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CONELRAD CIRCUITS

The requirements for conelrad compliance may be met with various equipments. The simplest method perhaps is to use a conventional broadcast receiver for continuous aural monitoring of any selected station and for quick tuning to either the 640- or 1240-kc emergency frequency. Completely aural monitoring is not suitable at most radiotelephone stations, however, since the volume must be kept to impracticably low levels to prevent rebroadcasting. This method is entirely feasible at c-w stations or in transmitter rooms isolated from the microphone.

Conelrad systems may be classified according to whether they are (1) indicators (aural, visual, or both), (2) control devices (actually switching the transmitter off when the monitored station leaves the air), or (3) a combination of the two — that is, controller-indicators. Individual preferences govern the selection. Neither type may be termed superior to the other unless all factors of installation and required service are considered. The degree of circuit complexity likewise depends upon the required sensitivity, permissible power drain, and the type and number of functions to be performed.

CORRECTION

On Page 5 of the article appearing in the December, 1957, issue of "The Capacitor," the sentence beginning in the 5th line of the left hand column should read as follows: "The d-c output voltage E_2, is equal to $IR=E_1$ minus the voltage drop across the tube."

In the same article, on Page 9, the text in line 35 of the left hand column should read: "(i.e., 2.82 x E_1 rms, etc.)."

Power-Line vs Battery Operation

Regardless of the type of conelrad device considered, the question is apt to arise as to whether it should be operated from the power line or be battery-powered. Therefore, the leading aspects of the problem should be considered here.

First of all, power-line operation has the advantage of requiring little or no maintenance. But power line failure throws the equipment out of operation. To be sure, a power failure would disable the transmitter, as well as the conelrad receiver, so that the station automatically would be shut down. But what about the station equipped with an emergency, battery-operated or engine-generator-powered transmitter? This station would be able to resume transmissions during the failure and would need its conelrad equipment. In the event of a general power failure during an attack, the key broadcast station for the area might turn to emergency power supplies for public safety transmissions, and other stations would need battery-operated receivers for listening on 640 or 1240 kc.

All of these considerations point up the possible desirability of battery-operated conelrad equipment at fixed stations where a-c power is available. The portable station, unless powered by an engine-driven generator, necessarily is battery-operated and so must be its conelrad receiver.

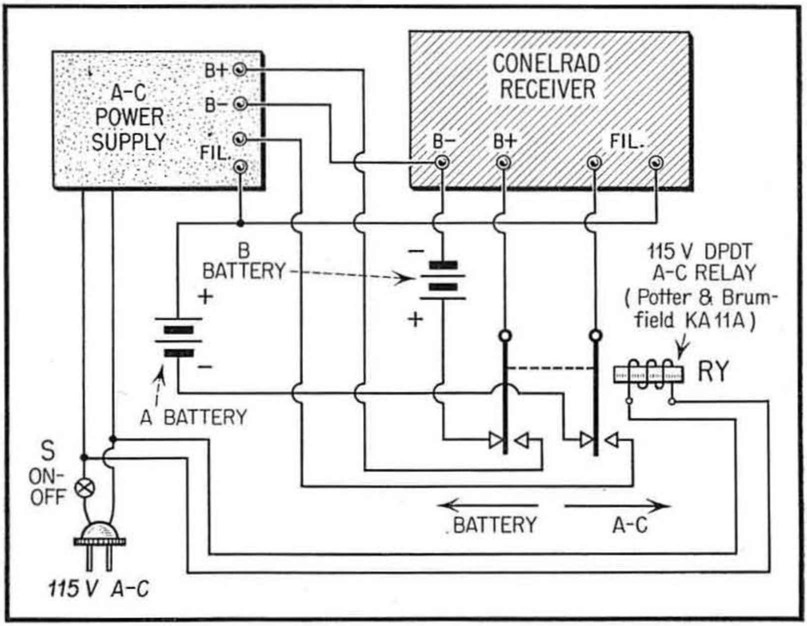

Fig. 1. AC-DC Automatic Changeover.

