Construction of a Tesla coil

This is an article that appeared in Experimental Electricity for Boys by Willard Doan, published in 1959. It is a fairly simple project, however some of the materials may no longer be readily available, and the next best substitution will need to be found. WARNING! This project involves high voltage electricity, and is therefore very dangerous, so use extreme caution. This is part of a series of three pages, which also includes companion articles on building a secondary coil and a leyden jar. All text and illustrations in this article are by Willard Doan. Links to the illustrations are listed at the end of this page. I am **not** expert in building these things, so I probably won't be much help answering your questions. This article is here primarily for historical reasons. Sorry this doesn't include metric dimensions, but this is an old book from the U.S., after all!

A TRANSFORMER, which will demonstrate one method of generating high frequencies and some of their interesting characteristics may be very easily and inexpensively made. This particular type of transformer is known as the Tesla coil after its inventor, Nikola Tesla. Unlike low-frequency transformers, it has an air core, and no iron is used in it construction

A short explanation of how the Tesla Coil converts the low-frequency ac into high-frequency ac is first necessary.

Referring to Fig. 8-5, an interruption of the primary circuit of the spark coil SC by the spark coil vibrator produces a current of high Voltage in the secondary. This current flows through the Tesla coil primary P, into the capacitor C, charging it from the other plate of the capacitor back to the spark coil secondary. But due to the inductance of the coil P, the current flow cannot stop instantly when the capacitor is charged but continues until it is overcharged. Then when the inductive effect of P dies out, the overcharged capacitor discharges backward through P, jumps across the spark gap SG, and completes the circuit to the other side of the capacitor. Here again the inductance of P does not let the current flow stop instantly, but it continues on until the capacitor is charged again, though this time in the opposite direction, and not quite so much as before. This back and forth charging and discharging of the capacitor continues but is gradually weakened by the resistance of the circuit, until the voltage is too low to jump the gap. The rate of these reversals may be many thousands or even millions of times per second, the number depending on the capacitance of the capacitor C and inductance of coil P. The lower the values of capacitance and inductances the higher is the frequency. It is evident then, that for each pulsation from the spark coil secondary, many, many cycles of alternating current will flow through the primary of the Tesla coil.

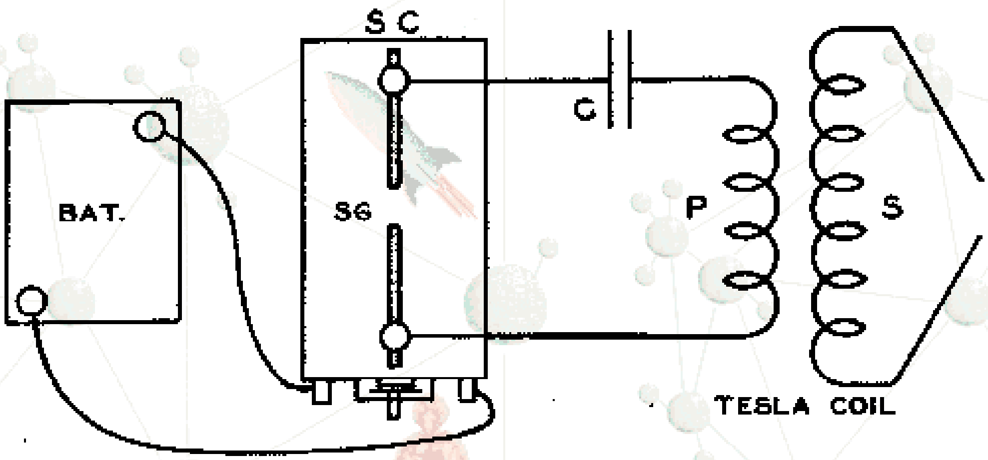

Fig. 8-8. Principles of the Tesla coil circuit.

The secondary of the Tesla coil usually has many more turns of wire than the primary, so there is a step-up in voltage due to transformer action.

We are now ready to start the construction of the experimental Tesla high-frequency coil.

Materials

- one cardboard mailing tube, 12 inches long, 2 inches outside diameter
- 500 feet or 1/4 pound of No. 29 enameled copper magnet wire
- 20 feet No. 10 enameled copper magnet wire
- one sheet of bakelite, hard-rubber, lucite, or wood, 8 by 9 inches, 1/8 inch thick
- piece of soft wood, 3 by 6 by 3/4 inches
- one sheet of "Empire" cloth, 12 by 48 inches
- two 8-32 brass machine screws, 1 1/4 inches long
- four 8-32 brass nuts
- 4 washers to fit 8-32 screws
- two small battery clips
- paraffin wax
- model-maker's or radio service cement

We shall begin by constructing the secondary winding. It may be wound on a cardboard mailing tube, 2 inches outside diameter and 12 inches long. Soak the tube thoroughly in hot paraffin until it is impregnated with the wax.

Wind on this tube one layer of No. 29 enameled magnet wire, leaving about 3/16 inch of the tube uncovered by the wire at each end. Fasten the ends of the wire by threading them through two small holes punched through the tube at each end, leaving several inches for connections.

