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RADIO MAINTENANCE

JUNE-JULY 1946

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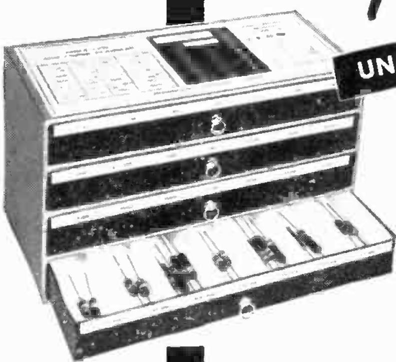

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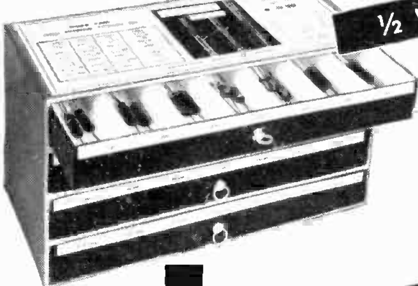

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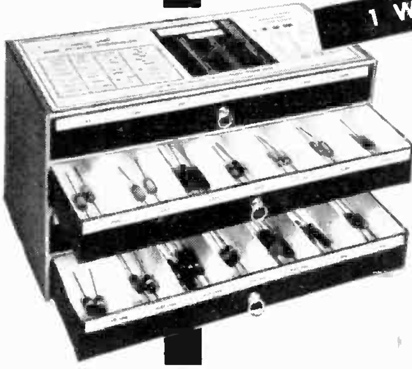

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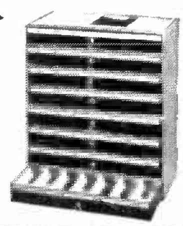

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fundamentals of television

This article covers the transmission of television signals. Another article to follow will cover the fundamentals of the television receiver.

By Lionel P. Paradise

ALTHOUGH TELEVISION is a specialized form of radio, it requires not only certain modifications of standard radio circuits, but also various new circuits for production of the necessary waveforms. Whereas standard radio transmission involves the conversion of sound into electrical energy at the transmitter and the reconversion of electrical energy into sound at the receiver, television requires that *light* be converted into electricity at the transmitter and reconverted into light at the receiving end.

This basic principal of energy conversion in television is demonstrated in Figure 1, wherein an optical image is projected (by means of lenses) upon a bank of photoelectric cells as shown at (a). A pair of wires is run from each photoelectric cell to the corresponding electric light bulb in the bank shown at (b). With this arrangement the light falling on any one photocell would cause that cell to produce a proportional electric current which, theoretically at least, would result in a corresponding intensity of light from the particular bulb to which the cell was connected. Thus the light image of the letter T projected on the photoelectric cell bank would result in the true reproduction of the image by the electric bulbs at (b). This system is impractical, however, since it requires a pair of wires (or an individual transmitter) for each cell and bulb combination. Futhermore, in order to reproduce more detailed images, many thousands of minute photoelectric cells and bulbs would have to be used.

Scanning

The first aforementioned difficulty can be overcome by employing a scanning process which results in the transmission of individual picture points consecutively rather than all simultaneously. This might be done by having only a single pair of wires running between the transmitter at (a) and the receiver at (b). A mechanical switching or commutating device could be provided at the transmitter and so arranged as to connect the conductors to the upper left photocell for a moment. At the same instant a similar commutator at the receiver would connect the pair of wires to the upper left electric light bulb. Any light on the photoelectric cell would result in a proportional amount of light from the bulb. Let us assume that the two commutators are then switched to the second cell and bulb respectively, and the procedure is repeated across the top row, then across the second row and so on down to the bottom of the bank, whereupon the scanning again starts at the top. The individual bulbs would then light up in accordance with the corresponding light values of the image on the photoelectric cells. If this process could be continued at a sufficiently fast rate, the eye, having a persistence characteristic, would form the illusion of seeing an image continuously on the bank of electric light bulbs. Thus the process of scanning solves the multichannel difficulty of simultaneous transmission of picture information. It does, however, impose additional requirements upon the television system, namely the need for accurate synchronization of transmitter and receiver scanning systems together with the solution of other problems. The importance of synchronization is immediately apparent when one considers the scrambled picture that

Two RCA Cathode Ray Tubes of the type used in television receivers.

would result from the two commutators being out of step. Unfortunately the mechanical scanning system is not very useful for high-definition television since mechanical devices could not be easily manufactured to scan a large number of lines at a sufficiently high repetition rate (for example, 30 times per second), and furthermore, the size and number of photoelectric cells and bulbs would be beyond practical limits. These problems have been met successfully, however, by electronic devices.

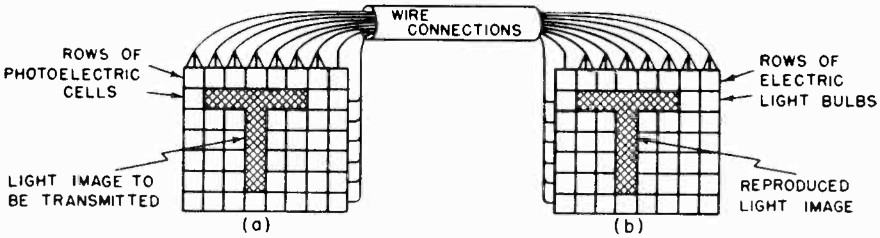

Fig. 1. Elements of the simplest television system. One similar to this is in use at Times Square, New York.

Principle of the Camera Tube

In present day electronic systems, a camera tube is used at the transmitter. There are various types, such as the iconoscope, orthicon and image orthicon, all of which have different characteristics but perform the common function of converting light values into a series of electrical values, the output voltage at any instant being proportional to the illumination at some particular picture point on the mosaic of the tube. In Fig. 2, the basic functioning of a camera tube is indicated, while Fig. 3 pictures one of these tubes. The tube itself consists of a mosaic plate, on which millions of light-sensitive silver globules are deposited, together with an electron gun for producing and projecting a narrow beam of electrons toward the mosaic, and two sets of deflection plates to control the direction of the beam. These components are placed within an evacuated glass bulb and the combination is called a camera tube. The tube is housed in a light-proof box with a lens system so arranged as to project an image on the mosaic in the same fashion as the lens of an ordinary camera projects an image on film. The object to be televised is illuminated by studio lights as in moving picture filming. When the optical image is focused on the mosaic of the camera tube, each photo-sensitive globule emits electrons in an amount proportional to the intensity of light at that particular spot, thereby causing each globule to become charged in proportion to the light intensity. The electron gun may be considered as a commutating device which, when properly directed at the mosaic, discharges each globule in its path. Assume for the moment that the beam is directed first at the upper left corner of the mosaic, striking a small group of globules and discharging them through the load resistor. Across the latter then will appear a voltage whose amplitude is proportional to the intensity of illumination on this small group of globules which we may call a picture point. If the beam is then made to move horizontally across the mosaic, a succession of voltage values will be developed across the load resistor, each value representative of the light intensity at the various points on the top line of the image. At the end of the first line, the beam is returned to the left side of the mosaic but slightly below the first scanning line. In this way the entire mosaic is scanned line by line, resulting in an output voltage that varies with time and in accordance with the illumination on the picture points of the mosaic. After one such complete scanning, or frame, the process is repeated, standard practice being to scan 30 frames per second.

An improved type of camera tube

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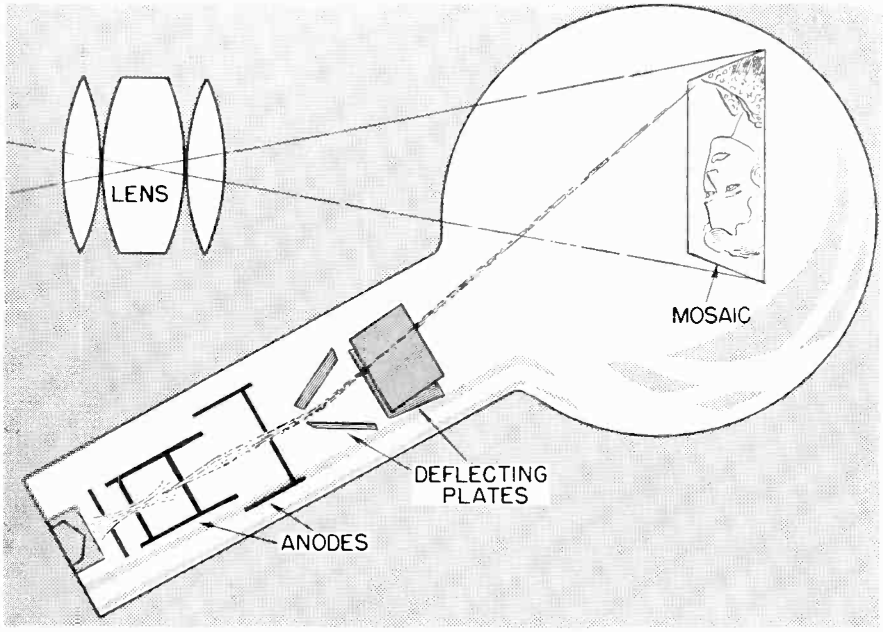

Fig. 2. Diagram of camera tube in television camera.

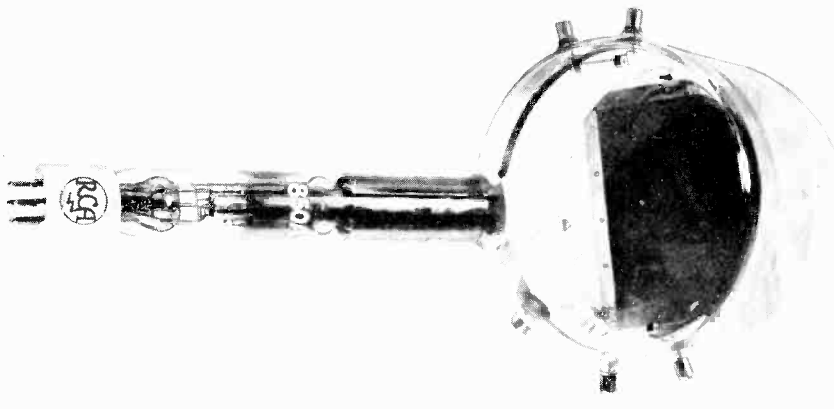

Fig. 3. An RCA Iconoscope (camera tube) of the large studio or professional type.

Fundamentals of Television

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has recently been developed in which the orthicon principle is combined with an electron multiplier (Figs. 4 and 5). This tube has extremely high sensitivity, and permits television pick-up from scenes with very little illumination. In particular, this tube will permit the televising of outdoor scenes in practically any weather, being capable of producing satisfactory images under approximately the same conditions in which the eye is able to see. In Fig. 4, the principle of the tube's operation is shown. The light image from the arrow (or any other subject) is projected on the light-sensitive face of the tube, releasing electrons from each of thousands of tiny cells in proportion to the intensity of the light striking them. These electrons strike the target, releasing several more electrons and leaving a pattern of positive charges on the front of the target. As the electron beam is scanned across the back of the target, electrons are deposited on this target in sufficient numbers to neutralize the positive charges—the rest of the beam returning to a series of electron multiplier stages in which it is amplified tremendously.

It is now necessary to consider the mechanics of properly deflecting the electron beam in the camera tube. This may be done either electrostatically or magnetically, and we shall consider the former first since it is the simpler of the two.

Referring back to Fig. 2, it will be seen that the beam passes between two pairs of metal deflecting plates. One pair is horizontal and the two plates of this pair are called the vertical deflection plates. Terminal connections are provided so that separate potentials may be applied between the two plates comprising each set. When the beam, which consists of negatively charged electrons, passes between the vertical deflection plates, in accordance with basic electrostatic laws, it will be repelled from the negatively charged plate and attracted toward the positively charged plate. Because of the relatively high velocity of the electrons, they will not actually strike the deflection plate, but instead the beam will be bent toward the positive plate. Having left the area of the plates, the electrons will continue on toward the mosaic in the direction in which they were deflected. Thus, for example, if the upper vertical deflection plate is positive with respect to the lower one, the beam will be deflected vertically toward the top of the mosaic in an amount directly proportional to the potential applied between the two plates. By properly controlling the amplitude and polarity of the deflecting voltage, the beam may be made to strike the mosaic anywhere between the top and bottom. In a similar fashion, the horizontal deflection plates will deflect the beam horizontally upon application of the necessary voltage. Simultaneous application of proper voltages to the two sets of plates will permit the beam to be deflected to any desired point on the mosaic.

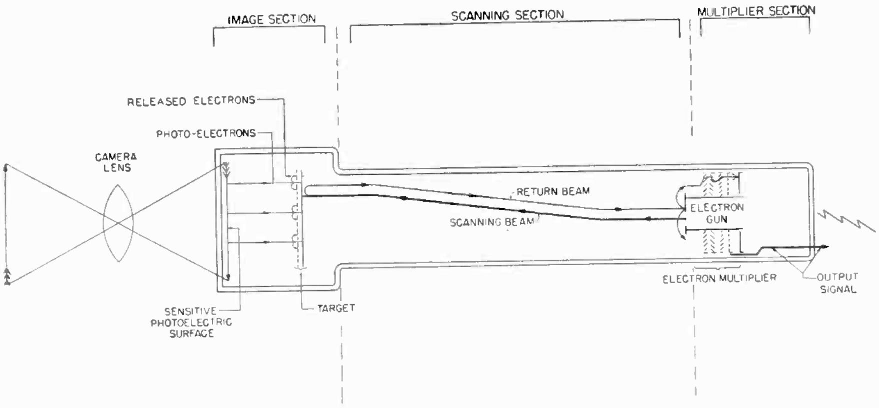

Fig. 4. Diagram of Image Orthicon of Fig. 5, showing functioning of electron beam within the tube. Electron multiplier greatly increases amplitude of output signal.

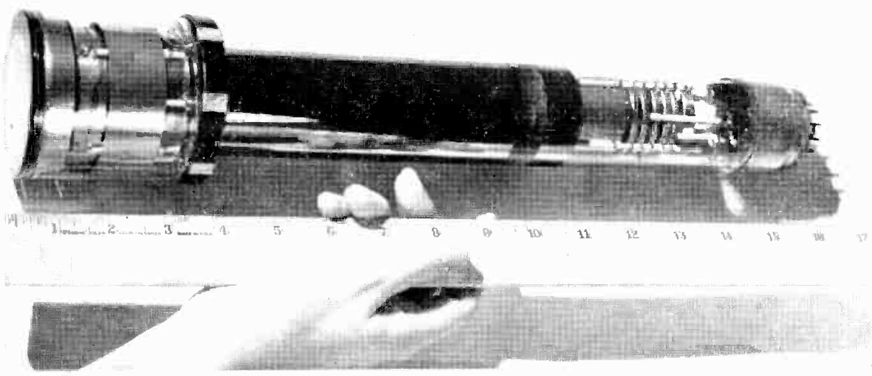

Fig. 5. The RCA Image Orthicon, a super-sensitive camera tube of recent development.

Deflection Requirements

Let us now consider the requirements for deflection voltages which will cause the electron beam to scan the top line of the mosaic, from left to right, then return to the left side of the mosaic, scan the second line, and repeat to the bottom of the mosaic, whereupon the process begins all over again. With this objective, assume that a voltage whose waveform is shown in Fig. 6 is applied to the horizontal deflection plates in such a fashion that the initial high negative value causes the beam to be deflected to the extreme left side of the mosaic. As this negative voltage decreases toward zero, the beam moves toward the center of the mosaic, and as the saw-tooth voltage increases in a positive direction, the beam continues to move toward the extreme right side of the mosaic until a time T_t has elapsed from the start of the cycle. The saw-tooth voltage then breaks sharply from its most positive value to its most negative value during the time T_r and the cycle repeats itself. If only this horizontal deflecting voltage were applied, the beam would move at a constant rate of speed across the mosaic, quickly snap back and scan the same line again. In the ideal saw-tooth, this retrace, or fly-back time (represented by T_r in Fig. 6) would be zero, and the entire period T of the saw-tooth would be occupied by the trace time T_t (in practice T_r is about 10%). Similarly, a saw-tooth voltage applied to the vertical deflection plates would produce linear deflection in the vertical direction. Now when two different saw-tooth voltages are applied to the two sets of deflection plates such that the frequency of the horizontal saw-tooth is 525

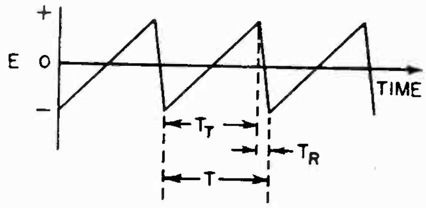

Fig. 6. Saw-tooth scanning voltage, as applied to deflection plates of electrostatic tube.

times that of the vertical saw-tooth, the following result is obtained: Vertical deflection proceeds at a relatively slow rate while the beam quickly moves from left to right, snaps back and again scans horizontally. Thus, in the time required for one full cycle of the vertical saw-tooth, the beam scans horizontally 525 times, thereby tracing 525 horizontal lines in one vertical scanning or frame. (Strictly speaking, these lines would not be exactly horizontal, but for all practical purposes may be so considered.) If the vertical saw-tooth voltage had a frequency of 30 cycles per second, the mosaic would be completely scanned 30 times per second. For 525 lines per scanning (or frame), the horizontal saw-tooth frequency would have to be exactly 30 x 525=15,750 cycles per second.

Interlaced Scanning

The characteristic of the human eye is such that 30 frames per second would cause flicker and motion might appear jumpy rather than continuous. Since it is highly desirable to have the frame repetition rate integrally related to the power line frequency, it first appeared necessary to use 60 frames per second. However, this would have imposed additional amplifier problems and the final decision was to employ interlaced scanning whereby all the odd lines of the picture are scanned in the first 1/60 of a second, and the even numbered lines are scanned in the second 1/60 of a second. Thus there are 60 half-scannings or fields per second, which dispel any flicker, but at the same time only 30 complete frames are required per second. This permits the use of the same horizontal or line frequency of 15,750 cycles per second but necessitates a vertical saw-tooth frequency of 60 cycles per second. The procedure may readily be understood by referring to Fig. 7. At the simultaneous start of the vertical and horizontal saw-tooth cycles, the beam is at the upper left corner of the mosaic (point A). As the horizontal deflection voltage causes the beam to move from A to B the vertical saw-tooth produces only a small downward component. At the end of the first horizontal saw-tooth cycle, the beam snaps back to the left side to point C, scanning this line to D, the process continuing toward the bottom of the mosaic where line IJ is scanned. The beam again returns to the left side where horizontal scanning proceeds from K to some point such as L, whereupon the retrace of the vertical saw-tooth starts. Horizontal scanning, being at a faster rate, will continue during the vertical fly-back time, causing the beam to go from L to M, N to O, toward the top of the tube from P to Q, and finally from R to A'. It is important to note that A' corresponds to the beginning of the next vertical saw-tooth cycle and furthermore is displaced exactly ½ line from A, the point at which the first scanning started. This effect is caused by the relation between vertical and horizontal frequencies. Dividing 15,750 lines per second by 60 fields gives 262½ lines per field, resulting in the half-line displacement at the start of successive fields.

The second field proceeds from A' to B', C' to D', and down the tube, these lines falling in between those of the first field because of the half-line delay at A'. The last line is scanned from I' to J', whereupon the

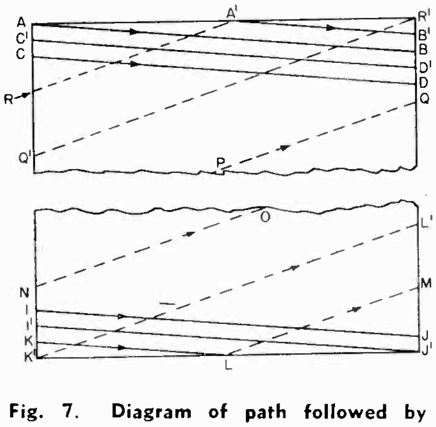

Fig. 7. Diagram of path followed by electron beam in scanning target of camera tube or screen of kinescope.

retrace of the vertical saw-tooth quickly carries the beam through several scanning lines K'L' toward the top of the tube to Q'R' and back to point A where the process of the first field is repeated. This system of interlace therefore requires two fields for one complete scanning or frame, resulting in 60 fields, and 30 frames, per second. Since the interlace depends upon the use of an odd number of lines (525) it is called odd-line interlace.

