Howard W. Sams

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REPORTER

for the Electronic Service Industry

JANUARY • 1955
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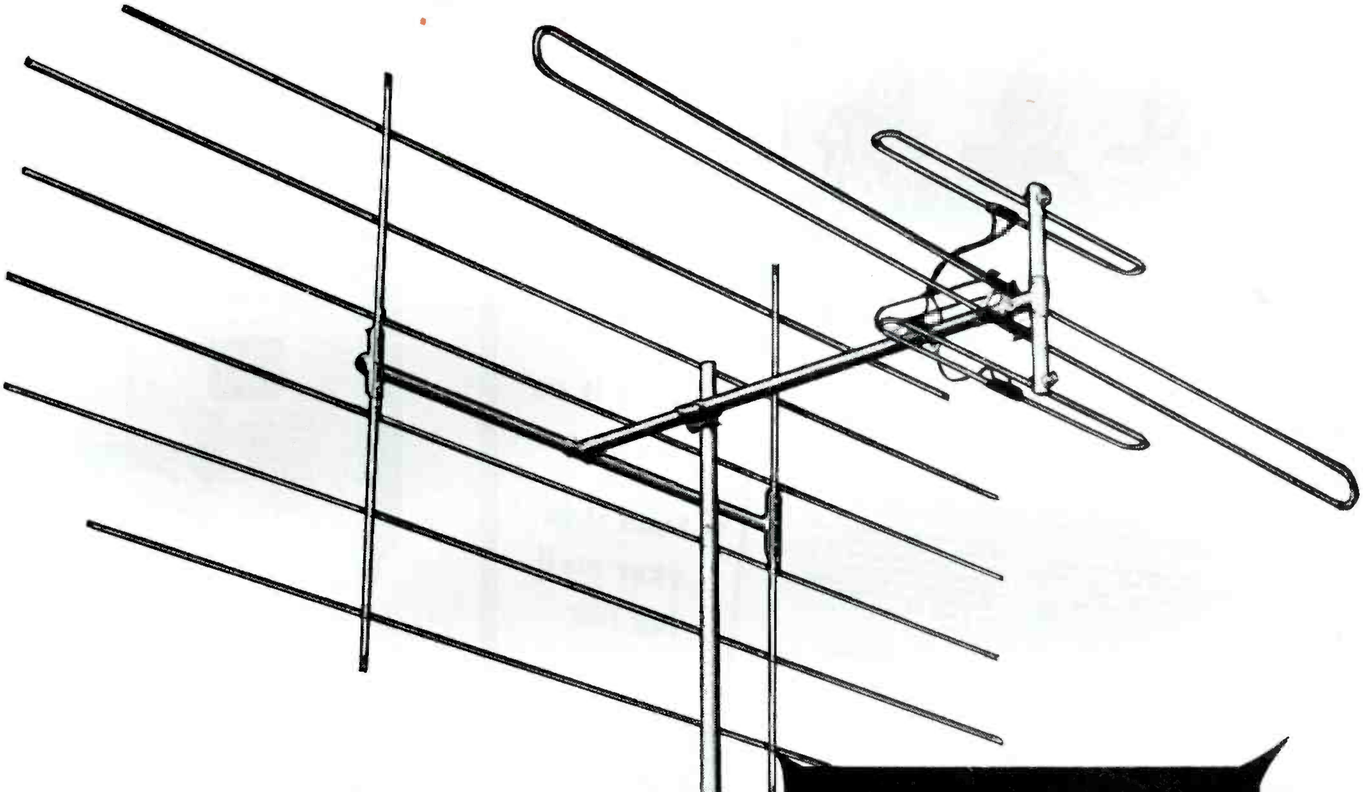

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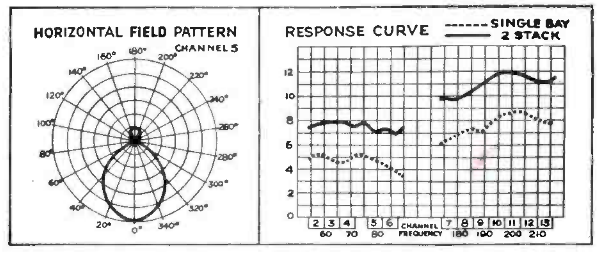

MODEL UM-213 . . . double stacked UM-213-2

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CLEVELAND 13, OHIO

TV ANTENNAS ★ AUTO AERIALS ★ VIBRATORS ★ ROTORS ★ POWER SUPPLIES

Howard W. Sams

PF REPORTER

for the Electronic Service Industry

VOL. 5 · NO. 1 JANUARY · 1955

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SUBJECT REFERENCE

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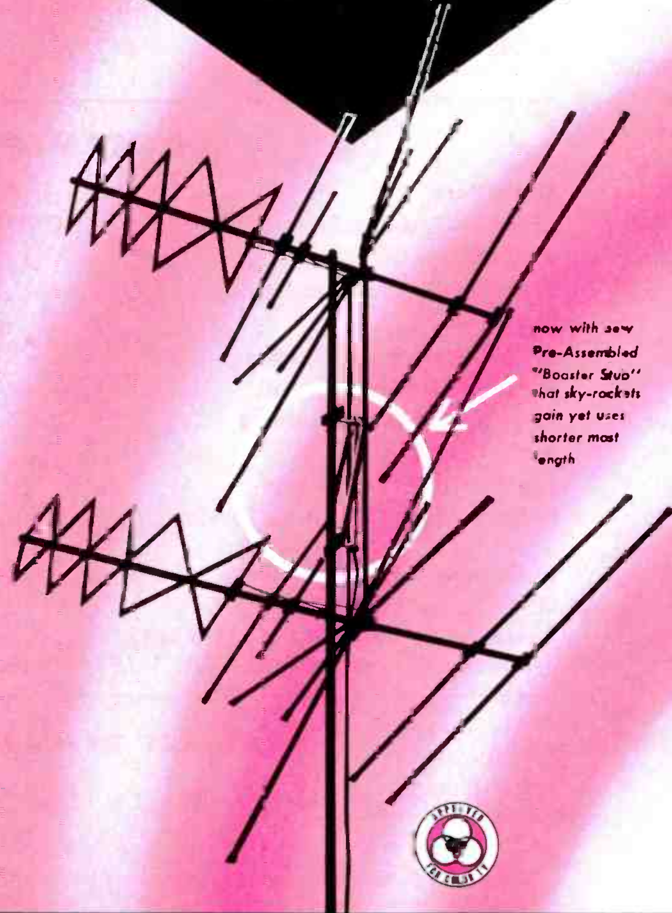

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"SUPERJET" JET213S	6.8	8.3	9.5	8.8	8.6	10.5	11.2	12.	13.5	13.8	13.6	12.9
"SUPER POWERJET" JET213S-5	7.5	9.5	11.2	10.5	9.3	11.8	12.2	12.8	13.2	13.3	14.2	14.
"DODO" Screen Type REFLECTOR	4.75	4.5	7.2	7.1	7.	11.	11.2	11.8	11.5	11.1	12.1	12.
"SUPER DODO" Screen Type REFLECTOR	6.3	6.8	8.8	7.8	7.5	9.5	11.2	11.8	12.	11.1	12.1	12.
Broad Band Yagi with Phasing Stubs	4.3	5.7	4.5	7.1	9.	13.	14.	13.5	14.	13.	14.	15.
Inline Yagi with Phasing Stubs	5.2	5.5	6	8.	8.	11.5	9.5	10.	9.	11.	11.5	11.8
Inline Yagi with Triple Dipole	6.25	6.5	8.7	8.6	9.	11.5	11.7	11.8	11.5	11.1	13.1	13.5
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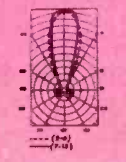
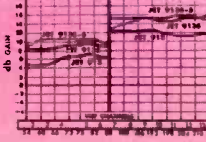
Horizontal Pattern



gain represents that over ½ wave reference folded dipole



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CAPACITORS

PRACTICAL DATA ON TYPES, CHARACTERISTICS, AND APPLICATIONS

by James M. Foy

With the exception of vacuum tubes, no other circuit element causes as much trouble as does the capacitor. Most of the troubles encountered in these units are shorts within the capacitor and leaky or open circuits between the plates. To a lesser degree, troubles will be caused by arcing and, in certain critical applications, by changes in capacity. In the following article dealing with the theory and construction of capacitors, an effort has been made to cover some of the points which may lead to a better understanding of these troubles and their causes. Although several different types of capacitors are used in radio and television circuits, some of these types are quite simple in construction and cause little trouble. Only the basic design and construction of these will be covered. Because the electrolytic capacitor is unique in its characteristics, the major part of this discussion will be confined to this type.

