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APRIL 1947

- PHASE INVERTER CIRCUITS
- A UNIVERSAL SPEAKER
- PART II ANTENNAS... FM AND TELEVISION
- TELEVISION RECEIVERS— THE HORIZONTAL SWEEP

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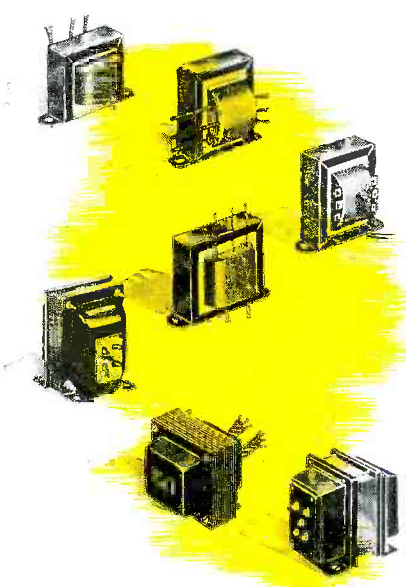

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RADIO MAINTENANCE

INCLUDING
ELECTRONIC MAINTENANCE

Volume 3 APRIL, 1947 Number 4

Contents

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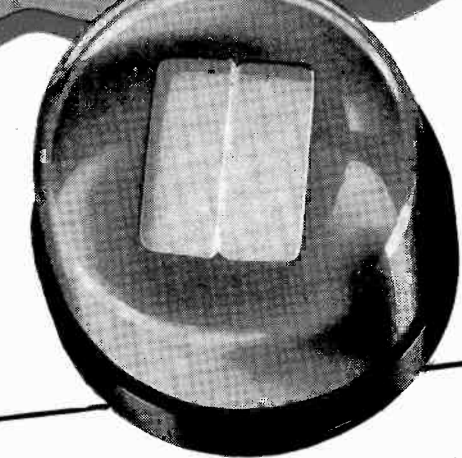

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TYPICAL OPERATING CONDITIONS
(indicator service)

Heater voltage	6.3 v
Heater current	0.150 amp
Target voltage	315 v
Voltage, deflection electrodes 1, 2 and 3	0 v
Cathode resistor (approx)	3,300 ohms
Deflector sensitivity (approx)	1.0 mm/v
Fluorescence cut-off, grid volts (approx)	—6.0 v

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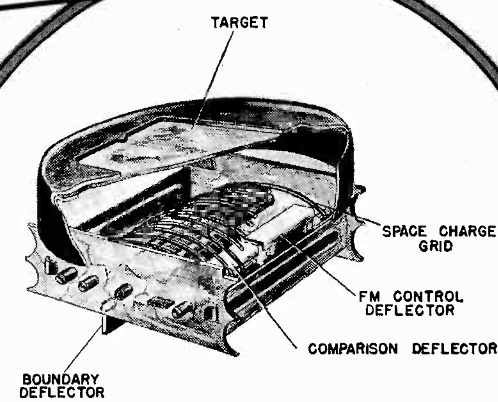
● The 6AL7-GT's principle of operation is unique and effective. In the cutaway drawing at the right, note that the three deflection electrodes are close to the cathode, with this whole assembly in turn separated from the target by the grid. The latter operates either at cathode potential, or at a few volts negative with respect to the cathode. Because electrons move slowly in the area between cathode and grid, the 6AL7-GT's deflectors easily control the position of the electron beams on the target. Increasing the negative voltage on the grid slows down the electrons still more, augmenting their response to the deflectors' pull and thus heightening the tube's sensitivity.

More detailed technical information and performance data on the 6AL7-GT will be furnished promptly on request. If you manufacture electronic equipment, Ken-Rad tube engineers gladly will work with you to apply the new Indicator Tube to radio receivers or test equipment you may have on your drawing-boards. Communicate direct with Ken-Rad at the address below.



CUTAWAY VIEW OF A KEN-RAD 6AL7-GT, SHOWING SCREEN TARGET, GRID, ELECTRON-RAY DEFLECTORS, ETC.

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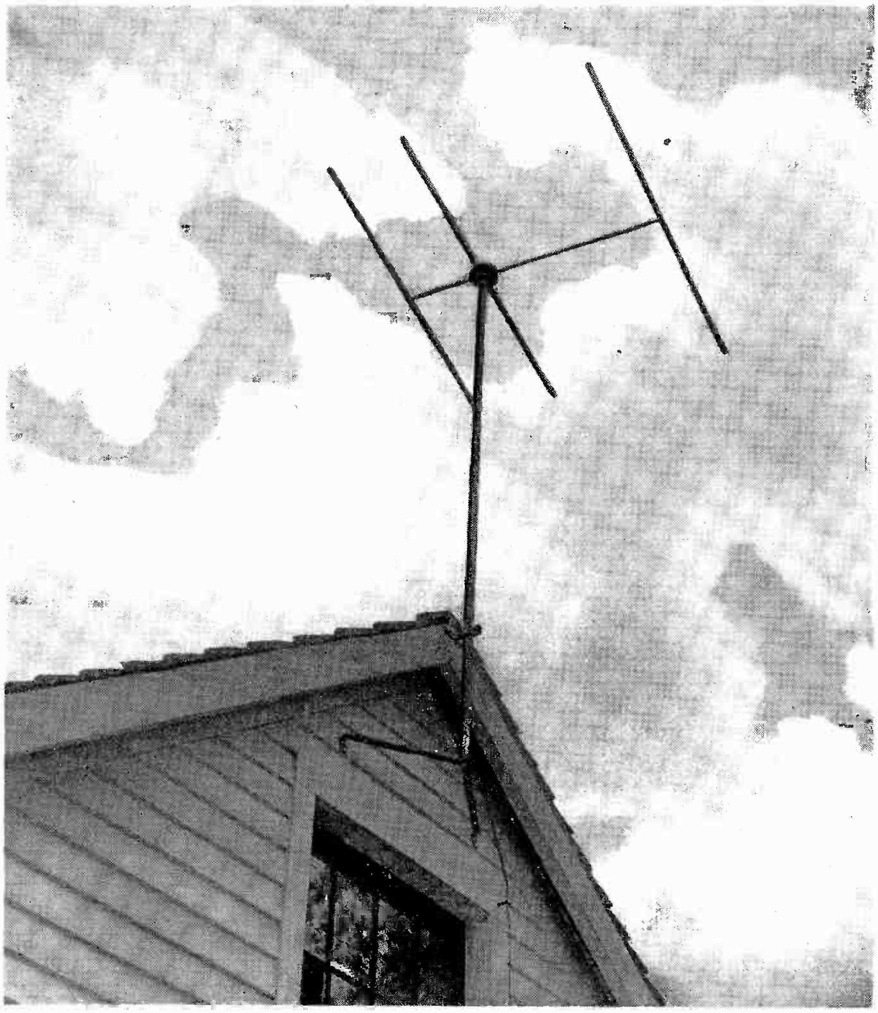

PART II

by
Milton Kaufman
RCA Institute

ANTENNAS... f-m and television

To obtain satisfactory reception of FM and television signals, the antenna must be carefully chosen and installed. Knowledge of the various types of antennas available and their characteristics is necessary if a correct choice is to be made.

THE NATURE of the ultra high frequency waves used for television and FM broadcasting is such as to pose special problems in the choice and installation of suitable antenna systems. Such factors as broad band response, directional characteristics, and the elimination of unwanted signals and reflections must be taken into consideration if satisfactory reception is to be obtained. Each installation must be considered as a new problem to be analyzed on its own merits. Because of the great number of situations that will be met, it is important that the serviceman have a general knowledge of the characteristics of many of the practical antenna systems.

An antenna is a resonant circuit and, as such, possesses a Q which determines its bandwidth. The Q is determined from the approximate formula

$$Q = \frac{X_L}{R}$$

Either a decrease in inductance or an increase in resistance will decrease the Q and increase the band width of the circuit. It follows then that for antennas which are to be used for television and FM, a low value of Q is needed if a wide band of frequencies is to be picked up without attenuation at the sides of the band. The Q of an antenna is a function of its length to diameter ratio. An increase in the diameter of the antenna conductor will reduce the inductance and lower the Q. Therefore, large diameter conductors must be used for the elements of an antenna when wide band requirements are to be met. For example, the length of a dipole is 72" at 77 mc. If the diameter of the dipole is 1½ inches, then the length to diameter ratio is 72/1½, or 48, and the percentage of band width is equal to 21 per cent. Thus, this antenna will function efficiently from 57 to 87 megacycles and will cover five television

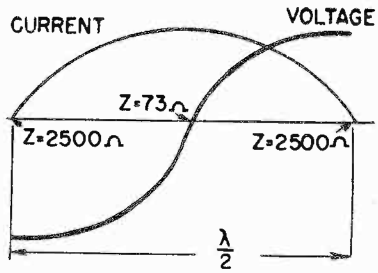

Fig. 1 The voltage and current distribution as they appear on a half wave dipole.

channels (45-88 mc). However, a thin dipole of #10 wire will only cover from 65-80 mc, and will function well over only two channels. The above reasoning assumes perfect matching conditions which seldom exist so that in practice the actual band width is considerably reduced. Thus, we see that the diameter of the antenna elements is of major importance, and large diameters must be used when a wide band of frequencies is to be received.

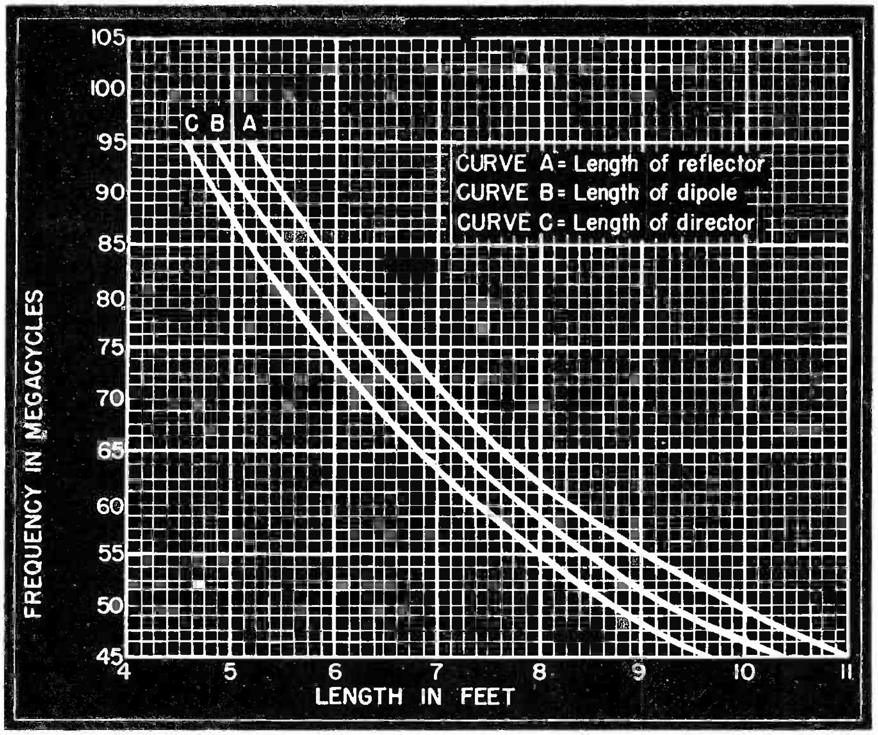

Fig. 2 A curve showing the length in feet of a dipole, a reflector or a director for frequencies from 45 to 95 mc.

Basic Dipole Antenna

The simple dipole antenna is the basis of practically all antenna systems. As shown in Fig. 1, it is an electrical half wave length long. The actual length of a dipole in feet may be computed from the formula

$$L = 492 \times .94/f \text{ (mc)}$$
$$= 462/f \text{ (mc)}$$

A graph of length vs frequency, computed from this formula, is shown in Fig. 2. The factor .94 is necessary because the velocity of propagation on the antenna is less than the velocity in free space.

Impedance values measured at any point on an antenna are a function of the magnitude of the current and voltage at that point. At the center of a dipole where the current is a maximum and the voltage a minimum, the impedance is equal to 73 ohms. At the ends, the impedance is about 2500 ohms. Since dipoles are usually fed at the center, the value of 73 ohms is of great importance because it must be matched to the transmission line.

Polarization

The physical position of the transmitting antenna determines the polarization of the emitted wave. An antenna which is vertical with respect to the earth emits a vertically polarized wave, while an antenna which is parallel with the earth emits a horizontally polarized wave. At television and FM frequencies, horizontally polarized waves are used because noise interference is decreased and the possible distance of transmission and reception is greater.

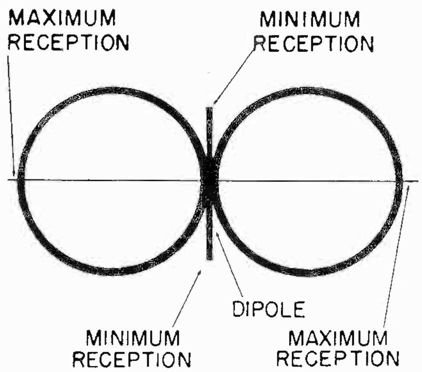

Fig. 3A The horizontal pattern of a half wave antenna.

Directional Characteristics

An antenna is said to have directivity when it receives greater signal strength from certain directions than from others. The directional pattern of a simple dipole is shown in Fig. 3A. It will be noted that the dipole responds best to signals traveling broadside to the antenna, and will receive equally well to the front or rear. It discriminates greatly against reception off either end. Thus, by rotating the dipole broadside to the desired direction of reception, it is often possible to eliminate unwanted signals coming from other directions. Reflections can still be received from the rear, however, and they may impair the quality of the picture. Since it is usually desirable to cover a wide band of frequencies rather than just a single frequency, the dipole must be constructed of large diameter conductors, ½ inch or greater. Many modern television receivers are designed to receive all of the allotted channels and even the cheapest will cover at least three. Therefore, the antenna must respond properly to all of the stations in each area which

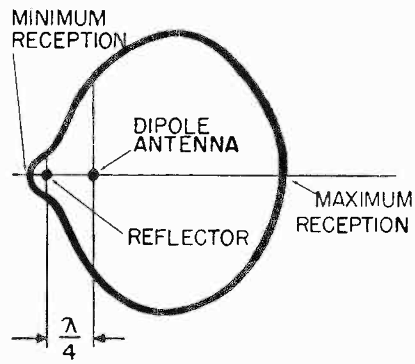

Fig. 3B The horizontal pattern of a dipole and reflector.

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are operating. For example, in the New York area, at present, three channels are being used: Channel 3 WCBW, Channel 4 WNBT, and Channel 5 WABD, which cover a range of frequencies from 54 to 82 megacycles. The antenna should be cut to the geometric center of the range, or 67 mc.

From the graph (Fig. 2) the length is determined to be 6.9 feet. An exception is occasionally made when one station is received very much weaker than the others. In this case, the dipole may be cut to favor the weaker station.

Folded Dipole

The folded dipole (Fig. 4) features several advantages which make it a popular choice for television and FM reception. It is simple in construction and has an impedance at the center of 300 ohms which matches perfectly to a standard 300 ohm transmission line, and to most television and FM receivers. Since the impedance of this antenna is high, the Q is correspondingly low, thus giving it a band pass characteristic greatly superior to the simple dipole. An examination of Fig. 5 shows the flatness of response over any given band as compared to a dipole of #10 wire. The folded dipole will cover the entire television or FM band when constructed of at least ¼ inch tubing. Spacing between the conductors should be very small, two or three inches being a satisfactory value. Directional characteristics are similar to the simple dipole. The length of a folded dipole can be computed from the graph of Fig. 2.

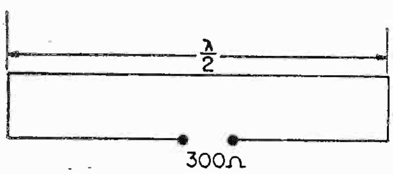

Fig. 4 A folded dipole. The center impedance of this antenna is 300 ohms which can be matched by standard twin parallel conductor transmission line.

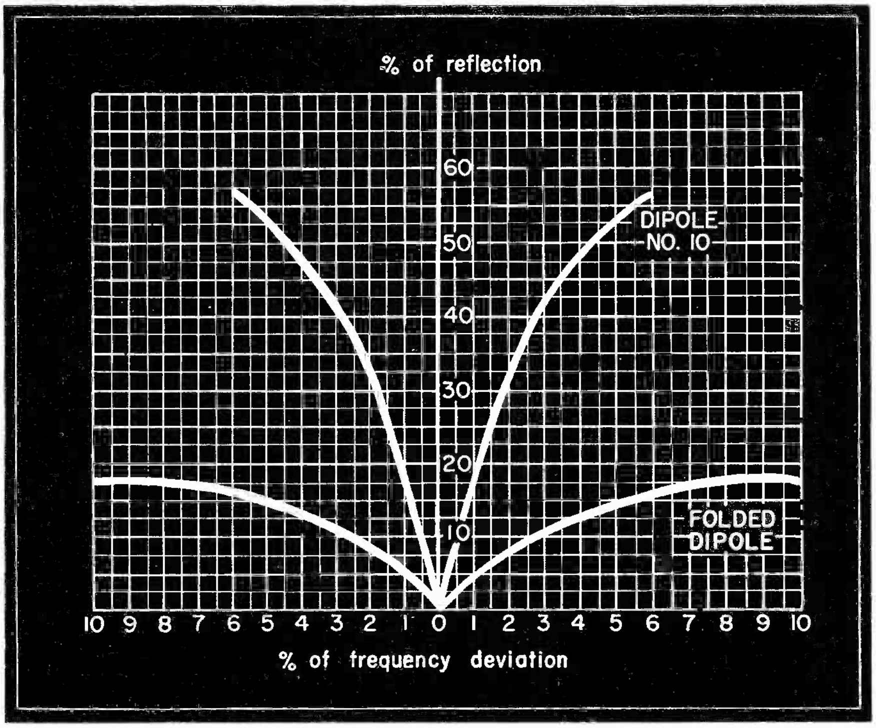

Fig. 5 Curves showing the comparative band widths of a folded dipole constructed of 1" tubing and a simple dipole constructed of #10 wire.

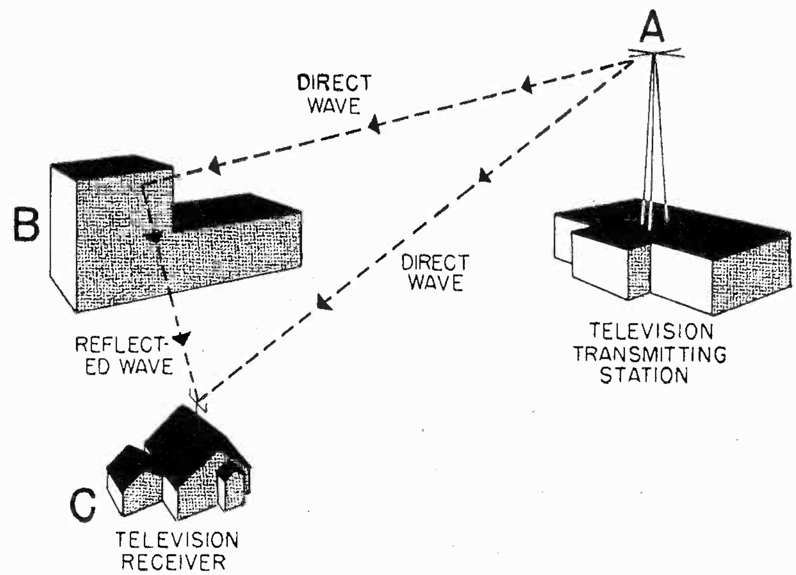

Fig. 6 As shown above, a reflected wave reaching the antenna of a television receiver follows a longer path than the direct wave. When this phenomenon takes place, the result is a distortion of the picture which is commonly known as a "ghost."

