Excerpt from Popular Mechanics 1968

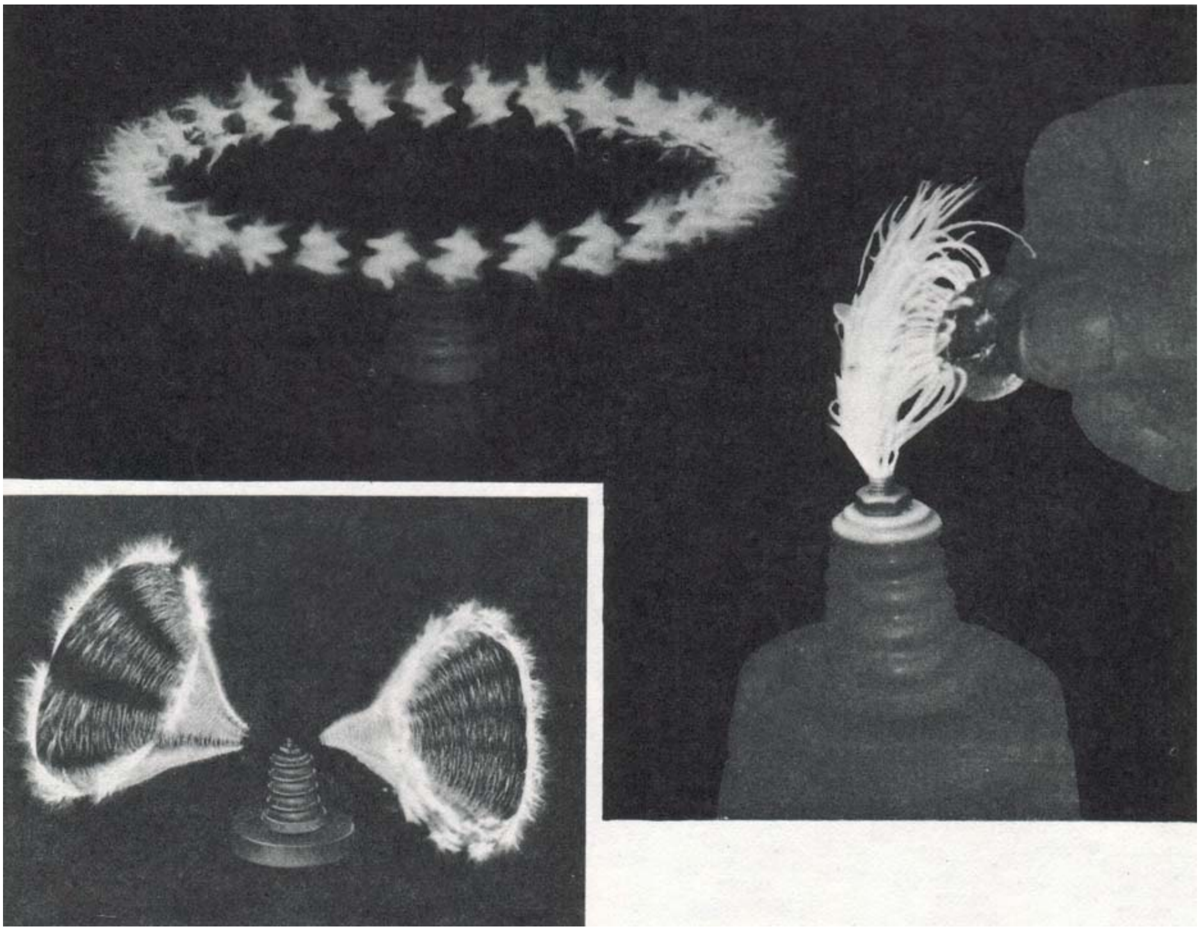
# Electrical fantasies with a Tesla coil

By HAROLD P. STRAND

IT JUST SITS there spitting fire, like a fugitive from a mad scientist's laboratory. The current it's discharging-in a wicked, noisy 2-in. brush is of such a high frequency you can't measure it, but maybe it runs up to 40,000 volts! Feeling just a bit suicidal, you move a coin toward this geyser of fire. The greedy tentacles snatch toward it, but there's no shock. Even if you poked a finger into the brush, the current would just splash over your skin.

