BUILD THIS

Telephone Add-On

NO MORE WRONG NUMBERS!

Receive only the calls you want to receive with this inexpensive and easy-to-build telephone accessory.

GARY McCLELLAN

Part 2 LAST TIME WE STARTED building a device that keeps unwanted telephone calls from reaching you. It's time now to finish assembling the main board. Once that's done, we'll turn our attention to the second part of the project, the decoder board. Incidently, the decoder board has fewer parts and is easier to build than the main board, so it shouldn't take as long to complete.

Before we continue, an incorrect Radio Shack number was given in the Main Board Parts List for RY1; the correct number is 275-213. Now, picking up from where we left off last time, let's turn to the diodes.

Be sure to observe the polarities of those devices. Install four 1N4002 diodes at D8–D11, next to the fuse. Then go to SO1 install a 1N4148 diode at D7. Move over to IC5 and install four 1N4002 diodes at D3–D6. Finish up by installing 1N4002 diodes at D2 and D1 as shown.

The capacitors are installed next. Since there are many, they will be installed a few at a time. Be sure to push the capacitor bodies firmly against the board before soldering in place. Also, double-check the polarities before soldering the tantalum or electrolytic capacitors in place.

Start by installing a 0.01-μF disc at C2. Then install a 0.22-μF film at C1. Move to the right and install a 47-μF electrolytic at C3. Then install a 1-μF tantalum at C4. Make sure the capacitors are installed properly before continuing.

Continue by installing a 0.1-μF polyester at C5. Then a 1-μF tantalum at C6. (Be careful not to install it in the R5 or R7 positions.) Install another 1-μF tantalum at C7. And install a 0.1-μF disc capacitor at C8.

Continue by installing another 1-μF tantalum at C10. Then install a 0.1-μF polyester at C12. After that, install another 0.1-μF polyester at C11, just below IC5. Move over the IC4 socket and install a third 0.1-μF polyester at C9.

At this point, the remaining capacitors are installed. First install 0.1-μF discs at C16 and C17. Then install a 470-μF electrolytic at C15. Make sure it is installed properly before soldering in place. Finally, install 0.01-μF discs at C13 and C14, next to F1.

Now the transistors and two IC's may be installed. Be sure to position the flat side of the transistor cases as shown in the parts-placement diagram. Start at the top of the board. Install a 2N2222 transistor at Q2. Then install the other 2N2222 at Q1, near RY1. Move on to the IC's, install a 78L05A at IC7 and another 78L05A at IC6.

Some wire jumpers are required and they will be installed now. Use pieces of leftover resistor or capacitor leads for them. Note that there are four jumpers and that they are located around the IC3 and IC4 sockets. Start with the jumper above IC3. Bend a lead to fit, then install it as shown. Move to the right of IC3 and install another jumper as shown. Finally, move to SO1 and install two jumpers above it. Be careful not to put a jumper in place of R16. Two other jumpers, located on the foil side of the board, will be installed later.

The resistors are installed next. Since there are so many, they will be installed a few at a time.

Start by installing a 10K potentiometer at R12. Then move to the left and install a 1K resistor at R1. Then install a 10K resistor at R13 and a 4.7K resistor at R4. Then install a 100K unit at R6.

Continue by installing a 33K resistor at R8 and a 22K resistor at R9. Move to the left, next to IC1, and install a 10K resistor at R2. Then install a 1K resistor at R3. Jump over the capacitors and install a 270K resistor at R5. Then install a 10K unit at R7.

The remaining resistors, which are grouped around the IC4 socket, are installed next. Install a 100K resistor at R16, a 10-megohm resistor at R14, and a 2.2K resistor at R20.

The next step is to install the two insulated wire jumpers on the foil side of the board. Simply cut to pieces of insulated wire to the appropriate length and carefully solder them in place.

Finish up the assembly by installing the IC's. Install the M290 into the IC2 socket. Then install a CD4538 into the IC3 socket and a CD4093 into the IC4 socket.