THEORY

In general, we can say that all capacitors are devices for storing static electricity. They are composed of two electrodes separated by a thin dielectric or insulating medium. The electrodes are usually constructed of metallic members or plates, and the dielectric may consist of gasses such as air; liquids such as mineral oil; or solids such as mica, glass, wax-impregnated paper, and other materials. Fig. 1 is an example of a basic capacitor.

Capacitors are rated according to their voltage and capacity, with the voltage rating being the maximum amount of potential that should be applied across the plates. If a greater amount of voltage is used, arcing may possibly occur with a resultant breakdown of the insulation. This breakdown occurs when a spark jumps between the electrodes through a tiny flaw in the insulation. The heat generated by the spark burns out the insulation, and it becomes conductive. If the arcing is very severe, the heat may even become great enough to melt the foil of the plates and thus create a direct short circuit.

Capacity is a measure of the quantity of electricity that can be stored at a given potential. The unit of capacitance is the farad, which corresponds to one coulomb of electrical energy at one volt of pressure. (In actual practice, since the farad is too large a unit for practical use, capacitors are rated in microfarads or in micromicrofarads. A microfarad is one millionth of a farad, and the micromicrofarad is one millionth of a microfarad. The determining factor for capacity value will be discussed later in the article.) The relationship of capacitor charge can be expressed as:

$$Q = CE,$$

where

C = farads,

E = volts,

Q = coulombs.

Thus, it is evident that the amount of charge in a capacitor is directly proportional to the applied voltage. From this relationship, we can see that when a direct current is applied to the

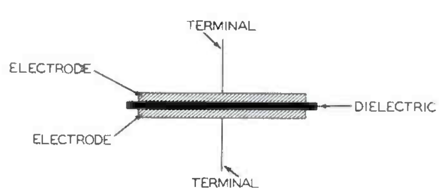


Fig. 1. Component Parts of Basic Capacitor.

plates of a capacitor, a static charge is established in the dielectric. This static charge rises until it is equal to the source voltage. When this point is reached, the source voltage is opposed by the electrostatic charge and there can be no further flow of current into or out of the capacitor unless the source voltage either rises or falls. If the source voltage rises above the electrostatic charge, additional current will flow until the charge again equals the applied voltage. If the source voltage falls below the electrostatic charge, current will flow from the capacitor into the circuit until the capacitor charge drops to a value equal to the applied or source voltage. Through utilization of this principle of charge and discharge, capacitors can be used as filters to smooth out ripple voltages; to block direct current; and to bypass alternating current wherever necessary.

Three physical factors govern the capacitance of a capacitor. The capacity is directly proportional to the area of the plates and inversely proportional to the thickness of the dielectric. This statement is easily proved when we look at the formula for computing the capacity of a simple capactior, such as the one diagrammed in Fig. 1. This formula is:

$$C = \frac{8.84 \times K A}{10^8 \times D},$$

where

C = capacitance in microfarads,

K = dielectric constant for the dielectric being used,

A = area of one side of one of the plates in square centimeters,

D = thickness of the dielectric in centimeters.

When multiple plates are used to increase the capacity, a modification of the formula just given can be used. In this instance, we have:

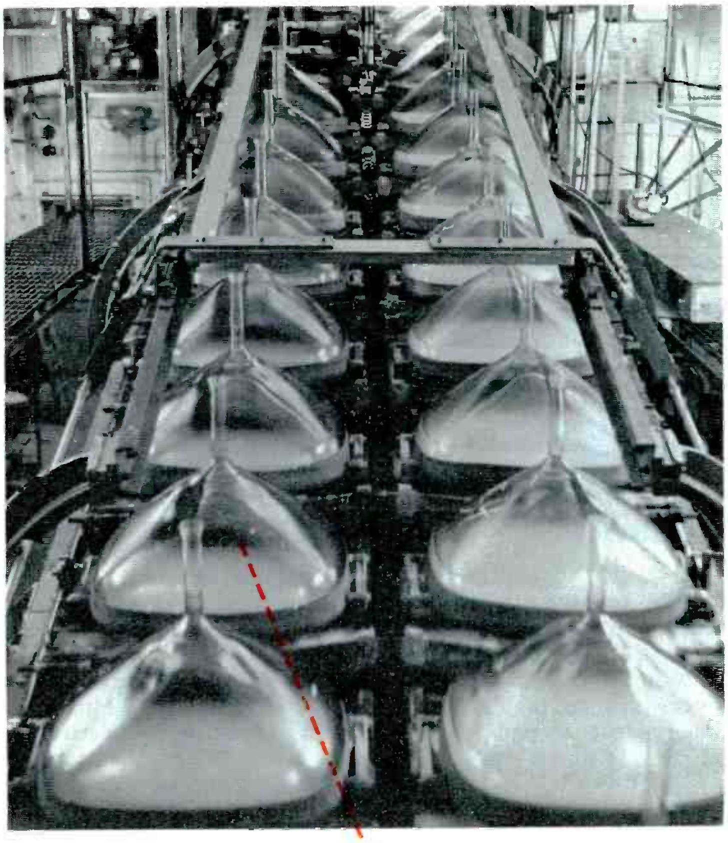
$$C = \frac{8.84 \times K A (n - 1)}{10^8 \times D},$$

where

n = the total number of plates.

Thus, we see that the capacity of a capacitor will increase when the plate area is increased; it will also increase if the thickness of the dielectric is reduced. This is an important point to be remembered.

* * Please turn to page 62 * *



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COLOR TV TRAINING SERIES

PART VIII
COLOR-RECEIVER CIRCUITS

by C. P. Oliphant and Verne M. Ray

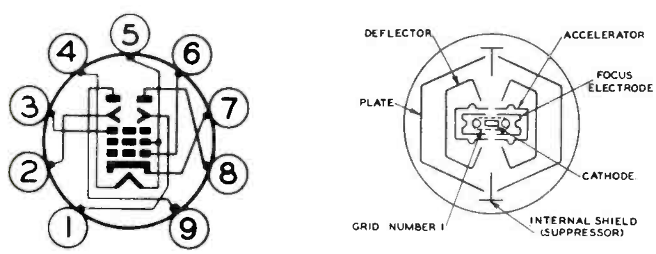
Part VII of this Color TV Training Series covered the theory of synchronous demodulation and discussed the operation of two commercially used demodulator circuits. In this part, additional demodulator circuits will be discussed and the operational theory of the matrix section will be covered. Typical commercial matrix circuits will also be described.

Demodulator Using a Sheet-Beam Tube

The 6AR8 is a sheet-beam tube which contains double plates, a pair of balanced deflectors which direct the beam to either of the two plates, and a control grid to vary the intensity of the beam. Through the use of this tube, balanced output signals of both positive and negative polarities are developed, thus eliminating the need for phase-inversion stages after the chrominance signal is demodulated.

Shown in Fig. 7-27 is the physical structure of the 6AR8. Fig. 7-27A shows the schematic of the tube and the pin connections of each of the tube elements. Pins No. 1 and No. 2 connect to the deflector plates. Pin No. 3 is the accelerator terminal which is the third grid. Pins No. 4 and No. 5 are the heater connections, with pin No. 5 being the terminal for the internal shield and focus electrodes. The focus electrodes are shown as the second grid. Pin No. 6 is the terminal for the control grid. The cathode is pin No. 7, and the two plates are pins No. 8 and No. 9.

Fig. 7-27B is a cross-section drawing of the 6AR8. The electrons pass from the cathode to either of the two plates in the form of a planar beam or sheet; from this comes the name, sheet-beam tube. After being emitted from the cathode, the electrons are acted upon by the conventional control grid which controls the intensity of the beam. Next, the focus electrodes serve to converge the electrons into the required sheet beam. Then the beam of electrons is accelerated by the acceleration electrode and then is deflected to either of the two plates by the deflectors. The function of the internal shield is to suppress the interchange of secondary-emission electrons between the plates.



(A) Basing Diagram. (B) Cross-Section Drawing.

Fig. 7-27. Physical Construction of the 6AR8 Tube.

