BUILDING THE TRIGGERED SPARK GAP

Designed by Marc Metlicka
Article by Ted Rosenberg
October 13, 2001

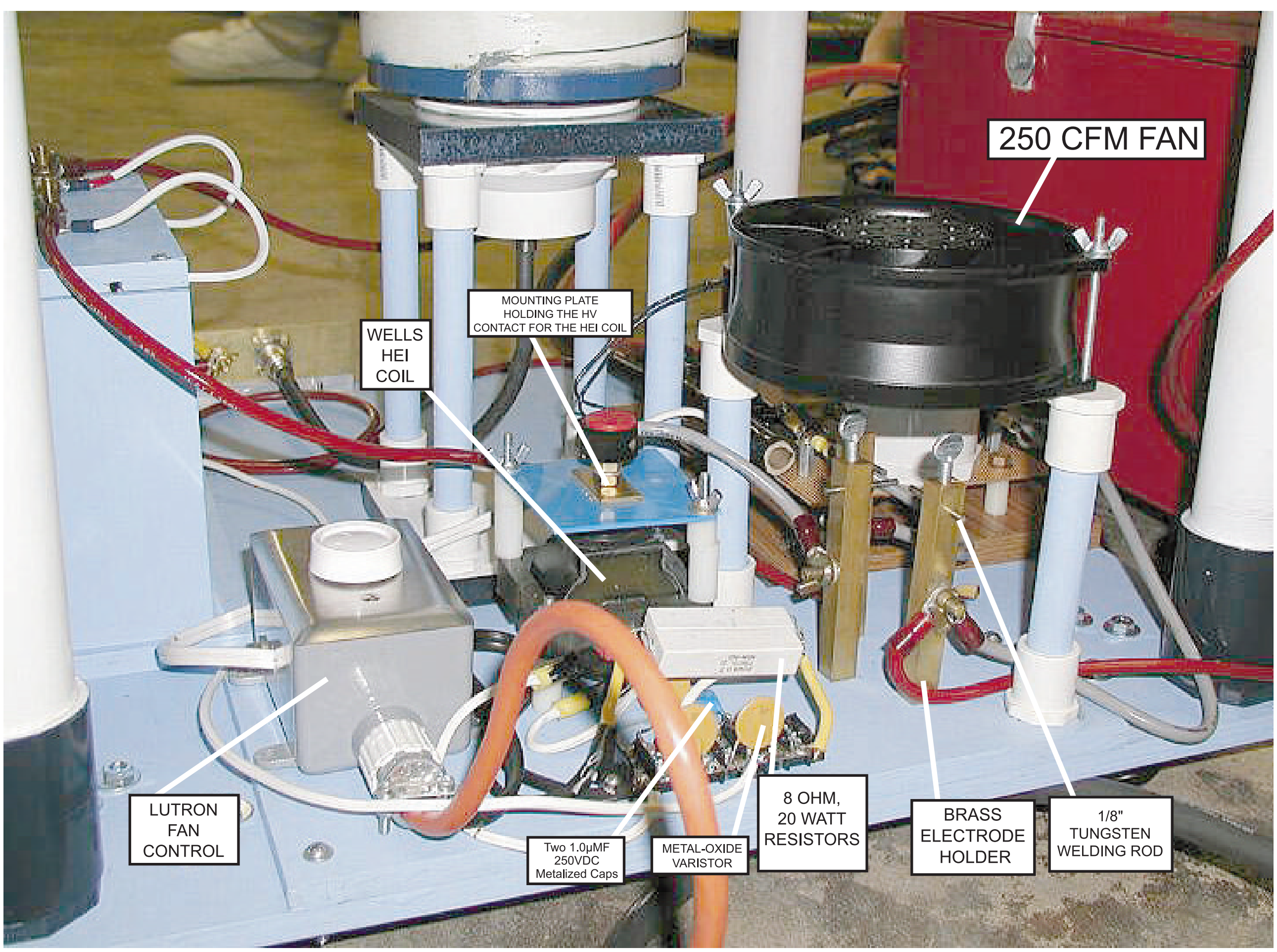
INTRODUCTION

The following material will show you how to build the Triggered Spark Gap as designed by Marc Metlicka. The descriptions, the assembly instructions, and the parts used are those used by the author when I constructed this module with Marc's guidance during the beginning of September 2001. Your style of construction may be different. Some of the parts you choose may also be different. However, I can assure you that if you select the parts I used or their performance equivalent, and follow the arrangement I used, the triggered gap will work