Parasitic Elements

As may often be the case, reflected waves will strike the antenna from the rear. In Fig. 6, if the total distance ABC is greater than the direct distance AC, by more than 170 feet, two separate images will be reproduced on the television screen. If the increased distance is less than 170 feet, loss of detail in the picture will result. The addition of so-called parasitic elements will remedy this fault. Parasitic elements may take the form of either a reflector or a director, or a combination of both. The reflector (Fig. 7) is an element which is about 5 per cent longer than the dipole and is placed a quarter wave length behind it. It has no electrical connection to the antenna and receives its energy by induction. The length of the reflector in feet is determined by the formula.

$$L = 492/f \text{ (mc)}$$

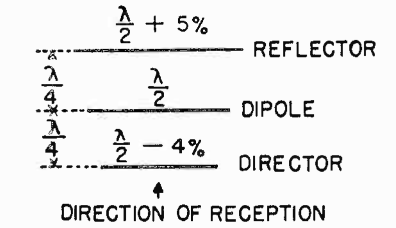

Fig. 7 A parasitic beam which consists of a dipole, a reflector and a director. Quarter wave spacing between the elements is used. The reflector should be approximately 5% longer than the dipole, and the director should be approximately 4% shorter than the dipole.

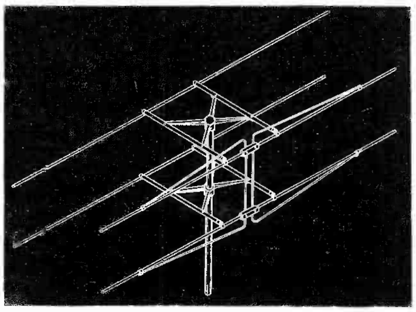

Fig. 8 The S/C Laboratories stacked array, consisting of two dipoles, one above the other, with a reflector behind each dipole. This type of antenna gives both horizontal and vertical directivity.

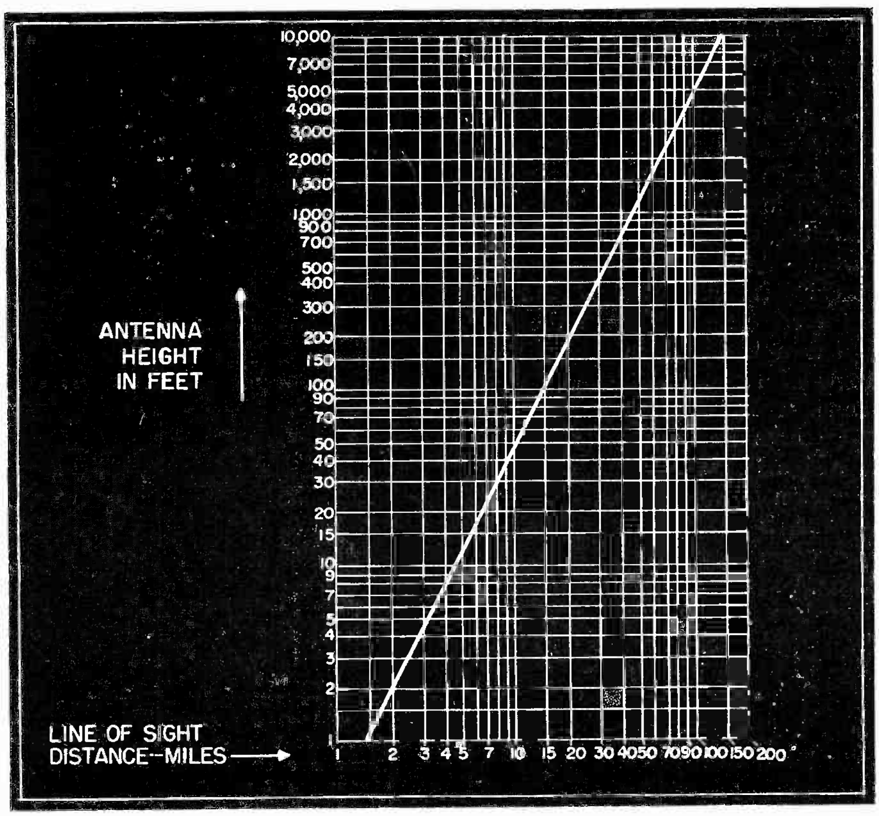

Fig. 9 The above graph shows the relation between antenna height and line of sight transmission distance.

The addition of a reflector has a number of important effects:

1. It will almost completely cancel reception from the rear (Fig. 3B).
2. Signal strength from the desired direction will be increased considerably.
3. Directivity will be sharpened, making it easier to "tune out" unwanted signals.
4. The band pass of the system will be reduced, making the use of large diameter conductors imperative.
5. The input impedance of the dipole will be lowered.

The action of a director is similar to that of a reflector, but it is placed a quarter wave length in front of the antenna. The director is made shorter than the antenna by about 4 per cent. Both reflector and director may be used when increased sharpness of directivity and greater signal strength are needed. While spacings as small as 0.1—0.15 wave length are usually recommended for communication purposes, such small spacings are not used for television and FM because of the greatly reduced band pass which results.

Stacked Array

The stacked array is constructed by mounting one dipole above the other, and is generally used with a reflector mounted behind each dipole. Such an array is typified by the S/C Laboratories' antenna shown in Fig. 8 which will cover a number of television or FM channels without serious attenuation. Such a combination has some decided advantages. By stacking dipoles, directivity is obtained in the vertical plane. Since only a line of sight path is useful at television frequencies, it is desirable to confine reception to low vertical angles. Signals arriving from high vertical angles, which may be in the form of noise pulses or undesired reflections, will be discriminated against, resulting in greatly improved reception. There will be a gain in signal strength pickup of about 1.5 to 1, and discrimination against reception from the rear of 3 to 1. The use of this antenna is therefore advantageous in congested areas or at distances where a single dipole would have insufficient signal pickup. The two dipoles are variations of the folded dipole and result in greater bandwidth and a higher center impedance.

The propagation characteristics of the antenna systems described herewith are "Quasi-optical" or similar to light waves. Just as with light waves, high frequency radio waves are limited mostly to line of sight transmission and reception, and are subject to reflection, refraction and attenuation by the mediums through which they pass. It follows, then, that for good reception, the transmitting and receiving antennas should be within sight of each other. This is impossible to attain with many installations; but in general the higher the transmitting and receiving antennas are above ground, the greater the distance that can be covered, and the greater the strength of the signal at the receiver. For example, the television antenna for Station WNBT is on top of the Empire State Building, about 1250 feet high. Assuming the receiving antenna to be at the surface of the earth, the maximum distance of transmission to the horizon is 50 miles. This is computed from the formula

$$d = \sqrt{2h}$$

where d is the transmitting dis-

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tance in miles, and **h** is the antenna height in feet. The graph of Fig. 9 shows transmitting distances to the horizon for various antenna heights. If the receiving antenna is elevated above the ground, the maximum distance of transmission and reception will be increased and is found by the formula

$$d = \sqrt{2Ht} + \sqrt{2Hr}$$

where **Ht** equals the height of the transmitting antenna in feet and **Hr** equals the height of the receiving antenna in feet. Thus, if the receiving antenna is 100 feet high and the transmitting antenna is 1250 feet high, the maximum distance becomes 15 miles plus 50 miles, or 65 miles.

A number of antennas have been specially developed which cover an extremely wide band of frequencies so that a single antenna would be capable of covering not only all the television channels, but all of the FM channels as well. One of these is the Andrew Di-Fan antenna (Fig 10). This antenna is said to cover the exceptionally wide range of 44 to 216 megacycles. The input impedance at the center of the antenna is equal to 300 ohms which corresponds to the new R.M.A. standard of 300 ohms for transmission line and receiver input impedance. The desirability of installing such an antenna is obvious.

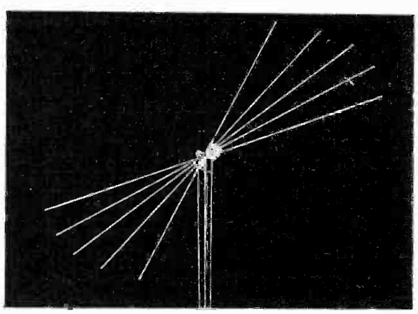


Fig. 10 The Andrew Di-Fan antenna. This antenna covers an extremely wide band of frequencies without serious attenuation.

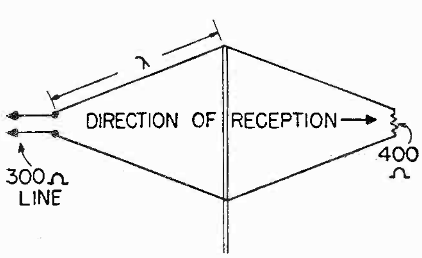


Fig. 11 The V antenna.

The V Antenna

In suburban areas where there is plenty of available space and the signal level is not high, the use of "long wire" antennas is highly recommended. One of these is the V antenna (Fig. 11). The V antenna is composed of two sections made of heavy wire (#12). Each section is made a full wave length long at the center frequency of the desired operating band. For this length, the angle between the wires should be about 75 degrees. The V is mounted in a horizontal position and receives best in either direction along a line bisecting the V. It has wide band characteristics, high gain, and a low angle pattern of reception. A transmission line of 300 ohms will provide a satisfactory match over its range.

The Rhombic Antenna

A more efficient version of the V antenna is the diamond or rhombic antenna (Fig. 12). This consists of two V sections and is terminated in a small wattage carbon resistor of about 400 ohms. The rhombic antenna has several qualities which make it very desirable as a television antenna where space requirements are not a determining factor. As shown in Fig. 12, the antenna is unidirectional and will not receive signals from the rear. It has a higher gain and a lower angle of reception than the V antenna, thus helping to eliminate noise impulses and other undesirable signals. Extremely wide band reception is easily attained. If the antenna is cut to 70 megacycles, it will cover from about 40 to 110 mc. A standard 300 ohm transmission line will match the antenna with good efficiency. If it is desirable to receive signals from the rear of the antenna, the terminating resistor may be removed and the V closed electrically.

Special Considerations

In some areas where the trans-

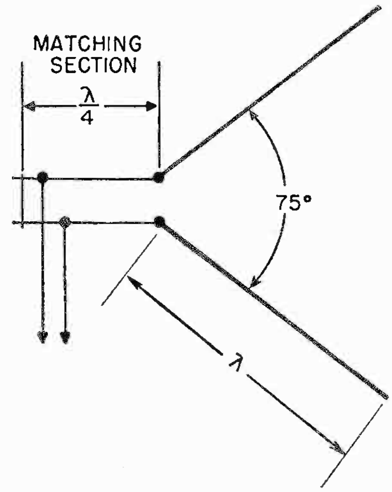


Fig. 12 The rhombic antenna. This antenna gives a low angle of reception and comparatively wide band coverage.

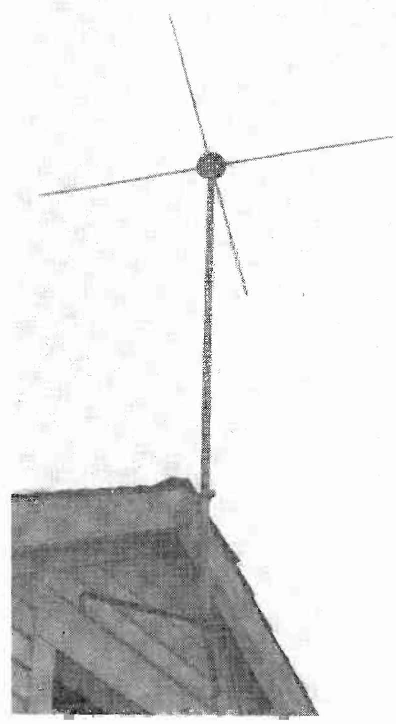
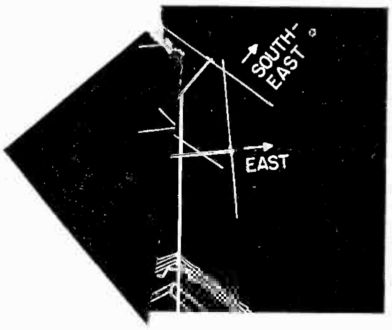


Fig. 13 The Workshop Associates non-directional antenna. In locations where signals must be received from widely different directions and no trouble is experienced with reflections, this antenna will give excellent results. In areas where the signal strength is low or there are serious reflected signals, this antenna can be converted to a three-element parasitic beam, using a kit supplied by the manufacturer. The heading of the article shows the converted antenna.



:ts of elements stacked other, fixed to receive directions. An antenna ives a flexible pattern adjusted for the reception coming from more than and, at the same time, reflections coming from the back.

r .ters are separated by large angular distances, the directional properties of the antenna will cause severe losses of signal strength from stations which are not broadside to the antenna. There are several possible solutions to this problem. The most obvious is the use of a non-directional antenna such as that manufactured by The Workshop Associates (Fig. 13). The use of this antenna enables equal amplitudes of signal strength to be received from all directions. The antenna is supplied in kit form and may be easily converted to a highly directional antenna consisting of a dipole with director and reflector by the addition of a few parts. The use of a non-directional antenna is advantageous for FM and television, provided that the signal strength is fairly good and that, in the case of a television set, there are no interfering reflections to cause ghosts. If reflections do occur, a more suitable arrangement can be used which is an adaptation of the stacked array. In this case, the upper and lower sets of elements are fixed at different directions, as shown in Fig. 14. Thus the upper set might be oriented to point to the East and the lower set to the Southeast while preventing reception from the other directions. The most desirable system which would overcome practically all of the problems to be encountered is a wide band antenna system which would automatically rotate to the most advantageous position for the reception of each television and FM station. Control for changing the position of the antenna might be obtained from added contacts on the station selector switch or by an external control box.

A rather ingenious antenna which fulfills most of the above specifications has been designed by Kings Electronics, and is illustrated in Fig. 15. The antenna consists of two dipoles, mounted at right angles to each other. The longer dipole is tuned to 64 megacycles, which is the geometric center of television channels 1-6, and the shorter dipole is tuned to 192 mc, the center of channels 7-12, which are not yet in use. The entire assembly may be rotated in either direction from a remote control box located at the receiver. The average impedance of this antenna is about 100 ohms. In very congested areas, it will sometimes be impossible to obtain a clear path to the transmitting antenna because of intervening buildings or other objects. In this event, it may be possible to obtain satisfactory reception by utilizing a reflected wave as shown in Fig. 16. However, reflected waves from other available stations may

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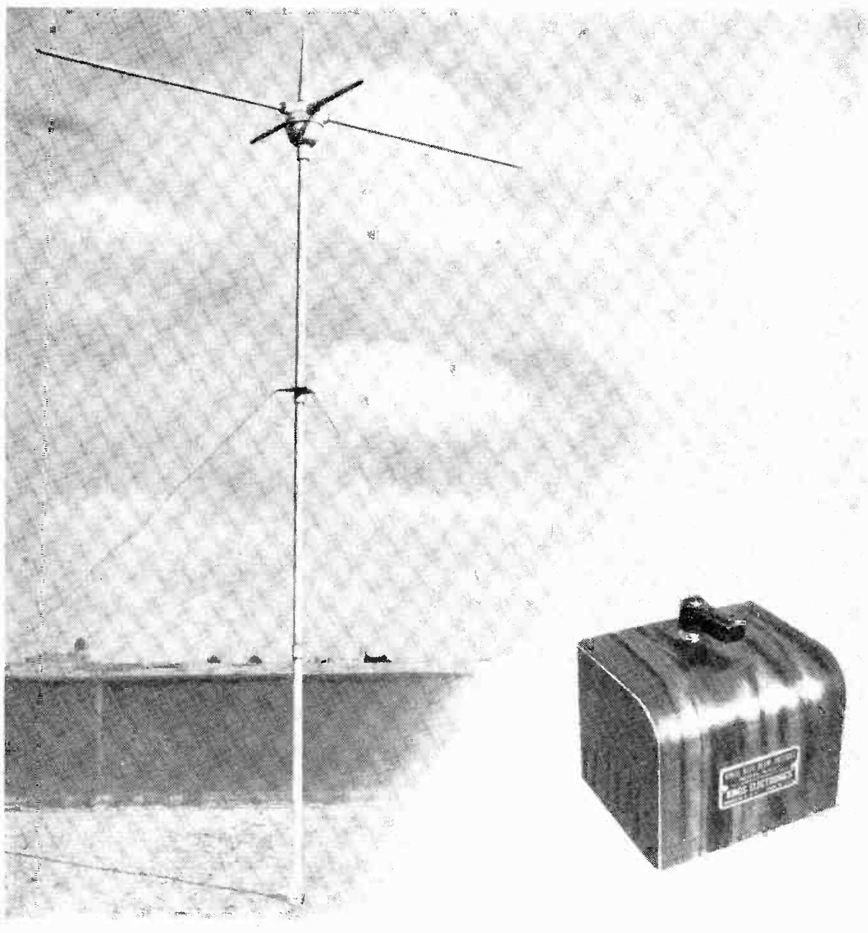


Fig. 15 Kings Electronics antenna which consists of two dipoles set at right angles to one another and cut for two different frequencies. The antenna can be rotated from a remote control box located at the receiver.

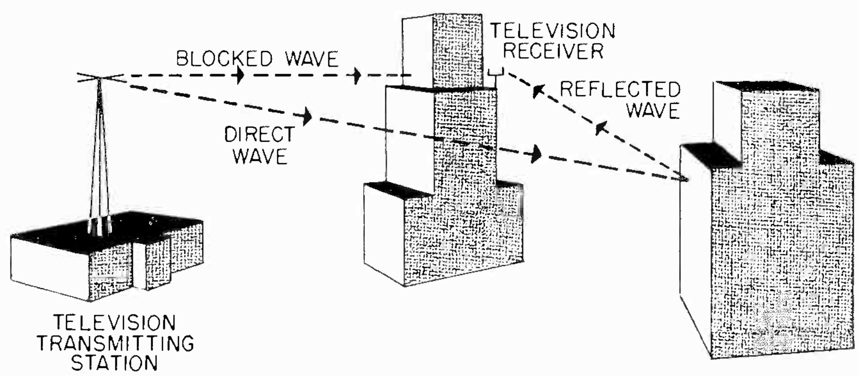
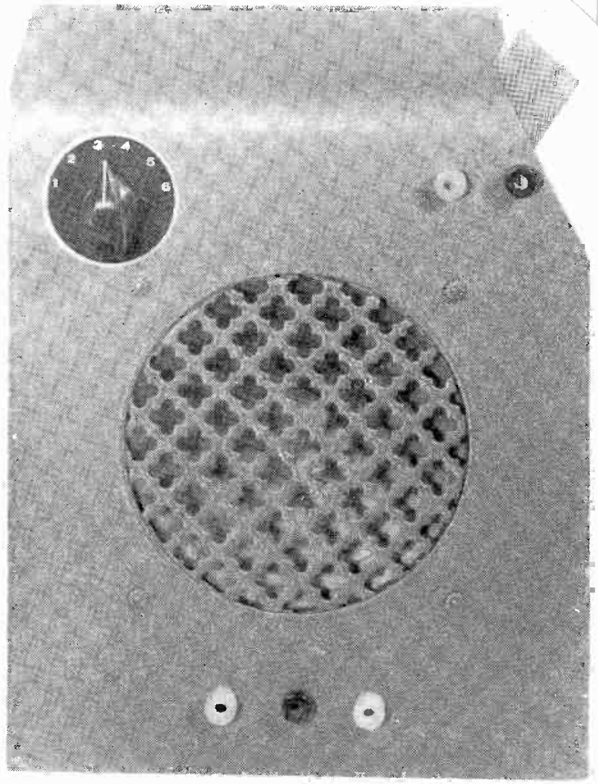


Fig. 16 The above figure shows the way in which a reflected wave can be used to obtain satisfactory reception.



A UNIVERSAL SPEAKER

by J. B. Crawley

Although comparatively simple, this universal speaker is a big timesaver in the shop.