Ever since Nikola Tesla invented a high-voltage, high frequency coil, science experimenters have been intrigued with their own variations on his coil. In Tesla's time, high-frequency current was obtained with an induction coil as a primary source of power. Leyden jars served as capacitors, with a spark gap and the inductance of a second coil combining to form an oscillatory discharge of high frequency. With today's vacuum tubes and mica capacitors, we can make a much more efficient and safer coil.

## Tesla coil



**Spectacular fireworks include a ring of fire scribed by a wire pivoting on a phonograph needle attached to a terminal. A finer wire, attached directly to a coil, produces trumpet pinwheels, shown in the smaller photo. This article tells how you can create these fireworks**

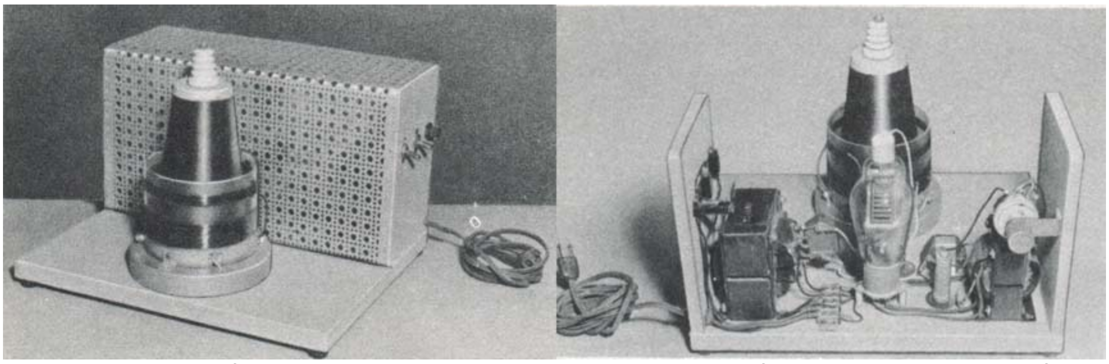
**MATERIALS LIST**

1 811-A tube
1 Ceramic 4-pin socket with oval mounting flange
1 9/16 ceramic plate cap
1 2500 or 3000 ohm, 25 watt Ohmite power rheostat with knob
1 3000 ohm, 20 or 25 watt fixed resistor
1 6.3 v. 6 amp. filament transformer. Thordarson 21F11 or equivalent.
1 1000 v., 150 ma. plate transformer. With enlarged enclosure, stand and Stancor PC8414 power transformer (1200 v., 200 ma.), can be substituted, using primary and these taps only
2 S.P.S.T. bat handle toggle switches with solder lugs, 6 amp. 125 v.
1 Finger knob panel type fuse mount for 3AG fuses
1 Box (5) 3AG fuses, slow-blow type, 2-4 amp.
1 5-way binding post
1 Line cord with plug attached
1 Johnson 135-45 insulator. Use top half only with 2½" 8-32 machine screw
1 Mica transmitting capacitor .0005 mfd. 3000 v. Type CM65
2 Mica capacitors .004 mfd. 2500 v. Type CM60.
Note: Values can be from .0002 to .001 mfd. for the CM65 and .002 to .005 for the two CM60s
1 Cinch-Jones barrier terminal strip Type 5-140
1 Cinch-Jones barrier terminal strip Type 2-140
About 1/4 lb. #32 Formvar magnet wire
About 1/4 lb. #18 Formvar magnet wire
About 1/8lb. #26 Formvar magnet wire
1 1/8" Lucite tubing 4 1/2" O.D., 3 1/2" long
1 Plastic conical vase (Carlisle Mfg. Co.) or equivalent.
10 ft. #33 or 34 Nichrome wire
10 ft. #18 or 20 plastic insulated stranded hook-up wire
4 5/8" rubber knob feet

**Note**: All above materials can be bought as a kit from Linwood Products Company, Box 186, Wollaston, Mass., for $39.50 (postpaid in U.S.)

