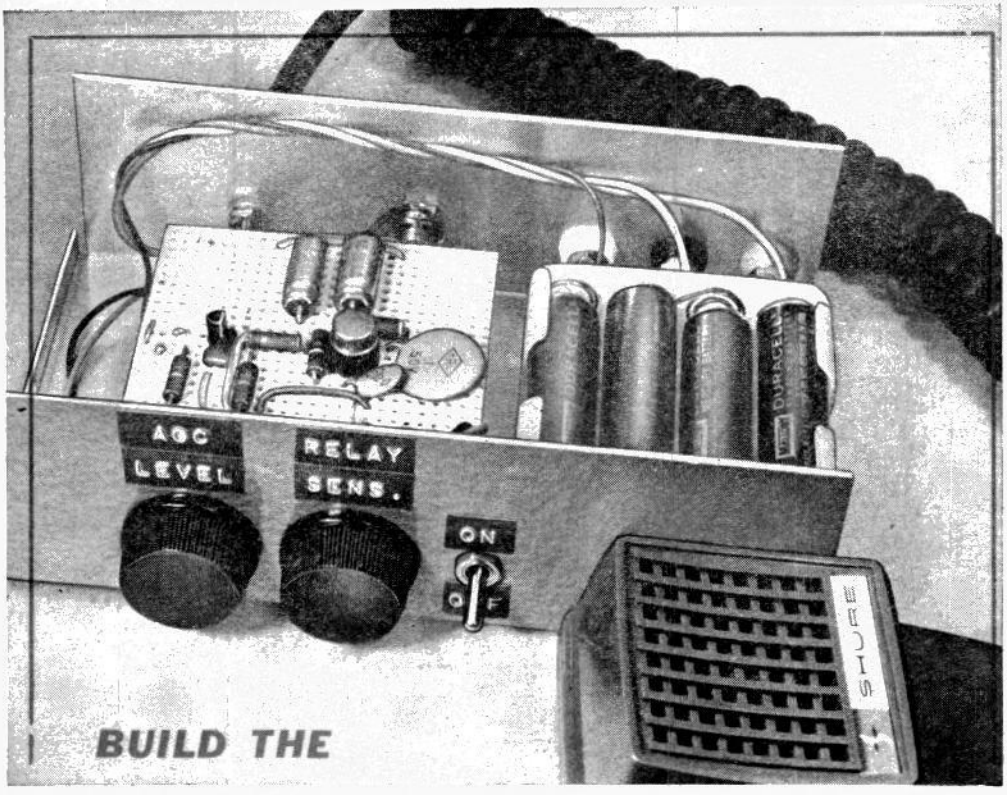


BUILD THE VOXOR

A VOICE-OPERATED MICROPHONE WITH SPEECH COMPRESSION

BY ROBERT A. HIRSCHFELD

HOW WOULD YOU like a microphone system that operates without a push-to-talk switch and compensates for differences in voice levels automatically? Whether you are using a tape recorder, ham or CB rig, these are real advantages. You can get both of them by building the "Voxor," a unit that has a voice-operated relay (VOX) and speech compression (audio a.g.c.)—features that are normally found only in expensive military and commercial equipment.

The Voxor uses the new National Semiconductor LM370 integrated circuit and is connected between your microphone and recorder or transceiver. All you do is start to talk and the system turns on immediately. When you stop talking, and if you're using a transceiver, it will switch immediately to the receive mode. In the meantime, while you are talking, the Voxor output will be at a nearly constant, high-modulation level.

Construction. The circuit of the Voxor (see Fig. 1) can be built on either perf board or on a printed circuit board. A possible layout is shown in Fig. 2. Components not shown in the figure are below the perf board. To make wiring easier, it is suggested that a 10-pin integrated circuit socket be used for *IC1*. Once the board is complete, it can be mounted on standoffs and connected to the external components.