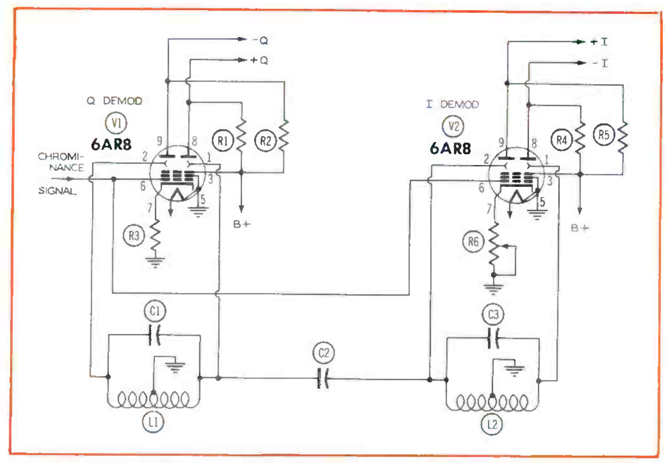
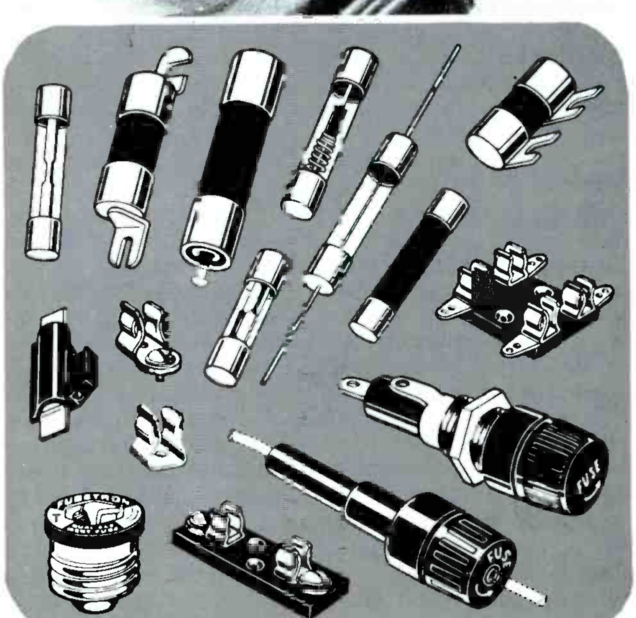


Fig. 7-28. Basic Circuit of Demodulators Using Sheet-Beam Tubes.

Under normal operation, positive DC voltages are applied to the accelerator and the plates. Signal voltages are applied to the deflectors and the control grid. The frequency of the signal voltages on the deflectors determines the rate at which the beam is switched from one plate to the other. The control-grid voltage varies the magnitude of the plate current. The 6AR8 can be compared to a voltage-controlled single-pole double-throw switch through which a current flows.

Shown in Fig. 7-28 is the basic diagram of two demodulator circuits using 6AR8 sheet-beam tubes. The chrominance signal is applied to the control grid of each stage in order to control the plate current in the demodulators. Two CW signals are applied to the deflector plates of each demodulator, and two output signals from each stage are produced. The CW signal which is in phase with the Q vector is applied to terminal No. 2 of the Q demodulator. This will result in the tube current of the Q demodulator being deflected to plate No. 1 during the positive portion of the applied reference signal. On the other deflector plate of the Q demodulator, the CW reference signal is applied after it has been shifted 180 degrees. This shifting is accomplished by passing the reference signal through coil L1 and will result in the tube current being deflected to plate No. 2 during the time that the reference signal is positive; thus, the plate current is switched from plate to plate by the voltage applied to the deflectors. The rate at which the switching takes place is determined by the CW-signal frequency which is 3.58 megacycles. Since the frequency of the chrominance signal is the same as that of the reference signal, the current in the demodulator will be switched from plate to plate each half cycle (180 degrees) of the chrominance signal. This action produces a signal of positive polarity on one plate and one of negative polarity on the other plate.



BUSS

Cathode bias for the Q demodulator is provided by resistor R3. The accelerator anode is directly connected to the B+ supply, and the plates are tied to B+ through the plate-load resistors R1 and R2. The output from one plate of the Q demodulator is a negative Q signal, and the output from the other plate is a positive Q signal. The negative Q signal is present on plate No. 1, and the positive Q signal is present on plate No. 2.

The I demodulator is similar in operation to that of the Q demodulator. The CW signal fed to the deflectors is shifted the necessary 90 degrees by capacitor C2. The reference signal is fed to deflector No. 1 of the I demodulator at this phase and is shifted 180 degrees by coil L2 before being applied to deflector No. 2. This controls the deflection of the current in the I demodulator from plate to plate in the push-pull manner as it does in the Q demodulator.

The I demodulator has a variable cathode-bias resistor R6 which controls the gain of this stage so that the relative gains of the two demodulators can be adjusted. The accelerator anode of the I demodulator is tied directly to B+, and the plates are connected to B+ by resistors R4 and R5. The output of the I demodulator consists of a positive I signal which is present on plate No. 1 and a negative I signal which is present on plate No. 2.

The sampling process of the sheet-beam demodulator is similar to that of the demodulators previously discussed. In the other demodulators, the sampling time is very short; but in the sheet-beam demodulator, the sampling time is very long. The chrominance signal is sampled by the sheet-beam demodulators at four places instead of two, which is the case for the other demodulators. The chrominance signal is sampled during the positive and negative portions of its cycle. Whenever a chrominance signal contains both I and Q information, it is sampled twice by the I demodulator and twice by the Q demodulator. This way, an I signal of both polarities and a Q signal of both polarities are produced at the plates of the demodulators.

The sampling process of the sheet-beam demodulators is shown in Fig. 7-29 which illustrates three different conditions. Sine wave A represents the chrominance signal when it contains only Q information. Sine wave B shows the condition when only I information is present. During the time of sine wave C, both I and Q information are present in the chrominance signal.

During chrominance signal A, there would be an output signal from the Q demodulator but none from the I demodulator, since the chrominance signal is going through zero during the sampling time of the I demodulator. When sine wave B is being sampled, there would be an output signal from the I demodulator but none from the Q demodulator because the sine wave is passing through zero during the sampling time of the Q demodulator. In the case of chrominance signal C, there will be an output from both demodulators. A Q signal of both polarities and an I signal of both polarities will be produced.

Actually a sheet-beam demodulator can be looked upon as being two separate synchronous-demodulator stages in which one is being controlled by a positive reference signal and the other is being controlled by a negative reference signal. From two such demodulators, there would be an output signal of one polarity from one of them and an output signal of the opposite polarity from the other.

Diode Demodulators

A basic circuit employing diode demodulators is shown in Fig. 7-30. Two twin-diode tubes are employed in this circuit. One pair of diodes is for the R - Y demodulator, and the other pair is for the B - Y demodulator. Each demodulator is connected so that one section will produce a rectified output voltage of positive polarity at its cathode, and the other section will produce a rectified output voltage of negative polarity at its plate.

In the R - Y demodulator, the chrominance signal is applied to the cathode of section A and to the plate of section B. The chrominance signal at the plate is 180 degrees out of phase with the chrominance signal at the cathode. This phase reversal is due to the action of the

* * Please turn to page 33 * *

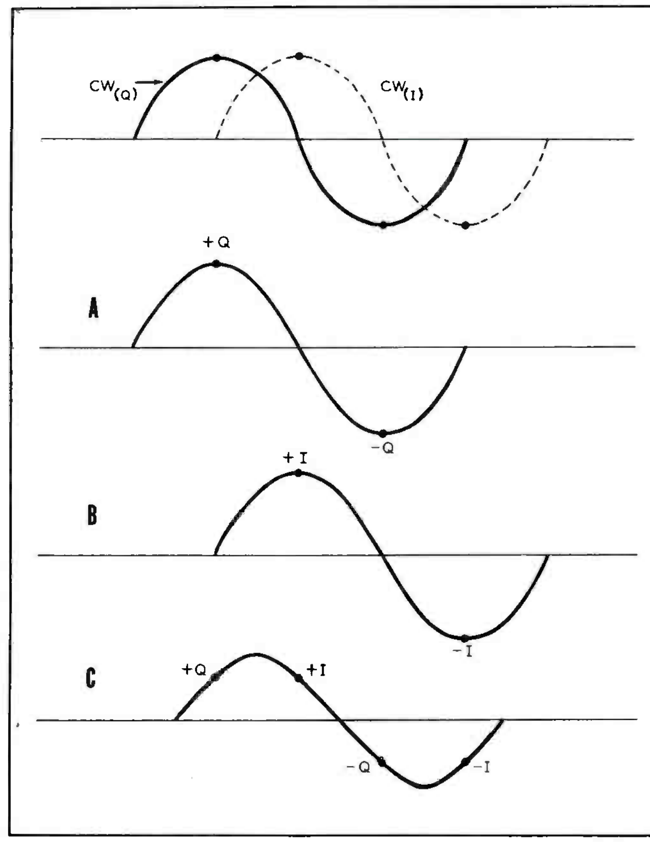


Fig. 7-29. Sampling Process of the Sheet-Beam Demodulators.

