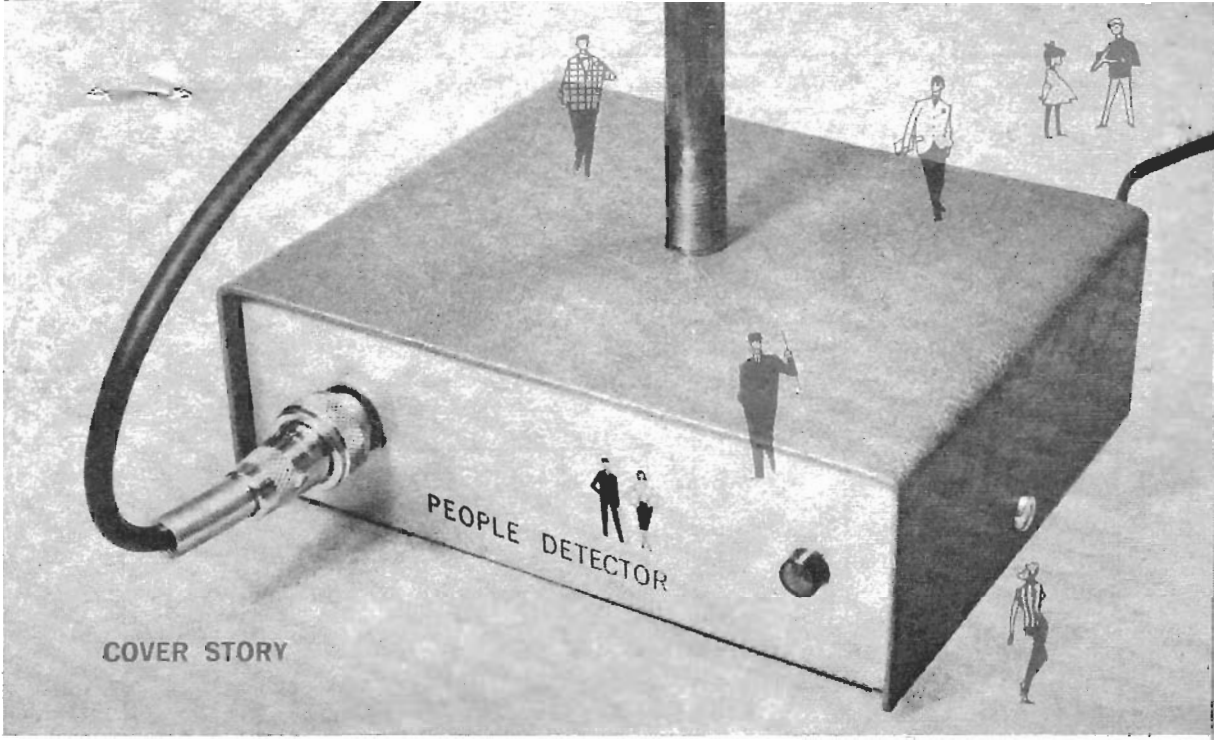


COVER STORY

The Amazing "PEOPLE DETECTOR"

BUILD A 1968 MODEL OF THE FAMOUS PROXIMITY RELAY— 100% PASSIVE— OPERATIONALLY STABLE— 3-FOOT RANGE

BY LOUIS E. GARNER, JR.

THERE ARE many ways to detect the presence of a person by means of electronic techniques such as ultrasonics, light beams (both visible and ultraviolet), microwave radar, r.f. capacitance relays, etc. All of these systems, however, suffer from a common disadvantage—they either radiate or emit some form of signal, and therefore leave themselves open to detection—and circumvention—by skilled intruders having a good working knowledge of electronics.

The tables are now turned, and even the most talented intruder is in for an unpleasant surprise when he comes up against the amazing "People Detector," shown both on the front cover and in the photo above. An entirely *passive* device which does not radiate or emit any type of signal, it cannot be detected or circumvented by conventional means.