Let us diverge to discuss the second method of deflecting an electron beam, namely by a magnetic rather than an electrostatic field. The principle is exactly that of the electric motor whereby a conductor carrying a current is acted upon by a force when there exists a magnetic field perpendicular to the conductor. Furthermore, this force will be at right angles to both field and conductor. Thus, if a current-carrying coil is placed near the tube with its axis horizontal but perpendicular to that of the tube (Fig. 8), a horizontal magnetic field will cross the electron

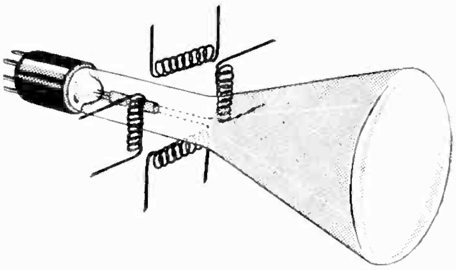

Fig. 8. Cathode ray tube showing position of deflecting coils.

beam and the field intensity will be proportional to the current through the coil. As a result, the beam will be deflected vertically by an amount proportional to the coil current, and in a "sense" dependent upon the direction of current flow. Therefore a saw-tooth form of *current* is required for linear electromagnetic deflection. The deflection coil is relatively flat and shaped to fit against the neck of the tube. The winding is split symmetrically with the two sections connected in series but placed on opposite sides of the neck. Another electrically independent pair is displaced 90° around the axis of the tube for horizontal deflection. Normally the two deflection coils are formed into a yoke which can be slipped externally over the neck of the tube. Some manufacturers use electrostatic deflection for all tubes

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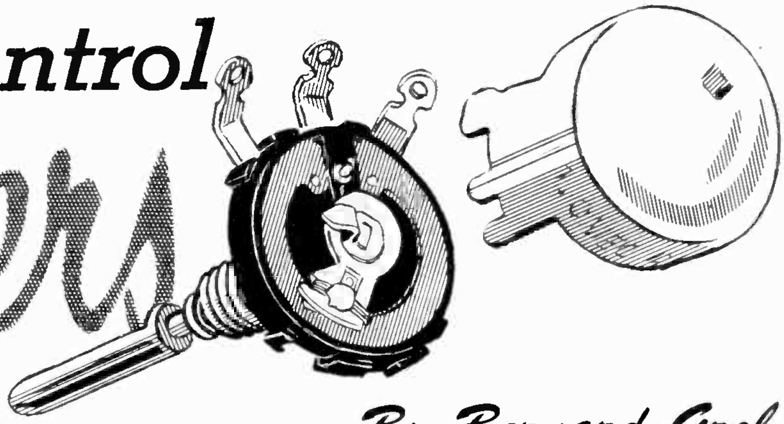
Volume Control tapers



By Bernard Grob

Use of the wrong taper in the volume control circuit can cause some annoying trouble in regulating the output of a receiver. This article explains why the proper taper must be used for satisfactory control of volume.

WHEN A VOLUME CONTROL RESISTOR is replaced, some peculiar troubles in controlling the volume can be eliminated by duplicating the taper of the original control, as well as the size. The taper indicates the way in which the resistance of the control varies with rotation of the shaft. In control with linear, or straight line, taper, equal amounts of rotation will result in equal changes in resistance. This is illustrated in Fig. 1, which shows how resistance changes in equal steps as the variable arm rotates around the control.

The nature of the response of the human ear to changes in sound intensity makes necessary the use of special tapers on volume controls. The ear is more sensitive to changes in sound at low volume levels than at high levels. If a receiver is operating at low volume, a small increase in output will be apparent as a change in volume. However, if the receiver is playing at high volume level, the same increase in output may not be noticed by the ear as a change in volume because at high levels it takes a greater increase in output in order that the ear will recognize an increase in volume. Mathematically, the response of the ear is proportional to the logarithm of the sound energy producing the response. For this reason, the decibel, which is a logarithmic unit, is often used in measuring or comparing audio output.

Non-Linear Controls

Because of this non-linear characteristic of the ear, volume controls are made with different tapers to provide proper control of the volume in different types of volume control circuits. To compensate for the logarithmic response of the human ear, the volume control should make smaller and more gradual changes in output at low volume levels than at high levels. If this is not done, the volume will be either too loud or too low; and it will be difficult, if not impossible, to get a fine adjustment for comfortable volume.

In non-linear volume controls, the resistance changes more rapidly during some parts of the rotation than during other parts. This is shown in Fig. 2. The first quarter turn increases the resistance from zero to 5,000 ohms. The next quarter turn increases the resistance to 25,000 ohms, making a change of 20,000 ohms compared to 5,000 ohms for the first quarter turn. With the control turned halfway up, the resistance is only 25,000 ohms out of the total 500,000 ohms. In this volume control, the resistance changes more rapidly as the high resistance side of the control is approached.

This non-linear variation of resistance is made a part of the control in the process of manufacture, and cannot be changed. As a result, many types of tapers are manufactured. Some of the common non-linear tapers are "audio," "C bias," "antenna shunt," and "C bias and antenna shunt," the names indicating their use.

Volume Control Circuits

Some of the common circuits for volume control will be examined now, along with the choice of taper to provide proper control of the volume. In modern receivers using a diode detector, the volume control is usually in the audio section. It consists of a potentiometer used as the diode load resistor as in Fig. 3a, as a shunt across the secondary of one of the audio transformers as in Fig. 3b, or as the grid resistor in a resistance coupled audio amplifier as in Fig. 3c. In all of these, the desired amount of audio voltage is taken off the variable voltage divider and applied to the grid circuit for amplification. With the variable arm of the "pot" at 1, no signal voltage is applied between the grid and cathode of the amplifier and the volume output will be zero. With the variable arm at 2, all the available signal is applied to the grid and the volume is maximum. Therefore, the control will have to be arranged so that the resistance between the variable arm and ground increases with clockwise rotation of the shaft.

A volume control for this type of circuit should have a taper that makes the resistance increase slowly at the low resistance side of the "pot." In this region, the volume of the receiver will be low, and a small increase in resistance will give the necessary increase in output for a noticeable increase in volume. At the high resistance end of the control, the volume of the receiver will be high, and a larger increase in resistance is necessary to increase the volume noticeably. The non-linear taper shown in Fig. 2 varies in this manner and is an audio taper. Note that with the control turned halfway up, only 25,000 ohms of the total 500,000 ohms are used. A half megohm control is used here as a typical value, but of course the same taper can be applied to controls of different values.

It should be noted, however, that the taper shown in Fig. 2 is not necessarily exactly the same as those produced by all manufacturers. There are slight differences with which we need not be concerned.

Cathode Bias Control

Fig. 4a shows a circuit in which a control serves as a variable cathode

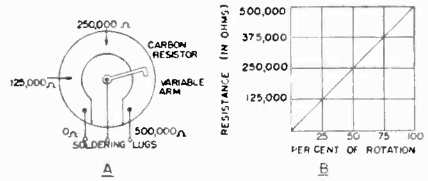


Fig. 1 Linear taper control showing the relation between rotation and change in resistance.

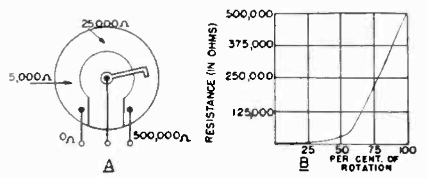


Fig. 2 A non-linear taper control showing the relation between rotation and resistance change.

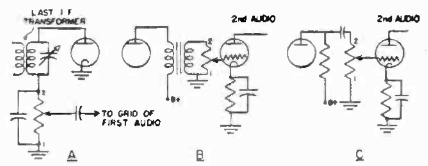


Fig. 3 Three methods of controlling the output of a receiver in the audio section.

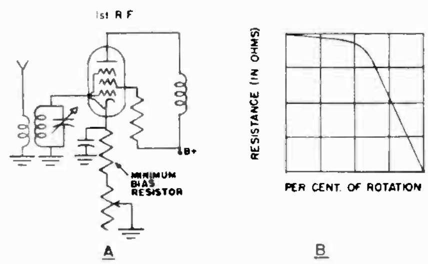


Fig. 4 Variable C bias method of controlling the output of a receiver.

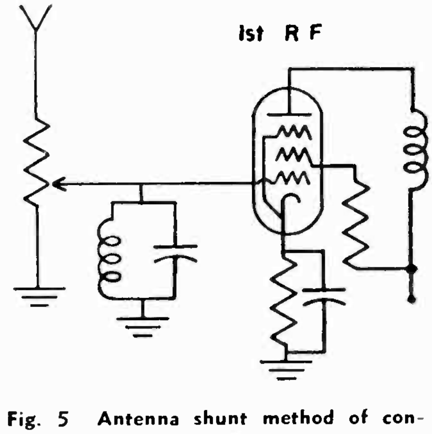


Fig. 5 Antenna shunt method of controlling the output of a receiver.

resistor, varying the bias; and, therefore, the amplification of a variable mu tube, such as the 6SK7. This is really an RF gain control, but it is used as a volume control in some receivers. In this type of circuit, the receiver will operate at maximum volume when "R" is at its minimum value because this will give the least bias and, therefore, the highest amplification. If the volume is to increase as the control is turned to the right, the resistance will have to decrease in this direction, with the "off" position corresponding to maximum resistance. Because low volume levels occur now for high values of resistance, this part of the control will have a gradual decrease, with the largest changes taking place at the low resistance end. This is just the opposite of the audio control.

The value of resistance for such a cathode control will be much smaller than that for the usual audio control. At the high resistance end, the cathode control regains enough resistance to allow the cathode current to develop an IR drop great enough to bias the tube near "cut-off." Of course, variable mu tubes are remote "cut-off" tubes, but with enough bias the plate current can be reduced to practically zero. For a 6SK7, this grid bias is 50 volts. At the low resistance side, it is advisable to have a fixed resistance in series with the control, as shown in the diagram, so that the bias will not be reduced to zero at maximum volume. For the 6SK7, a 260-ohm fixed resistor will hold the lowest bias to the recommended minimum of 3 volts. Fig. 4b illustrates the taper for this type of control. Note how the fine control is put at the high resistance end where the receiver will be playing at low volume. Some manufacturers provide slightly different tapers for control of one tube than for control of more than one tube. Values of resistance for cathode bias controls range from 5,000 to 75,000 ohms, depending upon the tube and the exact circuit used.

It is evident that an audio control cannot give good results in a cathode bias volume control circuit. The resistance will be too high, and the taper will be reversed. Therefore, an "audio" type control cannot replace a "cathode-bias" type control, or vice versa.

Antenna Shunt Control

In older receivers, the antenna shunt circuit shown in Fig. 5 was often used for volume control. In this system, the desired amount of signal voltage is tapped off a variable voltage divider in the antenna circuit in a manner similar to the audio control. The resistance increases as the control is turned to the right for increased volume, just as in the audio control, but the taper is slightly different. These controls are available in a special antenna shunt taper.

A combination antenna shunt and cathode bias circuit for volume control is common in midget TRF receivers, as shown in Fig. 6a. This method works well because the antenna shunt control and variable bias work hand in hand to insure uniform control of the volume. As the variable arm of the potentiometer increases the cathode to ground resistance, cutting down the volume, the resistance shunted across the antenna coil decreases to reduce the volume also. The taper for this control is shown in Fig. 6b. Note that the change in resistance is very gradual at both the high and low resistance ends.

Screen Voltage Control

A popular circuit for volume control in older receivers is shown in Fig. 7, where the control applies screen voltage to an RF amplifier. The amount of plate current that flows will depend upon the screen voltage which is adjusted by means of the potentiometer to give desired volume. Variable screen voltage can be applied to two or three stages simultaneously. While it is preferable that this type of volume control can be used on a variable mu tube, when the input signal is small it can be used on the type 24A screen grid tube with good results.

When the control is turned to the

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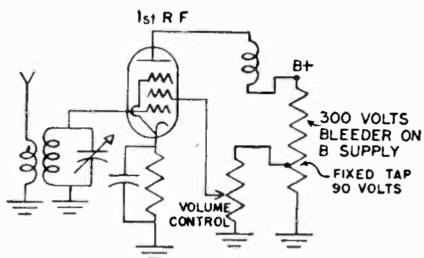

Fig. 6 Combination antenna shunt and C bias method of volume control.

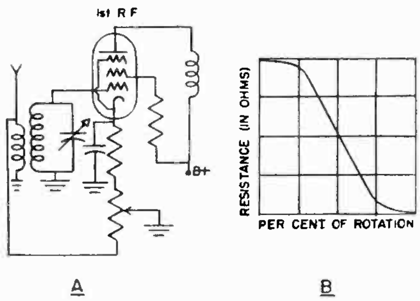

Fig. 7 Screen voltage method of controlling the output of a receiver.

The Electronic Volt Ohmmeter

By Ralph B. Roland

New improvements in design are making the electronic volt-ohmmeter increasingly versatile. This new versatility combined with the expansion of FM and television are making the instrument more and more a necessity for the serviceman.

TO USE TEST EQUIPMENT efficiently, it is essential that the technician be familiar with the full capabilities as well as the limitations of his apparatus.

One of the most versatile test instruments, which can be very useful in any radio serviceman's shop or radio laboratory, is the electronic volt-ohmmeter. Two good commercial versions are the Silver VOMAX and the RCA VoltOhmyst, Jr.

The former offers the unusual advantages of RF voltage measurements plus six direct current ranges. For routine testing of tube pin voltages, the VTVM is the most useful device available since it can be used as a DC or AC voltmeter as well as an ohmmeter. Whereas most of the ordinary non-vacuum-tube types do not have a particularly high input resistance, the electronic voltmeter, when used to measure DC, can present an input resistance of 10 to 125 megohms. This is an extremely important factor when it is desired to check DC voltages in high resistance circuits.

Before discussing the advantages of the electronic voltmeter, let us first realize why ordinary voltmeters have what today are serious limitations. The ordinary DC voltmeter is no more than a DC milliammeter in series with a resistance. The meter must draw a certain amount of current for full scale deflection, and it is this current which determines the sensitivity and effective meter resistance. The ordinary run-of-the-mill voltmeter is not too sensitive, requiring one milliampere for a corresponding full scale deflection. This figure of one milliampere applies to the so-called "1000 ohms-per-volt" type of meter. What this means is that if you want to use the one-volt scale, there are only one thousand ohms in the voltmeter circuit. Such a low value of resistance means that the voltmeter cannot be connected across a resistance of more than 50 ohms without causing the voltage to drop by more than 5 per

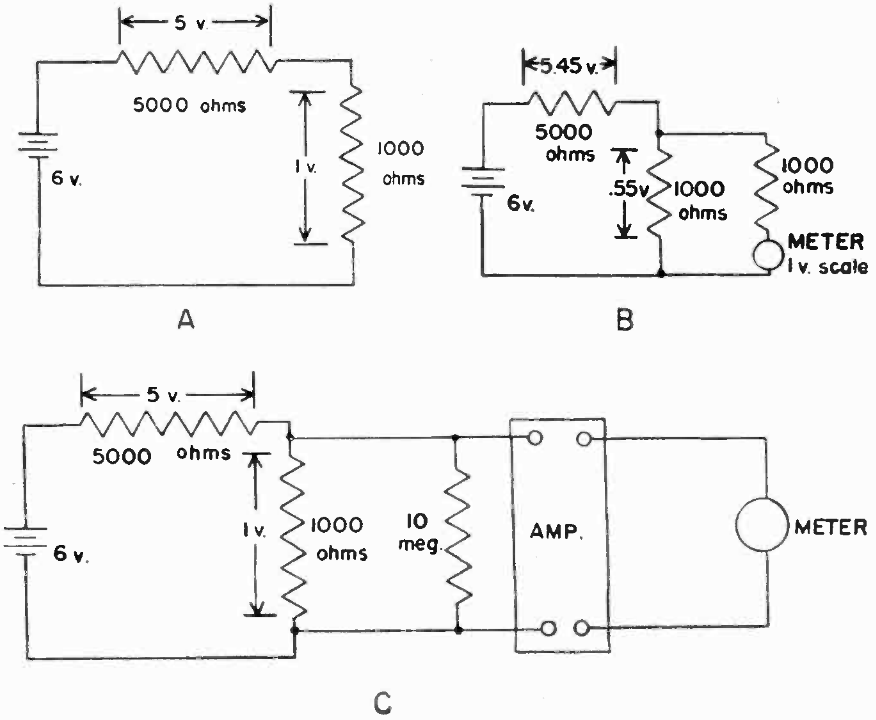

Fig. 1 Simplified diagrams illustrating the effect on circuit conditions caused by connecting a voltmeter to the circuit. 'A' shows circuit conditions before the instrument is introduced. 'B' shows circuit conditions when an ordinary voltmeter is connected to the circuit. 'C' shows how the electronic voltmeter does not disturb the circuit when connected.

cent. This is obviously a bad condition because the connection of the voltmeter into the circuit causes the voltage to change and results in erroneous readings. The same meter on the 100-volt scale has 100,000 ohms resistance; and, consequently, cannot be connected across a resistance of more than 5000 ohms without exceeding a five per cent error. Fig. 1 shows a graphic example of the serious errors which may be encountered with low resistance voltmeters.

General Physical Description

A photograph of the Model 900 VOMAX is shown in Fig. 2 and clearly portrays the appearance of the instrument. Fig. 3 is a detail drawing of the meter face itself, while the complete schematic is shown in Fig. 5. Constant reference will be made to these illustrations.

As can be seen from Figs. 2 and 3, the meter scale is of good size and can be read easily, since it consists of only five principal scales. The uppermost scale is the ohmmeter scale, and directly below this is the 3-volt AC scale. Due to the nature of the circuit, as will be later discussed, the lowest AC scale must be calibrated separately. The next two scales are either volts (DC or AC) or milliamperes, according to the use to which the instrument is being put. Two sets of ranges are provided: 3, 30, 300, and 3,000 volts or milliamperes. The fifth scale reads in db referred to one milliwatt in 600 ohms (i.e., 0 db = one milliwatt in a 600-ohm circuit) and is used for power level or output measurements.

A single pole switch controlled by the ADJ OHMS knob (designated as S-3 in the schematic) is located in the 115-volt AC line for turning the instrument on and off. This control is at the lower right corner of the front panel. A pilot lamp in parallel with the filaments indicates when the meter is on. Two more switches are located on the front panel and serve as function selector and range selector. The function selector allows the operator to use the meter in five different ways.

(1) AC voltmeter, reading RMS volts in 6 ranges for both low-frequency AC and RF, three ranges calibrated in db.

(2) DC voltmeter, reading positive volts, 12 ranges.

(3) DC voltmeter, reading negative volts, 12 ranges.

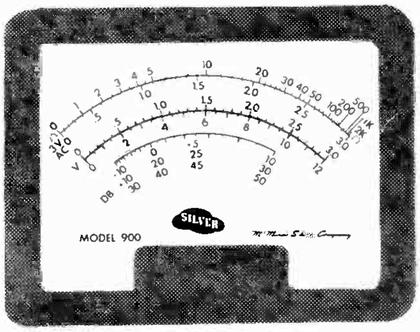

Fig. 3 The VOMAX meter face. The center scale is in green, all other scales being in black.

(4) Ohmmeter, 6 ranges.

(5) DC milliammeter and ammeter, 6 ranges.

The range selector switch is a six-step multi-gang ceramic switch which controls the full scale value of each of the ranges. Thus, for either AC or DC voltage, the steps are 3, 12, 30, 120, 300, and 1200 volts full scale; for current, 12, 30, 120, and 300 milliamperes or 1.2 and 12 amperes; for resistance, 2000, 20,000, 200,000 ohms, 2 megohms, 20 megohms, and 2000 megohms full scale. For power measurements, this range selector switch will allow three switches of scale, +10, +30, and +50 db.

The function selector switch is a six-deck switch with five positions per deck. It is designated as S-la, b, c, d, e, f, on the schematic diagram. The range selector switch is a five-deck six-position ceramic switch designated as S-2a, b, c, d, e, on the schematic.

There are five input terminals to the VOMAX, designated as COM-GND, V-ohm-MA, Vx2.5 DC, 12 A, and the RF probe, withdrawn from the panel for RF work, all measurements are made with two test leads, colored red and black, respectively. When using the RF probe, one input lead is a pin protruding from the probe can, the ground return being the shell of the probe.

