remote transistor ear

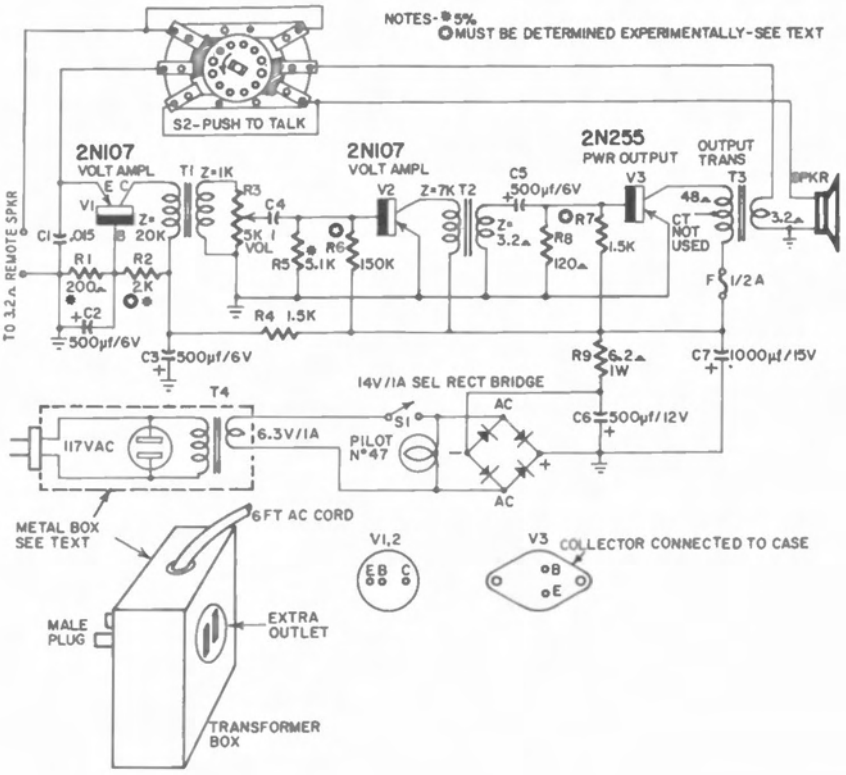
Now that low-priced power transistors are generally available, you can build transistor equipment with power output equal to that obtainable with vacuum tubes. The intercom described here is an all-transistor device which plugs into the 117-volt ac power line. It has an audio output of approximately 1 watt which is instantly available as no warmup time is required.

There are three transistor audio stages, and a selenium bridge rectifier for the power supply. The circuit is simple and conventional except for the input stage, which is connected as a common-base amplifier. This configuration does not require an input transformer since its input impedance is low enough to work directly from speaker voice-coil impedances. Eliminating the input transformer also reduces the possibility of hum pickup by the input stage and results in a quiet, high-gain amplifier. The .015 μf ceramic disc capacitor (C1 in Fig. 401) connected across the amplifier's input eliminates broadcast-station interference when the intercom is used with a long remote-speaker line. The rest of the amplifier circuit is straightforward, employing transformer-coupled common-emitter stages.

All parts are standard and readily available, with the possible exception of output transformer T3. (The original model used an Acme Electric Corp. T-24041. If you cannot obtain this unit, you can use a Thordarson TR-61.) The primary's ct is not used and only the 3.2-ohm tap on the secondary is shown on the diagram. The power transformer (T4) is a 6.3-volt heater transformer with a 1-ampere rating.

No attempt was made to miniaturize the unit. Plenty of room was available for standard components on the 6½ x 4-inch chassis. Standard components also reduce the cost of parts.

The 2N255 power transistor is plugged into a nine-pin miniature tube socket with no heat sink for the collector. Its case must be insulated from the chassis. A heat sink is not required because the power input to the 2N255 is limited to 1.25 watts, or half the transistor's maximum dissipation rating.



parts list for remote transistor ear

Resistors: R1—200 ohms, 5%; R2—2,000 ohms, 5%; R3—5,000 ohm potentiometer, audio taper; R4—1,500 ohms; R5—5,100 ohms, 5%; R6—150,000 ohms; R7—1,500 ohms; R8—120 ohms; R9—6.2 ohms, 1 watt (All resistors ½-watt 10% unless noted. Proper values for R2, R6 and R7 must be determined experimentally.)

Capacitors: C1—.015 µf, disc ceramic; C2, C3, C5—500 µf, 6 volts, electrolytic; C4—1 µf, metallized paper; C6—500 µf, 12 volts, electrolytic; C7—1,000 µf, 15 volts, electrolytic.

Transistors: V1, V2—2N107; V3—2N255.