Under maximum sensitivity conditions, the "People Detector" can respond to a person coming within several feet of its sensor antenna; and, once discovering an intruder within its protective field, it can sound an alarm, summon a guard, actuate machinery, turn the lights on, op-

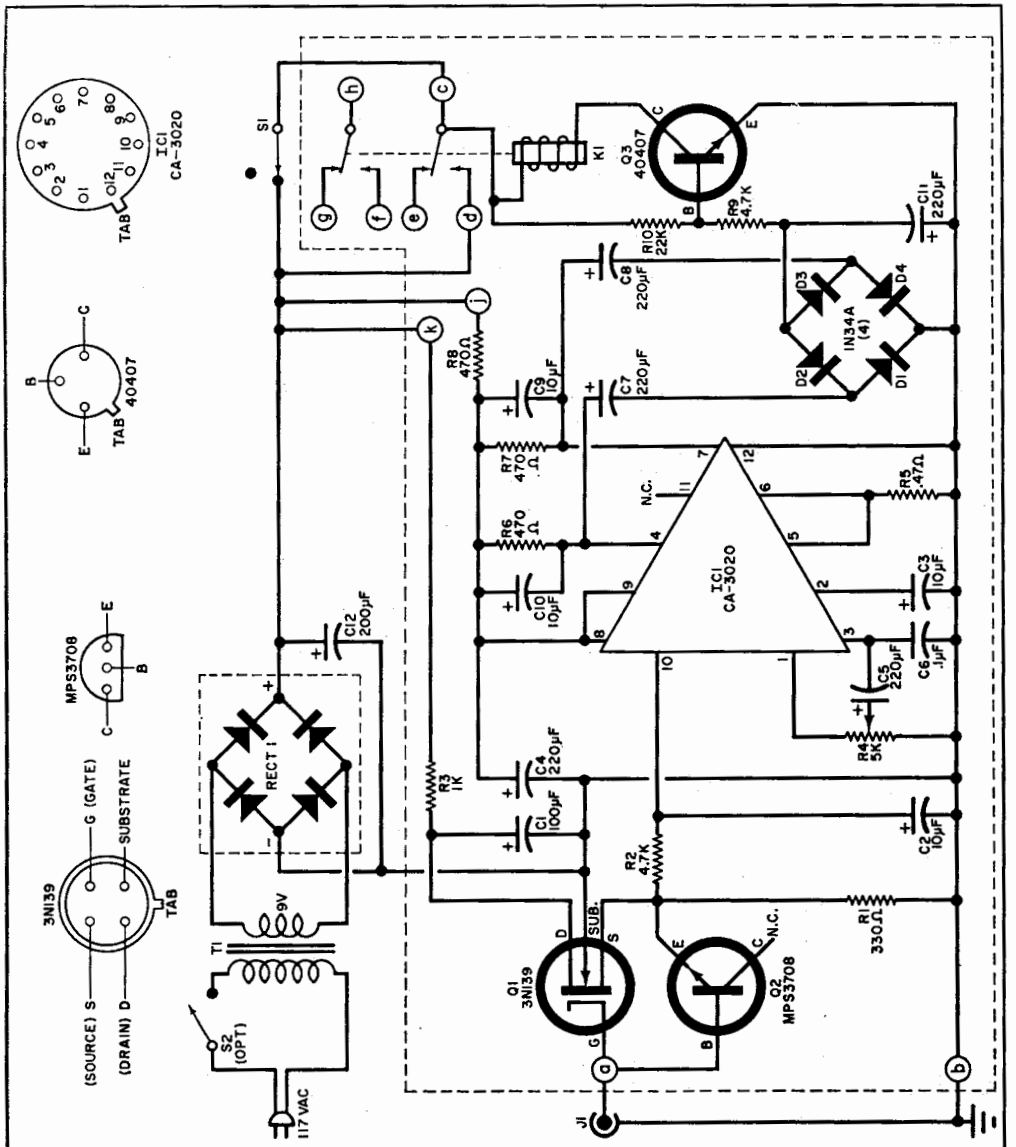


Fig. 1. Because the input impedance is many megohms, do not locate the sensor antenna near any source of r.f. noise, as operational range will be reduced. The metal antenna can be any shape desired.

erate a counter, release tear gas, or perform any task that can be "activated" by an electrical signal.