OFTEN WHILE WORKING on a set whose speaker was particularly difficult to remove, we have wished that we had a universal speaker available. While it is considered good practice to remove the speaker of a set so that the performance of the receiver (inclusive of the speaker) may be ascertained, there are instances when its removal is time-consuming, as in many car radio installations, and a universal speaker may be substituted while a bench check is made. A piece of test equipment of this sort is also helpful when the speaker of the set being repaired is defective.

The most important part of a universal speaker, and the most difficult to obtain, is the transformer. Conventional transformers of the so-called universal type will not match all types of output tubes and do not lend themselves to a simple switching system. For this reason we decided to wind our own. Actually, it is not necessary to wind the transformer completely; all that is necessary is to chose the proper transformer and revamp the secondary winding. At first thought, this may seem to be a difficult undertaking. However, on close examination, it proves to be a comparatively simple task.

The transformer chosen had to have adequate power handling capacity to take care of the larger receivers, and an impedance high enough to take care of such tubes as the 1A5 and the 1LA4 which require 25,000 ohm plate loads.

After checking several transformers, we finally decided on the Stancor A-3823 as the most suitable

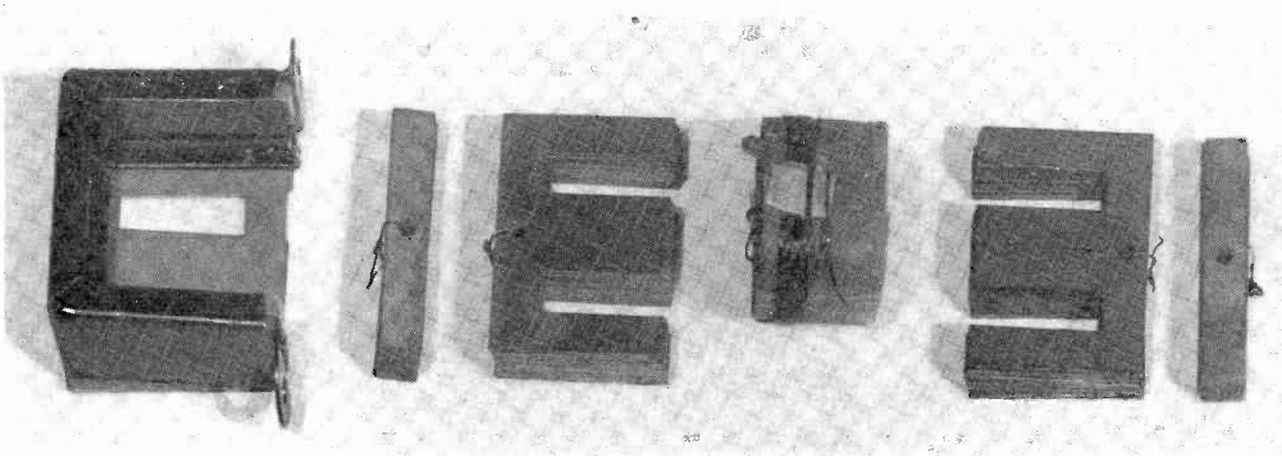


Fig. 1 The completely disassembled transformer ready to rewind.

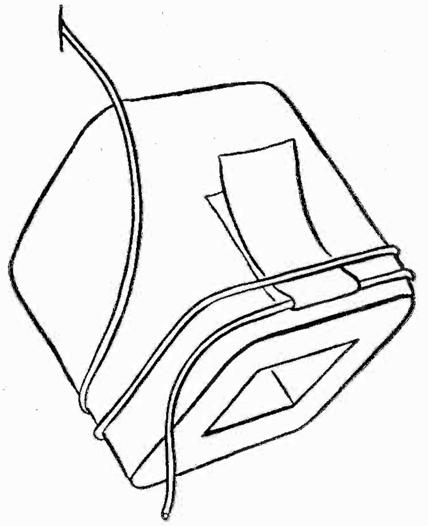


Fig. 2 As shown above, when starting the winding, a piece of paper is used to hold the first turn in place.

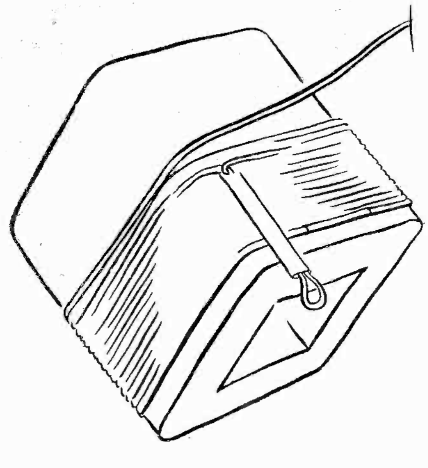


Fig. 3 The taps are made by twisting a pigtail of wire and bringing it to the edge of the winding between layers of insulating paper. The taps may be tagged or identified by their length.

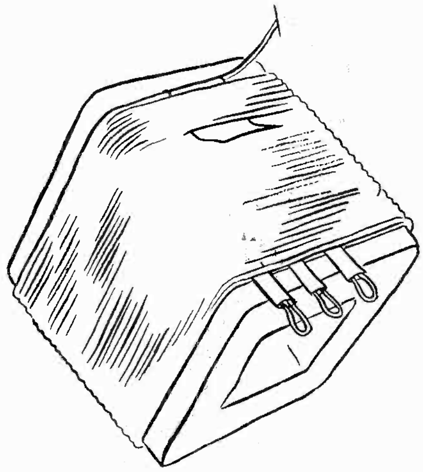


Fig. 4 As the winding is completed, a piece of insulating paper is used to hold the last turn in place as shown above.

for the job. It has an 8-watt rating and can match voice coil impedances from .08 to 90 ohms to plate loads of from 1500 to 20,000 ohms. Its primary impedance is approximately 60,000 ohms.

For the speaker, we chose the Jensen PM6-ES which has a voice coil impedance of 4 ohms and, therefore, requires a lesser number of secondary turns than would a speaker with an 8-ohm voice coil.

The first step is the dismantling of the transformer. The core of the transformer is held together by the frame. Four small tabs which are a part of the frame are bent under the core to hold it in place. Straighten these tabs, spread the frame slightly and the core and winding may be removed from the frame. The core may then be disassembled and the winding removed. While this disassembly is in process, note carefully the way in which the transformer is put together; it will make the reassembly job easier. Fig. 1 shows the completely disassembled transformer. Unsolder the wires from the lugs on the secondary terminal strip, remove the layer of wax paper from the secondary winding and proceed to unwind the secondary.

If possible, new wire of the same gauge and insulation as that removed from the transformer should be obtained. If new wire is not available, wire of approximately the same size removed from a burnt-out transformer will do. In our case, we kept the longest piece that we had removed from the transformer, straightened it, and added a piece of approximately the same size taken from a transformer in our junk box.

Rewind the transformer in the same manner in which it was unwound, alternating layers of wire and paper. Loop a piece of paper over the wire as the winding is started, then wind the succeeding turns of wire over this paper as shown in Fig. 2. The paper will serve to hold the winding in place. One hundred and twenty-seven turns must be wound on the secondary with taps as shown in Table 1. The taps are made by twisting a pigtail of wire as shown in Fig. 3, and bringing the pigtail to the edge of the winding between layers of insulating paper. As a means of identification, each succeeding pigtail may be made longer than the one preceding it.

As the winding is being completed, lay down a loop of paper as shown in Fig. 4, and wind the last few turns over it. The last turn

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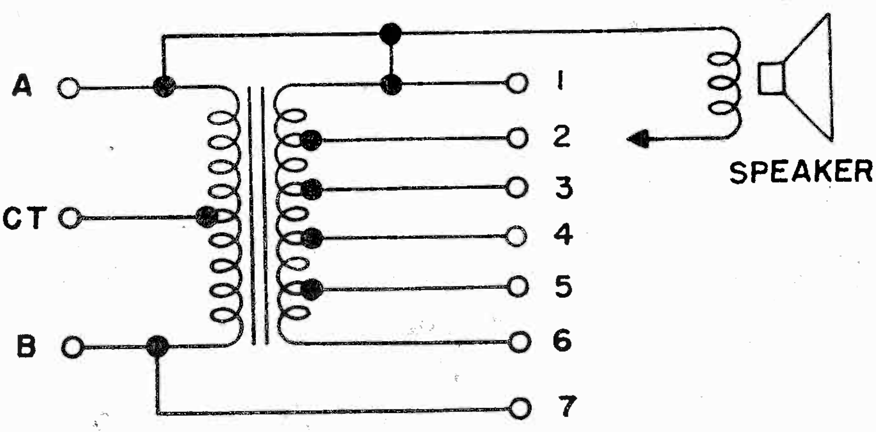
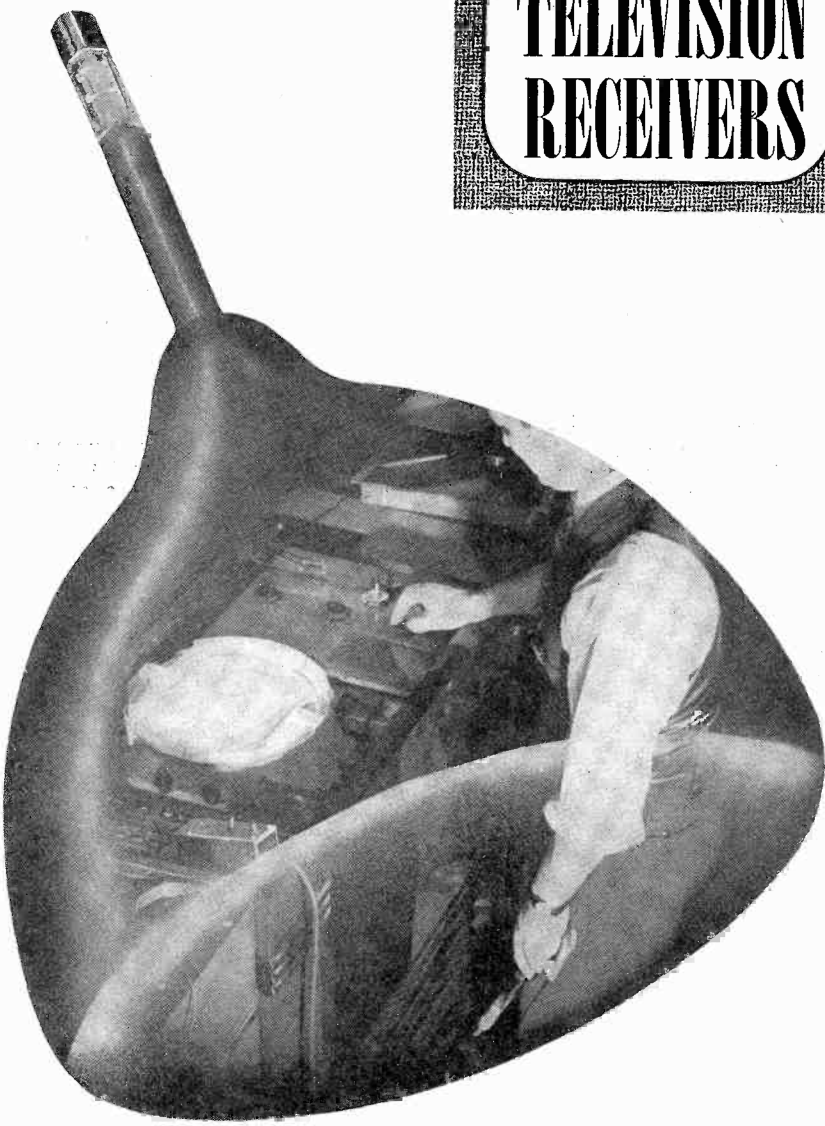


SWITCH TERMINAL 1 = 25,000 OHMS
" " 2 = 20,000 OHMS
" " 3 = 15,000 OHMS
" " 4 = 10,000 OHMS
" " 5 = 7,000 OHMS
" " 6 = 2,000 OHMS
" " 7 = VOICE COIL

Fig. 5 The circuit diagram of the completed universal speaker.

TELEVISION RECEIVERS



the Horizontal sweep

by
Morton Scheraga
Allen B. Du Mont Labs.

The author has divided the television receiver into seven separate sections. This is the fifth section to be discussed.

THE HORIZONTAL SWEEP SYSTEM is similar in many respects to the vertical sweep system which was discussed in detail in the last issue. The fundamental differences that arise between the two circuits are due to the scanning frequencies involved: 15,750 cps for the horizontal, and 60 cps for the vertical. The relatively high horizontal sweep frequency makes it necessary to use a different type of sync separating circuit from that which is employed in the vertical system. It will also be shown that the shape of the saw-tooth deflecting voltage is different, and that a damping network must be used in the horizontal circuit to prevent high frequency oscillations.

The vertical and horizontal systems start at the output of the sync separator. At this point the video information has been clipped, leaving the composite sync signal consisting of the horizontal sync pulses and the serrated vertical sync pulses. In the previous article, it was shown how this composite signal was directed to the vertical sync amplifier and the succeeding vertical stages. The output of the separator is likewise fed to a horizontal sync amplifier. Refer now to the block diagram of Fig. 1 and the schematic circuit of Fig. 2 to trace the signal path of the horizontal sweep system.

The separation of the horizontal pulses takes place at the output of the sync separator. Since the horizontal pulse is much shorter in duration than the vertical pulse, a high pass filter will select the former and discriminate against the low frequency vertical pulse. Such a high pass filter is known as a differentiating circuit and is shown in Fig. 3. This network consists of a capacitance and resistance combination, the capacitance being in series with the signal input and the resistance in shunt across the output. The impedance of the capacitance relative to the resistance of the resistor is small at the horizontal line-scanning frequency of 15,750 cps. The horizontal pulses are, therefore, passed by the capacitor and develop correspondingly large signal voltages across the resistor. The relative impedance of the capacitor to the lower field-scanning frequency of 60 cps is much higher than for the hori-

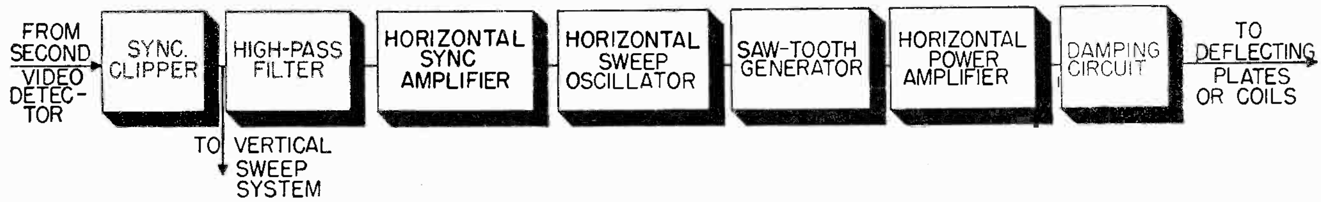


Fig. 1 A block diagram of the horizontal sweep channel of a television receiver.

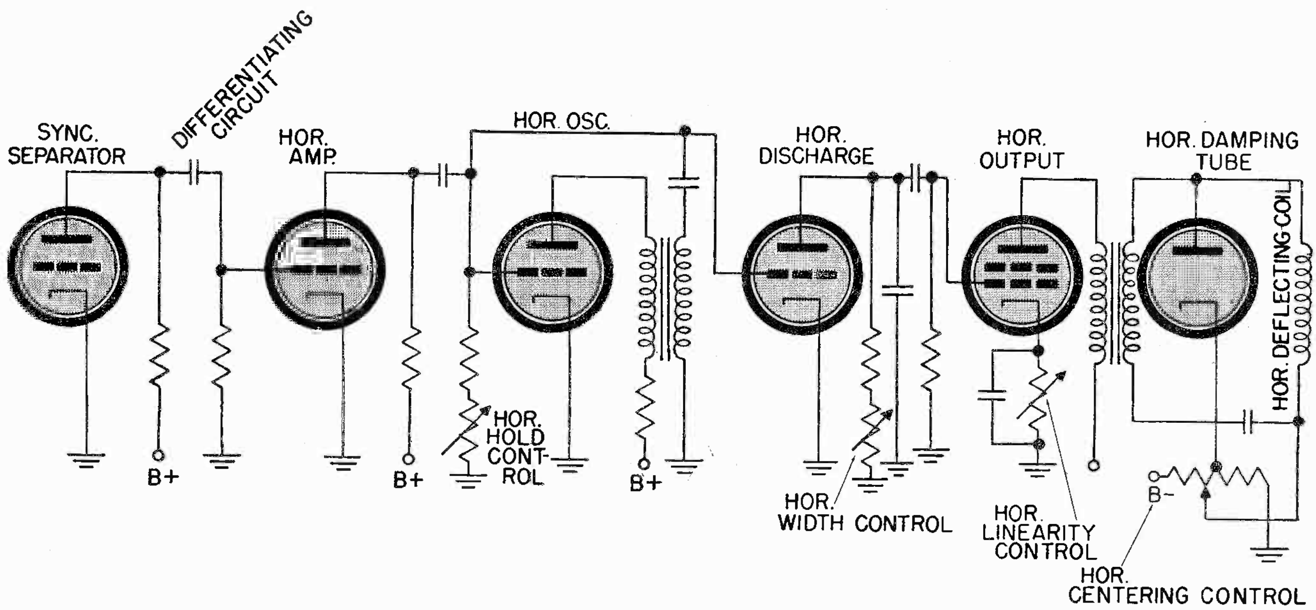


Fig. 2 A partial schematic diagram of the horizontal sweep system of the television receiver.

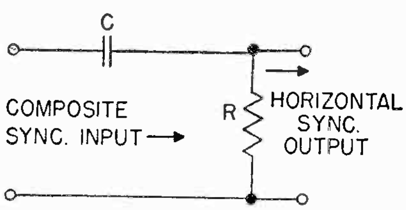


Fig. 3 Differentiating circuit as used in television receivers to separate the horizontal sync pulses from the composite sync signal.

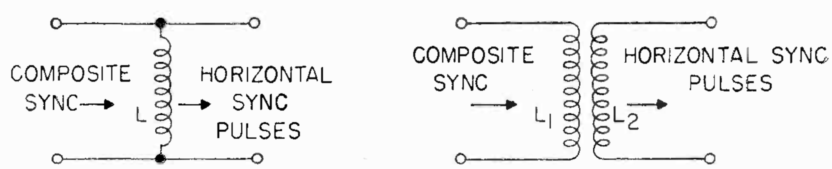


Fig. 4 Differentiating circuits using inductances.

zontal repetition rate. Thus, most of the frame-scanning signal appears across the capacitor and very little of it across the resistor. Consequently, this differentiating circuit is a simple means of separating the horizontal sync pulses. In the circuit of Fig. 2, these are then amplified and applied to the grid of the blocking oscillator.

Another simple type of differentiating circuit which is employed in some receivers consists of an inductance in series with the plate circuit of the horizontal sync amplifier tube, as for example in Fig. 4. The voltage appearing across the inductance is much greater for the short duration horizontal pulses than for the longer serrated vertical pulses. This voltage can then be applied directly to the sync terminals of the horizontal generator if they are of positive polarity. If not, a phase reversal may be obtained by a single amplifier stage. It is sometimes more convenient to use a two-winding transformer in the differentiating circuit. See Fig. 4. The primary then provides the inductance of the network, while the secondary is connected to the horizontal sync generator. With a two-winding transformer, the secondary can be reversed, if need be, to produce positive sync at the horizontal generator.

The synchronizing of a vertical blocking oscillator was described in the previous article. By way of example of another type of synchronizing oscillator that is favored by some manufacturers, the operation of a multivibrator circuit is shown in Fig. 5.

