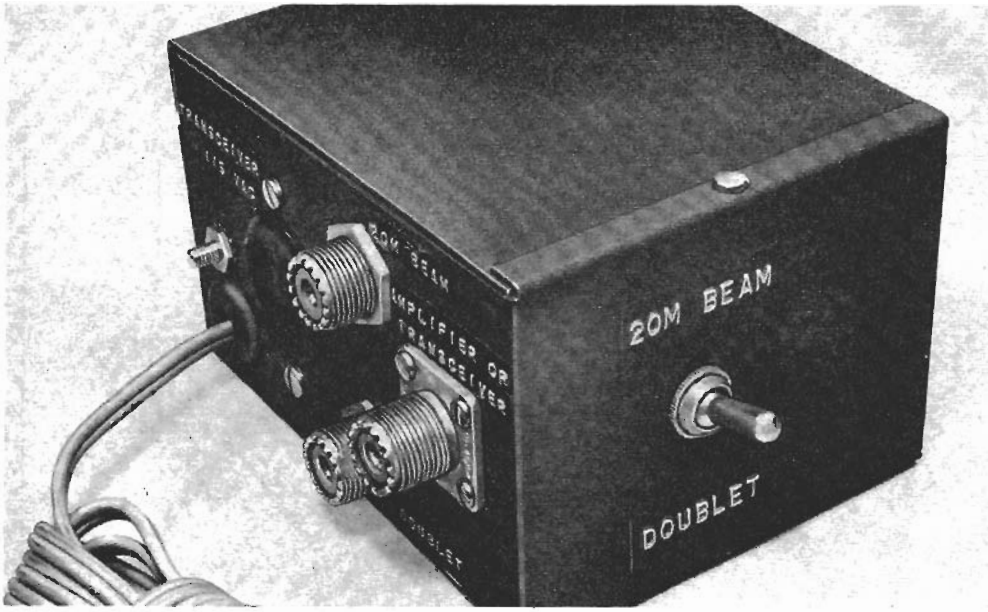


AUTOMATIC LIGHTNING PROTECTION

DON'T *zap* YOUR ANTENNA SYSTEM

BY HOWARD PHILLIPS

MOST HAMS FORGET, on occasion, to ground their antennas—or never even bother to provide a grounding facility—when they are not operating their rigs. These oversights or lack of foresight can have grave consequences before or during an electrical storm, causing a lot of good equipment to go up in smoke. There is no substitute for connecting an antenna to the earth ground common to the communications equipment for good protection against lightning damage.

Regardless of the quality of your present antenna grounding system, the automatic lightning protection system described here can reduce the possibility of your equipment's sustaining serious damage from lightning or static charge buildup. The operation of the system is automatic in the sense that turning on and off your transceiver is all that is required. So, you cannot forget to ground your antenna, since you are not likely to forget to turn off your transceiver when you are finished using it.

Lightning Effects. There are three basic effects of electrical storm activity that can cause damage to communications equipment.

First is static charge buildup on the antenna. This is not caused by a direct lightning "hit" on the antenna but by the same conditions which produce lightning. Static charge buildup occurs when an ungrounded antenna accumulates a large d.c. charge as a result of its coming

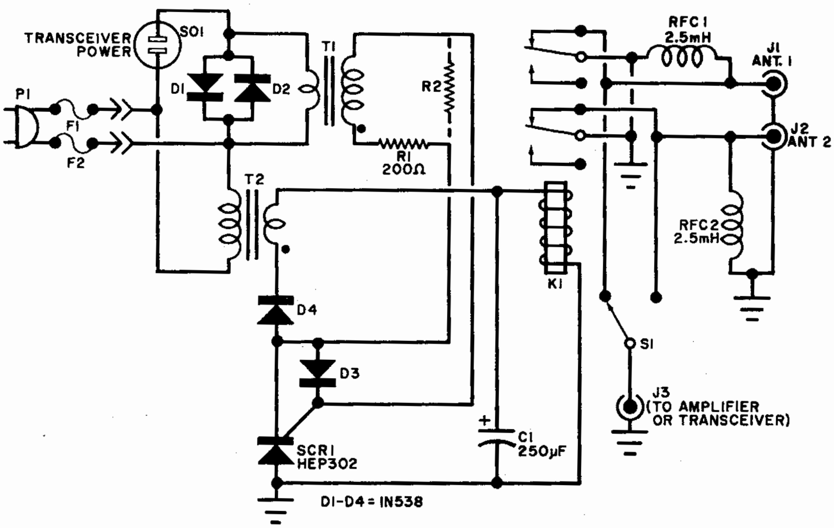


Fig. 1. Lightning protector features switching facilities for two antennas. Use fused plug for supplying power to obtain maximum lightning protection.