**ADDITIONAL NON-ELECTRICAL PARTS**

1 3/4" plywood 12" X 13 3/4"
2 ½" plywood 5" X 7 ½"
1 3/8" plywood 4" X 4" (cone disk)
1 Pine or other stock 1" X 6" X 6" (tubing disk)
1 Aluminum or other sheet metal 1/16" X 5/8" X 2 ½" (rheostat bracket)
2 Aluminum or other sheet metal .025" X ½" X 1" (tubing brackets)
1 Aluminum or other sheet metal .025" X ¾" X 4 ½" (capacitor clamp)
1 Perforated aluminum or sheet metal 13 5/8" X 19 ¾" (enclosure)



**Neat housing presents a coil on a platform with all the wiring running underneath to the transformer section behind the perforated metal cover. Note the switches on the right side of the housing**

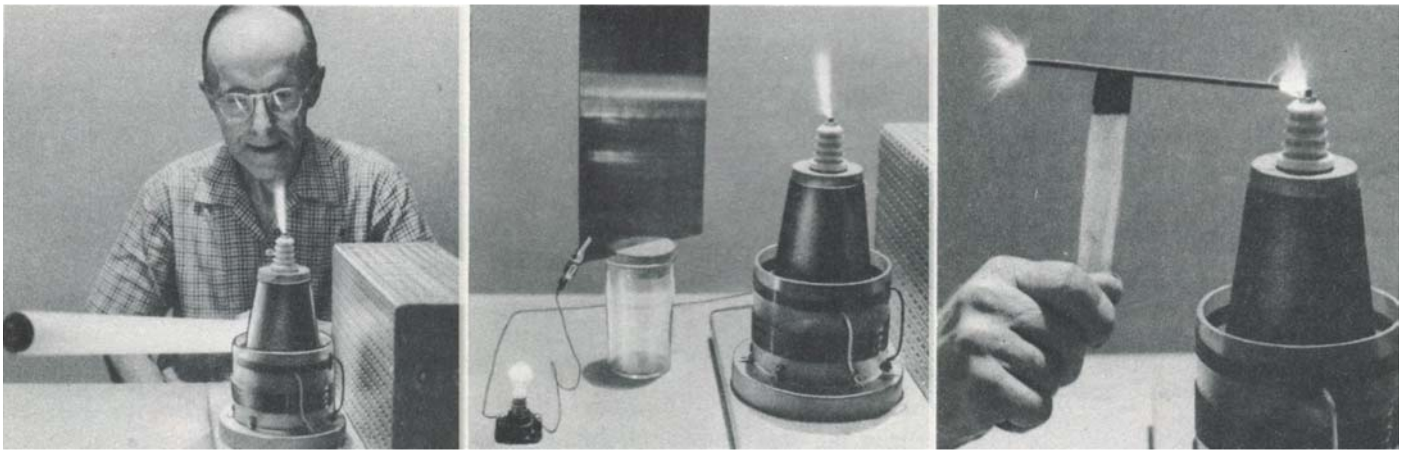
Our small model operates at a resonant frequency of about 850 kilocycles, depending somewhat on the tap selected on the lower outer coil, and the value of the capacitance used across it.

The coin stunt isn't the only fun you can have with a Tesla coil. There are other spectaculars. Wrap the center of a length of Nichrome wire around the terminal with the ends formed out straight, like feelers. The ends become red-hot and bright lavender sparks quiver along the wire as each half begins to rotate. Two fiery trumpets blaze forth in the darkened room. Just why the wire ends rotate is not known.

Another bit of fireworks results when you balance a wire rotor (detailed in the bottom panel on page 5) on the point of a phonograph needle erected on the terminal. Jet propulsion from the corona discharges at each end sets the rotor spinning. The result is a startling ring of fire.

No less intriguing are three other demonstrations. Holding a fluorescent tube near the coil activates the phosphors on the inside, causing a mysterious glow. Various types of neon lamps will also light when introduced into the coil's field. Since this field is strongest near the coil, as you draw the lamp away it dims, then goes out.

Sample experiments include (left) lighting a fluorescent tube by simply moving it into the high-frequency current field surrounding the coil; (center) lighting a 115-volt light bulb without plugging it into a power line-by means of energy radiated to a sheet-metal plate; (right) passing the current from the coil's own brush discharge through a metal rod taped on a plastic strip to form a duplicate brush at the other end.



**Illustrating Tesla's dream**

One experiment graphically illustrates Tesla's dream of lighting entire buildings from a distance without wires. As shown, you erect a sheet of aluminurn on an insulating stand, to serve as a collector for currents radiating from the coil. Attach one clip lead to the plate and to one side of a small 11 5-volt lamp; another clip lead connects the other side of the lamp to ground. When the coil is switched on, the plate picks up energy and lights the lamp. The closer the plate is moved to the coil, the brighter the lamp glows. If you disconnect the lamp, you can draw sparks from the plate to your fingers, indicating that the plate is charged by radiation from the coil.