Transformers: T1—interstage transformer: primary impedance 20,000 ohms; secondary impedance 1,000 ohms (Argonne AR—104 or equivalent); T2—output transformer for 50L6 or 50C5: primary impedance 7,000 ohms; secondary impedance 3.2 ohms; T3—output transformer: primary impedance 48 ohms, center tap — not used; secondary impedance 3.2, 8, 16 ohms (Thordarson TR—61 or equivalent); T4—heater transformer: primary 117 volts; secondary, 6.3 volts, 1 ampere (Thordarson 21F08 or equivalent.)

Rectifier: Rect—selenium-bridge, 14 volts dc, 1 amp (Barry Electronics Corp., 512 Broadway, New York 12, N.Y.)

Switches: S1—spst; S2—dpdt, spring-return wafer type (Centralab 1464 or equivalent.)

Miscellaneous: F—0.5 ampere fuse; fuse holder; speaker—impedance 3.2 ohms: 3-, 4- or 5-inch; pilot-lamp assembly and No. 47 bulb; chassis, 6½x4 inches; cabinet, 6½ x5½x4 inches; transformer box, 4x2⅛x1⅝ inches; male plug; 9-pin miniature tube socket; transistor sockets (2) for V1 and V2; hardware.

Fig. 401. *The remote transistor ear is an all-transistor intercom with an audio output of about 1 watt. The unit is always ready for action since no warmup time is needed.*

Hints for better construction

The parts layout is not particularly critical. In general, the amplifier follows a logical layout from left to right when viewed from the rear, with low-level components such as the small transistors and interstage transformers mounted at the left end. The output transformer, power transistor and selenium rectifier are mounted at the right end of the chassis, as shown in Fig. 402.

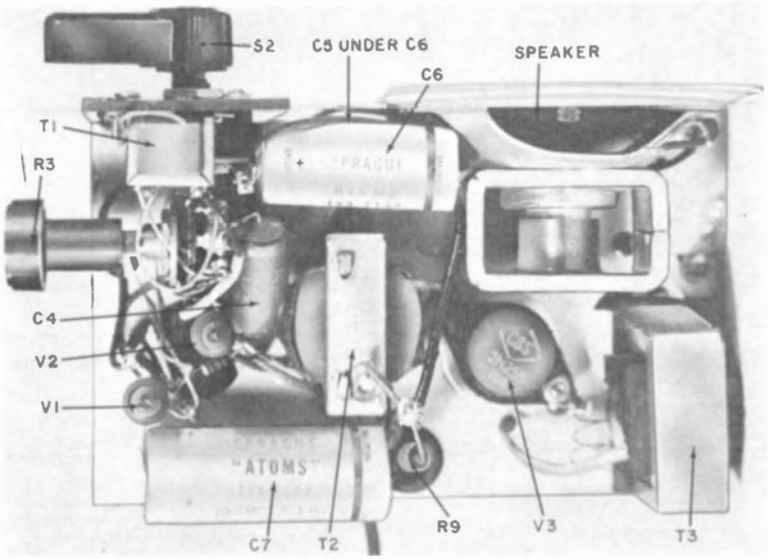


Fig. 402. *This photo shows the positioning of the components above the chassis.*

When laying out the amplifier, pay particular attention to these items to avoid possible feedback troubles:

A ½-inch separation between the speaker frame and output transformer core is minimal. If the transformer is too close to the speaker, you'll get audio feedback when the intercom speaker is used as a microphone.

The output transformer's secondary leads must be routed well from the speaker, preferably below the chassis to prevent feedback. Shield the "hot" lead and ground the shield to the chassis.

Do not mount the power transformer on the chassis. The field from the transformer will induce a 60-cycle hum in the speaker when it is used as a microphone, no matter where the transformer is placed on the chassis.

This problem is solved by completely isolating the transformer from the intercom. The transformer is mounted in a small metal

box which plugs directly into the ac outlet. The ac line running from the transformer box to the intercom unit carries 6 volts. During operation, the remote power transformer is left on continuously and the intercom switch is used to turn the unit on and off. The switch merely opens a lead to the bridge rectifier. (Fig. 403). This arrangement is practical since the transformer draws

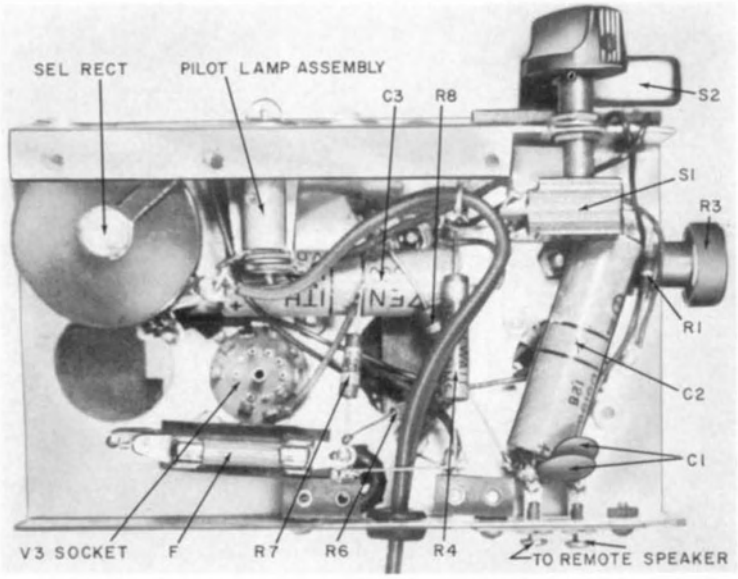


Fig. 403. *There is ample room below the chassis for mounting all the components.*

negligible power from the line, especially with the intercom switch in the off position.

