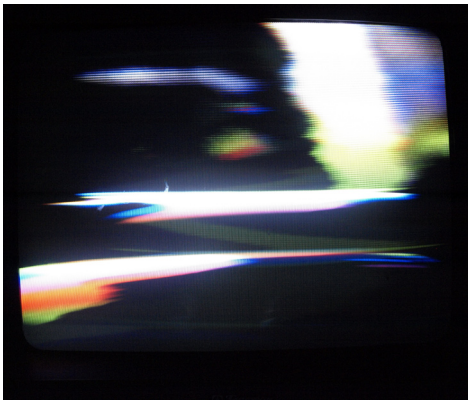
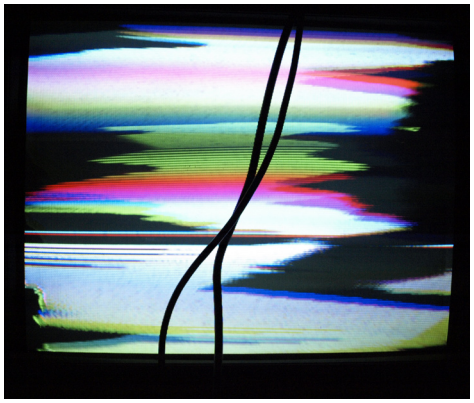
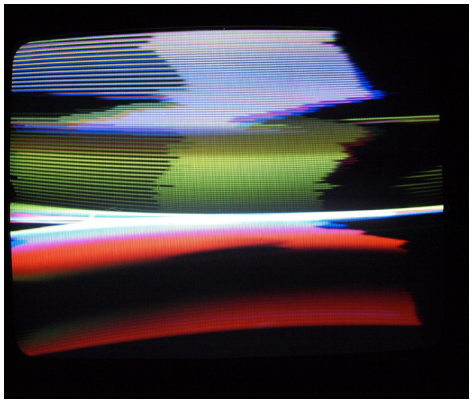
HACKING A TELEVISION WITH A DIY ELECTROMAGNET

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.

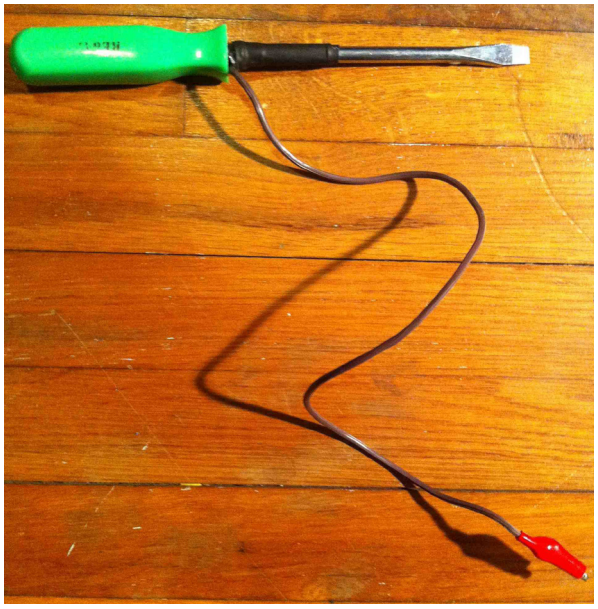
Before you open up the TV, make sure it is unplugged from the wall. Remove all the screws and set them aside. The big back part of the TV will be loose and can now be slid off. Sometimes older TV's will have extra latches in the casing that you may have to use a screwdriver to detach. Be sure not to 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

