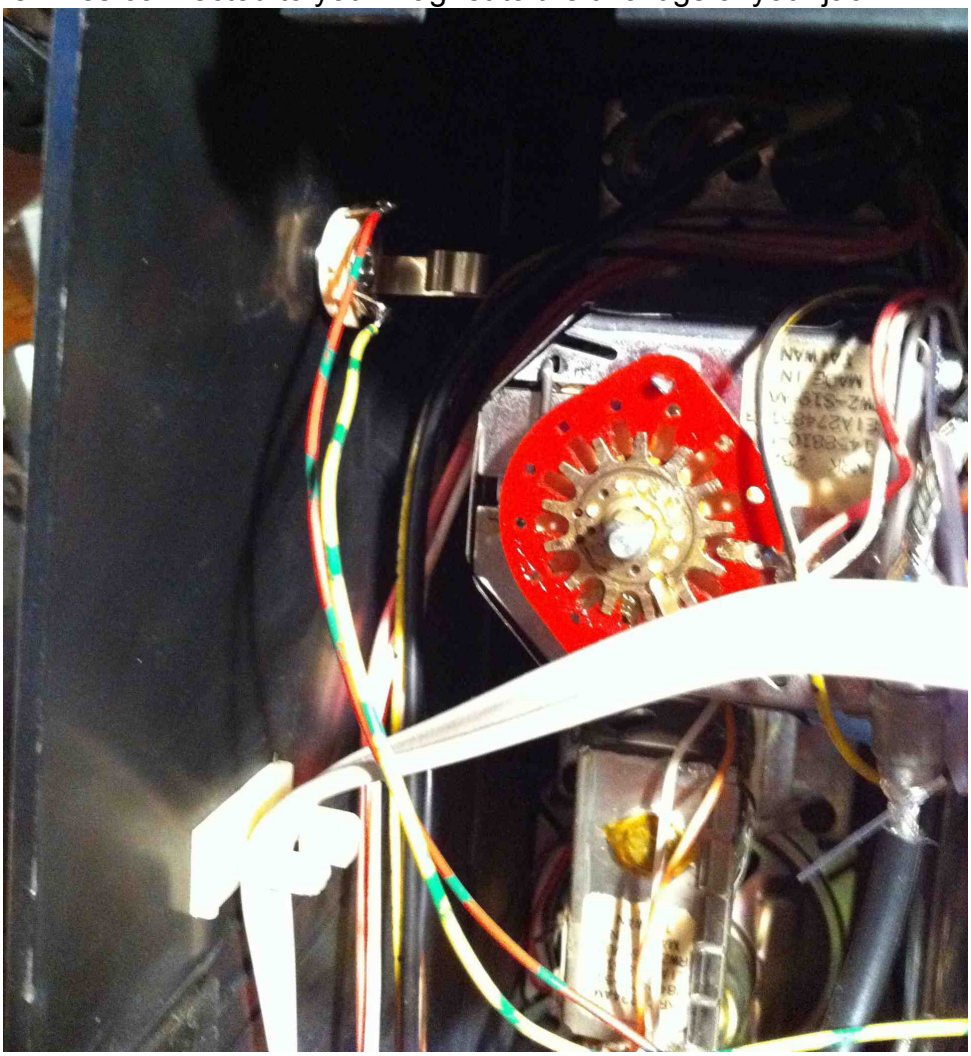


- Find a location on the side of your TV that you can drill a hole to put your jack. 1/4” audio, RCA, terminal mounts or any connection will work for this. You just need a way to be able to plug into your magnet from the outside of the TV.
- Drill a hole using the appropriate bit size for your selected jack and install it.





- Solder the wires connected to your magnet to the two lugs of your jack.