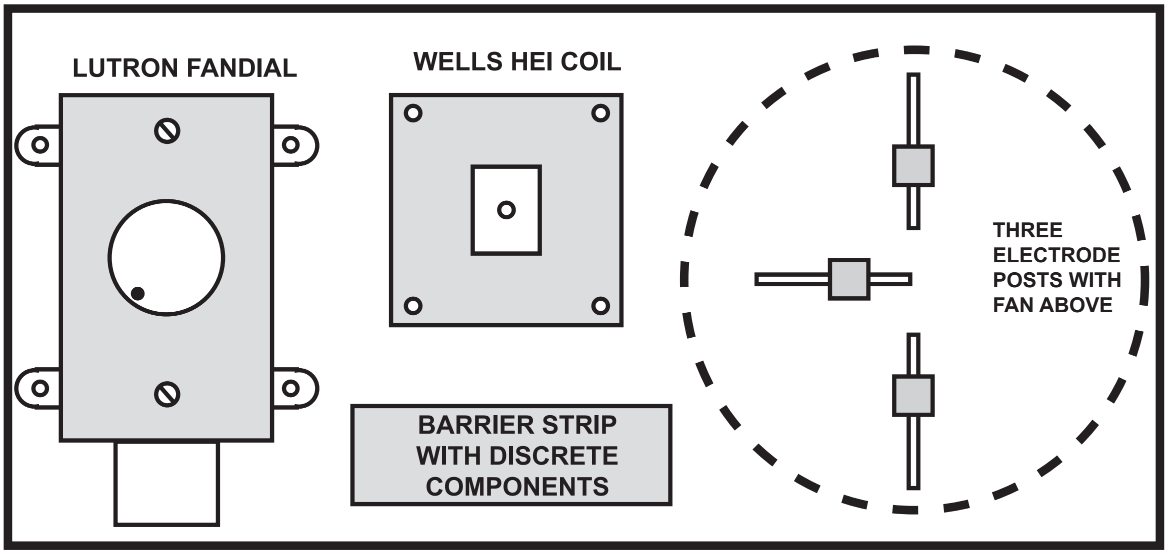
I wish to extend my thanks to Terry Fritz for the testing he did which helped me to finalize the construction. I also want to thank Ross Overstreet for his fine photo of the coil that let me easily label the major parts of the gap.

Finally, I want to thank Marc Metlicka for a great design, as well as for his patience with my dozens of questions while I built the gap under extreme time constraints.
All coilers will, I am certain, appreciate this design once installed. Why fight success?

One last comment. This is purely a construction article. If you seek answers to the "whys" and the "how does it work" questions, I suggest posting them to the list or direct such questions to Marc .
I'm just the technician.