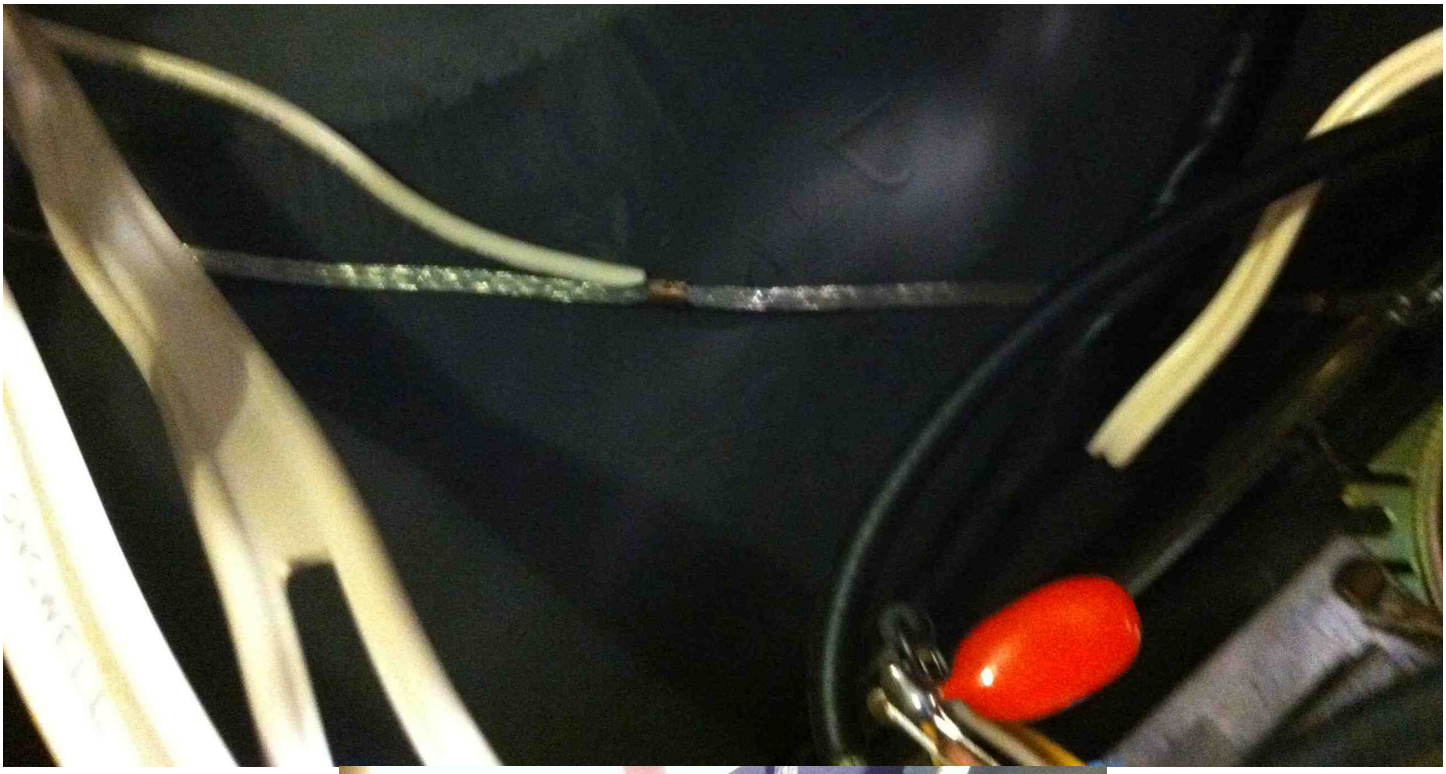
***NOTE* It is important to follow basic electrical safety measures when dealing with high voltages. Where rubber sole shoes to keep yourself insulated and work on wood floors if available. Always keep one hand behind your back when discharging, as this will prevent the electricity from moving through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

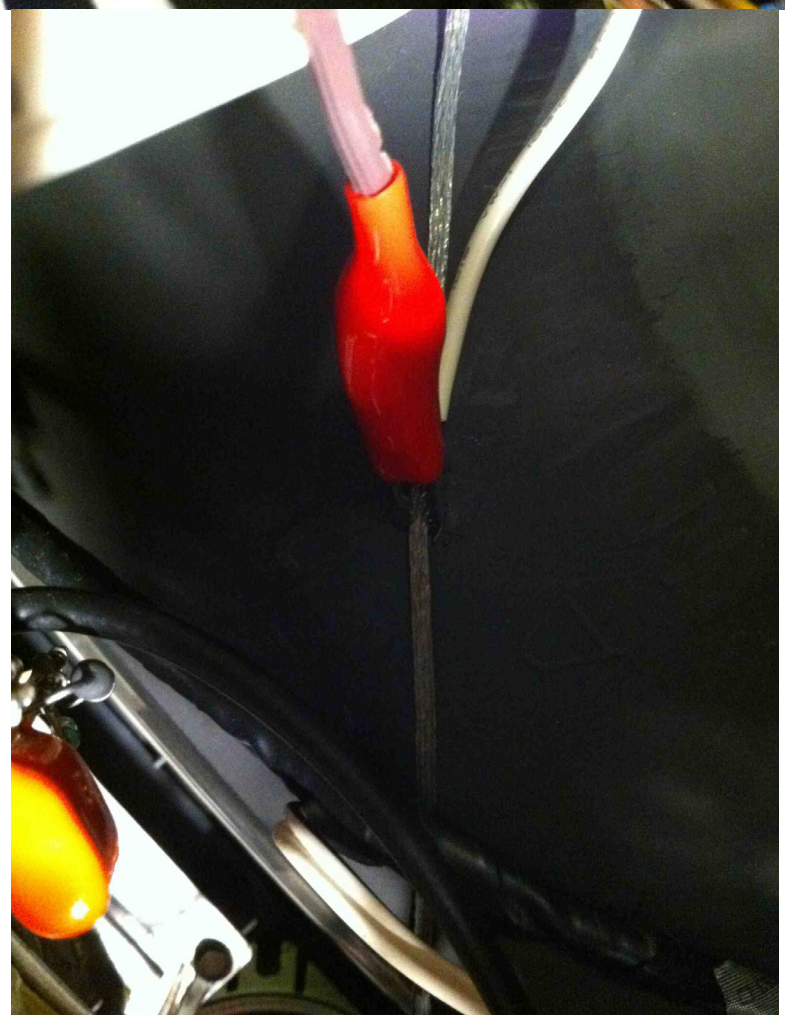
For this step you will need to make a discharging tool using a big flathead screwdriver with an insulated handle (rubber or plastic) and a clip lead (alligator clip). Attach one side of the clip lead to the base of the metal of the screwdriver. The image below shows the tool I use to discharge TV's that 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.