Operation of the instrument is as follows:

1. *Voltage measurements with direct reading scale.* With the black lead inserted in the COM-GND jack, firmly touch the other end of the lead to the chassis under test. The red lead is inserted in the V-ohm-MA jack and the other end is touched to the point at which the voltage is to be measured. The function selector switch should be set to AC, DC+, or DC—, as the case may be. The range selector switch should be set to the desired range. The meter will now

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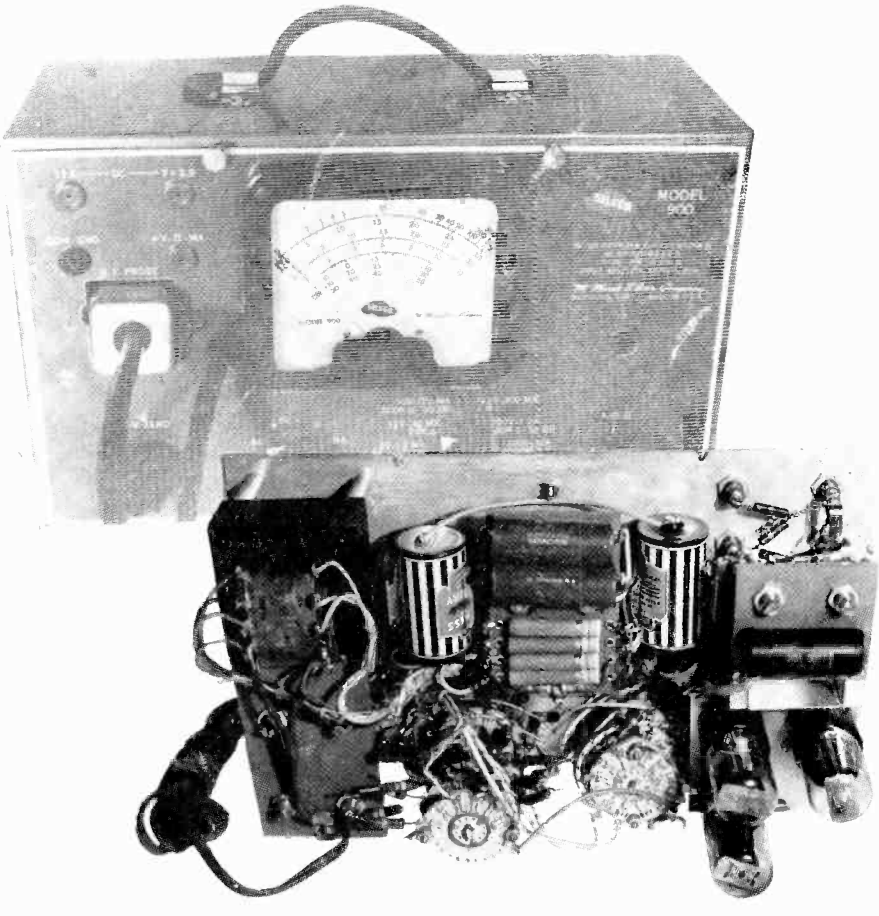

Fig. 2 The Silver Model 900 VOMAX which is used in this article as an example of the electronic volt-ohmmeter.

The Electronic Volt Ohmmeter

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read directly in volts.

2. *Voltage measurements. Scale reading multiplied by 2.5.* Leave the black lead connected as before. Insert the red lead into the Vx2.5 jack. Set the function and range selector switches as before. The meter scale will indicate only 40 per cent of the previous value. This extends the useful range of the instrument from 1200 volts to 3000 volts maximum, multiplying every DC voltage range by 2½.

3. *Current measurements, except for currents greater than 1.2A.* Connect the black lead to COM-GND and the red lead to V-ohm-MA jack. To measure current, open the circuit under test and connect a lead to each side of the opening. This places the meter in series with the circuit under test. The function selector switch must be set to MA and the range selector switch must be set to the proper scale. Start at the highest range to avoid meter burnout due to overload. In case the meter reads backwards, reverse the leads. This instrument reads direct current only. Alternating current may be measured by inserting a known resistor of small value in the circuit and measuring the voltage drop across it.

4. *Current measurements in excess of 1.2 amperes.* Leave the black lead on COM-GND, but connect the red lead to the 12 A jack. This connects a special shunt across the meter to give a full scale deflection of 12 amperes. Current measurements are made in the same way as described above.

5. *Resistance measurements.* Connect the black lead to COM-GND and the red lead to V-ohm-MA. The test prods are then touched to either side of the resistor being measured. The function selector switch must be thrown to ohm and the range selector should be set to the proper range.

6. *AC measurements with the RF probe.* Remove the probe from its socket in the front panel. For measurements below approximately 5 megacycles, connect the black test lead from COM-GND jack to the chassis under test. Place the prod tip of the RF probe on the point at which the voltage is to be measured. For measurements above 5 megacycles, the chassis connection should be made by touching the probe shell to the outer side of the circuit being measured. The function selector switch should be set to AC, and the range selector to any convenient range. It should be carefully noted that the RF probe must not be used to measure signals at frequencies below 15,000 cycles. From 20 cycles to 15,000 cycles, the RF probe should be inserted into its panel receptacle, and the measurements made with the test leads in the panel jacks.

In addition to the switches and input terminals, there are also located on the front panel two adjustment knobs, marked SET V ZERO and ADJ OHMS. These controls are respectively the potentiometer R-34 and R-33, shown on the schematic, Fig. 5. The SET V ZERO control is used to adjust the meter needle to zero when no voltage is applied, and the ADJ OHM control is used to position the needle to the infinite resistance reading, full scale, when the input terminals are open, in addition to switching the instrument on and off.

Since it is always well to understand fully how a piece of test equipment works, a discussion of the circuit will prove profitable. The power supply is a simple full-wave rectifier operating from the secondary of a step-up transformer, T, so that approximately 360 volts DC are developed between the filament of the 5Y3-GT rectifier and the center tap of the transformer secondary. Filtering is provided by the 8-ufd electrolytic condensers C-5 and C-6. The bleeder, composed of R-37, R-38, R-39, and R-40, is grounded at the center, so that positive voltages appear at one side of R-38 and R-37, and equal negative voltages appear at the opposite sides of R-39 and R-40.

DC Voltmeter Circuit Functions

When used as a DC voltmeter, the measuring circuit itself consists of a four-arm bridge, two arms being resistors R-35 and R-36, and the other two being the two sections of a 6SN7, V-3 and V-4. Referring to Fig. 6, it may be seen that if the two tubes draw the same current, there will be no voltage difference between their cathodes, and no current will flow through the meter. The SET V ZERO control, R-34, allows equalization of the cathode voltages.

The grids of V-3 and V-4 are connected respectively to the cathodes of V-1 and V-2. Considering that the grid is at a fixed reference potential for the moment, the grid of V-3 is

Fig. 4 Three other excellent versions of the electronic volt-ohmmeter. Looking from top to bottom they are, the RCA VoltOhmyst, the Hickok Model 203, and the Superior Model 400.

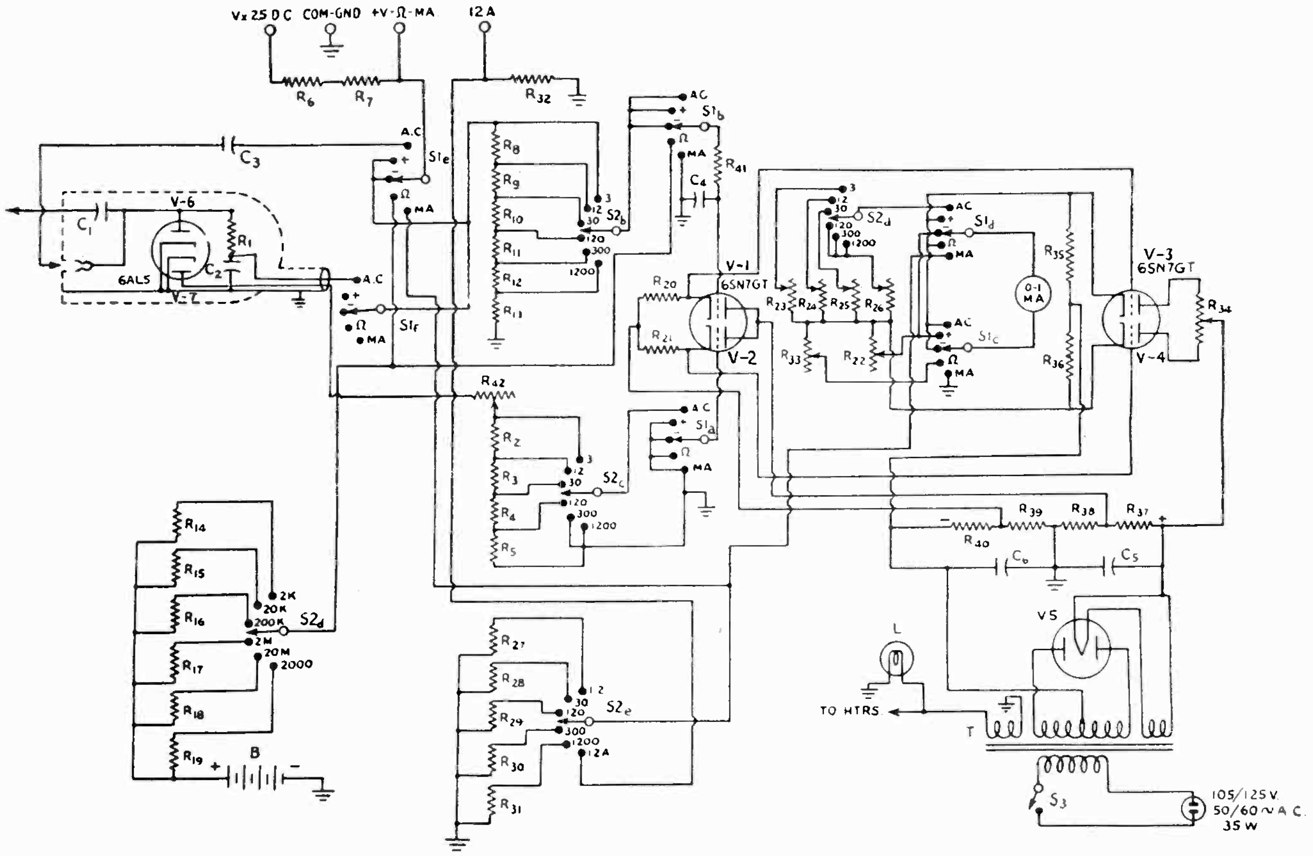

Fig. 5 The circuit used in the VOMAX.

subjected to the positive and negative variations in potential about this reference due to the applied voltage being measured.

When S-1 is set to DC, either + or —, a voltage proportional to the measured potential is applied to the grid of V-3, causing it to draw more current if the voltage is positive, or less if negative. This will cause current to flow through the meter, indicating the magnitude of the applied voltage. R-22 is provided to enable accurate calibration of the DC ranges. This is factory-adjusted, but in the case of tube aging, it may require a resetting. Apply a definitely known voltage of 3 volts to the instrument, and adjust for full scale deflection on the lowest range.

The bridge, V-3, V-4, R-35, and R-36, is independent of applied polarity, but to read both as required, it is necessary to reverse the meter. This is done on the c and d decks of S-1.

Having discussed the final or metering stage, it is necessary to explain how the input voltage is applied to the grid of V-3. Referring to Fig. 5, the circuit can be traced easily. The applied voltage is fed through the e deck of S-1 and thence to the voltage-dividing "stick" composed of resistors R-8 to R-13 to ground. The range selector switch S-2b taps off any desired portion of the input voltage and applies it to the grid of V-1 (½ 6SN7) through the RC network, R-41 and C-4, which filters hum or ripple from the applied voltage. The grid of V-2 is grounded through S-1a.

V-1 and V-2 are two cathode-followers whose purpose is to maintain high resistance. While an ordinary amplifier tube operating at normal voltages cannot have a grid leak much greater than one megohm to avoid grid current flow due to minute amounts of residual gas within the tube, a cathode-follower may employ a very high grid resistor, especially when the cathode resistor is large (note that R-20 is 5.1 megohms) and if the tube is operated at a low plate voltage. Since the input resistance of a cathode-follower is practically infinite, the loading placed on the measured circuit is at no time less than 50 megohms, the sum of R-8 to R-13. With such a high input resistance, *any* DC voltage in a radio receiver may be measured safely.

Since the grid of V-2 is grounded, the plate current is constant, and hence the voltage of the cathode is constant. This is the voltage which is applied to the grid of V-4, previously called a fixed reference potential. The grid voltage of V-2 depends on the voltage under test. If this voltage is zero, the grid of V-2 is at ground potential, and the cathode voltages of V-1 and V-2 are equal; thus the grid voltages of V-3 and V-4 are equal, and the meter will not be deflected. With an applied voltage, however, the cathode "follows" the grid at a fixed ratio (hence the name "cathode-follower"). This voltage is transferred to the grid of V-3, unbalancing the bridge circuit, and causing the meter to be deflected. Reversing the meter connection by means of the function switch enables measurements to be made of either positive or negative polarity.

The Vx2.5 DC input connection puts two series resistors, R-6 and R-7, 37.5 megohms each, in series with the voltage divider stick, and only 40 per cent of the applied voltage operates in the remaining circuits. This causes the scales to be multiplied by 2.5 when this feature is used; thus the 3-volt scale now has a full scale value of 7.5 volts, the 12-volt scale becomes 30 volts, and so on, with the 1200-volt scale being expanded to 3000 volts.

Ohmmeter Circuit Functioning

When used as an ohmmeter, the V-ohm-MA lead is connected to the grid of V-1 through the ohms tap on e and b decks of S-1. A three-volt battery and the range selector switch S-2d are also connected to the grid of V-1. For any position of the range selector switch, there is a series resistor forming a voltage divider with the unknown resistor being meas-

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ured so that the voltage on the grid of V-1 is proportional to the unknown resistance. If there is no resistance (i.e., a dead short), the DC voltage on the grid of V-1 is zero, and the meter will read zero if the SET V ZERO knob has first been adjusted properly. On open circuit, the meter should read infinity, and the adjustment can be made by the ADJ OHMS control which is the variable resistor R-33. The ADJ OHMS control is in the meter circuit only when the instrument is used as an ohmmeter, replacing R-22 by the switching action of the c deck of S-1. The instrument operates in precisely the same manner for measurement of ohms or DC volts. As a voltmeter, the voltage to be measured is applied to the grid of V-1; as an ohmmeter, the voltage drop across the unknown resistor is applied to the grid of V-1, with the current supplied from a 3-volt battery. A battery is used because it is by far the most stable source of voltage.

Milliammeter Circuit Functioning

The circuit for the VOMAX when used as a milliammeter is exceedingly simple. The black lead is grounded at the COM-GND jack. The red lead is plugged into the V-ohm-MA jack and the current to be measured flows through the MA tap on switch S-le, thence splitting into two parallel paths to the return ground. One path is through the meter by way of S-ld and S-lc. The other path is through the meter shunt on the range selector switch S-2e. The meter shunts R-27, R-28, R-29, R-30, and R-31, control the sensitivity of the meter and determine the full-scale range as 1.2, 30, 120, 300, or 1200 milliamperes.

For the 12-ampere range, it is necessary to plug the red lead into the 12 A jack, which places a factory-adjusted shunt, R-32, across the meter. When measuring currents on this range, the black lead is still connected to the COM-GND jack. This range is particularly useful when measuring input currents in automobile receivers or aircraft equipment.

AC Voltmeter Function and Operation

The most interesting aspect of VOMAX is its use as an AC voltmeter, since in this type of service it includes all the DC voltmeter circuits as well as additional special circuits. Whereas most of the other electronic voltmeters on the market utilize a copper-oxide, or similar, type of 1000 ohm-per-volt rectifier, VOMAX uses a miniature double diode 6AL5, designated as V-6, V-7 on the schematic of Fig. 5, which not only permits the measurement of low frequency AC but also audio, IF, and RF voltages right up to the television frequencies. An AC voltmeter utilizing a copper-oxide rectifier is not a high resistance device, and cannot be used to measure voltages in high resistance circuits. However, by using the 6AL5 as the input tube, it is possible to realize an effective input resistance of 6.6 megohms. This property makes VOMAX usable as a signal tracer right from the antenna to the speaker, as well as for measuring the 60 cps power circuits.

For a fuller discussion of the AC voltmeter operation of VOMAX, reference should be made to Fig. 7 which is a simplified schematic diagram of the input circuit. AC voltages can be measured in two distinct ways with this instrument:

(1) By means of ordinary test leads in the COM-GND and V-ohm-MA jacks, with the function selector switch thrown to the AC position. This method should be used when measuring AC voltages at frequencies below 15 to 20 kilocycles.

(2) By using the RF probe. This method should be used for all frequencies over 15 to 20 kilocycles.

The internal circuit functioning of VOMAX is very nearly the same for either method, the only major difference being in the input leads and the input condenser. The low frequency connection, using the red test lead in the V-ohm-MA jack, uses the condenser C-3, .03 ufd, in the input circuit. Measurements of AC voltage can be made down to 80 cps with 1 per cent accuracy, or 20 cps with 4 per cent accuracy. For high frequency measurements, the most important quantity is the input *shunt* capacitance, which is comprised mainly of stray wiring capacitances and interelectrode capacitances in the 6AL5 diode, V-6. Inductance of the input condenser leads is important, and for RF use, only mica or ceramic

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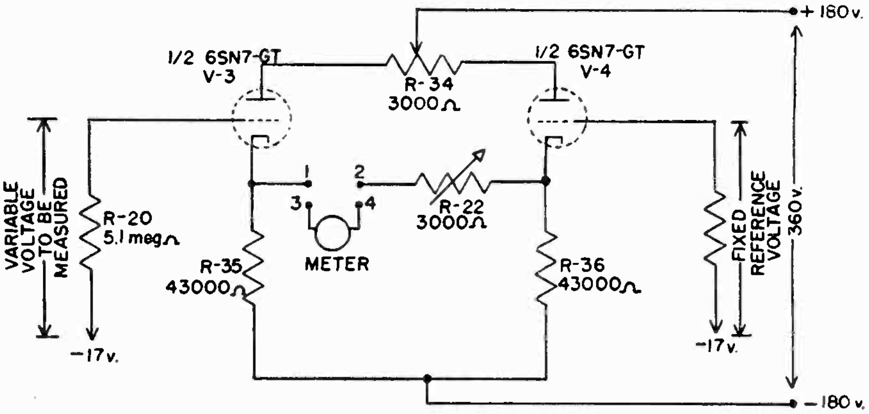

Fig. 6 Simplified diagram of the DC metering circuits.

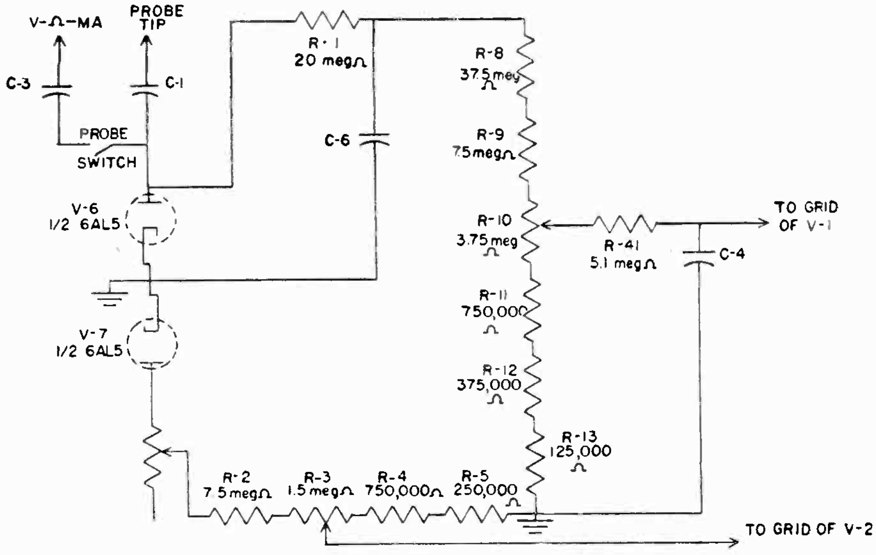

Fig. 7 Simplified diagram of the AC voltmeter input circuit.

Vector Analysis for the Radio Serviceman

Radio has come a long way since 1920. Simple circuits have been replaced with complex arrangements. The electronic engineer and radio maintenance man have learned to think in terms of involved electronic systems using every conceivable circuit twist. New symbols and methods of presentation have come into use and in a larger sense, these have become tools which our radio maintenance men have found useful.

by N. B. Cook

RADIO ENGINEERS OF TODAY speak the language of technology and employ a symbolism peculiar to their profession. The purpose is not to conceal knowledge but to facilitate its acquisition and dissemination.