COMPONENT LAYOUT - NOT TO EXACT SCALE

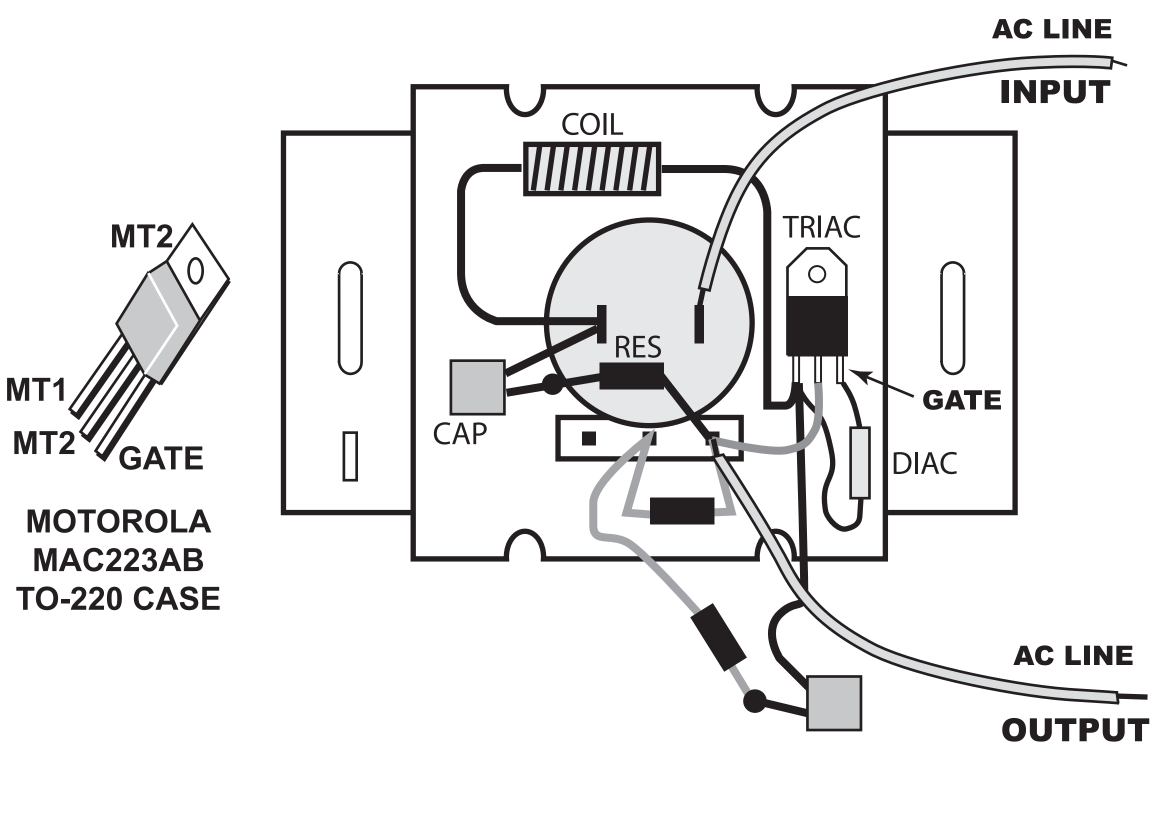


OVERVIEW OF THE TRIGGERED GAP ASSEMBLY

The Triggered Gap (tgap) assembly was built on a piece of Birch plywood. The wood was sanded, sealed and painted to match the rest of my cabinet. The wood measured 7-inches by 15-inches by 1/2-inch thick.Obviously your installation requirements may be different.

The assembly is comprised of four modules.

1. A modified **LUTRON FS-5FH-WH FanDial** Fully Variable Fan Speed Control
2. A **Wells C834** High Energy Ignition Coil
3. A set of three electrode holders, electrodes, and a cooling fan.
4. Several discrete components to drop the incoming voltage to the HEI coil and offer circuit protection



MODIFYING THE LUTRON CONTROL

The Lutron FanDial, as sold, lets you control fans that draw up to 5A. In order to use it for this application, the triac mounted on the conrol panel must be removed and replaced with a 20A triac. Refer to the drawing above. This drawing shows what you will see when you remove the control from it’s plastic case. The modification consists of only exchanging the low amperage triac, as supplied, with a 20A Motorola triac.