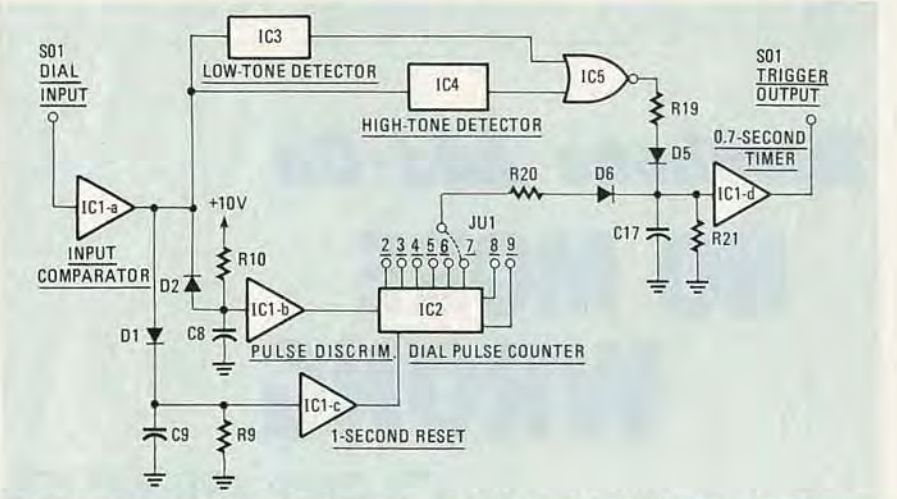

FIG. 5—THE VARIOUS STAGES of the decoder board are shown in this simplified schematic diagram.

The decoder board

Lets discuss the circuitry briefly and then build the board. The decoder has one basic job; to detect tone pairs from *Touch-Tone* phones or detect pulses from rotary-dial phones. A desired code number is programmed into the board, and whenever that number is detected, the board produces an output.

Returning to the main board, an output from the decoder triggers a one-shot. The one-shot enables a 2-Hz oscillator. As a result, the project produces a distinctive beep-beep-beep sound for ten seconds. That is what tells you to answer the phone.

Figure 5 shows a simplified schematic diagram of the board; the complete schematic is shown in Fig. 6. Incoming dial pulses or tones from the phone line appear on the DIAL pin of PL1. The tones or pulses drive IC1-a, an analog comparator. That device provides gain and squares up all signals.

The output from IC1-a branches in two directions; to the tone-detector circuitry and to the dial-pulse circuitry. The tone-detector circuitry consists of two phase-locked tone-detectors, IC3 and IC4. Recall that pushbutton tone telephones produce two tones; low and high. (That's why the system is known as DTMF or *D*ual-*T*one *M*ulti-*F*requency.) The low tones have frequencies of less than 1 kHz, while the high tones have frequencies that are above 1 kHz. At any rate, when the appropriate low and high tones are present, IC3 and IC4 produce logic-low outputs. Gate IC5 detects that condition and produces a logic-high output. The output from IC5 goes to a timer circuit that will be discussed shortly.

Note that the tone detectors are adjusted to respond to the number "7." That means that the low-tone detector, IC3, is adjusted for 842 Hz and the high-tone detector, IC4, for 1209 Hz.

The dial-pulse circuitry consists of three parts—a pulse discriminator, a one-second reset, and a dial-pulse counter. Comparators are used for everything except for the dial-pulse counter.

The purpose of the pulse discriminator is to prevent tones from pushbutton phones, as well as any other stray audio, from clocking the dial-pulse counter. In effect, that circuit works as a low-pass filter.

In operation, input signals cause the output of IC1-a to pulse high. If the frequency is too high, diode D2 prevents capacitor C8 from charging. As a result, comparator IC1-b never triggers, and no output goes to the counter. But if the frequency is low, C8 has time to charge through resistor R10. The comparator then triggers and each pulse clocks the dial-pulse counter. Note that the values of R10 and C8 are set for 45 milliseconds, or half the pulse width of a standard rotary-dial phone.

The purpose of the one-second reset circuitry is to reset the dial-pulse counter one second after the pulses stop. That way, the circuitry will be ready for the next call. In operation, input signals cause the output of IC1-a to pulse high. That causes capacitor C9 to charge through diode D1. At the same time comparator IC1-c triggers, removing the reset from the dial-pulse counter so that the counter is free to count pulses. About one second after the pulses stop, C9 is discharged through resistor R9. Thus, comparator IC1-c is untriggered and resets the dial-pulse counter.

