

Build the SHOTGUN SOUND SNOOPER

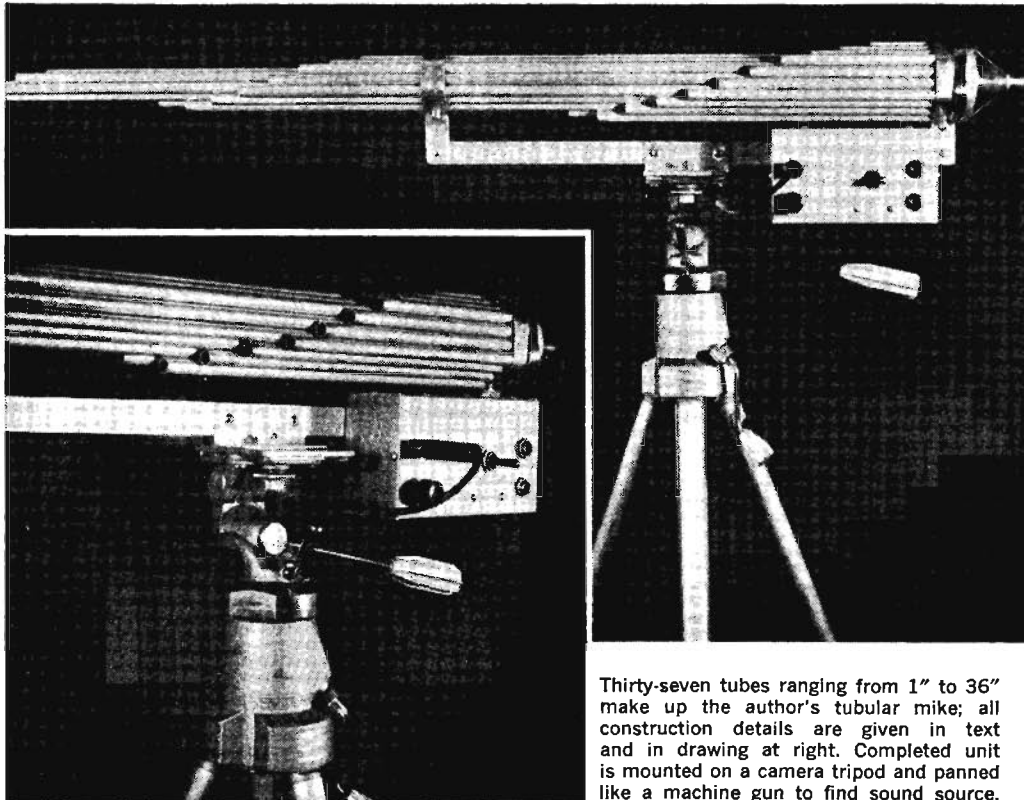
*Operating on "organ pipe"
principles, this amazing
tubular microphone
amplifies distant sounds*

By **JAMES R. HOLLINGER** and
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ONE WINDY DAY last fall, the authors hustled a skeptical friend out into a field bordering on a wooded area to test a homemade long-range tubular microphone. Waiting until the friend had crossed the field and disappeared completely, we panned the mike toward the spot where he had last been seen. At first only the sounds of birds were heard; then, on the last swing, came the sound of crashing brush and a voice mumbling "Mary had a little lamb." When we told him later that we had enjoyed his nursery rhyme, he looked at us incredulously. At a range of 250 yards, under adverse wind conditions, we had picked his voice out of the woods!

The tubular microphone, one of the less publicized but one of the most spectacular long-range listening devices, might be described as a bundle of open-end tubes designed to pick up and amplify sounds of different frequencies by virtue of different tube lengths. The principles involved are familiar: In re-





Thirty-seven tubes ranging from 1" to 36" make up the author's tubular mike; all construction details are given in text and in drawing at right. Completed unit is mounted on a camera tripod and panned like a machine gun to find sound source.

sponse to sounds of various frequencies, the air columns within each tube vibrate and, in doing so, amplify the original sounds.