The operating cycle consists of tube V-1's plate current first increasing rapidly, while tube V-2 is cut off. Tube V-2's plate current then rapidly increases while V-1 is cut off. The oscillations continue in this manner with the frequency largely determined by the grid resistors and condensers, R-1, R-2, C-1, and C-2. If the horizontal sync pulse obtained from the differentiating circuit is now inserted at one of the grids, and if its frequency is close to the natural frequency of the oscillator, it is pos-

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PHASE INVERTER CIRCUITS

There is nothing new about phase inverters but with the advent of frequency modulation and television, high fidelity audio systems are becoming increasingly common. High fidelity reproduction requires the use of a push-pull audio power stage which, in turn, necessitates a phase inverter system. The author discusses those phase inverters which are most commonly encountered.

by
J. Richard Johnson

WITH THE TRANSITION from transformer coupled audio amplifiers to those of the resistance type, the phase inverter has become increasingly more important. This importance will continue to grow as more and more frequency modulation receivers demand high fidelity amplifiers with resistance coupled output stages. Consequently, it is felt that a full explanation of the theoretical and practical aspects of this type of circuit will be found useful to the service engineer.

First, why is a phase inverter necessary? To understand this, it is important that we clarify the difference between a single-ended or "unbalanced" circuit and a double-ended or "balanced" type. Fig. 1 shows two simple load circuits. Suppose in each of these circuits we assume that a signal voltage is applied between points X and Z. In Fig. 1a, let's assume that at a given instant X is positive and Z is negative. This means that they have these polarities with respect to each other, and either one could be used as a reference. As soon as we ground Z as shown, however, we establish a fixed reference, or starting point. We then have only one "phase" or direction of voltage available since signal voltages are measured with respect to ground. Point Z will now coincide with ground and our one phase exists at X (above ground) producing the single-ended type of circuit. Ordinary voltage amplifiers and detectors put out this type of signal.

Let us now take the same circuit and move the ground up to the midpoint of the resistor as shown in Fig. 1b without disturbing the source of the signal. Point X will still be above ground, but at only one-half of the previous potential. But point Z still differs from point X by the full potential. This means that when point X is positive with respect to point Y, point Z will be the same amount negative with respect to Y. Thus, with point Y grounded, we now have two voltages, both above ground and 180 degrees out of phase with each other. This relation is shown graphically in Fig. 1c, and is representative of the double-ended type of circuit.

A push-pull amplifier is a double-ended circuit in which each tube works against ground and is 180 degrees out of phase with its companion tube in the stage. Fig. 1c could represent the voltages in the plate circuit of a push-pull amplifier, or the voltages applied to the push-pull grids.

Since a great majority of voltage amplifiers and all ordinarily used AM second detectors are single-ended, it becomes necessary to convert from one type of circuit to the other. One way to do this is by use of a push-pull audio transformer. With a transformer, one can run the primary single-ended and the secondary double-ended and

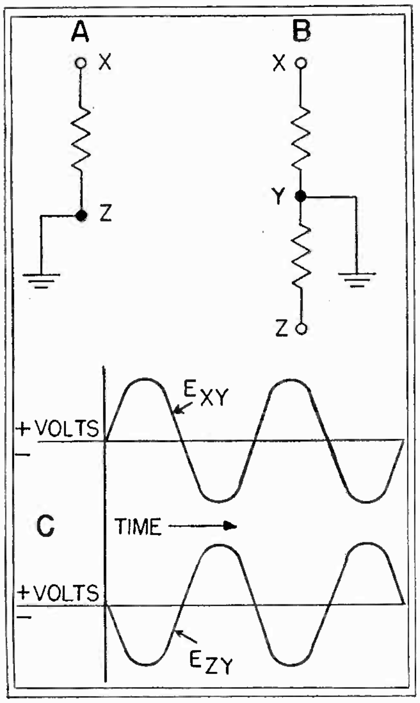

Fig. 1 **A representation of single- and double-ended circuits. A represents the load circuit of a single-ended amplifier and B represents the load circuit of a double-ended amplifier. C shows the phase relationships of the voltage present in B when a sine wave signal is applied across points X and Y.**

thus solve the problem. But a transformer is expensive, bulky, and subject to resonance effects. That is why the phase inverter is the logical alternative since it overcomes these disadvantages.

One of the basic principles upon which phase inverter circuits are founded is the fact that the plate voltage of a vacuum tube is 180 degrees out of phase with the grid voltage of that tube. The reason this is so can be explained as follows. Assume a rise in the grid voltage in the positive direction. This will be accompanied by an increase in plate current, causing the voltage drop across the plate load resistor to increase. This increase in voltage drop causes the voltage at the plate itself to fall off. Thus, an increase in grid voltage causes a lowering of plate voltage, and a 180 degree phase relation therefore exists. Let us now consider some actual circuits in which this principle is put to work.

Probably the most popular inverter circuit is the type shown in Fig. 2. An ordinary single-ended resistance coupled amplifier is used in conjunction with an additional tube which gives the phase shift needed for the second output tube grid. Notice that except for the tap at point X and the use of a push-pull output transformer, the upper portion of Fig. 2 is simply a conventional resistance coupled amplifier.

Now some of the signal voltage applied to the output grid at point Y is tapped off at point X and fed into the grid of the phase inverter tube at point Z. The phase inverter grid now has a signal voltage of exactly the same phase as the grid of the top output tube but a lower voltage because it is tapped down on R1.

Because of the fundamental phase shifting property of a vacuum tube described above, the signal will appear in the plate circuit at M, not only amplified, but 180 degrees out of phase with the signal at point Z. This voltage is then passed on to point N, the grid of the lower output tube. Thus points Y and N have the opposite phase necessary for proper operation of the output stage. The only components which could change the exactness of the 180 degree relation are the coupling condensers. Since these are always chosen to have negligence reactance at the frequencies used, they do not disturb the relation.

But there is another important requirement. The voltages on the two output grids must be balanced; they must be equal. If balance is not obtained, the output wave form will not be symmetrical and third harmonic distortion will appear. To preserve balance, the ratio of the signal voltages at points X and Y must be carefully adjusted in conjunction with the gain of the phase inverter tube. Since the voltage at X is amplified to produce the voltage at N, which should be equal to that at Y, it becomes clear that the ratio of the voltage at Y to that at X should equal the gain of the phase inverter tube. Of course, in any receiver using this type of circuit, the correct component values will be given on or with the circuit diagram, but the service engineer will find it worthwhile to understand the factors involved in the choice of the values of these components.

Self-Balancing Inverter

An important variation of this circuit is shown in Fig. 3. This is known as the *self-balancing* type of phase inverter. Since the main portion of the diagram would be the same as that described above, only the grid circuit of the push-pull amplifier is shown. Notice that the low side of the grid resistor of output

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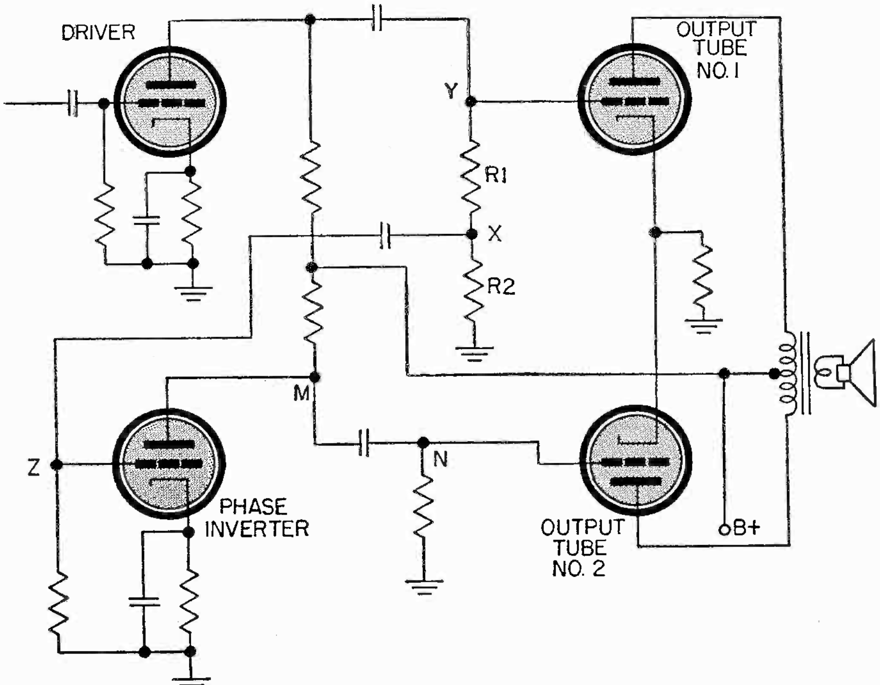

Fig. 2 **A phase inverter circuit using two triodes. This circuit is one of the most popular now in use.**

PHASE INVERTER CIRCUITS

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tube No. 2 now goes to the point X in Fig. 2, instead of directly to ground. This means that part of the voltage applied to the grid at point N is fed back (along with part of the voltage at point Y) through point X to the phase inverter tube through point Z. Since the voltages at points N and Y are out of phase with each other, the portion of the N voltage appearing at point X is degenerative feedback. This degeneration has a balancing effect on the two voltages. As soon as the voltage at N gets too large, the portion of it at X reduces the signal voltage on point Z, reducing the voltage at N, where it was originally too large. This design has the advantage that the division between the X and Y portions of the grid resistor of output tube No. 1 is not as critical as in the case of the first circuit described. It can be seen that if the three resistors involved in the grid circuit of the push-pull stage are all made the same resistance, there will be 50 per cent negative feedback. This feedback not only helps to balance the signals on the two grids, but also gives the other advantages of degeneration in an audio amplifier.

The Cathode Follower

The cathode follower type of circuit is utilized as a phase inverter since it has the proper phase relation between plate and cathode voltages. The tube is connected as shown in Fig. 4. Two plate circuit resistors, R1 and R2, are used, both of which carry the fluctuating plate current. One is connected between the plate and B+, the other between B— (ground) and the cathode resistor. Since a triode is normally used, there is no screen current and the same currents flow through R1 and R2. With ground connected between the resistors as shown, equal voltages with respect to ground will exist at points A and B. But, since the electron flow is toward ground through R1 and away from ground through R2, the voltages will be 180 degrees out of phase with each other. These voltages can be applied through coupling condensers to the grids

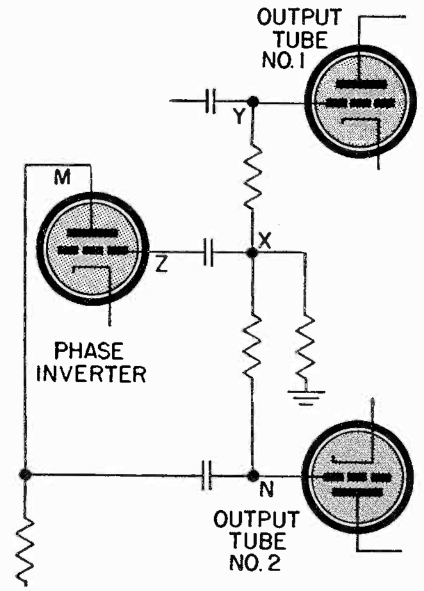

Fig. 3 A partial circuit diagram of the self-balancing type of phase inverter. In this circuit negative feedback is used to balance the signals on the grids of the two tubes used in the phase inverter.

of the push-pull stage. Notice that since the cathode of the inverter tube must be operated with a signal voltage above ground, the grid signal voltage must vary with respect to cathode, rather than ground. An extra resistor is therefore added to the plate circuit of the previous stage to keep point X above ground potential. Condenser C1 ties point X to the cathode of V2 since C1 and C2 are chosen to have negligible reactance at the signal frequency. This keeps the grid voltage from having to work against the signal voltage appearing across R1. As explained above, the voltages across R1 and R2 are out of phase and are coupled through C3 and C4 to the output stage grids.

The big advantage of this circuit and ones similar to it is the fact that it requires one tube while those previously described require two. However, since dual triodes of the 6N7 and 6SC7 variety are readily obtainable, this is not always such a powerful argument in its favor. A disadvantage of the single-tube inverter is that the circuit values are more critical than those of the two-tube type, and therefore can get out of balance more easily.

Another type of one-tube inverter is shown in Fig. 5. Here again, two resistors (R1 and R2) are used in the external plate-to-cathode circuit, but this time both are placed between B+ and the plate. The distinctive feature of this circuit is the fact that the grid of tube V3 is grounded. This may seem an impossible condition at first thought. It must be remembered, however, that the input voltage to a tube exists between the grid and the cathode. This means that we may run the grid at ground signal potential providing the cathode runs "hot" or at a voltage above ground. This gives the same effect as does running the grid at a negative potential with respect to ground when the cathode is as in Fig. 5. Now

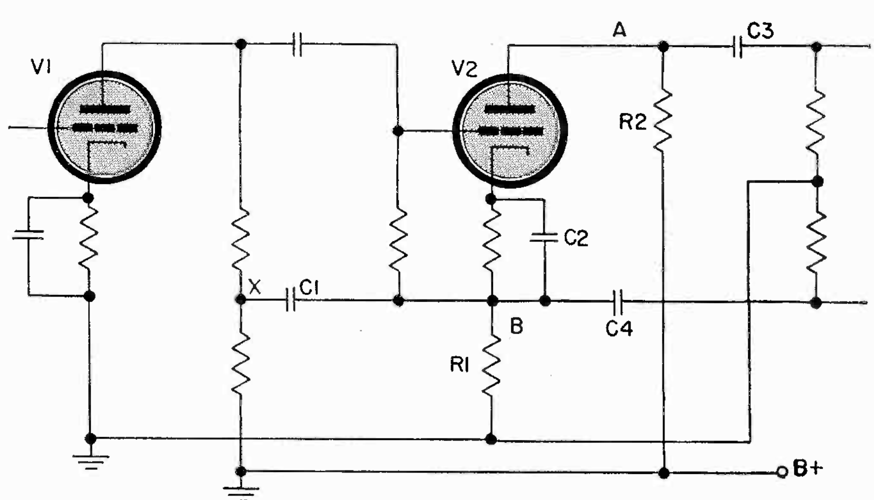

Fig. 4 A phase inverter utilizing the cathode follower principle. While this circuit requires only one triode, circuit values are much more critical than those of the two-tube phase inverters.

let's trace the signal through the diagram.

The input audio signal is applied at point A and is amplified in the normal manner by tube V1. The amplified signal appears across the load resistors R1 and R2. This signal is fed to the grid of tube V2 through coupling condenser C1 and appears at point Y. The bottom of resistor R1 goes through condenser C2 to point N and ground. Thus, the signal between the top and bottom of resistor R1 is applied across resistor R3, and between grid of tube V2 and ground. Now V2 amplifies the signal and it appears as fluctuating plate current which is conducted through half of the output transformer, through the power supply, and back to the cathode of V2 through cathode resistor R4. Since no cathode by-pass condenser is used, these fluctuations produce a signal voltage across resistor R4. But R4 is connected between the grid and the cathode of tube V3 (through ground). This voltage is therefore the input signal to tube V3. Suppose we now check the phase relationships. When point Y gets more positive, more plate current flows through tube V2; this increase in current flows through R4 in such a way as to make the cathode more positive than ground. Since the cathode is more positive than the grid, the grid thus becomes more negative than the cathode. In this manner, we have opposing voltages at points Y and N at any given time—which is what we want to get from the phase inverter.

Notice that here again we have introduced some negative feedback as a by-product of our phase inverting process. This is true because the plate current of tube V3, as well as that of tube V2, flows through resistor R4. Since these two plate currents are 180 degrees out of phase with each other, they tend to balance out the voltage drops across R4 as far as signal fluctuations are concerned. Thus, a considerable amount of degeneration is taking place. It now becomes clear that this is another *self-balancing* circuit. But notice that it cannot be perfectly balanced because the input voltage to tube V3 is obtained as a result of unbalance of currents through resistor R4. Since the input voltage necessary for the tube is usually very small, this unbalance is not serious, and this circuit is used successfully in several sets now on the market. The types of phase inverter described above are ones that you are most likely to tun across in the course of service work. There are several other ways in which the same results may be obtained, but they are not much different from those described and work on the same principles.

Now that we have covered the theoretical aspects of the subject, let us investigate the practical realm of servicing technique involved in repair work on sets using the phase inverter. Of course, the inverter is essentially an audio amplifier; and, therefore, is subject to usual audio amplifier faults in addition to those which are peculiar to the phase inverter itself.

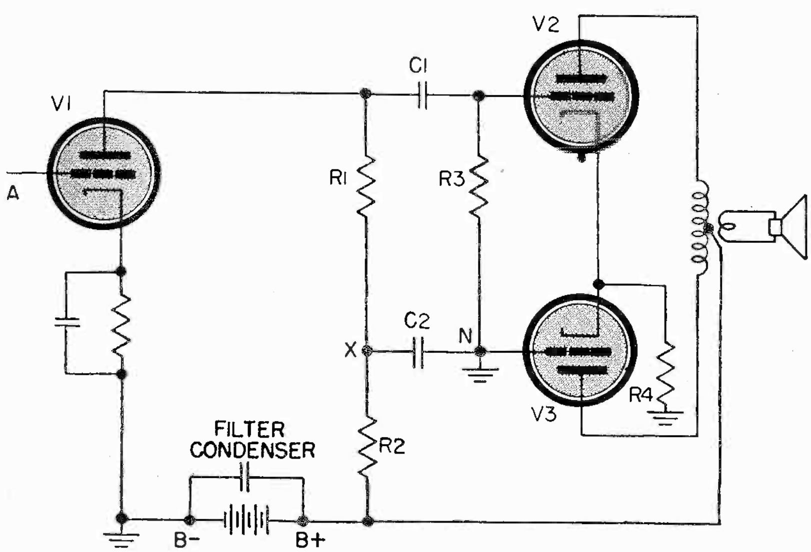

Fig. 5 A variation of the circuit shown in Fig. 4.

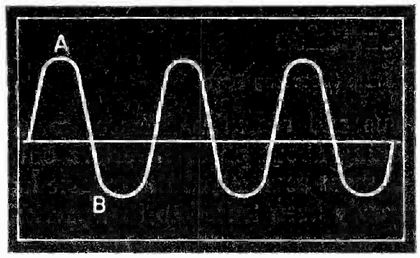

Fig. 6 Distortion of the wave form which results from an improperly balanced phase inverter circuit. The positive peak is of higer amplitude than the negative peak. This condition results in harmonic distortion.

First, there is the possibility that the relatively critical relations between bias resistors and plate and grid resistors, as well as coupling condensers, might be upset by a change in value of one or more of these components. A number of these parts have a dual purpose, and thus small changes which would not necessarily be noticed in an ordinary amplifier can cause trouble. Carbon resistors will often age and change their value; this fact must be kept in mind when searching for trouble in these circuits. Don't let a qualitative reading on an ohmmeter give you a false sense of security about a resistor. Make sure it has the correct value within the tolerance required by the parts list. Condensers are not quite as critical as resistors; but if one of them is leaking excessively, the result may be distortion and loss of signal strength.

Second, there is the matter of balance. Aging of resistors can, of course, seriously affect the balance of the two voltages on the grids of the output stages. Even if all other things in the circuit are working perfectly, this factor will produce distortion in the output. Fig. 6 shows the type of wave form which results from unbalance of the phase inverter circuit. One peak of the wave (A) has a higher value of voltage than the other peak (B). Thus harmonics, or voltages having twice, three times, etc., the fundamental frequency are produced in the output. The result is speech or music which has that "marbles in the mouth" or fuzzy or scratchy sound which is so often the cause of dismay on the part of the customer.

Having analyzed in a general way the possible causes of trouble, let's get more specific about symp-

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Phase Inverter Circuits

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toms and remedies. Since we are talking about phase inverters only, we must asume that the trouble has already been traced to that particular section of the receiver and that is where we are going to concentrate our efforts. Now for our symptoms.

