Ultrasonic Listening Device

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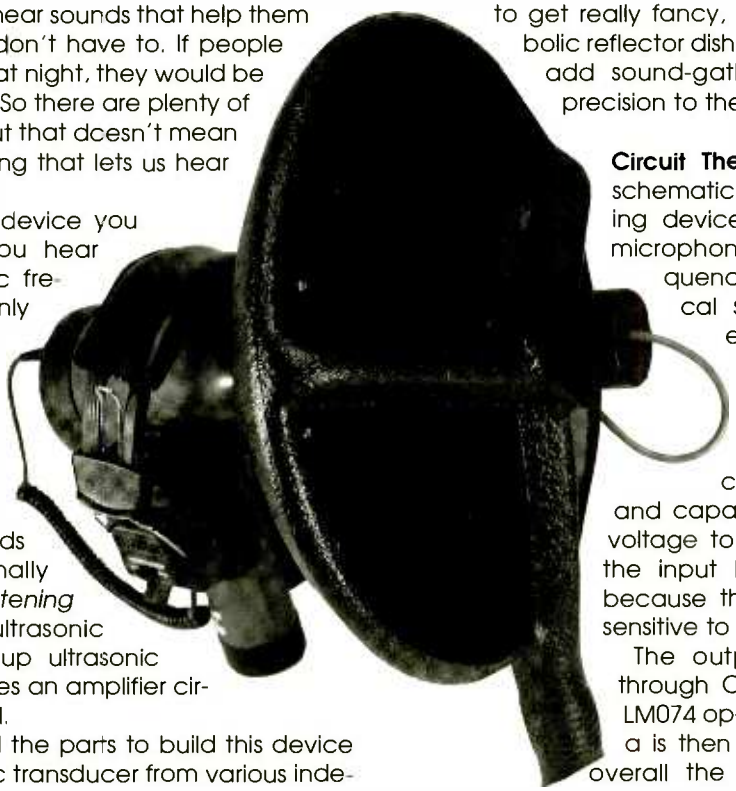
LISTEN TO BATS, INSECTS, AND OTHER HIGH-FREQUENCY NOISES

There are sounds that people can hear and there are sounds that people just can't hear. It has to do with the frequency response of the human ear or the sounds it is designed to hear. Certainly bats and various insects have to hear sounds that help them do things that people don't have to. If people had to fly around blind at night, they would be better off with bat ears. So there are plenty of things we can't hear, but that doesn't mean we can't build something that lets us hear these sounds.

This article details a device you can build that lets you hear sounds in the ultrasonic frequency range. Not only bats and insects make ultrasonic sounds. Things like leaking gases or rushing air, jingling keys and coins, electrical equipment, and people and animals walking in grass make sounds that you don't normally hear. The *Ultrasonic Listening Device* contains an ultrasonic transducer that picks up ultrasonic frequencies and provides an amplifier circuit with a proper signal.

You can purchase all the parts to build this device except for the ultrasonic transducer from various independent sources. The transducer is a custom-made part available only from the source given in the Parts List. Basically, you need to build the circuit containing the transducer, isolate the transducer from vibrations with a rubber mounting scheme, and power up the circuit aiming the transducer in various directions.



With a bit more investment in time and cost, you can also make a slick gun-like housing for the device with your own parts or with the pre-cut and drilled parts also available from the parts source. If you want to get really fancy, a molded plastic parabolic reflector dish is also available. It helps add sound-gathering and directional precision to the device.

Circuit Theory. Figure 1 shows a schematic of the ultrasonic listening device. Ultrasonic transducer microphone TD1 converts high-frequency sounds into an electrical signal using the piezoelectric effect. Inductor L1 helps tune the transducer to 25 kHz. The signal is coupled to FET transistor Q1 through capacitor C2. Resistor R1 and capacitor C1 decouple bias voltage to the drain. Shielding of the input lead is very important because this part of the circuit is sensitive to noise and feedback.

