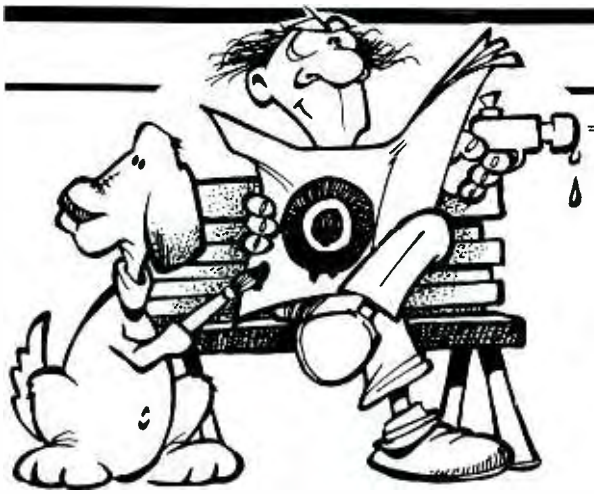


Audible Target

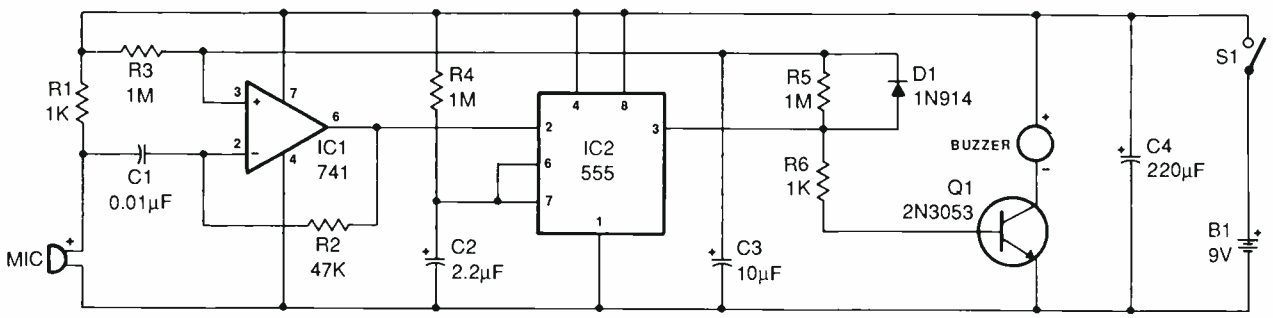
Sounds a tone when it detects a "hit" from a BB or pellet

By James H. Brown

Many people practice shooting at a target (with all safety precautions taken, we hope) that is located too far away to know if it was hit or not. Our Audible Target is designed to overcome this problem by sounding a piezoelectric buzzer when a hit is score by, say, a pellet fired by a BB or pellet gun. Electronic circuitry that detects the hit is housed inside an enclosure that is, in turn, mounted on a block of wood that protects it from damage.

About the Circuit

The Audible Target's circuit (Fig. 1) is designed to respond to only sharp-attack sounds like those produced when a hard object like a BB or pellet strikes a block of wood. The sharp-attack sound produced by a single "hit" from a BB or pellet impacting the wood block travels through the block and is picked up by electret microphone element *MIC*. The microphone element converts the sound in-



PARTS LIST

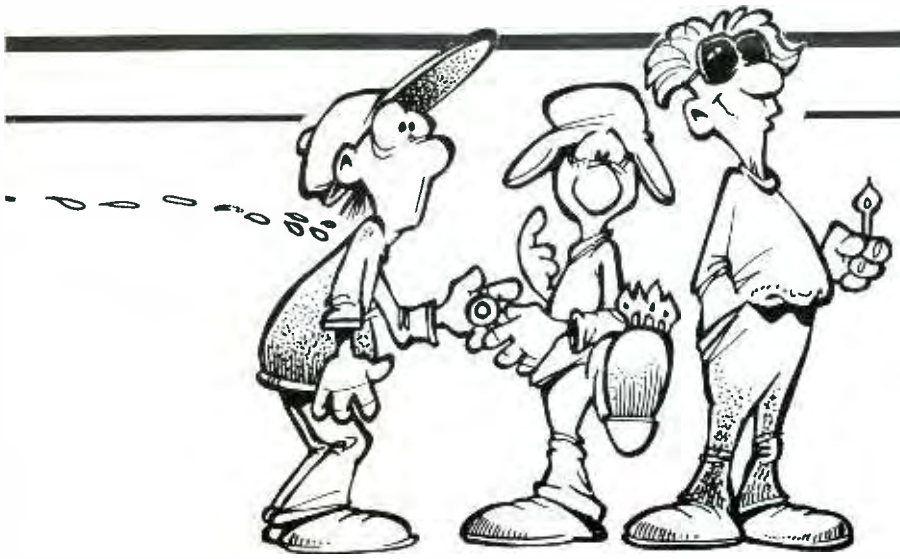
Semiconductors
D1—1N914 switching diode
IC1—741 operational amplifier
IC2—555 timer
Q1—2N3053 medium-power npn transistor