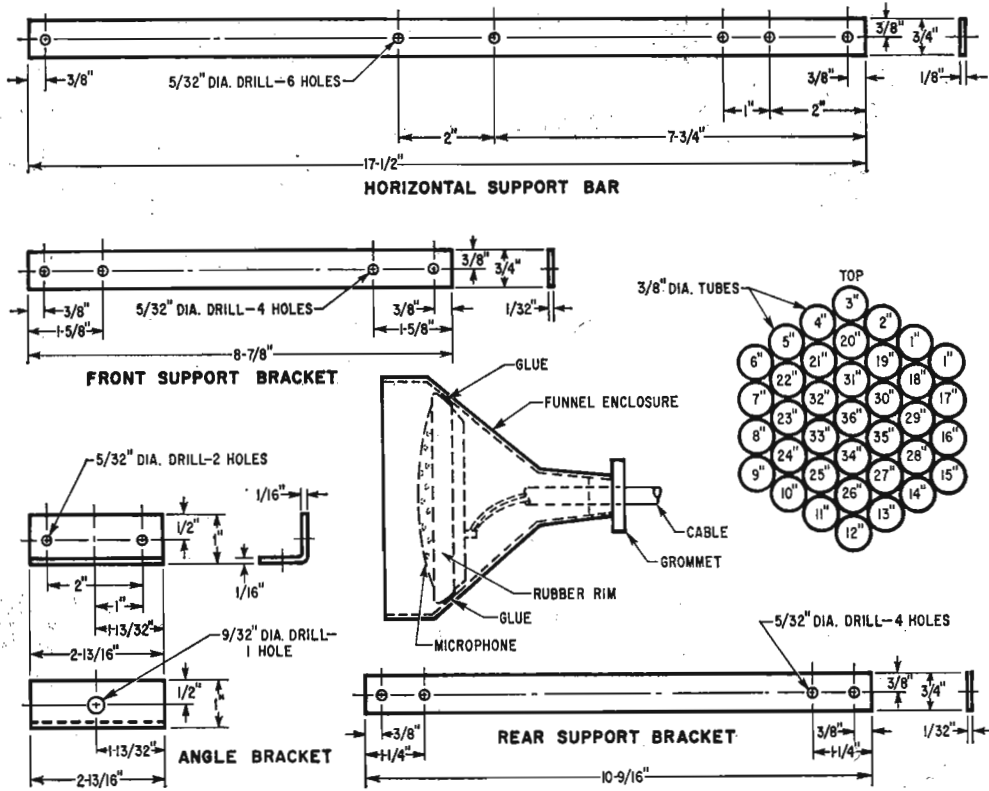
Applications of the tubular mike, which has far greater sensitivity, better frequency response, and superior directional characteristics than parabolic types, are many. Bird and animal watchers are delighted with the added dimension of sound when it is applied to nature studies. Small boat operators may find the unit of value as a navigational aid, especially in fog or conditions of poor visibility. The tubular mike can pick up conversations from busy streets, and under the right conditions, can actually pick up conversation through closed windows 40 or more yards away.

Design and Construction. As you might assume, tubes are cut to resonate over a specific range of frequencies. To calculate tube length, first find wavelength by dividing the speed of sound (1100 feet per second for practical purposes) by the frequency. For example, the wavelength of 256 cycles equals 1100

÷ 256, or 4.296 feet. *Tube length*, however, is half this, or 2.14 feet, since tubes open at both ends resonate at a wavelength twice as long as their length.

In designing a tubular mike, it is necessary only to assemble enough tubes to cover the frequency range of sounds you want to hear. The exact number of tubes is not critical, but should be the greatest number that can be efficiently covered by the microphone element. The range of tube lengths may vary too. Some builders may wish to use tubes longer than those suggested here for increased pickup of the lower frequencies. The graduated lengths should be stepped evenly from the shortest to the longest so frequency nulls are avoided.

The "Shotgun Sound Snooper", designed for portability, is built with 37 aluminum tubes, $\frac{3}{8}$ " O.D., ranging from 1" to 36" in length, and graduated in 1" steps. The 37th tube is an extra 1" length added to complete the hexagonal symmetry of the pickup. The tubes can be conveniently cut from ten 6' lengths, using a tubing cutter or fine-tooth hack-



Easily worked aluminum is used for fabricating the pickup. The tubes can be conveniently cut from ten 6' lengths of 3/8" diameter stock, the support bracket-

ets from a sheet or strip of 1/32" aluminum. The horizontal support bar is made from heavier stock. Angle bracket mounts to standard camera tripod.

BILL OF MATERIALS FOR MICROPHONE

- 1—56' length of 3/8"-O.D. aluminum tubing (ten 6' lengths preferable)
- 1—Crystal microphone cartridge, approx. 2 1/8"-diameter (Lafayette PA-27 or equivalent)
- 1—Household funnel, 2 3/4"-diameter (or equiv.)
- 1—3/4"-wide, 1/82"-thick aluminum strip for support brackets, battery bracket (approx. 2' required)