If desired, the sensitivity can be reduced so that the effective range of the "People Detector" is measured in inches, and the device can then be used as a proximity control for advertising displays, automatic door openers, as a safety or manufacturing control for industrial equipment, as a limit control, and in dozens of other ways. It will even detect the presence of large animals and can serve as a trigger for a flash camera in wildlife photography.

Construction. DO NOT remove the eyelet surrounding the MOSFET leads until instructed to do so later in the text. The "People Detector" circuit in Fig. 1 should be constructed on a printed circuit board such as that shown full size in Fig.

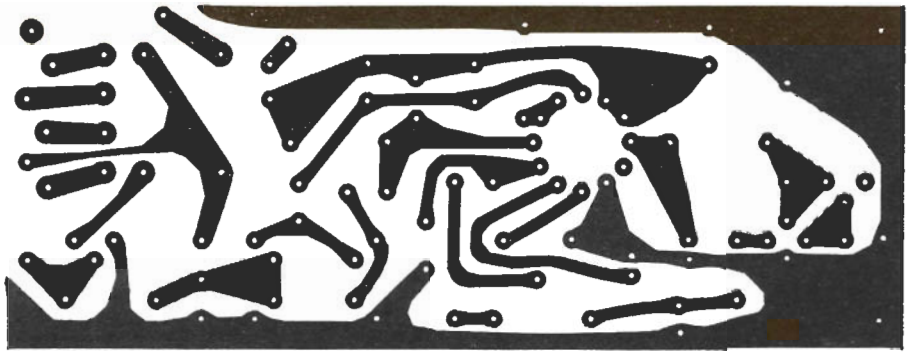


Fig. 2. This actual-size PC board foil layout should be made on a glass-epoxy board, rather than paper-phenolic, to reduce the possibility of poor operation due to stray leakage paths.

PARTS LIST

C1—100-μF, 15-volt electrolytic capacitor
C2, C3—10-μF, 15-volt electrolytic capacitor
C4, C5, C7, C8, C11—220-μF, 6-volt electrolytic capacitor
C6—0.1-μF, 12-15 volt disc ceramic capacitor
C9, C10—10-μF, 25-volt electrolytic capacitor
C12—200-μF, 15-volt electrolytic capacitor
D1, D2, D3, D4—1N34A general-purpose germanium diode
IC1—Linear integrated circuit amplifier (RCA CA-3020)
J1—Coaxial microphone jack (Amphenol 75-PC1M, or similar)
K1—D.p.d.t. relay, 12-volt, 40 mA coil
Q1—3N139 n-channel MOSFET (RCA)
Q2—MPS 3708 npn transistor (Motorola)
Q3—40407 npn transistor (RCA)
R1—330-ohm, ½-watt resistor
R2, R9—4700-ohm, ½-watt resistor
R3—1000-ohm, ½-watt resistor
R4—5000-ohm trimmer potentiometer (CTS X-201, or similar)
R5—0.47-ohm, ½-watt resistor
R6, R7, R8—470-ohm, ½-watt resistor
R10—22,000-ohm, ½-watt resistor
RECT 1—Bridge rectifier assembly, 2 amp (Varo VS-148, or similar)
S1—S.p.d.t. slide switch
S2—S.p.s.t. switch (optional)
T1—Power transformer: primary, 117 volts; secondary, 9 volts, 100 mA (Southwest Technical Products Corp. P9-1 or similar)
Misc.—Etched circuit board, four-lead transistor socket, line cord and plug, antenna plate (copper-clad PC board), short length of RG-58/U coax cable, coaxial microphone connectors (male and female), female chassis-mount line receptacle, 117-volt neon-lamp assembly (with internal resistor), small metal case (approx. 4½" x 6" x 2"), screws, nuts, wire, solder, etc.*
Optional—Lock-type s.p.s.t. power switch, alarm bell or buzzer, alarm power supply, heavy-duty 12-volt battery, power relay

**A pre-etched and drilled circuit board is available from Southwest Technical Products Corp., 219 W. Rhapsody, San Antonio, Texas 78216 for $2.65 postpaid. A complete kit, including circuit board and cabinet, less optional accessories, is available for $18.50.*

2. Use a glass-epoxy base copper-clad board rather than the more common paper-phenolic type to avoid leakage which may reduce sensitivity or impair operation. Remember that you are dealing with a very high input impedance circuit.

