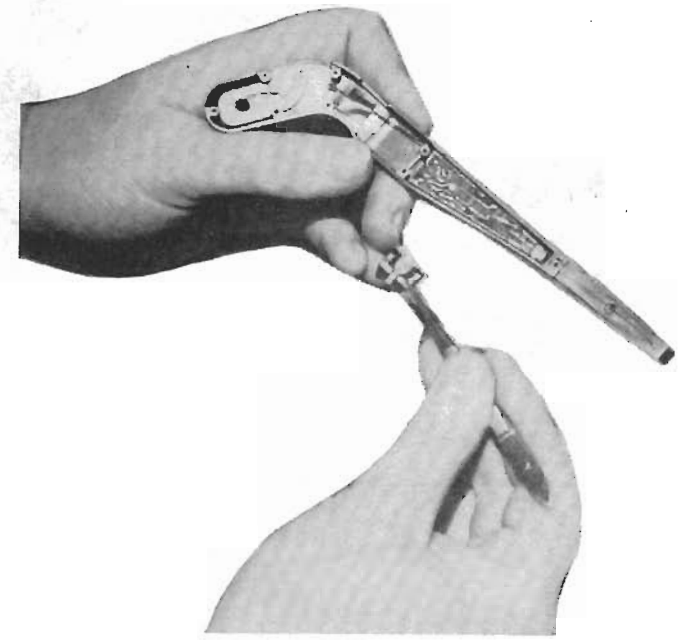


Fig. 1—The "eyeglasses" hearing aid shown here incorporates an electronic amplifier and volume control in its temple frame.

Servicing Transistorized Hearing Aids

- *How They Work*
- *Repair Methods*
- *Obtaining Parts*

LEO G. SANDS

• The public spends around $60,000,000 for 300,000 new hearing aids every year. Many different types are available, such as the eyeglass temple-type shown in Fig. 1. No figures have been published on how much is spent for servicing hearing aids. But, it is a significant number, you can be sure.

The standard price charged by hearing aid repair specialists for repair and overhaul of a transistor hearing aid is $12.50 and $7.50 for tube type aids. These prices include parts, but no batteries. The repair jobs are seldom performed by a hearing aid dealer. Instead, the dealer often ships ailing hearing aids to one of the few specialized shops where this kind of work is done, or to its manufacturer.

Many hearing aid dealers specialize in the *sale* of new hearing aids and confine servicing to replacement of cords, batteries and ear pieces. He chooses to send hearing aids to a distant city for repairs because none of the electronics service shops in his town has *asked* him to farm out his repair business to them.

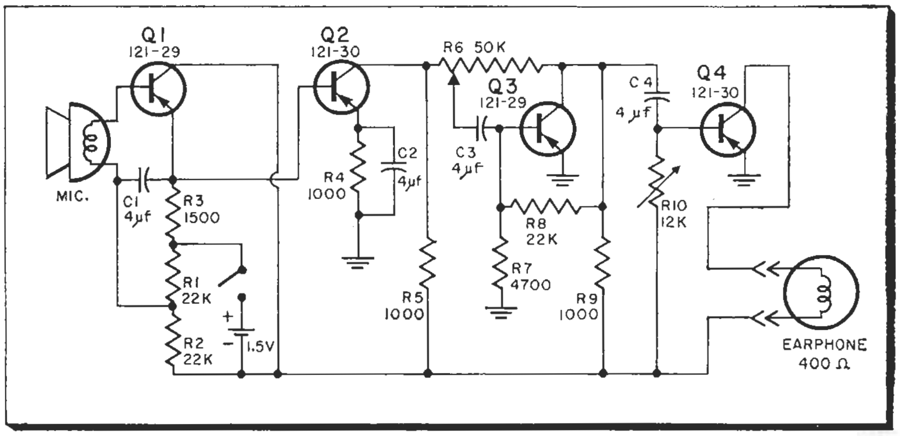
There is nothing mysterious about a hearing aid. It is a very simple PA ("private" address) system consisting of a microphone, an amplifier and an earphone or bone conduction transducer. To see how really simple a hearing aid is, let's examine the circuit of one of the popular makes, a Zenith model 50R, shown schematically in Fig. 2.