Capacitors
C1—0.01-µF disc
C2—2.2-µF, 15-volt electrolytic
C3—10-µF, 15-volt electrolytic
C4—220-µF, 15-volt electrolytic

Resistors (1/4-watt, 10% tolerance)
R1—10,000 ohms
R2—47,000 ohms
R3,R4,R5—1 megohm
R6—1,000 ohms

Miscellaneous
B1—9-volt transistor battery
MIC—Electret microphone element (Radio Shack Cat. No.270-090 or 270-092—see text)
S1—Spst pc-mount toggle switch
Two-tone piezoelectric buzzer (Radio Shack Cat. No. 273-070 or similar); pc board or perforated board and suitable Wire Wrap and/or soldering hardware or solderless breadboarding socket (see text); sockets for ICs; holder and snap connector for B1; suitable enclosure (Radio Shack Cat. No. 270-233 or similar); 7″ × 6″ × 1″ wood block (see text); cable clamp; small rubber grommet; ½″ spacers; 4-40 × ¾″ machine screws, nuts and lockwashers; 6-32 × 1¼″ machine screws, nuts and flat and lockwashers (see text); color-coded stranded hookup wire; solder; etc.

Fig. 1. Full schematic diagram of Audible Target project.



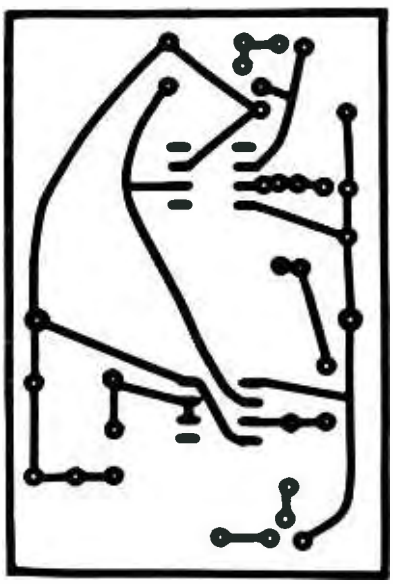


Fig. 2. Actual-size etching-and-drilling guide for fabricating printed circuit board.

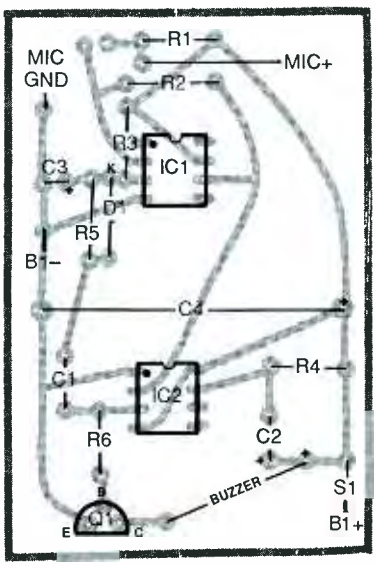


Fig. 3. Wiring guide for pc board. Use this for component layout if you wire on perforated board.

to an electrical signal that is then coupled through capacitor *C1* and fed into the inverting (–) input of operational amplifier *IC1* at pin 2. The negative peak of the amplified signal at *IC1*'s pin 6 output is then passed to the pin 2 "trigger" input of timer *IC2*, which is configured as a monostable multivibrator. The trigger pulse delivered to *IC2* is then internally stretched to about 2 seconds in duration.