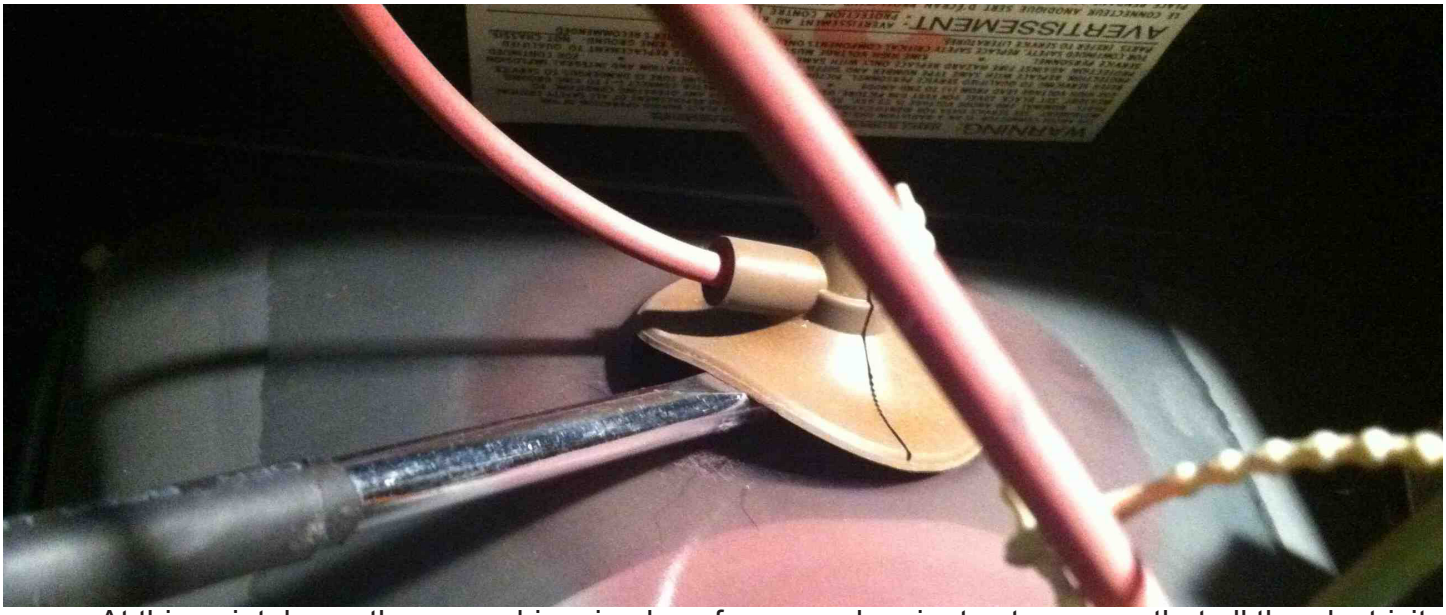


Now attach the other end of the clip lead to the grounding wire or plate of the CRT. This will most likely be an exposed wire that runs around the outside of the tube. It looks like picture hanging wire. If that is not there then it is the metal frame surrounding the tube. The images below show the ground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