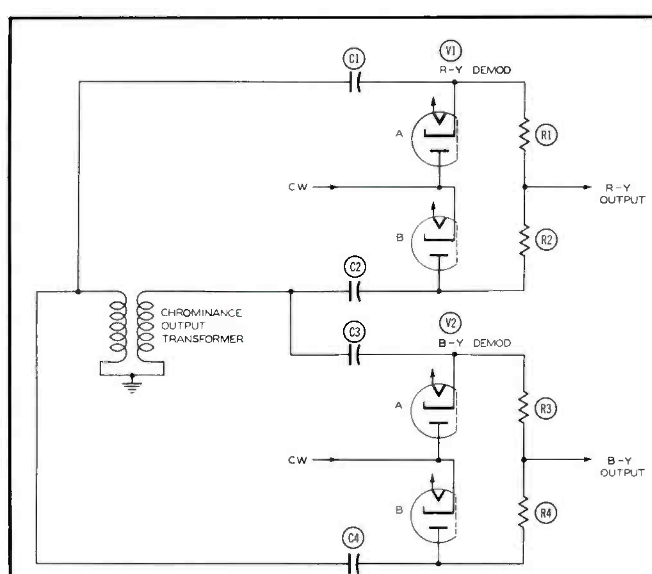


Fig. 7-30. Basic Diode Demodulator Circuit.

These

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High voltage surges due to inequalities of heater warmup time previously have limited the most effective use of "series connections" of tube heaters in TV receivers. The new Raytheon "Series String" Tubes — now used by many leading set manufacturers — virtually eliminate heater burnouts, permitting the use of this type of circuitry which results in lighter, more compact receivers.

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RAYTHEON 3AL5 is a heater-cathode type double diode of miniature construction. Its principal application is as a diode detector, automatic volume control rectifier, or as a low current power rectifier.

RAYTHEON 3AU6 is a heater-cathode type, sharp cutoff pentode of miniature construction designed for service as a high-frequency amplifier in radio and television receivers.

RAYTHEON 3BC5 is a heater-cathode type, sharp cutoff pentode, of miniature construction. Used as an RF amplifier and as a high-frequency, intermediate amplifier.

RAYTHEON 3BN6 is a 7-pin miniature, heater-cathode type, sharp cutoff pentode. Designed to perform the combined functions of limiting and frequency discrimination in FM and TV receivers.

RAYTHEON 3CB6 is a heater-cathode type sharp cutoff pentode of miniature construction designed for use as an intermediate frequency amplifier, operating at frequencies in the order of 40 megacycles, or as an RF amplifier in VHF Television Tuners.

RAYTHEON 5AM8 is a diode pentode of miniature construction designed for use as a video detector and IF amplifier in television receivers.

RAYTHEON 5AN8 is a medium-mu triode and a sharp cutoff pentode of miniature construction designed to perform combined functions of a video detector or IF amplifier and sync separator.

RAYTHEON 5J6 is a heater-cathode type, double triode of miniature construction designed for mixer applications.

RAYTHEON 5U8 is a heater-cathode type triode-pentode of miniature construction designed for use as an oscillator mixer.

RAYTHEON 6S4A is a heater-cathode type medium-mu, high-perveance triode of miniature construction for use as a vertical deflection amplifier in TV receivers.

RAYTHEON 6SN7GTB is a dual triode designed for use as a combined vertical oscillator and vertical deflection amplifier in television receivers.

RAYTHEON 7AU7 is a heater-cathode type double triode of miniature construction designed for use as a resistance coupled voltage amplifier, phase inverter, horizontal deflection oscillator or vertical deflection oscillator-amplifier in television receivers.

RAYTHEON 12AX4GTA is a heater-cathode type diode designed for use in Horizontal frequency damper service in television receivers.

RAYTHEON 12BH7A is a heater-cathode type medium-mu double triode of miniature construction designed for use as a vertical deflection amplifier in television receivers employing "Series String" heater designs.

RAYTHEON 12BK5 is a miniature beam power pentode designed for use as a power output tube in radio and TV receivers.

RAYTHEON 12BY7A is a heater-cathode type pentode of miniature construction designed for use as a video amplifier.

RAYTHEON 12L6GT is a heater-cathode type beam pentode power amplifier. Generally used as an output tube in ac-dc receivers.

RAYTHEON 12W6GT is a heater-cathode type beam pentode designed for service as a vertical deflection amplifier in TV receivers having a relatively low B supply voltage.

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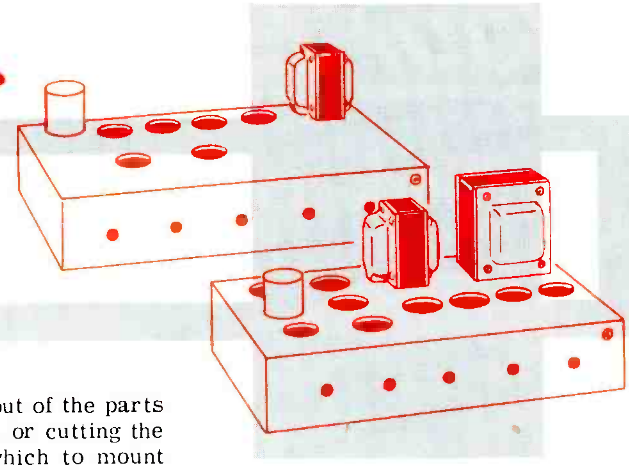

by Robert B. Dunham

TRIAD KITS

Any one who wishes to construct his own audio equipment can have a lot of profitable fun while designing and building a preamplifier or amplifier, but a number of problems are usually encountered both before and after actual construction is in progress. These problems must be considered and solved if the desired results are to be obtained from the completed unit.

For instance, if the constructor wants to design and build a preamplifier, he must among other things decide how many inputs and outputs are required; what type of phono preamplifier circuit will be most suitable; which of the many methods of tone control should be chosen; what kind of output circuit will serve best in matching the unit to the rest of the equipment; and whether the unit should be self-powered or obtain its power from the power supply of the power amplifier. After these things have been decided and circuit components have been selected, these components must be mounted on a suitable chassis or in a cabinet or box before the preamplifier can be used properly with the rest of the audio system. Working out a satisfactory layout of the parts and drilling, punching, or cutting the necessary holes in which to mount them can be time-consuming chores. Correct placement and proper mounting of the parts have a great influence upon the results to be obtained from the completed unit as well as upon its appearance and convenience of operation.

Most of the same problems will be encountered when the audio enthusiast constructs an amplifier. He must decide whether or not he wants preamplifier and control circuits included on the same chassis with the power amplifier, how much power output is desired, what output tubes and transformer will have to be used in the circuit selected, and what the power-supply requirements will have to be.

Now all of this can be a lot of fun and can serve as a challenge to any one with the ability and time to work out all of the design and layout details. The constructor who does not have the time or inclination to develop the equipment "from scratch" may find just what he is looking for in the Triad kits shown in Figs. 1 and 2.

There are many advantages to be gained by using one of these kits. The circuits have been tried and proved, so the constructor knows what he is getting before he even starts construction, that is, if he will follow the detailed data furnished with the kit. A large-sized schematic; a pictorial drawing showing the actual layout, mounting, and point-to-point wiring of all components; and a detailed construction procedure are supplied with each kit. Also included is a complete and itemized parts list giving parts numbers and specifications of the parts recommended for use in the unit being constructed.

All appropriate transformers and chokes are supplied with each kit. A punched aluminum chassis, a gray enamel hammertone-finished front panel, and decals are added features.

* * Please turn to page 59 * *

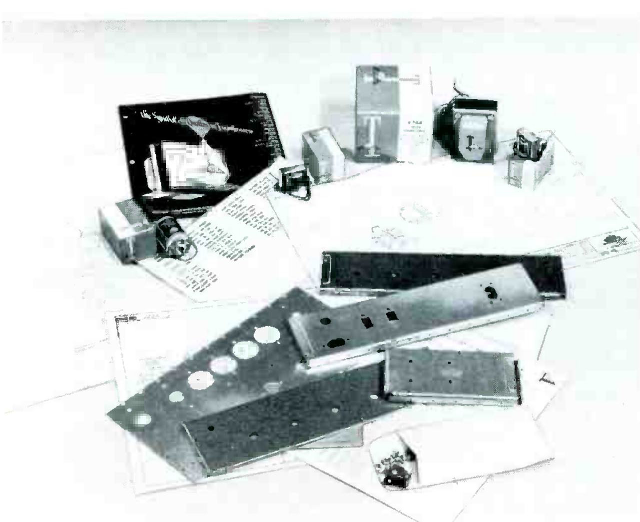

Fig. 1. Triad HF-3 Preamplifier and Equalizer Kit.

