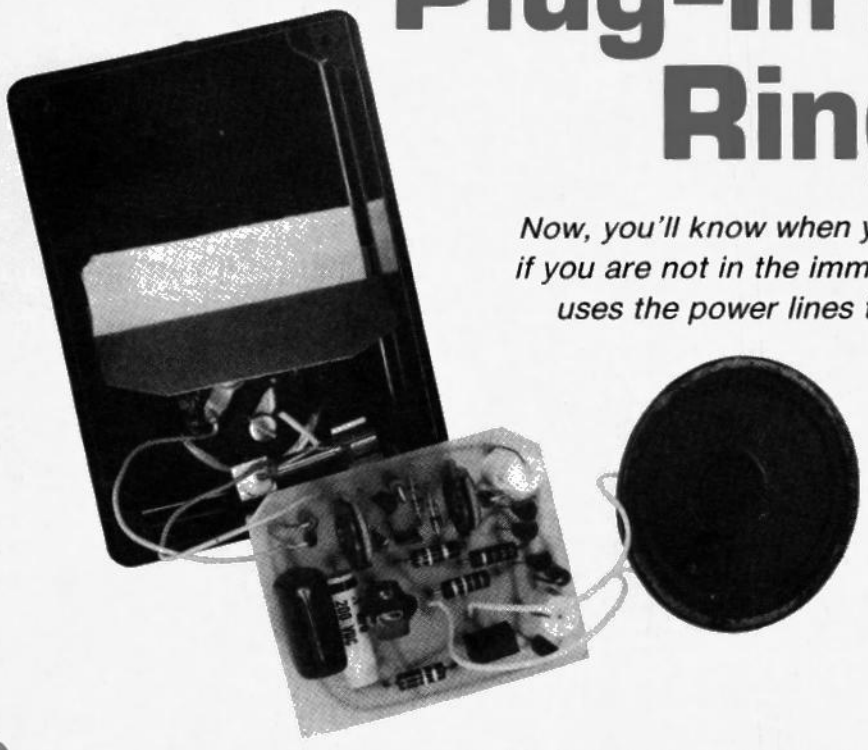
Plug-In Remote Ringer

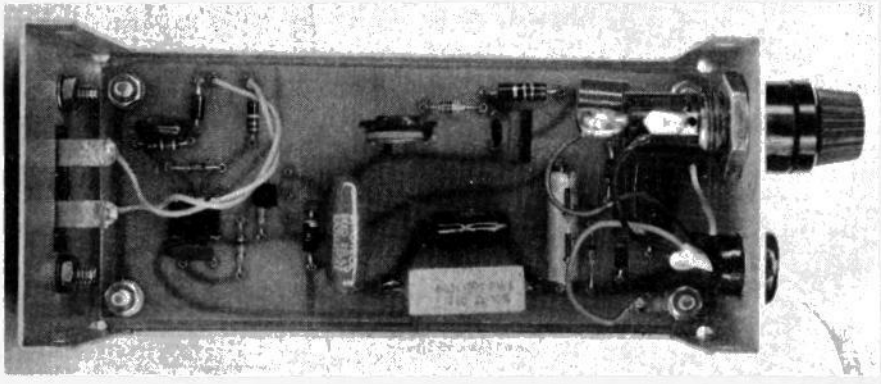


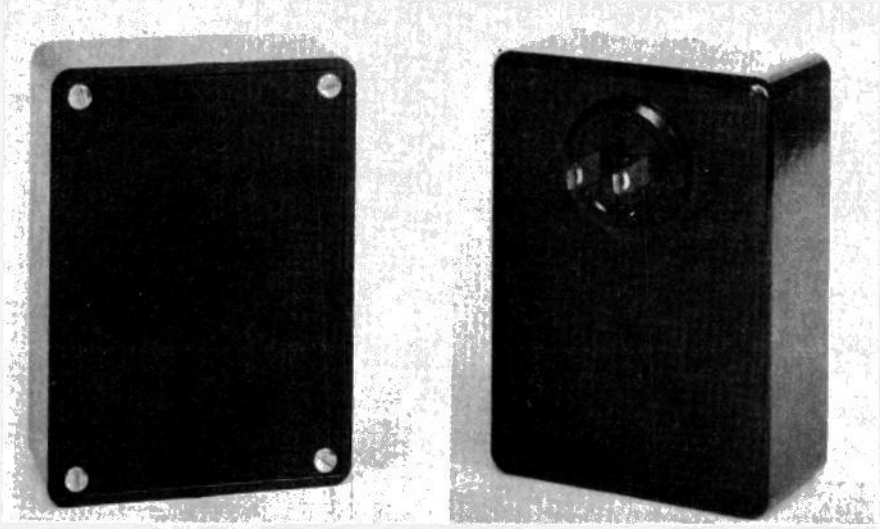
Now, you'll know when your telephone is ringing even if you are not in the immediate vicinity. Wired-wireless uses the power lines to trigger the remote ringer

R.K. ATWOOD

HAVE YOU EVER FELT TIED DOWN TO YOUR telephone waiting for an important call but afraid to miss it if you left the immediate area? This remote telephone ringer will prevent a lost call, yet allow you to work in the garage, lounge by the pool or even visit a neighbor for coffee.

The device consists of a ring detector connected to the telephone line. When the telephone rings, the ring detector impresses high-frequency pulses on the AC power line. A receiver placed anywhere on the same power line detects these pulses and emits an audible tone in synchronization with the telephone signal.





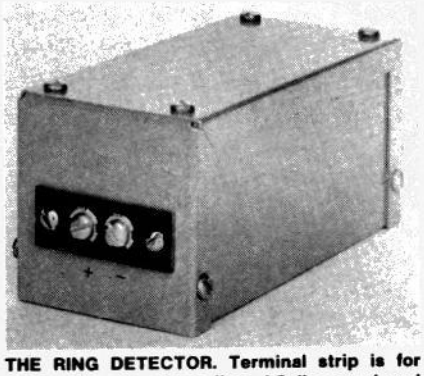
How it works

Figure 1 shows the schematic diagram of the ring detector. Power for the ring detector is derived from the 117-volt AC line by C1, D1, D2 and C2. Diode D3 prevents the supply voltage from exceeding the voltage limits of IC1, a low input-current optic isolator. The ringing signal from the telephone line forward-biases the isolator LED, and the internal Darlington-pair provides the bias to turn on Q1. Integrating capacitor C4 slows the isolator response. The collector current of Q1 operates relay RY1.

Setting R7 controls the turn-on bias of Q2, which is a sensitive-gate SCR (*Silicon-Controlled Rectifier*). The C5–R5 network allows Q2 to turn on and off rapidly at about a 2-kHz rate, providing

a series of pulses near the positive peak of the 60-Hz line voltage. The amplitude of the higher harmonics of these pulses applied to the power line is limited by L1.

The line receiver shown in Fig. 2 has a DC voltage at point A of about 100. Under nonringing conditions, the voltage at point B is held to about 10 by the voltage divider consisting of R3 and R4. Base bias to Q3 is provided by R7, holding its collector saturated and preventing gate turn-on bias from being applied to SCR Q6.



THE RING DETECTOR. Terminal strip is for connections to phone line. AC line cord and fuse post are on other end.

The incoming 2-kHz pulses on the power line are applied across L1 and R2 via C2. Resistor R2 varies the pulse amplitude. It is the amplitude of these pulses that turns on Q1. The collector pulses of Q1 are rectified by D2 and D3, resulting in a staircase DC voltage appearing across C4. Eventually this potential reaches a value sufficient to forward-bias Q2, which then saturates and removes the turn-on bias from Q3.