Another experiment (not shown) demonstrates that this peculiar form of current seems to pass through material that's considered a good insulator. A piece of 1/4-in. plastic, held in a spark gap connected from the top terminal and the ground post, seems to offer no resistance-you can watch the discharge continue to jump the gap. You can also conduct this experiment with other insulation materials of various thicknesses.

Start construction with the tall, tapered core coil. The winding form is a plastic flower vase with a stake base. Be sure it's plastic. Remove the spike by pulling it out of its socket and drill a center hole through the socket bottom for a machine screw long enough to pass through the top insulator. At the large end make up a plywood disk with tapering edges, to exactly fit the opening. Drill 3 equally spaced holes through the edge of the vase for small nails, driven into the plywood edge. Fastening is temporary; the disk must be removed for interior connections.

Bore a center hole in the disk to pass whatever spindle you've devised for the winding process. This type of jig is pictured (lefthand photo on page 4) in operation. A simpler setup would be to pass plain rod through the form, cradling each end on a notched upright. Bend the spindle's projecting end to form a crank.

Apply a thin, even coat of varnish to the vase and let it dry enough to get tacky. Coil up about 2 in. of wire and tape it out of the way at the upper end of the vase-form. Wind the turns on in a single even layer with no overlap or space between. The tacky varnish prevents the turns from slipping out of place on the smooth plastic. When you're within 5 1/8-in. of the edge, anchor the end of the wire with tape. The height of the winding should be about 5 ½-in.; that's roughly 550 turns-but it's not critical enough to warrant an actual count. At the top of the coil, bore a small hole just beyond the point where the turns end, to pass a piece of small-diameter spaghetti tubing. Slip this over the hole to the inside. Clean the end of the wire by holding it over a match a moment, then burnish with sandpaper before clamping it under the head of the insulator screw. Coat the head with quick-dry varnish or shellac to eliminate possible corona discharges here. Apply two or more even coats of varnish to the winding, letting each dry thoroughly.

The two outer coils are wound on the Lucite tubing without any sort of jig. The start of the lower coil has a permanent terminal; a second terminal provides a short lead that can connect to any of the taps. Two terminals are also provided for the ends of the upper coil, at the opposite side of the tube. For connections to these terminals, slip on pieces of spaghetti tubing where the wires cross the lower coil, and make sure the leads don't contact it, as shorting might result.

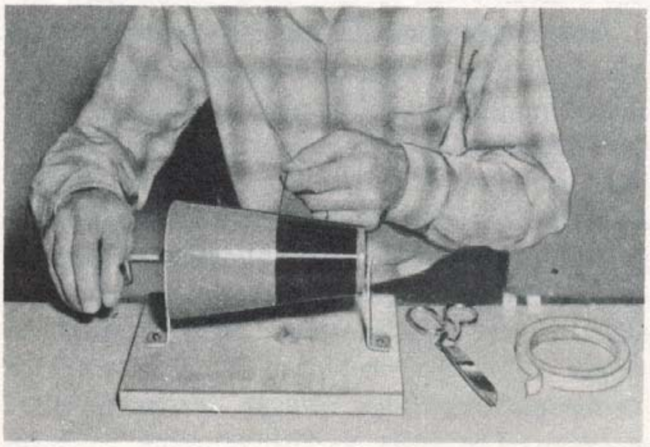
This disk is cut to 5 3/4-in. dia. as shown in the exploded view, then positioned temporarily on the platform so you can drill holes (to pass the 5 leads) through both thicknesses at once. Center the core coil on the base disk and drive two flathead screws up through it, countersinking them flush. Now drop the outer coil unit down over the core coil (after cutting a notch in the tubing to clear the inner terminal).