Triggering *IC2* causes a positive output to appear at output pin 3. This positive signal sends transistor *Q1* into conduction to complete the electrical circuit from the positive side of battery *B1* through the two-tone piezoelectric buzzer to circuit ground. The result is that the buzzer sounds to audibly register the hit. Once pin 3 of *IC2* goes high, *IC1*'s noninverting (+) pin 3 input is taken more positive through diode *D1*.

When *IC2* times out, *D1* becomes reverse biased, causing *Q1* to stop conducting and silencing the piezo buzzer. With *D1* reverse biased, the voltage at pin 3 of *IC1* starts to discharge through the RC network made up of *R3, R5* and *C3*. The voltage at pin 3 of *IC1* will remain high long enough to allow the buzzer to completely turn off. The RC network and capacitor *C4* prevent the piezo buzzer from falsely triggering.

Construction

Since there is nothing critical about circuit layout, assembly of the Audible Target can be accomplished using any traditional wiring technique. If you wish, you can etch and drill a printed-circuit board on which to mount and wire the majority of the components that make up the project, using the actual-size artwork shown in Fig. 2. Alternatively, you can mount the components on a piece of perforated board with 0.1" hole spacing and use Wire Wrap, soldering or a combination of the two types of hardware to wire the circuit. As a final choice, you can assemble the circuit on a solderless breadboarding socket.

Whether you use a printed-circuit board or a perforated board and hardware, it is a good idea to use sockets for the integrated circuits. (No sockets are needed or desirable if you assemble the project on a solderless breadboarding socket.) When you are ready to install the components on the board, follow the wiring guide given in Fig. 3. You can also use Fig. 3 as a rough guide to component placement if you are assembling the circuit on perforated board. Install the components exactly as shown, paying particular attention to the orientations of the integrated circuits, transistor and electrolytic capacitors.

Start wiring the board by plugging in and soldering into place the IC sockets. Use only enough solder on each pin to assure a good mechanical and electrical connection. Avoid using excess solder; otherwise, you might create short-circuiting solder bridges between the closely spaced

SAFETY FIRST

Any target-shooting game in which a BB or pellet is propelled at high velocity should be given the same respect one would give to a firearm. Though a BB or pellet fired by spring or compressed air (CO_2) or launched by heavy-duty elastic bands might not have the same power behind it as a bullet fired by an explosive charge, it can be dangerous nevertheless. Therefore, you should never fire these devices at anything but a properly set up target, such as the Audible Target described in this article.

Set up your target in the same manner as you would set up a firing range for true firearms. That is, make sure there is a safety backdrop to prevent off-target shots from going astray. Additionally, locate your "range" so that people cannot casually cross it and step into the line of fire. If your firing range is out of doors, post the area to alert others to its existence.

Make it a practice to conduct your target shooting with safety foremost in mind. Never fire at anything but your target. Never fire indiscriminately into the air. Always point your ready-to-fire gun or slingshot downrange, whether or not you are planning to fire it at the moment.

A final word of caution: *Never* fire an explosively propelled bullet from a hunting rifle or pistol at the Audible Target. If you do so, you will destroy the Target.