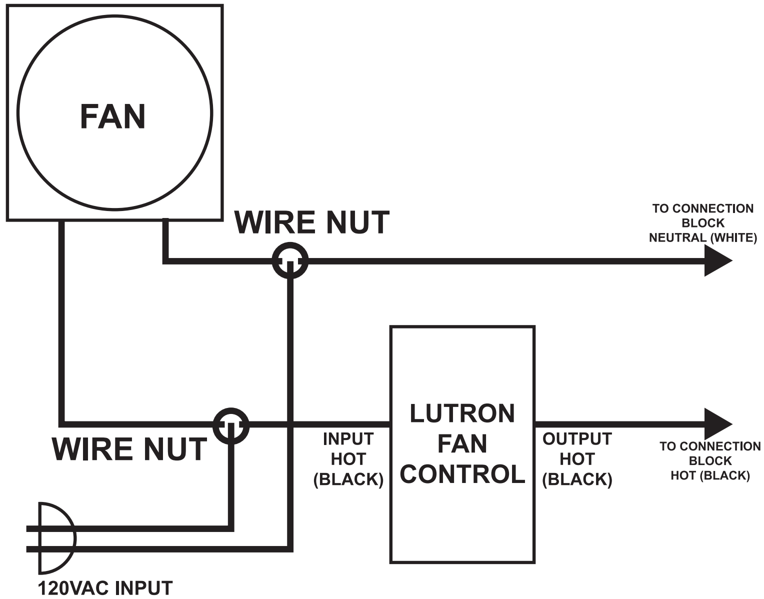
1. Drill out the two brass rivets that secure the control panel to the brown plastic case. Use a drill bit only sufficient to drill out the rivet. Remove the plastric case carefully and discard it.
2. Once you have removed the assembly from the case, locate the triac. It is mounted by a rivet to the aluminum base. Carefully unsolder the items that currently go to the three leads of the triac.
3. Drill out the rivet that holds the triac to the mounting plate and discard the triac.
4. Replace the triac with a Motorola MAC223A8 20A unit. This has the same T-220AB case. Use a small amount of heat sink grease between the back of the triac and the control mounting plate.
5. Secure the triac using a brass 4-40 machine screw and nut or a pop rivet.

Warning: The heat sink tab is **electrically connected to one side of the AC line** (pin MT2). Use only a plastic control box cover and paint any protruding mounting screws with an insulating material such as the rubber coating made for tool handles. Alternatively, you might mount the new triac on a small piece of aluminum or brass and place that in a different location within the control box.In that case make sure the heat sink does not touch any other component also inside the box.

6. Re-attach the wires you previously removed from the original triac to the same pins of the new triac.
7. Obtain an single gang electrical box (holds one item) designed to mount on a flat surface. These are typically called **weatherproof switch boxes**. They are made from gray PVC and have mounting ears at the base that allow mounting on flat surfaces. I bought mine in Home Depot. Obtain a suitable cover for the box made of plastic (**see the Warning above**).
8. Insert a 1/2-inch threaded PVC pipe fitting into the exit hole of the electrical box and secure it using PVC cleaner and cement.
9. Thread a 1/2-inch metal electrical conduit clamp fitting into the PVC pipe fitting.
10.Connect a 3-prong grounded plug onto a 12-inch length of #14 three-wire AC line cord.

Note: the Lutron control is wired in the incoming HOT (Black) AC line. The NEUTRAL (White) line is not interrupted. I wanted to have my cooling fan power up when power was applied to the control box. Therefore, my wiring diagram reflects this approach. You might wire the fan through a separate line with it’s own switch, for example.