The microphone output signal is fed directly to the base of Q1 and to the emitter through C1. Bias is developed across R3 and is augmented by the voltage fed to the base from the junction of the voltage divider R1-R2. The signal developed across R3 is fed directly to the base of Q2, functioning as a common emitter amplifier. The signal developed across R5 is applied through C3 to the base of Q3 whose output signal is developed across R9 and is fed through C4 to the base of Q4. The varying collector current (output) of Q4 passes through the coil of the 400-ohm earphone.

The circuit is conventional except for the manner in which volume is controlled. Fig. 3A shows how the third-stage circuit looks when the volume control is set for minimum gain. Q3 is essentially out of the circuit. The signal voltage developed across R5 is also developed across R6 and R9 which form a 50:1 voltage divider. Hence, there is a 34 db loss through the third stage.

When the volume control is set to

Fig. 2—Schematic diagram of a Zenith Model 50R Hearing Aid.



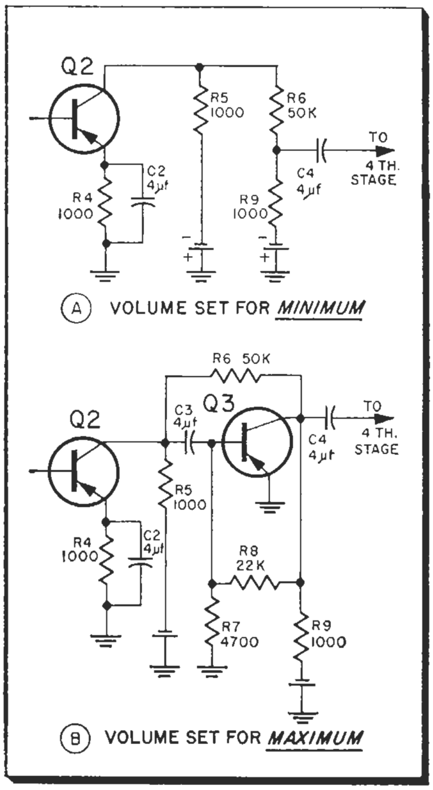


Fig. 3—Equivalent circuits of Zenith Model 50R when volume is set for minimum sound (A) and maximum sound (B). See text!

its maximum gain position, the circuit is as shown in Fig. 3B. The transistor Q3 is now in the circuit. The signal voltage developed across R5 is applied to the base of Q3 through C4 and is developed across R7. But, also appearing across R7 is an out-of-phase feedback voltage from the collector of Q3 whose value is determined by the ratio of R7 and R8 as well as the gain of Q3. In addition, the output signal developed across R9 is fed back through R6 to the input of Q3. The magnitude of this feedback voltage is determined by the gain of the transistor as well as the ratio of R6 to R5, which is 50:1. The feedback through R8 is the same at all frequencies while the feedback through R6, which must pass through C4, has less effect as frequency decreases because of the rising reactance of C4.

R7 and R8 also bias the base of Q3 at the desired d-c value. R10 in the input circuit of Q4 affects gain as well as bias.

It should now be obvious that there is nothing complex about a hearing aid amplifier. But, let's look at another circuit. Fig. 4 is a schematic of the Conny model T2 hearing aid which also employs a four-stage transistor amplifier. All

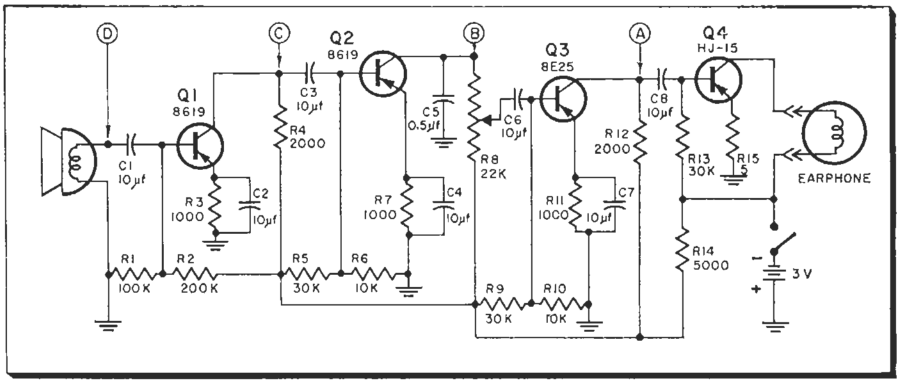


Fig. 4—Conny Model T-2 Hearing Aid that uses a conventionally-wired volume control circuit.