The average radio serviceman, as the writer knows him, understands a good part of the Engineer's language and some part of the symbolism. But sometimes he is unfamiliar with the hieroglyphics called Vector Diagrams which the Engineer seems to find so useful.

The use of vectors as tools in understanding and applying theory of necessary electronic circuits for today's maintenance problems especially pertaining to FM and Television will be discussed here. Please be aware that this article is a forerunner to descriptions, operations and maintenance of FM and Television to follow.

Actually, Vector Analysis is incredibly easy. Any one who can draw a straight line and is also able to do a little straight thinking can learn to handle Vector Diagrams. Students who were fearful of these symbols become joyful at their own mastery of them.

Anyone who can sketch the simplest of road maps can draw a Vector Diagram. To prove it, try this:

If we drive 4 miles east and 3 miles north, how far are we from the starting point? Fig. 1 is a diagram of our movements.

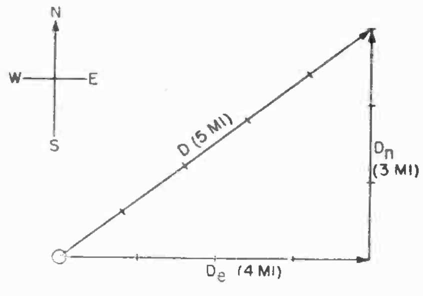

Figure 1

The horizontal and vertical lines take their directions to agree with the "weather vane" shown on the left. Line lengths are scaled in convenient units.

Distance D may then be found by measurement or by computation. Since this is a right triangle we may use a rule proved by Pythagoras about 550 B.C.

Now this "road map" is exactly the same mathematically as an engineer's Impedance Triangle.

Consider the circuit of Fig. 2. Component R is a simple resistance of 3 ohms. Let us say that its value was determined separately by using Voltmeter, Ammeter, and Ohm's Law.

$$R=E/1$$

Component L is an inductor or choke. The opposition it offers depends upon the fact that inductance opposes any change in current. This opposition is called Reactance and in this case is denoted by the symbol X_L.

Reactance may be measured separately in the same manner as resistance and we find by Ohm's Law:

$$X_L=E/1$$

In the figure:

$$R=3 \text{ ohms}$$
$$X_L=4 \text{ ohms}$$

Since the components are in series it might seem reasonable to say that the total opposition or *Impedance* (denoted by Z) is the sum of the separate values of opposition.

However, when we read the meters and apply Ohm's Law to the entire circuit, we find:

$$Z=E/1$$
$$=10/2$$
$$=5 \text{ ohms}$$

Now here is a simple physical fact, a measured result, not based on higher mathemtics or difficult theory. It can be reproduced with simplest equipment by any student.

And we have, most surprisingly, a new kind of addition which makes 3 plus 4 equal 5. How can 3 plus 4 equal 5? The ancient Egyptians knew. To square up their buildings and to orient their temples they used a large right-triangle made of rope, the three sides being respectively 3, 4 and 5 units. This try-square was pulled tight by special craftsmen known as "rope-fasteners".

Four thousand years have not changed the fact that 3 plus 4 equals 5, *if we add these quantities as lines at right angles.*

Conversely, if we find that 3 plus 4 equals 5 by measurement on electrical measuring instruments, spring balances, or other indicators, we may represent 3 and 4 as lines at right angles while 5 is the third side of the triangle.

Ordinary mechanical forces may be directed at right angles as in Fig. 3. It is not difficult to see that two mechanical forces directed at right angles produce a total force that is

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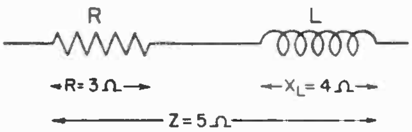

Figure 2

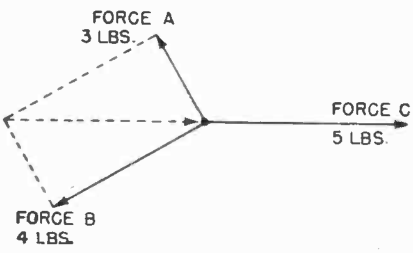

Figure 3

Vector Analysis for the Radio Serviceman

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the "right-angle sum" of the two. Thus the total pull of Force A (3 lbs) and Force B (4 lbs) is Force C (5 lbs). This is a common experiment in Physics.

On the other hand, it is not easy to see that the electrical opposition of Inductive Reactance may be *represented* as being at right angles to the opposition offered by Resistance. However, all experiments and all measurements indicate that these two effects always do add as if they were at right angles. Therefore they may be so represented. For any series circuit containing Resistance and Inductive Reactance, a right-triangle may be drawn to find the Impedance. The *magnitude* of Z is found as follows:

$$Z = \sqrt{R^2 + X_L^2}$$

Question: Why is the line for R drawn horizontally? Why is the line for X_L drawn upward? Why is the 90° angle at the right of the figure?

Answer: Because that is the way engineers have agreed to draw them.

The horizontal line representing R is also the *reference line* for the measurement of angles.

Problem: What is the impedance of a series circuit containing 100 ohms resistance and 50 ohms inductive reactance? (The solution to this problem will be found at the end of the article).

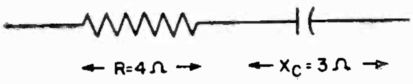

Figure 4

In most cases the Inductance is given. The Inductive Reactance is proportional to the frequency and may be found by the use of the following formula:

$$X_L = 2\pi fL$$

where X_L = Inductive Reactance in ohms
π = 3.1416
L = Inductance in Henrys
f = Frequency in cycles per second

Next, consider a series circuit containing Resistance and Capacitance, such as Fig. 4.

E and I may be measured directly. R may be found by measuring the drop IR and applying Ohm's Law. Similarly the reactance X_C may be computed. The impedance equals E/I.

Again it will be found that it is necessary to add at right angles in order to make Z equal to the sum of R and X_C.

Drawing the triangle, we have the diagram of Fig. 5.

Now, X_C is directed downward. Why? Because of physical facts. Measurements have shown that when

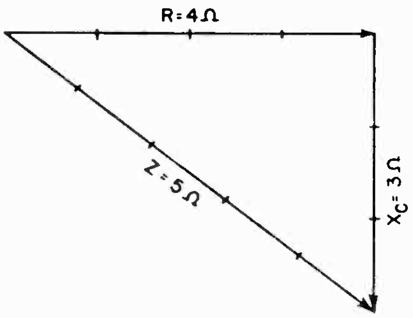

Figure 5

both inductive reactance X_L and capacitive reactance X_C are present in a series circuit, the effect of one reduces the effect of the other. Since it is known that the effect of each one is at right angles to the effect of resistance, the line representing X_C must be exactly opposite to the line representing X_L. And since the X_L line has been chosen as *upward* vertically, the X_C line must be drawn downward vertically. Moreover, the upward direction is considered *positive*, the downward direction *negative*.

When the Capacitance is given, the Capacitive Reactance may be found as follows:

$$X_C = \frac{1}{2\pi fC}$$

where X_C = Capacitive Reactance in ohms

π = 3.1416

C = Capacitance in Farads (*not* Microfarads)

f = Frequency in cycles per second

Let us now analyze the circuit of Fig. 6 which contains both X_L and X_C, in addition to R.

To draw the impedance triangle we use the following conventions:

R is represented by a horizontal line.

X_L is represented by a Vertical line upward (positive)

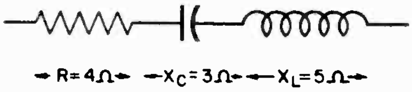

Figure 6

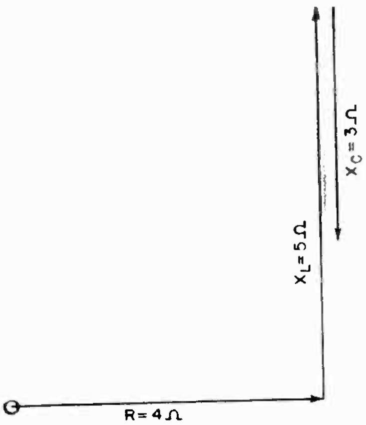

Figure 7

X_C is represented by a vertical line downward (negative)

Assigning a convenient scale for magnitudes, we draw Fig. 7. First we add X_L and X_C *algebraically*. Since X_C is negative the sum is $X_L - X_C$. The total reactance may be positive, negative, or zero depending upon the magnitudes.

In our example, the total Reactance is

$$5 - 3 = 2 \text{ (ohms)}$$

Now we are able to draw the Impedance Triangle of Fig. 8.

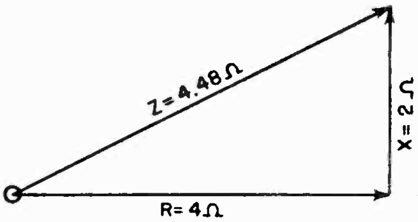

Figure 8

So what? What have we gained by drawing a triangle? We have gained a great deal.

(1) One picture is worth a thousand words. Here we have a picture that shows how three electrical quantities are related in a particular circuit.

(2) The figure is a right-triangle, the most useful plane figure in all mathematics.

(3) We can exploit the properties of the right-triangle to investigate the properties of the circuit.

(4) Trigonometry, "the handmaid

→ **To Page 40**

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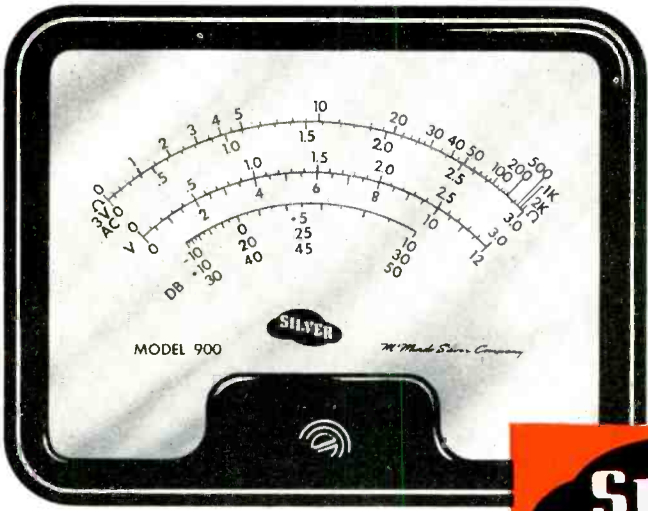

In "VOMAX" we find that unusual versatility and enormous range of performance which makes "VOMAX" truly a *post-war* meter of almost unlimited capability . . . . a tremendous benefit to every serious laboratory and maintenance technician. That "VOMAX" is more than good . . . . is truly extraordinary . . . . is proven by its overwhelming acceptance. In it you get not only true vacuum-tube measurement of d.c. and a.c. voltages, of resistance, of decibels, but you get a.c., a.f. and r.f. voltage measurements right up to over 100 megacycles . . . . true visual dynamic signal tracing.

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SOLAR MFG. CO.
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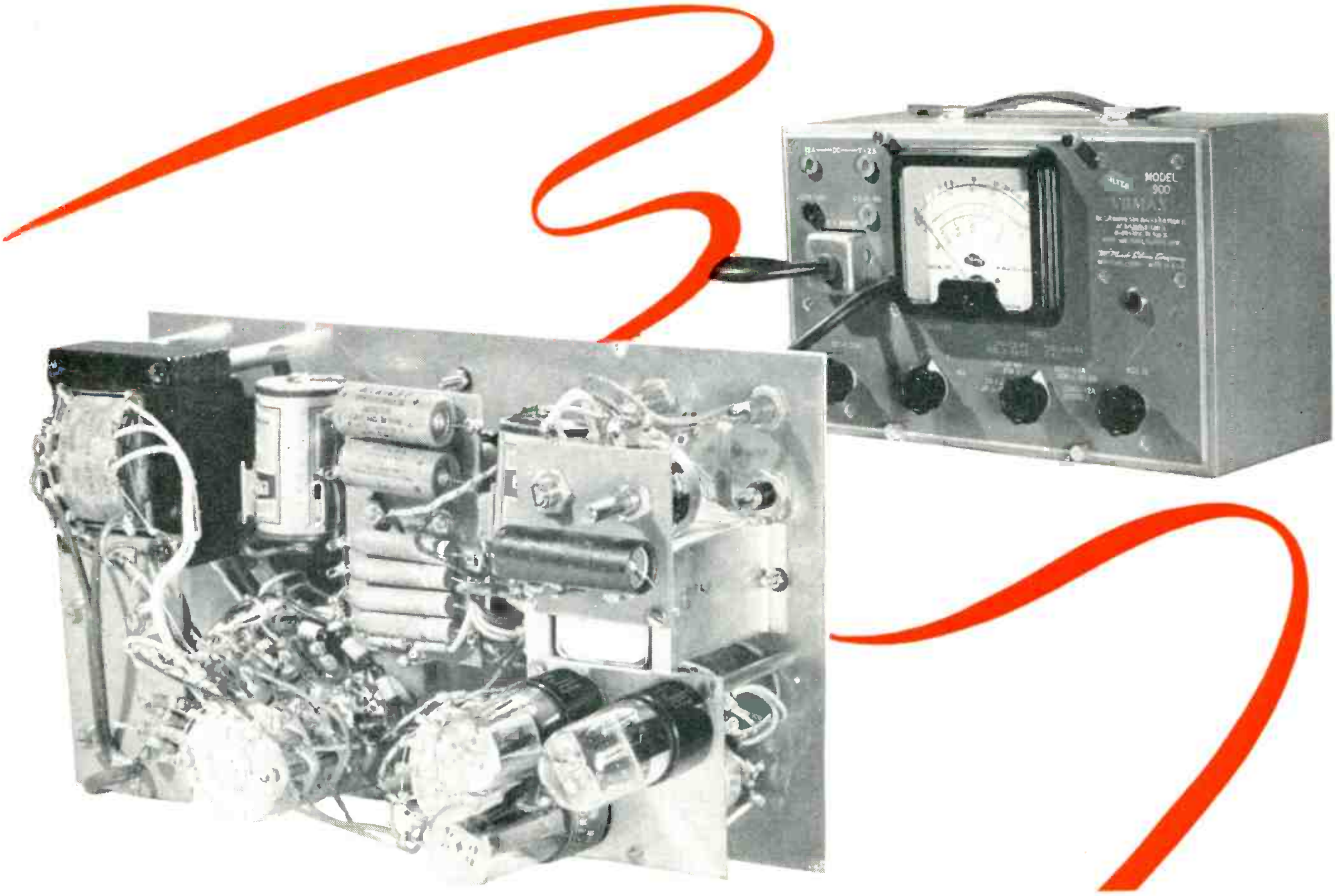

The great BENDIX RADIO Division of Bendix Aviation Corp. is a "tough customer." That Bendix has the real "know-how" is proven by the heavy dependence placed upon its design and production facilities by Uncle Sam before, during and after the war.

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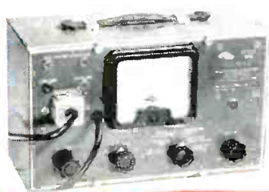

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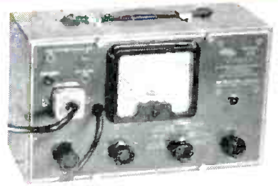

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Come in and examine "VOMAX". Look over its superb quality of parts, husky construction. You'll wonder, as we do, how its maker can price it only $59.85. We suspect today's give-away price may rise any minute. Better order quick at only $59.85

VOMAX

ACME RADIO SUPPLY

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TOPEKA, KANSAS
110 N. 9th St., St. Joe, Mo.

NEW POST-WAR V.T. V-O-DB-MA METER

Pre-war meters weren't complete enough for pre-war servicing. Why accept less than complete measurements — r.f., i.f., a.f., a.c., d.c., a.v.c., a.f.c., etc., etc. — including visual dynamic signal tracing 20 cycles through over 100 megacycles. "VOMAX" gives you this mastery. Prompt shipment. Only $59.85.

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Lampley Radio Company

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(Formerly Complete Radio Co.)

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When we examined, tested, "VOMAX" we realized that here was radio's outstanding "buy". Our customers say it's unbeatable. We can ship your "VOMAX" promptly at only $59.85.

Prompt shipment, too, on the new SILVER 904 C/R Bridge at $49.90 — and on "SPARX" aural/visual dynamic signal tracer and set tester at only $39.90.

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IN N. CAROLINA

EASTERN RADIO SUPPLY
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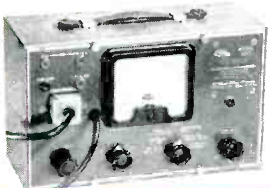
We know "VOMAX" to be the very best . . . . can ship your order promptly at only $59.85. We enthusiastically recommend the new SILVER 904 C/R Bridge which measures capacitors and resistors under actual operating voltage conditions from 1/4 mmfd./ohm thru 1,000 mfd./megohms. Only $49.90. "SPARX" is what we've been waiting for . . . . a dynamic signal tracer that tests every-*thing* in a receiver, yet costs you only $39.90.



Silver
"VOMAX"

TRI-CITY HAS IT

SILVER
VOMAX

What's good enough for the U. S. Bureau of Standards

in Washington is plenty good enough for us. That's "VOMAX" . . . . the outstanding vacuum-tube volt-ohm-db.-ma.-meter which ex-*clusively* gives you visual dynamic signal tracing, too.

Similarly tested and recommended highly by Bendix to *all* its distributors and dealers is the 904 C/R Bridge at only $49.90.

"SPARX" is the real answer to fast, positive visual/aural dynamic signal tracing at $39.90.

$59.85
The famous
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Prompt shipment

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New Silver 904 C/R Bridge 49.90
"SPARX" Signal Tracer 39.90

Radio Equipment Co.

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UNIVERSAL V.T.V.M. PLUS VISUAL SIGNAL TRACING

It's news to discover a meter truly universal — that will measure any and every type of receiver voltage, resistance, d.c. ma. and amperes, even capacity. But when it includes visual dynamic signal tracing too, we recommend it as the "buy" of buys. Prompt shipment at only $59.85 net.

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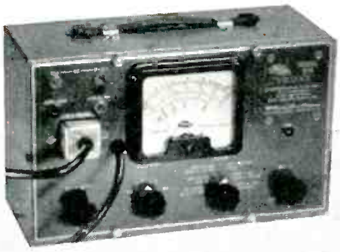
A.C., D.C. and R.F. VACUUM-TUBE VOLT-METER

True v.t.v.m. on a.c., d.c., ohms, db., all frequencies from 20 cycles to over 100 megacycles, "VOMAX" is what you have been asking for. With it you get resistance, capacity, power output, even power input. Only $59.85 net. Prompt shipment, too, on the new SILVER 904 C/R Bridge at $49.90 —and on "SPARX" aural/visual dynamic signal tracer and set tester at only $39.90.

VOMAX



"VOMAX" is standard of comparison: • D. C. volts; .05/3000 at 51 and 126 megohms • A. C., a.f., r.f. volts; .05/1200 at 6.6 megohms • D. C.; .05 ma./12 amp. • Decibels; —10/+50 • PLUS visual dynamic signal tracing.

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"VOMAX"

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When **SILVER** Says

"See Your Distributor":

SEE SUN RADIO

The service man on the left can't get a microphone big enough to broadcast his joy. He's discovered that when he calls Sun Radio, his search for replacement parts and test equipment ends, and so do all his worries.

Now Sun has "Vomax," the meter with *exclusive* visual dynamic signal tracing. As with everything else at Sun, you get prompt delivery. It will be to your own advantage to act now — today. "Vomax" is a buy at $59.85.

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RADIO SERVICE CO.
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A.C., D.C. and R.F. VACUUM-TUBE VOLT-METER

True v.t.v.m. on a.c., d.c., ohms, db., all frequencies from 20 cycles to over 100 megacycles, "VOMAX" is what you have been asking for. With it you get resistance, capacity, power output, even power input. Only $59.85 net. Prompt shipment, too, on the new SILVER 904 C/R Bridge at $49.90 —and on "SPARX" aural/visual dynamic signal tracer and set tester at only $39.90.

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NEW LONDON	363 Bank St.
WATERBURY	89 Cherry St.
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"VOMAX"

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New Silver 904 C/R Bridge	49.90
"SPARX" Signal Tracer	39.90

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SCOTT RADIO SUPPLY
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Prompt shipment at only $59.85. Prompt shipment upon Model 904 C/R Bridge at $49.90 and "SPARX" aural/visual dynamic signal tracer-tester at $39.90.

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Radionic Equipment Co.
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OUTSTANDING FEATURES

D.C. Volts at 51 and 126 megohms
A.C. and r.f. volts at 6.6 megs.
Resistance .2 ohms to 2,000 megs.
D.C. current 1.2 ma. through 12 amperes.
D.B. —10 through +50
PLUS visual dynamic signal tracing.