The output of Q1 is coupled through C3 and R4 to IC1-a, an LM074 op-amp. The output of IC1-a is then coupled to IC1-b; and overall the signal is amplified by about 50, set by the ratio of resistors R6 and R4. The output of IC1-c is coupled back into the circuit simply by stray pickup, but you can experiment with this part of the circuit by adding a "gimmick" capacitor, which involves nothing more than soldering bits of wire leads to pins 2 and 8 of IC1 and twisting

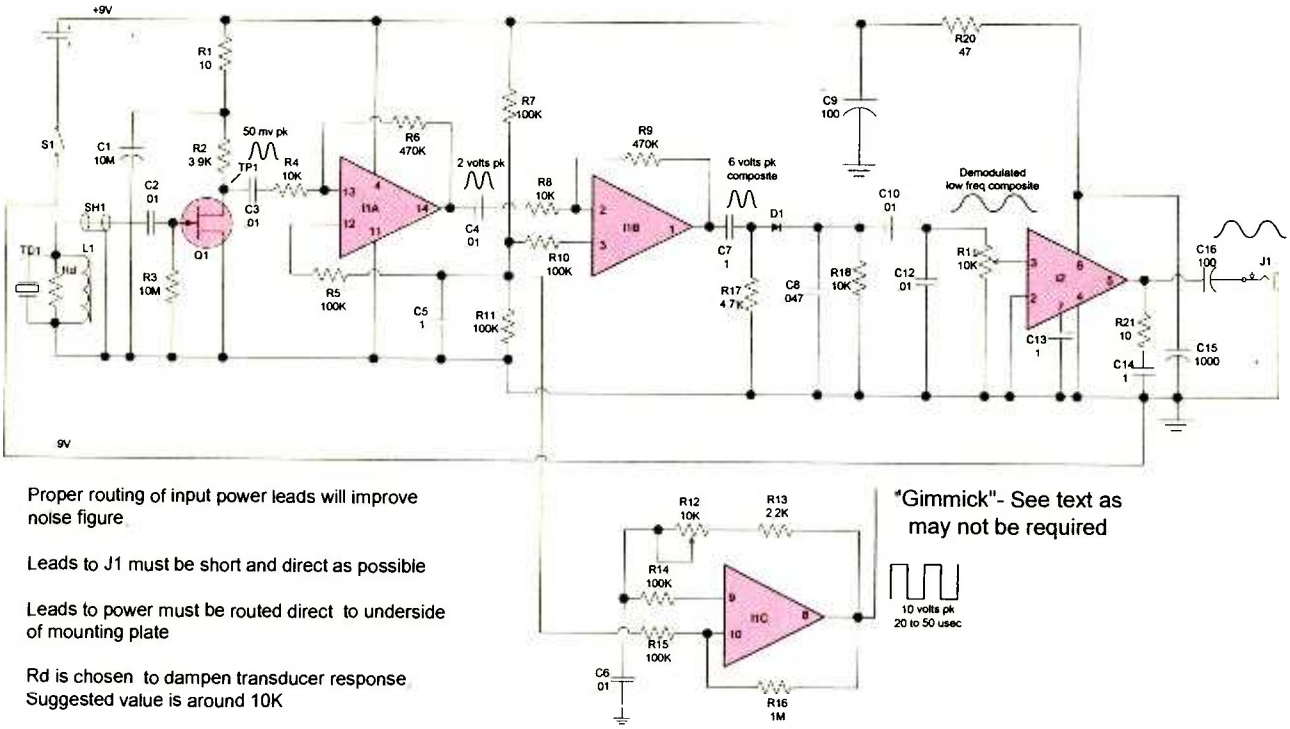


Fig. 1. Schematic of the ultrasonic listening device. Ultrasonic transducer microphone TD1 converts high-frequency sounds into an electrical signal using the piezoelectric effect

them together... but again, this is an optional step, as pin 2 tends to pick up the signal from pin 8 automatically.

With or without the gimmick, the oscillator now generates a signal that is mixed with the picked-up signals, creating sum and difference signals. Capacitor C7 and R17 form a filter that attenuates the higher frequency component of the mixed signals while allowing lower frequencies to pass by a factor of 20 dB. The resulting signal is the difference between the received signal and the oscillator frequency. This is similar to the super heterodyne effect. The resulting signal is rectified by 1N914 diode D1, transformed into a signal that produces sounds you can hear.

