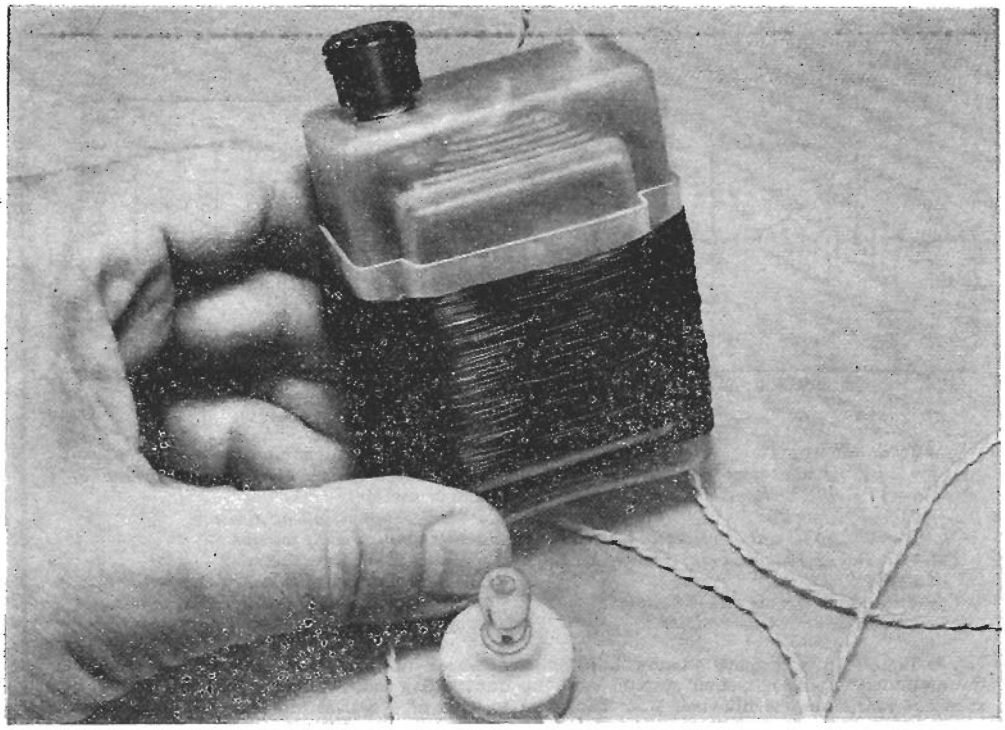

BUILD THE LIBERATOR

KEEPS YOU IN TOUCH WHILE ON THE GO

Built inexpensively and easily in a plastic cigarette case, this handy project "liberates" you from the necessity of sticking by your receiver when calls are few and far between. An integrated circuit and printed circuit board make construction foolproof.

THERE ARE TIMES when it becomes an impossible task to remain glued to a communications receiver if you are a ham, CB'er or SWL. Having to sit waiting for an identification to be made or a call to come through can be quite boring. The "Liberator," a shirt-pocket-size induction (not r-f) receiver, permits you to move about the house, office, or even a large area away from the receiver and still hear everything that is going on at the receiver.

The Liberator can also be used for private, individual listening to conventional radios or audio systems. This is a particular advantage if one person in a group likes to hear loud music and the others don't.

Theory of Circuit Design. The complete system can be considered to be a form of audio transformer. The receiver or amplifier drives current through an ordinary wire transmission loop that is strung around the area of interest and produces a magnetic field that varies at the audio rate. This forms the primary of the transformer.

The receiver (see Fig. 1) has an "antenna" which forms the secondary of the transformer and detects the varying magnetic field. This

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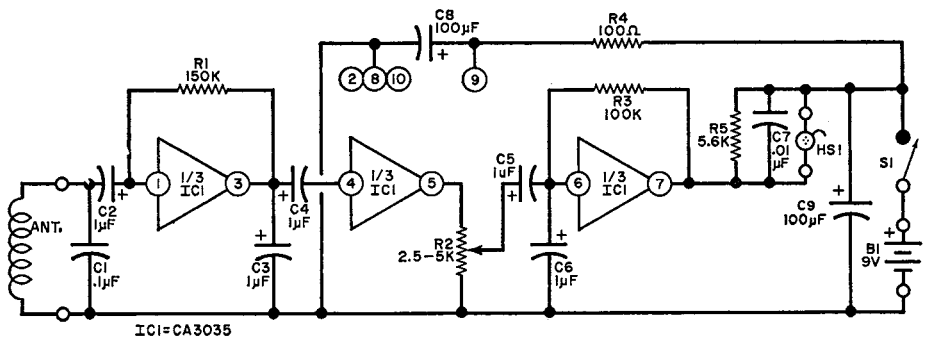