Install all the components except *Q1*, after first making sure that the polarity of the semiconductors and electrolytic capacitors are correct, as shown in Fig. 3. Mount a conventional four-lead transistor socket at the *Q1* position.

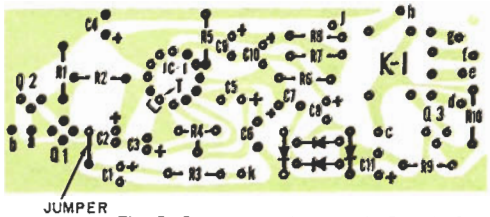


Fig. 3. Component layout of "People Detector." Use transistor socket for Q1.

After the other components have been mounted, and the circuit double-checked, remove the eyelet from *Q1*'s leads, and slip the transistor into the socket, avoiding contact with the gate lead. If possible, install the substrate and source leads first. Once mounted in its socket, *Q1* is protected by *Q2*

For optimum performance, the PC board should be mounted on four short standoff spacers (one at each corner), in a shielded metal housing. A good-quality coaxial microphone jack is used for *J1*. In the author's model, the *K1* "h" and "g" contacts switch a.c. power to a con-

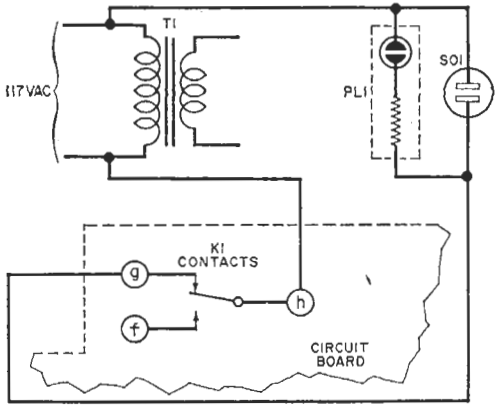


Fig. 1. One method of connecting a power outlet socket to relay K1. PL1 indicates power condition.

ventional a.c. receptacle mounted at the rear of the metal cabinet. This wiring is shown in Fig. 4. A 117-volt neon lamp pilot light assembly (with internal resistor) can be connected in parallel with this outlet to indicate when the outlet is activated.

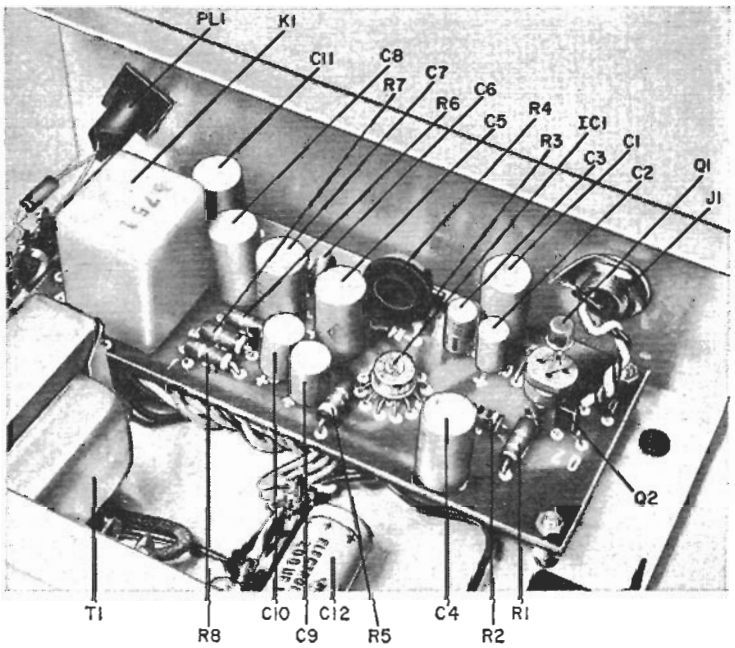
Almost any antenna configuration can be used, ranging from a short length (10″ to 12″) of wire attached directly to the *J1* center terminal to a small metal plate connected to *J1* via a short length of low-capacitance coaxial cable, such as RG-58/U. Only the center lead connects the metal plate to the center terminal of *J1*, so make sure that the coax braid makes contact *only* at *J1*. The metal plate (or copper-clad PC board if you prefer), can range from two to eight inches square, and shape is unimportant.