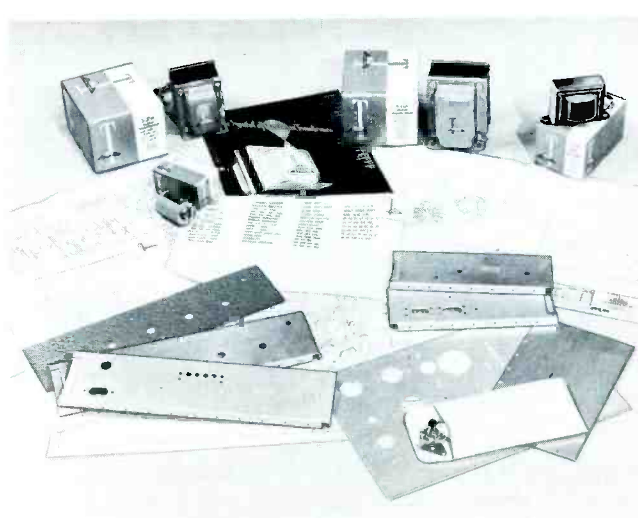

Fig. 2. Triad HF-12 10-Watt Amplifier Kit.

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RCA WR-59C
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In color receivers, all of the color information is contained in the region from about 2 Mc to 4.1 Mc on the over-all rf-if response curve, as shown in Fig. 1. Any loss of gain in this region will weaken the color signals. If the loss is appreciable, it may result in such effects as poor color sync, poor color "fit" (incorrect registration of color and brightness information on the kinescope), or cross-talk or color contamination between I and Q channels.

The rf-if amplifiers must be aligned correctly to provide flat response for modulating frequencies up to 4.1 Mc. *The RCA WR-59C Sweep Generator and WR-89A Marker Generator provide the flatness of sweep output and crystal accuracy essential for aligning color circuits.*

In color receivers, there are a number of video-frequency sections, including the video amplifier, the bandpass amplifier, the demodulator channels (see Figures 2, 3, 4), and the green, red, and blue matrix networks—including the adders and output stages. A flat video sweep extending down to 50 Kc is a necessity in checking or aligning the tunable bandpass filter and the I and Q filters. *Late model RCA WR-59C Sweep Generators provide a flat video sweep extending down to 50 Kc. They also cover all rf and if ranges required for both color and black-and-white receivers.*

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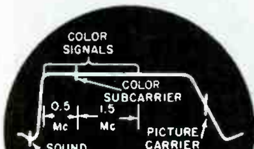


Fig. 1.
RF-IF Response

Fig. 2.
Bandpass Filter Response

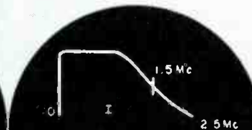


Fig. 3.
I Channel Response

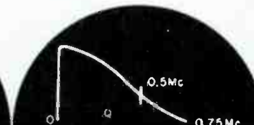
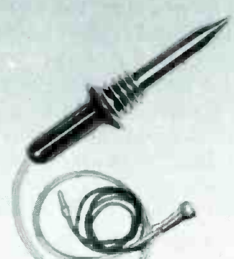


Fig. 4
R-Y, B-Y, or Q Channel Response



REMEMBER that the high voltage (up to 30,000 volts and more) must be set to the specified value before adjusting purity and convergence. The RCA VoltOhmysts can be used with the RCA High Voltage Probe (WG-289 and WG-206 Multiplier Resistor) to measure dc voltages up to 50,000 volts.

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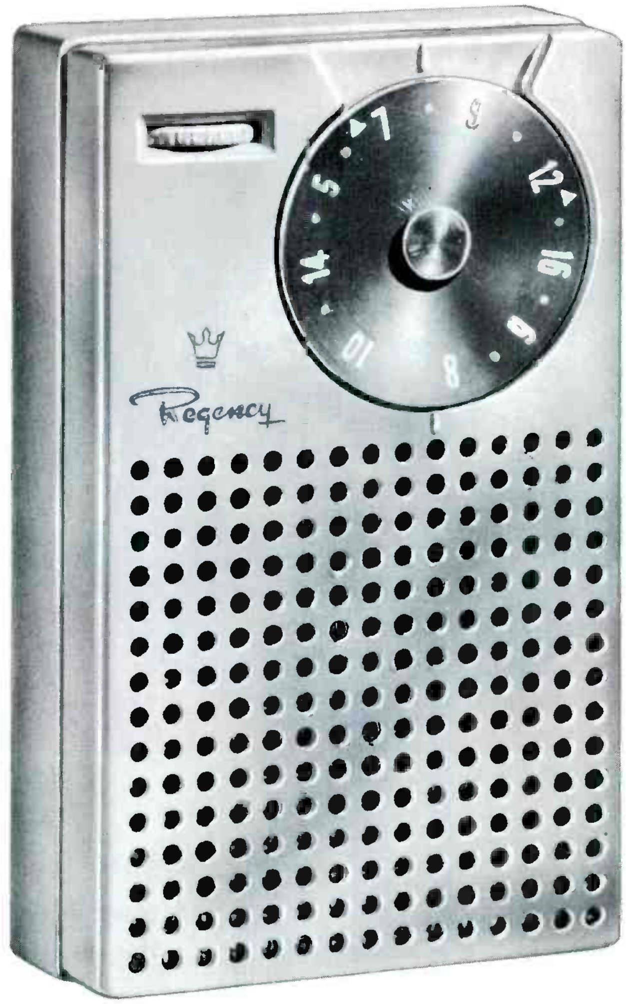

A DESCRIPTION OF THE REGENCY MODEL TR-1 POCKET RADIO

BY WILLIAM E. BURKE

The advent of transistors into the commercial products which the service technician will eventually encounter has been predicted many times in the past several years. The volume production of the first of such items has recently been announced by Regency, a division of Industrial Development Engineering Associates, Inc., (I.D.E.A.) of Indianapolis, Ind. It is the Regency Model TR-1 completely transistorized pocket-sized radio receiver. Four transistors replace the four vacuum tubes commonly found in battery receivers.

Since Regency is located in the vicinity of our company, the author was priviledged in being allowed to examine several of these receivers in detail and in seeing the production line where the receivers are assembled. This article is presented as a preview of the circuitry used in the Model TR-1 so that the service technician can become somewhat familiar with the type of receiver which he may expect to encounter in the future.

General Features

This receiver has been completely transistorized; in addition, it has been miniaturized to the point where it truly is a pocket-sized radio receiver. The dimensions of 5 inches by 3 inches by 1 1/4 inches are small enough so that the receiver conveniently fits into the pocket of a man's shirt. The size of the receiver can be judged from the fact that the picture in the heading of this article shows its actual size. The receiver

* * Please turn to page 55 * *

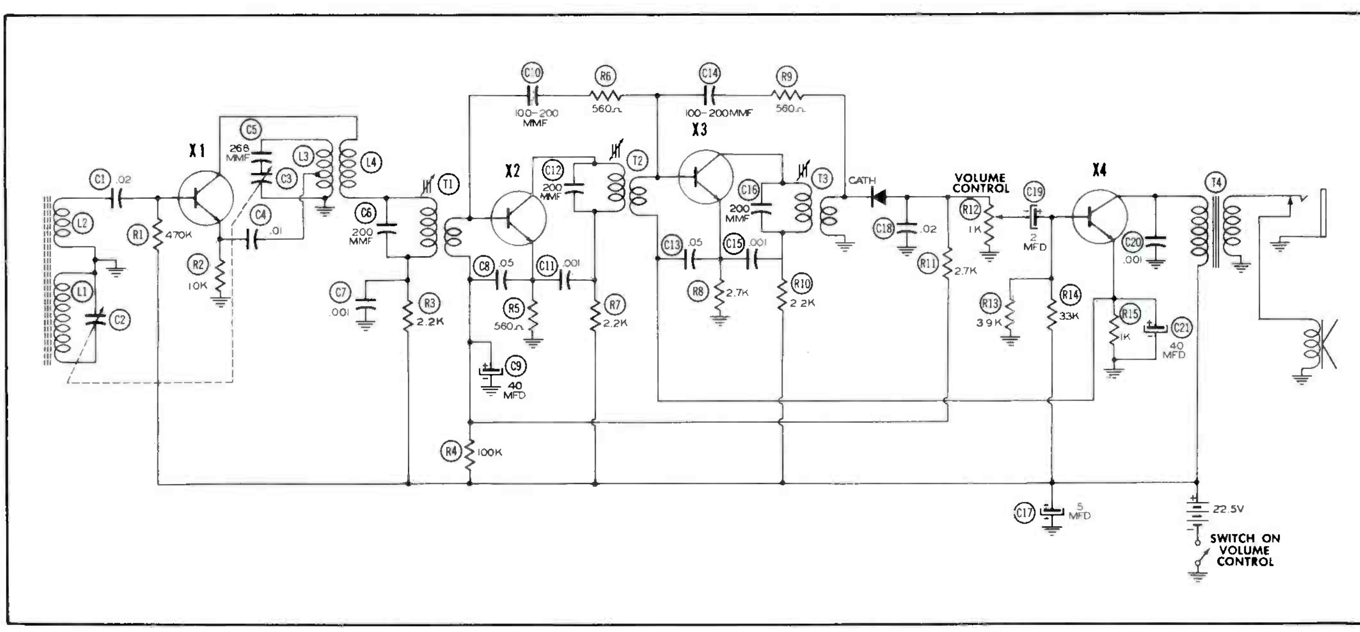

Fig. 1. Schematic of Regency Model TR-1 Pocket-Sized Radio Receiver.