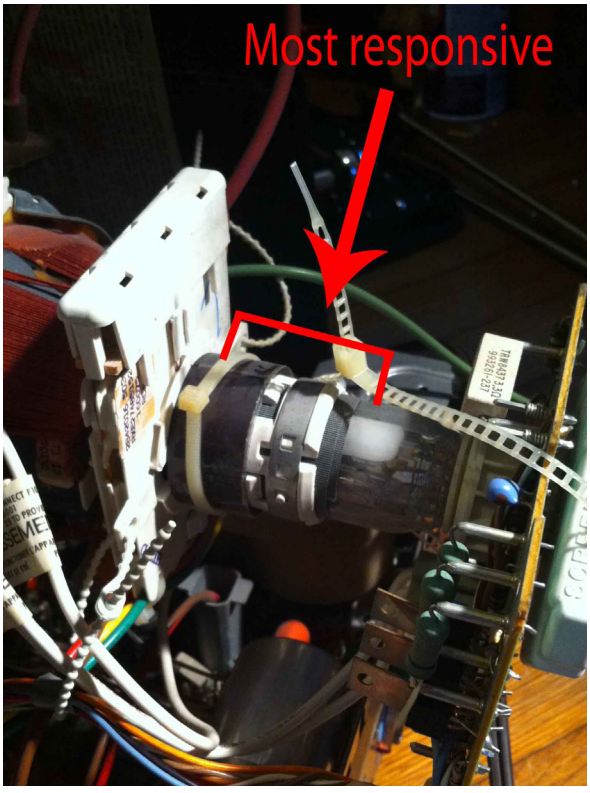


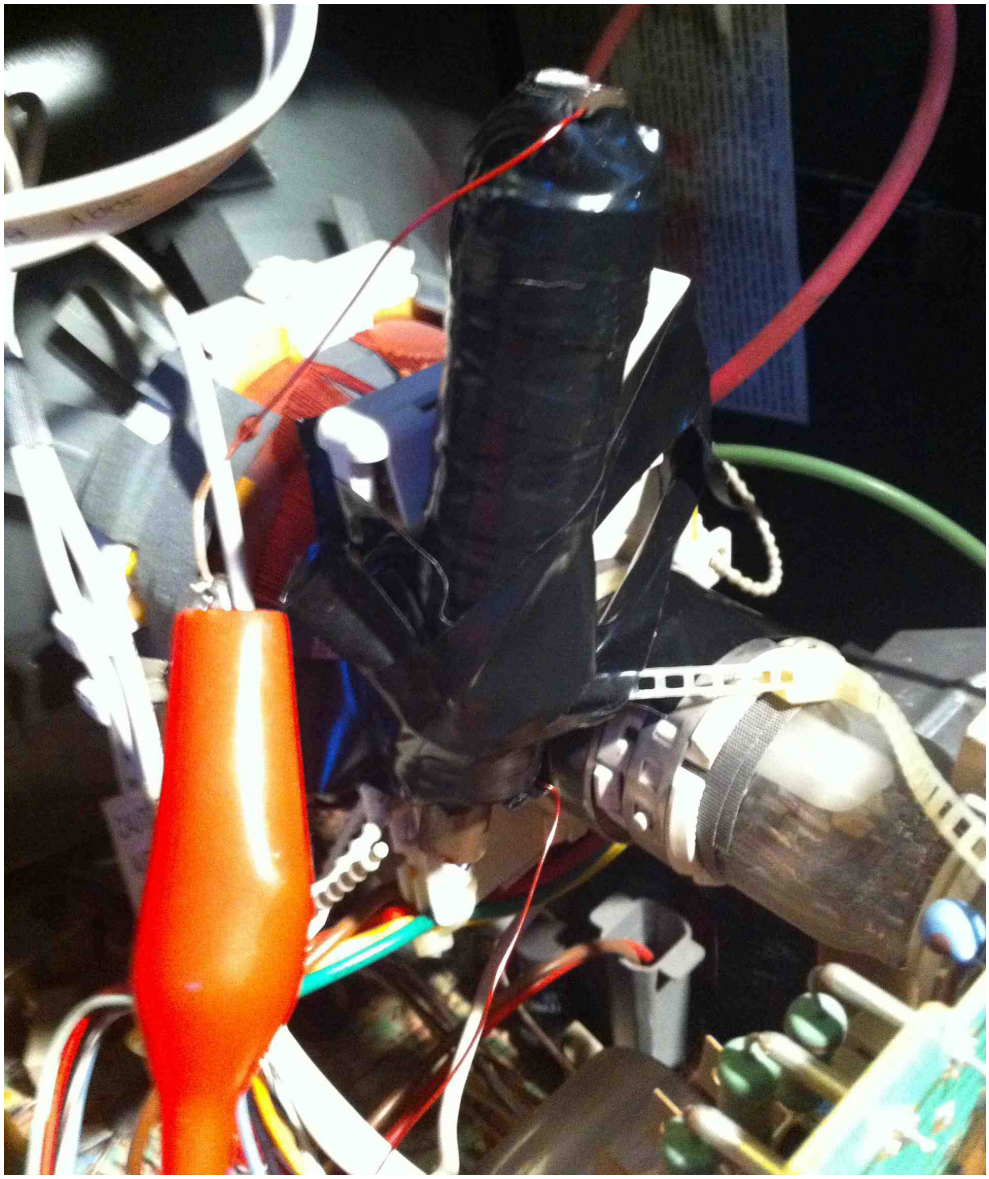
At this point, leave the screwdriver in place for a couple minutes to ensure that all the electricity has been discharged. After that, try discharging it one more time just to be safe. Now you have a safely discharged TV to work with.

