

Solid-state Tesla Coil (TCL3)

The following project shows how to construct a high-frequency, high-voltage device capable of causing a fluorescent lamp to light (without wires), the corona effect (St. Elmo's Fire), and the wireless transmissions of radio-frequency energy. The device as a safety feature may be powered from a 12-volt battery source as well as 120 Vac. It is completely solid-state, simple to construct, and is to be considered as an introduction to the larger generating devices such as the 250 kV Tesla Coil and other high-powered devices.

CIRCUIT THEORY

As can be seen by the schematic (Fig. 18-1 and Table 18-1) the device is a high-voltage inverter circuit taking advantage of the high step up in voltage and low capacitance resonant secondary properties inherent in TV flyback transformers. This high-voltage, high-frequency output energy can light lamps without wires and perform many otherwise impossible feats. Power is obtained either by

an external battery or a conventional transformer full-bridge rectifier circuit.

T2 TRANSFORMER REWORK

1. Two new windings ("*primary*" and "*feedback*" windings) are added to the flyback transformer T1 (Fig. 18-2) that connects to the switching transistors Q1, 2. These windings are hand-wound on the bottom leg of the ferrite core where the original two-turn filament winding was located. In its place, wind a ten-turn, center-tapped winding (designated P1 and P2) using approximately 30 inches of #18 or heavier insulated hook-up wire. This is easily accomplished by winding five turns at one end of the core and bringing out a loop and twisting for a center-tap lead (PCT) before adding the second five turns. The complete ten-turn winding should then be held in place with a turn or two of electrical tape with the two ends (P1 and P2) and the center-tap (PCT) loop all protruding. Connection can be made to the center-tap loop when the insulation has been carefully removed. If it becomes