Resistor R8 then provides gate drive to Q6, which turns on at a 60-Hz rate. The speaker sees a series of narrow 60-Hz high-harmonic pulses. The voltage at the junction of R9–R10 holds Q4 in saturation. When a signal voltage appears at the collector of Q1, the base-emitter voltage of Q4 is lowered. At the same time, C4 charges in a staircase fashion, and C5 integrates the turn-on voltage.

The slow charge rate of C4 provides high immunity to power-line transients. In several months of operation, no false triggering has occurred, even with the deliberate introduction of high line-noise levels with SCR dimmers, drill motors, etc.

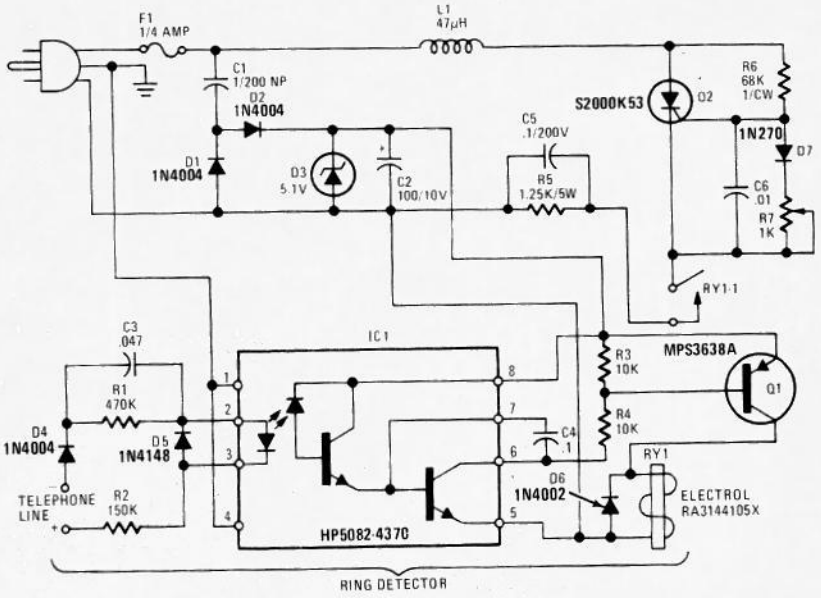


FIG. 1—RING DETECTOR uses an optical isolator to isolate the telephone line.

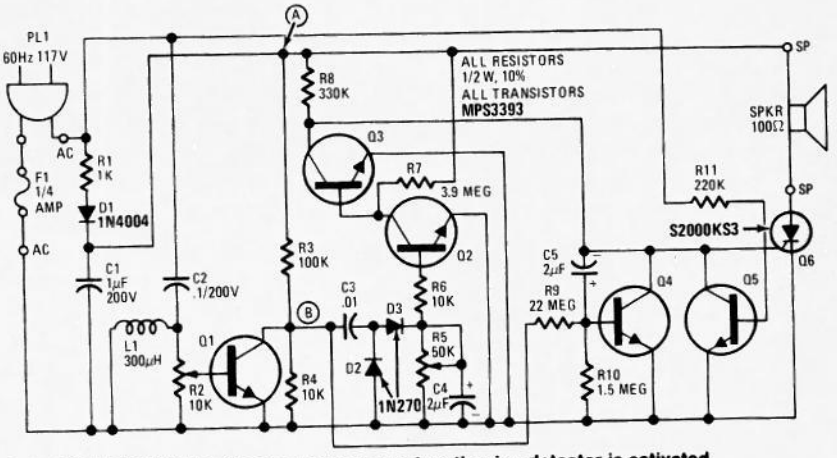


FIG. 2—LINE RECEIVER emits an audible tone when the ring detector is activated.

All resistors are ½-watt, 10%, unless noted.