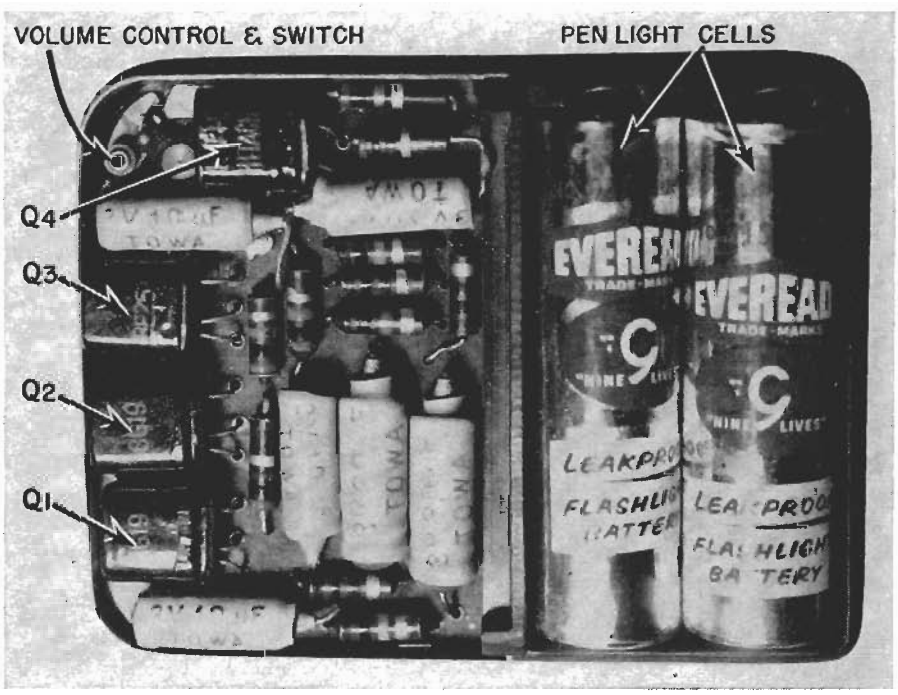
stages employ the grounded emitter connection. In the fourth stage, feedback is provided by leaving R15 unbypassed and by the loop, consisting of R16 and C8, from the collector back to the base. Power is derived from a pair of 1.5-volt penlight cells. Fig. 5 illustrates the unit pictorially.

Troubleshooting

What can go wrong with a hearing aid? The most common trouble is a dead battery. The easiest way to find out, of course, is to replace the battery. Earphone cords are a common source of trouble. Earphones and microphones can also go bad. These troubles can be remedied without requiring any skill in electronics.

To determine if it is the amplifier, earphone or its cord that is defective, simply remove the earphone plug from the amplifier output jack. Connect a d-c voltmeter in place of the earphone plug, turn the hearing aid on and talk into the microphone. There should be voltage and its reading should increase as you talk closely into the microphone. Or, connect a d-c milliammeter through a 200 to 450 ohm resistor to the output terminals. When talking into the microphone, the current reading should increase because of the action of the class B amplifier. If the amplifier is equipped with an output transformer, use an a-c voltmeter or VTVM. It should read zero when no sound is picked up. Output voltage should exist and vary when

Fig. 5—Pictorial view of a Conny T-2 Hearing Aid, showing major components.



talking into the microphone. If these tests are passed, but you can hear nothing when the earphone is plugged in, you can assume that the amplifier is functional and that the earphone, its cord or its plug is defective.

Diagnosing amplifier troubles

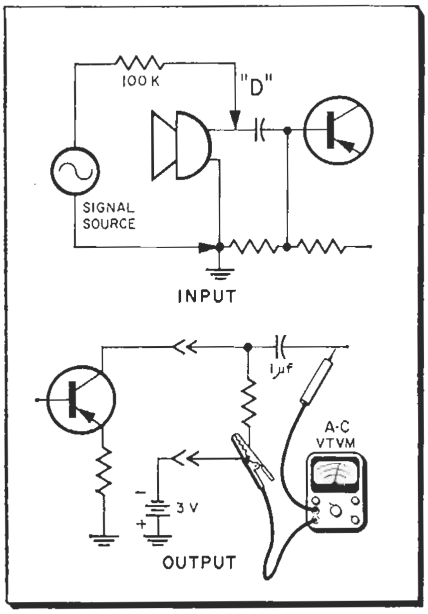


Fig. 6—Practical test set-up for checking the overall gain and frequency response of a transistorized hearing aid.

requires skill, but not a great deal. In the first place, it is a simple electronic audio amplifier. But, because of its compactness, good eyesight and careful workmanship are required. What can go wrong with a hearing aid amplifier? Resistors can change in value, capacitors can open, short or become leaky, and transistors can go bad.