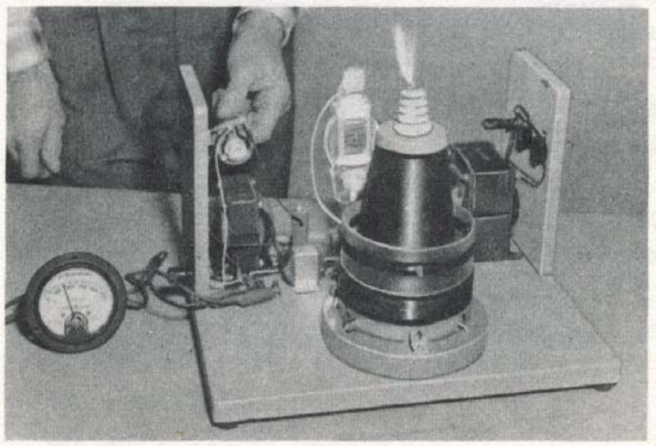
In the photo, page 2, the 1000-v. transformer is at the left and the filament transformer is at the right. The tube socket has been mounted with spacers so it will clear the bottom connections. The rheostat for the grid control is bracketed to the side. Use plastic insulated stranded wire with clamp-on terminal lugs at all screw terminals.

The milliammeter you use to adjust the plate current (right hand photo, page 4) should have a scale of 0-300 or more. To hook it into the circuit, remove the center tap of the filament transformer from the ground and connect it to one side of the meter with a clip lead; another lead connects the other side of the meter to the ground terminal. If, when you turn on the power, the meter reads *down* scale, reverse the leads. To avoid shock, be sure all power is off before you touch any wires or connections around the coil.

The strong brush discharge shown in several photos indicates a good combination of capacitor value and the best tap on the low outer coil. You can experiment with various capacitor values and taps while adjusting the grid resistance to keep it within the 150-ma. limit for the plate current. When the best combination has been found, solder the lead to the tap selected. You'll have to scrape the varnish off each tap with a sharp knife and sandpaper before making any connection.

**A simple hand jig speeds winding of the core coil on a plastic-vase form. The crank is a threaded rod secured. through the base disk with nuts on each side, bent twice to form a handle. The crank is suspended between two brackets.**