These features establish "VOMAX" as standard of comparison. Early shipment at only $59.85 net.

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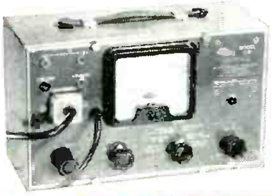

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World Radio LABORATORIES INCORPORATED

740-42-44 WEST BROADWAY

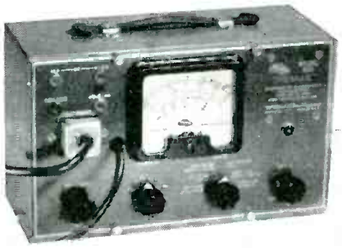
Council Bluffs Iowa

PHONES 3-0147 OMAHA - Jackson 7394

"VOMAX"

PROMPT SHIPMENT

Silver "VOMAX" at only	$59.85
New Silver 904 C/R Bridge	49.90
"SPARX" Signal Tracer	39.90



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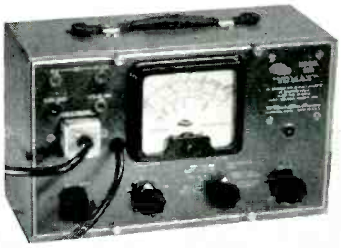
Speedy, Reliable Service
Low Prices
Complete Stocks of Standard Merchandise

Federated Purchaser

CABLE: FEDERPURCH
INCORPORATED
distributors of RADIO — ELECTRONIC and SOUND EQUIPMENT

80-M Park Pl., New York 7



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L. B. WALKER RADIO CO.

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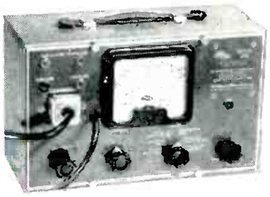

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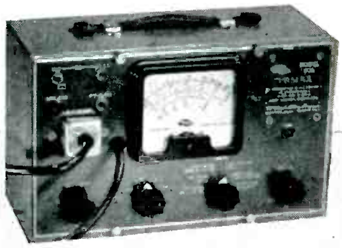

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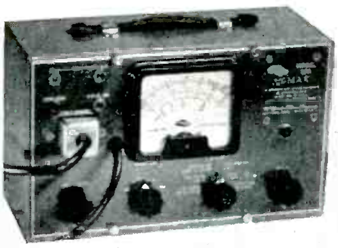
The Lukko Sales
CORPORATION



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Wheeling Radio Supply
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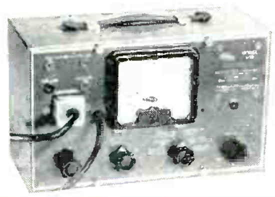

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in Washington is plenty good enough for us. That's "VOMAX" . . . . the outstanding vacuum-tube volt-ohm-db.-ma.-meter which *exclusively* gives you visual dynamic signal tracing, too.

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$59.85
The famous
"VOMAX"
Prompt shipment

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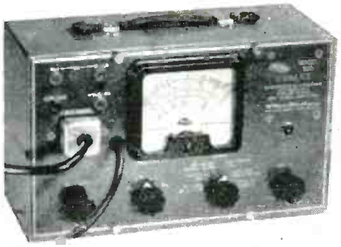
New Silver 904 C/R Bridge	49.90
"SPARX" Signal Tracer	39.90

"VOMAX"

RADIO & TELEVISION EQUIPMENT CO.



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207 OAK ST.
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Our thousands of customers know us for fast, friendly service . . . . service with a smile. Our stocks are large, our shipments prompt. Get your "VOMAX" from us at only $59.85 . . . . and better add on the 904 C/R Bridge at $49.90 and the new "SPARX" at $39.90 so you'll be completely equipped for big profits.

And don't forget your parts requirements — condensers, resistors, tubes, speakers, controls, etc. — Harrison has it! The products of all top quality manufacturers — Harrison has it! . . . . better—quicker and at lowest prices.

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"VOMAX"

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1284 Market St., San Francisco, Cal.

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VOMAX

G. M. POPKEY CO.

Marinette, Wis., Duluth, Minn.
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Prompt shipment, too, on the new SILVER 904 C/R Bridge at $49.90 — and on "SPARX" aural/visual dynamic signal tracer and set tester at only $39.90.

VOMAX

THE RADIO SHACK

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U.S.A.

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"SPARX" Signal Tracer	39.90

"VOMAX"

S. R. S. Distributors

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VOMAX

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VOMAX

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VOMAX

Walder Radio & Appliance Co.

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MEASURES EVERY RECEIVER VOLTAGE

All those vital measurements you've never been able to make are "duck soup" to "VOMAX". At meter resistance so high as not to upset circuits you can now directly measure r.f., i.f., a.f., a.c., d.c. — all voltages — visual dynamic signal tracing on operating receivers. "VOMAX" makes you the master. Only $59.85.

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Silver "VOMAX" at only	$59.85
New Silver 904 C/R Bridge	49.90
"SPARX" Signal Tracer	39.90

"VOMAX"

Be Sure to Read the August Issue of Radio Maintenance

Television Receiver Fundamentals

The second article on television by Lionel P. Paradise. A simple explanation of the operation of a television receiver. Future issues will carry other articles on this subject written in a straightforward, easy to understand style.

F.M. Troubleshooting

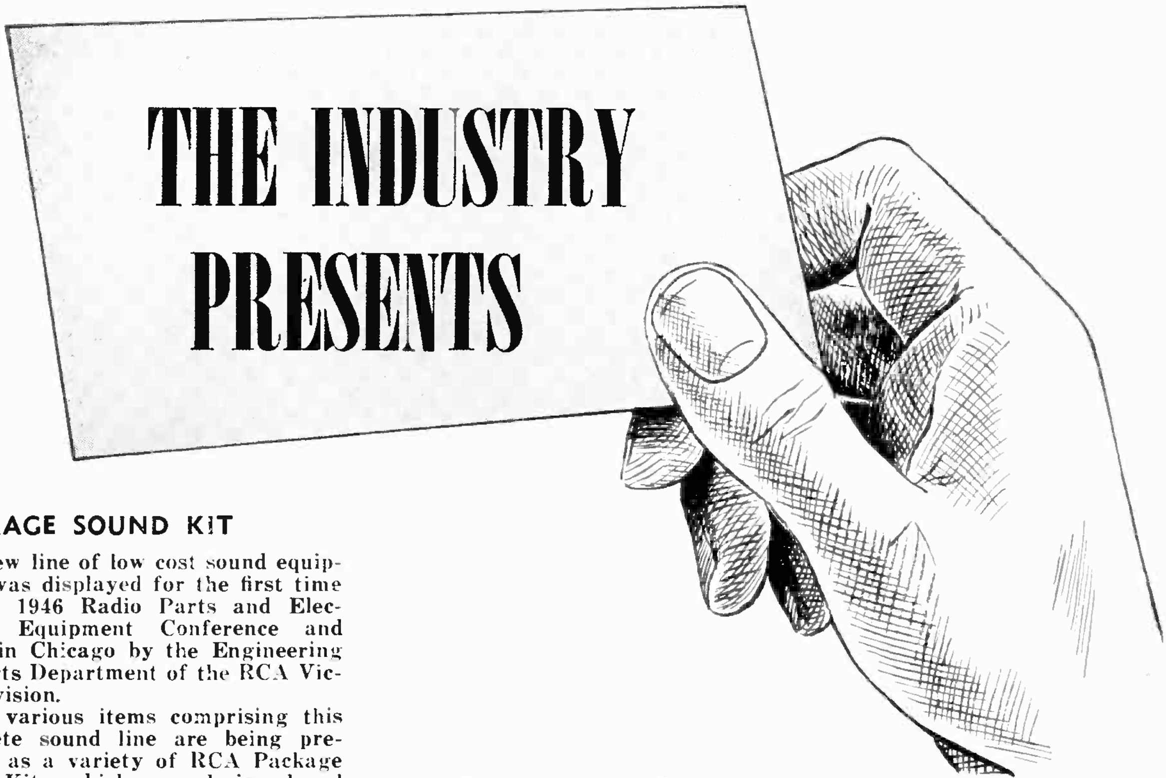
By Ralph B. Roland. The first of a number of articles on F.M. Servicing.

Record Changers

By George O. Smith. The operation and common faults of record changers. How to repair and adjust them.

"More of Everything You Want"

THE INDUSTRY PRESENTS



PACKAGE SOUND KIT

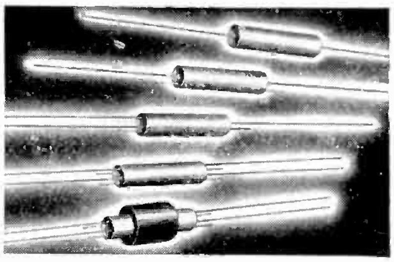
A new line of low cost sound equipment was displayed for the first time at the 1946 Radio Parts and Electronic Equipment Conference and Show in Chicago by the Engineering Products Department of the RCA Victor Division.

The various items comprising this complete sound line are being presented as a variety of RCA Package Sound Kits, which were designed and engineered specifically for smaller establishments, night clubs, small lecture and concert halls, retail stores, classrooms and similar locations.

The Sound Equipment Sections exhibit also included a complete line of microphones, amplifiers, speakers, baffles, horns, record players, disc recorders and portable sound systems.

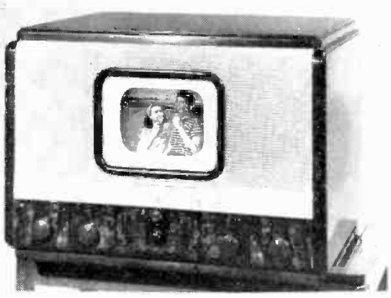
RADIO-PHONOGRAPH COMBINATIONS

Two new radio-phonograph combinations will soon be in production, according to an announcement from the Howard Radio Company: Model 909-M and 909-R, with 9-tube superheterodyne circuits (including rectifier and one double-purpose tube) and push-pull output with bass boost amplification plus one stage of RF amplification. Special features are 6" x 9" oval dynamic speaker, Acousticolor tone control, light-weight tonearm with permanent needle, slide-away drawers for automatic record changer and control dial, 9" slide-rule dial which lights each of two bands individually. Cabinets are blonde finish (Modern) and highly finished mahogany woods (Regency).



MOLDED COIL FORMS

Molded bakelite coil forms with anchored "hairpin" wire leads announced by the Electronic Components Division of the Stackpole Carbon Company, St. Mary's, Pa., provide inexpensive, easily-installed coil winding supports. Uses range from universal and tapped universal windings to solenoid windings, antenna or coupled windings, iron-cored universal windings, iron-cored IF transformer or coupled coils, and various others. Standard types include forms with coaxial leads each end; single hairpin lead each end; single hairpin lead one end, double hairpin lead the other end; and double hairpin lead each end.

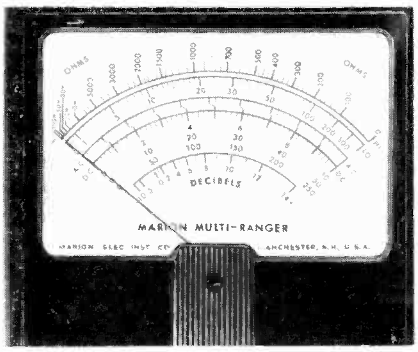


NEW TELEVISION RECEIVER

The Belmont Radio Corp. Division of Raytheon Manufacturing Co. expects to start delivery in July of the Belmont television receiver which will retail at approximately $150.

Belmont's television picture is sufficiently brilliant to be viewed in the home during daylight hours, as it employs an improved 7" picture tube.

The Belmont television receiver is as easy to operate as is the conventional broadcast set. Dimensions of the cabinet are 14½" high, 21" wide and 16" deep, and can be easily moved about.

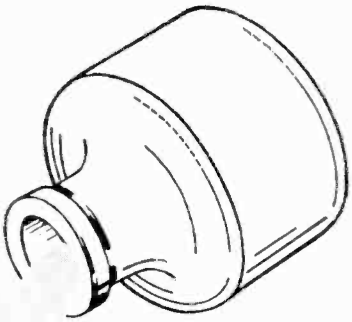


NEW FOUNDATION INSTRUMENT

The Marion Electrical Instrument Company, Manchester, N. H., is manufacturing a new foundation instrument, the Marion Multi-Ranger, designed to permit the user to assemble a highly accurate instrument for use as a voltmeter, milliammeter, high and low resistance ohmmeter, AC voltmeter and decibel meter.

The Multi-Rangers are available in 3½, 4½ and 8½-inch sizes.

RADIOMEN'S OPINIONS



Editor
Radio Maintenance
Dear Sir:

In your magazine you have attempted to supply a long needed place in radio journalism, that of the service man's side. The professional must make a living from his business or hobby, whichever he chooses to call it.

It is our hope that for the benefit of the trade and yourself that you are completely successful.

It strikes the writer that it is time that someone did something for the radio service man . . . that sap that keeps all radio factories in good repute and does their good will work for nothing so that auto dealers, druggists, hardware stores, and sundry retailers can make money out of this, the biggest single industry in unit volume in the appliance age.

The final blow is the present warrantee system that manufacturers are trying to shove down our throats. If you haven't seen some of these contract forms then they would be enlightening. One in particular calls for the replacement of a vibrator for 75 cents. Imagine a radio shop with men on a minimum of $50.00 per week removing a radio and replacing a vibrator in a car set for that figure. My experiences would show that the loss would amount to about $2.25. What is more, this is not for a set sold by the service man but any one of a certain model less than one year old.

Again wishing you success in your worthy undertaking and assuring you that we are going to read your efforts, we are,

Yours very truly,
J. E. WHARTON,
618 Travis Street,
Shreveport 45, La.

Boland & Boyce, Inc.
Gentlemen:

Enclosed please find our check for two dollars in payment for one year's subscription to your publication Radio Maintenance, beginning with the February, 1946 issue, if possible.

Through an oversight this subscription was not purchased several months ago as intended.

We feel that this magazine fills a gap left by other publications—a gap, the presence of which, was not apparent until the stopper was provided.

May it have a long and increasingly useful life.

Sincerely yours,
F. J. Kane,
OLYMPIC APPLIANCES CO.,
653 West 87th,
Seattle 7, Washington.

Dear Sir:

This evening I obtained a copy of your "Radio Maintenance" publication, February, 1946 Volume 2, Number 2, which impressed me very much. Your contents were very useful and constructive. I have been in radio service work for six years. For the last three years I have run the Service Department of the Miami Beach Radio Co. Referring to "Repair or Reconditioning" on page 18 which I have been doing for the past two years when parts were available. And found it to be the best system to work by. Over a period of time one will find that he cannot find a better system.

Very truly yours,
LOTHAR DIETEL,
11530 Griffen Boulevard,
Biscayne Park,
Miami, Florida.

Gentlemen:

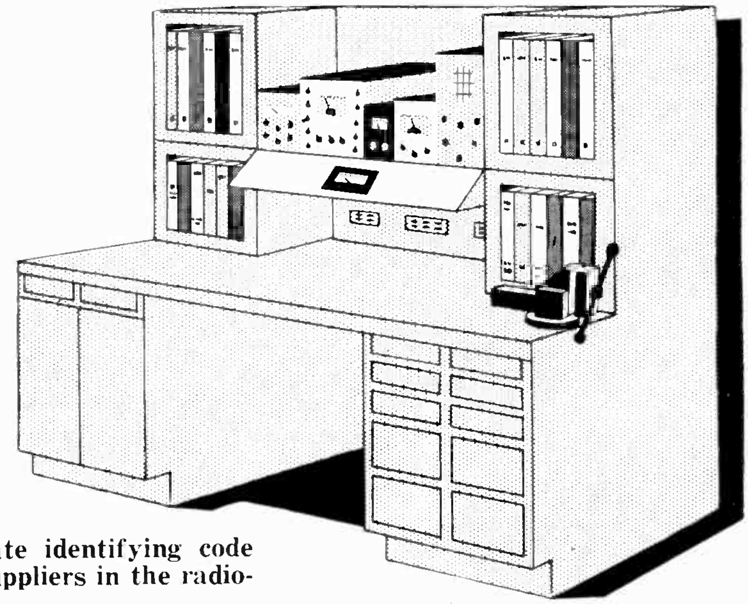
Under Radiomen's Opinions, the letter from Mr. James A. Robinson warms my heart. I, too, have experienced a loss of religion with the messes made by radio engineers. Often the strings get off the pulleys and a puzzle of hours ensues to guess them back on again. One set made by a prominent manufacturer a few years back was a phono-radio combination of TRF vintage. This heavy box had been the rounds of many service shops only to be turned down. After a year of wandering, it finally came back to me with a no ceiling cost proposition. All this set needed was two electrolytics. It took me four days to build up scantling around this box before I could get into the filter.

The condensers I replaced in five minutes and then spent two days getting it all back together again. This firm is out of business and no wonder. Some battery sets call for a major operation to replace a single tube. So many times the identification marks become rubbed off and nothing but a tube complement book will help one to guess the model. Then, again, a radio set is for the purpose only of bringing in the signal, but some manufacturers delight in doing the same thing a hundred different ways.

One more gripe: A small shop like ours cannot afford to stock so many different types of tubes, and we are miles and miles from a supply house. Why not hang some of the tube manufacturers along with the engineers?

Sincerely yours,
W. Harvey Merwin,
MERWIN COMPANY
Jensen, Florida

The Radio Service Bench



The new RMA production source and date identifying code numbers assigned to manufacturers and suppliers in the radio-electronic industry.

By Alfred A. Ghirardi

IDENTIFICATION OF THE SOURCE of production of many receiver parts, especially those in "Brand" name receivers, etc., has long been a headache to the Serviceman. Now a new RMA standard code that every serviceman should become familiar with has been designed to identify the *source* and *date* of production of all radio-electronic apparatus. This code consists of two parts, the *production source* code number and the *production date* code.

Assignment of an identifying three-digit production source code number has been made to every RMA manufacturer member and to a considerable number of their parts suppliers—352 in all, to date. A numerical list of these assigned production source code numbers, together with the name and address of the manufacturer to which each registration number has been assigned, is presented herewith for reference.

The three digits of the production source code number will be followed by a figure to designate the *year* of production; for example, fourth figure *6* designates production in 1946, fourth figure *7* designates production in 1947, etc.

These will be followed by a date code consisting of another two digits to designate the particular *week* of production in that year. A tabulation of the date code numbers that have been assigned to the various weeks in the years 1946 and 1947 is presented herewith. Reference to this tabulation shows that for 1946 the date code *21* would signify production in the period between May 19 and May 25, etc.

The following examples illustrate use of the complete source, year, and date code marking:

Code Marking:	Production Source and Date:
101615	Made by Admiral Corporation, Chicago 47, Ill. Produced during period between April 7 and April 13, 1946.
274608	Made by RCA Victor Division of RCA, Camden, N. J. Produced during period between Feb. 17 and Feb. 23, 1946.

Reference to the accompanying tabulations will verify these interpretations of the two code markings.

By the use of these simple, uniform, production source and date and code symbols, a radio manufacturer may identify any radio equipment or component by simply stamping the proper series of numbers. The new RMA code is designed to standardize identification practice by eliminating the use of individual systems of identification previously used by various manufacturers in the industry—and to establish a uniform, identical system applicable to all items of any registered manufacturer's products. All non-RMA manufacturers are expected to be included eventually.

No recommendations have been made to the manufacturers as to where the code symbol should be placed on the article, as this would necessarily vary with the different types of equipment and parts.

Servicemen should keep this production *source* and *date* code tabulation on hand at all times, for many manufacturers are already using the system. It will make a handy "pin-up" for the shop.