The first step is to make a visual inspection, looking for goo running out of capacitors, dirt, corrosion and broken connections. Don't expect to find scorched resistors since the voltages are so low that current flow through resistors is extremely small.

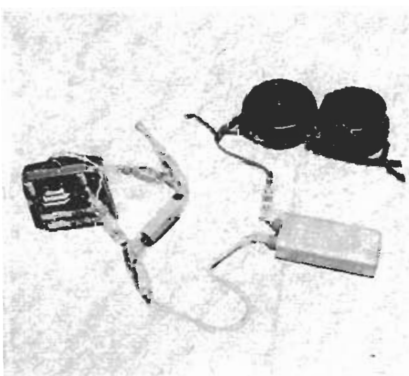
Once it has been determined that the transistors and battery are good, signal tracing is the next step. With a hearing aid earphone or an ordinary radio headset connected to the output jack, you're ready to proceed. You need an audio signal source. If you're using an audio signal generator, be sure to ground the signal generator case. Also, connect the signal generator's grounded output lead to the ground bus or case (if it is grounded to the circuit) of the hearing aid. Apply a 1000-cycle signal through a 100,000-ohm resistor, using one of the resistor leads as a probe, successively to the input of each amplifier stage, starting with the last stage. Typical signal injection points are identified as A, B, C and D in Fig. 4.

You should hear a tone when you apply the signal to point A. When you apply the signal to points B, C & D, the tone should get progressively louder. Be sure the hearing aid volume control is turned up and keep reducing the output of the signal generator as you progress toward the head end of the amplifier. If you do get tone when you apply a signal at point B, but you get none when feeding signal to point C, you have trouble in the second stage. When you apply signal to point A, you might hear the tone through the microphone, functioning as a loudspeaker.

You can measure overall gain and frequency response by applying a signal to point D and measuring a-c output voltage across a dummy load as shown schematically in Fig. 6. Monitoring an output section with headphones is shown in Fig. 7.

Hearing aids, like other electronic devices, last longer and work better if given periodic preventive maintenance. Cleanliness is most important. Amplifiers worn close to the human body are subjected to heat and moisture. Leaky batteries can contaminate parts. Earphones are apt to become clogged with wax. A simple way to clean amplifiers and earphones is to dunk them into a cleaning solution, using an ultrasonic cleaning system. In a matter

Fig. 7—Monitoring a hearing aid's output with headphones. The phones are shunted across a resistor through a 1µf capacitor.



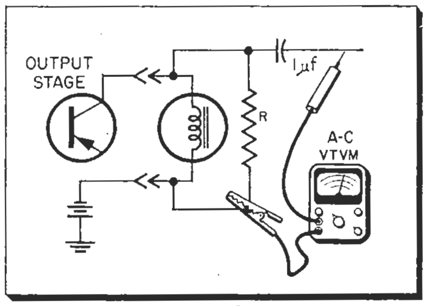


Fig. 8—Test set-up for finding the impedance of a headset, using an a-c meter to indicate voltage drop at R.

of seconds, they will be amazingly clean. Remove batteries first, and make sure the cleaning solution will not dissolve any of the parts. Manufacturers of ultrasonic cleaning systems generally provide information on which cleaning fluid to use for various applications.

Parts Problems

It may be difficult to get parts or information from some hearing aid manufacturers who want to restrict all servicing to themselves or their dealers. If you run into unmarked or unknown transistor types, you can quickly determine which lead is base, collector and emitter if you have an in-circuit transistor tester. Merely try the test leads in various combinations. When you find the right combination, the tester gives an indication, if the transistor is operative. You can also determine if it is PNP or NPN and its beta.

To determine the impedance of an earphone, measure the a-c voltage across it as shown in Fig. 8, trying various values of R. When the voltage is twice as great with R disconnected than it is with R connected, the impedance of the earphone is approximately equal to the value of R.

The resistors and capacitors used in hearing aids are usually standard types available at radio parts jobbers. Volume controls and transformers may be special. Microphones and earphones are usually available from firms specializing in these miniaturized devices. Cords, plugs and other accessories are available from such firms as those listed in the Chart I.