Line receiver:
R1—1000 ohms
R2—10,000 ohms, ¼-watt trimmer (CTS X201R103B or equiv.)
R3—100,000 ohms
R4–R6—10,000 ohms
R5—50,000 ohms, ¼-watt trimmer (CTS X201R503B or equiv.)
R7—3.9 megohms
R8—330,000 ohms
R9—22 megohms
R10—1.5 megohms
R11—220,000 ohms
C1—1 μF, 200 volts, Mylar
C2—0.1 μF, 200 volts, Mylar
C3—0.01 μF, 50 volts, Mylar
C4, C105—2 μF, 50 volts, electrolytic
L1—300 μH RF choke
Q1–Q5—MPS3393 (Motorola)
Q6—S2000KS3 (ECC-Teccor) sensitive gate SCR
F1—AGC, ¼ amp
PL1—chassis mount male AC connector (Amphenol 61P or equiv.)
Speaker—Miniature, 100 ohms
Case—1⁹⁄₁₆ × 2⅞ × 4-inches (Keystone No. B703PK or equiv.)

Ring detector:
R1—470,000 ohms, ¼ watt
R2—150,000 ohms, ¼ watt
R3, R4—10,000 ohms, ¼ watt
R5—1250 ohms, 5 watts, WW
R6—68,000 ohms
R7—1000-ohm ¼-watt trimmer (CTS X201R102B or equiv.)
C1—1 μF, 200 volts, Mylar
C2—100 μF, 10 volts, electrolytic
C3—0.047 μF, 50 volts, Mylar
C4—0.1 μF, 50 volts, Mylar
C5—0.1 μF, 200 volts, Mylar
C6—.01 μF, 50 volts, Mylar
D1, D2, D4—1N4004
D3—5.1 volts, 400-mW Zener
D5—1N4148
D6—1N4002
D7—1N270
Q1—MPS3638A (Motorola)
Q2—S2000KS3 (ECC-Teccor)
IC1—5082-4370 (Hewlett-Packard)
F1—AGC, ¼ amp
L1—47 μH, RF choke
RY1—reed relay (Electrol RA3144105X or equiv.)
Case—2¼ × 2¼ × 5-inches aluminum (Bud CU2104A or equiv.)
Misc.—fuseholder, 3-wire line cord, terminal strip, ¼-inch No. 6 spacers.

The following parts are available from R.K. Atwood, 11010 159th E, Redmond, WA 98502:

Line receiver kit, order No. LR, consisting of PC board, $5.00

Ring detector Q6, order No. LT, consisting of PC board, IC1, Q2 and RY1, $10.30.

Washington residents add 5.2% tax.

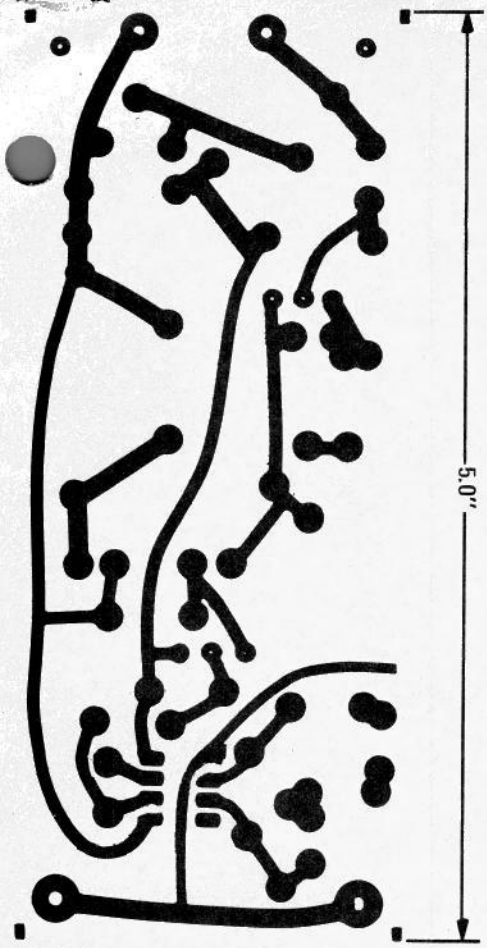


FIG. 3—FOIL PATTERN of the ring detector PC board shown full size.