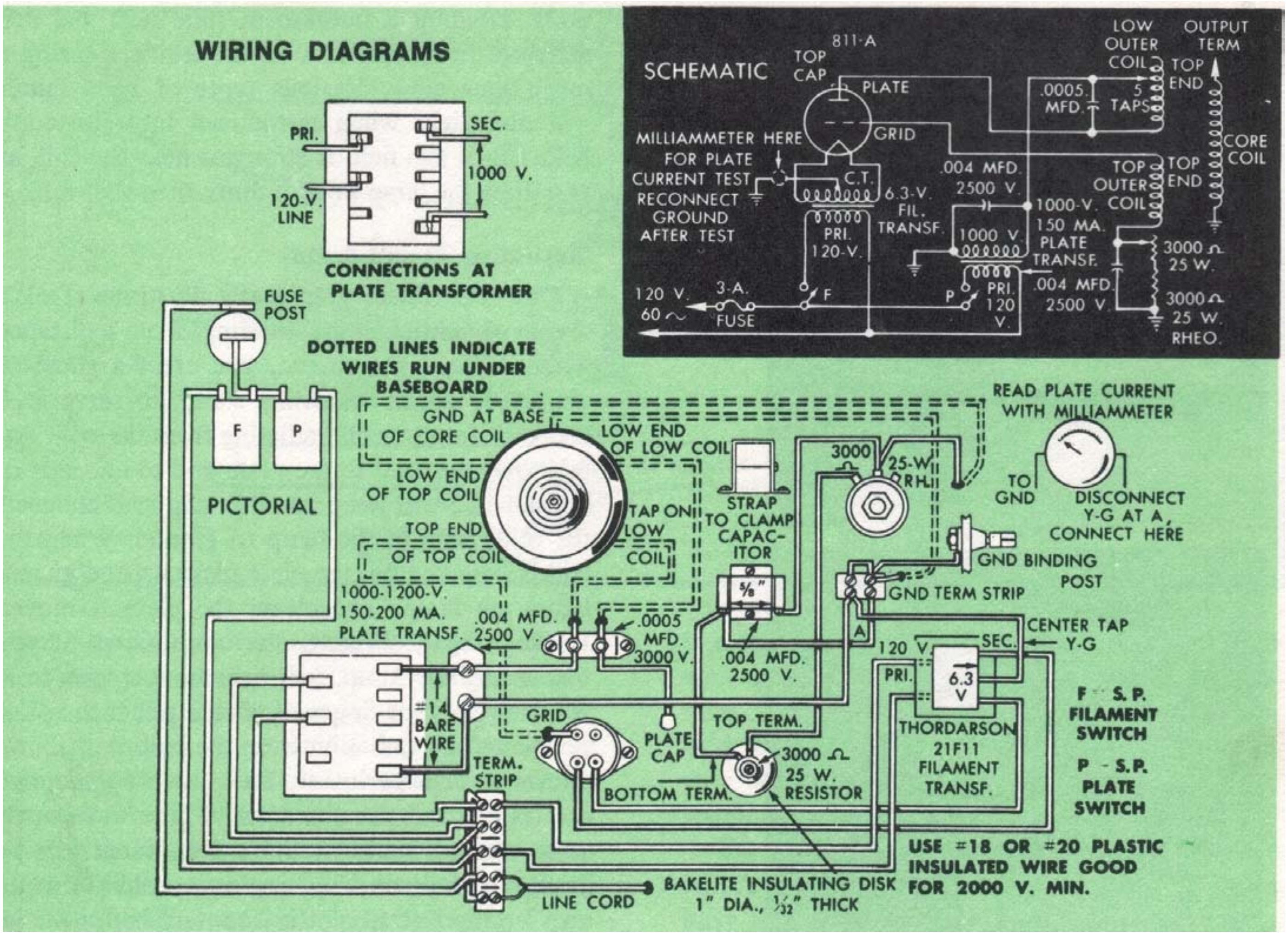


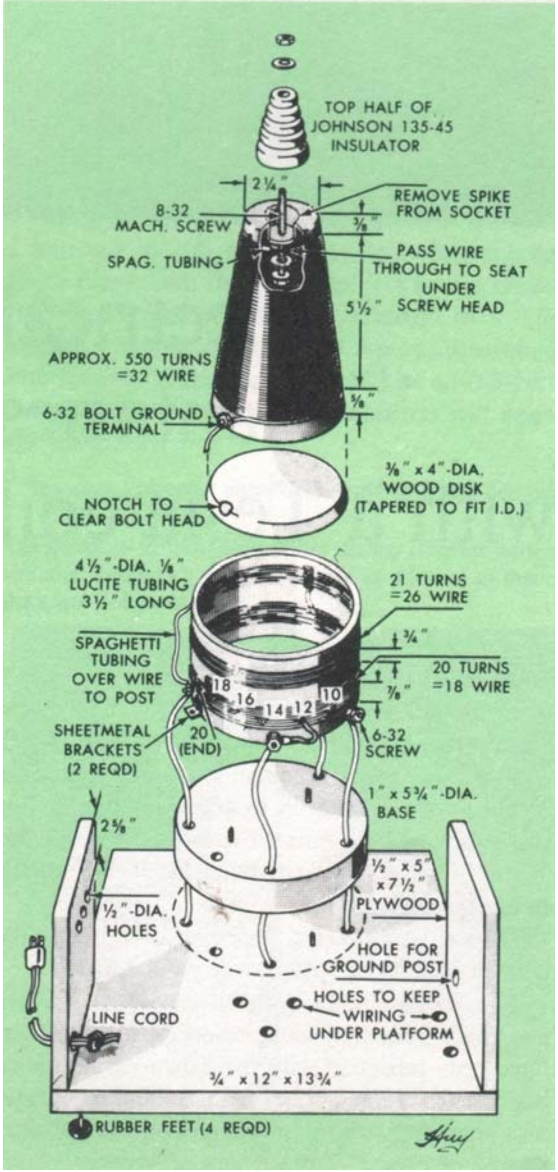


**After you finish the assembly, read the plate current by connecting a D.C. milliammeter between the center tap of the filament transformer and ground. Adjust the rheostat to 150 ma. maximum for any combination of capacitors and taps**