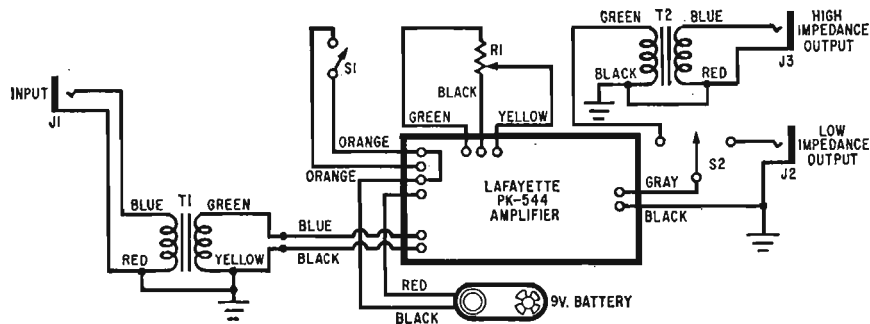
- 1—3/4"-wide, 1/8"-thick aluminum strip for horizontal support bar (approximately 1 1/2' length required)
- 1—Standard camera tripod
- Misc.—Glue (fast-drying rubber base contact cement or epoxy glue), 8-32 machine screws and nuts, rubber grommet, microphone cable, solder, etc.

saw. Dress the edges with a fine file to remove burrs. Assemble the tubes as shown in the drawing above, starting with the 36" length and gluing the 35" tube to it for the entire length. The authors used fast-drying rubber base cement, but epoxy glue can be used for greater strength. In any case, be sure the tubes are flush at one end by checking each one against the others as you glue them in place. Don't worry about the spaces between the tubes; they simply become air columns.

Cut and drill the front and back support brackets from easily worked 1/32"-

thick aluminum as shown in the drawings. The brackets are shaped around the tubes to form a tight fit; it will help if you bend each one at the exact center to form a slight V before you shape it. Make the horizontal support bar from 1/8" aluminum as shown, and cut off a piece of aluminum angle to form the angle bracket.

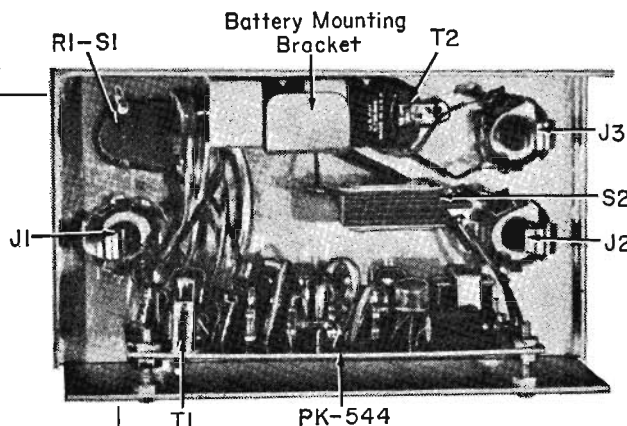
Cartridge Mounting. The microphone cartridge enclosure is made from a 2 3/4"-diameter household funnel, but can be improvised from sheet metal. The shape of the enclosure is not important, provided it permits the microphone car-



Wire amplifier and other components as above; T2, S2, J3 are optional.

AMPLIFIER PARTS LIST

- J1, J2, J3—Standard open-circuit phone jack
- R1—10,000-ohm miniature potentiometer with s.p.s.t. switch S1 (Lafayette 32-G-7364 or equiv.)
- S1—Part of R1
- S2—S.p.d.t. toggle switch
- T1—Transistor input transformer; 200,000-ohm primary, 1000-ohm secondary (Lafayette 99-G-6034 or equivalent)
- T2—Transistor output transformer; 2500-ohm primary, 11-ohm secondary (Argonne AR-114 or equivalent)
- 1—Lafayette PK-544 5-transistor audio amplifier or other high-gain amplifier
- 1—9-volt transistor battery (Burgess 2U6 or equivalent)
- 1—Aluminum box, approximately 2 1/8" x 3" x 5 1/4" (LMB #136 or equivalent)
- 1—Miniature knob (Lafayette 32-G-2405)
- 1—18" length of single-conductor shielded microphone cable
- 1—Set of headphones, high or low impedance
- Misc.—4-40 x 3/8" machine screws and extra nuts, scrap aluminum, contact cement or epoxy glue, wire, solder, etc.



Follow parts placement indicated (unit is inverted in this photo) to avoid possible feedback problems.

tridge to be mounted very close to the ends of the tubes. Hold the wide end to the tube cluster and mark the sides to indicate the corners of the hexagonal shape. Place the funnel on a smooth, solid surface, and make dents at each of the six corners of the hexagon with a small ball peen hammer. With the flat head of the hammer, flatten the areas between the indentations for about 1/4" in from the edge of the funnel. Place it over the end of the tube cluster and peen again if necessary. A tight sliding fit is desirable, but a loose fit can be remedied with tape.