It should be recognized, however, that conelrad monitors must operate continuously over long periods. Under such conditions, conventional battery operation of tube-type equipment is expensive, as regards both initial cost and maintenance. If the equipment is left running accidentally when not in use, the life of both A and B batteries is seriously shortened if not terminated completely. This consideration precludes the practical use of batteries, except during short-term emergency periods, unless the equipment is transistorized. The current drain of a transistorized receiver is so low that no serious consequences are caused by occasionally forgetting to turn the set off. Furthermore, the batteries for such a receiver may be of the inexpensive flashlight type which are readily obtainable at almost any store.

Required Sensitivity

The required sensitivity of a conelrad receiver depends upon the distance and power output of the stations to be monitored. Very little sensitivity is needed for strong, local stations. The same is true for very near low- and medium-powered stations. Under such conditions of "local" reception, the complexity of a superheterodyne usually is not needed, a selective tuned r-f or tuned-detector receiver being adequate, especially if a good outside antenna and ground are employed. When operation from a self-contained antenna is desired, maximum sensitivity is necessary and a superhet is mandatory.

When the monitored station is located at some distance and/or is low-powered, high sensitivity is required in the conelrad receiver. Here, the superhet is necessary and should be operated from a good outside antenna and ground unless performance tests show that maximum response can be obtained with indoor or self-contained antennas.

There is no adequate rule-of-thumb by means of which the minimum required sensitivity can be determined. The reason for this is that many variables influence the received field strength. Reliable reception at all times is the major requirement of the conelrad receiver. However, experience would indicate that insensitive circuits (simple detectors and trf types) should be employed only for monitored stations within 10 miles airline having carrier power of 1 kilowatt or higher, and then only with a good outside antenna. Under all other conditions, use a superhet. When the station is more distant than 10 miles airline, use a superhet with outside antenna.

Emergency Power Changeover

Since conelrad service must remain uninterrupted during the operating shift of a monitoring station, additional reliability is afforded by any means for automatically switching an ac-operated conelrad receiver to battery operation in the event of power failure.

Figure 1 shows a simple arrangement for accomplishing this changeover. Here, the small, dpdt a-c relay (RY) is the automatic switch. When the a-c power is on, this relay is held in by current from the 115-v line and connects the receiver to the a-c power supply. If the a-c power is interrupted, the relay is released and connects the receiver, through its other pair of contacts, to the A and B batteries. Upon resumption of power service, the relay disconnects the batteries and returns the receiver to the power supply. This arrangement is fast acting and requires no attention. While shown separate for simplicity in Figure 1, the a-c power supply and batteries may be self-contained in the receiver.

The small relay may be installed on the chassis of a 3-way portable radio to provide this automatic changeover service in this type of receiver in which both the batteries and a-c power supply are self-contained.

Receiver Circuits

Figures 2 and 3 show two of the

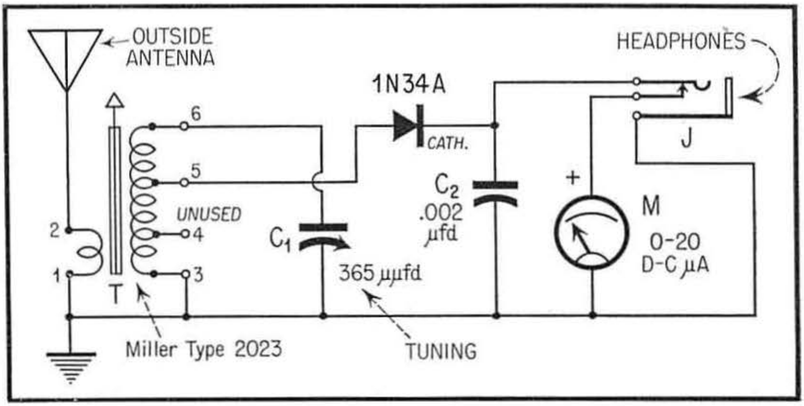

Fig. 2. Simple Aural-Visual Receiver.