Shop Talk

MILTON S. KIVER
President, Television Communications Institute

ANTENNA RESPONSE CURVES

Several months ago, some basic facts about antennas were discussed in this column. At that time, the reasons were given for the different lengths which may be encountered in antennas designed to operate on the same frequency. In this month's column we would like to probe deeper into the subject of antennas because of the particular importance of that portion of a receiving system.

A manufacturer likes to present his product in its most favorable light. Anyone who has done any buying is well aware of this practice. As part of the presentation, the manufacturer frequently uses engineering charts and data; and in order to judge these facts competently, the service technician must be capable of interpreting them correctly. There are a few pitfalls that he may encounter, and it might be of interest to see what these are.

One type of chart which is frequently included with technical equipment is a graph that depicts operating characteristics. For antennas, two typical response curves are shown in Fig. 1. Both reveal how the response of an antenna will vary with directional angle. Curves of this type are very common in antenna sales literature. These are further supplemented by data concerning such things as the materials used in the structure, the ease in mounting, and the gain to be expected.

Although nearly all response curves are smoothly drawn and symmetrically placed, as shown in Fig. 1, these are in reality only idealized curves. It is more likely that an actual curve would appear as shown in Fig. 2, and even this would be true only under the specific conditions observed by the manufacturer in testing the array. If you erect the same array in some area where space is limited and where there are a number of nearby antennas and steel buildings, then the response curves can be modified to a remarkable degree. This is obviously not the responsibility of the antenna manufacturer; the problem, rather, must be faced by the technician.

Another fact, about which the technician should be cognizant concerning response curves, is the difference which the use of power or voltage units will have on the shape of the curve. In Fig. 1, we have two response curves; and if these are carefully examined, the conclusion is reached that the response of Fig. 1B is more desirable than the response of Fig. 1A. For one thing, the curve of Fig. 1B is narrower and therefore indicates better discrimination against undesired signals from directions adjacent to the direction marked zero degrees. Also, the rear lobe shown in Fig. 1B is smaller than that in Fig. 1A, and we would expect to have less rear-signal pickup on the second array. In view of these considerations, any technician faced with the choice of both antennas would undoubtedly tend to favor the second.

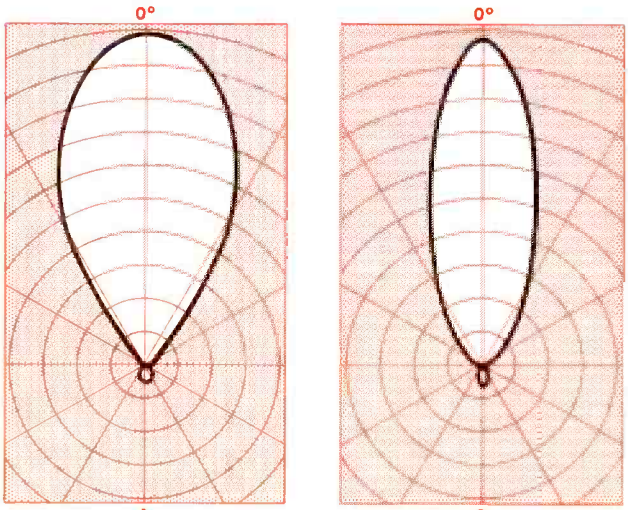

Fig. 1. Typical Antenna-Response Curves.

Unfortunately, neither antenna offers any more advantages than the other because both curves are for the same array! The reason the curves differ in appearance is that one is plotted in terms of relative voltage, whereas the other is fashioned by the use of relative power. To appreciate the reason why the change in units should make any difference, it must be recalled that power is proportional to the voltage (E) squared, or

$$\text{power} = \frac{E^2}{R} .$$

In the polar diagrams of Fig. 1, everything is expressed in relation to the maximum gain in the forward direction. This occurs at the point marked zero. If a point which is 30 degrees away from zero provides the antenna with only half the signal that it does at zero; then on the polar diagram using voltage values, the curve at 30 degrees will extend along its radial line only half the distance that it does at zero. On the polar diagram based upon power values, however, the amplitude at 30 degrees will be one half squared or one fourth the amplitude at zero. On a power plot, the curve will obviously be narrower and will seem to the

* * Please turn to page 70 * *


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A TV RECEIVER CHECK TUBE

The Uses of The New Sylvania 5AXP4 as a Servicing Tool

by W. W. Hensler

Have you ever wished for a device that would permit the cabinet-mounted picture tube to be left in the cabinet while the receiver is being serviced in the shop? Have you ever wished that you had a universal picture tube which could be inserted into any TV chassis while the set is being serviced? A TV-receiver check tube, now being manufactured by the Sylvania Electric Products Inc., fulfills these wishes.

This tube which is designated as a 5AXP4 is a 5-inch, round, magnetically deflected tube using electrostatic self-focusing. It is so designed that it can be inserted into any receiver which employs electromagnetic deflection. Since the tube has a focus system built into it, no focus mechanism needs to be used on the tube nor does the ion trap need to be installed while making tests on a receiver. The tube is so light that the yoke of the receiver will very easily support the tube. The only electrical connections required are the high-voltage lead and the picture-tube socket of the receiver. The tube may be used in any receiver regardless of the deflection angle. When it is being used in a 90-degree deflection system, some oversweep of the tube face is experienced. This presents no problem, however, since the portion of the picture which is visible makes possible an accurate check on the operation of the receiver.

There are several advantages afforded by this tube. To illustrate how it can be employed as a servicing tool, let us point out a few of its applications. One of the most time-consuming steps in the removal of a receiver from the cabinet is that of removing the cabinet-mounted picture tube. In many instances, several brackets are employed to hold the picture tube in the cabinet. The removal of these brackets not only takes considerable time but also exposes the picture tube to possible breakage. Since the TV-receiver check tube can be used in the shop as a substitute for the original tube in the receiver, it is not necessary to remove the large tube from the cabinet. After the receiver chassis and the deflection yoke have been removed from the cabinet, they can be taken to the service shop where complete analysis of the operation of the receiver can be made. The ease with which the yoke can be removed from the picture-tube assembly is illustrated in Fig. 1. The focus assembly is removed first, and the wing nut holding the deflection yoke is removed. The yoke can then be slipped off the neck of the tube, as shown in the illustration. After the receiver is placed on the bench in the service shop, the deflection yoke is slipped over the neck of the check tube and the picture-tube socket and high-voltage lead are connected. A thorough analysis of the receiver operation can then be made. This procedure of leaving the picture tube in the cabinet can be followed in almost every instance except in those cases in which the picture tube itself is suspected. If, however, the trouble in the receiver is obviously not being caused by the picture tube, there is no need for its removal.

This suggests another application for the TV-receiver check tube. It is the use of the 5AXP4 as a substitute for the picture tube in the receiver to determine whether or not the original tube is operating properly. The substitution of the picture tube presents quite a problem in many service shops since it is not possible to stock all types of picture tubes. Thus, when a tube is suspected of being defective, there may be no real means of verifying the suspicion unless another tube can be substituted. It is true that a test of the tube on a reliable picture-tube tester will indicate the condition of the tube in most cases; however, a more positive test is made through substitution. Since the installation of the 5AXP4 is a very simple one, the substitution tests can be made in a very minimum of time; and the results are very conclusive.

Another advantage offered by the 5AXP4 is brought about by its small size. Fig. 2 shows a receiver with a vertical chassis and its 17-inch picture tube mounted in place on the chassis. As can be seen in the photograph, the presence of the large tube

* * Please turn to page 80 * *

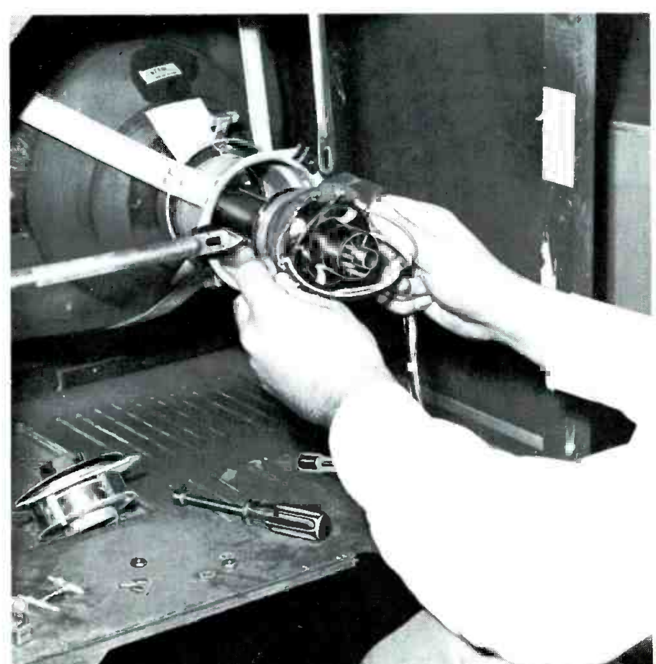

Fig. 1. Removing Yoke From the Neck of a Cabinet-Mounted Tube.