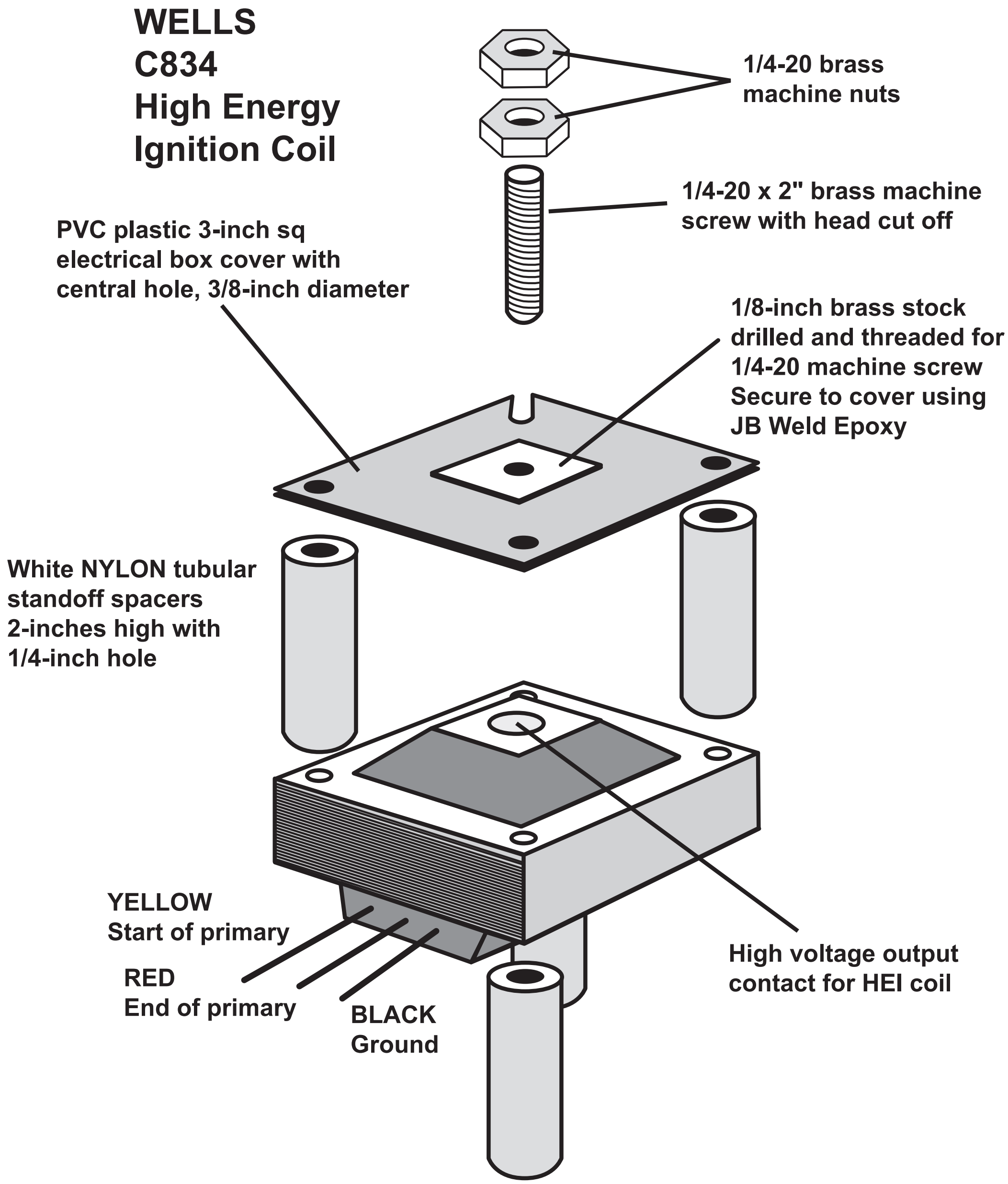
11.Thread the short length of AC power lead through the pipe compression fitting making sure enough wire extends into the electrical box.
12. Using suitable wire nuts, attach the AC input lines to the Lutron as shown in the wiring diagram.



MODIFICATION OF THE HIGH ENERGY IGNITION COIL

When used in an automotive application, the HEI high voltage electrical contact is designed to mate with a carbon brush secured in the automotive cover that normally goes over the coil. Since that is not the case here, I had to design a means to make good electrical contact with the HV “button” area. That contact ihas a diameter of about 3/8-inch. Although it appears to be steel, I chose not to attempt soldering due to the possibility of unsoldering a hidden wire inside the coil. Instead, I chose a mechanical connection to be on the safe side.