***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”)

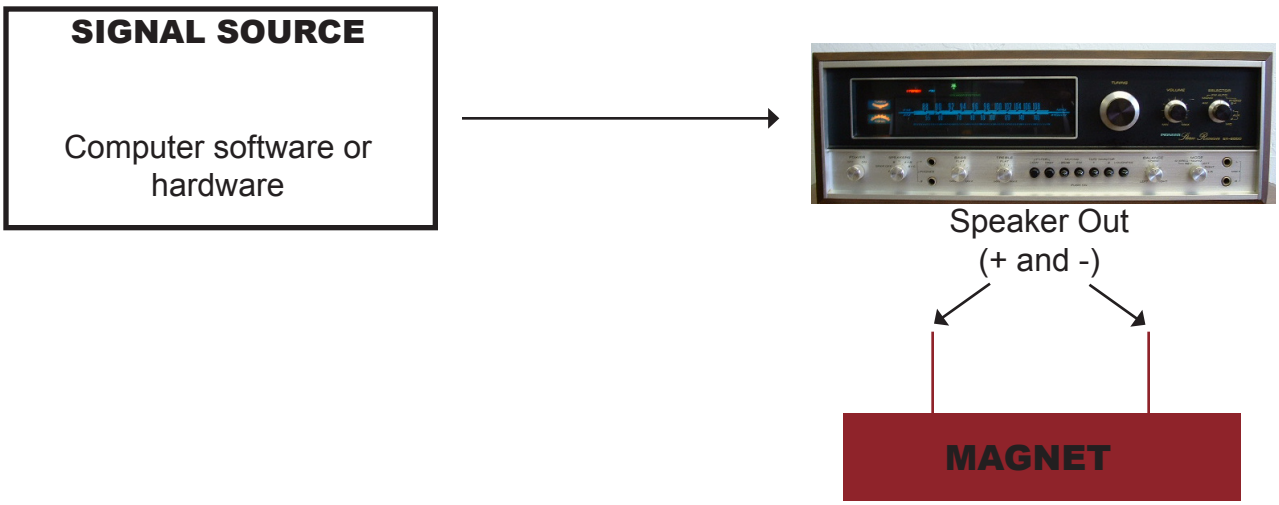
NOTE The best range of frequency for magnet response is ~1Hz - ~300Hz. But experimentation is the best way to figure out what works best for you.

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

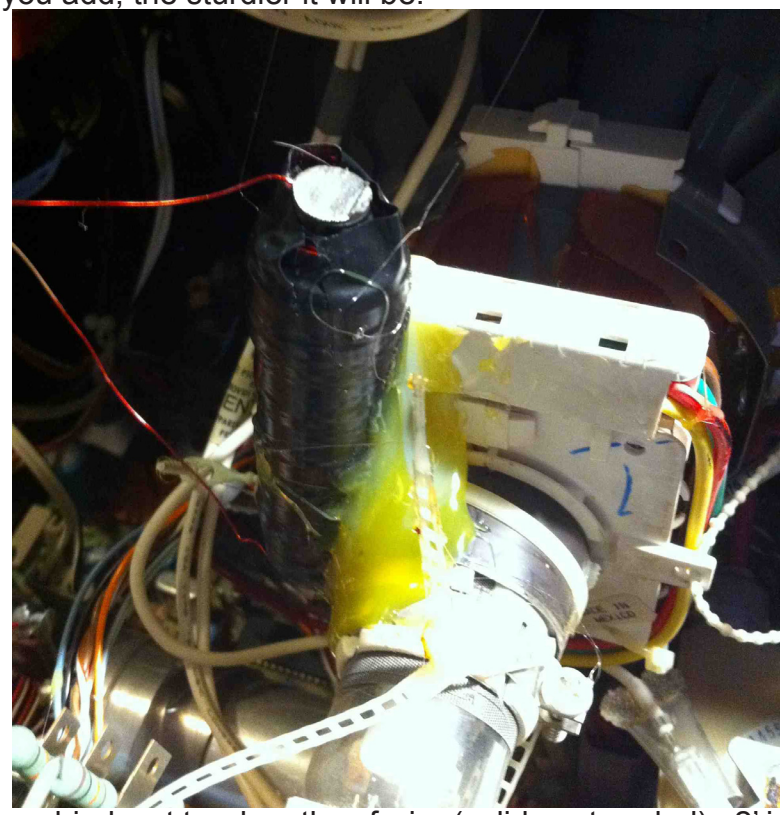
This part will take some experimentation on your part until you find the perfect positioning.
If that is still not fixing the problem, here are some troubleshooting techniques…