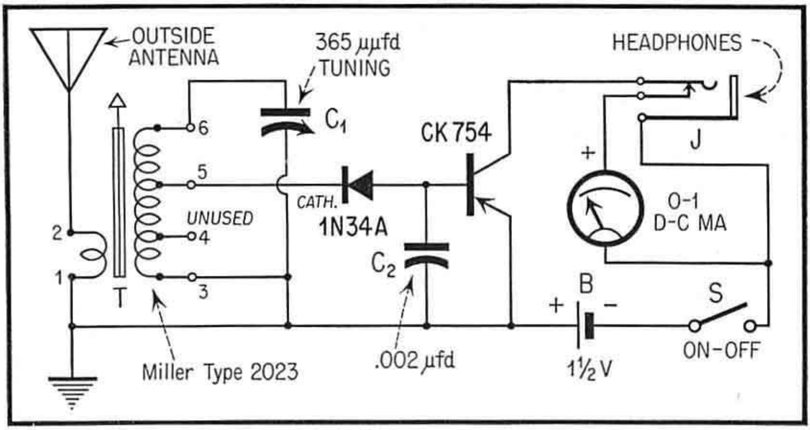

Fig. 3. Improved, Simple Aural-Visual Receiver.

simplest circuits which may be used for combined aural and visual indications. Each is tunable throughout the standard broadcast band by means of a single tuning control, C_1. The r-f transformer (T) is a miniature, transistor oscillator coil (Miller Type 2023). Initial alignment is performed by adjustment of the tuning slug of this transformer.

The circuit in Figure 2 is the simpler of the two and requires no local power supply of any kind. It is also the least sensitive and is satisfactory only for use with strong, nearby local stations. Nevertheless, it is stable and reliable in high field strength areas.

The detector is a 1N34 diode. Peak deflection of the 0-20 d-c microammeter is obtained at resonance, and tuning is fairly sharp because of the high Q of the inductor and the impedance-matching tap for the detector circuit. When high-impedance magnetic headphones (2000 ohms or higher) are plugged into jack J, the microammeter automatically is disconnected and visual indications are supplanted by aural ones. If the meter is left in the circuit, it will lower the audio volume.

The circuit in Figure 3 employs a d-c amplifier to boost the d-c output of the 1N34 diode detector. This allows the use of a more rugged 0-1 d-c milliammeter as the visual indicator and provides higher sensitivity than the circuit given in Figure 2. The basis of the d-c amplifier is a high-beta transistor, CK754. This transistor is operated from a single, 1½-volt, Size-D flashlight cell, B. No zero-set rheostat is required. When magnetic headphones (2000 ohms or higher resistance) are plugged into jack J, the milliammeter automatically is disconnected and the transistor serves as an audio amplifier to boost the headphone signal.

A receiver employing either of these circuits is used mainly as a visual indicator. Deflection of the meter indicates that the monitored station is on the air. The deflection is steady, since it is proportional to the carrier, not to the modulation. Interruption of the carrier is signalled by a fall of the pointer to zero. When this happens, the headphones may be plugged in and the receiver tuned to either 640 or 1240 kc. The latter two frequency points should be marked plainly on the C_1 dial.

In some instances, loudspeaker operation will be preferred to headphone reception. The transistorized audio amplifier shown in Figure 4 will serve this purpose. The CK722 Class-B output amplifier stage delivers approximately 100 milliwatts to the 3.2-ohm loudspeaker. The primary winding of input transformer T_1 may be connected to a phone plug for insertion into jack J in Figure 2 or 3. The amplifier then will be available for other purposes when the station is not in operation. Insertion of the plug automatically disconnects the indicating meter in the simple receiver circuit.