Mount some of the electrolytic capacitors above the chassis since they are bulky and chassis space is available. Cover the capacitor leads with insulating tubing and route through holes in the chassis as required.

Selecting the bias resistors

The unit should be completely wired except for the base bias resistors (R2, R6 and R7) and the push-to-talk switch (S2). Connect the intercom speaker to the output transformer temporarily and connect a remote speaker to the amplifier input. Be sure the remote speaker is placed so it does not cause acoustic feedback. Connect a 500-ma meter across the fuse holder (F) with no fuse installed. The amplifier is now ready for bias adjustments of the various stages.

Connect a 5,000-ohm potentiometer in the circuit for R7 and make certain that the full potentiometer resistance is in the circuit before the power is turned on. Adjust the potentiometer for a collector current of 250 ma. Allow the 2N255 power transistor to reach full operating temperature by letting it run for about 20 minutes, meanwhile readjusting the potentiometer to keep the collector current at 250 ma. When the output stage has stabilized,

Fig. 404. *The completed intercom makes a fine appearance.*

as evidenced by no further change in collector current, check the potentiometer's resistance on an ohmmeter and install the nearest standard-value resistor permanently. Now check the collector current with the resistor installed and, if all is well, you can disconnect the milliammeter and put the 0.5-amp fuse in its holder.

Follow the same procedure to determine the proper bias resistor for the driver stage, starting with approximately 300,000 ohms for R6. Adjust the 2N107's collector current to 1 ma and again allow sufficient time for the stage to stabilize with respect to collector current.

If collector current cannot be limited to 1 ma, the 2N107 transistor should be replaced with another. Some transistors have a tendency to draw excessive current even with zero bias when operated near maximum ratings of 5 volts or so, due to the lack of uniformity. Such transistors will still perform satisfactorily in low-level low-voltage applications.

When adjusting the bias of the common-base amplifier stage, use a 5,000-ohm potentiometer to determine the value of R2. You will find that the base voltage adjustment for a given transistor is fairly critical. Low emitter-base voltage will result in low collector current and noise with low amplification.

As the emitter-base voltage is increased, the thermal noise heard in the speaker is gradually reduced and amplification increases

noticeably. If the bias adjustment is carried too far, the useful amplification will drop and the amplifier will cease to function. The proper adjustment for maximum gain is just below that point. You will find that the easiest way to make this bias adjustment is to place the remote test speaker in a quiet location and use the ticking of an alarm clock as the signal source.

After adjusting the bias on the various stages and checking the amplifier for stability, wire in the PUSH-TO-TALK switch. If the amplifier tends to oscillate on talk-back, reroute the output transformer lead to minimize feedback. Careful routing of the output transformer's output lead is very important.

The routing of this lead is particularly critical where it connects to the push-to-talk switch, since it is close to the amplifier input at this point. The best procedure is to shield the lead and move it around until there is no feedback on talk-back with the gain nearly wide open. During this test be sure that the remote speaker is far enough from the master unit so you will not be fooled by a case of acoustic feedback.

Most of the time electrical feedback cannot be completely eliminated with the gain wide open on talk-back.

Final steps

It will probably be necessary to treat the cone of the intercom speaker. If the speaker size is less than 5 inches, it tends to produce distortion when used as a microphone because of the thinner cone material used in such a small unit. If distortion is experienced on talk-back, give the speaker cone two coats of shellac to increase the diaphragm stiffness. Shellac the flat conical section only and leave the ribbed outer section near the frame untouched. This will give you a relatively stiff diaphragm with a flexible suspension. This way, performance as a microphone is greatly improved without impairing its performance as a loudspeaker.

No station-selector switching system was built into the unit because this feature was not desired. However, a regular station-switching system may be added if you want more than one remote station. (The photo in Fig. 404 shows the completed unit installed in its cabinet.)

If excessive thermal hiss develops after the intercom has been in service for a while, it is an indication that the first stage has changed characteristics due to transistor aging. This may be corrected by determining a new value for bias resistor R2. Low-noise transistors are available, so if you feel that the residual amplifier

noise is objectionable, after bias adjustment, try a 2N189 in place of the 2N107 (V1).