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

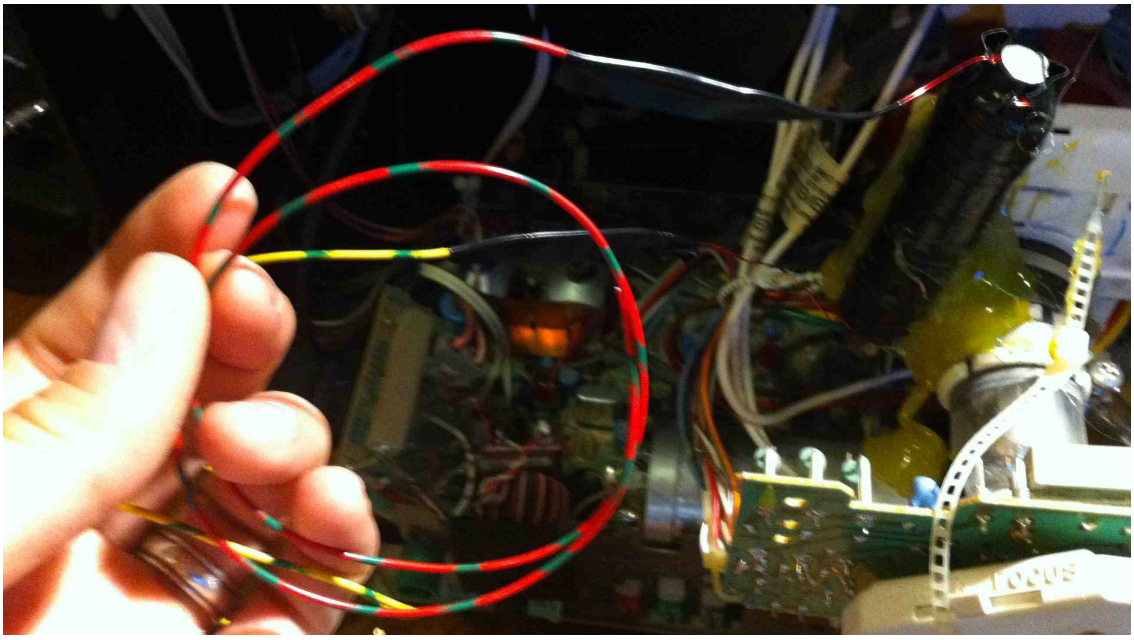
Once you have found the perfect positioning for the magnet, its time to install it permanently and create a way to “plug in” to your magnet from outside the TV after you close it up.

- 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.

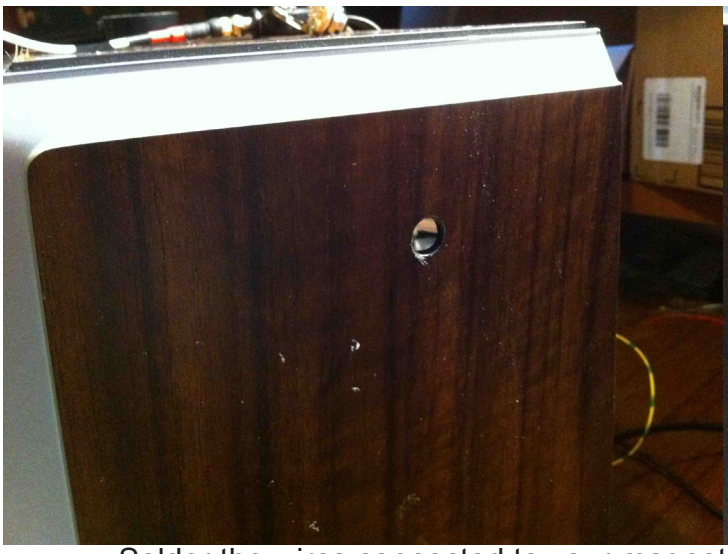


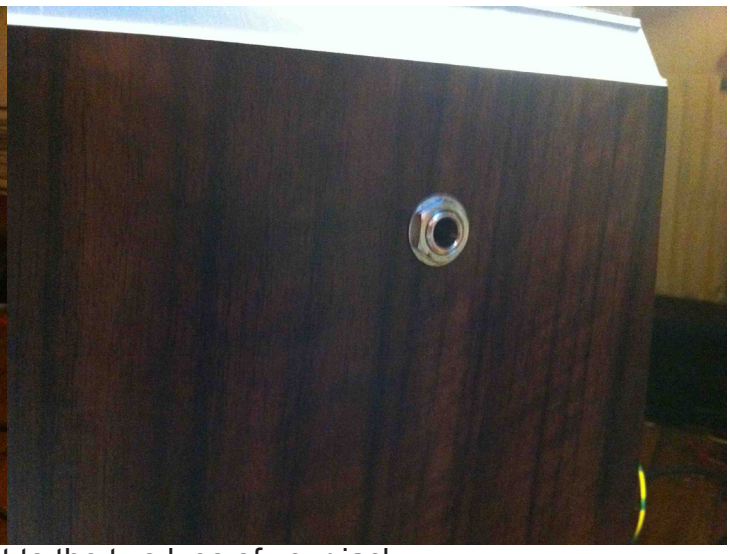
- After the glue has dried, cut two lengths of wire (solid or stranded) ~2’ in length. Strip both ends and solder each wire to the two leads coming from your magnet. Wrap the connections with electrical tape when you’re done.