RMA Production Source Code Numbers Assigned to Companies
(To April 1, 1946)

Production Source Code No.	Company
101	Admiral Corporation, Chicago 47, Ill.
102	Aerovox Corporation, New Bedford, Mass.
103	Airadio, Incorporated, Stamford, Conn.
104	Aireon Manufacturing Corporation, Kansas City 15, Kan.
105	Air King Products Company, Inc., Brooklyn 19, N. Y.
106	Allen-Bradley Company, Milwaukee 4, Wis.
107	The Alliance Manufacturing Company, Alliance, Ohio.
108	American Coil & Engineering Co., Chicago 22, Ill.
109	American Condenser Company, Chicago 40, Ill.
110	The American Steel Package Company, Defiance, Ohio
111	Amperex Electronic Corporation, Brooklyn 1, N. Y.
112	Amy, Aceves & King, Inc., New York 18, N. Y.
113	Andrea Radio Corporation, Long Island City 1, N. Y.
114	Ansley Radio Corporation, Long Island City 1, N. Y.
115	A. R. F. Products, River Forest, Ill.
116	The Arnold Engineering Company, Chicago 11, Ill.
117	Arpin Manufacturing Co., Orange, N. J.
118	The Audio-Tone Oscillator Company, Bridgeport 3, Conn.
119	Automatic Manufacturing Corporation, East Newark, N. J.
120	Automatic Radio Mfg. Co., Inc., Boston 15, Mass.
121	Bank's Manufacturing Company, Chicago 40, Ill.
122	The Bead Chain Manufacturing Co., Bridgeport 5, Conn.
123	Bell & Howell Company, Chicago 45, Ill.
124	Belmont Radio Corporation, Chicago 39, Ill.
125	Bendix Radio, Towson 4, Md.
126	Bentley Harris Mfg. Company, Conshohocken, Pa.
127	The Benwood Linz Company, St. Louis 3, Mo.
128	Bliley Electric Company, Erie, Pa.
129	Boonton Radio Corporation, Boonton, N. J.
130	William Brand & Company, New York 10, N. Y.
131	Browning Laboratories, Inc., Winchester, Mass.
132	Call-A-Phone Mfg. Co., Chicago 23, Ill.
133	C. F. Cannon Co., Springwater, N. Y.
134	Centralab, Milwaukee 1, Wis.
135	Chicago Condenser Corporation, Chicago 40, Ill.
136	Chicago Molded Products Corporation, Chicago 51, Ill.

RMA Production Source and Date Code

Code No.	Company
137	Chicago Telephone Supply Co., Elkhart, Ind.
138	Chicago Transformer Division, Chicago 18, Ill.
139	Cinch Manufacturing Corporation, Chicago 12, Ill.
140	Clarostat Mfg. Co., Inc., Brooklyn 2, N. Y.
141	Coil Engineering & Mfg. Co., Inc., Roanoke, Ind.
142	Colonial Radio Corporation, Buffalo 7, N. Y.
143	Communication Equip. & Engineering Co., Chicago 44, Ill.
144	C. G. Conn, Ltd., Elkhart, Ind.
145	Consolidated Radio Products Co., Chicago, Ill.
146	Continental Carbon, Inc., Cleveland 11, Ohio.
147	Continental Electric Company, Geneva, Ill.
148	Corning Glass Works, Corning, N. Y.
149	Cornish Wire Company, Inc., New York 7, N. Y.
150	Crescent Industries, Inc., Chicago 41, Ill.
151	Croname, Incorporated, Chicago 13, Ill.
152	The Crosley Corporation, Cincinnati 25, Ohio
153	Crystal Research Laboratories, Inc., Hartford 3, Conn.
154	Tobe Deutschmann Corporation, Canton, Mass.
155	DeWald Radio Mfg. Corp., New York 3, N. Y.
156	Wilbur B. Driver Company, Newark 4, N. J.
157	Dumont Electric Co., New York 13, N. Y.
158	Allen B. Du Mont Laboratories, Inc., Passaic, N. J.
159	DX Crystal Company, Chicago 22, Ill.
160	Hugh H. Eby, Inc., Philadelphia 44, Pa.
161	Eckstein Radio & Television Co., Minneapolis 2, Minn.
162	Eitel-McCullough, Inc., San Bruno, Calif.
163	Electrical Reactance Corporation, Franklinville, N. Y.
164	The Electro Motive Mfg. Co., Willimantic, Conn.
165	Electronic Corp. of America, New York 11, N. Y.
166	Electronic Engineering Company, Chicago 47, Ill.
167	Electronic Laboratories, Incorporated, Indianapolis 4, Ind.
168	Vokar Corporation, Dexter, Mich.
169	Electronic Specialty Co., Los Angeles 26, Calif.
170	Electronic Tube Corporation, Philadelphia 18, Pa.
171	Emerson Radio & Phonograph Corp., New York 11, N. Y.
172	Ensign Coil Company, Chicago 23, Ill.
173	Erie Resistor Corporation, Erie, Pa.
174	Espey Manufacturing Co., Inc., New York 19, N. Y.
175	Essex Wire Corporation, Fort Wayne 6, Ind.
176	Fada Radio & Electric Co., Inc., Long Island City, N. Y.
177	Farnsworth Television & Radio Corp., Fort Wayne 1, Ind.
178	John E. Fast & Company, Chicago 41, Ill.
179	Federal Telephone and Radio Corporation, Newark 2, N. J.
180	Felt Products Mfg. Co., Chicago 7, Ill.
181	Finch Telecommunications, Inc., Passaic, N. J.
182	A. W. Franklin Mfg. Corp., New York 14, N. Y.
183	Freed Radio Corporation, New York 13, N. Y.
184	Billings S. Fuess, South Orange, N. J.
185	Galvin Manufacturing Corporation, Chicago 51, Ill.
186	Garod Radio Corporation, Brooklyn 1, N. Y.
187	Gates Radio Company, Quincy, Ill.
188	General Electric Company, Schenectady 5, N. Y.
189	General Electronics Inc., Paterson 3, N. J.
190	The General Industries Company, Elyria, Ohio
191	General Instrument Corporation, Elizabeth 3, N. J.
192	General Laminated Products, Inc., Chicago 8, Ill.
193	General Magnetic Corporation, Detroit 7, Mich.
194	General Radio Company, Cambridge 39, Mass.
195	General Television & Radio Corporation, Chicago 51, Ill.
196	Gits Molding Corporation, Chicago 44, Ill.
197	Goat Metal Stampings, Inc., Brooklyn 7, N. Y.
198	Edwin I. Guthman & Co., Chicago 7, Ill.
199	The Hallicrafters Co., Chicago 16, Ill.
200	Hamilton Radio Corporation, New York 11, N. Y.
201	Hammarlund Mfg. Co., Inc., New York 1, N. Y.
202	Harvey Radio Laboratories, Inc., Cambridge 38, Mass.
203	Harvey-Wells Electronics, Inc., Southbridge, Mass.
204	Hawley Products Company, St. Charles, Ill.
205	Haydu Brothers, Plainfield, N. J.
206	Hewlett-Packard Company, Palo Alto, Calif.
207	Hoffman Radio Corporation, Los Angeles 7, Calif.
208	Howard Radio Company, Chicago 13, Ill.
209	Hudson American Corporation, New York 18, N. Y.
210	Hytron Radio & Electronics Corp., Salem, Mass.
211	The Indiana Steel Products Company, Chicago 2, Ill.
212	Industrial and Commercial Electronics, Belmont, Calif.
213	International Detrola Corporation, Detroit 9, Mich.
214	International Resistance Company, Philadelphia 8, Pa.
215	Irvington Varnish & Insulator Co., Irvington 11, N. J.
216	The Jackson Electrical Instrument Co., Dayton 1, Ohio
217	Jackson Industries, Chicago 47, Ill.
218	Jefferson Electric Company, Bellwood, Ill.
219	Jefferson-Travis Corporation, New York 10, N. Y.
220	Jensen Radio Manufacturing Company, Chicago 38, Ill.
221	J. F. D. Manufacturing Company, Brooklyn 19, N. Y.
222	E. F. Johnson Company, Waseca, Minn.
223	Kerrigan Lewis Manufacturing Co., Chicago 51, Ill.
224	Kester Solder Company, Chicago 39, Ill.
225	Kuthe Laboratories, Inc., Newark 4, N. J.
227	Lear, Incorporated, Piqua, Ohio
228	Lenz Electric Manufacturing Co., Chicago 47, Ill.
229	Libbey Glass, Toledo 1, Ohio
230	Littelfuse, Incorporated, Chicago 40, Ill.
231	Machlett Laboratories, Incorporated, Norwalk, Conn.
232	The Magnavox Company, Fort Wayne 4, Ind.
233	Maguire Industries Incorporated, Greenwich, Conn.
234	Majestic Radio & Television Corporation, Chicago 32, Ill.
235	P. R. Mallory & Co., Inc., Indianapolis 6, Ind.
236	Measurements Corporation, Boonton, N. J.
237	John Meck Industries, Inc., Plymouth, Ind.
238	Meissner Manufacturing Division, Maguire Industries, Inc., Mt. Carmel, Ill.
239	Merit Coil and Transformer Corporation, Chicago 40, Ill.
240	Micamold Radio Corporation, Brooklyn 6, N. Y.
241	Micro Switch Division, Freeport, Ill.
242	James Millen Manufacturing Co., Inc., Malden 48, Mass.
243	Minerva Corporation of America, New York 7, N. Y.
244	The Muter Company, Chicago 5, Ill.
245	National Company, Inc., Malden 48, Mass.
246	National Fabricated Products, Chicago 47, Ill.
247	National Union Radio Corporation, Newark 2, N. J.
248	Noblitt-Sparks Industries, Inc., Columbus, Ind.
249	Oak Mfg. Co., Chicago 10, Ill.
250	The Ohio Carbon Co., Cleveland 11, Ohio
251	Ohmite Manufacturing Company, Chicago 44, Ill.
252	Operadio Manufacturing Company, St. Charles, Ill.
253	Oxford-Tartak Radio Corporation, Chicago 15, Ill.
254	Packard-Bell Company, Los Angeles 15, Calif.
255	Packard Manufacturing Corp., Indianapolis 7, Ind.
256	Panelyte Division, St. Regis Paper Co., New York 17, N. Y.
257	Parisian Novelty Company, Chicago 9, Ill.
258	Permoflux Corporation, Chicago 39, Ill.
259	Permo, Incorporated, Chicago 26, Ill.
260	Philco Corporation, Philadelphia 34, Pa.
261	Philharmonic Radio Corporation, New York 21, N. Y.
262	Philmore Manufacturing Co., New York 3, N. Y.
263	Phonovision Corporation, Chicago 22, Ill.
264	Pilot Radio Corporation, Long Island City 1, N. Y.
265	Poray, Inc., Chicago 51, Ill.
266	Precision Specialties, Los Angeles 4, Calif.
267	Premax Products Division, Chisholm-Ryder Co., Inc., Niagara Falls, N. Y.
268	Press Wireless, Inc., New York 18, N. Y.
269	Quality Hardware and Machine Corp., Chicago 26, Ill.
270	Quam-Nichols Company, Chicago 16, Ill.
271	Radell Corporation, Indianapolis 5, Ind.
272	Radex Corporation, Chicago 22, Ill.
273	Radio Condenser Company, Camden, N. J.
274	RCA Victor Division of RCA, Camden, N. J.
275	The Radio Craftsmen, Chicago 5, Ill.
276	Radio Engineering Laboratories, Inc., Long Island City 1, N. Y.
277	Radio Speakers, Inc., Chicago 16, Ill.
278	Radio and Television, Inc., New York, N. Y.
279	The Radiotechnic Laboratory, Evanston, Ill.
280	Raytheon Manufacturing Company, Newton 58, Mass.
281	Rea Magnet Wire Company, Fort Wayne 4, Ind.
282	Rek-O-Kut Company, New York 13, N. Y.
283	Remington Rand, Inc., Middletown, Conn.
284	Remler Company, Ltd., San Francisco 10, Calif.
285	The Rola Company, Division, The Muter Company, Cleveland 14, Ohio
286	The Ross Manufacturing Company, Chicago 16, Ill.
287	Walter L. Schott Company, Beverly Hills, Calif.
288	Screenmakers, New York 7, N. Y.
289	J. P. Seeburg Corporation, Chicago 22, Ill.
290	Selenium Corporation of America, Los Angeles 15, Calif.
291	Sentinel Radio Corporation, Evanston, Ill.
292	Sheridan Electronics Corp., Chicago 16, Ill.
293	Sherron Electronics Company, Brooklyn 6, N. Y.
294	The F. W. Sickles Company, Chicopee, Mass.
295	Mark Simpson Manufacturing Company, New York 14, N. Y.
296	Solar Manufacturing Corporation, New York 17, N. Y.
297	Sonora Radio & Television Corporation, Chicago 12, Ill.
298	Sound, Inc., Chicago 16, Ill.
299	The Sparks-Withington Company, Jackson, Mich.
300	Speer Resistor Corporation, Saint Marys, Pa.
301	Sperry Gyroscope Co., Great Neck, Long Island, N. Y.
302	Sperti, Inc., Norwood 12, Cincinnati, Ohio
303	Sprague Electric Company, North Adams, Mass.
304	Stackpole Carbon Company, St. Marys 3, Pa.
305	Standard Coil Products Company, Inc., Chicago 39, Ill.
306	Standard Transformer Corporation, Chicago 22, Ill.
307	Stewart-Warner Corporation, Chicago 14, Ill.
308	Stupakoff Ceramic & Manufacturing Co., Latrobe, Pa.
310	Superior Tube Company, Norristown, Pa.
311	Supreme Instruments Corporation, Greenwood, Miss.
312	Sylvania Electric Products Inc., Emporium, Pa.
313	Synthane Corporation, Oaks, Pa.
314	Syracuse Ornamental Company, Syracuse 2, N. Y.
315	Technical Radio Company, San Francisco 3, Calif.
316	Telicon Corporation, New York 21, N. Y.
317	Templetone Radio Mfg. Corp., New London, Conn.
318	Thomas & Skinner Steel Products Co., Indianapolis 5, Ind.
319	Thordarson Electric Mfg. Division, Maguire Industries, Inc., Chicago 10, Ill.
320	Trav-Ler Karenola Radio and Television Corp., Chicago 6, Ill.
321	Triplett Electrical Instrument Co., Bluffton, Ohio
322	Tung-Sol Lamp Works, Inc., Newark 4, N. J.
323	United Electronics Company, Newark 2, N. J.
324	United States Radium Corporation, New York, N. Y.
325	U. S. Television Manufacturing Corp., New York 11, N. Y.
326	Universal Microphone Company, Inglewood, Calif.
327	Universal Television System, Kansas City 8, Mo.
328	Utah Radio Products Company, Chicago 10, Ill.
329	Viewtone Company, New York, N. Y.
330	Wm. T. Wallace Mfg. Co., Peru, Ind.
331	The Ward Products Corporation, Cleveland 3, Ohio
332	Warwick Manufacturing Corporation, Chicago 44, Ill.
333	Watterson Radio Mfg. Company, Dallas 1, Texas.
334	Wells-Gardner & Co., Chicago 39, Ill.
335	Wm. H. Welsh Co., Chicago 16, Ill.
336	Western Electric Company, Inc., New York 5, N. Y.
337	Westinghouse Electric Corporation, Baltimore 3, Md.
338	Weston Electrical Instrument Corp., Newark 5, N. J.
339	Wilcox Electric Company, Inc., Kansas City 1, Mo.
340	Wilcox-Gay Corporation, Charlotte, Mich.
341	Winters & Crampton Corporation, Grandville, Mich.
342	The Zell Company, New York 12, N. Y.
343	Zenith Radio Corporation, Chicago 39, Ill.
344	Argus, Incorporated, Ann Arbor, Mich.

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Fundamentals Of Television

→ From Page 7

while others use electrostatic deflection for the smaller ones and magnetic deflection for the larger sizes. The important differences in the sweep circuits is that one requires a saw-tooth *potential* across the plates, and the other a saw-tooth *current* through the coils.

Blankouts and Synchronizing Impulses

It is apparent that the scanning lines produced during the vertical and horizontal retrace times contribute no useful information to the picture, and indeed would produce spurious signals. They are therefore obliterated by cutting off the electron beam during these times. This is accomplished by transmitting negative pulses, or blankouts, at the end of each line and field; these blankouts being used to drive the grid of the receiving cathode ray tube to cutoff during all retrace periods of the receiver's horizontal and vertical deflection circuits.

We have seen that during the scanning time of each line a voltage is obtained from the camera tube proportional at each instant to the intensity of light on successive points of the mosaic. In addition, the blankout voltage is inserted at the end of each line and at the end of each field. The resultant signal is shown in Fig. 9 which represents approximately two successive scanning lines or 2/15,750 of a second. In order to keep the receiver scanning circuits exactly synchronized with those of the transmitter, a synchronizing impulse is transmitted during the blankout time and appears as voltage added to the blankout or "pedestal" voltage. Since the blankout must drive the grid of the receiver cathode ray tube (or kinescope) to cut-off, it represents the black level. The synchronizing pulses, being more negative than the blankout, will produce no visible effect on the kinescope, and the synchronizing voltage is used to control the deflection circuits of the receiver. To summarize, therefore, the complete video signal which amplitude modulates the transmitter contains three basic components:

(1) Picture information
(2) Blankouts
(3) Synchronizing pulses.

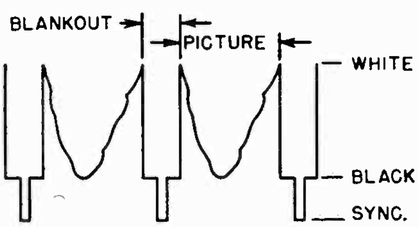


Fig. 9. **Waveform of basic video signal.**

Video and Audio Signals

The sound accompanying the picture is transmitted on an individual frequency-modulated carrier by a separate transmitter whose frequency is quite close to that of the video transmitter. The two basic signals, audio and video, are shown in Fig. 10 (a) and (d) respectively. An amplitude-modulated sound carrier is shown at (b) for comparison with the actual frequency-modulated sound carrier at (c). The amplitude-modulated video signal appears at (e), and finally the complete television signal at (f) comprising FM sound carrier and separate AM television carrier.

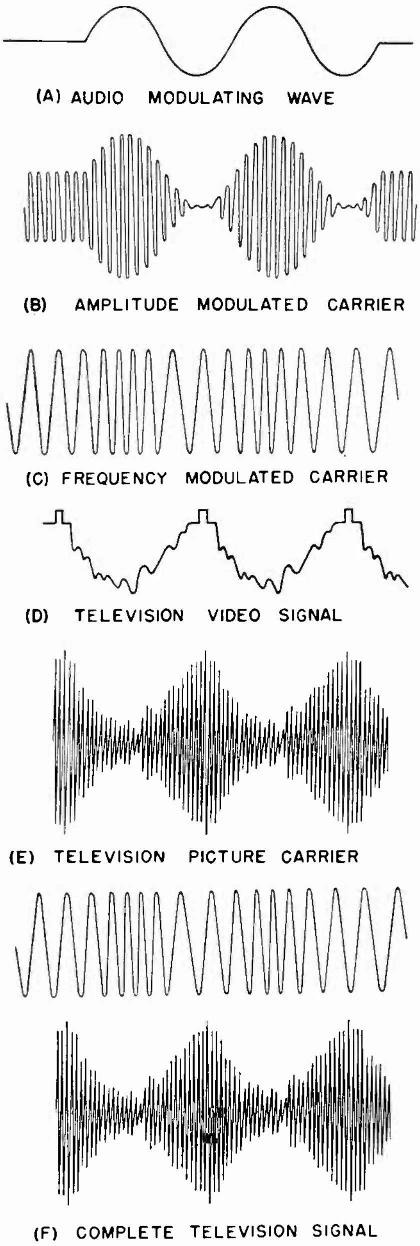


Fig. 10. **Sound- and picture-modulated carrier signals.**

Comparison of video and audio signals reveals important information. Since the standard television picture has an aspect ratio (the ratio of width to height) of 4 to 3, we may say that there are 4/3x525 picture points per line in a 525 line picture (assuming a picture point to be square). In the most detailed picture, the points would be alternately black and white, and two successive points would produce a negative and a positive voltage excursion respectively. Thus each two picture points would represent one cycle of a periodic voltage. There would then be 1/2x4/3x525 complete cycles per line. Since one line occurs in 1/15,750 of a second, a little arithmetic will show that there would be approximately 5.5 million cycles per second in the most detailed picture. In other words, the video amplifiers would theoretically have to handle frequencies up to this value. For practical purposes, however, 4 mc is considered sufficient, but even this band width is many times greater than the 5 kc required for standard broadcast work and the 15 kc encountered in exceptionally high fidelity audio equipment. Since for proper modulation of a transmitter, the highest modulating frequency must be much less than the carrier frequency, television signals are transmitted on carriers above 40 mc.