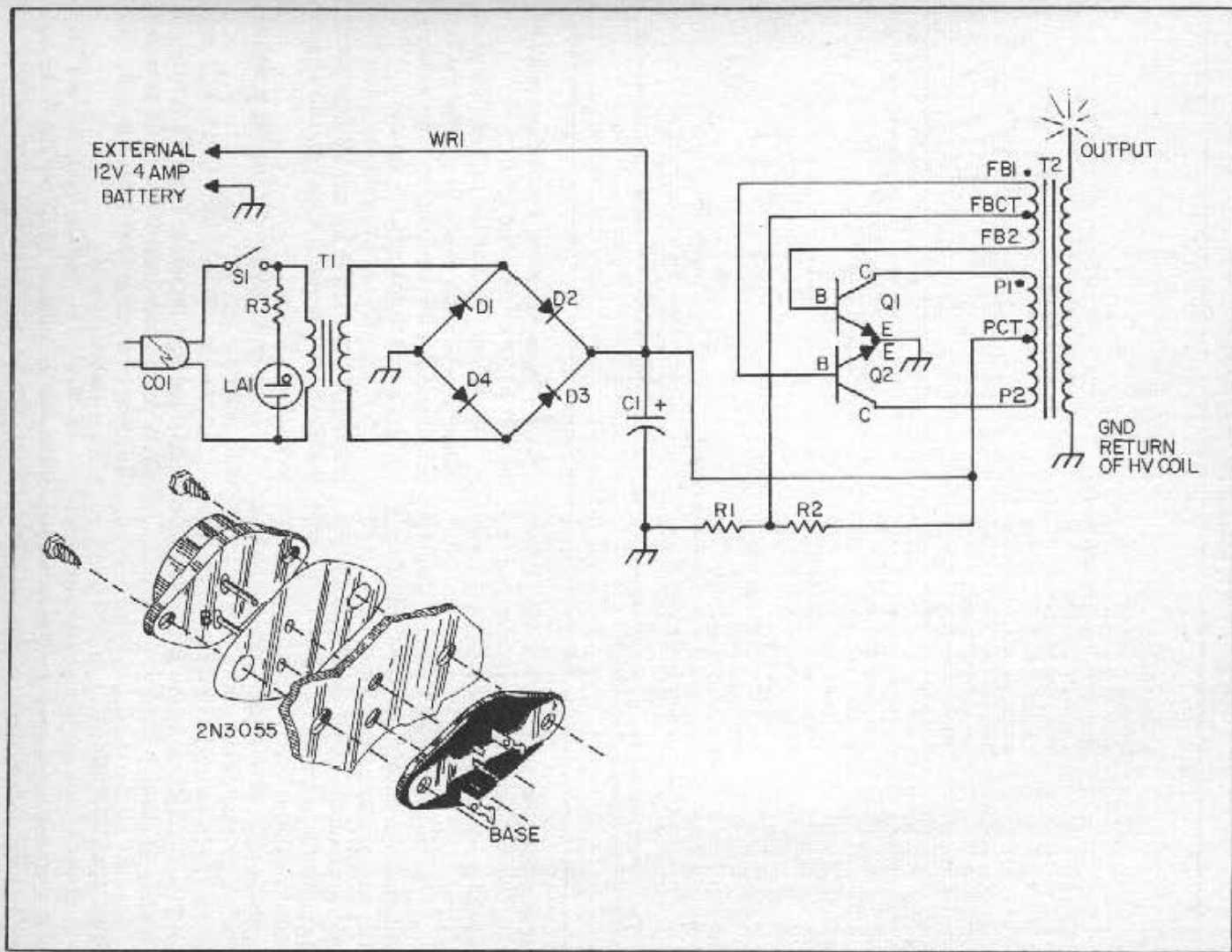


Fig. 18-1. Circuit schematic.

Table 18-1. TCL3 Universal Solid-State Tesla Coil

R1	(1)	27 ohm 1/2 watt resistor
R2	(1)	270 ohm 1/4 watt resistor
R3	(1)	100 k 1/2 watt resistor
C1	(1)	8000 μ F/16 V electrolytic capacitor
D1,2,3,4	(4)	3 amp 50 volt rectifier
T1	(1)	12 V 3 amp transformer
T2	(1)	TV flyback 20-25 kV
Q1,2	(2)	2N3055 npn TO3 transistor
MK1,2	(2)	TO3 mounting kit
LA1	(1)	Neon lamp with leads
CO1	(1)	Molded power cord
S1	(1)	Toggle switch 3 amps
EN1	(1)	7 x 5 x 3" al box
HS1	(1)	Dual TO3 heatsink
BU1	(1)	Cord clamp bushing
BU2	(1)	3/8" plastic bushing
BU3	(1)	1/2" plastic bushing
WR1	(3)	#18 stranded hook-up wire
WR3	(2)	#24 stranded hook-up wire
TE1	(1)	7 terminal strip
EN2	(1)	3 1/2 x 4" sked 40 PVC tubing
CA1	(1)	3 1/2" plastic cap
LAB1	(1)	Danger HV label
TER1	(1)	Large smooth metal door knob for output terminal

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necessary to cut the center loop, be sure that the two ends are scraped and joined to form a mechanical as well as an electrical connection to the winding.

2. The second winding (feedback) should be wound directly on top of the first, but it should only have a total of four turns—two each side of the center tap. Wind two turns of #22 hook-up wire, pull and twist a center-tap loop (FBCT) and wind the other two turns. Tape this winding in place on top of the first. Do not let the center-tap loops of the two windings touch each other, however, they should not be more than one-quarter of an inch apart. (Note Fig. 18-2 that shows larger separation for the sake of clarity.)

GENERAL CONSTRUCTION

3. Fabricate the metal case as shown from a 7 x 5 x 3" aluminum minibox. Drill holes for the indicator lamp, feed-through bushing for power, switch on the front panel, three holes for T2, shield

EN2, four holes for rubber feet, and two holes for the heatsink (Figs. 18-3 and 18-4).