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

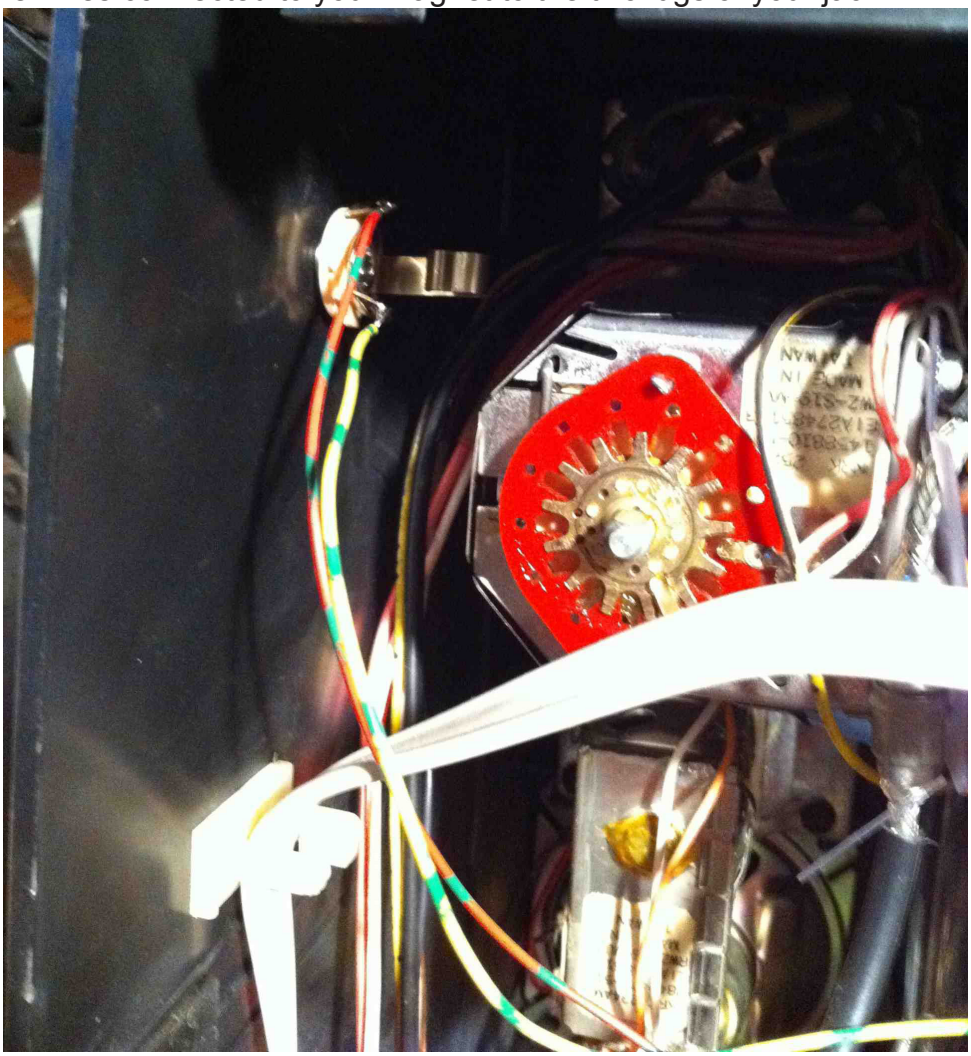


- Find a location on the side of your TV that you can drill a hole to put your jack. 1/4” audio, RCA, terminal mounts or any connection will work for this. You just need a way to be able to plug into your magnet from the outside of the TV.
- Drill a hole using the appropriate bit size for your selected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