PARTS LIST

C1—250-μF, 50-volt electrolytic capacitor
D1-D4—1N538 diode
F1,F2—250-volt, 5-ampere fuse
J1-J3—Coaxial connector (Amphenol No. SO-239)
K1—9- or 12-volt a.c. or d.c. relay with 250-volt, 5-ampere d.p.d.t. contact arrangement
P1—117-volt fused male plug (fuses F1 and F2)
R1—200-ohm, ½-watt resistor
R2—Load resistor (see text)
RFC1,RFC2—2.5-mH, 20-mA radio-frequency choke
S1—S.p.d.t. switch with 250-volt, 5-ampere contacts
SCR1—150 PIV, 3-ampere silicon controlled rectifier (Motorola HEP302 or similar)
SO1—117-volt a.c. chassis-mounting receptacle
T1,T2—24-volt, 1-ampere filament transformer
Misc.—Metal utility box; hookup wire; solder; machine hardware; etc.

in contact with partially ionized air. The charge builds up a high d.c. potential between ground and the ungrounded antenna parts. The damage which can result is caused by over-voltage applied to the transmission line or to components in the front end of a transceiver.

The damage resulting from static buildup can be prevented by grounding all parts of the antenna system either directly or through a radio frequency choke (RFC). The RFC provides a low-resistance discharge path for the d.c. charge but does not affect normal antenna operation. The static charge buildup is greatest during the early stages of a storm, before any rainfall occurs. Consequently, equipment damage can occur before clouds or other storm symptoms appear.

The second effect of an electrical storm which can cause equipment damage is important when lightning strikes nearby but misses hitting the antenna. In this case, high transient voltages can be induced in the antenna and transmission line. These transient voltages have a short duration but can be the cause of extensive damage due to their r.f. effect. A RFC to ground offers no protection against these r.f. voltage transients. The only effective protection is good, direct earth grounding.

The third and final effect is that of the direct hit by lightning. This, of course, is the most damaging of the effects discussed. A direct earth ground is the best possible protection against the damage to the antenna system caused by a direct hit, but some damage can occur even when the antenna is connected directly to ground.

About The Circuit. Shown in Fig. 1 is the schematic diagram of the automatic lightning protection system. Notice that there is a facility (switch *S1*) to switch into the circuit either of two antennas. Jacks *J1* and *J2* should be r.f. coaxial type connectors.

Radio frequency chokes *RFC1* and *RFC2* provide protection against damage from static charge buildup on either antenna. Relay *K1* shorts both antennas directly to ground when the transceiver, connected to a.c. receptacle *SO1*, is turned off or when a power failure occurs.

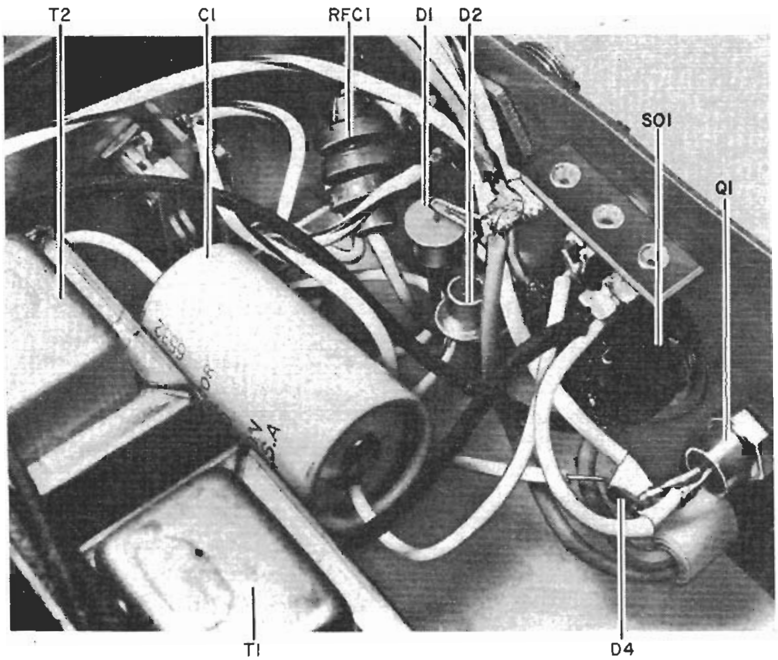
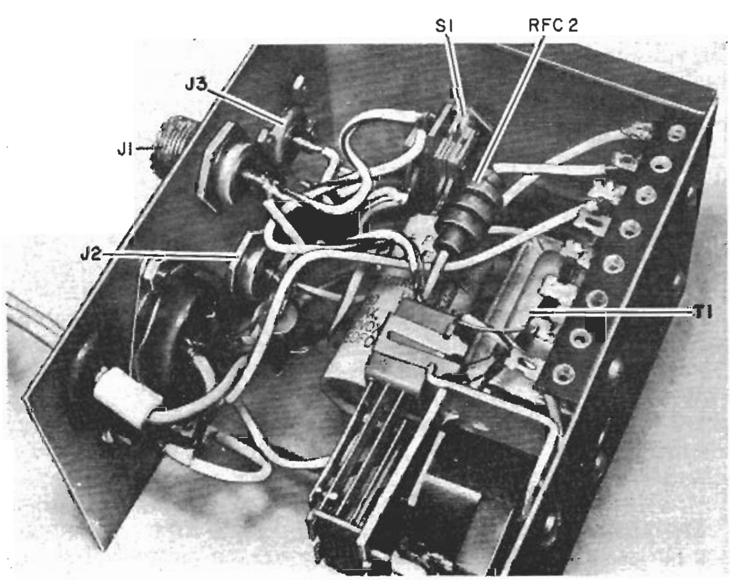