No signal: Trace with an audio oscillator or a signal generator having an audio output. Start at the output grids, placing the audio voltage on one grid, then the other. Audio output from the speaker should be heard from either tube, although the gain of the power tubes is quite low so don't be alarmed if the output sounds quite weak. If the set itself is dead, it is quite unlikely that one of the output tubes will be any different from the other in this test since the proper operation of either one would produce some sort of signal. An exception to this, of course, would be the case of a short in the common B+ lead. If the signal through the output stage seems to be okay, then we can move back a stage and try applying our signal to the grid of the inverter itself, depending upon whether it is of the one- or two-tube type. It is not likely that the inverter tube or circuit is at fault in the two-tube circuit since in this type (See Fig. 2) failure of the inverter itself will not prevent signal from going through the other tube (driver). On the other hand, failure of the driver tube in this setup would be just the thing likely to cause a complete loss of signal. When a single tube is used (See Fig. 4 and 5) naturally a defect almost anywhere in the circuit of this tube can be the cause.

Distorted Signal: First, use the same method as described above, except that now we try to find the point at which the distortion starts. We should, of course, check all bias resistors and make sure that power supply voltages are proper. If none of these normal measures produces results, we should look for unbalance. If an audio oscillator with a good wave form is available, as well as an oscilloscope, we can follow the wave form through the circuit until we find the point at which distortion shows up in the wave shape. Perhaps a better way to check balance is to read signal voltages on the push-pull plates or grids. Put an audio signal into the input of the audio section; and with a condenser of about 0.05 ufd in series with the prod or lead from an AC voltmeter, check the voltages on the two push-pull plates. The difference between the voltages should not be more than 10 per cent. If they are okay, then the same test can be made on the grids. Here, we should use a high impedance meter, preferably a good vacuum tube voltmeter, since a low impedance meter will load down the grid whose voltage it is reading, and thus cause an unbalance which did not exist originally. We must not overlook the fact that unbalance can also be caused by a weak tube, especially in the two-tube variety of Fig. 2 and 3. It is worthy of note that the weakness of a tube which would ordinarily cause nothing more than low output now is a definite cause of distortion in inverters which are not of the "self-balancing" type.

Low output: All the ordinary causes of low output in an audio amplifier *except* those which would also cause unbalance are to be suspect in this case. Weak tubes in self-balancing types or low supply voltages are possible causes.

The trouble chart at left includes some of the more common troubles to look for in each case, although one should remember that there is no "cure-all" like understanding the circuits.

Symptom	Possible causes.	What to look for.
No signal	Power failure, shorted resistors or condensors, open resistors or output trans.	Check power supply including rectifier, filter condensers, choke, transformer. Burned out tube, shorted plate or grid resistors, open plate or grid resistors, open output transformer primary or secondary, speaker field or voice coil open, shorted coupling condensers, open cathode resistors.
Distortion	Unbalance, improper bias, impedence mis-match.	Cathode by-pass condensers shorted, open return on grid resistors. Plate, grid, or cathode resistors aged to improper resistance value. Weak inverter or driver tube. One half or some portion of output transformer shorted internally or to ground, speaker cone damaged, leaky coupling condenser, filter condenser losing capacity, decoupling condenser resistor shorted.
Low output	Weak tubes, low plate or fil. voltage.	Weak tube, leaky filter condenser, low filament voltage, shorted portion of bleeder resistor or output transformer primary.

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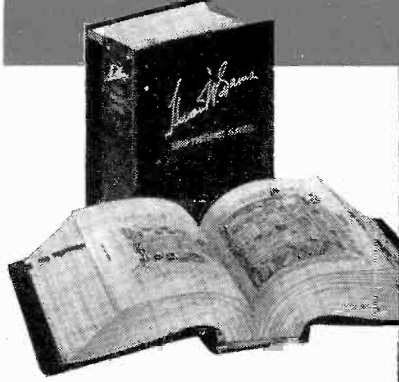

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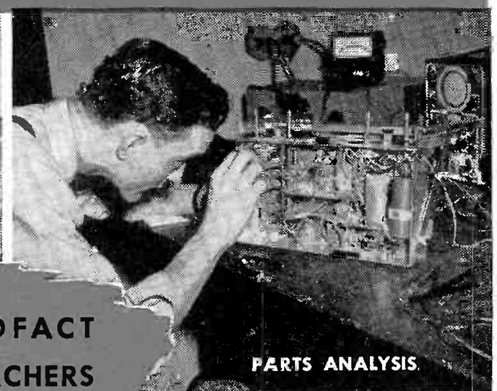

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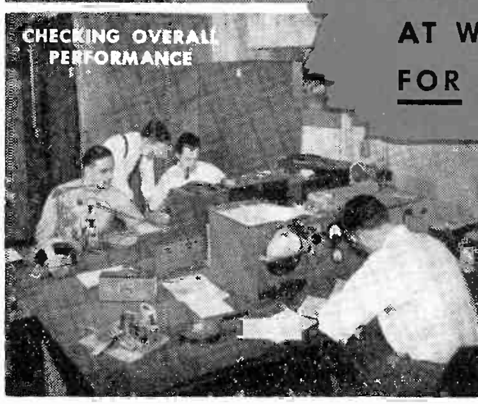

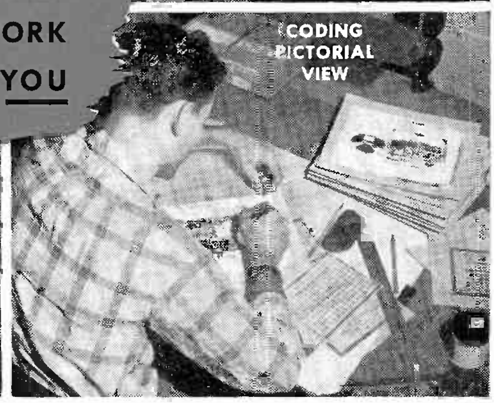

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PHOTOFACT SERVICE

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The Horizontal Sweep

→ From Page 15

sible to control the period of the multivibrator. With the addition of the charge and discharge condenser, C-3, across the plate of tube V-2, the horizontal saw-tooth voltages are generated by the multivibrator in the following manner: When tube V-2 is not conducting, the power supply will slowly charge C-3. When V-2 suddenly conducts, its internal resistance decreases and condenser C-3 discharges rapidly through the tube. During the next cycle, V-2 is again non-conductive, and again C-3 slowly charges. R-2 is made variable to permit adjustment of the frequency of the multivibrator so that it can be locked in with the synchronizing pulse. R-2 thus serves as the horizontal hold control.

Regardless of whether a blocking oscillator or multivibrator is used as the generator, it is seen that either is synchronized by the incoming sync pulse, and in turn serves as a triggering device to discharge the saw-voltage condenser.

In receivers with electrostatically deflected cathode-ray tubes, the horizontal saw-voltage is amplified by a suitable voltage amplifier and applied to the deflecting plates. On the other hand, with a magnetically deflected tube which employs deflection coils, a large saw-tooth current is required rather than voltage. Hence, a power amplifier with a step-down transformer is utilized to develop this large current.

It was previously shown that the voltage waveform in Fig. 6 was necessary to generate a saw-tooth current in the vertical deflecting coil. In the horizontal system, however, only a saw-tooth voltage need be injected into the grid of the power amplifier. This is because the inductive reactance of the horizontal deflecting coils, which is reflected into the plate circuit of the power amplifier, is small compared to the plate resistance of the 6L6 (the power amplifier used in the circuit of Fig. 2). Thus, for a circuit which is essentially resistive, a saw-tooth voltage can cause a saw-tooth current to flow. This is the reason

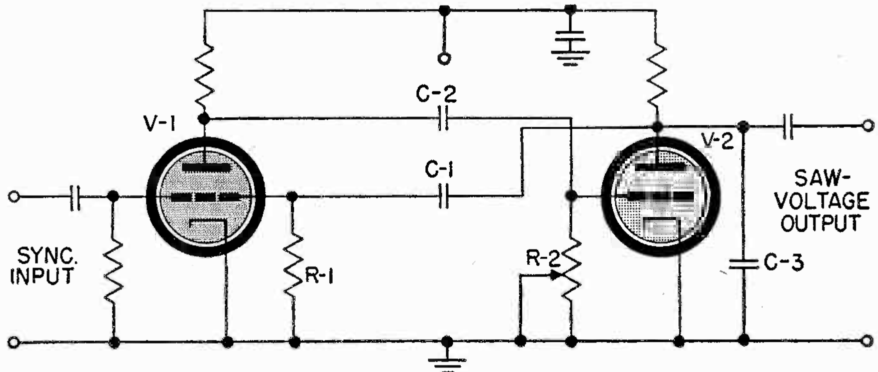

Fig. 5 Circuit diagram of a multivibrator with provisions for synchronization.

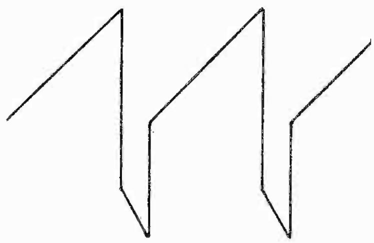

Fig. 6 The voltage wave form required to produce a sawtooth current in a deflection coil.

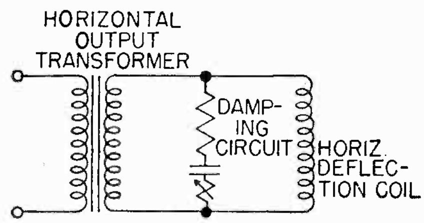

Fig. 7 A damping circuit using a resistance and capacitance network.

why it is unnecessary to place a resistor in series with the discharge condenser in order to obtain the peaked wave, as was the case with the vertical signal. If, however, a triode with a low plate resistance is used, then the peaked wave of Fig. 6 is required. In comparison to the usual inductance of 2 to 8 mh for horizontal coils, the vertical coils have an inductance of about 30 to 60 mh.

One more major difference exists between the horizontal and vertical system, that is the damping circuit in shunt with the horizontal deflection coil. This circuit is shown in Fig. 2. The damping tube eliminates shock-excited oscillations which are set up in the electromagnetic coils by the high frequency return trace pulse. The diode provides a low-resistance path whenever the plate becomes positive and current flows through it. On the negative half of the transient waves, the plate is negative, the tube non-conductive, and its resistance infinite. The damping, therefore, is done when the plates are positive and enough energy is absorbed to cause the oscillations to decay. The damping circuit is required only for the horizontal coils; whereas, in the vertical system, the low frequency saw-tooth voltages do not readily generate frequencies close to the resonant frequency of the coils.

A diode is not always used in the damping circuit. Some receivers have a damping network of capacitances and resistances which serve the same function. Such a circuit is shown in Fig. 7. It should be noted that there is no need for damping circuits with electrostatically deflected tubes where, obviously electromagnetic deflection coils are not used.

The positioning control is similar to that employed in the vertical circuit. A variable DC voltage is injected in series with the deflection coil and enables positioning of the beam to the left or right.

Most of the troubles in the horizontal deflection system can readily be eliminated once the reader has understood the foregoing description. The obvious troubles are indicated on the face of the tube where any picture distortion is quickly detected.

Picture Size Incorrectly Set

This control is the variable resistor in series with the charge and discharge condenser and deter-

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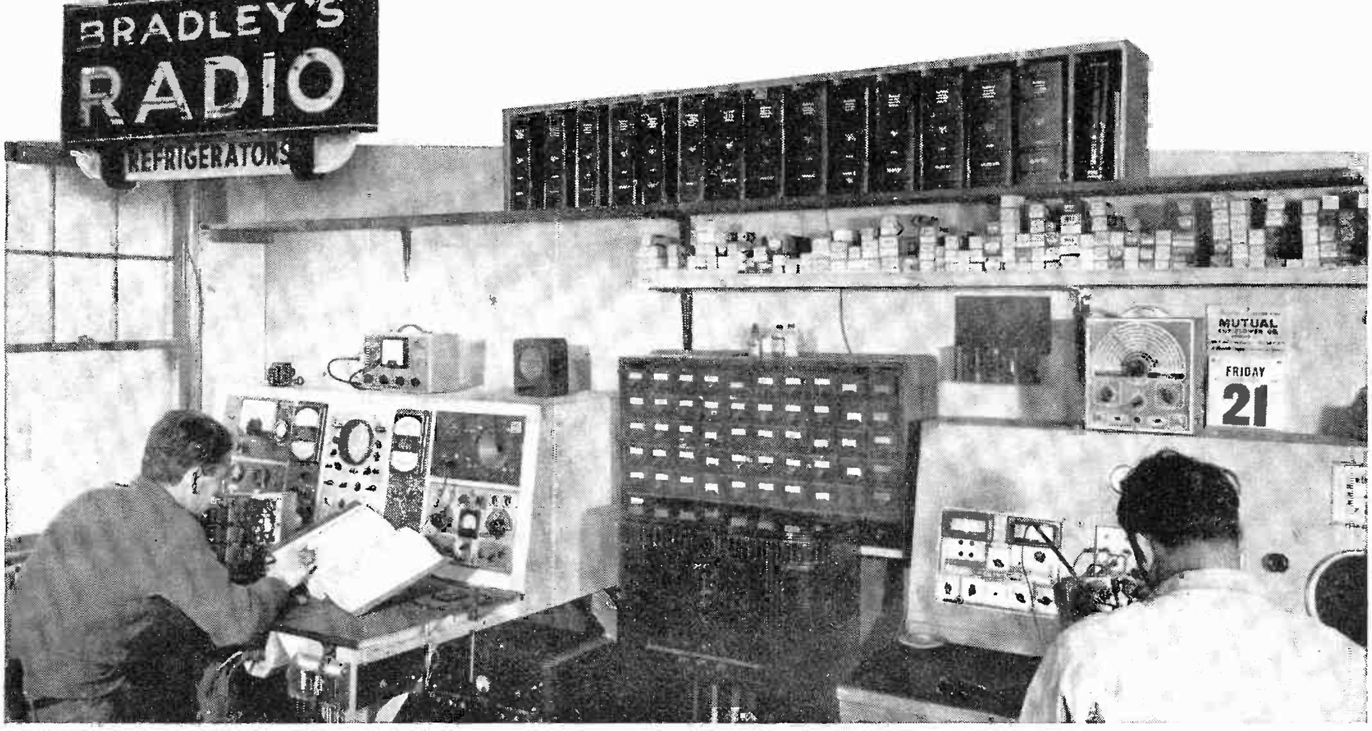
A SIGN OF SUCCESSFUL SERVICING



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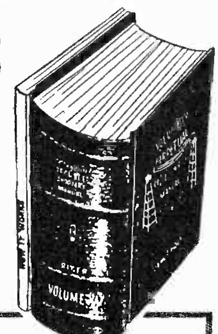

A leading radio publication recently featured Bradley's of Red Bank, N. J. on an editorial spread, which told of the profitable efficiency of its service department. Characteristically, Bradley's has all fifteen RIDER MANUALS, depending upon them for authoritative information supplying all necessary servicing data on American-made receivers issued from 1930 to 1947.

From no other single source is this information available. In no other way can you have at your fingertips the information you need to diagnose troubles in any and all radio receivers that come to your shop for repair; receiver schematics, voltage data, alignment data, resistance values, chassis layouts and wiring, and trimmer connections.

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RIDER MANUALS
MEAN **SUCCESSFUL SERVICING**

The Organizations

In the last few years, there has been a marked increase in organizational activity in the trade. Feeling that the reader would like to know more about the organizations and their activities, Radio Maintenance is inaugurating this column containing correspondence received from servicemen's organizations. If you are a member of an organization, we would like to hear about the activities of your group.

John Barsophy, Secretary of the newly formed **Federation of Associated Radio Servicemen's Associations of Pennsylvania** (the (FRSAP) writes as follows:

"At our regular monthly meeting on March 4th, our delegates to the Harrisburg, Pa., meeting of the Federation of Associated Radio Servicemen's Associations of Pa. on Feb. 16th, reported on a proposed State Convention of Radio Servicemen. The idea is to have exhibits of test equipment, perhaps a television set-up, and other displays of interest to radio servicemen; also a speaker or two. No radios! The boys voted unanimously in favor of the idea. A standing vote revealed all present would attend.

"Our speaker for the evening was Mr. Kenneth Breon, Commercial Engineer of the Pennsylvania Power and Light Co., Williamsport, and Consulting Engineer of Breon Laboratories. He spoke on the use of crystals and electronic tubes in industrial applications.

"Mr. Breon had some interesting ideas to present. 'It is true that manufacturers of electronic gear are training personnel to service their products,' he said. 'But this will not take care of all contingencies by a long shot. Sooner or later, you, the radio serviceman, will find yourself being called up by—well, say Mr. Smith, who runs a factory. Sure, it's an emergency. You've serviced Mr. Smith radio year after year. Now he has some vital electronic equipment that isn't functioning; production is curtailed. Waiting for the manufacturer's man will mean days of delay So Mr. Smith thinks of you. And there you are—or are you?'

"Mr. Breon told us how thyratrons, ignitrons, strobotrons, phanotrons and kenotrons work. He sketched some circuits and explained how they were applied to solve certain problems in industry. He dwelt briefly on photo-electric cells, detailing typical circuits and applications now in use. Crystals (in which Mr. Breon is particularly interested) are coming into their own, especially in high frequency work. This is made practical by the use of circuits tuned to a harmonic of the crystal.

"Mr. Breon's parting words were, 'Keep abreast of all electronic developments, and that includes industrial applications. You'll find it pays. Remember Mr. Smith—and others like him. They may have an emergency call for you tomorrow.' "

John Barsophy, Secretary

Ed. Mr. Barsophy is also secretary of the **Associated Radio Service Men of Central Pennsylvania.** The group meets monthly at Williamsport. In connection with their activities, he informs us that they now have an FM class in progress. The class is held at the Radio and Electronics Department of the Williamsport Technical Institute.

J. Leo Phelan, President of the **Independent Radiomen's Association., Inc. of Waterbury, Connecticut,** recently sent a letter to a number of set manufacturers regarding service information. The text of the letter follows:

"Gentlemen:

"It may be that this letter is addressed to the wrong depart-

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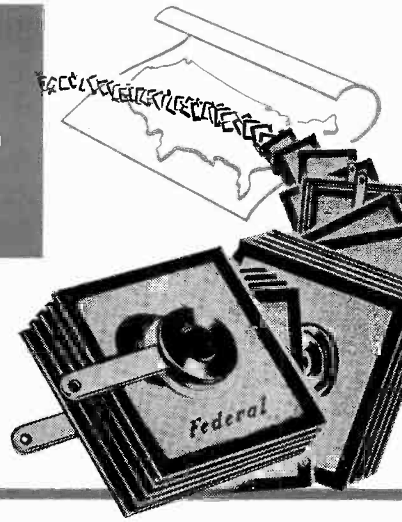
At a recent meeting of servicemen at Poughkeepsie, N. Y., J. K. Poff, Service Engineer of The Astatic Corp. (left) gave a talk on Crystals and Their Various Applications.

GET YOUR *PROFIT-MAKING* FEDERAL SELENIUM RECTIFIERS FROM THESE JOBBERS!



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Thurow Distributors, Inc.