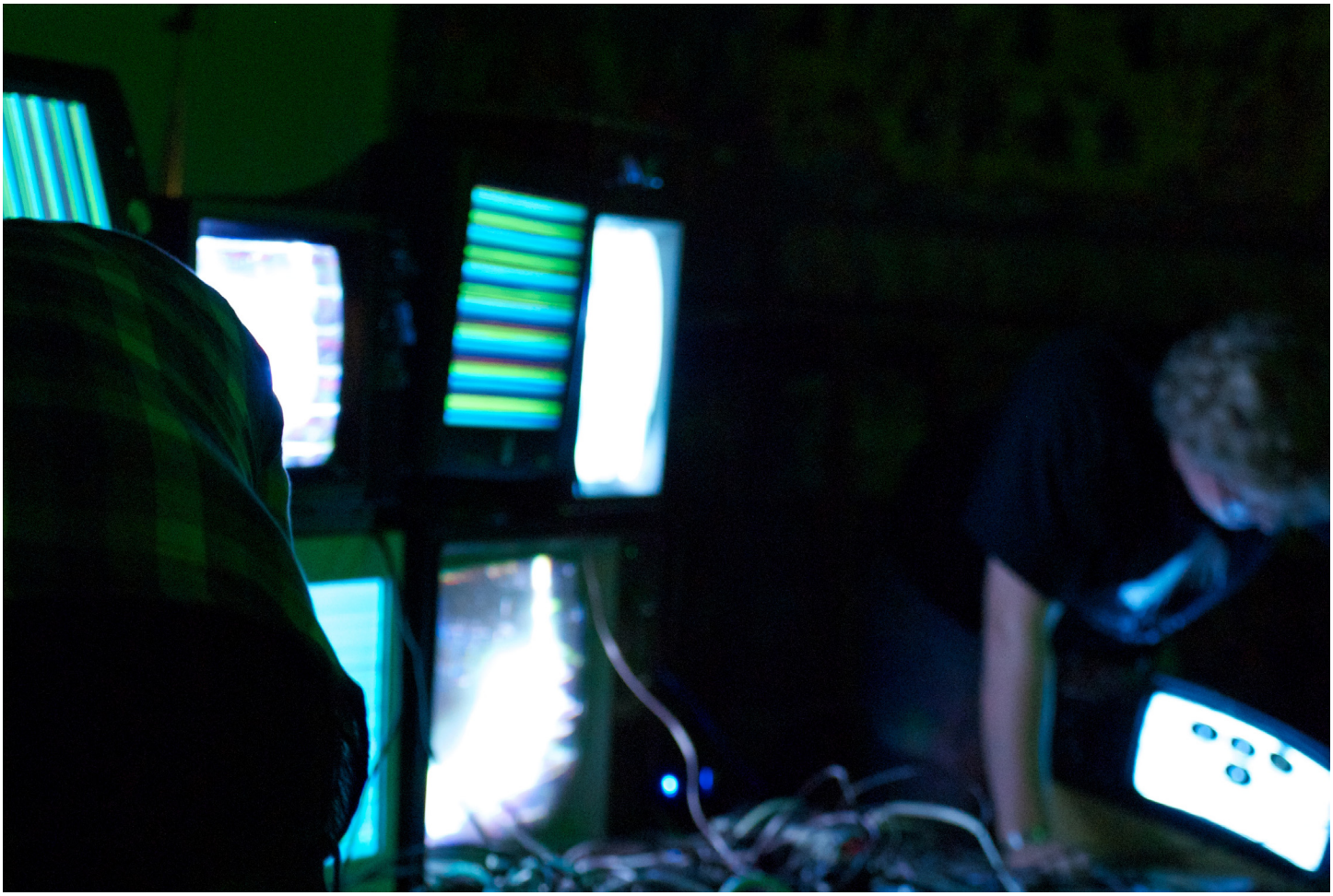


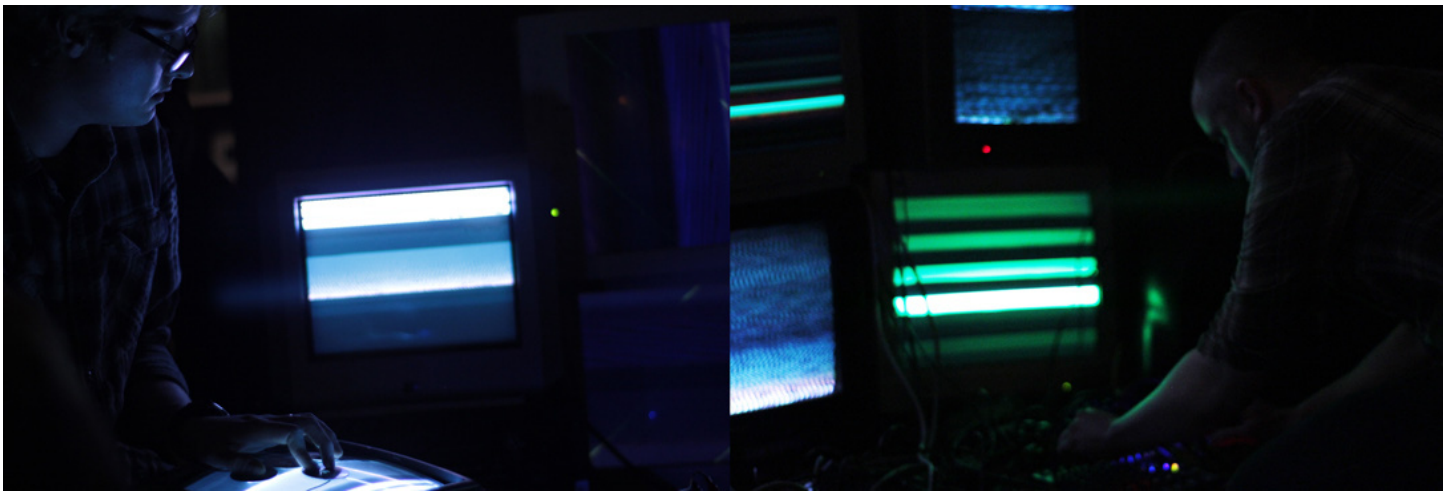
- Close up the TV and your ready to go.

OPERATING

Create the same setup as before with your signal source and stereo. The output of the stereo will have to match the input you chose to mount the TV so you will most likely have to cut up or create a cable for this. (Ex. Speaker wire from your stereo to a ¼” audio plug).

Now you can experiment with using different video sources and signal sources to drive the magnet. Experiment with a range of frequencies or try using multiple sources at ounce. Check out yaktronix.com/tvhack to see how different frequencies affect the TV





James Connolly (BFA With Emphasis in Art History, Theory, and Criticism, The School of the Art Institute of Chicago) is a sound, new media, and video artist, curator, and writer living in Chicago, Illinois. His work takes a critical relationship to digital culture through methods of appropriation, His work has been performed and shown at the 2009 SAIC Undergraduate Film Festival at the Gene Siskel Film Center, the Version Festival at the Co-Prosperity Sphere in Chicago, the *Crtical Glitch Artware* realtime event at NOTACON 2010, and the GLI.TC/H festival, among several other venues. He has been interviewed regarding his work and curatorial practices by blogs and periodicals including Bad At Sports and Furtherfield. He currently works as the Assistant Curator of the Roger Brown Study Collection of the School of the Art Institute of Chicago, and is co-organizer of the Strange Electronics series of realtime performances.

Kyle Evans MFA, The School of the Art Institute of Chicago) is a sound designer, computer musician, electronic instrument creator, and realtime video performer. While his educational background was focused toward experimental music and sound art, his collective artistic work ranges from music technology development to multimedia installation. He has invented many electronic musical and video instruments ranging from studio-based synthesizers and performance-based computer interfaces to electronic modifications and augmentations to acoustic instruments. His performances and installations commonly explore the relation between modern and obsolete technologies, breaking and repurposing, and the dialogue between performer and technology. He has performed and presented his work throughout the United States including the *2010 International Computer Music Conference* (ICMC) in New York, the *Pixilerations* New Media Showcase in Providence, the *Guthman New Musical Instrument Competition 2010* in Atlanta and the *2011 Milwaukee Avenue Arts Festival* in Chicago. His work has been presented in several publications including *Popular Science Magazine* and *Hand Made Electronic Music* by Nic Collins.

Any questions and comments regarding the material in this document can be sent to jconno@saic.edu and kyleevans1123@gmail.com.

crackedraytube.com
jameshconnolly.com
yaktronix.com