Several factors determine the maximum sensitivity that can be attained in a given installation: antenna size (metal plate area), connecting coax cable length, and the amount of a.c. "noise" present. As a general rule, the larger the antenna plate and the shorter the connection cable, the greater the instrument's sensitivity. Where possible, the coax cable length should be kept under three feet.

The power supply can be mounted in the same case as the instrument using conventional point-to-point wiring.

Adjustment. Under ideal conditions, and with a moderately large antenna, the unit will respond to a person's movements at a distance of up to eight to ten feet (with *R4* set to maximum sensitivity). In some cases, it may be difficult to achieve this range due to local electrical interference, *i.e.*, local radio transmitters, fluorescent or neon lamp noise, motor noise, or any type of arcing. In such a case, the range may be reduced to three or four feet.

Once the system has been installed,



The neat layout within the device contributes to its excellent operation. Unidentified resistor at far left is the current-limiting resistor selected for operation of the neon lamp (PL1). The relay shown here is a Price Electric 226-24P (furnished with kit), although any other 12-volt, 40-mA coil d.p.d.t. relay can be used with external wiring from the PC board.

adjust *R4* for the desired control range. Move toward (and away from) the antenna sensor plate to activate the instrument. If you require a limited range—2″ to 18″ for proximity control purposes—no difficulties should be encountered. On the other hand, if you are seeking maximum range for intruder alarm or safety control applications and find that adjusting the sensitivity control (*R4*) for maximum gain causes relay *K1* to chatter, you must relocate the antenna plate, use a small antenna, or reduce the gain.

Modifications. Although the author does not recommend changes in the basic circuit, a number of different power supply and output connections can be used to meet individual installation requirements.

For example, a battery (12-volt) can be used in place of the line-operated power supply. You would connect the battery positive lead to the positive input of the "People Detector" (Fig. 1) and the negative lead to the negative input.

The on-off switch (*S2* in Fig. 1) is an optional feature and can be replaced

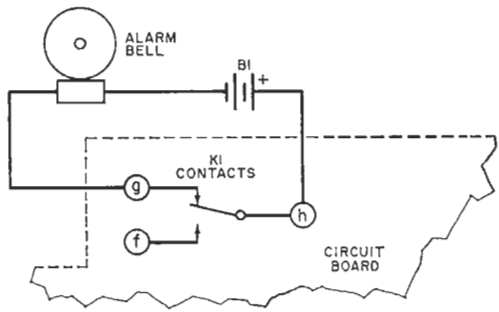
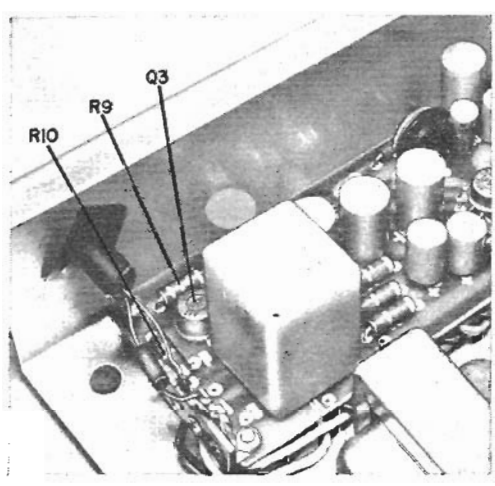


Fig. 5. A remote bell, or other alarm, with its associated battery power can be connected as shown here.