A complete superheterodyne circuit is not shown here. The reason for omitting it is that ready-made midget broadcast receivers suitable for conelrad purposes are readily available at prices lower than the experimenter can duplicate by building a set. Also, transistorized superhet receivers are available in comparatively inexpensive kit form for private assembly. These receivers are suitable, as supplied, for aural indications.

There are several ways of adding a visual indicator to a superhet circuit. (1) A 0-100 d-c microammeter may be installed in series with the second detector diode. When a tube-type

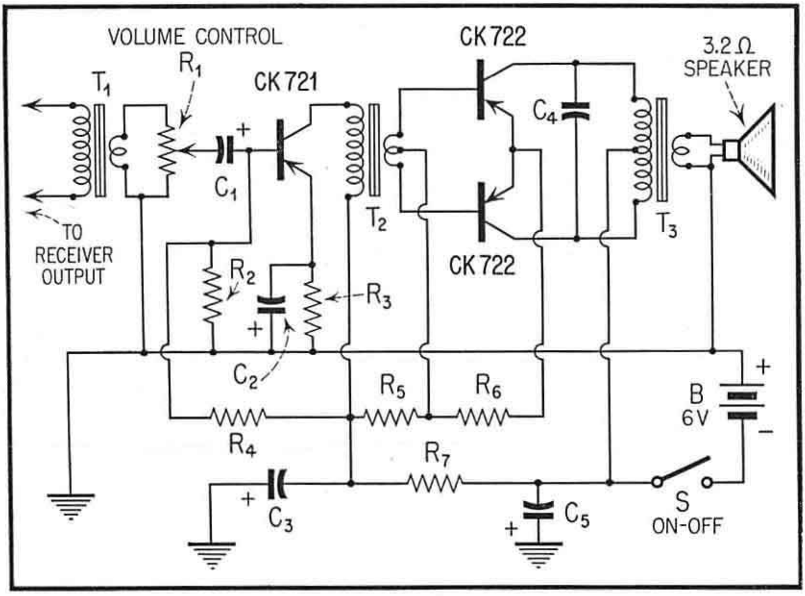

Fig. 4. Loudspeaker Amplifier for Simple Receivers.

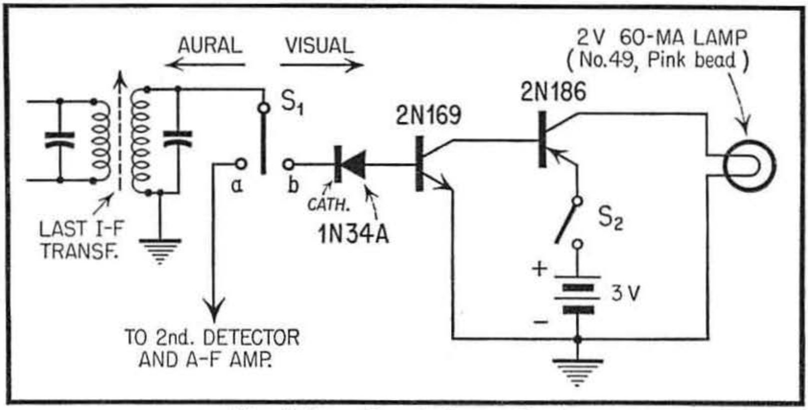

Fig. 5. Lamp-Type Indicator Circuit.

diode is used, a reverse d-c voltage (obtained from the power supply through a 1- megohm rheostat) must be applied to the meter to buck out the steady d-c diode current due to contact potential of the tube. When a crystal diode is used as the second detector, no bucking voltage is required. Any one of the standard S-meter circuits used in tube-type communications receivers also may be employed to give visual on-the-air indications via a d-c milliammeter. (2) A magic eye tube may be operated in the conventional manner from the second detector- avc circuit, to provide visual indication of monitored-station operation. However, this type of indicator requires closer viewing than is necessary with the meter.