On the prototype shown in the photos the a.g.c. level potentiometer *R2*, the relay sensitivity potentiometer *R9* and the power on-off switch *S1* are mounted on the front of the chassis. The micro-

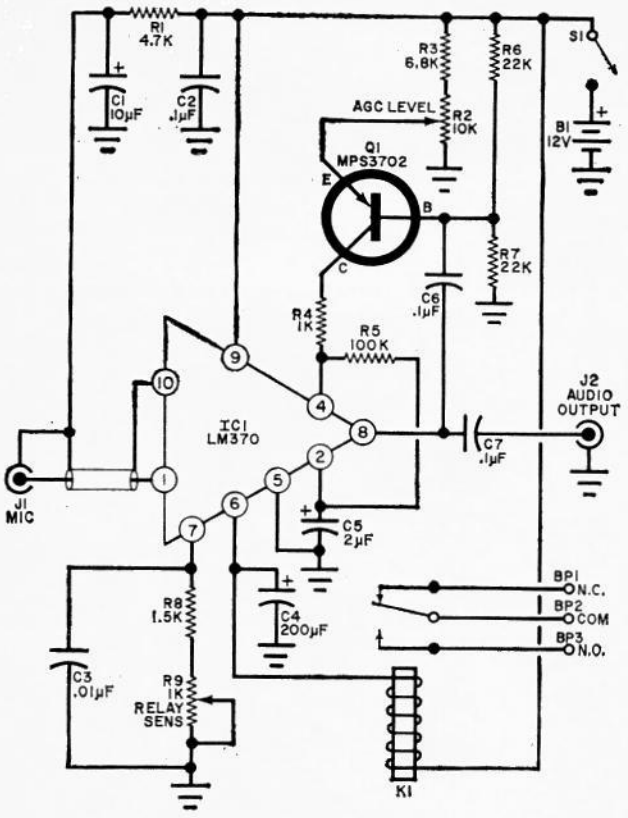


Fig. 1. The circuit is not a speech clipper but a legitimate speech compressor. When connected to a radio telephone transmitter or a tape recorder, the circuit will maintain a high modulation level with the speech clarity of the original input. As a bonus, the circuit will also operate a relay that can be used to switch the transceiver on or start a tape machine when speech does.

PARTS LIST

BP1-BP3—Insulated binding post
B1—12-volt d.c. battery or power source
C1—10μF, 25-volt electrolytic capacitor
C2,C6,C7—0.1-μF capacitor
C3—0.01-μF capacitor
C4—200-μF, 25-volt electrolytic capacitor
C5—2-μF, 10-volt electrolytic capacitor
IC1—Integrated circuit (National Semiconductor LM 370 or Sylvania ECG370)
J1,J2—Phono jack
K1—1640-ohm relay, s.p.d.t., 1-ampere contacts (Sigma 65F1A-12DC or similar)
Q1—Npn silicon transistor (Motorola MPS3702 or similar)
R1—4700-ohm
R3—6800-ohm
R4—1000-ohm
R5—100,000-ohm
R6,R7—22,000-ohm
R8—1500-ohm
All resistors ½-watt
R2—10,000-ohm linear potentiometer
R9—1000-ohm linear potentiometer
S1—S.p.s.t. switch
Misc.—Metal chassis, perf board, standoffs, microphone (Shure 401A), battery holder, knobs, 10-pin IC socket (Cinch-Jones 10-ICS), mounting hardware, etc.

phone input *J1*, audio output *J2*, and the three relay contact binding posts are on the rear. As with any high-gain amplifier, leads should be kept short and direct to prevent feedback and high-frequency oscillations.

While almost any dynamic microphone capable of delivering up to five millivolts can be used, the one specified in the Parts List works especially well with this circuit. Certain microphones, including the one used here, have push-to-talk switches that close the circuit when the microphone is in use and also short out the microphone element itself when it is not in use. Such microphones must be rewired so that the element is never shorted.