PARTS LIST

B1—9-volt battery
C1—0.1-0.47-µF capacitor (see text)
C2-C6—1-µF, 10-volt electrolytic capacitor
C7—0.01-µF capacitor
C8, C9—100-µF, 10-volt electrolytic capacitor
HS1—Crystal earphone (Lafayette 99E25512 or similar)
IC1—Integrated circuit (RCA CA3035)
R1—150,000-ohm, ½-watt resistor
R2—2500-5000-ohm miniature replacement potentiometer with switch (Lafayette 99E60-196 or similar)
R3—100,000-ohm, ½-watt resistor
R4—100-ohm, ½-watt resistor
R5—5600-ohm, ½-watt resistor
Misc.—Battery clip, plastic cigarette case, #24 or #26 enamelled wire, knob, wire for loop, switch for loop.

Fig. 1. The circuit is basically a high-gain IC amplifier whose input is a loop "antenna", which forms the secondary of the induction system. With the transmitting loop wound around the main floor, excellent reception was obtained from basement to attic of a typical three-story brick structure.

signal is then amplified by an integrated circuit (*IC1*) to drive an earphone. The antenna and *C1* resonate within the audio range to reduce the effect of interference from nearby r-f transmitters. The frequency response is limited to reduce noise from both 60-Hz power lines and emissions from TV receiver sweep circuits. A crystal earphone is used to prevent feedback between it and the receiving antenna. The IC contains three independent amplifiers and has an overall gain of approximately 100,000 (100 dB). Resistors *R1* and *R3* bias the first and last amplifiers for linear operation.

Transmitter. The transmitting loop consists of a length of insulated wire surrounding the area to be covered. Inside a building, the loop may be concealed in the wall moldings, under a large rug, or taped to the walls or ceiling. For outside use, the wire can be supported on insulators on posts or just simply strung (off the ground) around the area. The actual configuration depends on the location. Keep the coil off the ground and make sure it is insulated from metal surfaces. If the loop is to be located some distance from the amplifier, connect the two with ordinary two-conductor lamp cord or TV twin lead.

Usually, one turn of wire around the area should be enough. However, two things should be kept in mind: the current in the loop and the number of turns determine the strength of the field; and do not overload or short circuit the transmitting amplifier by connnecting a loop having too low a resistance.

Survey the area to be covered by the loop and calculate how long the wire will have to be to make the loop. Then determine the output impedance of the amplifier used (usually specified on the amplifier or in the instruction manual). The loop dc resistance can then be made approximately equal to the amplifier output impedance by choosing the correct wire size. Resistances of the more common wire sizes are given in the Table. Pick the wire whose resistance for the length required comes

RESISTANCE (OHMS) OF WIRE

Wire Length	Wire Size			
feet	#20	#22	#24	#26
25	0.26	0.40	0.64	1.0
50	0.51	0.80	1.3	2.0
100	1.0	1.6	2.6	4.1
150	1.5	2.4	3.9	6.1
200	2.0	3.2	5.1	8.2
300	3.0	4.8	7.7	12.2
400	4.1	6.4	10.2	16.3
500	5.1	8.0	12.9	20.4

closest to the output impedance of the amplifier. If the finished loop has less resistance than that required, a small fixed resistor can be added in series with the loop to make up the difference. However, since signal will be lost in this resistor, consider using a double loop around the area, with a larger-diameter wire.

To power the transmitting loop, simply switch the normal output leads that go to the speaker to the loop (see Fig. 2).

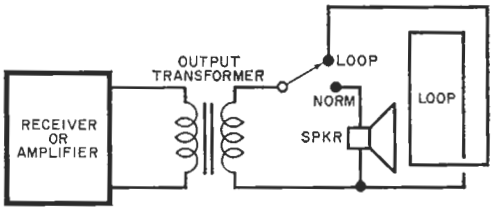


Fig. 2. If you wish simultaneous loop and speaker operation, hook a low-impedance speaker in series with the loop, so that the total load is the same as normally used with the particular transformer.

Receiver. The circuit of the receiver is shown in Fig. 1. It can be constructed on a printed circuit board using the foil pattern shown in Fig. 3. Once the board has been made, install the components, taking care to observe the polarity of the electrolytic capacitors and the orientation of the IC.