With this background of fundamentals, the serviceman who is entering television for the first time should have a good understanding of the principles of picture transmission by radio. Regardless of the degree of familiarity the reader may have attained with the practical aspects of television servicing, it is an undeniable fact that a thorough knowledge of principles is an aid to the more down-to-earth, practical side of any art. It is with this thought in mind that this material is presented ✓ ✓

RMA Production Source and Date Code

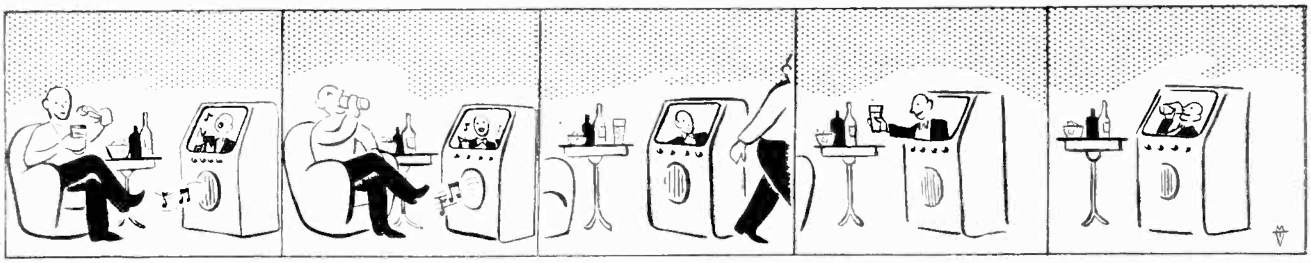
→ From Page 37

Code No.	Company
315	The Astatic Corporation, Conneaut, Ohio
316	Madison Electrical Products Corp., Madison, N. J.
317	Teletone Radio Company, New York 19, N. Y.
318	Rayenergy Radio & Television Corp. of America, New York, N. Y.
349	Franklin Photographic Industries, Chicago 10, Ill.
350	American Transformer Company, Newark 5, N. J.
351	Symphonic Radio and Electronic Corp., Cambridge 42, Mass.
352	Magnetic Windings Company, Easton, Pa.
353	Gralnick Bros. Inc., Philadelphia 22, Pa.
354	Lewis Electronics, Los Gatos, Calif.
355	Boonton Molding Company, Boonton, N. J.
356	R. Prescott & Son, Inc., Keeseville, N. Y.
357	Teleradio Engineering Corporation, Wilkes Barre, Pa.
358	Cinaudagraph Corporation, Stamford, Conn.
359	Webster Electric Company, Racine, Wis.
360	Gavitt Mfg. Co., Inc., Brookfield, Mass.
361	Hartford Industries, Inc., Jackson Heights, N. Y. C., N. Y.
362	National Vulcanized Fibre Co., Wilmington, Del.
363	Eastern Electronics Corporation, New Haven, Conn.
364	The Sillcocks-Miller Company, South Orange, N. J.
365	Industrial Synthetics Corporation, Irvington, N. J.
366	New York Transformer Company, New York 3, N. Y.
367	National Moldite Company, Hillside 5, N. J.
368	Santay Corporation, Chicago 24, Illinois
369	Stoddart Aircraft Radio Co., Hollywood 38, Calif.
370	United-Carr Fastener Corporation, Cambridge 42, Mass.
371	Best Manufacturing Co., Inc., Irvington 11, N. J.
372	Holyoke Wire and Cable Corporation, Holyoke, Mass.
373	Regal Electronics Corporation, New York 11, N. Y.
374	Harry A. Prock Cabinet Company, Glenside, Pa.
375	Webster-Chicago Corporation, Chicago 47, Ill.
376	Hazeltine Electronics Corporation, New York 19, N. Y.
377	DeMornay-Budd, Incorporated, New York 51, N. Y.
378	Bachmann Bros. Inc., Philadelphia 24, Pa.
379	United States Trunk Co., Inc., Fall River, Mass.
380	Radio Receptor Company, Inc., New York 11, N. Y.
381	The Ucinite Company, Newtonville, Mass.
382	Waters Conley Company, Rochester, Minn.
383	Wilmak Corporation, Benton Harbor, Mich.
384	Red Lion Cabinet Company, Red Lion, Pa.
385	Dearborn Glass Company, Chicago 8, Ill.
386	Arpee Products Co., Glendale, Calif.
387	Kyle Corporation, South Milwaukee, Wis.
388	Modern Electronic Company, Inc., New York 11, N. Y.
389	National Design Service, New York 6, N. Y.
390	Printloid, Inc., New York 12, N. Y.
391	Peerless Electrical Products Co., Los Angeles 3, Calif.
392	The Wheeler Insulated Wire Company, Inc., Bridgeport 4, Conn.
393	Western Gasket & Packing Company, Los Angeles 11, Calif.
394	The A. P. Foster Company, Lockland 15, Ohio
395	Permoflux Products Co., Glendale 5, Calif.
396	General Cement Mfg. Co., Rockford, Ill.
397	The Workshop Associates, Newton Highlands 61, Mass.
398	Stamford Electric Products Company, Inc., Stamford, Conn.
399	Industrial Electronic Corporation, Brooklyn 31, N. Y.
400	Noma Electric Corporation, New York 11, N. Y.
401	Wellman Manufacturing Company, Los Angeles 46, Calif.
402	Andrew Co., Chicago 19, Ill.
403	Super Electric Products Corp., Jersey City 7, N. J.
404	Lincoln Electronics Corporation, New York 19, N. Y.
405	Ohio Tool Company, Cleveland 11, Ohio
406	Wirt Company, Philadelphia 44, Pa.
407	Radio Navigational Instrument Corp., New York 21, N. Y.
408	Mercury Equipment Co., Ashtabula, Ohio
409	British Industries Sales Corp., New York 13, N. Y.
410	Midwest Electric Products, Inc., Indianapolis 8, Ind.
411	Hardwick, Hindle, Inc., Newark 5, N. J.
412	General Transformer Corporation, Chicago 7, Ill.
413	The Acme Electric & Manufacturing Co., Cuba, N. Y.
414	Radiation Products, Inc., Los Angeles 15, Calif.
415	United Mfg. & Service Co., Milwaukee 2, Wis.
416	Lewyt Corporation, Brooklyn 11, N. Y.
417	Tone Products Corp. of America, New York 10, N. Y.
418	United Transformer Corporation, New York, N. Y.
419	Radio Development & Research Corp., Jersey City, N. J.
420	Schrader Electronic & Coil Corp., Los Angeles 11, Calif.
421	Lee Radio Manufacturing Corporation, New Hyde Park, N. Y.
422	Crimp-Seal Products Co., Chicago 10, Ill.
423	North American Philips Company, Inc., Dobbs Ferry, N. Y.
424	Milwaukee Stamping Company, Milwaukee 14, Wis.
425	Essex Electronics, Newark 2, N. J.
426	E. W. McGrade Manufacturing Co., Kansas City 2, Mo.
427	Communication Measurements Laboratory, New York 6, N. Y.
428	Schulmerich Electronics, Inc., Sellersville, Pa.
429	Bernard Rice's Sons, Inc., New York 16, N. Y.
430	Camburn, Inc., New York 13, N. Y.
431	Watterman Products Company, Inc., Philadelphia 25, Pa.
432	Premier Crystal Laboratories, Inc., New York 7, N. Y.
433	Cleveland Electronics Inc., Cleveland 15, Ohio
434	Electrical Reproduction Co., Chicago 22, Ill.
435	Plastoid Corporation, New York 18, N. Y.
436	Adaptol Company, Brooklyn 13, N. Y.
437	Newcomb Audio Products Company, Los Angeles 7, Calif.
438	The Gudeman Company, Chicago 10, Ill.
439	Collins Radio Company, Cedar Rapids, Iowa
440	Cannon Electric Development Company, Los Angeles 31, Calif.
441	Gilner Manufacturing Company, Steger, Ill.
442	J. B. T. Instruments, Inc., New Haven 8, Conn.
443	Quakertown Luggage Company, Philadelphia 47, Pa.
444	A. F. Smuckler & Co., New York 6, N. Y.
445	Adler Manufacturing Co., Louisville 11, Ky.
446	Good-All Electric Manufacturing Co., Ogallala, Nebr.
447	Radionic Controls, Chicago 18, Ill.
448	Radiomarine Corporation of America, New York 13, N. Y.
449	Wilder Manufacturing Corp, Chicago 47, Ill.
450	Columbus Process Company, Inc., Columbus (E), Indiana
451	Vertrod Corporation, New York 17, N. Y.
452	Empire Coil Company, New Rochelle, N. Y.
453	Russell Electric Company, Chicago 10, Illinois

RMA Production Date Code - Year 1946

(Code Number for Each Week in Period of January 1, 1946, to December 31, 1946)

Production Date Code	Manufactured During Period From:						
01	December	30	to	January	5	incl.	
02	January	5	to	January	11	"	
03	January	12	to	January	18	"	
04	January	19	to	January	25	"	
05	January	26	to	February	1	"	
06	February	2	to	February	8	"	
07	February	9	to	February	15	"	
08	February	16	to	February	22	"	
09	February	23	to	March	1	"	
10	March	2	to	March	8	"	
11	March	9	to	March	15	"	
12	March	16	to	March	22	"	
13	March	23	to	March	29	"	
14	March	30	to	April	5	"	
15	April	6	to	April	12	"	
16	April	13	to	April	19	"	
17	April	20	to	April	26	"	
18	April	27	to	May	3	"	
19	May	4	to	May	10	"	
20	May	11	to	May	17	"	
21	May	18	to	May	24	"	
22	May	25	to	May	31	"	
23	June	1	to	June	7	"	
24	June	8	to	June	14	"	
25	June	15	to	June	21	"	
26	June	22	to	June	28	"	
27	June	29	to	July	5	"	
28	July	6	to	July	12	"	
29	July	13	to	July	19	"	
30	July	20	to	July	26	"	
31	July	27	to	August	2	"	
32	August	3	to	August	9	"	
33	August	10	to	August	16	"	
34	August	17	to	August	23	"	
35	August	24	to	August	30	"	
36	August	31	to	September	6	"	
37	September	7	to	September	13	"	
38	September	14	to	September	20	"	
39	September	21	to	September	27	"	
40	September	28	to	October	4	"	
41	October	5	to	October	11	"	
42	October	12	to	October	18	"	
43	October	19	to	October	25	"	
44	October	26	to	November	1	"	
45	November	2	to	November	8	"	
46	November	9	to	November	15	"	
47	November	16	to	November	22	"	
48	November	23	to	November	29	"	
49	November	30	to	December	6	"	
50	December	7	to	December	13	"	
51	December	14	to	December	20	"	
52	December	21	to	December	27	"	
01	December	28	to	January	3	"	1947



Vector Analysis For the Radio Serviceman

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of the sciences," comes to do our bidding the moment we draw a right-triangle.

(5) The triangle suggests a useful, different way of expressing Z (by the use of "complex numbers").

While the triangle gives a clear picture of relations that may be so represented, it is not considered to be a full-fledged Vector Diagram. The right-triangle has been known since very ancient times but the Vector is a modern invention. Vector notation is based upon the methods of Analytic Geometry developed by the French mathematician Descartes, (pronounced day-cart') early in the seventeenth century.

Common observation tells us that forces are not always directed at right angles. When we get pushed around in a crowd, the pressure may be uncomfortable fore and aft or anywhere.

And though it beehooves a man to walk the "straight and narrow", he is not constrained to walk in paths that lie always at right angles. In an open field he is free, physically, to walk in any direction. For him a complete road map would require lines drawn to any point on the compass, without restriction.

There are many measurements in which we are concerned with *magnitude* only. Examples are *weight*, *cost*, *length*, etc. Such quantities can be represented by means of the familiar graph, so useful to statisticians and analysts.

Some important quantities can not be expressed by size alone but include other characteristics such as *direction*. A common example is *force*.

Any quantity that requires both magnitude and direction to define it is called a vector quantity. A *Vector* is a line that represents such a quantity. The *length* of the line represents magnitude; the *angle* (measured from a reference line) indicates the direction.

Vectors are usually drawn from a central point called the *Origin*. The end of the vector is tipped with an arrowhead so that there can be no doubt as to its direction. Angles are measured from a base line drawn horizontally to the right. Angular measurement is taken in a *counter-clockwise* direction. When the angle is measured in a clockwise direction it is called a negative angle.

These conventions are summarized in Fig. 9, where A is a vector representing a magnitude of 3 units directed at an angle of 45 degrees from the reference line; B represents a magnitude of 2 units directed at an angle of 135 degrees; and C represents a magnitude of 1 unit, at an angle which may be read as 315 degrees or *minus* 45 degrees.

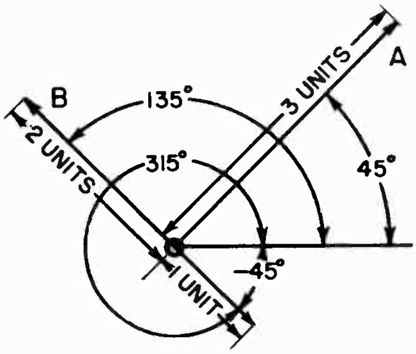

Figure 9

The convention used to denote the magnitude and direction of vectors A, B, and C as described above is 3/45°, 2/135°, and 1/315°. It will be noted that the magnitude is indicated first, followed by the slant line and then the angle in degrees.

In the foregoing figure we have the basic material, the fundamental facts, of *Vector representation.* So far it is pure mathematics, available to anybody and applicable to any appropriate line of investigation. However, Vector Analysis has become the special property of the Electrical Engineer. Experience has taught him that Vector Diagrams are exceedingly valuable in the study of alternating current circuits.

There are three reasons for this:

(1) Alternating currents and voltages are fundamentally sine waves.

(2) Sine waves drawn on paper are awkward to handle when addition and subtraction are required.

(3) A vector may replace a sine wave for many operations. Manipulation of vectors is simple and easy.

"Sine wave" is a mathematical name for the wave form of natural vibratory motion, or as it is called, simple harmonic motion. When drawn on paper the wave is seen to rise and fall in a particular pattern, as in Fig. 10. A swinging pendulum, properly arranged to track on a strip of paper moving horizontally, will trace a sine wave. There are many other examples of Nature's fondness for motion in the sine wave pattern.

The A-C voltage supplied by the electric company can be represented by means of the same curve. For technical reasons the designers try hard to make their generators produce a pure sine wave. The oscilloscope shows that the waveform is usually very good indeed.

Although the output of a simple elementary A-C generator is roughly a sine wave, the production of a pure waveform is not a simple matter. It is interesting to inquire why the sine curve has been chosen as standard, since ingenious designers could have altered the pattern if necessary, even fifty years ago. Today we have square waves, rectangles, triangles, and

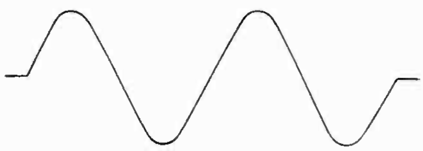

Figure 10

trapezoids. All these have their own fields of usefulness but the sine wave remains the basic pattern. Why?

Because the sine wave greatly simplifies the analysis of alternating current circuits. *A sine wave voltage impressed upon a network of resistance, inductances, and capacitances of fixed value will set up a sine wave current in every branch of the network.*

The sine wave in this respect is unique. In no other wave shape (except direct current) will the impressed e.m.f. set up a current that has the same wave shape as the voltage.

The great superiority of the sine wave is assured, both physically and mathematically, by three important properties:

(a) A sine wave voltage gives a sine wave current through a resistance, inductance, or capacitance.

(b) When a voltage is induced by a sine-wave current, this voltage is a sine wave.

(c) Sine waves of the same frequency can be added or subtracted and the result will be a sine wave.

The reader may recall at this point that sound wave patterns, as he has seen them on the oscilloscope, are far from being sine waves. How then can we utilize the foregoing properties in studying the behavior of communication circuits?

Briefly, the answer is two-fold:

(1) We analyze the circuit on a sinewave basis, accepting the results as accurate enough for our purpose.

(2) By both mathematical and

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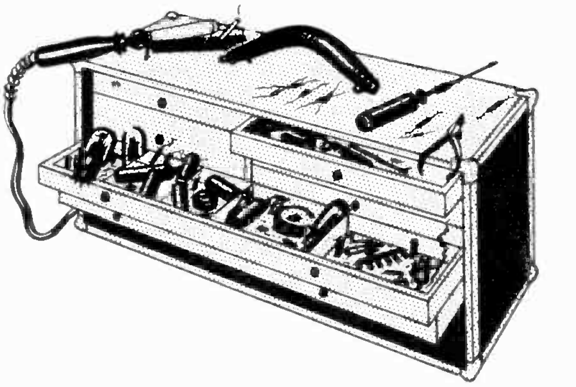
Service Kit



Little items that increase profit and create good will.

AT THE RISK of discussing too often a list of the things a serviceman should carry with him when he goes out on a call, either to repair a set in the customer's home or to return a shop-repaired job, we feel that the subject should be brought up again. Many servicemen overlook the possibilities of money-making sales at such times—extra items which bring in only a few pennies of profit each perhaps, but which will help swell the income appreciably when added together at the end of the month.

Cabinets

One of the first of these items is the Scratch Remover. Most of us are familiar with these handy little devices, having had to resort to their use when a screwdriver slips while removing a knob, for instance. Carry one of these with you when you return a set, and take the scratches off the cabinet. Many times the customer, especially the ladies, will marvel at the speed and efficiency with which the scratch remover operates, and most of them will want one for their own use. It is only 14 cents profit; but 14 cents is not to be overlooked, especially when it takes but a minute to demonstrate the item. Even if you do not sell one, you will have made an impression on the customer, and that is a valuable asset at any time.

Be sure to carry a small bottle of polish and a soft polishing cloth with you. After you have finished with your *radio* work on the set, go over the cabinet thoroughly and make it look as good as possible. This is a service which most radio cabinets of the table variety need badly, and a little effort along these lines will restore the original appearance to the set. It is small items of real service like this that impress the customer with your sincerity in doing a complete job on the set, and bring you a feeling of having done a real service to the customer.

Many table model receivers have their grille cloth cemented to the cabinet; and after a year of normal use, this is apt to loosen, allowing the cloth to wrinkle and present a poor appearance in addition to rattling against the loudspeaker cone. You will not be able to make anything from the application of a little grille cloth fabric cement, but again you will have made an impression on the customer. Carry a bottle of this cement with you and use it wherever necessary, and be sure the customer sees that you are actually doing something for which you are not making a charge. A bottle of wood cabinet glue and a bottle of bakelite cement will help in improving the appearance of many small cabinets. In the worst cases, you may have an opportunity to do a complete cabinet refinishing job, which you will be able to do with the complete kits of refinishing equipment that may be obtained for a few dollars. Also obtainable are small bottles of porcelain "glaze" which will fill in those nicks in porcelain refrigerators, sinks, washing machines and kitchen ranges. Still no direct profit, but good will is worth courting, and every little additional service helps along this line.

Dial Knobs

Carry a few dial knobs of assorted types, and a complete assortment of knob springs and set screws. Suggest the use of knob felts under each knob to avoid scratching the cabinet—and as an aid in silencing the various vibrations that may be interfering with best reception. An assortment of phonograph needle set screws will often be of value, particularly when there are small children in the house. Several packages of phonograph needles should be included, as well as several of the more expensive "permanent" needles.

An assortment of dial drive springs and two or three spools of dial cable of various types should be in the Service Kit at all times. A little powdered resin will stop slipping of cable-type dial drives.

An assortment of snap-in trimounts will make it possible to replace those that have been lost from the back of AC-DC sets, thus protecting the customer from the possibility of shock caused by touching the chassis while grounded. These trimounts are used in original construction to hold the cardboard cabinet backs in place, and often the loop is mounted on the cardboard back. By replacing the back, it is probable that you will improve performance by securing the loop in its correct position.

Extension Cords

So much for the items that pertain exclusively to radio. But there is another field in which the serviceman can pick up a few extra jobs with the attendant profit. Carry a roll of lamp cord with you, preferably the type known as "rip cord," and designated by the letters POSJ. This, with a few dual outlet receptacles of the surface mounting type and a number of plug caps, will make it possible for you to fulfill the needs of the customer with regard to extensions for clocks or lamps; and a little practice will enable you to sell an average of one extension cord to every three calls you make. Insulated staples and the spring clips intended to facilitate installation along baseboards make up the remainder of items necessary for this service.

If you want to go further along these lines, carry a few plug fuses of well assorted ratings, and a few socket bodies and fixture switches. Nearly every household has at least one lamp which needs repair of this nature. Of course, we could go still further and recommend your carrying wall switches. At least, you will be familiar with the requirements of your own community, and will know best what the "trade will bear." But, do not hesitate to offer these services to any customer whose home you happen to visit.

Speakers

A little more salesmanship is required to sell the idea of an extra

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ELECTRONICALLY SPEAKING . . .