To use the Voxor with an input other than the signal from a dynamic microphone, rewire the input circuit as shown in Fig. 3. This can be used as long as the maximum input level does not exceed about 50 millivolts. Larger inputs will

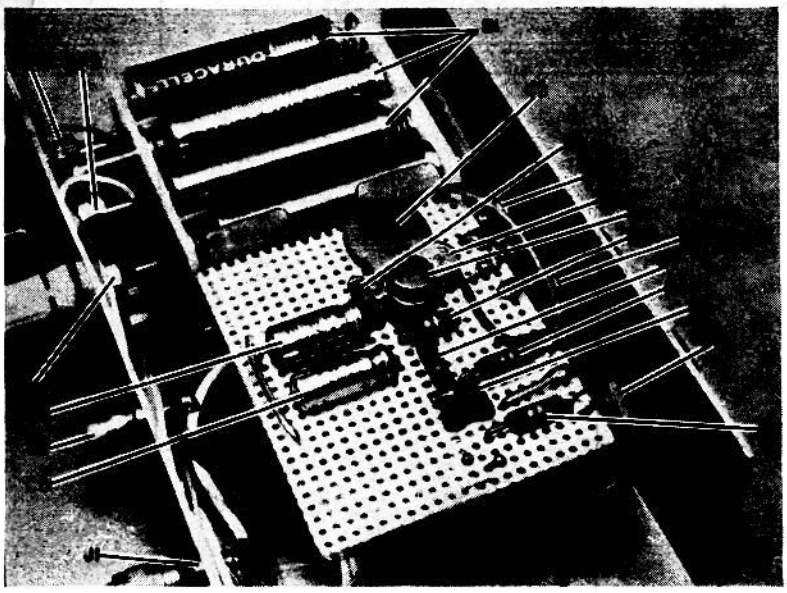


Fig. 2. The author constructed his Voxor on a section of perf board, although any other type of construction may be used. Sockets were used for both IC1 and Q1.

produce distortion. Inputs of less than one millivolt do not give reliable operation of the relay.

While the Voxor can be used with any d.c. supply from 9 to 24 volts, it works best with a 12-volt supply.

The attack and release times of the Voxor are determined by the value of capacitor *C4*. With the value prescribed in the Parts List, the timing is just about right for normal speech. Doubling the capacitance doubles the attack and

HOW IT WORKS

The integrated circuit—containing a complex combination of 34 transistors, diodes, and zeners, plus 20 resistors—performs two separate functions. The first is preamplification, with gain controlled by an external d.c. voltage (applied to pin 4). When this potential is less than 2 volts, the gain of the preamplifier is a maximum (about 100 with a 12-volt supply). With higher voltages, the gain decreases; until, with 2.6 volts or more, there is an attenuation of 100.

The second function is performed by a very high-gain amplifier-detector that receives the same input as the preamplifier but is otherwise independent. A potentiometer, external to the IC, sets the desired "squelch" threshold at pin 7. The output stage of the amplifier-detector is a medium-current *npn* power transistor. This transistor is normally off when only low-level inputs are present; but when the threshold is exceeded, pin 6 provides nearly a short circuit to ground, and the current is sufficient to operate the relay.

The input from the microphone is applied directly to both sections of the IC with d.c. bias derived from *R1* and *C1*. Sensitivity for the VOX section (the second function of the IC) is set by *R9* and the relay is driven directly by the output at pin 6. Normally, *C4* is charged up to the positive supply voltage through the relay coil. When a microphone input occurs, the relay is energized and *C4* discharges. Thus, the relay remains closed even after the input disappears—until *C4* has had time to recharge. This provides a "fast attack" so that early speech won't be lost, and a "slow release" so that the relay won't cut out between normally spaced words in a sentence. Capacitor *C3* makes the VOX less sensitive to high-frequency noise, so that sensitivity to speech frequencies is retained and false triggering made less likely.

Speech compression is performed by detecting the negative audio peaks at the output of the preamplifier (pin 8) through capacitor *C6*. With no audio present, the potential at the base of *Q1* is half of the supply voltage, as determined by the voltage divider made up of *R6* and *R7*. A negative-going audio peak causes *Q1* to turn on momentarily, which quickly brings the control input (pin 4) above the voltage where the preamplifier begins to turn off. This, in turn, charges *C5*, the a.g.c. smoothing capacitor. The net effect is that the first excessive peak seen by the detector causes the gain to be reduced just enough so that succeeding peaks of the same signal strength no longer activate the detector. A nearly constant amplitude of the output voltage is the result. Capacitor *C5* discharges more slowly than it charges so that the a.g.c. action also has a fast attack and slow release. If the speech level drops below the desired level, the amplifier gain increases as *C5* discharges until the preset level is reached.