Potentiometer R12 tunes the circuit to cover a small band of frequencies. Potentiometer R19 attached to LM386 amplifier IC2 controls volume or the level of the signal reaching headphone jack J1. The output is set to 8 ohms. While you're better off with headphones, you can substitute a small speaker. Suitable headphones are available from the source given in the Parts List.

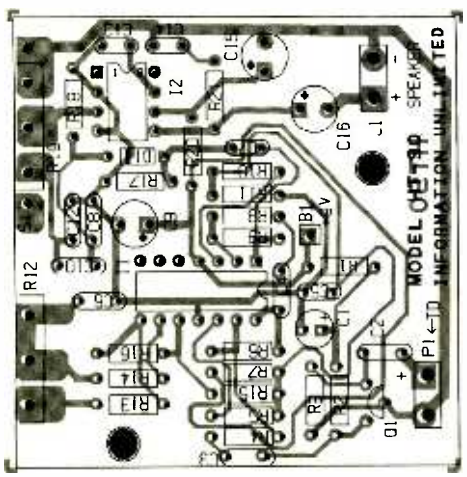


Fig. 2. Parts-placement diagram. You can build this circuit on perfboard, but you're much better off using a PC board.

Construction. You can build this circuit on perforated construction board, but you're much better off using a PC board. You can make one using the foil pattern provided here or buy one with the kit. Figure 2 shows the parts-placement diagram and Fig. 8 is the foil pattern. Note that the potentiometers supplied with the kit mount to the PC board using bits of scrap component leads so that the potentiometers stand vertically as shown in Fig. 3.

Twisted leads work fine for the headphone jack, but the transducer must be connected to the circuit using shielded cable. Figures 3–6 show details on how to assemble the device. Be sure to solder components L1 and Rd directly across the leads of transducer TD1 as shown in Fig. 4.

After you have assembled the board and checked for errors, connect either a 9-volt battery or 12 volts from 8 AA cells, turn on the circuit and listen for a rushing sound in the headphones. If the circuit seems to be working, proceed to the final assembly of the gun handle and reflector if you're adding them. If you're not, it helps to mount the PC board insulated from and directly above a metal plate of the same size.

The gun handle is easy and fast to build if you're doing it from the kit. Otherwise you're on your own from here. Assemble the handle parts as shown with