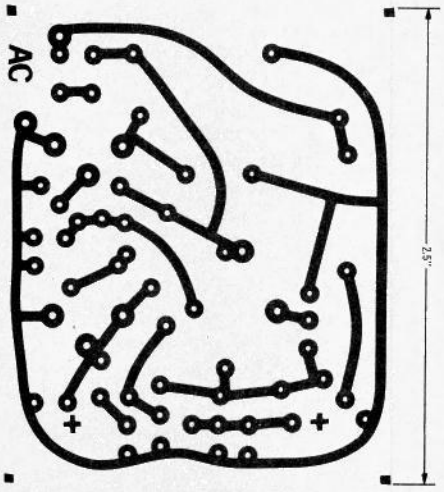


FIG. 5—FOIL PATTERN of the line receiver PC board shown full size.

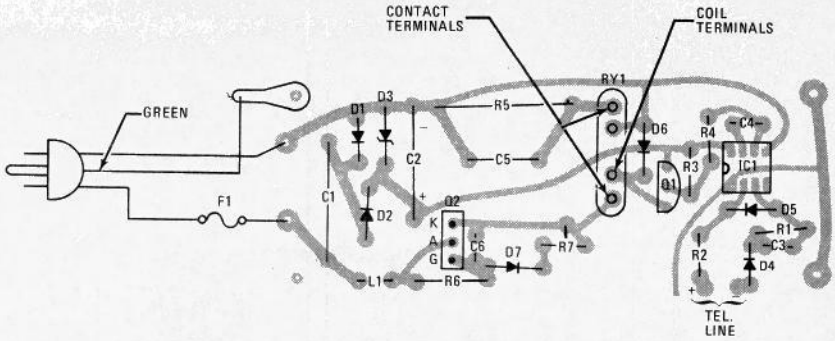


FIG. 4—COMPONENT PLACEMENT diagram for the ring detector PC board.

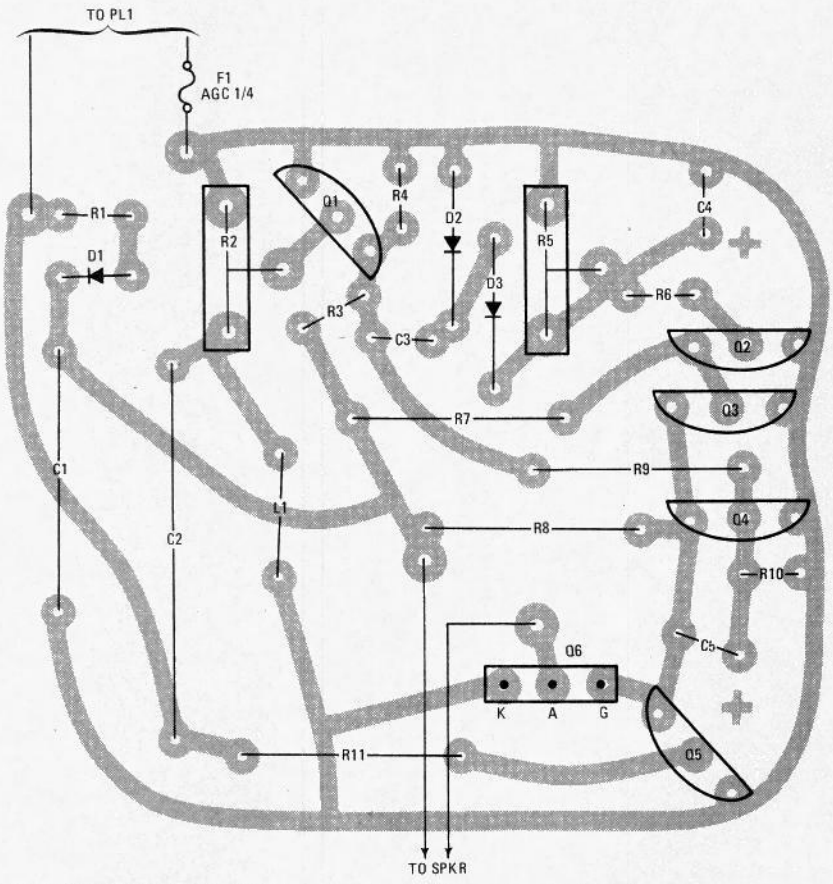


FIG. 6—COMPONENT PLACEMENT diagram for the line receiver PC board.