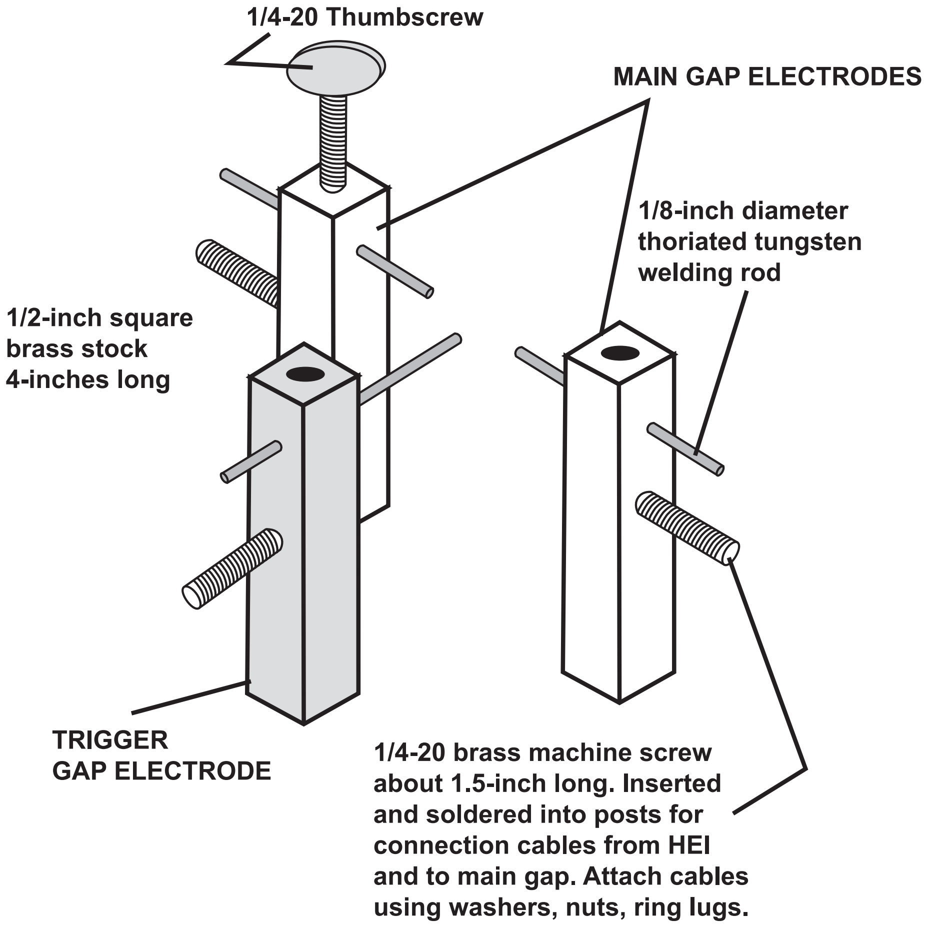
1. Drill a 3/8-inch hole in the middle of a 3-inch square PVC electrical box cover.
2. Cut a 1-1/2-inch length of 1-inch wide brass stock about 1/8-inch thick.
3. Drill and tap the middle of this piece of brass for a 1/4-20 machine screw.
4. Using JB Weld, secure the brass stock onto the middle of the electrical cover so the 1/4-20 threaded hole is exactly aligned with the 3/8-inch hole in the PVC square.
5. Cut the head off a 2-inch long, 1/4-20 brass machine screw and file both ends as flat as you can.
6. Using two 8-32 by 3-inch machine screws along with washers and nuts and two 1/2-inch nylon tubular spacers, 2-inches long, mount the HEI to the tgap module board. I started the screws from beneath the board. I used small wing nuts to secure the HEI core to the nylon spacers.
7. Insert two more 8-32 machine screws from beneath the core in the opposite corners and, after sliding the two other spacers over the screws, place the PVC electrical cover onto the screws. I also used washers and wing nuts to secure the cover so it is suspended above the HV contact of the coil and clears the contact on top by about 1-inch.
8. Attach a 1/4-inch ring lug to both ends of a a short length <9-inches or so> of GTO wire.
9. Thread the 1/4-20 brass headless screw into the brass stock on the PVC cover until one flat end is stopped by the HV contact. Do not force the screw or over-tighten it. You can distort or even crack the plastic PVC cover.
10. Thread a 1/4-20 brass nut over the screw and bring it against the cover.
11. Slide the GTO lug over the screw and secure it in place with another nut. A small radio knob may be attached to the upper end of the screw for small tightness adjustments if needed.