Figure 5 shows how a separate circuit may be added to a transistorized or tube-type superhet for a lamp-type indicator. The lamp glows as long as the monitored station is being received and goes out when the carrier is interrupted. Maximum brilliance occurs at exact resonance. Two additional transistors and a crystal diode are required. The transistors are NPN (General Electric 2N169) and PNP (General Electric 2N186). The diode is a 1N34A. The transistors are direct-coupled in a simple d-c amplifier circuit. The 2-volt, 60-ma pilot lamp is connected in the collector output circuit of the second transistor. The 1N34A rectifies the i-f signal. When switch S_1 is thrown to its Position **b**, the amplifier input is connected across the secondary of the last i-f transformer and visual indications are obtained from the lamp. When S_1 is thrown to Position **a**, the amplifier and lamp are disconnected and the i-f signal is applied to the second detector and audio circuits for aural monitoring. A brighter, 6-volt pilot lamp may be used if the auxiliary battery voltage is increased to 7.5 v.

Relay Circuit

Figure 6 shows an automatic carrier-operated relay which may be added to a transistorized or tube-type superset. When the carrier of the moni-

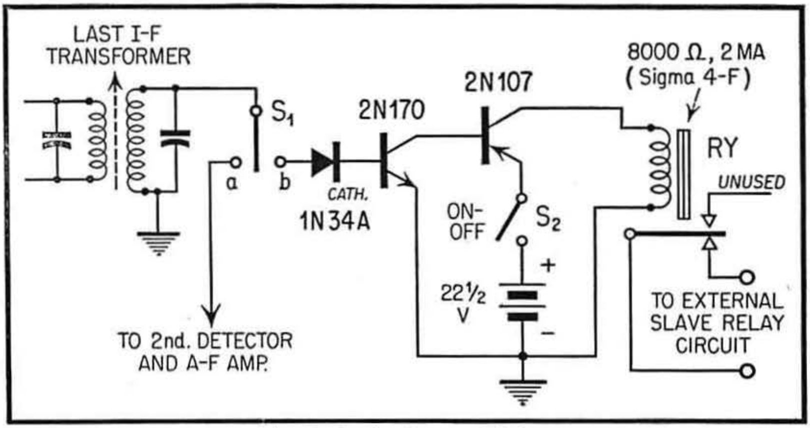

Fig. 6. Carrier-Operated Relay.

tored station is interrupted, this relay system automatically will switch-off the transmitter.

Like the preceding circuit, this relay circuit utilizes a direct-coupled, transistorized d-c amplifier connected to the last i-f transformer secondary through the spdt changeover switch, S_1. When the latter switch is thrown to its Position b, the 1N34A crystal diode rectifies the i-f signal and the resulting direct current is delivered to the d-c amplifier. The amplified current picks up the relay (RY) opening its lower contact. If the carrier is interrupted, the resulting loss of direct current allows the relay to drop out, closing the circuit through the lower contact and actuating an external, high-current, slave relay which switches-off the transmitter. When switch S_1 is thrown to its Position a, the i-f signal is delivered to the second detector and audio amplifier of the receiver, and aural monitoring is afforded.

PARTS LIST FOR FIGURE 4

B—Four 1½-v, Size-D flashlight cells connected in series

C_1, C_2, C_3, C_5—25 ufd, 10 v, miniature electrolytic — (C-D NL 25-10)

C_4—0.05 ufd, 200 v tubular — (C-D CUB 2S5)

R_1—25,000-ohm potentiometer

R_2—2200 ohms ½ watt carbon

R_3—820 ohms ½ watt carbon

R_4—10,000 ohms ½ watt carbon

R_5—5000 ohms ½ watt carbon

R_6—120 ohms ½ watt carbon

R_7—100 ohms 1 watt carbon

S—Spst switch on volume control potentiometer R_1

T_1—Transistor interstage transformer — Thordarson TR-14

T_2—Transistor driver transformer — Thordarson TR-7

T_3—Transistor Class-B output transformer — Thordarson TR-27