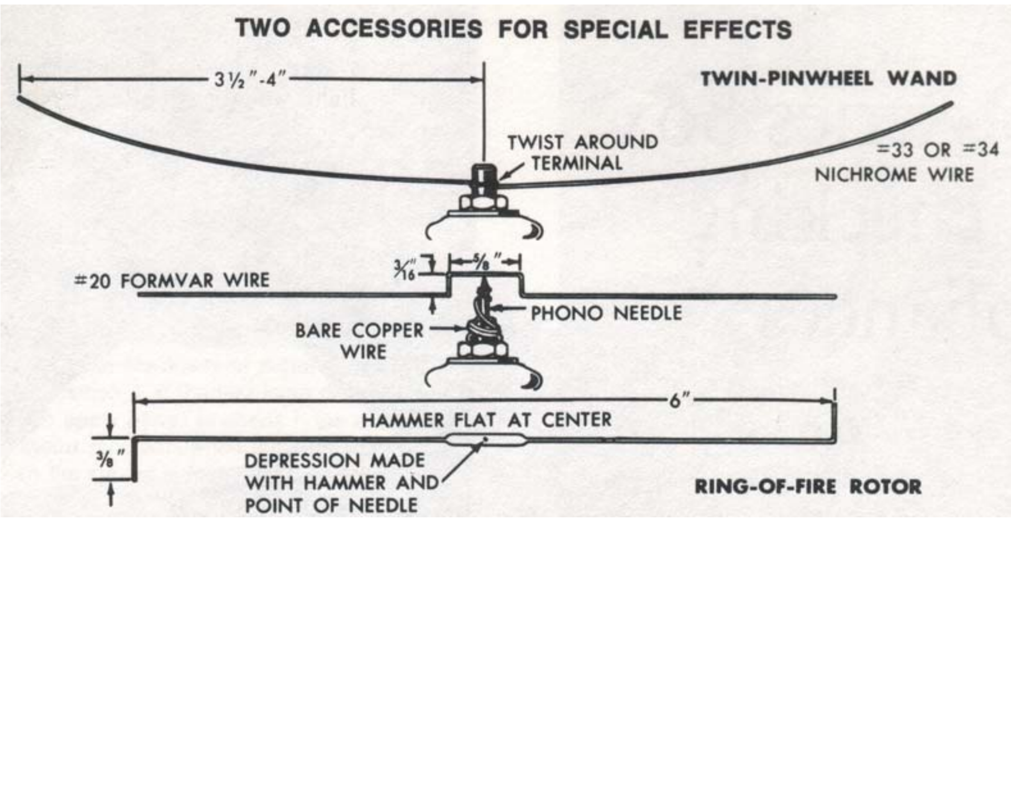
When operating the coil, be sure to turn on the filament switch first and let the tube warm up 15-20 seconds before you flip the plate switch.

Note that a ground post has been provided at the opposite side from the switches. You can ground the coil with a clip lead to a water pipe or radiator. This post may also be required in some experiments requiring both the ground and high-voltage sides of the circuit.





TOP HALF OF JOHNSON 135-45 INSULATOR
2 1/4"
REMOVE SPIKE FROM SOCKET
8-32 MACH. SCREW
3/8"
PASS WIRE THROUGH TO SEAT UNDER SCREW HEAD
SPAG. TUBING
5 1/2"
APPROX. 550 TURNS =32 WIRE
5/8"
6-32 BOLT GROUND TERMINAL
3/8" x 4"-DIA. WOOD DISK (TAPERED TO FIT I.D.)
NOTCH TO CLEAR BOLT HEAD
4 1/2"-DIA. 1/8" LUCITE TUBING 3 1/2" LONG
21 TURNS =26 WIRE
SPAGHETTI TUBING OVER WIRE TO POST
3/4"
20 TURNS =18 WIRE
3/8"
18
16
14
12
10
SHEETMETAL BRACKETS (2 REQD)
20 (END)
6-32 SCREW
1" x 5 3/4"-DIA. BASE
2 5/8"
1/2" x 5" x 7 1/2" PLYWOOD
1/2"-DIA. HOLES
HOLE FOR GROUND POST
HOLES TO KEEP WIRING UNDER PLATFORM
LINE CORD
3/4" x 12" x 13 3/4"
RUBBER FEET (4 REQD)

TWO ACCESSORIES FOR SPECIAL EFFECTS
3 1/2"-4"
TWIN-PINWHEEL WAND
TWIST AROUND TERMINAL
=33 OR =34 NICHROME WIRE
#20 FORMVAR WIRE
3/16"
5/8"
PHONO NEEDLE
BARE COPPER WIRE
6"
HAMMER FLAT AT CENTER
3/8"
DEPRESSION MADE WITH HAMMER AND POINT OF NEEDLE
RING-OF-FIRE ROTOR