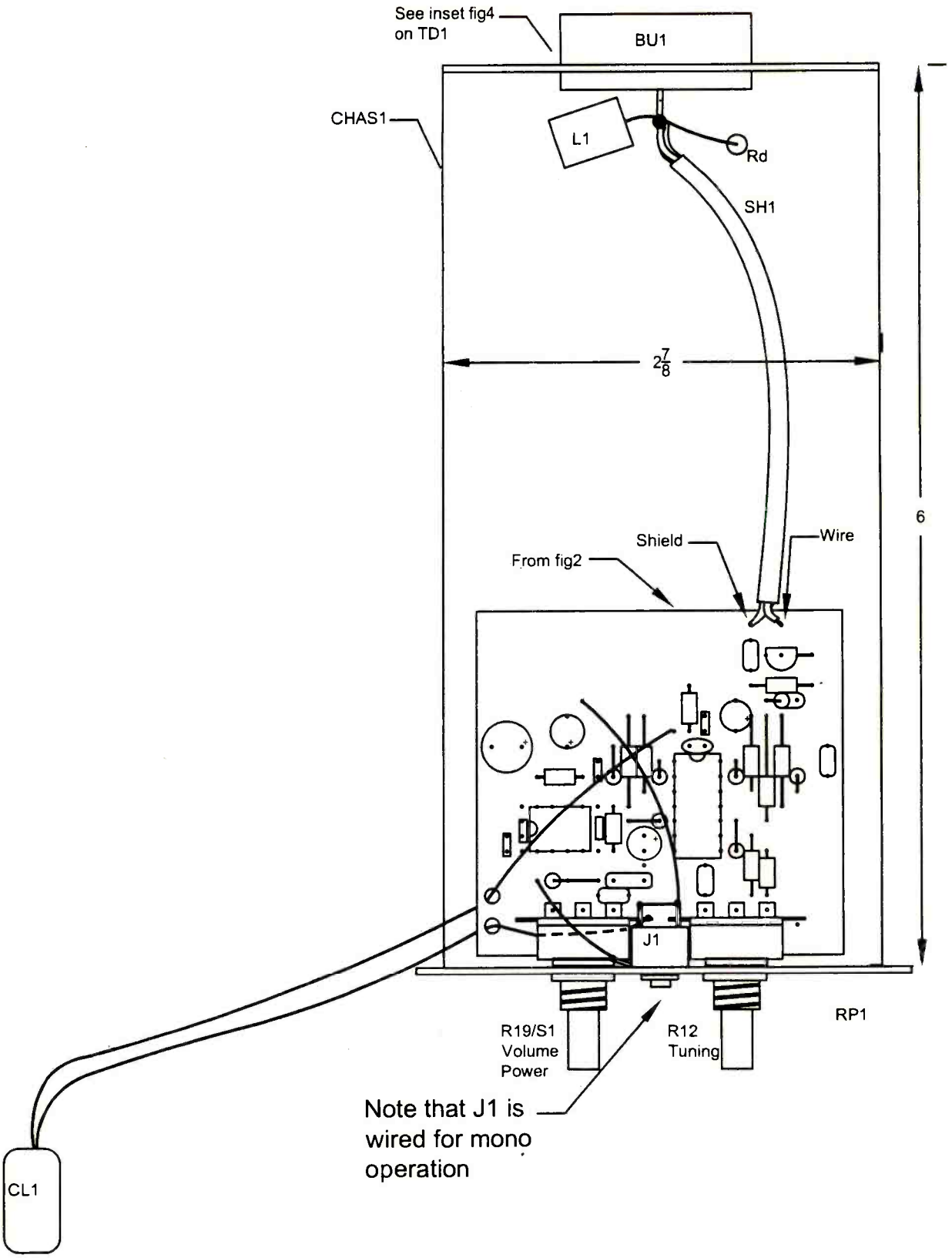


Fig. 3. Follow this mechanical layout if you're building the basic gun-handle type case.

the board mounted above the pre-formed metal plate that holds everything in place (see Fig. 5). Be sure to mount the transducer in the rubber grommet to prevent it from picking up stray bumps and taps from the handle.

The parabolic dish assembly is shown in Fig. 7. Note that the assembly is designed to allow the transducer to slide toward and away from the center of the dish