With a coping saw, cut two disks out of soft wood to fit in the ends of the tube. Smooth with a file, then soak them in melted paraffin. Drill a hole in the center of each disk for an 8-32 machine screw 1 1/4 inches long. Insert the screws in the disks and tighten a nut on each one.

Cement a disk in one end of the secondary coil with the head of the terminal screw inward and attach the coil to the screw. Do not mount the other disk until after the secondary coil has been assembled inside the primary coil.

Over the secondary winding wrap 6 or more layers of "Empire" cloth or paper to insulate it from the primary. These may be fastened in place with cellulose tape or by cement.

The construction of the primary coil comes next. The frame for it is illustrated in Fig. 8-9. It may be made of any good insulating material, such as 1/8-inch thick bakelite, hard rubber, Lucite, or even paraffined wood. The pieces are cut and drilled as in the illustration, but are not to be assembled yet. Assembling must be done in conjunction with the forming of the primary coil.

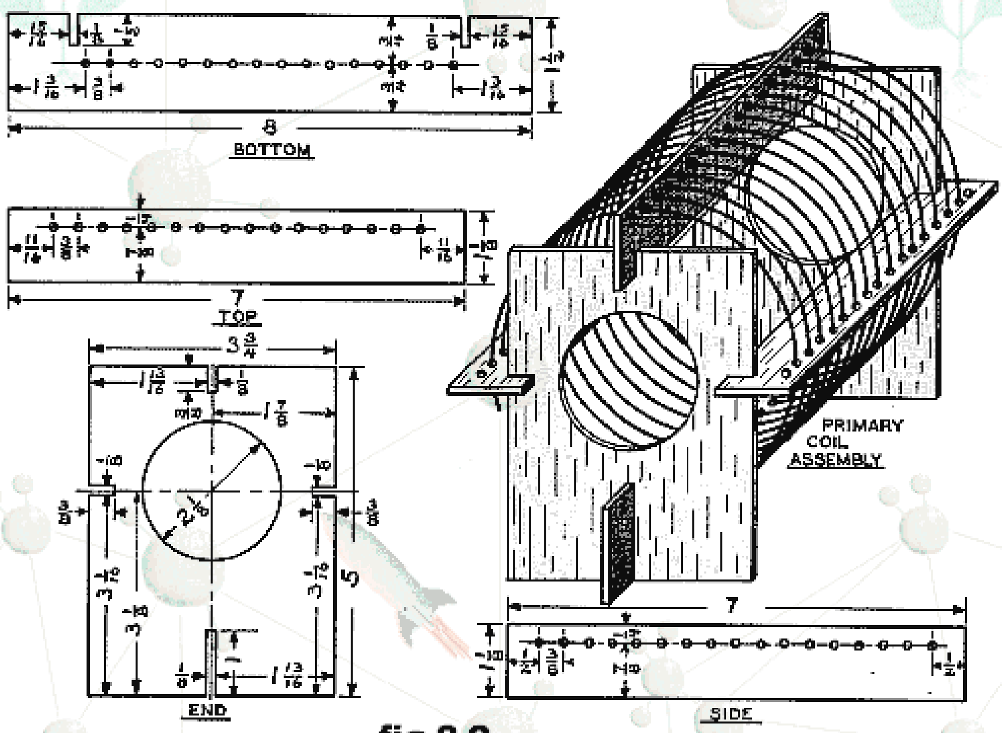

fig 8-9

This coil consists of 14 turns of No. 10 enameled or bare copper wire. Before beginning to assemble the coil and frame, form the coil to approximately the proper size, which is 4 3/4 inches in diameter. Next, thread it into the supporting strips, starting in a hole at one end of one strip after another. Screw the coil clown until it has passed through all the holes of all the strips. Separate the strips until they are arranged at approximately 90-degree intervals around the coil.

When this operation is completed, it will usually be found that the coil is not the right size. Adjust the coil for size as follows: first stand it on one end. If it is too small, take strip No. 1, and continuing around and around the coil, slide the top end of each strip about one half inch toward the free end of the wire. This gradually threads in more wire, increasing the diameter of the turns.

When the proper size has been obtained, turn the coil over and adjust the other end the same way. It should be evident that the wire should not be cut off until the coil is the correct size. If the coil is too large at the start, the supporting strips should be slid in the opposite direction. If both coils are made to the sizes suggested, about 20 feet of wire will be required for the primary coil and 500 feet for the secondary coil.

If the secondary coil happens to be slightly larger in diameter than that suggested, make the primary inside diameter at least 2 3/4 inches larger than the secondary. This is to lessen the danger of the secondary discharge jumping into the primary circuit and causing damage.

After the primary coil has been properly sized, the end pieces of the frame may be slipped into place. The size given in Fig. 8-9 for these end pieces is for a primary coil 4 3/4 inches inside diameter. If a larger coil is made, the end pieces must be proportionately larger. If there is much variation in dimensions from those given for either the primary or secondary coils, some experimenting with the number of turns in the primary will be required for best results.