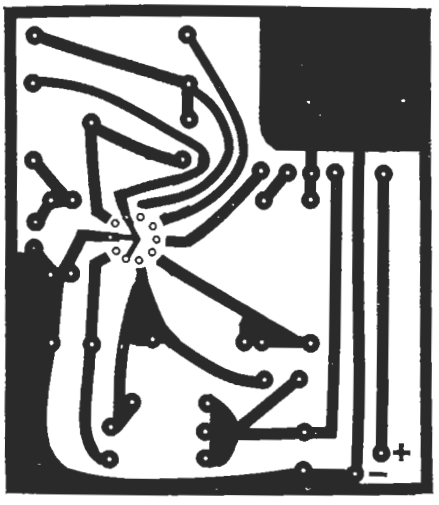
The prototype was built in a common plastic cigarette case with the board supported by the mounting hardware of potentiometer *R2*. A small hole, just large enough to accommodate the twisted-lead cable from the earphone, is made on the same side as the *R2* mounting.

Before installing the board in the case, the receiving antenna must be made. Drill two small holes at the end of the larger of the two plastic halves and feed about six inches of the end of #24 or #26 enamelled wire through one hole. Wind 150 to 200 turns of the wire around the plastic case and feed the other end of the wire in through the second hole. Leave about six inches on this end also. Coat the winding with cement or tape to hold it in place.

After connecting the earphone and battery leads and the two antenna wires to their proper holes on the PC board, slide the board into the plastic case. Locate the position of the shaft of *R2* and drill a suitable hole for it. Insert the board and secure it in place with the mounting hardware of *R2*. Put a knob on the potentiometer and turn the switch off. The battery is stored in the antenna half of the case.

Operation. With the earphone in your ear, turn on the Liberator. You should hear some hum, which can be made a maximum by orienting the antenna in different directions. The hum will be loudest when the Liberator is held near a fluorescent lamp.

Apply power to the transmitting loop by having some program material properly set up on the transmitter amplifier. Turn the amplifier gain up slightly. Switch its output to the loop position. If the Liberator is turned



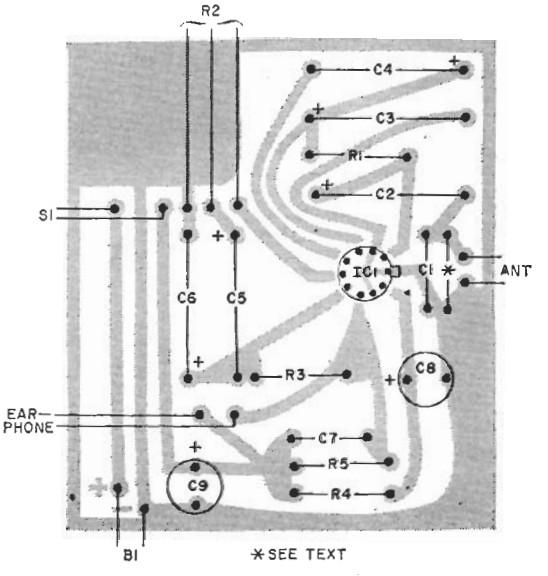
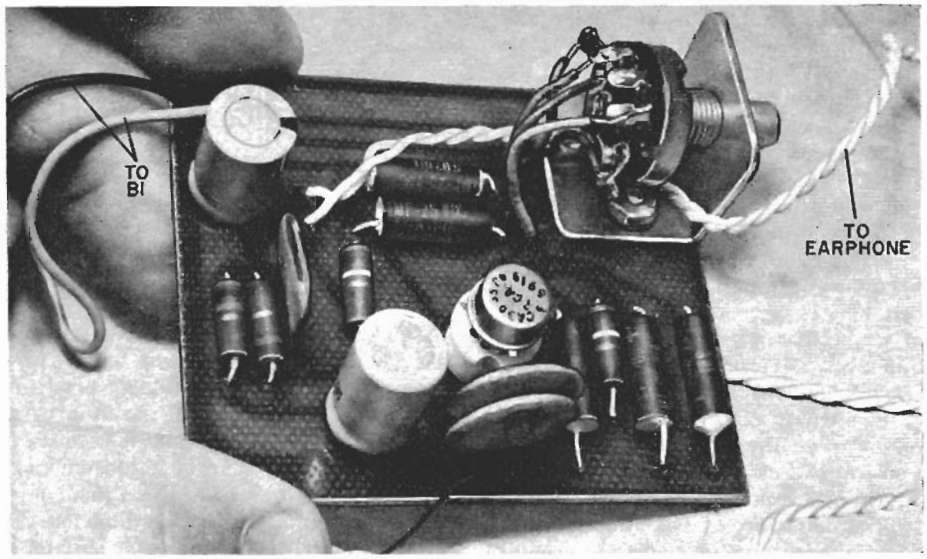
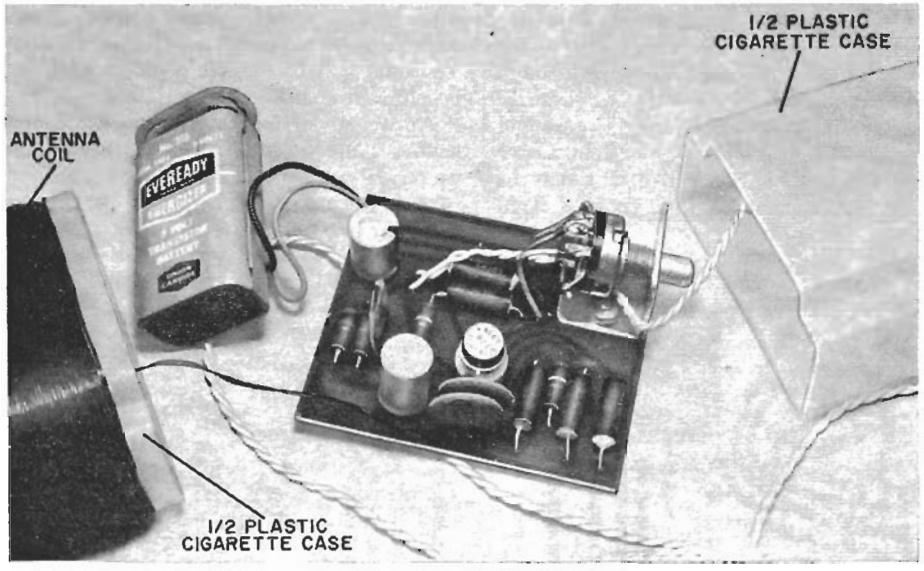