To get into the hearing aid am-

(Continued on page 50)

Hearing Aids

(Continued from page 32)

plifier repair business, you must establish sources of supply for cords, plugs and other special parts. Some hearing aid manufacturers will furnish service manuals. Some will not. See Chart II for a list of major hearing aid manufacturers). If you're going to do farmed-out work for hearing aid dealers, they should be able to help you get parts and servicing information.

CHART I

Parts & Accessories Suppliers

A. J. Schneider, Reading, Mass.

ADCO Distributors, 631 15th St., Denver 2, Colo.

All-Makes Hearing Aid Exchange, Mellie Esperson Bldg., Houston 2, Tex.

Danavox, c/o Rye Sound Co., 145 Elm St., Mamaroneck, N. Y.

Hal-Hen Co., 3614 11th St., Long Island City 6, N. Y.

Hearing Mart, 84 Ellis St., San Francisco, Calif.

Mears Radio Hearing Device Corp., 145 Elm St., Mamaroneck, N. Y.

Shelby Instrument Co., 1701 Magnolia Ave., Long Beach, Calif.

The standard price, $12.50, is fair compensation for a repair job, including parts. Seldom will you find more than one defective part or transistor. Cords, plugs, earphones and batteries are extra, since they are expected to require frequent replacement. •

"The picture's fine but I can't get channel 2."

CHART II

Hearing Aid Manufacturers & Distributors

Acousticon International, 95-25 149th St., Jamaica, N. Y.

Audio Company of America, 401 W. Jackson St., Phoenix, Ariz.

Audiovox, 123 Worcester St., Boston 18, Mass.

Beltone Hearing Aid Co., 2900 W. 36th St., Chicago, Ill.

Dahlberg Co., (Motorola), Golden Valley, Minneapolis 27, Minn.

Danavox, c/o Rye Sound Co., 145 Elm St., Mamaroneck, N. Y.

Gem Earphone Co., 89 E. Jericho Trnpke, Mineola, N. Y.

Hal-Hen Co., 36-14 11th St., Long Island City 6, N. Y.

Kendall Laboratories, Inc., 440 E. Las Olas Blvd., Ft. Lauderdale, Fla.

Lafayette Radio, 165-08 Liberty Ave., Jamaica 33, N. Y.

Maico Electronics, Inc., 21 No. Third St., Minneapolis, Minn.

Muller-Ernesti, Hamburg-Wandsbek, Germany

Nichols & Clark, Inc., Hathorne, Mass.

Otarion Listener Corp., Ossining, N. Y.

Paravox, Inc., 2056 E. Fourth St., Cleveland 15, Ohio

Qualitone Co., Linden Hills Station, Minneapolis, Minn.

Radioear Corp., Valley Brook Rd., Canonsburg, Penna.

Sears, Roebuck & Co., Chicago, Ill.

Sonotone Corp., Elmsford, N. Y.

Superior Hearing Aid Co., 411 W. 7th St., Los Angeles 14, Calif.

Telex, Telex Park, St. Paul, Minn.

Tonemaster Mfg. Co., 128 S. Monroe, Peoria, Ill.

Trans-Audio Corp., 45 Bromfield St., Boston 8, Mass.

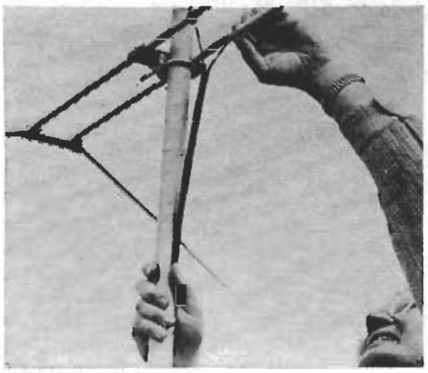
Vicon Instrument Co., Vicon Bldg., Colorado Springs, Colo.

Zenith Radio Corp., 5801 W. Dickens Ave., Chicago 39, Ill.

CBS TOOL

"Kwik-Klip," for quick and easy TV antenna lead replacement, provides simple, one-hand, clip-on operation. Its use eliminates the bother of removing rusted or corroded nuts and bolts to replace the antenna lead-in; and avoids unnecessary danger when working on roof tops. Its use is also reported to improve reception and restore the original signal strength in many older installations. CBS Electronics, Danvers, Mass.

For more data, circle 2-51-2 on coupon, p. 46



For more data, circle 2-51-1 on coupon, p. 46