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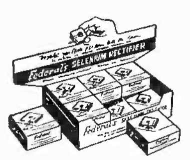

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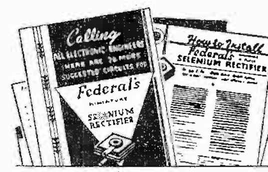

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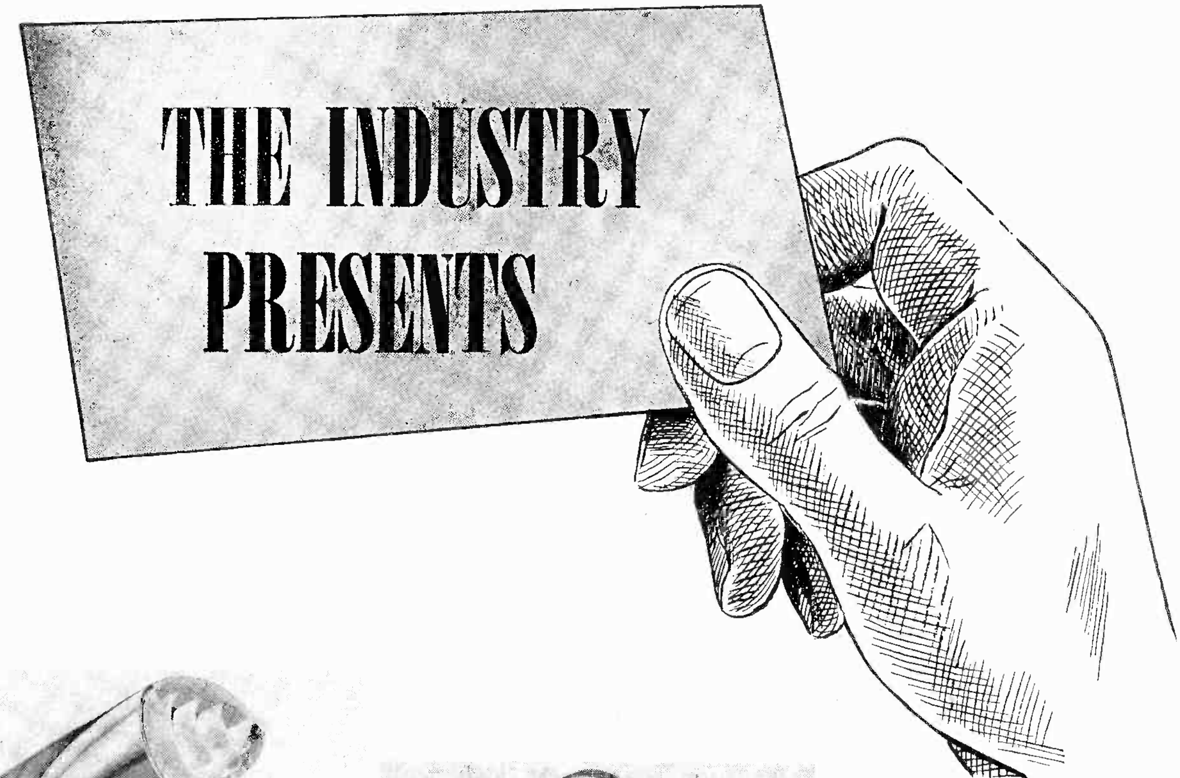
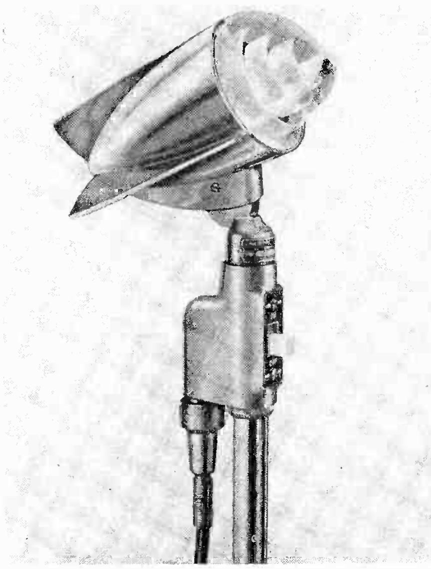
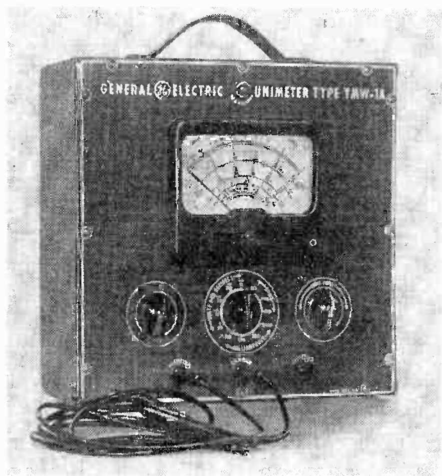






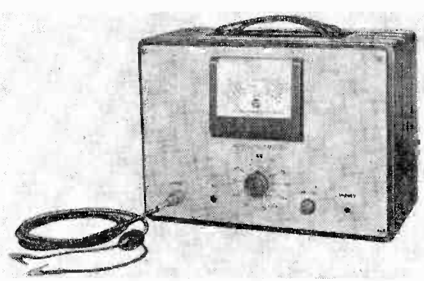
CRYSTAL MICROPHONE

Among recent acquisitions to the Astatic line of microphones is "The Conneaut," a new streamlined beauty with chrome body and blond plastic grille. The Astatic Corporation has named this microphone in honor of the prominent Lake port town in Ohio where its main plant and offices are now located. The Conneaut, a crystal microphone with relatively high output and wide frequency range, is especially desirable for use with public address and paging systems. This new microphone, with an overall frequency response exceptionally smooth up to 10,000 cps, will satisfy the most critical demands for high fidelity performance. Model 600-S is supplied with Type S On-Off switch.

NEW UNIMETER

A new Unimeter, Type YMW-1A, designed for simplicity of operation and high accuracy, has been announced by the Specialty Division of General Electric Company's Electronics Department. Designed for rapid, accurate measurement of volts, ohms, current and decibels, the YMW-1A is especially adapted for service work. It is a 20,000 ohms per volt multi-range instrument. The YMW-1A specifications include resistance with a total coverage of 1ohm to 20 megohms; voltage, AC and DC, 0-1000 volts; current, 0 to one-half ampere; decibels, minus 4 to plus 62, all designed in convenient ranges.

Further information on the new Unimeter may be obtained on request to the Wolf Street Plant, G-E Electronics Department's Specialty Division, Syracuse, N. Y.



AUDIO VOLTMETER

RCA has announced a new portable vacuum tube audio voltmeter (RCA Type WV-73A). The unit measures AC voltages over ranges of frequencies and amplitude far beyond the limits of ordinary meters of this type. The unusual sensitivity of this new unit makes it possible to measure the electrical conductivity of switches, circuit breakers, relays, buses and grounds, in addition to transmission losses in lines and circuits and the response of special filters and compensators.

TEST LEADS

The JFD Manufacturing Company has announced the assembling of its new line of test leads and test lead accessories. The

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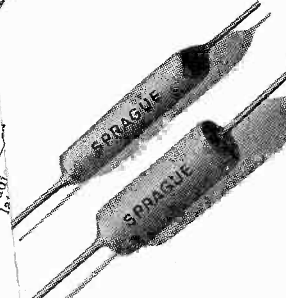
...UE TRADING POST

WHAT'S THIS ABOUT MIDGET TUBULARS?



ACTUAL SIZE
Type 68P Capacitors . . . Ranges from .001 mfd. 400V to 0.5 mfd. 100V.

There's more about the new line of Sprague Type 68P Midget Tubular Capacitors than appears on the surface:

They're the smallest, most dependable midgets yet offered for normal applications. They're the direct result of Sprague engineering experience in developing capacitors for the famous VT fuse and other miniature wartime electronic assemblies. . . .

But, even more important, they offer concrete evidence of what you can expect from Sprague in the future. No manufacturer was called upon to engineer as many unique capacitor types for war equipment as was Sprague. The Type 68P Midgets are the first of these to be converted for everyday service and amateur radio use. Many more are coming.

Look to Sprague for the newest—and the best!

See us at BOOTH 89 at the Chicago Show

...ok ...ec- ...radio Robert Florence,

...ont 274, 5" os- 599 combination ...ster; RCP 705 sig. ...est radio course; 5BP1 ... tubes. Want good com- rec., no surplus, wire re- ... F. Raposa, 167 Washington ...all River, Mass.

...R SALE—Stancor T Power Pack, new condition, $40; 1947 Chrysler, Dodge, DeSoto and Plymouth auto radio, 8-tube. Fits 1941 to 1947 model cars. Paul Capito, 637 W. 21st St., Erie, Pa.

SELL OR SWAP—Speco sig. tracer and probe, new; output meter in metal case, rectifier type, scale 10-.6 db, new, square face; 20 new tubes in cartons, 2.5 and 6.3 volt. Will sell or trade for new vacuum tube volt-meter. C. Thomas, 1445-A Donner Ave., Bldg. 9-P, San Francisco 24, Calif.

FOR SALE—Supreme model 592 set tester, new condition $50. D. Montgomery, R.D. 4, N. Webb Ext., Alliance, Ohio.

FOR SALE—New Electronic Development oscilloscope, $65; Feiler TS-2 sig. tracer, $25; have some meters to trade. Harry Weese, General Delivery, Elkins, W. Va.

FOR SALE—Simpson tube tester 305, hardly been used in excellent condition. Cost $49.50 will sell for $40. Bailey's Radio Service, 1004 Ave. H., Brownwood, Texas.

SWAP—Black Rider's and No. 4 Rider's (almost new) for portable multimeter in good condition. Precision meter preferred. Suydam Radio Service, 39 W. Hills Rd., Huntington Sta., N. Y.

SELL OR SWAP—New Model 200 signal tracer for automatic record changer, or what do you have? Cost $29.50. John Spisak, 3200 W. Run Rd., Munhall, Pa.

SELL OR SWAP—Radio Engineering by Terman, 900 pages $4; Elect. Engineer's Handbook, communications ed. 800 pages $4; 5 tube GE table model radio $15 good condition. Want tube tester, back issues of Radio Craft. Dan & Ted's Radio Shop, 4355 S. Honore, Chicago 9, Ill.

WANTED—Wire recorder complete, or unit without amplifier and case. Will trade home made 10 mtr transmitter with 807 final, Xtal control less modulator and 750 volt power supply. Bob R. Radmore, 915 Walnut Ave., Niagara Falls, N. Y.

FOR SALE—Stancor A power supply, new condition $35; New Solar CE condenser analyzer $45; good used ¼ hp. motors $15; new r.f., i.f. cables and prods for RCA-Rider Analyst, $3. Paul Capito, 637 W. 21st St., Erie, Pa.

SPEAKERS RE-CONED. Full line of Carron cones. Send us your old speakers; we will re-cone and return good as new. 3-5" $2.15; 6" $2.70; 8" $3.15; 10" $4.25 up; 12-&-14" $4.75 up. Leonard J. Melser, 505 14th St., Denver, Colo.

SELL OR SWAP—1R4/1294; 3B7/1291; 3D6/1299; 6AC7/1852's $23 or will trade for equivalent in tubes used in popular portable, table model sets. R. Bianchetto, 125-11 135 Ave., S. Oz. Plc., L.I., N. Y.

SELL OR SWAP—HQ-129X complete or swap for BC 342 as part payment. Have Wilcox-Gay wireless phono and ten watt ECO. Lots of tubes and parts to swap. W0EER, Box 97, Dresbach, Minn.

SELL OR SWAP—New radio tubes; condensers; resistors; transformers; test meters; speakers; other parts. Will trade for short wave equip. or what do you have? Carl E. Rickel, RD. 1, Cowansville, Pa.

FOR SALE—450 tube tester, used one month, $32.50; new 650 signal generator, never used, in original package $42.50; CA-11 signal tracer, used one month $12.50. K. H. Logan, 13 Water St., Northfield, Vt.

SWAP—RCP 423 multi-meter in excellent condition for used auto-radio or sell $15: also 15 used tubes, 6 to 117 V., hardly used $6.50. Richard Price, 1737 Summerdale Ave., Chicago 40, Ill.

FOR SALE—Complete shop equipment; tubes: testers; sig. generator; etc., inventory at $575, will sell for $525. Good buy, send for itemized list. Leo's Radio Shop, Rib Lake, Wisc.

FOR SALE—New Precision E 200 signal generator, in original carton. Guaranteed in A-1 condition. $40. All inquiries answered. Jim's Radio Shop, 125 Chestnut St., Wrightsville, Pa.

FOR SALE—Philco tube checker 'R', excellent condition with 20 new tubes $25. Want good used ½ hp. electric motor, Radio Trouble Shooters Handbook. Loring Hulse, Circleville, Ohio.

FOR SALE—Superior tube tester 450 $30; Simpson tube tester 305 $40; Philco signal generator 077 $20; Earl Webber comb. tube and set tester $50. All in excellent condition. Stephenson Music Shop, Austin, Minn.

FOR SALE—Well equipped radio business established 27 years. Includes test equipment, tubes, parts, Rider's Manuals, Photofacts. Good location. A. W. Wallace, Wallace Radio Service, 308 N. 3rd St., Monroe, La.

WANTED—Technical literature re. atmospheric static as it affects radio. Charles F. Borengasser, 300 Towson Ave., Fort Smith, Ark.

FOR SALE—Set of Rider's Manuals; assortment of i.f. coils; new, hard to get tubes. Write for free list. Lost my lease and must sacrifice. Jas. B. Abernathy, 1311 12th Ave., Tuscaloosa, Ala.

FOR SALE—Used Presto professional dual speed turn-table $40; new Astatic pick-up HP-16 $10; used inter-comm set, one master, one sub station $15; new deluxe wood wall baffle for 8" speaker $2.50. James Garber, Box 234, Covington, Va.

WANTED—Second hand professional recorder or Howard home recorder; Hallicrafter; radio kits; tube and set testers; oscilloscope; tools; radio parts; etc. What do you have to offer? We pay cash. Studios Supertone, P.O. Box 195, Santiago de Cuba, Cuba.

SELL OR SWAP—Riders Manuals 1-2-3 in RCA backs; Triplett tube tester 12-13; pocket-size Triplett milliammeter 866-H. Henry G. Ellis, 19 Marion St., Knoxville 16, Tenn.

SELL OR SWAP—New Vomax 900 VTVM $50, or will trade for used Rider's Manuals 6 to 9, or 7 to 11. Or what do you offer. B. J. Hanna, 1432 Dakota Ave., Flint 6, Mich.

SELL OR SWAP—Unused RCA 154 Beat. freq. audio osc. Want good R.F. sig. generator or what do you have? Joseph DeLuccia, 29 East 22nd St., Paterson, N. J.

SELL OR SWAP—New Vomax 900. Want oscilloscope or will sell for $50. All letters answered. Michael Cupello, 1138 Mifflin St., Lebanon, Pa.

WANTED—Tube testing chart for Supreme 450 90-push button tube tester. Carl Ziebell, Sedco Woolley, RD 1, Wash.

SWAP—New Carter genemotor. Want test equipment; a-c motors or what do you have? R. E. James, Box 589, Guthrie, Okla.

WANTED—Tube tester and sig. generator. Must be in good shape and reasonable. For sale: new Superior signal tracer $15; 1 to 6 Sam's Foto-Fact folders, in binders $6. Hilltop Radio, Box 156, East Canaan, Conn.

FOR SALE—Complete NRI radio course with experimental kit, etc., also NRI all-wave, all-purpose tester with instructions. L. O. Dupps, 1319 Newton St., Jasper, Ind.

FOR SALE — RCA volt-ohmyst Jr.; 510X Hickok tube and circuit tester, $45 each; Meissner analyst, $90. All in A-1 condition. Val Obal, 4165 J. St., Omaha, Nebr.

YOUR OWN AD RUN HERE FREE

The Sprague Trading Post is a free advertising service for the benefit of our radio friends. Providing only that it fits in with the spirit of this service, we'll gladly run your own ad in the first available issue of one of the six radio magazines in which this feature appears. Write CAREFULLY or print. Hold it to 40 words or less. Confine it to radio subjects. Make sure your meaning is clear. No commercial advertising or the offering of merchandise to the highest bidder is acceptable. Sprague, of course, assumes no responsibility in connection with merchandise bought or sold through these columns or for the resulting transactions.

Send your ad to
DEPT. RM47
SPRAGUE PRODUCTS COMPANY
North Adams, Mass.
(Jobbing distributing organization for products of the Sprague Electric Co.)

ASK FOR SPRAGUE CAPACITORS and *KOOLOHM RESISTORS by name!

* Trademark Reg. U.S. Pat. Off.

Antennas . . . FM & Television

→ From Page 11

not follow the same path and another antenna may be necessary to receive these.

Multiple Installations

Where a number of television receivers are to be operated from a single antenna system, such as in showrooms or for apartment houses or hotels, added difficulties arise which must be taken into consideration. In the case of showroom demonstrations where the receivers are close together, transformers are available to match a number of receivers to the transmission line. However, beat frequency interference may occur between the local oscillators of the receivers and give rise to interference patterns. If this difficult arises, some form of isolation must be used between receivers. The simplest form of isolating circuit consists of a H pad, constructed of 5 low wattage carbon resistors. Table II shows the values of resistors for different attenuation constants. Use the one which removes the interference with the least attenuation of signal strength.

Apartment house or hotel multiple receiver installations will require special techniques. A suggested system would use several highly directional antennas, each tuned and pointed to different stations. All of the antennas would then be connected together and fed to a system of simple isolation amplifiers, using a cathode follower output. Each cathode follower would then feed a transmission line going to one or possibly two receivers.

The concluding portion of this article is composed of practical information and hints for installation which, it is hoped, will be of some assistance to the installer.

When reflections are observed on a television screen in the form of blurred or double images, they will be due to one of two reasons:

1. *Reflections of signal on the transmission line due to improper matching to the receiver.* According to the new standards which are now being adopted, the input impedance of television receivers is standardized at 300 ohms. Thus, the impedance of the transmission line is automatically set at the same value. If these standards are observed, no difficulty with line reflections should be noted. Matching of the transmission line to the antenna can then be easily accomplished by one of the methods described in last month's installment. If noise conditions make the use of coaxial cable vital, the impedance of 300 ohms may be obtained by using two 150-ohm cables in series. In this case, the center conductor of each cable is connected to the balanced input of the receiver and to the antenna, and the outer shields are connected together and grounded.