Fig. 3. Actual size foil pattern and component installation. Observe the placement of IC1 and the polarity of the electrolytic capacitors.



Although presently as small as a cigarette pack, the receiver can be made smaller by tightening up on the foil pattern, eliminating the IC socket, and using smaller physical sizes for C8, C9 and R2. A hearing-aid battery can be substituted for the 9-volt transistor radio battery, and a ferrite loopstick can be tried in place of the coil. Any number of receivers can be used on one loop.



on, you should hear the program on the earphone. You will get the best reception when the plane of the Liberator antenna coincides with the plane of the transmitting loop, and you are within the loop. Adjust the transmitting amplifier's volume for minimum distortion; gain can be adjusted on the Liberator. If you are using battery powered gear for the transmitter, keep its volume control down to conserve power.

Modifications. To improve low-frequency response, the values of coupling capacitors *C2*, *C4*, and *C5* can be increased. However, the pickup of unwanted 60-Hz noise will be increased. Shunting capacitors *C3*, *C6*, and *C7* control the high-frequency gain and amplifier noise. Smaller values here will improve the high-frequency response, but will also increase the noise.

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LIBERATOR

(*Continued from page* 52)

Do not substitute a magnetic earphone for the crystal unit. If you do, oscillations may set up and possible damage to the IC can result.

If 60-Hz pickup is a serious problem, wrap the antenna with aluminum foil, leaving a small gap somewhere so that the antenna is not completely shielded, and connect the foil to the circuit ground. To optimize signal pickup, the antenna may have to be tuned. Experiment with various capacitors in parallel with *C1* (provisions for this are made on the PC board) to get best results with the antenna on the package. If you want to remove the 200-turn antenna from the outside of the plastic case, try a common ferrite loopstick in its place, experimenting with various values of *C1* to get maximum signal.

How much power do you need to cover an area? The author used a conventional transistor pocket radio to power a 30′ by 50′ loop. The 100-mW audio output from the radio was more than sufficient to do the job and a good magnetic field was found 25′ above the loop. (It might have been higher but the house wasn't.)

If you want speaker and loop operation at the same time, select a speaker with a lower impedance than normally used and couple it in series with the loop so that the total resistance is approximately the same as the output impedance of the amplifier. -30-

CIRCUIT QUIZ ANSWERS

(*Quiz appears on page* 44)

1. $(10)^2 = (8)^2 + (VR)^2$; VR = 6V
2. $(20)^2 = (7+VC)^2 + (12)^2$; VC = 9V
3. $(24)^2 = (VL-6)^2$; VL = 30V
4. $(15)^2 = (350-350)^2 + (VR)^2$; VR = 15V
5. $(VT)^2 = (15-3)^2 + (16)^2$; VT = 20V
6. $(50)^2 = (VL)^2 + (12)^2 = (VC)^2 + (12)^2$; VL = VC
   $(VT)^2 = (VL-VC)^2 + (12)^2$; VT = 12V
7. $(IT)^2 = (6)^2 + (8)^2$; IT = 10 mA
8. $(20)^2 = (16-IC)^2 + (16)^2$; IC = 4 mA
9. $(IT)^2 = (17-13)^2 + (3)^2$; IT = 5 mA
10. $(9)^2 = (20-4-IC)^2$; IC = 7 mA