After the primary coil is completed and the frame assembled, slip the secondary coil through the holes in the ends of the frame, centering it so it projects equally from each end of the primary coil. Slip the remaining end disk in the secondary coil form and connect the end of the coil to the terminal screw. Cement the coil in place and secure all the joints in the frame with service cement. The finished coil is shown in Fig. 8-10.

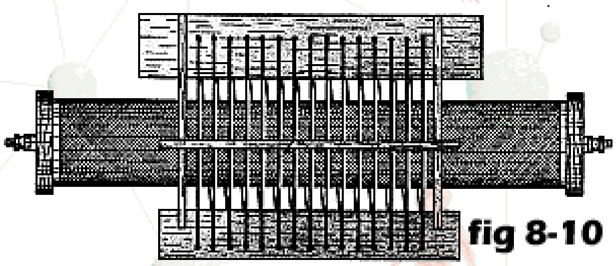

fig 8-10

In operation, the Tesla coil is connected as shown in Fig. 8-1 1 The spark coil described in Chap. 7 will excite it. Use either a 6-volt storage battery or a transformer capable of supplying 8 to 12 volts and about 4 amperes for power. The higher a-c voltage is required because of the inductance of the spark-coil primary. Most electrical equipment having inductive coils and constructed to operate on either ac or dc requires a higher voltage on ac than on dc to obtain the same results, because of the inductive reactance of the coils.

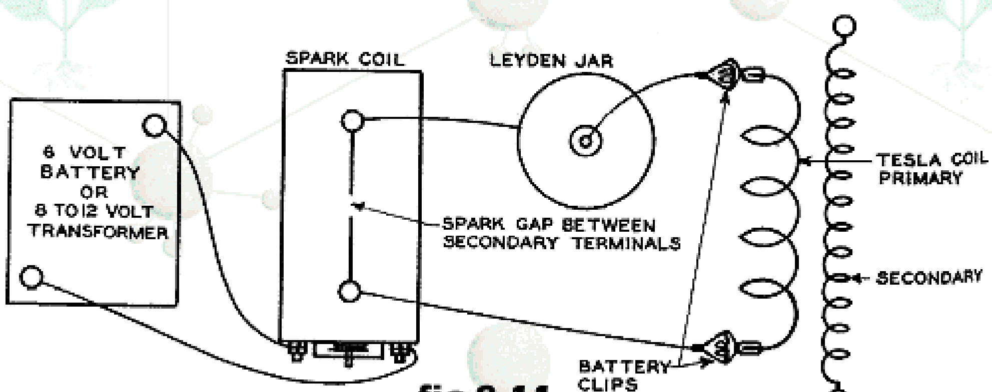

fig 8-11

The spark gap is formed by attaching two pieces of wire to the spark-coil secondary terminals. The best adjustment is usually the longest gap that will allow a steady spark. The Leyden jar capacitor is described in Chap 2. Use short pieces of electric light cord for connections. They should be as short as possible. Two small battery clips may be purchased from an auto parts store and fastened to two of the connections. They may be clipped to various points on the primary of the Tesla coil until the best secondary discharge is obtained. *Do not under any circumstances touch the primary circuit of the Tesla coil while the current is turned on, as severe shock and injury may result.*

EXPERIMENTS WITH THE TESLA COIL

Some spectacular experiments may be performed with this Tesla coil in a darkened room. A burned-out fluorescent light tube held in one hand will light when the high-frequency spark jumps to one end of it. A 300- to 500-watt incandescent light bulb produces a very beautiful effect when held by the glass and placed so the spark jumps to the base of the bulb. Small neon bulbs light with their characteristic rose color when the spark is attracted. These experiments are performed using only one terminal of the Tesla coil secondary.

If two stiff wires are connected to the secondary terminals of the Tesla coil and bent so they are parallel to each other for a distance of 3 or 4 inches, but separated slightly farther than the spark can jump, the area between them will be filled with innumerable tendrils of violet light. A wheel or cone of light tendrils may be formed by bending the end of one wire into a circleabout 3 or 4 inches in diameter, and pointing the end of the wire attached to the other secondary terminal at the center of the formed circle. A very interesting experiment may be performed as follows: take a glass jar like that used for the Leyden jar and put a coating of tinfoil on the inside as was done in constructing the Leyden jar. This tinfoil coating is connected to one secondary terminal of the Tesla coil. A very fine wire is formed into letters and stuck to the outside of the jar. When this wire is connected to the other secondary terminal of the Tesla coil, the letters will glow with a weird violet light.

All these experiments must be performed in a dark room. It may be necessary to shield the spark gap with a small wooden or cardboard box making sure it is not set afire by the spark. Many more interesting experiments may be devised, taking great care to avoid shocks and burns. Keep your face away from any object connected to either coil.

The frequency of the voltage in the Tesla coil will probably be in the neighborhood of 2000 kilocycles (2 million cycles). While the voltage is high, the current is low, and since high-frequency currents travel almost entirely at the surface of a conductor, the current does not produce much of a shock when passing through the body. However it will burn the skin at the point where the spark strikes it. This may be avoided by holding a piece of metal in the hand and letting the spark jump to it.

Care should be taken that the operation of the coil does not interfere with nearby radio receivers. It might be well to operate the coil only for short periods at a time, and not too frequently.

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