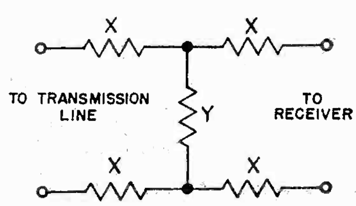
2. *Reflections due to multiple paths traveled by the signal before reaching the antenna.* In this case, It will usually be of assistance to attempt to locate the source of the reflection. In highly congested areas, it may prove difficult but, nevertheless, can often be accomplished. An approximation of the distance between the receiving antenna and the

TABLE I

CHANNELS	FREQUENCY
1	44–50
2	54–60
3	60–66
4	66–72
5	76–82
6	82–88
7	174–180
8	180–186
9	186–192
10	192–198
11	198–204
12	204–210
13	210–216
EXPERIMENTAL	480–920

TABLE II

ATTENUATION	VALUE X	VALUE Y
2:1	18Ω	82
4 1/2:1	27Ω	47Ω
9:1	33Ω	33Ω



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nearly one mile. Kn
fact greatly narrows dow
sible objects from which r
could occur. The figure
microseconds is standard rega
of the size of the screen involv

Antenna Installation

Both the position of the antenna and its directional orientation are of the greatest importance. The antenna should not be permanently installed until the optimum location has been predetermined. A simple two-way telephone system with about 200 feet of wire is very useful when making antenna installations. By keeping in constant communication with a competent person observing the effects on the receiver, the most suitable arrangement of the antenna can be quite easily determined. A change of antenna position of only a few feet may result in a great improvement of reception. Use a temporary transmission line to allow the antenna to be moved to different positions. The antenna should be installed at the greatest practical height to obtain line of sight conditions, and must be kept at least ten feet from conducting objects in its vicinity. Since neither the eye nor the ear is particularly sensitive to small variations of signal intensity, it is highly desirable when orienting the antenna to make use of some form of indicator at the receiver to produce a more accurate indication of maximum performance. It is not a good idea to alter the circuits of the receiver in any way, especially in the high frequency portions. A suggested method of measurement would be to

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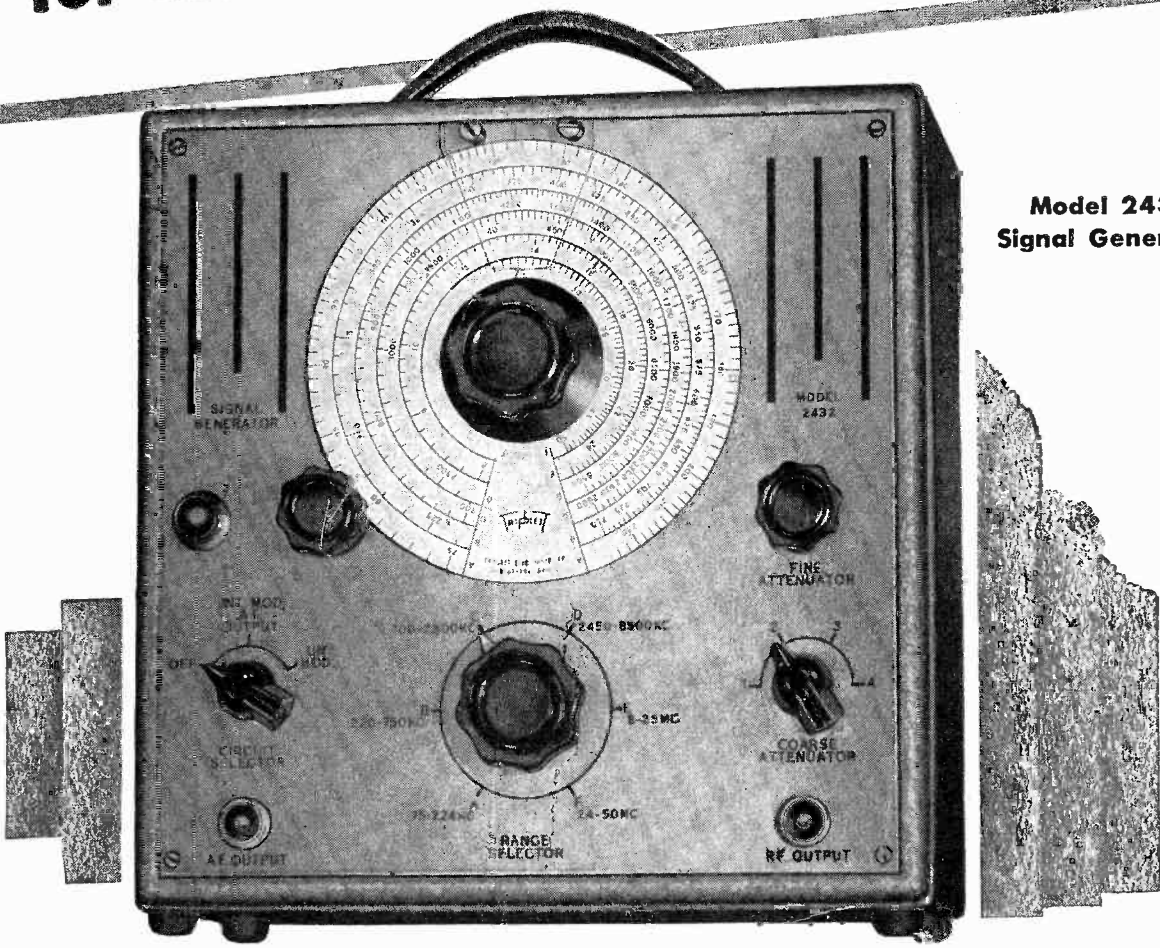
For the Man Who Takes Pride in His Work



Model 2432
Signal Generator

FM AND TELEVISION BAND COVERAGE ON STRONG HARMONICS STRONG FUNDAMENTALS TO 50 (MC)

Another member of the Triplett Square Line of matched units this signal generator embodies features normally found only in "custom priced" laboratory models.

FREQUENCY COVERAGE—Continuous and overlapping 75 KC to 50 MC. Six bands. All fundamentals. **TURRET TYPE COIL ASSEMBLY**—Six-position turret type coil switching with complete shielding. Coil assembly rotates inside a copper-plated steel shield. **ATTENUATION**—Individually shielded and adjustable, by fine and course controls, to zero for all practical purposes. **STABILITY**—Greatly increased by use of air trimmer capacitors, electron coupled oscillator circuit, and permeability adjusted coils. **INTERNAL MODULATION**—Approximately 30% at 400 cycles. **POWER SUPPLY** — 115 Volts, 50-60 cycles A.C. Voltage regulated for increased oscillator stability. **CASE**—Heavy metal with tan and brown hammered enamel finish.

There are many other features in this beautiful model of equal interest to the man who takes pride in his work.

Precision first ...to last

STANDARDS ARE SET BY TRIPLETT

Triplett

ELECTRICAL INSTRUMENT CO. BLUFFTON, OHIO

A Universal Speaker

→ From Page 13

should be run through the loop and the loop pulled tight. The finished secondary should be covered with a layer or two of paper, the terminal board put in place, and a final layer of paper or tape used to finish the job. The core is then reassembled and the taps soldered to the lugs on the terminal board.

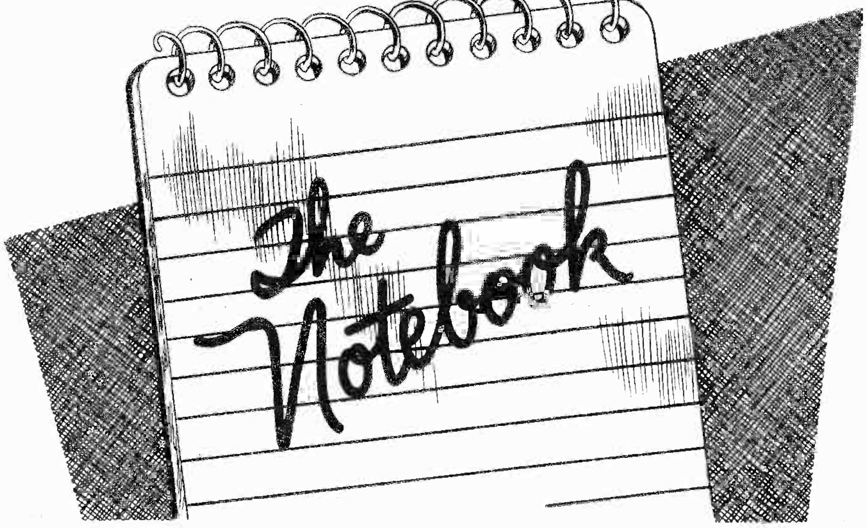
The transformer may then be mounted on the speaker in the conventional manner and the circuit wired as shown in Fig. 5. Notice that in switch position 7, the voice coil is connected to the speaker input jacks. The transformer primary is left in parallel with the voice coil; but since it has such a high impedance, its effect is negligible. We mounted our unit in a small cabinet as shown in the heading of the article. In the cabinet, we placed a 200 milliampere filter choke to serve as a field coil substitute when using the instrument with receivers having electrodynamic speakers. Another good place to mount the speaker would be right on the panel of the bench where it would be conveniently accessible.

As stated previously, the speaker we used has a 4-ohm voice coil. A speaker with an 8-ohm voice coil can also be used. Table I gives the number of turns and the taps for both 4-ohm and 8-ohm voice coils. Using a 4-ohm speaker has the advantage that a lesser number of turns are necessary and, therefore, the rewinding job is somewhat easier.

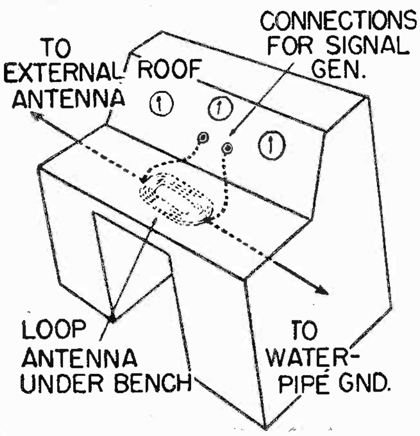
While the primary impedances shown will not result in an exact match for all types of tubes, the match will be found close enough for test purposes. ✔ ✔ ✔

TABLE I

Impedance Entire Primary	Impedance Half Primary	No. of Turns on Secondary
4 Ohm Speaker		
2,000 ohms	500 ohms	124
7,000	1750	67
10,000	2500	56
15,000	3750	46
20,000	5000	39
25,000	6250	25
8 Ohm Speaker		
2,000	500	176
7,000	1750	97
10,000	2500	79
15,000	3750	63
20,000	5000	56
25,000	6250	50



Each month the reader sending in the best suggestion receives a crisp ten dollar bill. For all others published, RADIO MAINTENANCE will pay five dollars. Let's hear from you.



Loop Receivers

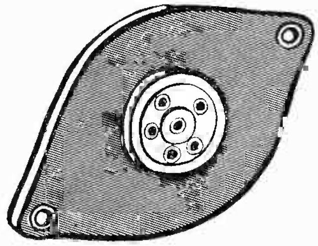
A REPLACEMENT loop antenna fastened underneath the work bench and connected to an outside antenna and ground, as shown in the diagram, will greatly improve the reception of loop receivers standing on the top of the bench. In areas where it is normally necessary to use an outside antenna to secure adequate reception, the auxiliary loop is particularly helpful. The loop is also useful in aligning AC-DC type receivers.

The output of the signal generator is connected directly across the auxiliary loop through a pair of binding posts on the test panel. If the receiver under test is placed directly over the loop under the bench, a clear hum-free signal will result.

Lloyd E. Kaun
American Radio Laboratory
Santa Barbara, Calif.

Socket Adapter

Miniature tube sockets with standard socket size mounting features are not available, although such a socket is desirable when using miniature tubes on a chassis punched and drilled for standard size sockets. This difficulty may be overcome by taking an octal wafer socket, removing all the terminals and reaming the center to a 5/8 inch



hole. The wafer socket is mounted in the usual manner and the miniature socket is placed in the hole and held by its retaining ring.

Philip Ross
P. O. Box 905
Hoboken, N. J.

Novel Test Clips

Two small battery or alligator clips with Fahnestock clips fastened to them as shown in the diagram are very useful when checking for open condensers or substituting re-

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The Horizontal Sweep

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mines the charging rate of the condenser. Variation of this potentiometer increases or decreases the width of the picture. If sufficient amplitude cannot be attained by resetting this control, the fault is probably a weak amplifier tube. Tube substitution is the best means of determining whether or not the tube is defective. Fig. 8 shows a test pattern with the width control incorrectly set.

Poor Horizontal Linearity

A control is provided to compensate for any non-linearity in the saw-tooth voltage or current. Usually a variable resistor is inserted in the cathode of the amplifier tube so that the grid bias can be adjusted in order to allow the tube to operate on a portion of its characteristic curve which helps to correct the effects of non-linearity. Fig. 9 illustrates a condition of non-linear horizontal deflection.

Failure of the Damping Circuit

This type of distortion appears on the left hand side of the image.

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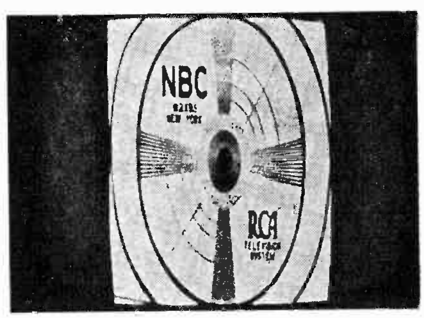

Fig. 8 A test pattern showing the effects of an incorrectly set horizontal width control.

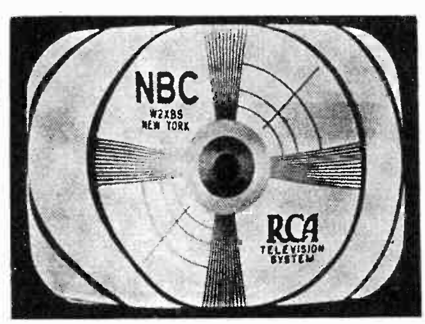

Fig. 9 A test pattern showing horizontal non-linearity.

OVER THE BENCH

by John T. Frye

"HAVE A PLACE for everything and keep it somewhere else. This is not advice, but practice." So wrote Mark Twain with his uncanny knowledge of human weaknesses. We all know the advantages of order and system in our work; but unless you are one in a thousand, you occasionally forget to practice what you know.

It is certain that I do, in spite of the fact that I have demonstrated to myself over and over again that a definite procedure, religiously followed in the testing and repairing of sets, pays off good dividends in time and effort saved. Occasionally, using a combination of hit-and-miss testing, together with a strong dash of inspiration, I have succeeded in by-passing almost all of the steps of my usual routine and have gone directly to the cause of the trouble in less time than would have been consumed in the standard procedure; but far more often I have wasted several minutes in this desultory testing and ended up by starting right at the beginning of my set procedure and following it through—as I should have done in the first place. Over an average of several sets, a good testing routine will definitely prove a time-saver.

Now I am not going to outline a testing procedure for you. There are too many variables in such a procedure. The kind of equipment you have has a lot to do with it. The fellow with a signal tracer proceeds altogether differently than does the man without one. Experience is another thing that strongly affects the particular system to follow. The real old-timer has a vast store of information concerning the common weaknesses of particular models to aid him. What is more, his ear is trained to interpret the symptoms that the sound of the radio itself gives him. He can, with confidence, omit more small steps in his testing procedure than can a fellow without this storehouse of knowledge.

The complexity of the system is worthy of consideration. In planning such a procedure, it might be well to take a tip from seining minnows. Remember when you used to try to do it with a seine made of grain sacks? The water passed through the close weave with so much friction that you could scarcely drag it through the water fast enough to trap your minnows. On the other hand, if the mesh was too big, you could drag it through the water with the greatest speed, but your minnows went through too. If you make the steps of your procedure too minute — for instance, you *could* start right in at the antenna connection and proceed straight through the set, testing every coil, condenser, resistor, and soldered connection as you went—your progress will be too slow to be called progress. On the other hand, if there are great gaps in your system, the trouble spot may well slip right through one of these gaps in your search, just as did the minnows. The right system is one that moves slowly enough to be thorough but fast enough not to waste time.

Let us consider a few generalities. The first thing to do, of course, is to study the customer's complaint. I admit that they quite often do not know what they are talking about; they call a whistle a "hum," and a hum a "scratching sound"; but it is still a good thing to see what they are complaining about and *fix that first*, before you forget it. I recently put a new set of filter condensers in a set that had been left without a complaint tag and eliminated a

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The Organizations

→ From Page 24

ment, and, if so, perhaps you can direct it to the proper channel.

"Yearly you spend large sums of money advertising and developing your product. From the advertising angle, there is a definite tie-up to a great extent between the radio service man and the radio he services. He can, to a great extent, sell or discourage the sale of a certain product, all dependent on the relationship between him and the manufacturer.

"At any rate, we as radio service men feel that we should be entitled to technical information essential to the proper servicing of the radio. This information the manufacturer should be able to supply readily, but for some reason or other from past experience we feel that the manufacturer isn't always cooperative. There seems to be a certain reluctance to supply information essential to the radio service man.

"Is there any way in which you can help us in this matter?

Very truly yours,
The Independent Radiomen's Association, Inc.
J. Leo Phelan, President"

Harry E. Ward, Public Relations Man for the **Long Beach (California) Radio Technicians Association, Inc.**, tells us of a recent meeting of that organization.

"The February 12th meeting was held at the Pacific Broiler under sponsorship and represented by Calvin Demarest, recently appointed Assistant District Manager of the Southern California Edison Company, who conducted a fine meeting. Giving us information on the changeover from 50 to 60 cycle now in progress, he also showed us the General Electric film entitled 'Purification of Water,' which enlightened the service boys on the necessity of proper handling of drinking water. Mr. Demarest gave quite a biography of Thomas

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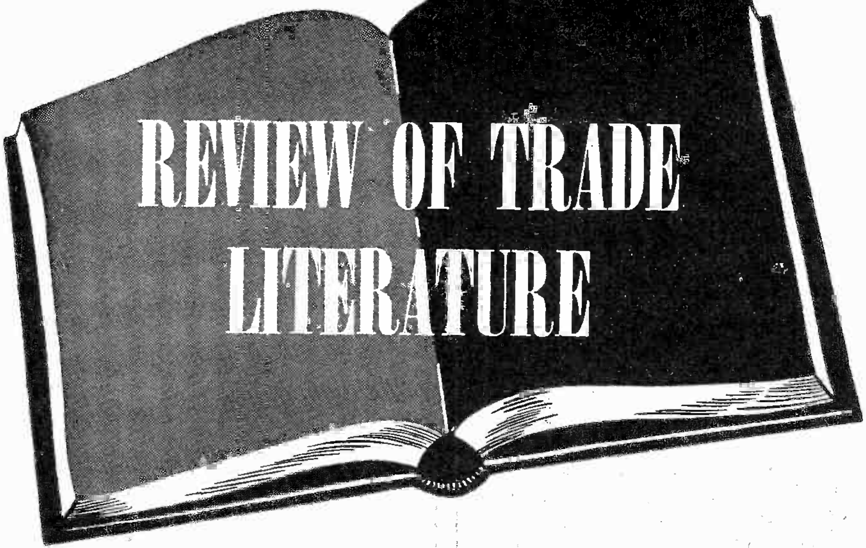

REVIEW OF TRADE LITERATURE

To avoid delay when writing to the manufacturer give issue and page number.

RADIO WIRE TELEVISION, Inc., has issued their new Lafayette Radio Catalog. It is 144 pages and contains thousands of items including radio parts, sets, phono radio combinations, amplifiers, microphones, build-it-yourself kits, public address systems, automatic record changers, tools and test equipment. Included in the catalog are many items which have not been previously obtainable.

You may secure a copy free by writing to Lafayette Radio, Dept. RM-4, 100 Sixth Avenue, New York 13, N. Y.

Four new booklets for radio servicemen have just been published and distributed free by Howard W. Sams PhotoFact Service to the members of the Sams Institute. The subjects are as follows: "How Much Is Your Labor Worth?" "How to Make Radio Cabinet Repairs," "How to Build a Successful Radio Service Business," and "Accounting Procedures for Radio Service Engineers (Parts 1 & 2)."

The extensive information in these booklets is based on research and actual tested experience gathered by the Sams PhotoFact staff. At present, all PhotoFact Service subscribers are automatically eligible to become members of the Sams Institute.

The 1947 Reference Book and Buyers Guide of Walker-Jimieson, Inc., is one of the neatest jobber catalogs we have seen. It contains 100 pages, listing over 10,000 radio and electronic parts, and highlights new products developed through wartime research and ingenuity. It is clearly illustrated and has complete sections on public address systems, nationally advertised tubes, batteries and electrical maintenance supplies, as well as testing equipment.

A copy may be obtained free of charge on request to Walker-Jimieson, Inc., 311 South Western Ave., Chicago 12, Ill.

A small pocket chart listing army-navy and RMA color codes for mica capacitors has been prepared by Cornell-Dubilier Electric Corporation. The capacitance, tolerance and drift of almost any given mica capacitor can be determined very quickly by reference to this easy-to-read card.

Copies may be obtained free by writing Cornell-Dubilier Electric Corporation, South Plainfield, N. J., Dept. R.

A new 16-page booklet containing technical information about electron tubes has just been published by the Tube Department of RCA, suplying servicemen and the trade liberal data on RCA tubes in ready reference form. *"Receiving Tubes for Television, FM, and Standard Broadcast* (Form 1275-C)" gives detailed information about characteristics and socket connections for rectifiers, detectors, oscillators, converters, etc., listed in

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The Horizontal Sweep

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Hence, if only this side of the image is distorted, the first thing to check is the damping circuit and all resistors and condensers associated with it. Usually it is the damping tube itself which fails for it is subjected to high inverse peak voltages. Fig. 10 shows the effect on the image of damping tube failure.

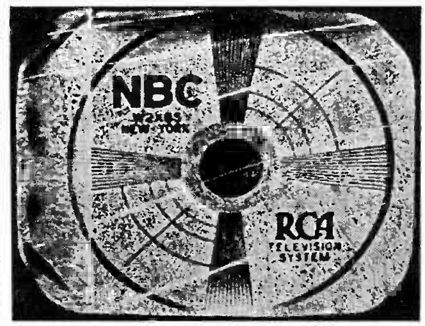

Fig. 10 A test pattern showing the effects of failure of the damping tube.