As shown in the drawing on page 63, the rubber-rimmed microphone cartridge is mounted in the funnel with

glue. It is important at this point to make sure the cartridge will position as close as possible to the ends of the tubes without actually touching them when the enclosure is fitted to the tubes. The cartridge must be insulated from the enclosure, either by the rubber rim which is part of the recommended cartridge, or by some equivalent means. The space behind the microphone element may be packed with a sound insulating material such as glass wool or foam plastic to help reduce pickup from the rear. Before placing the cartridge, first connect a length of mike cable and install a rubber grommet in the small end of the funnel; apply glue to the rubber rim of the mike cartridge and to the funnel. Press the cartridge into the funnel, truing it up and clamping it into position until the glue is dry.

Final Assembly. Place the rear support bracket over the tube cluster 1/4" forward of the flush end and tighten it onto the

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(Continued from page 64)

cluster with a 6-32 x $\frac{3}{8}$ " machine screw and bolt. Install the front bracket the same way, and slide the horizontal support bar between the brackets, aligning the holes in the bar with the lower ones in the brackets. Bolt the horizontal bar in place along with the angle bracket for mounting the microphone to the pan head of a camera tripod. Now fit the microphone enclosure over the tubes; it can be taped on if necessary with a strip of masking or metalized Mylar tape around the enclosure and the rear support bracket. The Mylar tape is not necessary, but looks better.

The Amplifier. Weak or distant sounds naturally require a high-gain amplifier. Tube type amplifiers, because of their inherent hum at high gain settings, definitely are not recommended. The five-transistor Lafayette PK-544 is an ideal choice for this purpose, and the cost is low. The high-impedance microphone cartridge is matched to the low-impedance amplifier input with a transformer. As 8-11 ohm output transformer is an integral part of the PK-544. The high-impedance output shown in the schematic on page 64 is optional; $T2$, $S2$, and $J3$ may be omitted if low-impedance output will suffice.

The PK-544, $R1$, $S1$ (part of $R1$) $T2$, $S2$, and $J1$, $J2$, and $J3$ are mounted in half of a $2\frac{1}{8}$ " x 3" x $5\frac{1}{4}$ " aluminum box (LMB #136). As a matter of convenience, the authors first mounted input transformer $T1$ to the board of the PK-544 amplifier. To do this, you bend off the mounting tabs of the transformer. Then apply quick-drying cement to the bottom of $T1$ and to an open area on the amplifier board near the input leads. Mount transformer $T1$ in this area.

When the cement is dry, remove the PK-544 input leads where they fasten to the board. Referring to the schematic, trim the low-impedance leads of $T1$ and solder them to the board where the original input leads were attached. The high-impedance primary of $T1$ is later connected to $J1$.

As shown in the photo on page 64, the PK-544 is mounted with four 4-40 x $\frac{3}{8}$ " machine screws and extra nuts to the top of the box. Tighten the screws with nuts, then use eight more nuts, four above and four below, to mount the board so it is well away from the metal box. Mounting holes are already drilled in the PK-544; disregard the mounting hardware that comes with it.

Drill holes in the front of the box for mounting the three jacks, controls $R1$ - $S1$, and transformer $T2$. Drill a hole in the bottom of the box for the battery mounting bracket which is made of a piece of scrap aluminum. Referring again to the photo and schematic on page 64, mount and wire the remaining components, cutting any excess leads. In general, it's a good idea to follow the arrangement shown to avoid possible feedback problems.

The bottom section of the box is fastened to the horizontal support bar of the tubular pickup unit by means of two 6-32 $\frac{3}{8}$ " screws and matching nuts. Place the top section of the box with the mounted amplifier components onto the bottom section, fasten with the screws provided, and the completed unit is ready to use.

Operation. Operation of the "Shotgun Sound Snooper" is simple—just connect a pair of headphones and turn on the amplifier, adjusting the volume control carefully to avoid painful sound volume. Earplugs or single phones are not suitable for critical listening. For best results, use good-quality dual headphones.

The tubular mike must be aimed toward the location from which sound pickup is desired—sight along the tops of the tubes and turn the volume up gradually. Picking up weak distant sounds amidst other distracting sounds becomes much like trying to listen to a newscast in a room filled with noisy people. It becomes necessary to mentally "tune out" the unwanted sound in order to concentrate on the news.

Wind has the effect of carrying sound, so straight-on reception is not always possible. Under windy conditions, the unit should be panned until the best reception is achieved as determined by ear. Noisy winds can spoil listening—especially if the tube ends cannot be sheltered a bit—but moderate wind noise

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can be cut down by draping the mike with a cloth.

If you enjoy experimenting, you'll find the "Shotgun Sound Snooper" a unique, fascinating project. Endless variations are possible, of course—in tube length and diameter, in the microphone cartridge, the amplifier, etc. Just as endless are the applications you'll find for the microphone. Construction is easy, and the cost is reasonable. Don't delay! ~~—30—~~