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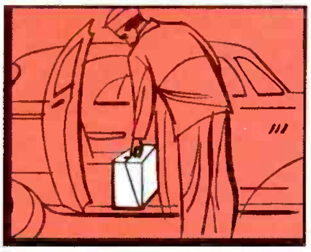

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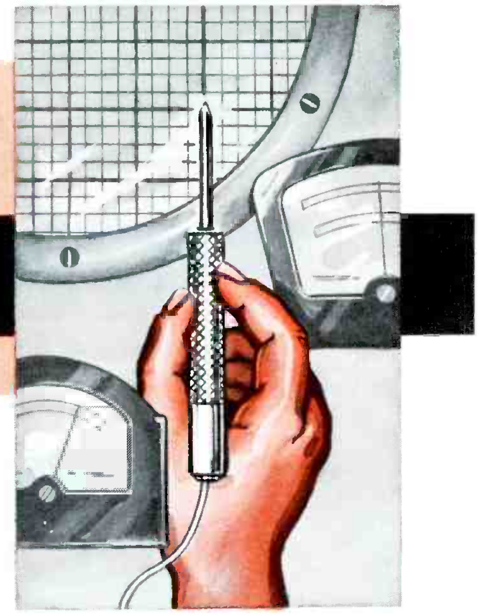

Presenting Information on Application, Maintenance, and Adaptability of Service Instruments

by Paul C. Smith

Fig. 1. Hickok Model 755 Noise Generator.

Hickok Model 755 Noise Generator

The Hickok Model 755 noise generator pictured in Fig. 1 provides a convenient means for checking the noise figure in decibels of amplifiers or receivers that operate in the range of 10 to 250 megacycles. The benefits of increasing the sensitivity of a receiver for weak-signal reception can be nullified if the signal-to-noise ratio is lowered at the same time. Therefore, some way of determining the noise characteristics of the receiver or amplifier is necessary for proper evaluation of performance. Generally speaking, the lower the noise figure obtained by means of the Hickok Model 755 noise generator, the better the reception of weak signals by the television receiver.

The Model 755 noise generator is entirely self-contained and requires no external associated equipment for making the tests for the noise figure. Three push buttons are provided for OFF, ON, or STAND-BY operation. A green pilot light indicates the STAND-BY condition, and a red pilot light indicates the ON condition. A four-position RANGE switch for the VTVM provides for selection of the proper range for the noise voltage being measured. A ZERO ADJUST knob is mounted directly below the RANGE switch and is also directly above the VTVM input terminals. On the front panel are mounted two meters, the one on the left for VTVM readings and the other for reading the noise figure in db. The noise-figure meter is calibrated with three scales which are marked with 50, 75, and 300 ohms respectively. The proper scale is selected to correspond to the impedance of the antenna input of the receiver being measured. An output control regulates the strength of signal supplied by the noise diodes of the instrument. This control has a spring return to prevent operation of the noise diodes at high output for any excessive period of time. The diodes are enclosed in a small shielded box or head at the end of the output cable. Three binding posts on this head are provided for connecting to either 300-ohm or 75-ohm antenna inputs. When the head is not in use, it can be stored in a receptacle on the front panel.

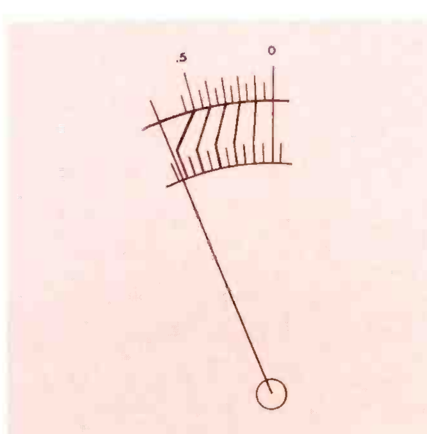

Fig. 2. Portion of the VTVM Scale on the Hickok Model 755 Noise Generator.

A noise reading is easily made in the following manner. After a short warm-up period for both the instrument and the receiver, the output of the generator is connected to the input terminals of the receiver. The proper binding posts on the head containing the diodes are chosen to match the input impedance of the receiver. The VTVM section of the noise generator is connected across the video-detector load. The tube immediately preceding the video detector is removed from its socket, and the ZERO ADJUST knob is set for zero at the center of the meter scale. This adjustment cancels any contact potential present at the video detector. Then the video IF tube is replaced in its socket; and after it has warmed up, a deflection of the VTVM pointer will be observed. This deflection represents the noise generated internally within the receiver stages. The VTVM is calibrated with two scales, the lower one being an expanded version of the upper. At regular intervals along the dial, the calibrations of the upper scale are connected by diagonal lines to the corresponding calibrations on the lower. See Fig. 2. When the pointer reading for the upper scale has been noted, an output signal from the noise diodes is fed

* * Please turn to page 48 * *

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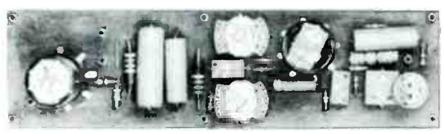
Examining DESIGN Features

by DON R. HOWE

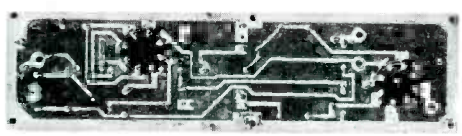
CALTECH CHASSIS T1

The Caltech Chassis T1 shown in Fig. 1 demonstrates a departure from the more conventional practices of television-receiver construction. The chassis is positioned vertically, a condition which permits greater accessibility to the tubes for replacement purposes. This arrangement also permits the various controls to be mounted close to their associated circuits and still be accessible for adjustment.

One of the most outstanding features is the unitized construction employing printed circuits. The receiver is divided into subassemblies. These are mounted on a chassis base which contains the interconnecting wiring. A special plug-in arrangement is used so that the smaller units may be removed or installed very easily. One of the subassemblies is shown in Fig. 2. This particular one contains the horizontal-oscillator section. A top view showing the mounting of the components constitutes Fig. 2A. The printed-circuit wiring is clearly visible in the bottom view of Fig. 2B. The leads for most of the components are accessible from the top of the chassis in order to facilitate voltage and resistance checks.



(A) Top View.



(B) Bottom View.

Fig. 2. Horizontal-Oscillator Subchassis in Caltech Chassis T1.

The receiver is supplied with a remote-control head which permits changing channels and controlling the volume from a remote position.

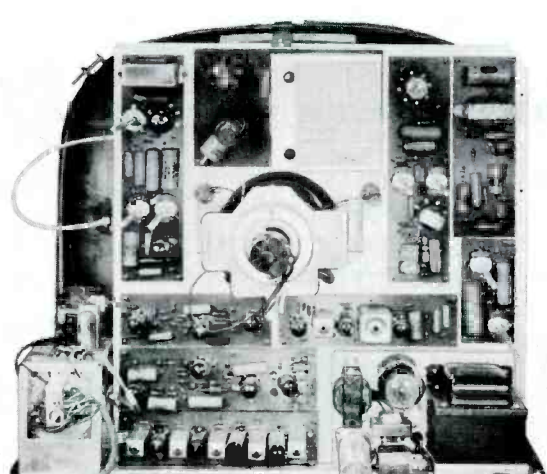


Fig. 1. Caltech Chassis T1.

Tuner

The tuner is a 12-position turret type. RF amplification is obtained by the use of a 6BQ7A tube connected in a cascode circuit. The mixer-oscillator stage employs the two triode sections of a 6J6. The output of the tuner is fed to the 40-megacycle IF strip.

Video IF

The video IF strip contains four stages of amplification. Each of these four stages employs a 6CB6. Interstage coupling is accomplished by inductive means. The secondaries of the IF transformers are shunted by resistances to obtain the desired bandpass. An interesting feature of the IF strip is the liberal use of traps. A total of five absorption traps are used.