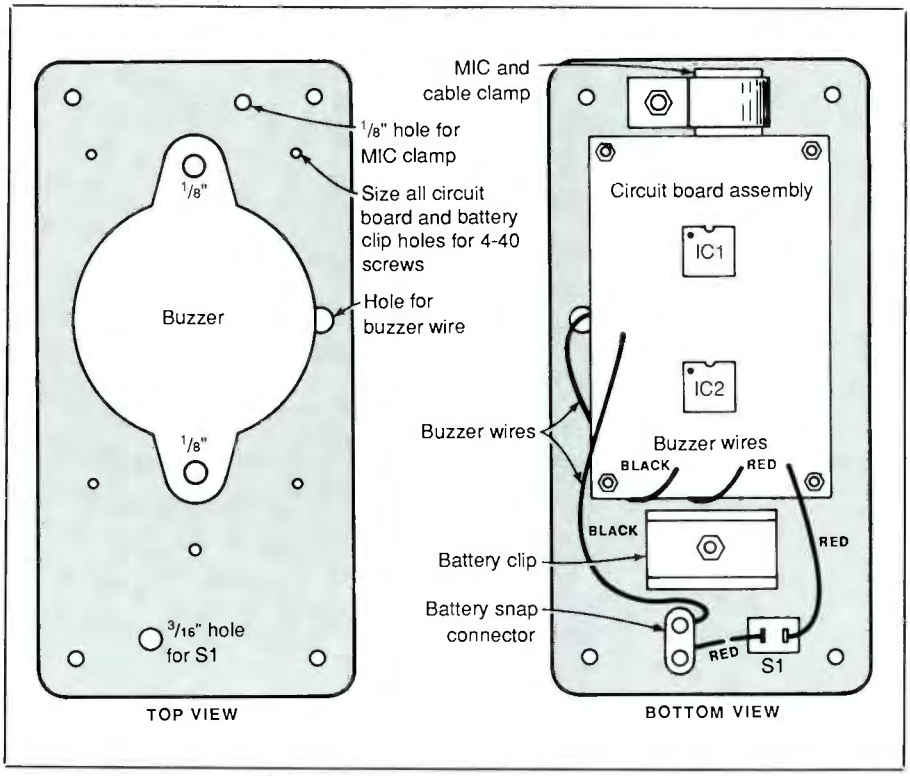


Fig. 4. Mounting details for components on lid of project box.

copper pads on the pc board. Continue populating the board by plugging in and soldering into place the resistors, the diode, and the transistor. Plug the 741 op amp into the *IC1* socket and the 555 timer into the *IC2* socket. Make sure these devices are properly oriented and that no pins overhang the sockets or fold under between sockets and IC bodies as you seat them solidly into place.

Trim ¼" of insulation from the ends of both leads of the battery snap connector, piezoelectric buzzer and microphone element wires. You have a choice between two electret microphone elements. The Radio Shack Cat. No. 270-092 element has leads already attached to it, while the Cat. No. 272-090 has no leads. If you use the leadless element, you can mount it directly on the board or solder wire leads to allow off-the-board mounting. If you go the latter route, prepare two 3" lengths of hookup wire, preferably stranded and with different colored insulation, and solder the ends of the individual wires to the contacts on the element, as shown in Fig. 3. Prepare a 3" length of red-insulated stranded wire by removing ¼" of insulation from both ends. In all cases, tightly twist together the fine wires at all prepared ends and sparingly tin with solder.

Plug one end of the red-insulated wire into the vacant hole near *C4*'s positive lead and solder it into place. Similarly, plug the black-insulated lead from the battery connector into the vacant hole near *C4*'s negative lead. Observing polarity, plug the positive (+) wire coming from the microphone element into the vacant hole between *R1* and *R2* and the ground wire into the hole at the edge of the board just above *C2*'s negative lead and solder both into place. The free ends of the red-insulated wire and the red battery connector lead will be connected later. Do not connect the buzzer leads into the circuit until after the buzzer has been mounted. Then install and solder into place the wire jumper.

Set aside the circuit-board assembly. Now prepare the metal lid of the enclosure in which you will house the project (see Parts List). First, use the circuit board as a template to mark the locations for and drill the four mounting holes. Similarly, drill the

holes for the buzzer and its leads, battery holder, microphone element clamp and mounting switch.

Line the buzzer's lead entry hole with a small rubber grommet. Pass the buzzer's leads through the grommet and mount the buzzer on the lid of the enclosure with appropriate machine hardware. Plug into the appropriate holes in the circuit-board assembly the buzzer's leads (black to vacant hole near *Q1* and red to vacant hole near lower-right with board oriented as shown in Fig.3) and solder both into place. Mount the circuit-board assembly to the lid of the enclosure with ½" spacers and 4-40 × ¾" machine screws, lockwashers and nuts.

Place a cable clamp around the body of the microphone element and mount it with machine hardware. Mount the switch on the panel with its own supplied hardware. Locate the free end of the battery connector's black wire and connect and solder this to one switch lug. The free end of the red-insulated wire coming from the board now goes to the other lug on the switch. See Fig. 4.

Strike a line down the center of the plastic enclosure's bottom. Measure 1" in from both narrow ends of the enclosure and strike a cross line on the center line. Drill a ⅛" hole at both crossed locations. Then center the plastic enclosure all around on 7" × 6" × 1" wood block (you can use any solid hardwood or pine lumber or plywood, as long as it is 1" or more in thickness) and mark the locations of the holes. Similarly, drill a ⅛" hole through both marked hole locations.