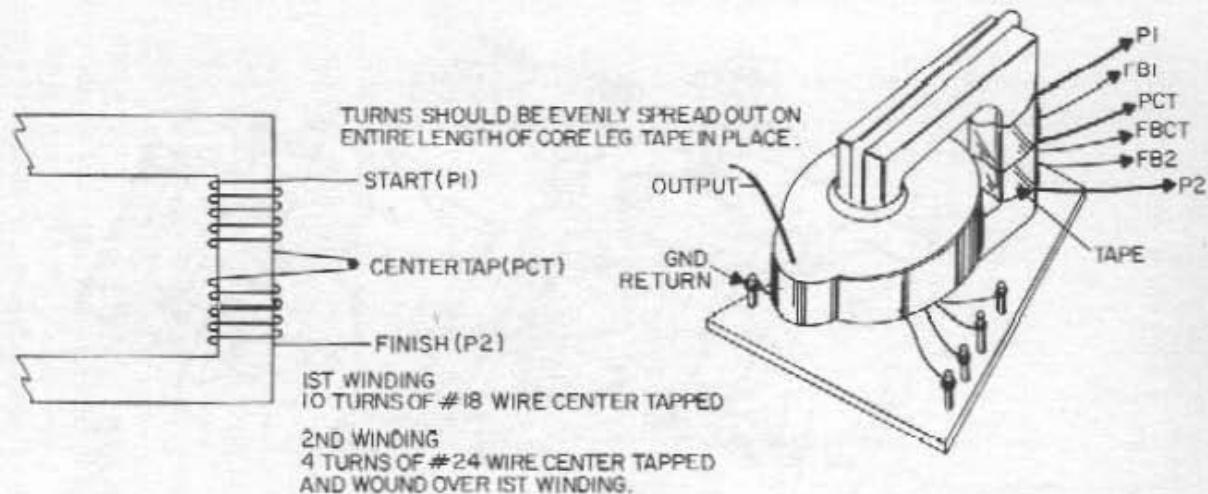
4. Mount Q1 and Q2 to heatsink using mounting hardware as shown. Be sure that the TO3 mounting cases are insulated from the heatsink. Apply heatsink compound for best results.

5. Solder R1 and R2 as shown. Solder FB1 and FB2 to bases (B) of Q1 and Q2 respectively. Use pliers as a heatsink whenever soldering directly to a transistor.

6. Solder lead from FBCT to TE1 at junction of R1 and R2.

7. Attach +12 volt power lead to PCT connect Q1 and Q2 collectors to P1 and P2. Attach -12 Vdc to emitter buss jump of Q1 and Q2 as shown. This point is chassis ground, connect ground return of T2 to chassis ground.

8. Final wire T1, C1, LA1, R3, and TE1. Watch out for primary 120 V wiring. Make sure there are no ac grounds. Cover leads of A1 with RTV or equivalent.



WINDING I

TWO NEW WINDINGS ("PRIMARY" AND "FEEDBACK" WINDINGS) ARE ADDED TO THE FLYBACK TRANSFORMER (T2) THAT CONNECTS TO THE DRIVER TRANSISTORS. THESE WINDINGS ARE HAND WOUND ON THE BOTTOM LEG OF THE FERRITE CORE WHERE THE ORIGINAL TWO TURN FILAMENT WINDING WAS LOCATED. REMOVE AND DISCARD THE ORIGINAL FILAMENT WINDING. IN ITS PLACE, WIND FIRST A TEN-TURN, CENTER-TAPPED WINDING (DESIGNATED P1-P2) USING APPROXIMATELY 30 INCHES OF #18 OR LARGER INSULATED HOOKUP WIRE. THIS IS EASILY ACCOMPLISHED BY WINDING FIVE TURNS AT ONE END OF THE CORE AND THEN TWISTING A LOOP IN THE FREE END BEFORE ADDING THE SECOND FIVE TURNS. THE COMPLETE TEN TURN WINDING SHOULD THEN BE HELD IN PLACE WITH A TURN OR TWO OF ELECTRICAL TAPE WITH THE TWO ENDS (P1 & P2) AND THE CENTER TAP (PCT) LOOP ALL PROTRUDING. CONNECTION CAN BE MADE TO THE CENTER TAP LOOP WHEN THE INSULATION HAS BEEN CAREFULLY REMOVED. IF IT BECOMES NECESSARY TO CUT THE CENTER LOOP, BE SURE THAT THE TWO ENDS ARE SCRAPPED AND JOINED TO FORM A MECHANICAL AS WELL AS AN ELECTRICAL CENTER TAP CONNECTION TO THE WINDING.