Fig. 2. Component mounting is best accomplished if ends of chassis are bent slightly outward during machining and chassis wiring.



The current threshold detector circuit made up of *D1*, *D2*, and *T1* controls the power delivered to the solenoid of *K1*. The voltage drop across monitoring diodes *D1* and *D2* is on the order of 1.5 volts peak-to-peak and is independent of the power required by the transceiver. The square-wave voltage drop across the diode pair is coupled through transformer *T1* to silicon controlled rectifier SCR1.

Resistors *R1* and *R2* form a voltage divider which determines the amplitude of the triggering signal delivered to the gate of *SCR1*. The value of R2 depends on the sensitivity of *SCR1* and the power required by the transceiver when turned off (some transceivers contain a heating element which operates continuously).

When the transceiver is turned on and the voltage applied to the gate of *SCR1* is sufficient, the SCR turns on and voltage is applied to the coil of *K1* through rectifier diode *D4*. Diode *D3* insures that excessive reverse bias is never applied to the gate of *SCR1*. The transformer phase relationships, indicated by the dots in the schematic diagram, are required to provide d.c. power to *K1*'s solenoid.

The voltage applied to *K1* is half-wave rectified d.c. with some ripple content (C1 provides filtering). Because of voltage drops across *D4* and *SCR1*, the relay voltage is typically between 5 and 20 volts, depending on the d.c. resistance of the relay coil. Hence, a 9- or 12-volt relay will work well. An a.c. or a d.c. coil can be used, since the ripple content of the voltage is low enough to prevent relay "chatter."

Construction. Component placement in the metal utility box is shown in Fig. 2. To facilitate machining and project assembly, it is suggested that you bend outward the ends of the utility box. Then parts mounting and connection can be quickly accomplished.

Leads carrying r.f. power should be kept as short as possible so that the transmission line standing wave ratio (SWR) will not be adversely affected. Also, the relay should not be mounted too close to the transformers unless the transformers have reasonably good magnetic shielding.

The phasing of the transformers need not be known during assembly since no component damage will result from a wiring error. If the assembled project will not unground the antennas when transceiver power is turned on, the leads from any pair of the four transformer lead pairs can be reversed to provide proper phasing.

The anode (mounting stud) of *SCR1* is at ground potential in this project to obviate the need for special insulating hardware. A fused power plug is recommended because it provides more protection from damage due to over-voltage which can be caused by a hit by lightning on the power line.

A special note is in order here. The circuit shown schematically in Fig. 1 should first be wired without *R2*. When the turned-off transceiver is plugged into *SO1*, *K1* should not unground the antennas. If it does, a potentiometer can be connected across the secondary of *T1* to determine the value of *R2* required to cause *K1* to trip only when the transceiver is turned on.

Checkout and Use. If both an amplifier and a transceiver are to be used, the amplifier output should be connected to the lightning protector via *J3*. Standing wave ratio measurements should be made with the project in and out of the antenna system to insure that the quality of construction is adequate. There should be no detectable difference between your SWR readings.

The antenna-switching capability of the lightning protector is more than adequate to handle any 1-kW transmitter. With proper construction techniques, the antenna switch can be used to switch any transmitting antenna operating in the frequency range between 3.5 and 30 MHz.

The project provides more than adequate protection against damage from static charge buildup on the antennas, even when the transceiver is switched on. When the transceiver is off, full protection against voltage transients on the antennas is automatically provided and the antennas are automatically grounded via the relay contacts. So some protection—although not complete—against damage caused by direct lightning hits is also provided.

Antenna ungrounding requires 117-volt a.c. line power to trip *K1*. Consequently, a power failure insures that the antenna will automatically be grounded. –30–