CONSTRUCTING THE SPARK GAP ASSEMBLY

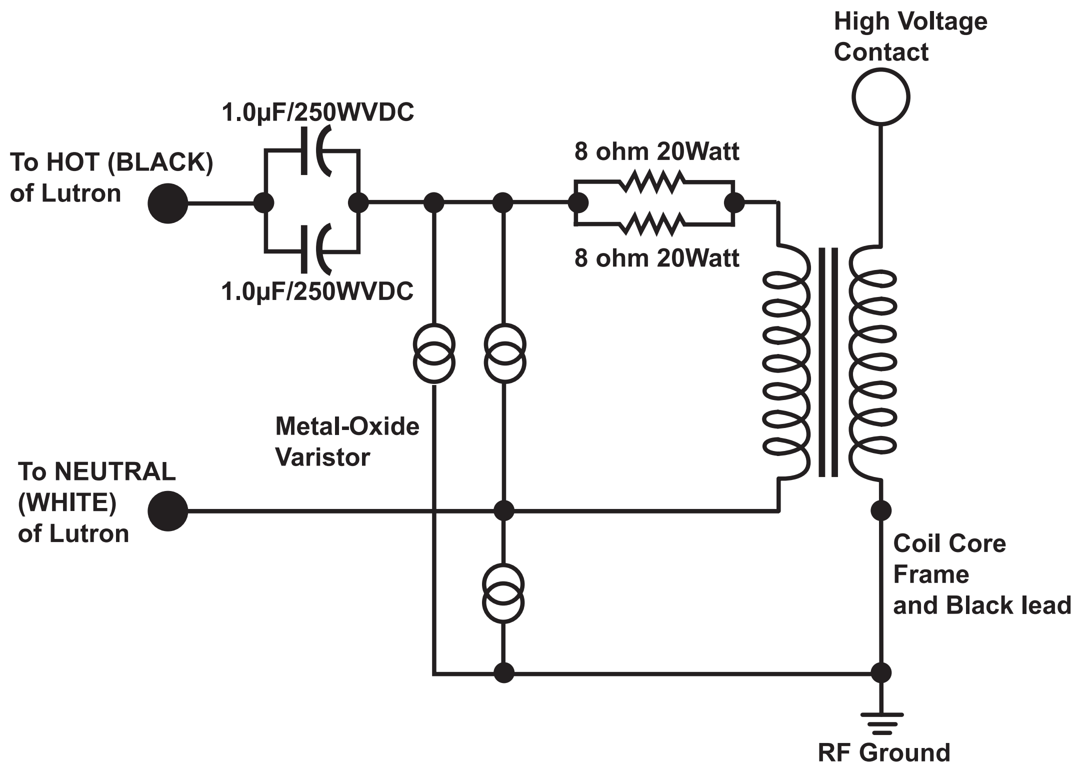
The spark gap is comprised of three electrodes. Two are connected to the cables that normally would go to the main spark gap (connections to the MMC and the output of the MOV array for NST protection. The other electrode going to the outside of the primary and the other HV output side of the MOV array.

The third electrode, or trigger electrode, connects to the high voltage contact of the Wells HEI coil. For each electrode post, I used a 4-inch length of brass stock, 1/2-inch square. You might want to use another material depending on the power of your coil. The main consideration is to keep the holders of the electrodes cool. Since my coil is only 900W, I selected 1/8-inch tungsten welding rods as the actual electrodes. If your coil is much more powerful, you should consider a tungsten carbide contact as the electrode facing. For example, you could use a 1/2-inch brass rod in larger diameter posts, with each rod faced with a carbide donut. Other than the arrangement to disapate heat, there is no basic difference when the gap is used for a small NST powered coil and a larger pig-powered coil. The following steps outline how I constructed the t-gap assembly.