The purpose of the dial-pulse counter, IC2, is to count pulses from rotary-dial type phones. It has eight decoded outputs and each output represents the number dialed. Note that there are two other outputs, but they are reserved for housekeeping purposes. Also note that the desired output, "7", is jumpered to the 0.7-second timer circuitry. Note that for simplicity, only the "7" output is shown in Fig. 6.

The remaining bit of circuitry on this board is a 0.7-second timer. The purpose of that circuit is to prevent false triggering, mainly by the tone detectors, which can sometimes be tricked by human speech. For that circuit to produce an output, either the decoded tones or the dial pulse must be present for at least 0.7 second. For times less than that, the circuit will not produce an output.

In operation, a good pair of tones makes the output of IC5 high. That causes capacitor C17 to charge through resistor R19 and diode D5. If the tones last over 0.7 second, comparator IC1-d triggers and produces a high output. That triggers the beeper circuitry on the main board through the TRIG output of PL1. In the case of a rotary-dial phone, a good number makes the jumpered output of IC2 high. So capacitor C17 charges through resistor R20 and diode D6.

Note that after the tones or dial pulses disappear, resistor R21 discharges capacitor C17, untriggering the comparator. So the TRG output goes low and the circuitry is ready for the next call.

That completes the theory—on to assembly!

Assembly

Start by referring to the Parts List for the decoder board and obtaining all of the parts. Here are a few suggestions that may be helpful as you shop.

The IC's are all industry standard, and many manufacturers make them. For example, the National LM567CN is also made by Signetics (NE-567N) and Exar (XR-567CP).

The only capacitor that might cause problems is C17—a 1μF tantalum type. A low-leakage electrolytic may be substituted for that capacitor if needed.

As for the resistors, R14 and R17 may require some searching. To make things easier, a supplier and part number is given in the Parts List. Also, two odd-value resistor types are used; 6.2 kilohms and 180 kilohms. If you can't get the 6.2-kilohm units, simply parallel a 6.8-kilohm resis-