WINDING II

THE SECOND WINDING (FEEDBACK) SHOULD BE WOUND DIRECTLY ON TOP OF THE FIRST, BUT IT SHOULD ONLY HAVE A TOTAL OF FOUR TURNS—TWO EACH SIDE OF THE CENTER TAP. WIND TWO TURNS OF #22 HOOK-UP WIRE, PULL AND TWIST A CENTER TAP LOOP (FBCT) AND WIND THE OTHER TWO TURNS. TAPE THIS WINDING IN PLACE ON TOP OF THE FIRST. DO NOT LET THE CENTER TAP LOOPS OF THE TWO WINDINGS TOUCH EACH OTHER

Fig. 18-2. T2 rework winding instructions.

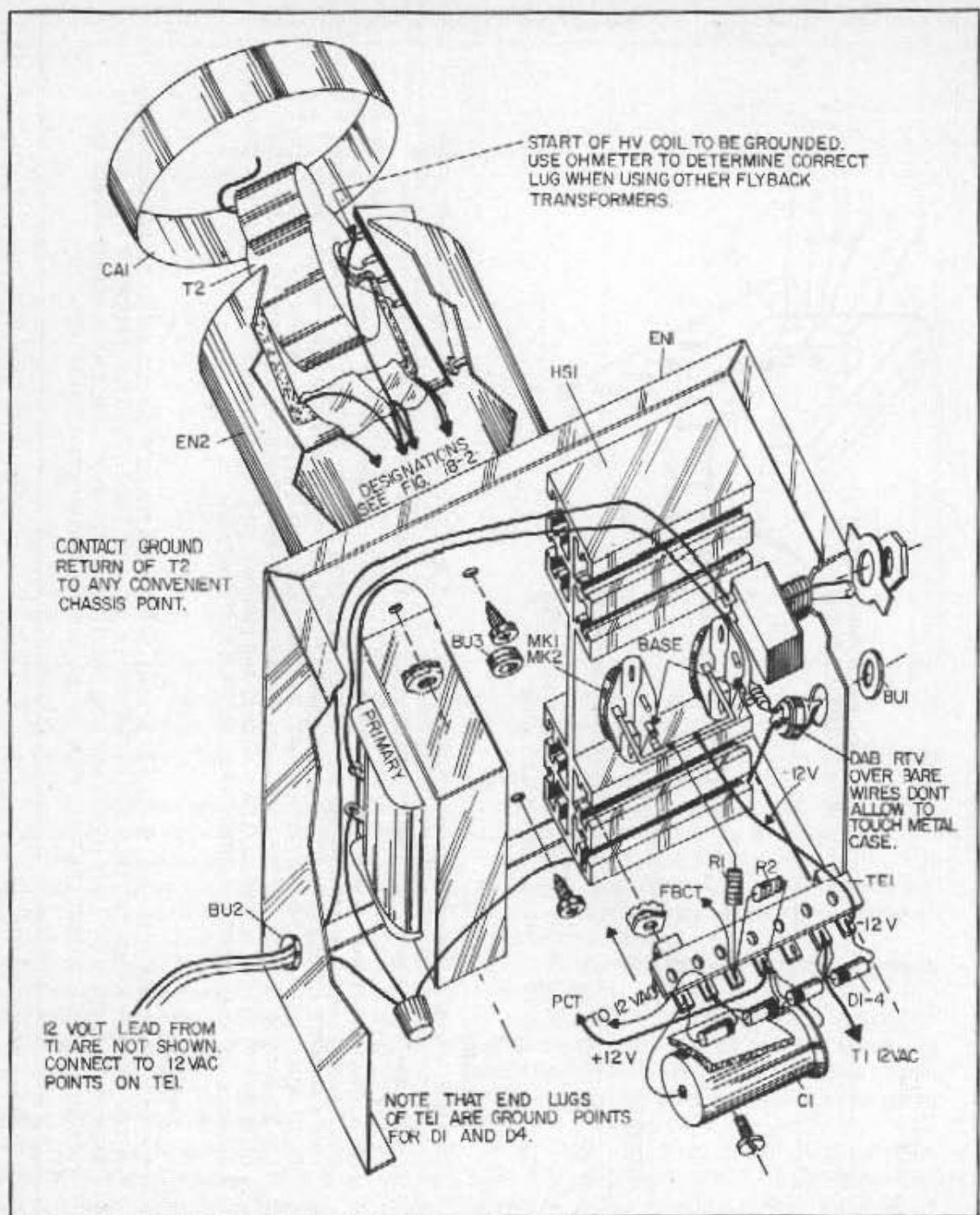


Fig. 18-3. Assembly sketch blowup.