1. Cut three, 4-inch lengths from 1/2 square brass stock. Face each end of the length flat using a grinder or a hand file with a guide.
2. Drill and tap a 1/4-20 in the bottom of each rod for the machine screw that you will use to secure each post to the module board. Use a depth of at least 1-inch. Use a 13/64-inch drill bit for the pilot hole.
3. Drill a snug clearance hole, 1/4-inch diameter, through each post about 1-1/2-inches from the bottom.
4. Cut the head off three 1/4-20, 1-1/2 inch long brass screws. Insert each screw into the hole so it is flush with the post surface on one side. Using a propane torch, solder each screw in place.
5. Drill a 1/8-inch hole in the same direction as step 3 about 1-inch from the top of each post. test for fit using a 1/8-inch welding rod. Be sure these holes are horizontally true and perpendicular to the post. A drill press is highly recommended for this work.
6. Drill and tap a 1/4-20 hole downwards from the top of each post until the depth of the hole passes the horizontally drilled welding rod hole.
7. Insert a 1/4-20 thumbscrew in each post and be sure it can secure a welding rod inserted into each hole for the rod.
8. Mount all three posts making certain that they are square to each other when the bottom screws are tightened.
9. File a notch in a 7-inch welding rod to break the rod into three, 2-inch sections.
10 Break the rod at the notches by holding the rod in a vice at the notch and snapping the rod.
Warning: Be sure to wear appropriate eye protection during this step.

11. Insert a 2-inch rod piece into each post and adjust the main electrode posts so the there is a gap of about 3/4-inch between them. Bring the trigger rod closer to the main gap until the trigger rod barely cuts the line between the main gap rods. Tighten each thumbscrew to secure the position of each rod.
12. Attach all cables using ring lugs, brass washers and brass nuts.



THE CONNECTIONS BETWEEN THE FAN CONTROL AND THE HIGH ENERGY IGNITION COIL

Refer to the schematic above. The parts list provides the part numbers. For convenience in wiring you might use a printed circuit board, or a perf board, or a barrier strip.
The purpose of this group of discrete components is to allow using a 12V coil from 120VAC and to offer protection to the modules in case of circuit failure via the MOVs.

The two 8 ohm resistors in parallel provide 4 ohms at 40 watts. The two 1.0μF caps in parallel present 2.0μF to the circuit.

THE COOLING FAN

I should mention the use of the cooling fan. I obtained several high speed muffin type fans and decided to use one for this arrangement. The fan is rated at 250 CFM and sounds like it! It measures 6-inches in diameter. I mounted it, blowing downwards, using several PVC plugs fitted into painted wooden dowels. The result is that after hours of on/off use, the brass posts are room temperature

.

KEY PARTS USED AND ASSOCIATED SOURCES

Dimmer Module LUTRON FanDial Fully Variable Fan Speed Control FS-5FH-WH
Purchased from Home Depot $11.00
Motorola MAC223AB 20A Triac available from Allied Electronics and other parts companies

HEI Coil Wells C834 purchased from AutoZone $10.00.

Electrodes 1/2 Sq Brass Stock One foot length purchased from McMaster Carr
1/8-Inch Thoriated Tungsten Welding Rods purchased at a local welding supply store. About $1 per rod.

RadioShack Components

Two 8 ohm/20 watt wirewound resistors	Cat. No. 271-120	$1.49 each
Two 1.0µF, 250 VDC Metalized Capacitors	Cat. No. 272-1055	$1.19 each
Three Metal Oxide Varistors	Cat. No. 276-568	$1.99 each

Fan: high speed fan purchased from MECI (www.meci.com)

The rest of the material can easily be found in any Ace Hardware Store including the wire, the nylon spacers, the machine screws, the PVC plumbing and conduit items, the wooden dowel, and the ring lugs.

I have used RadioShack #8 MegaCable in lieu of GTO cable with excellent results. It is sold by the foot at 99 cents/foot in red and black. It accepts a 1/4-inch solder lug connector.

SUMMARY

The Trigger Gap has three drawbacks which I have not mentioned until now. First, the arc is extremely bright. Consider working a shield of welder's glass into your configuration to surround the spark. I will add one to mine very soon. Second, the noise is much louder than expected. Thirdly, because of the intense spark, liberal amounts of ozone are emitted.

Other than the foregoing, the gap requires modest tweaking of the rotary control to find the best phase setting. But even if you are "off", it still works beautifully.

Since the gap is automatically set to 120 BPS, you will need a LTR tank cap.
My first coil used a .0117µF MMC (with a 15KV/60ma NST) which was slightly LTR. Now, with the trigger gap, I use a .028µF LTR MMC.

I hope those who have read this and who go on to construct the gap will enjoy the same convenience and success that I have had with mine.

Ted Rosenberg - Fort Worth, TX