Note location of the 40407 transistor (Q3). A terminal strip is used for neon lamp (PL1) connections.

HOW IT WORKS

The "People Detector" operates by detecting and responding to a *very small* change in its antenna-(sensor)-to-ground capacitance. This action is achieved by an input stage having a very high input impedance—in this case, an insulated gate field effect transistor, or IGFET, usually called a MOSFET, for metal oxide semiconductor field effect transistor.

The sensor antenna is directly connected to the gate of *Q1*, allowing a small static charge to accumulate on the gate. Note that the gate in a MOSFET is not directly coupled to the semiconductor; therefore, the accumulated charge on the gate (ignoring *Q2* for the moment) has no place to go and establishes a fixed bias. The gate charge determines the current flow between *Q1*'s drain (D) and source (S); therefore, any change in the value of gate bias produced by a person approaching the sensor antenna will cause a current flow through *Q1*. Bipolar transistor *Q2*, diode-connected between *Q1*'s gate and source electrodes, is not a functional part of the circuit, but only serves as a zener diode to prevent an excessive gate static charge which could damage the MOSFET.

The output signal from *Q1*, developed across *R1*, is coupled through a low-pass filter (*R2-C2*) to remove the possibility of triggering by nearby radio transmitters, and is passed to the input of an integrated circuit (*IC1*). This IC contains seven *npn* transistors, three diodes, and eleven resistors, which make up a high-gain, wide-band, general-purpose amplifier with push-pull output. The output signal from the IC is generated across *R6* and *R7*, and coupled via *C7* and *C8* to a bridge rectifier made up of *D1* through *D4*. The voltage present across capacitor *C11* will then be proportional to any change in the antenna-to-ground capacitance. Potentiometer *R4* determines the gain of the IC amplifier, hence is used as the sensitivity control.

"Fail-safe" performance is obtained by biasing relay driver *Q3* to its conducting state for normal operation, thus keeping relay *K1* closed. If the operating power, transistor *Q3*, or the relay coil should fail, the relay armature will drop out, closing contacts "g" and "h," and thereby actuating the external alarm equipment. When the detector is activated, the negative voltage developed across the bridge rectifier will "buck" the bias on *Q3*'s base. If the sensor antenna capacitance to ground changes, this bias will then cut off *Q3* to drop out the relay, sounding the external alarm.

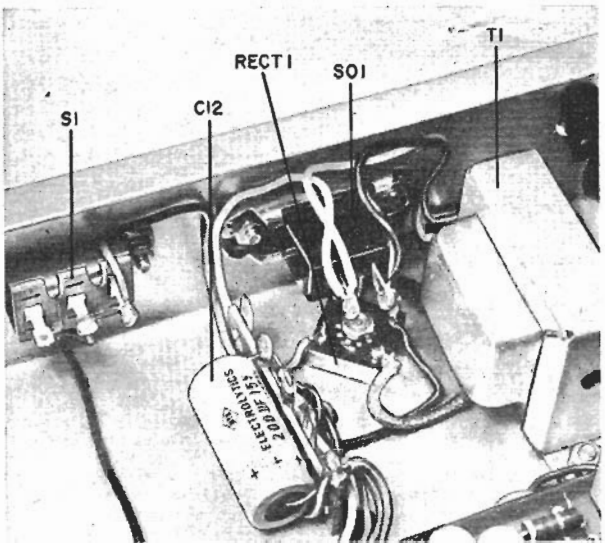
Relay *K1* is connected so as to permit optional "latching" operation, as may be required for burglar alarm and safety control applications. Note that *Q3*'s collector and base voltage is supplied through relay contacts "c" and "d," shunted by switch *S1*. As long as *S1* is closed, the instrument resets itself automatically after activation (there is a short inherent time delay built in). If *S1* is open, *Q3*'s collector and base voltage is removed when the relay opens; *K1* remains open (latched) until it is manually reset by closing *S1*.

with a key-operated switch in the interests of safety.