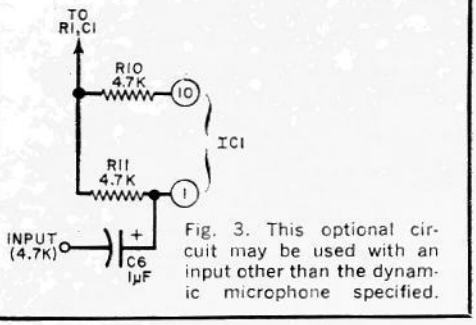


Fig. 3. This optional circuit may be used with an input other than the dynamic microphone specified.

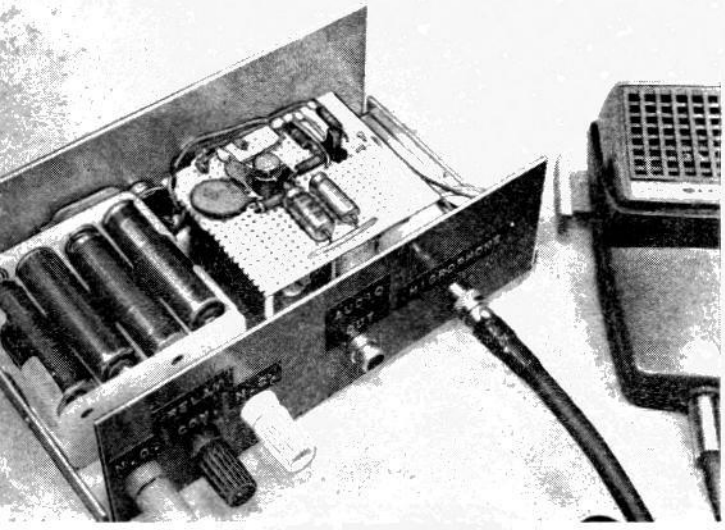
release times; reducing the capacitance, reduces the times.

Operation. After checking the circuit, connect the power supply and microphone and set *S1* to ON. Set the RELAY SENS. control for maximum resistance and note that relay *K1* is de-energized. Decrease the resistance of *R9* until the relay picks up and then back off slowly until it drops out again. Speaking into the microphone should cause the relay to be energized rapidly, with dropout occurring about one second after speech has ended. Setting *R9* closer to the "threshold" point increases relay sensitivity, while increasing *R9* resistance makes the relay less sensitive.

Connect the audio output of the Voxor to the input of the equipment with which it is to be used and set the equipment audio gain to the desired level. Set potentiometer *R2* for minimum resistance (rotor to grounded end). Speaking in a normal voice, the correct distance away from the microphone, adjust *R2* until the audio output of the Voxor decreases to the desired level. Note that changing the voice level or moving closer to or farther from the microphone does not change the audio level. In this way, it is possible to modulate fully a radio transmitter or tape recorder without overloading it.

For use with a transceiver, connect the relay common and normally open contacts to the wiring that formerly went to the microphone push-to-talk switch and the audio output of the Voxor to the mike input. Adjust the relay sensitivity so that the Voxor is not activated by the sound from the speaker during the listening interval. To operate the transceiver, just speak into the mike and the switching is done automatically. If the Voxor a.g.c. level and transceiver audio modulation level (if any) controls have been properly set, you will notice an increase in the talk power due to the constant high level of modulation.

The relay in the Voxor can handle most battery or low-voltage tape recorders. Connect the relay common and normally open contacts in series with the recorder motor and associated power supply. Speaking into the Voxor will automatically start the recorder. As with the transceiver, the tape recorder and Voxor controls are set to provide maximum modulation of the tape. —30—



The three relay contacts—normally open, normally closed, and armature are terminated in three binding posts on the rear apron. These are connected as required by the external equipment being controlled, which can be either a tape recorder or transceiver.