THE RECEIVER PRODUCTION SURVEY made by the FCC to ascertain the probable production of various types of broadcast receivers in 1946, covered a total of 85 manufacturers. It is believed that this 85 includes all but four of the companies which are expected to be substantial producers.

Total set production reported—almost 22,000,000—is far in excess of the largest volume of radio receivers sold in any pre-war year. In 1941, the largest receiver sales up to that date amounted to about 13,000,000 sets.

The companies reporting estimate that they will produce in the neighborhood of 1,800,000 FM sets, or about 9 per cent of total set production. The Commission hopes that manufacturers may revise their production schedules to include a greater proportion of FM receivers as the FCC had received, as of April 1, 1946, applications for 834 FM stations in addition to the 50 stations now on the air, and has made 383 conditional grants to FM applicants.

TOTAL NET TIME SALES realized by licensees of the 53 standard broadcast stations of 50 kilowatt power located in the United States, for the year 1945, amounted to $60,-981,196, according to preliminary reports submitted to the FCC. This was an increase of 4.3 per cent over the 1944 total of $58,625,000.

A NEW AUTO VIBRATOR has been developed by the Electronic Laboratories of Indianapolis, Indiana, it was announced by Walter E. Peek, sales manager and vice-president. Used during the war by the signal corps, it operates at 180 cycles and is particularly adapted to auto radio service because of its reliability, small weight and convenient size.

Peek predicts that the entire auto radio picture will be based on the use of high frequency vibrators. He stated that the Electronic Laboratories will supply service outlets as soon as manufacturers have been furnished with an inventory backlog.

OPA PRICE APPROVALS have been given to 142 radio set manufacturers, according to the RMA, after a study of weekly OPA price reports through the week ending March 29. After four months of OPA pricing of radio sets, RMA announces the following facts regarding the radio set and phonograph industries:

Prices have been given by OPA on 745 radio receiver models and 194 phonographs.

Applications of 142 set manufacturers and 8 non-manufacturers have been approved by OPA in the radio set field. Only 43 of these were in production before the war.

Price ceilings have been given by OPA to 101 phonograph companies, including three non-manufacturers.

Despite the large number of set manufacturers which have obtained price approvals, OPA officials believe that many of the newcomers have not started production. A score or more of set companies, including some old-line manufacturers, have not yet obtained price approvals.

LT. COL. JOHN F. RIDER, prominent radio engineer and writer, has been retained by the RCA Victor Division of RCA as a consultant on test equipment, it was announced by Meade Brunet, Vice President in charge of Engineering Products Activities. Col. Rider will work in co-operation with the Test and Measuring Equipment Section.

Well known for his technical writings and his work in the field of radio servicing and servicing methods, Col. Rider has been active in radio for more than a quarter century. Among his achievements are development of the Chanalyst and the VoltOhmyst and pioneering in the development of signal tracing as a means of diagnosis.

Col. Rider will supplement the activities of RCA's test equipment specialists with his reports being made available to RCA distributors and servicemen.

A CLIFTON, N. J., PLANT is announced by Allen B. Du Mont Laboratories, Inc., to be located in the Doherty Building, 1000 Main Avenue. This building has been purchased by Du Mont and will be occupied in September for the manufacture of oscillographic instruments and television receivers, adding 150,000 square feet of production space to the company's extensive plants in Passaic which produce cathode-ray tubes, oscillographs and allied equipment and house the general offices.

The new plant, a four-story brick building with elevators and other modern facilities for efficient production, occupies an entire city block or about 8½ acres of ground, with frontage on four streets.

A 4½ BILLION DOLLAR BUSINESS for the coming year, as compared with the industry's one billion dollar business in 1941, is forecast by E. A. Nicholas, Chairman of Set Division, RMA, and President of Farnsworth Television & Radio Corp.

"During the war, while the electronic industry was devoting its entire resources to defense production, a pent-up consumer demand for radios and radio-phonographs accumulated

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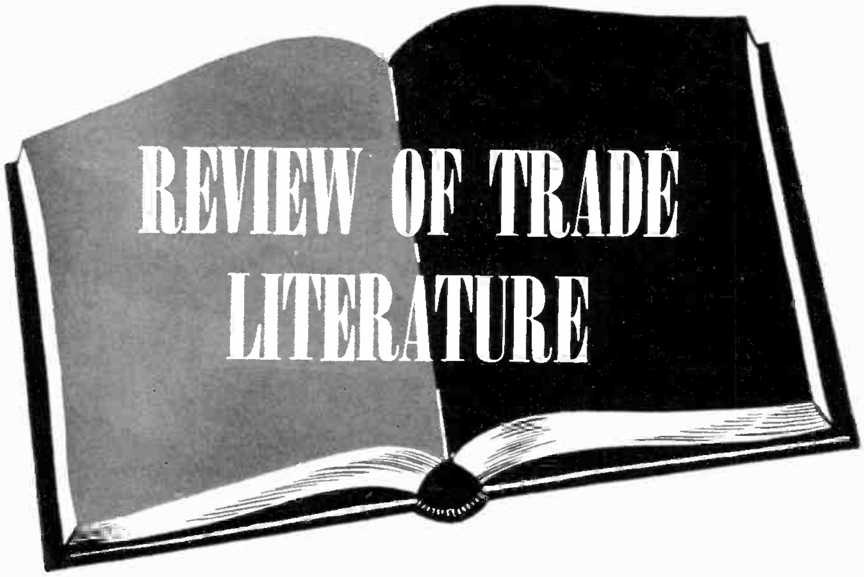

REVIEW OF TRADE LITERATURE

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

GENERAL ELECTRIC has just issued two new 40-page booklets on receiving tubes. They contain interpretations of ratings and technical data, recommended tube types, characteristics and ratings, and outline drawings and basing connections. The characteristics and ratings section presents electrical design characteristics, maximum ratings, and typical operation conditions for each tube type as well as tube base connections and outline drawings.

Both of these books contain a great deal of information of value to the serviceman. To secure a copy, write to the Tube Division, Electronics Department, General Electric Co., Schenectady, N. Y.

The first issue of The Solar Manufacturing Company's new magazine has just arrived. Entitled "The Solar System," it contains a wealth of information of interest to the serviceman. The first issue contains a chart showing the RMA color code for capacitors. The RMA color code is a new one recently adopted and every serviceman should have a copy of it. The publication also contains a number of other articles which the reader will find interesting.

The magazine will be issued bimonthly and may be secured simply by writing to the Solar Manufacturing Corporation, 285 Madison Avenue, New York 17, N. Y.

The Ohmite Manufacturing Company's bulletin number 126 containing complete data on Riteohm precision resistors may be secured by writing the Ohmite Manufacturing Company, 4835 West Flournoy Street, Chicago 44, Ill. Riteohm resistors are a new line of precision resistors manufactured in a wide variety of sizes. They are ideal for voltmeter multipliers, laboratory equipment, radio and electrical test sets, attenuation pads, and in electronic devices requiring extremely accurate resistance components.

The Kato Engineering Company has just issued a folder containing information on eleven alternating current generator sets which they manufacture. The folder gives information on estimating the size of plant needed for a given installation and other data which are helpful when choosing equipment for small alternating current installations.

To secure a copy of the folder, write to the Kato Engineering Company, Mankato, Minn.

The Metropolitan Electronic & Instrument Company has just issued a 16-page booklet describing and giving prices for test equipment such as signal generators, tube testers, multimeters, combination tube & set testers, signal tracers, etc.

A copy of the booklet will be sent upon request to the Metropolitan Electronic & Instrument Company, 6 Murray Street. New York, N. Y.

A new supplement, Bulletin 10, to the General Price List of Andrew Company, has just been released. This bulletin, their general price list and catalog may be obtained by writing the Andrew Company, 363 East 75 Street, Chicago 19, Ill.

Sprague Products Company has released a new 40-page catalog on Koolohm Resistors, Capacitors, Test Equipment and Radio Interference Filters. Items appearing for the first time include Type LM universal vertical chassis mounting replacement capacitors; Filterol, which reduces man-made noises on practically any electrical device; mica capacitors ranging from tiny "toothpick" types to giant potted-case units. Complete listings including dimension diagrams of all the various units are given.

A copy of the catalog may be obtained by writing to the Sprague Products Company, North Adams, Mass.

The Electronic Volt Ohmmeter

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condensers are suitable. In the VOMAX, the input shunt capacitance has been kept down to 8 uufd when the RF probe is used. An idea of the significance of this value of capacitance may be obtained from the following figures: If the probe is placed across the 1000-ohm resistor at a frequency of 6.3 megacycles, the voltage across the resistor will be measured within an accuracy of 5 per cent. This example is typical of measurements which can be made in the video circuits of television receivers. When measuring voltages across tuned circuits, the RF probe can be used up to frequencies of 100 megacycles or more, but it is important to remember that the 8 uufd input capacitance of the probe will tend to detune a resonant circuit. Consequently, when making such measurements, it will be necessary to adjust temporarily the tuning of the resonant circuit under test so as to allow for the additional capacitance introduced by the probe.

An examination of the simplified schematic diagram of Fig 7 shows that there are two similar diodes with associated circuits. One of the diodes, designated as V-6, is connected across the AC input and acts as a peak detector. By this we mean that the rectified AC appearing across the resistor stick R-8 through R-13 would be equal to 1.41 times the RMS AC voltage at the input terminals were it not for R-1, which with condenser C-2 acts as a filter, and also serves as a voltage divider to apply across the stick 1.0/1.41 times the peak voltage developed by the diode. By means of the range selector switch, it is possible to select the rectified AC voltage from any one of the resistors in the resistor stick. These positions correspond to the 3, 12, 30, 120, 300, and 1200-volt AC ranges. The combinations R-1, C-2 and R-41, C-4, are each filter sections which serve to eliminate all AC voltages from the grid of V-1. It will be recalled that V-1 is the cathode-follower, ½ 6SN7, which is a part of the DC voltmeter circuit.

There is, however, an added complication due to diode "contact potential," and this extraneous voltage must be balanced out by means of the second diode circuit, comprising V-7 and the resistor chain R-42, R-2, R-3, R-4, R-5. This contact potential is due to the fact that a cathode, when heated and although not subjected to any applied voltages, will emit electrons which flow through the external circuit. This current flow builds up a voltage drop across the circuit resistance, causing small errors in the low voltage ranges. By utilizing an identical diode which will develop the same contact potential, it is possible to counteract this effect. Consequently, it will be noted that the grid of V-2 is not grounded as in the DC case, but rather is connected to the balancing diode circuit through S-1a. Thus, although contact potential exists, the grids of V-1 and V-2 are equally affected, so that the net result is complete cancellation. The resistor R-42 is made variable to allow for exact adjustment of the bucking contact potential.

One more detail should be pointed out to complete the discussion of the AC voltmeter operation. This is the group of internally adjustable wire-wound AC range set resistors R-23, R-24, R-25, and R-26, located near the range selector switch S-2d. The resistors are connected to the AC position on the function selector switch S-1d, and establish correct meter sensitivity on the different AC ranges. The resistors R-23, R-24, R-25, each control one of the three lower ranges, and

→ **To Following Page**

The Electronic Volt Ohmmeter

→ From Preceding Page

R-26 adjusts the meter sensitivity on the three highest ranges. Each of these resistors is placed successively in series with the meter to adjust the sensitivity.

The separate 3-volt meter scale is made necessary because of the curvature of the diode characteristic at low input voltages.

Since db are a measure of power, and since the power is specified in a circuit of a certain impedance, it is possible to calibrate an AC voltmeter in db, and use it for power measurements. When 1 milliwatt of power is flowing in a 600-ohm circuit, the voltage across the circuit is 0.7746 volts. Hence, the scale can be calibrated with the zero at this value, and the corresponding additional calibrations placed on the scale in proper relation. When 100 milliwatts of power is in a 600-ohm circuit, the voltage is 7.746 volts. Since this value is 100 times 1 milliwatt, the level difference is 20 db, and the scale may be calibrated accordingly. It is important to remember that the impedance of the circuit in which power is being measured must be known, and that it must be properly terminated for the readings to be accurate. A table in the VOMAX instruction book aids in determining the power in circuits of various impedances from 2.0 to 600 ohms.

Servicing the VOMAX

Since it is impossible to burn out the meter in the VOMAX with even 100 times the voltage for which the selector switch is set, little repair is ever required from that source. The only possible means of damaging the meter is by a DC current overload on the MA ranges. Tubes will require replacement occasionally, and the ohmmeter batteries will run down with use, but these are natural conditions.

The instrument is very adaptable since the range selector and function selector switches are designed to simplify operation. Calibration is done at the factory and will hold good for long periods of time. Since there are no special expensive parts, replacements are readily obtainable. In general, such an electronic voltmeter is superior to the ordinary "circuit checkers," little more expensive, and is certainly an instrument to be owned and *used* by any progressive radio shop or laboratory.

Vector Analysis for the Radio Serviceman

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physical means we have found that A-C waves of any shape may be resolved into a series of sine waves of different frequencies. These component waves are known as *harmonics* and have frequencies that are integral mul-

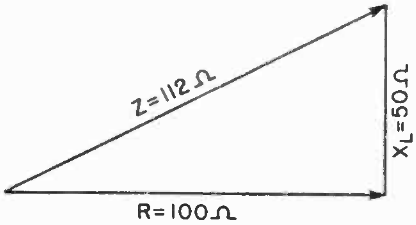


Figure 11

tiples of the fundamental frequency. A rectangular wave, for example, can be expressed in terms of ten or twelve harmonic sine waves. In this manner, sine wave analysis can be applied to any wave shape.

Figure 11 shows the answer to the problem on page 16. The impedance Z is 112 ohms, determined in the following manner:

$$Z=\sqrt{100^2-50^2}$$

Volume Control Tapers

→ From Page 9

right, the resistance will increase to increase the volume, just as in the audio control. Maximum volume will occur when the applied screen voltage is at its highest value, which will usually be 90 volts or less. The audio taper is not suitable for this type of circuit. With an audio taper control, it takes too long for the volume control to take hold, leaving little room on the control for actual variation of the volume, and making it impossible to have a gradual change in volume. A linear potentiometer will work well here, although some manufacturers have a special taper for this type of circuit.

In conclusion then, it is seen that some troubles in controlling the receiver volume can be eliminated before they arise by proper choice of the taper and resistance of the control when making a replacement. The problem is simplified by the fact that the manufacturers provide controls of many different sizes in all of the required tapers.

Service Kit

→ From Page 41

speaker to be attached to the existing radio to permit the programs to be heard in the kitchen, bedroom, or even outdoors, on the porch, or whereever the family is accustomed to gather. But the profit from such an installation should be measurable in dollars, and it is worth the extra effort. A small speaker in a wooden baffle box can be paralleled across the voice coil of the main speaker without too much ill effect. Under the worst conditions, it may be necessary to replace the output transformer to get the impedance match correct; and while this may increase the cost of such a job, it may possibly improve the response from the set, due to the use of a higher quality transformer. A "pillow" speaker makes a welcome addition to a set used in the bedroom when one person desires to listen to the radio and another prefers to sleep. Instructions for their connection are included with the unit, and the sale price of such an installation leaves room for quite a few extra dollars.

No startlingly new thoughts have been presented in this list of suggestions. But if you should happen to try out a few of these ideas, and add a few more of your own, it might make interesting reading for other servicemen. This department always welcomes money-making or time-saving ideas pertaining to radio servicing.

Electronically Speaking

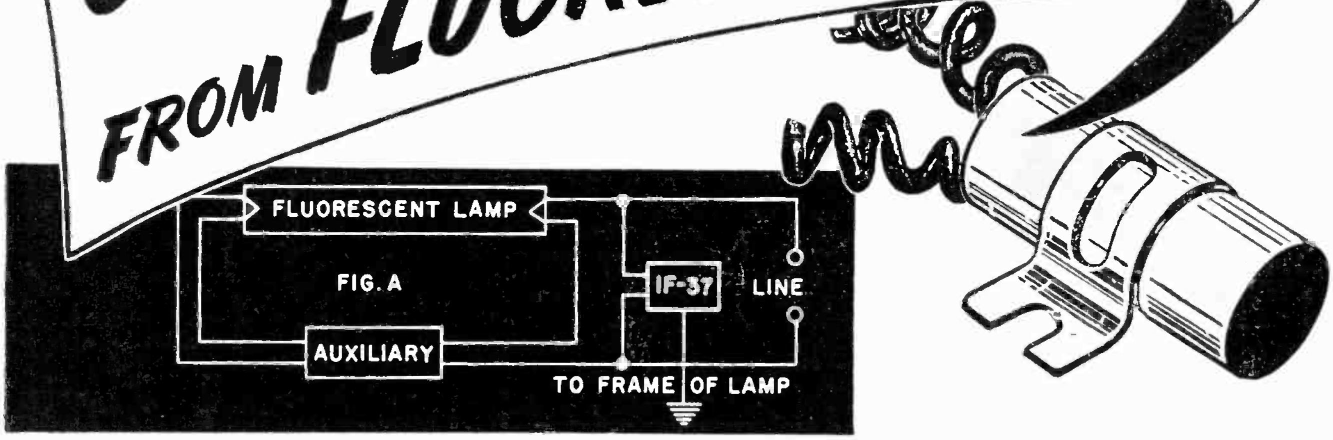
→ From Page 42

which today adds up to a backlog demand estimated variously as high as 27 million sets. This figure is twice the industry's total production of 13,-750,000 sets in the peak pre-war year of 1941.

"New vistas of distribution and sales are opening in many directions. Our Radio Manufacturers Association estimates, for instance, that rural electrification will make electrical radio service available to 3,150,000 more farm families in the next five years, with 5½ million farm radios possible by 1950.

"The above figures are for radio receivers alone. Remarkable wartime developments in almost all phases of electronics have brought promising new fields, as well as advancements in those already established, which are capable of expanding greatly the electronic industry's radio and home appliances consumer potential."

SUPPRESS RADIO NOISES FROM FLUORESCENT LAMPS!



EASILY INSTALLED — HIGHLY EFFECTIVE

The most serious radio interference from fluorescent lamps is that which is conducted down the power line to receivers at remote points. Such interference cannot be avoided merely by placing the lamp at a safe distance from the radio antenna circuit. Nor can it be avoided by using shielded lead-in wire, as in cases where interference is caused, either by direct radiation from the lamp bulb itself or by radiation to the radio antenna circuit from the electric supply lines.

Yet interference conducted down the power line to remote receivers should, and CAN, be reduced.

The really effective method is to connect Sprague IF-37 Filters directly to each fixture as indicated in the above diagram. These filters are specifically designed for fluorescent lamp interference suppression. They are recommended for single lamp fixtures, connected as shown in figure "A". One filter is required for each auxiliary.

Type IF-37 Filters are EASY to install. Inexpensive, too—only $1.11 each, net.

RADIO DEALERS! REMOVE INTERFERENCE IN YOUR OWN STORE

The use of Type IF-37 Filters in your own store will help you sell more radios through better demonstration. Your sets may be perfect, but if your own fluorescent lamps interfere with reception your customers may assume the radio is at fault.

Don't let noise spoil your sales!

WRITE

for your copy of the new Sprague Catalog No. C-306. It's the first Sprague Catalog in five years devoted to civilian radio service. In it you'll find new capacitor types and outstanding resistor improvements. Write for your new catalog today!

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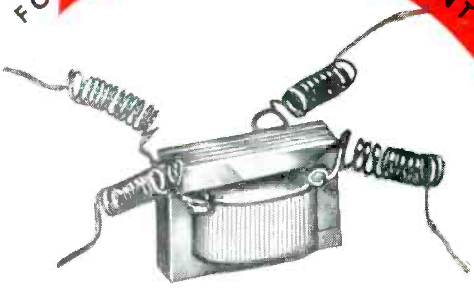
FOR MINIATURE EQUIPMENT



Miniature components to match the new "proximity fuse" miniature tubes. Output and input transformers, and reactors with dimensions 9/16" x 3/4" x 5/8".

FOR THE RESEARCH LABORATORY

Typical of the special units produced by UTC is this high gain, 100 cycle, matching transformer. Primary impedance 500 ohms, secondary impedance 37,500,000 ohms, shielding suitable for—160 DB signal level.

FOR THE RADIO AMATEUR

UTC Special Series components cover the entire range of amateur and low priced PA requirements . . . attractively cased . . . economically priced.

FOR THE BROADCAST STATION

UTC linear standard transformers are the ultimate in high fidelity design . . . frequency response guaranteed $\pm$ 1.5 DB 20 to 20,000 cycles . . . Low wave form distortion . . . Extremely low hum pickup.

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