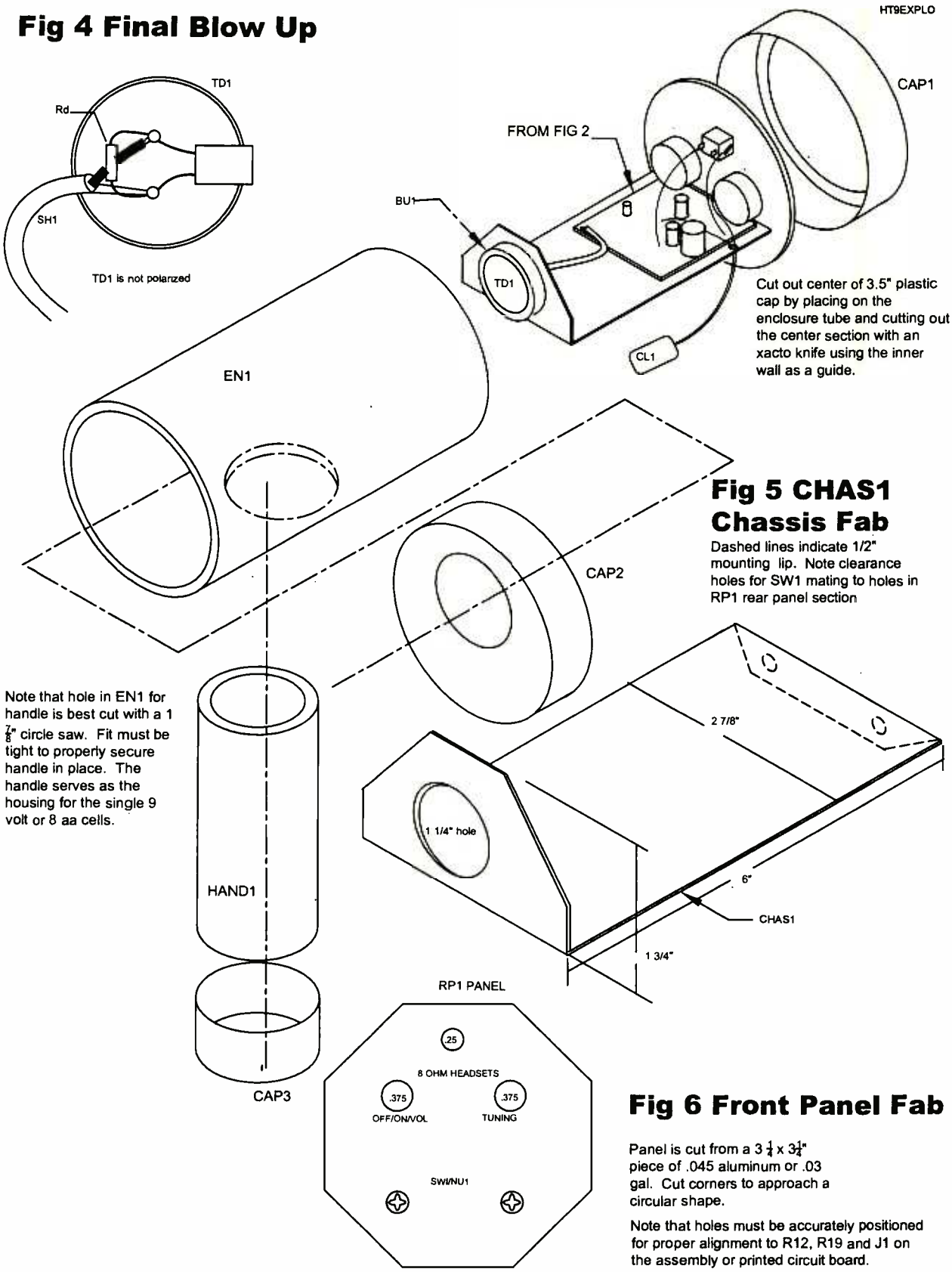
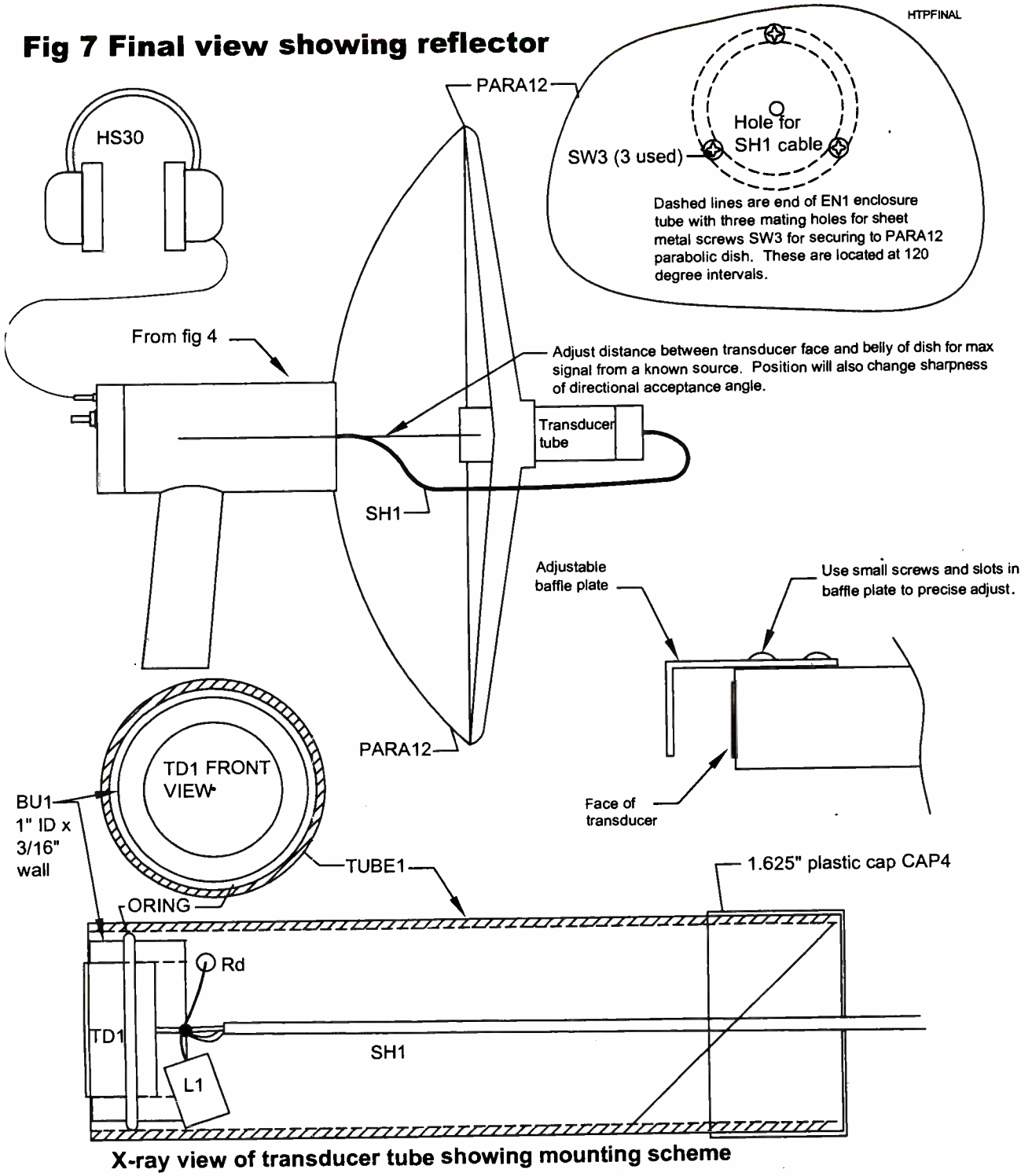