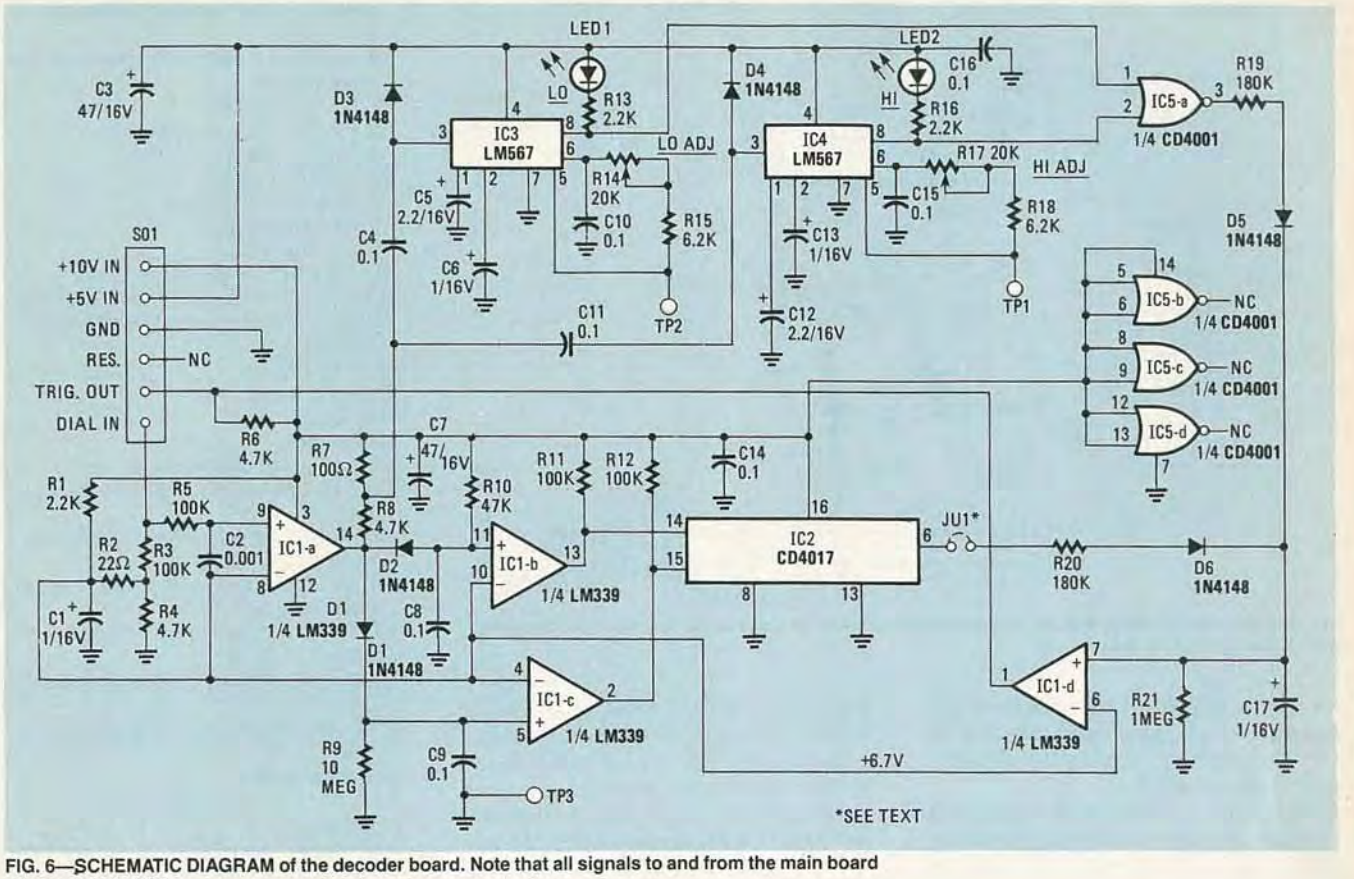

FIG. 6—SCHEMATIC DIAGRAM of the decoder board. Note that all signals to and from the main board are routed via SO1.

tor with a 68-kilohm unit. As for the 180-kilohm unit, simply parallel a 220-kilohm resistor with a 1-megohm unit.

You'll also need a PC board. If desired, order the set from the supplier given in the Parts List. Otherwise, you can make your own using the pattern shown in Fig. 7.

Once you have the parts, assembly can begin. Refer to Fig. 8, the parts-placement diagram, and position the board as shown.

Start with the IC sockets. Install a 14-pin socket at IC1 and solder in place. Then install another 14 pin IC socket at IC5. After that, install a 16-pin unit at IC2. Finish up the IC sockets by installing 8-pin units at IC3 and IC4.

Continue assembly with the two LED's. Be sure to look at the plastic cases carefully; one side should be flattened. And the lead closest to the flattened side should be shorter than the other. Install each LED with the flattened side (and short lead) to your right. Install LED2 first, near the top of the board. Then install LED1 in the same manner.

Continue assembly by installing the capacitors. Since there are so many, they will be installed a few at a time. Be sure to install the polarized capacitors with the + sign as shown in the figure, and double-check your work after soldering.

Install a 1-μF tantalum capacitor at C17 along the top of the board. Then move to your left and install a 0.1-μF disc capaci-