Place a flat washer on each of two 6-32 × 1¼" machine screws and feed the screws through the holes in the wood block. Place the plastic enclosure over the wood block with the screw ends aligned with the holes. Drop onto each screw end a lockwasher and follow with a machine nut. Solidly tighten the hardware to secure the plastic enclosure to the block of wood. See Fig. 5 for enclosure mounting details.

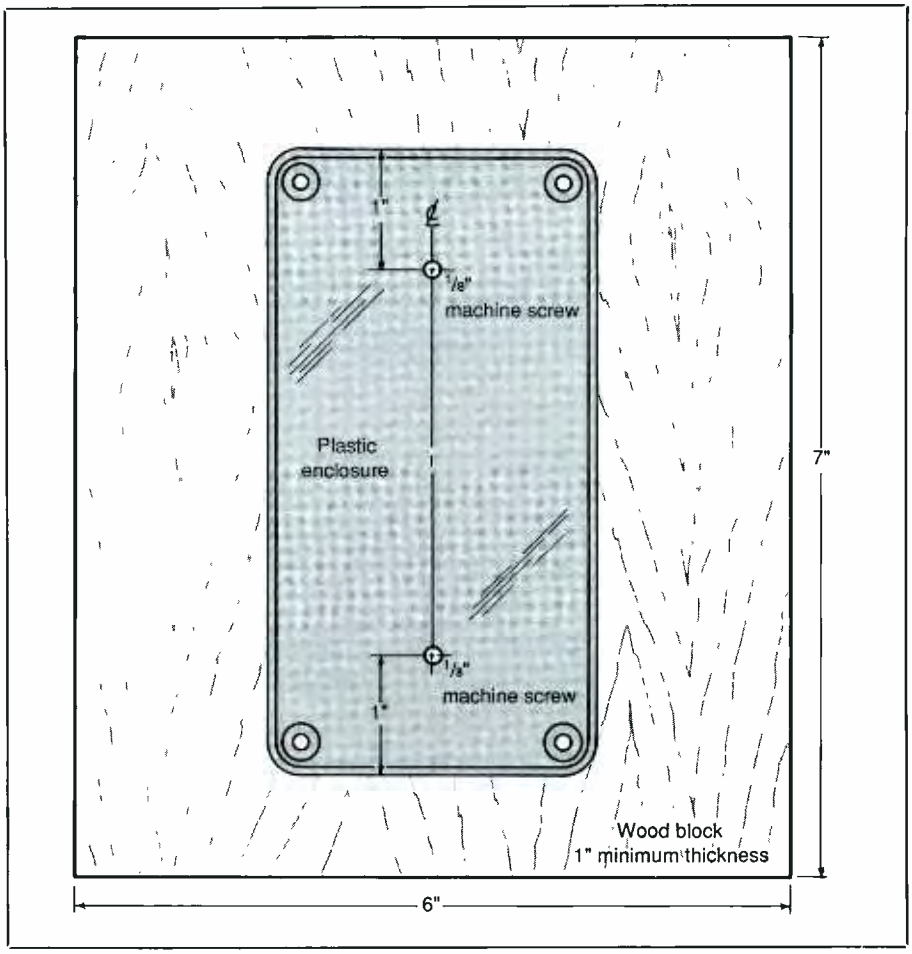


Fig. 5. Details for mounting project box on wood block.

Testing and Use

Connect a 9-volt transistor battery into the circuit by plugging it into its snap connector and flip *S1* to ON. The buzzer should immediately sound and, after about 2 seconds, should shut off. Now sharply rap the wood block with a hard object to produce a sharp-attack sound to which the circuit can respond. If everything is working properly, the buzzer should cycle on and then off. If you get these results, the Audible Target is operating properly. If not, power down the circuit and recheck all wiring and component orientations and all soldered connections.

Once the circuit is operating as described, you can finish assembly. This done, all you have to do to put the project into service is set up the Audible Target in a safe location at the distance from the "firing line" you want it to be and turn it on.

When using the Audible Target for target practice, always locate the project where there is a solid back wall to prevent BBs and/or pellets from going astray and where there is no access from the sides for casual pedestrians to pass as you are shooting at the target (also see the "Safety First" box). **ME**