Fig. 4. Be sure to solder components L1 and Rd directly across the leads of transducer TD1 as shown here.

Fig. 5. The basic gun-handle type case is assembled from PVC pipes and plastic end caps.

Fig. 6. Front-panel fabrication. The potentiometers and jack for the headphones mount here.

Fig 7 Final view showing reflector



X-ray view of transducer tube showing mounting scheme

Note shielded cable is 18" and is routed through a small hole in the rear cap CAP3 and in PARA12 reflector

TD1 is fitted into bushing BU1. Assembly is then inserted into the 5.5" x 1.625 diameter enclosure TUBE and is spaced by the ORING. This scheme shock mounts the transducer and secures it in place.

Transducer is wired as shown in fig.4

Fig. 7. Parabolic dish assembly. The assembly is designed to allow the transducer to slide toward and away from the center of the dish for tuning adjustment, so it needs a good length of shielded cable to allow it to do so.

PARTS LIST FOR THE ULTRASONIC LISTENING DEVICE

SEMICONDUCTORS

IC1—LM074 op-amp
IC2—LM386 audio amplifier
D1—1N914 diode
Q1—J202 N-channel FET

RESISTORS

R1, R21—10-ohm, ¼-watt, 5%
R2—3900-ohm
R3—10-megohm
R4, R8, R18—10,000-ohm
R5, R7, R10, R11, R14, R15—100,000-ohm
R6, R9—470,000-ohm
R12—10,000-ohm potentiometer, 17mm
R13—2200-ohm
R16—1-megohm
R17—4700-ohm
R19—10,000-ohm potentiometer, 17mm, with switch (S1)
R20—47-ohm
Rd—10,000-ohm