Construction

The foil pattern for the ring detector PC board is shown in Fig. 3. Use this board to locate the mounting holes in a $2\frac{1}{4} \times 2\frac{1}{4} \times 5$-inch aluminum chassis. Mount all parts on the board, using the component placement diagram of Fig. 4, being especially careful of the orientation of Q2, as well as the other polarity-sensitive components. Use a three-wire power cord and connect the green ground wire via a solder lug to one of the mounting screws at the C1 end of the board. This provides a ground for faulty power wiring and also grounds pins 1 and 4 of IC1, placing an earth ground between the power-line and telephone-line connections.

The line receiver case measures $1\frac{9}{16} \times 2\frac{7}{8} \times 4$-inches and accommodates the circuit board and speaker. Be sure to drill the power plug hole as high as possible, allowing room for its attachment ring. The circuit board will fit crosswise at the other end of the case. Attach wires about 6-inches long for power-line connections and about 3-inches long for the speaker connections to allow the board to extend outside the case for setting R2 and R5. The wires should be of different colors for easy identification. The foil pattern for the line receiver PC board is shown in Fig. 5, and the parts placement diagram is shown in Fig. 6.

Calibration

Adjusting the ring detector is simple but because a direct power-line connection is involved, take proper precautions. Connect an oscilloscope with a ground-isolating adapter on its power cord to the ring detector circuit board. Connect the scope ground to C2's negative lead and the vertical input to the junction of F1–C1. Set the scope controls to display a 60-Hz 200-volt P-P signal. Connect an insulated jumper between R5 and R7 to place a short across the relay contacts. Make no connection at this time to the telephone line.

Set R7 to midrange and apply power to the circuit. Adjust the scope controls to show the positive peak of the line input. A series of pulses of about 15- to 40-volts P-P will appear on this positive AC as R7 is adjusted. Set R7 carefully until 10 to 13 pulses are present. Remove one end of

the jumper between R5 and R7 and reconnect it while observing the pulse pattern. If the pulse pattern does not reappear, adjust R7 slightly, in the direction that lowers the number of pulses, until the pulses appear every time the connection is made. When R7 is set, remove the power from the circuit and disconnect the oscilloscope.

Referring to Fig. 6, on the line receiver set R2 near maximum and R5 at about three-fourths of maximum. Connect the scope ground to the power-line side that

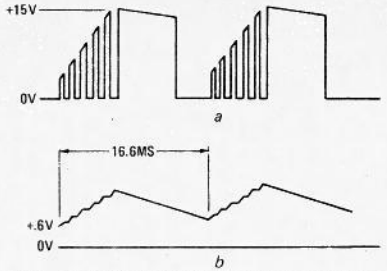


FIG. 7—THESE WAVEFORMS should be obtained during the calibration procedure. See text.

receiver in the farthest possible outlet to insure a satisfactory setting of R5. The power-line pulse level may be temporarily reduced by connecting a 1-μF, 600-volt paper capacitor across the line while adjusting R5.