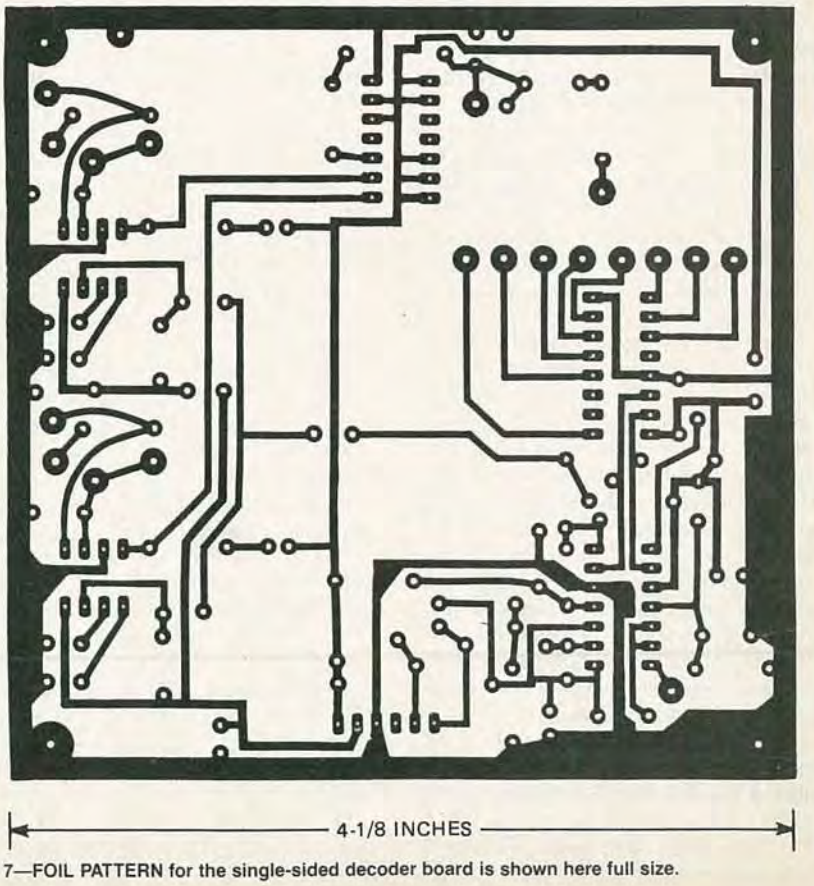

FIG. 7—FOIL PATTERN for the single-sided decoder board is shown here full size.

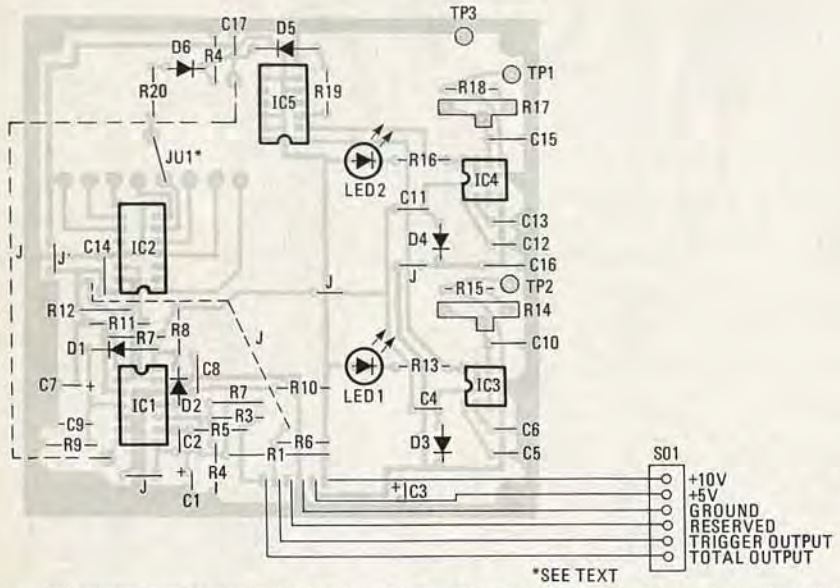

FIG. 8—THE UNUSED PADS around IC2 are provided to allow for the selection of a code number other than 7. See the text for details.

tor at C14. Move to the left some more and install a 47-μF electrolytic capacitor at C7. And after that, install a 0.1-μF polyester capacitor at C9.

Move to the bottom of the board and continue. Install a 1-μF electrolytic capacitor at C1. Then move up and install a 0.001-μF polyester capacitor at C2. Next, install a 0.1-μF polyester unit at C8.

Install another 47-μF electrolytic capacitor at C3. Then move up and install 0.1-μF polyester units at C4 and C10. Back up and install a 2.2-μF electrolytic capacitor at C5. Then above it, install another 1-μF electrolytic unit at C6.

Move up and install a 0.1-μF disc capacitor at C16. Be careful not to install it at R15 by mistake. Then install another 2.2-μF electrolytic capacitor at C12. After that, install another 1-μF electrolytic capacitor at C13. Finish up the capacitors by installing 0.1-μF polyester units at C11 and C15.