CAPACITORS

C1—10-µF, 25 volts, electrolytic
C2, C3, C4, C6, C10, C12—0.01-µF, 25 volts, disk or plastic
C5, C7, C13, C14—0.1 µF, 25 volts, disk or plastic
C8—0.047-µF, 50 volts, plastic
C9, C16—100 µF, 25 volts, electrolytic
C11—Not used
C15—1000-µF, 25 volts, electrolytic

ADDITIONAL PARTS AND MATERIALS

L1—27-mH inductor (available from Mouser)
J1—3.5-mm stereo audio jack wired for mono
TD1—25-kHz acoustical receiving transducer
Shielded mike cable, PC board or perfboard, insulating plastic, rubber mounting bushing for TD1, 9-volt battery holder with 12-inch leads (or 8-AA holder for 12-volt operation), two 3½-inch plastic caps, one 1⅞-inch plastic cap, 6-inch long 3.5-inch diameter PVC pipe, 7-inch long 1⅞-inch diameter PVC pipe, steel or aluminum shielding plate (see Fig. 4), headphones, one 1⅞-inch plastic cap, one 1⅞-inch × 1⅞-inch × ¼-inch rubber o-ring, one 5½-inch × 1⅞-inch O.D. plastic tube, #6 × ⅜-inch sheet metal screws, 12-inch plastic parabolic reflector.

Note: The following items are available from Information Unlimited, PO Box 716, Amherst, NH 03031, 800-221-1705, 603-673-4730, *www.amazing1.com*, e-mail: info1@xtdl.com. Complete kit (includes headphones, PC board, and all parts except parabolic reflector, PNT9K), $99.50; Kit for PC board only (PNPCT9K), $39.50; single PC board w/o parts (PNPCT9), $7.50; custom-made ultrasonic transducer (single part only) (PNTDT9), $24.50; fully assembled PC board (PNPCT90), $59.50; parabolic reflector (PNPRT9), $39.50; fully assembled and tested unit (PNHT9O), $149.50. Both PNPCT9K and PNPCT9O include a transducer.

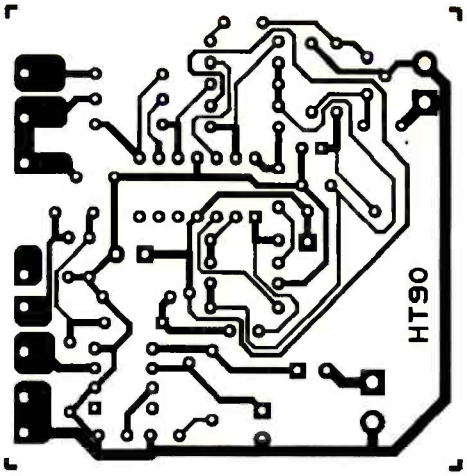
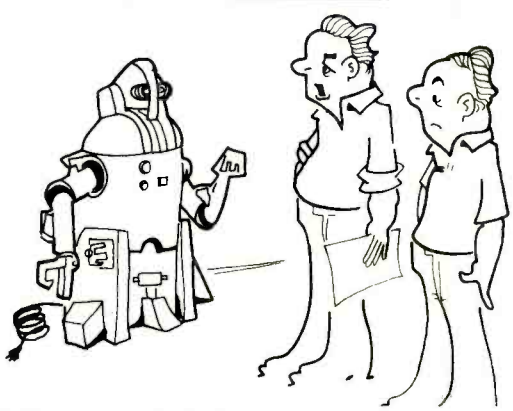


Fig. 8. You can make your own PC board using this foil pattern.

for tuning adjustment, so it does need a good length of shielded cable to allow it to do that.

Using the Listener. Once the unit is completely assembled in the form you have chosen, it's up to you to find interesting sounds to listen to. Of course you'll have no problem finding new sounds... but you might have trouble identifying what they are and where they are coming from. Regardless, and whatever you do hear, you will have opened up a whole new world of sounds to listen to. P

"Oh, I get it now, you throw some stuff in a box and then it does something or other."



"It replaces ten men, but it takes twenty technicians to keep it going!"