Put the receiver in its case after R5 is set. Place a piece of insulating paper across F1 and the power plug, then position the circuit board in the lower part of the case. The speaker should be placed over a small piece of foam rubber so that it is pressed securely against the case

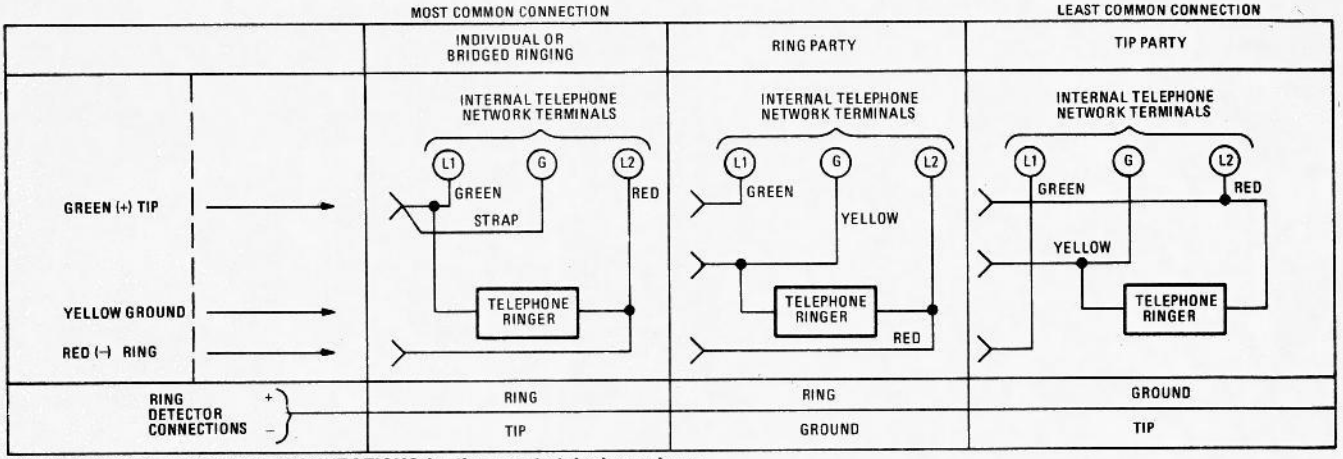


FIG. 8—TYPICAL TELEPHONE CONNECTIONS for the remote telephone ringer.

is common to all transistor emitters and the vertical input to point B. Set the vertical-input controls for a 20-volt P-P signal with DC ground at the bottom of the display. Connect power to the receiver and ring detector circuits.

Reconnect the jumper between R5 and R7 on the ring detector. Adjust R22 until the display shown in Fig. 7-a appears. Now connect the scope input across C4, and adjust the scope to display a 2-volt P-P signal. Disconnect the jumper between R5–R7. The scope pattern shown in Fig. 7-b should appear. After C4 charges up past the base-emitter voltage of Q2, the speaker will sound off. It may be advisable to wrap a piece of foam rubber around the speaker to lower the noise during testing. Adjust R5 until the speaker sounds off reliably when the R5–R7 connection is made. Resistor R5 serves as a sensitivity control, with R2 rarely needing more than initial adjustment.

Telephone connections

The ring detector is now ready to be connected to the telephone line. With a VOM set to the 50-volts DC or higher scale, measure the telephone-line polarity. Then connect the line to the circuit input so that D4 is reverse-biased. If D4 is not reverse-biased, the normal on-hook line voltage will probably keep the ring detector on continuouly. Figure 8 shows the correct tip-to-ground or ring-to-ground connections.

It should not be too difficult to place this unit into operation. As many line receivers as needed can be used but only across the same power line. Thus, the ringer would work when connected to one neighbor's house, but not to another on a different transformer secondary. Test the cover when the unit is being used. For safe operation, do not mount the speaker or circuit board with any metallic protrusions through the case.

The speaker holes should be centered above the speaker. The prototype has 18 holes, $^3/_{32}$-inch diameter, drilled in a grid pattern and covered with a thin cloth glued to the bottom surface of the panel. Since the power rating of most small 100-ohm speakers is limited, wrap foam rubber around the speaker to provide acoustic loading during testing. Do *not* enlarge the number or size of the holes.

The system could be used in alarm setups. However, any relay contacts that turn on the ring detector must be fully isolated, since full power-line voltage will appear across them. If a 2N5060 or a type C106 SCR is substituted for Q2, capacitor C5 should be changed to a 0.33-μF, 200-volt unit. **R-E**