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

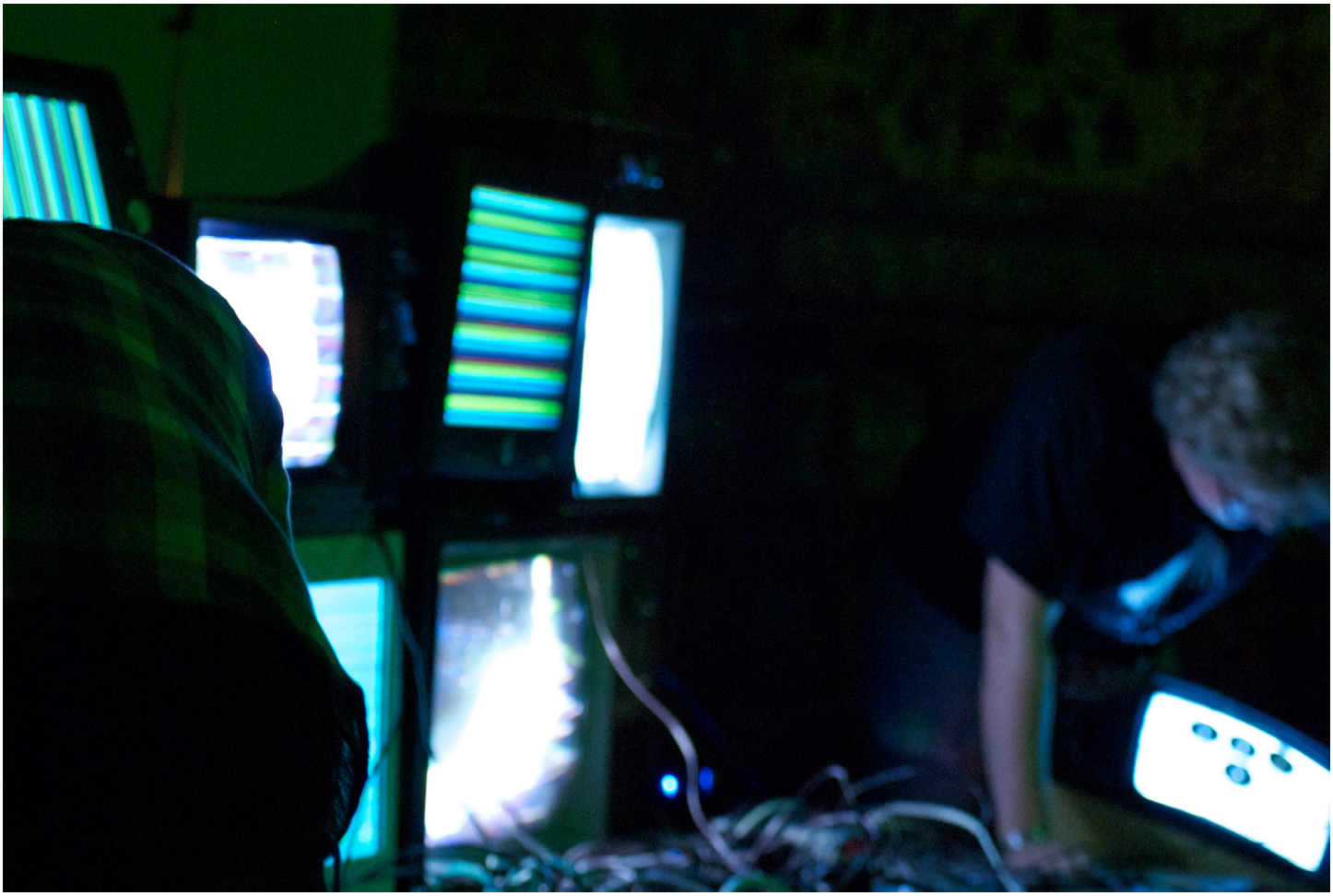


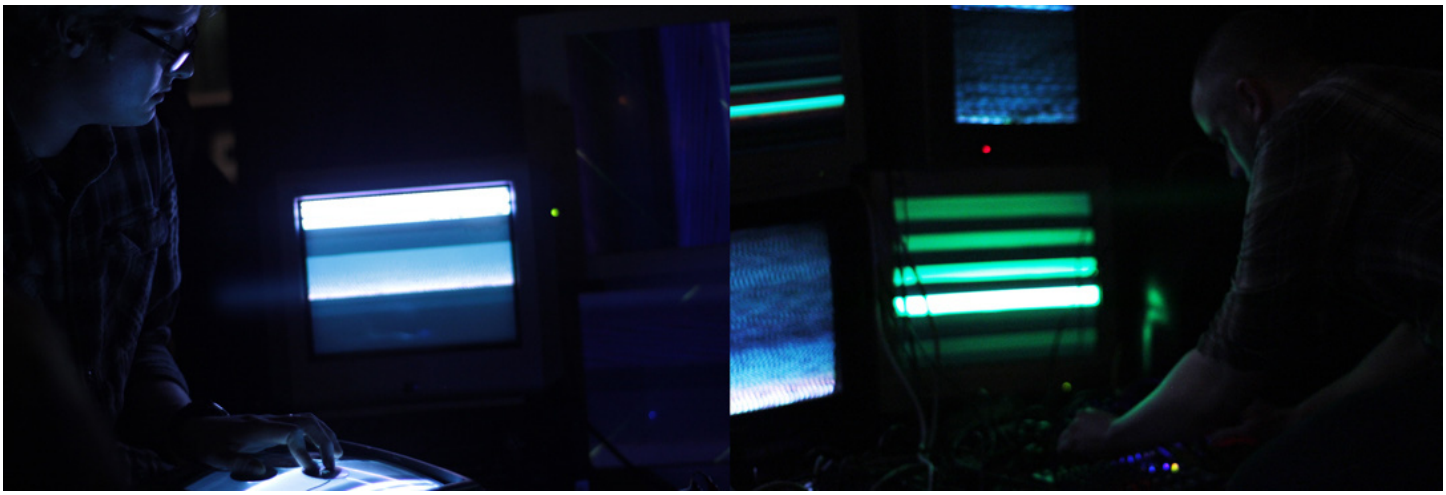
- Close up the TV and your ready to go.

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.

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