AN INTERESTING EXPERIMENT WITH YOUR COIL IS TO OBTAIN A SMALL 15 TO 20 WATT FLUORESCENT LAMP AND OBSERVING IT TO GLOW WHEN BROUGHT NEAR THE OUTPUT TERMINAL. THIS IS CAUSED BY THE HIGH FREQUENCY ELECTRO MAGNETIC FIELD IONIZING THE GASES IN THE TUBE.

PLACE VARIOUS OBJECTS ON TOP OF THE TERMINAL AND NOTE THE DISCHARGE BEING MORE INTENSE FROM SHARP POINTED OBJECTS.

OUTPUT LEAD
TERMINATE AS DESIRED
PREFERABLE A ROUND
SMOOTH OBJECT, SUCH
AS A ONE PIECE METAL
DOOR KNOB.

LAB1 INTENDED MORE FOR
IMPRESSION RATHER
THAN SAFETY.

MAY BE OPERATED FROM A SMALL STORAGE BATTERY OR GEL CELL FOR PORTABLE OPERATION. BATTERY MUST BE CAPABLE OF 5 AMPS.

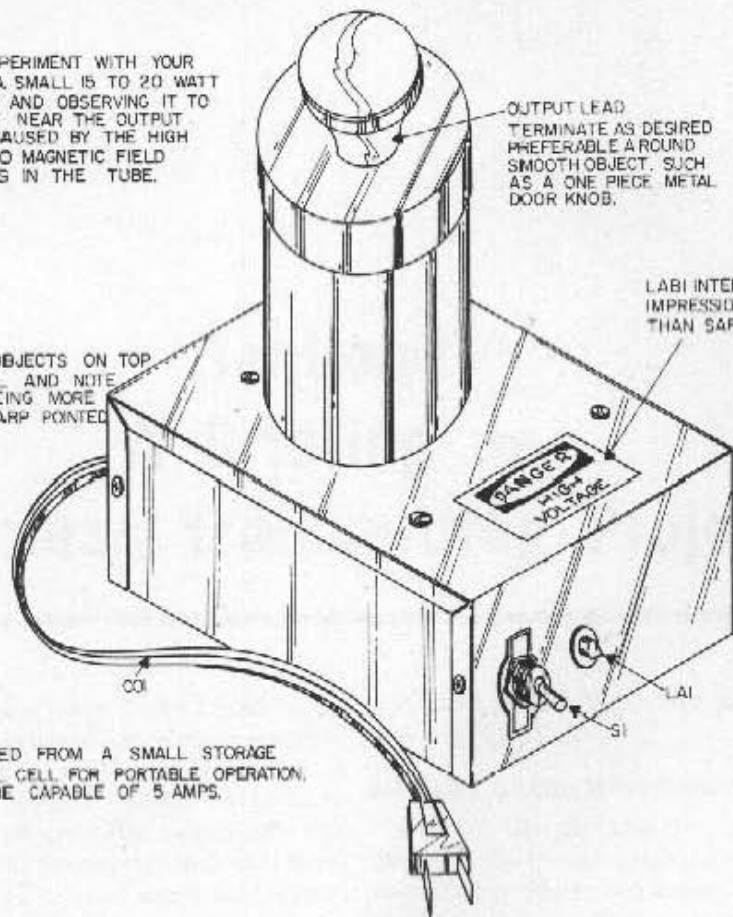


Fig. 18-4. Final assembly.

9. Tape and insulate all bare leads where possible shorting can occur. Check for wiring and shorts.

10. *The following should be done with a dc meter indicating current flow.* Apply power and immediately note that high voltage lead of T1 secondary (usually white lead with cap) emits a corona discharge (purplish sparks) when brought near ground. This should arc to about one inch. If the unit does not work, reverse wires FB1 and FB2, check

wire and soldering for accuracy, base and emitter leads of Q1 and Q2 reversed, improper mounting of transistors (without insulating mounting kits). Q1 and Q2 must be completely electrically insulated from the heatsink.

11. Once the unit is functioning properly, check the transistors for heating. You should be able to touch them with your finger after several minutes of operation. If not, a larger heatsink may be necessary for prolonged operation.