Continue with the four component-side jumpers. Use short pieces of leftover capacitor leads for those. Install the first jumper next to C14, along the lefthand side of the board. Then move to the bottom left side and install another jumper. Move to the center of the board and install the two remaining jumpers between the LED's.

Next, install jumper JU1. When that jumper is installed as shown the pulse-dial circuitry will respond to a dialed 7. The remaining pads in that area are provided to allow you to select a different code number and are normally unused.

Continue assembly with the resistors. Since there are so many, they will be installed a few at a time. Start at the top of the board by installing a 1-megohm unit at R21. Then install 180K units at R20 and R19 on either side of the IC5 socket. After that, move down and install 100K units at R12 and R11, adjacent to the IC2 socket.

Install a 100-ohm resistor at R7, below R11. Be careful not to place that resistor in the D1 position. Then move to the right and install a 4.7K resistor at R8. Move to the lower lefthand corner of the board and install a 10-megohm resistor at R9. After that, move to the right and install another 4.7K resistor at R4.

Install two more 100K resistors at R5 and R3. Then move up and install a 22-ohm unit at R2. Move to the right and install a 47K resistor at R10. After that, install another 4.7K resistor at R6. Next, install a 2.2K unit at R1. Bend the leads to size first, then install.

Move to the top of the board and install a 6.2K resistor at R18. After that, install a 20K potentiometer at R17. Be sure to push the body of the potentiometer firmly against the board before soldering it in place. After that, install another 2.2K resistor at R16.

Install another 6.2K resistor at R15. Then install another 20K potentiometer at R14. Push the body firmly against the board before soldering. Finish up the by installing another 2.2K unit at R13.

Continue assembly by installing three short pieces of wire at the pads marked TP1-TP3. Use short pieces of leftover resistor wire, cut to a length of ⅜-inch for that. Install two of the wires at the holes above R18. Then install the remaining one next to R15.

Next, we turn to the diodes. When installing the diodes, be sure to position them as shown. Double-check your installation after soldering. Note that all diodes are 1N4148's.

Install a diode at D5 as shown. Then install a diode at D6 to the left of it. Move down to the IC1 socket and install diode D1 next to it. Then install diode D2 to the right of it. Move to the IC3 socket and install diode D3 next to it. And finally, move to the IC4 socket and install diode D4 next to it.

Continue by installing two insulated foil-side wire jumpers. Note that they are shown as dashed lines in Fig. 8.

PARTS LIST—MAIN BOARD

All resistors ¼-watt, 5% unless otherwise noted

R1, R3—1000 ohms
R2, R7, R11, R13—10,000 ohms
R4—4700 ohms
R5—270,000 ohms
R6, R16—100,000 ohms
R8—33,000 ohms
R9—22,000 ohms
R10, R14, R15, R19—10 megohms
R12—10,000 ohms, potentiometer, linear taper, PC-board mount (Radio Shack 271-218)
R17—330 ohms
R18—470 ohms
R20—2200 ohms

Capacitors

C1–0.22 μF, 250 volts, metal film
C2, C13, C14—0.01 μF, 50 volts, ceramic disc
C3—47 μF, 16 volts, radial leads, electrolytic
C4, C6, C7, C10—1 μF, 16 volts, radial leads, tantalum
C5, C9, C11, C12—0.1 μF, 50 volts, polyester
C8, C16, C17—0.1 μF, 16 volts, ceramic disc
C15—470 μF, 25 volts, radial leads, electrolytic

Semiconductors

IC1—TIL-119 optoisolator (Texas Instruments)
IC2—M290 ring-detector subsystem (Mendakota—see below)
IC3—CD4538 CMOS one-shot (RCA)
IC4—CD4093BE CMOS Schmitt trigger NAND gates
IC5—MOC-5010 optoisolator (Motorola)
IC6, IC7—78L05ACP 5-volt, l00-mA regulator (Motorola)
Q1, Q2—2N2222 NPN transistor
D1–D6, D8–D11—1N4002 diodes
D7—1N4148 diode
F1—0.25 amp, 3AG fuse
PL1—6 pin male PC-header (GC Electronics 41-046 or similar)
RY1—DPDT relay, 12-volt DC coil (Radio Shack 27S-213 or equivalent)
PB1—Piezoelectric buzzer (Radio Shack 273-060 or equivalent)
S1—SPST momentary pushbutton switch (Radio Shack 275-618 or equivalent)

Miscellaneous: PC board, solder, wire, 2 PC-mount fuse clips (Littlefuse 122087), IC sockets, etc.