No Horizontal Deflection

If the horizontal deflection has failed, a bright vertical bar will appear on the screen. The brightness control should immediately be turned down so as not to burn the screen. A continuity check should then be made with an oscillograph at the following points:

1. Across the horizontal deflection coil where a saw-tooth voltage should exist.

2. At the grid of the amplifier tube. (Note that the plate circuit of the amplifier tube and the primary of the output transformer are not check points. The reason is that the induced voltages at these points are sometimes as high as 5 kv, which would probably break down the input attenuator of the oscillograph.

3. Continue to check for saw-tooth voltage at the plate of the discharge tube.

4. The final check point is at the grid of the oscillator tube where oscillations should be detected, whether it be a blocking oscillator or multivibrator. By looking for the correct circuit waveforms at

these points, any open circuit can be isolated and detected.

All those circuits associated with the reception of the television signal and the formation of the picture on the face of the cathode-ray tube have now been described. In the next issue, we shall discuss the cathode-ray tube itself. ✓ ✓ ✓

> Ed. In a previous article of this series RADIO MAINTENANCE inadvertently attributed the development of the Inductuner to Du Mont Laboratories. This was an error as the Inductuner is a development of P. R. Mallory & Co., Inc., to whom we tender our apology.

Over the Bench

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hum that could be heard all over the house; but when the lady called for it and tried it out, she turned the volume control clear down and then turned the tuning knob very slowly.

"Oh, you didn't fix what I meant. Hear that little squeak when I turn the dial? That is what was bothering me," she said. I oiled the shaft, and she left beaming; so remember: Be sure you take care of the complaint, whether it seems minor or not.

Some fellows start by taking out all the tubes and testing them. I am strongly opposed to this, especially in the case of an "intermittent." I always try to disturb one of these sets just as little as possible until I have an opportunity to hear it cut out; then I proceed like a cat sneaking up on a mouse, just tapping this grid cap ever so lightly, moving that condenser just a few thousandths of an inch each way. I want to locate definitely the cause of the trouble and remove it. The "shotgun" technique for handling these sets (I mean the indiscriminate replacing of all suspected parts) is not workmanlike. What is more, it robs you of that delicious feeling you have when you have tracked the trouble down to, say, a "thermostatic" condenser and have dragged the culprit out by the roots and have replaced it with a nice gleaming new one. You *know* you have fixed that set, and you know *how* you did it.

Finally, a good technique serves two ends: It locates a particular fault, the reason for the set's being in the shop, and it goes ahead to reveal any other weaknesses that may lead to future trouble. No set should ever leave the shop without having every tube pass through the checker, without having the alignment and response of *all* bands checked, without the tone control and volume control being tested for adequate, smooth and noiseless action. Tests for hum should be made at low volume and also when tuned to a strong station. Tests for speaker rattles should be made at well beyond normal volume. Push buttons should be tested for alignment and good contacts. AFC, if present, should be checked for equal compensating action. And oh yes! Don't forget to see if the "On-Off" switch works. I slipped up on that once! ✓ ✓ ✓

Ed. Comments on the subjects discussed in this column are always welcome. Address them to "Over the Bench," RADIO MAINTENANCE, 460 Bloomfield Ave., Montclair, N. J.

Antennas . . . FM & Television

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connect a conventional output meter in the audio system following the discriminator. In this way, the results of different antenna orientations can be accurately recorded and the best one chosen. An accurate map of the area and a good magnetic compass will be of considerable help in determining the transmitter location wth regard to orienting the antenna.

Transmission Line Installation

If the transmission line is of the balanced type, such as the two-wire parallel line, care must be taken to see that the line does not run close to conducting surfaces such as rain gutters as this will cause unbalancing effects. Whatever the type, it should be securely fastened about every ten feet of its length to prevent chafing of the insulation. Extremely sharp bends are to be avoided, especially with coaxial line, where breakage of the dielectric might occur. With the two-wire parallel type of line, it will be found that a twist of about one turn for each one or two feet of line will help to overcome local interference. Whenever possible, the line should lead directly to the receiver without breaks or splices. If it should be necessary to splice a transmission line, do not use ordinary tape which has a high loss, but obtain the special splicing tape now available. Local regulations regarding the use of lightning arrestors must be adhered to, and the following procedure is recommended to maintain the proper impedance match. Slit the insulation of the line for about ten inches, and at the center of the slit, remove enough of the insulation to connect the wires to the antenna terminals of the arrestor. In this way, the wires will be gradually fanned out and back about five inches on each side of the arrestor. The ground terminal should be connected to a cold water pipe or other good ground. When bringing the transmission line into the house, a hole may be cut through the window sill or frame and the line run through a piece of insulated tubing. When inside of the house, the line should be kept away from exposed wiring or metal baseboards.

In summing up, it would seem that an intelligent analysis of each installation is of prime importance. The manufacturers have made availa great variety of transmission line and antenna equipment to meet all possible cases; but the correct choice and installation are up to the serviceman and it must be remembered that no matter how much money is spent, if the selection and orientation are not appropriate to the needs of the installation, unsatisfactory reception will result. ✓✓✓

The Notebook

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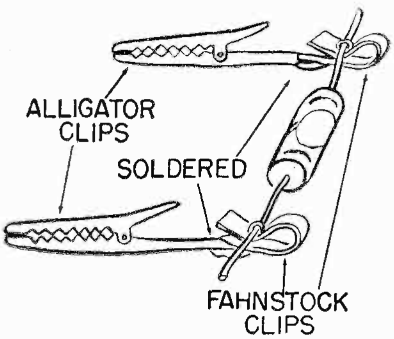
sistors. A resistor or condenser is connected between the two Fahnestock clips and the battery clips are snapped on to the correct points in the circuit. This makes it a simple matter to get into those hard-to-reach corners without twisting or bending wires. The clips can also be used to connect test prods when it is desired to keep the meter connected to the circuit for a period of time.

John T. Frye
1810 Spear Street
Logansport, Indiana



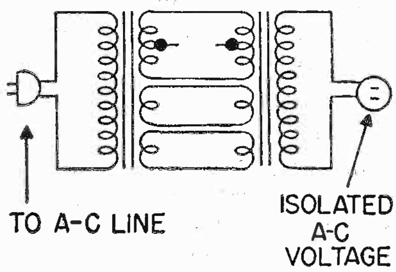
Repairing Changers

When repairing record changers, a four-legged stool makes a substitute for a changer rack. By turning the stool upside down and setting it on the bench, most record changers will fit nicely between the legs. This brings the changer up to eye level making it convenient to work on.

G. E. Gont
Les Anlauf Radio
Santa Paula, Calif.

Isolation Transformer

When checking AC-DC sets, it is often desirable to have the 110 volt AC isolated from ground. Two identical transformers connected as shown in the diagram will give ungrounded AC voltage. Two transformers of slightly different voltage



ratings can be used by connecting the filament windings so that they increase or decrease the output voltage. If hum is noticed in the set under test, the chassis can be grounded and will still be independent of the AC line.

Stanley T. Curtis, Service Mgr.
Earl B. Worden & Co.
Utica, N. Y.

Trade Literature

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numerical-alphabetical sequence for the user's convenience. Information on discontinued types is included for the radio repairman's use in servicing old equipment.

This booklet may be purchased at 10¢ from Commercial Engineering Tube Department, Radio Corporation of America, Harrison, N. J.

Catalog No. 129 lists the test instruments manufactured by Radio City Products Company. Featured are signal generators for use with FM as well as for standard AM application; up-to-date tube testers which even provide for testing the new sub-miniature tubes; vacuum tube voltmeters, multitesters, etc. The catalog may be obtained at no charge by writing Radio City Products Company, Inc., 127 West 26 Street, New York 1, N. Y.

Elementary Radio Servicing, by William R. Wellman, published

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The Organizations

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A. Edison, explaining many points of Edison's life not known to the writer. It was a very enlightening talk. Compton radio service man, Clarence Spencer, was Chairman of the day.

"The February 26th meeting, card enclosed explaining speakers' names and identification, was the occasion of the finest technical talk ever to be given to these technicians. Every phase of impedance matching was covered in the most minute detail.

"Those in this area who are not members of our Technical Association are missing a lot of instruction by not attending the meetings."

Harry E. Ward

Ed. The technical talks at the February 26th meeting mentioned above were given by Andy Futchik of the F. S. Dean Co., and Kurt Hockner, Pacific Coil & Transformer Co.

The following is an excerpt from a letter from George Payne of the **Rochester Chapter** of the **Radio Technicians Guild**:

"At the February open meeting of the fast growing Rochester Chapter, Radio Technicians Guild, the members were addressed by Mr. George Driscoll, inventer of the Driscoll FM Converter and Manager of the Stromberg-Carlson FM radio station WHFM. Mr. Driscoll outlined the technical processes of FM wave propagation with a description of the transmitter used by his own station. WHFM has sponsored a weekly half-hour program for the RTG and will soon inaugurate a joint meeting and school on FM for local jobbers, retailers and servicemen.

"The current program of setting push buttons for the new station WRNY is proving beneficial in the form of new business and advertising for the RTG."

George Payne

Ed. We understand that the push button program mentioned by Mr. Payne has been a great success in Rochester and in other chapters of the RTG. We hope to be able to tell you more about it in the near future.

Elbert Lear of the **Radio and Electronic Technicians Association of Indiana, Inc.,** comments on their new educational program as follows:

"To give you a brief report on the activities of our association, at the present time we have launched an educational program. We have secured the services of Mr. Arthur J. Quigley, Associate Professor of Electronic Engineering at the University of Notre Dame. Mr. Quigley is teaching the many uses and the advantages of the oscilloscope.

"We have recently had a work bench constructed and hope to have all modern equipment installed soon. This work bench is kept in our club rooms for the benefit of all members.

"We have a fifteen-minute program each week on one of our local broadcast stations. This program is in the form of a round table discussion on servicing problems, also new developments. The station donates this time to the association."

Elbert Lear, Secy-Treas.

Ed. We would like to hear more about your radio program.

The Delaware Valley Radio Association, Inc., Trenton, N. J., has recently formed a Servicemen's Division, according to David Van Nest, Chairman of the group. Mr. Van Nest writes telling us of the purposes of the new organization.

"We have formed the Radio Service Men's Division of the Delaware Valley Radio Association in order to create higher standards of workmanship, technical ability and business practice, and, by a group advertising campaign, to instill customers' confidence in members of the organization. There is also an Amateur Division of the D.V.R.A. with which we cooperate fully, and where newcomers in radio can obtain technical advice and training, and any person is welcome to join.

"In the Service Men's Division,

a person to be eligible to join must make radio his livelihood, be qualified as to technical ability and maintain a high standard of business ethics. We are united in the desire to discourage the public from doing business with the type of radio man who has little ability and a strong desire to take the public over the hurdles. We are also out to discourage the practice of the so-called wholesale radio dealers in selling radios to every garage, jewelry store, drugstore, tobacco store, houses of ill repute, and Cousin, Uncle and Friends—except radio men. Our campaign against this condition has in the short time we have been organized shown results; and if we can obtain the cooperation of clubs from other cities, we feel the service man will really come into his own.

"We will in the future advise you as to our progress each month and would like to hear from other clubs as to their views and aims."

David Van Nest

Ed. Mr. Van Nest's address is as follows: 114 Concord Ave., Trenton, N. J.

Commenting on the recent activities of the **Rhode Island Radiomen's Business Association,** G. G. Costantino, the Secretary, writes as follows:

"On February 5th, members of the Educational Committee of the Rhode Island Radiomen's Business Association were hosts to Set and Parts Distributors of Rhode Island at a dinner meeting at Butler's Diner.

"The principal speaker was the Chairman of the Committee, Gene Costantino, who stressed the aims and policies of the Association and outlined the proposed educational program for the ensuing year. Others who spoke were President Hugo Olubri and Chas. Sullivan of the Association, and Messrs. Stammers (Philco), Nye (Eastern Co., RCA), Feldman (Motorola), Dandreta (Dandreta Co.), Cooke (Tracy Co., Stewart-Warner), Farnum (Lunch & Co., Admiral), and Rosenfeld (Emerson).

"The distributors and their representatives pledged wholehearted support of the program as outlined; and those not able to attend due to previous engagements, including Mr. Shurtleff (Crosley) and Mr. Waterman and Howie Grinnell (General Electric), also promised full cooperation.

"The program will include business procedure and merchandising, as well as technical lectures."

G. G. Costantino

Trade Literature

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by D. Van Nostrand Company, Inc., $3.75.

This book, totally without mathematics, is planned to give the reader familiarity with the steps necessary in isolating, diagnosing, locating and clearing radio troubles, and to aid him in developing an orderly procedure for his troubleshooting and repairing. This book will be especially valuable for returning members of the Armed Forces and other beginning servicemen as it assumes the reader has had sufficient instruction in theory and radio mathematics so that he understands the basic principles of receiver circuit operation. There is a separate section on testing and making repairs on each stage of a receiver.

A Technical Manual containing basic application data for 545 types of radio receiving tubes has just been announced by the Radio Tube Division of Sylvania Electric Products Inc. The information given includes characteristic curves for types in common use; resistance coupled amplifier data; interchangeable tube charts; connections for standard RMA internal and external shields; typical receiver and amplifier circuits; dictionary of tube, circuit and FM terms.

This 378-page manual, bound with ring-type plastic, is available at 85¢ from Sylvania Electric Products Inc., Emporium, Pa.

Industry Presents

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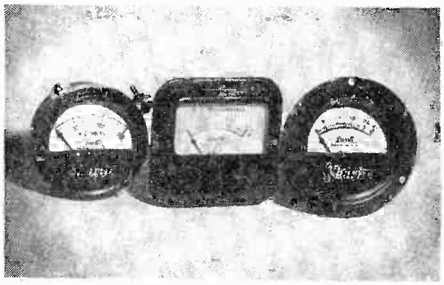
line contains 15 different types of test leads made with fiber and cast phenolic prod handles. They are made of No. 18 soft-drawn copper, insulated with kink-free flexible rubber. All end fittings are made of chromium-plated brass. End fittings used are the phone tip, phono needle point, spade lugs, alligator clip, banana plug, and the new elbow angle tips.

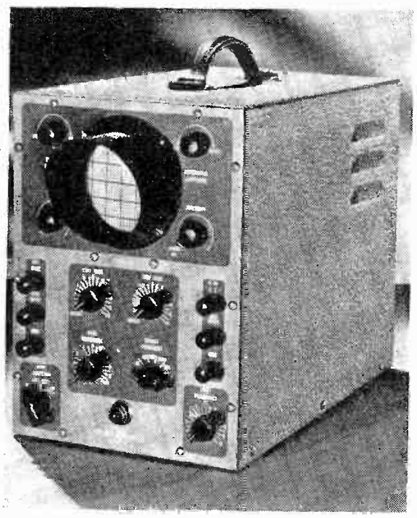
Descriptive literature and price lists will be sent on request to JFD Manufacturing Co., 4117 Ft. Hamilton Parkway, Brooklyn 19, N. Y.

PANEL METERS

Shurite Meters have announced a complete line of AC and DC 2" and 2½" panel



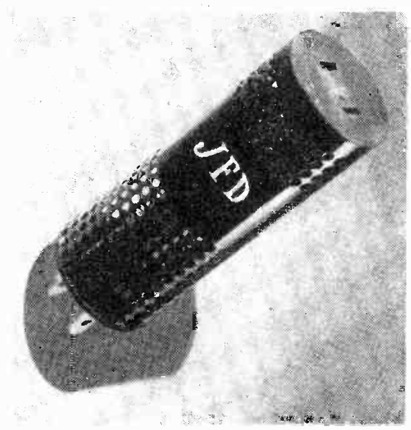
meters. All DC meters are polarized-vane, solenoid type; AC meters are double-vane, repulsion type. Both are accurate well within 5 per cent. Dials are metal-, age- and moisture-resistant, and lithographed in black and white for high visibility. Concealed coils, full-view scales, and attractive styling and finish give a modern appearance. All models are flush-mounting type of black enameled brass construction. Bracket, ring, or screw mounting, narrow or wide flange denote design differences. Zero adjusters are supplied when required on two of the DC case types. Standard models are now being stocked by electrical and electronic parts distributors.



CATHODE-RAY OSCILLOSCOPE

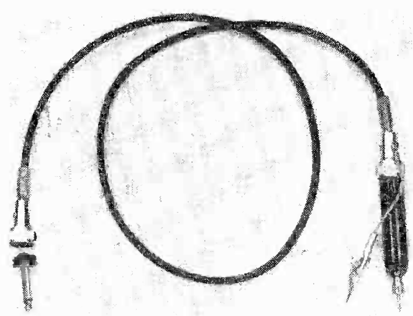
A new light-weight cathode-ray oscilloscope for general servicing has been announced by the Radio Tube Division of Sylvania Electric Products Inc., of New York City. Type 131 weighs 18 lbs., and is mounted in a gray crackle-finish cabinet 10¾" high, 8⅛" wide and 13¾" deep. Signal frequency range from 15 to 40,000 cycles is provided with a five-range selection control and a frequency control which permits close adjustment to any desired frequency. Visual study of wave form is provided by a 3-inch cathode-ray tube designed for 650 volt deflection plate operation.

Sweep circuit is built around a type 884 gas triode oscillator. The oscilloscope is rated at 105/125 volt; 50-60 cycle; 40 watt input.



STEP-DOWN BALLAST

A plug-in type step-down resistor ballast has been announced by JFD Manufacturing Co., designed to convert 110 volt radios and electrical appliances for use on 220 volt circuits anywhere in the world. The ballasts come with American, British and Continental male plugs and American female sockets, and can be used with radios, fluorescent fixtures, phono-radio combinations, etc. Descriptive literature will be supplied upon request to Dept. Q, JFD Manufacturing Co., 4117 Fort Hamilton Parkway, Brooklyn 19, N. Y.



CRYSTAL PROBE

A new miniature crystal rectifying probe, Type MI-8263, has been announced by the RCA Engineering Products Department, for adapting the VoltOhmyst and Chanalyst for circuit testing of television, FM, and other VHF applications. It employs a germanium crystal to rectify applied AC voltages which are measured by the DC circuit of the meter. The probe is equipped with an alligator clip ground lead and a special connector and detachable phone plug.

NEW PORTABLE

The "Commuter," Model G-613, is the

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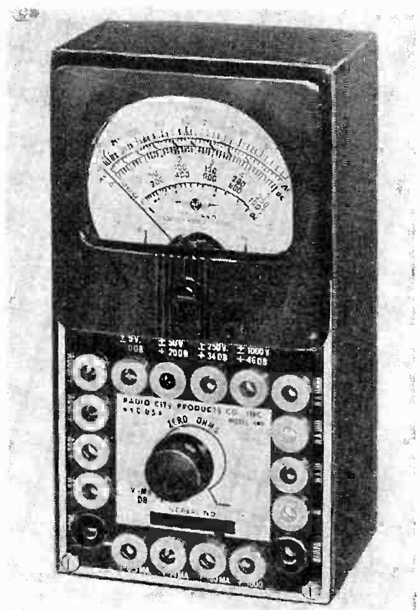
new National Union 3-way portable radio, 6 tube superhet. Weighing about 6½ lbs., it comes in a luggage brown simulated leather case. Further information may be obtained from National Union Radio Corporation, Newark, N. J.



SMALL MULTITESTER

Model 449A Multitester, manufactured by Radio City Products Co., has a DC sensitivity of 5000 ohms per volt and is especially effective in measuring low-current circuits where loading must be held at a minimum. The Germanium crystal rectifier permits AC measurements from 30 cps to 50 kc, affording unusual instrument stability and eliminating all AC voltmeter temperature errors. The 3" square high visibility meter is accurate to 2%. Further information may be obtained from Radio City Products Co., Inc., 127 West 26 St., New York I, N. Y.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