If the instrument is to actuate external equipment requiring relatively large currents (electric motor, horn, heavy-duty solenoid, or any multi-ampere device), a separate power relay controlled by *K1* is required. The "fail-safe" feature can be retained by using a double-pole relay, connecting the external equipment to the relay armature and the normally closed contacts, and controlling the coil power with *K1*'s "f" and "h" contacts. When *K1* opens, the external relay will also open.

Applications. There is virtually no limit to the number of ways in which the "People Detector" can be employed. Generally speaking, however, the instrument's practical applications can be grouped in three broad classes according to the degree of sensitivity needed: long range (3 to 6 feet); medium range (1 to 3 feet); and short range (1 to 12 inches).

Perhaps its most popular long-range application will be in burglar or intruder alarm systems. Here, best results are obtained in installations requiring *point*—rather than *area*—protection, *i.e.*, where the instrument protects a limited critical spot rather than an entire room—typically a safe, vault, file cabinet, desk, rear entrance, or gun case. The antenna is placed close to the item to be protected, while the alarm device (bell, buzzer, lights, or remote line to a guard station) is operated by a separate power supply, and is switched by *K1*'s "g" and "h" contacts as shown in Fig. 5. The unit is set up for "locking" operation (*S1* open).



Rear apron view shows the location of the power supply, the output a.c. socket, and reset switch S1.

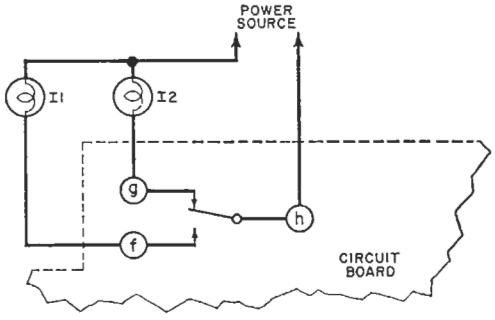


Fig. 6. When someone approaches the sensor antenna, I1 goes off while I2 comes on. This signaling can be used in a number of ways, as explained in text.

With 12-volt battery operation feasible, the "People Detector" also can be used as an intruder alarm in field applications (camping or boating, for example), in mobile installations (cars, trucks, campers, construction equipment), or in outdoor storage sheds and construction shacks.

Other long-range applications include its use as a safety control or alarm near dangerous machinery or equipment, at the entrances to classified areas, and, as previously mentioned, as a camera/flash control for automatic wildlife photography.

When set up for medium-range operation, the instrument can be used as an automatic doorbell (antenna by front door, *K1* used to operate chimes), to control an electric door opener, as a proximity counter (*K1* actuating an electromagnetic counter), for industrial or commercial installations, and to control advertising displays.

A possible circuit arrangement for an advertising display is shown in Fig. 6. Here, the instrument operates two lamps, *I1* and *I2*. Typically, lamp *I1* could illuminate a sign carrying a message to attract a customer to the immediate area

(*Continued on page* 93)

PEOPLE DETECTOR

(*Continued from page 32*)

—then, as he approaches the display, the instrument switches on spotlight *I2* to highlight the new product. If preferred, electric chimes, a gong, or even a programmed tape message could be actuated in addition to (or instead of) the second lamp. An arrangement similar to this one would be suitable for a Science Fair display.

There are, of course, innumerable short-range applications for the device. Typically, it could be used as a proximity (touch) control for office or shop equipment, by an amateur or professional magician to operate a mechanically actuated illusion, as an industrial control for production line process equipment, as a limit control or as a "through the window" remote control for a mechanical store window display. Here, the proximity antenna plate is concealed behind a sign mounted on the inside of the store's window, while the instrument can control an electric train, model car, or any other type of attention-getting display; the sign could carry the legend "PLACE HAND HERE."

If you don't have a serious application in mind, the "People Detector" is appropriate for a variety of "fun" situations or as a conversation piece in a recreation room or bar. For example, if the control antenna is hidden under a bar counter, the instrument can be wired to sound a gong or flash a light (such as a strobe) every time a guest reaches for his drink. —30—