The following is available from Mendakota Products, Ltd., PO Box 20HC, 1920 W. Commonwealth Ave., Fullerton, CA 92633: A set of three PC boards and the M290 ring detector IC (order part No. NWR). The cost is $26.00 postpaid in the U.S. and Canada. The M290 is available for $12. California residents please add 6% sales tax. Sorry, no C.O.D's or credit-card orders.

PARTS LIST—DECODER BOARD

All resistors 5%, 1/4 watt unless otherwise noted

R1, R13, R16—2200 ohms
R2—22 ohms
R3, R5, R11, R12—100,000 ohms
R4, 46, R8—4700 ohms
R7—100 ohms
R9—10 megohms
R10—47,000 ohms
R14, R17—20,000 ohms, 15-turn potentiometer, PC-mount (Radio Shack 271-340 or equivalent)
R15, R18—6200 ohms
R19, R20—180,000 ohms
R21—1 megohm

Capacitors

C1, C6, C13—1μF, 16V, electrolytic, radial leads
C2—0.001μF, 50V, polyester
C3, C7—47μF, 16V, electrolytic, radial leads
C4, C8, C9, C10, C11, C15—0.1μF, 50V, polyester
C5, C12—2.2μF, 16V, electrolytic, radial leads
C14, C16—0.1μF, 16V, ceramic disc
C17—1μF, 16V, tantalum

Semiconductors

IC1—LM339 linear quad comparators (National)
IC2—CD4017 CMOS counter (RCA)
IC3, IC4—LM567 linear tone decoders (National)
IC5—CD4001 CMOS quad NOR gates (RCA)
D1–D6—1N4148 silicon switching diodes
LED1, LED2—jumbo red LED's (Radio Shack 276-041 or equivalent)
SO1—6-pin female plug (Calectro 41-126 or equivalent)
S2—SPST rocker switch (Radio Shack 275-690)
T1—12 VAC, 250mA, plug-in transformer (Jameco AC-250 or equivalent)

Miscellaneous: PC board, front-panel board, 2×5×5-inch cabinet (CM5-200, Pac Tec, Inc., Enterprise and Executive Aves., Philadelphia, PA 19153)(Radio Shack 270-218), 12-foot modular telephone cord (Radio Shack 279-374 or equivalent), IC sockets, 4 1-inch threaded spacers for 4-40 screws, 4 0.125-inch unthreaded spacers, 4 4-40×0.25 inch screws, 7 4-40×0.5 screws, 11 No. 4 lockwashers, 3 4-40 nuts, 0.25-inch cable clamp, etc.

Cut a piece of insulated hookup wire to about 2.5 inches and strip both ends. Install one end in the hole next to C14, near the IC2 socket. Then install the other end in the hole between resistors R6 and R10.

Cut a piece of insulated hookup wire to about 4 inches and strip both ends. Install one end in the hole near the top of the board, next to C17 and the IC5 socket. Then install the other end in the hole below the IC1 socket.

Continue by installing connector SO1. If possible, use a piece of six-conductor ribbon cable for the wiring; it gives a neater appearance. However, short pieces of hookup wire will work fine.

Cut a piece of cable (or six wires) about 2.5 inches long and strip all ends. Install SO1 at one end.

IMPORTANT! Insert the wires from SO1 into the board so that the key (raised plastic ridges) on SO1 points DOWN. Double-check all of them before you do any soldering.

Observe the preceding precaution, then insert each wire into the holes on the board and solder.

Complete the assembly by installing the IC's. Be sure to position them with pin 1 as shown. Install an LM339 into the IC1 socket. Then install a CD4017 into the IC2 socket. After that, install a CD4001 into the IC5 socket. Finally, install the LM567's into the IC3 and IC4 sockets.

Basically, all that's left for next time is to do the cabinet work, install the boards, and perform a few adjustments. That shouldn't take long to do and then this project will be standing guard over your phone! **R-E**