A 1N60 crystal diode serves as the video detector. The resultant composite signal is then fed to the first video amplifier, a 6AU6. A parallel-resonant circuit tuned to 4.5 megacycles is contained in the cathode circuit of this stage, and the sound take-off point is located at the cathode. The amplified video signal is applied to the grid of the video-output tube which is a 6AR5 or a 6AQ5. Cathode bias on this stage is adjustable by means of the contrast control. The output signal drives the control grid of the picture tube. One diode section of a 6AL5 is included in the picture-tube grid circuit to act as a DC restorer.

Sound

In the sound system, two stages of amplification precede the ratio detector. These two stages employ 6AU6 tubes and are transformer coupled. The signal from the un-

* * Please turn to page 68 * *

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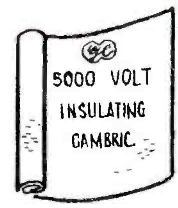
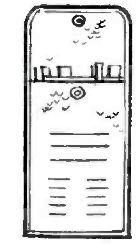
THE FIRST 4...

RADIO SERVICE CEMENT



VARNISH CAMBRIC

RADIO SERVICE SOLVENT



STEEL SPEAKER SHIMS

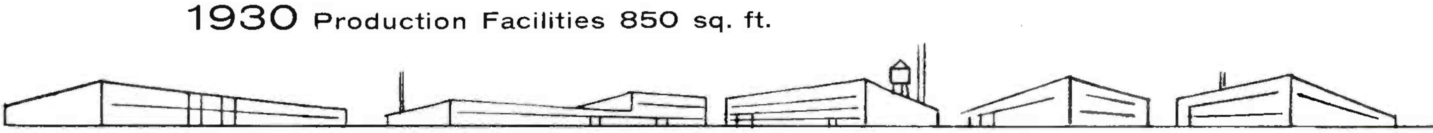
How 4 Radio Service Products

Celebrating the first 25 years of

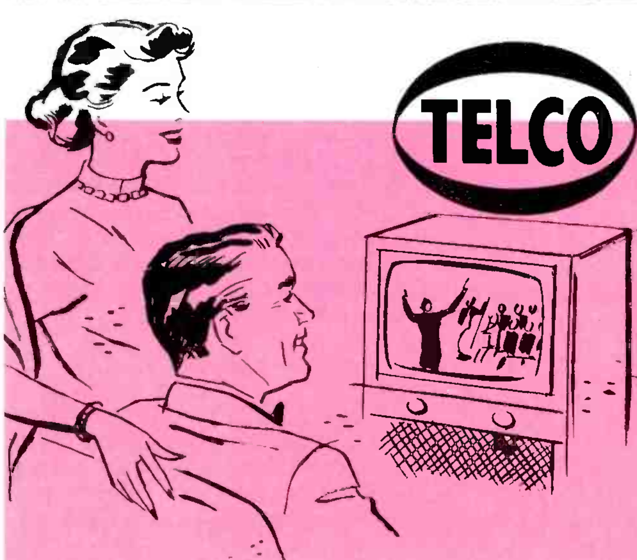
G-C Radio—Television SERVICE AIDS

Just 25 years ago this month, General Cement was little more than a hopeful gleam in its two founders' eyes. Yet such was their determination to bring quality, imagination and utility to the then infant radio service industry that today G-C is one of the best known names in radio—television—electronics. For this great acceptance, we of G-C are truly grateful and promise to maintain our reputation for manufacturing economically priced, top quality service aids . . . chemicals . . . tools . . . hardware . . . whether it's one item or several thousand!

1930 Production Facilities 850 sq. ft.



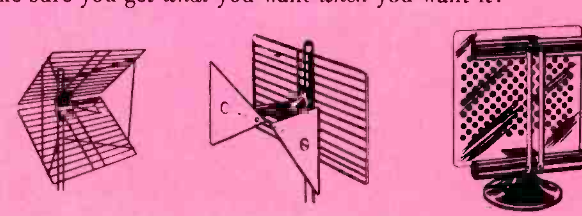
1955 Five plants, 150,000 sq. ft.

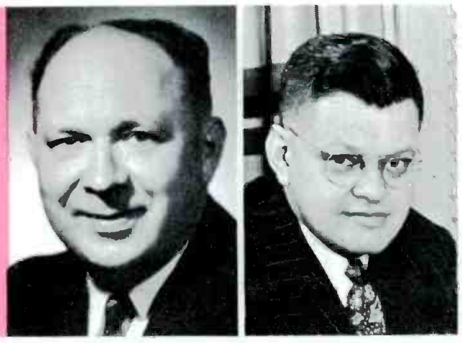


TELCO

FOR BETTER TV SERVICE!

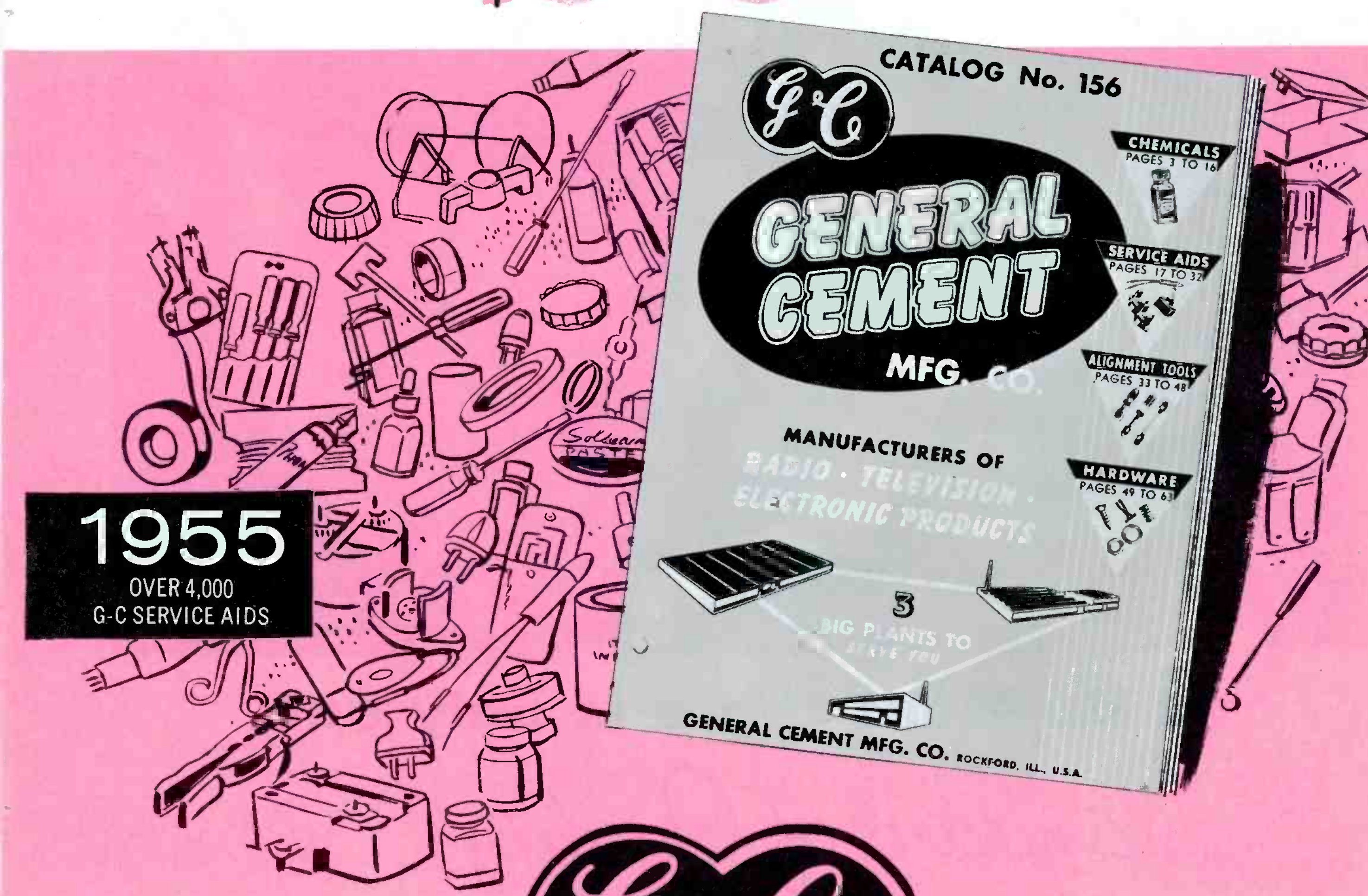
Remember the TELCO name for all your television service needs—antennas, antenna mounts, accessories and hardware. Television Hardware Mfg. Co., is a separate G-C division to make sure you get *what* you want *when* you want it!





FOUNDERS . . . S. B. Valiulis, President, and R. G. Ellis, Secretary, Treasurer and General Sales Manager, founded G-C (General Cement Mfg. Co.) on January 6, 1930.

Became 4000!



G-C

General Cement Mfg. Co.

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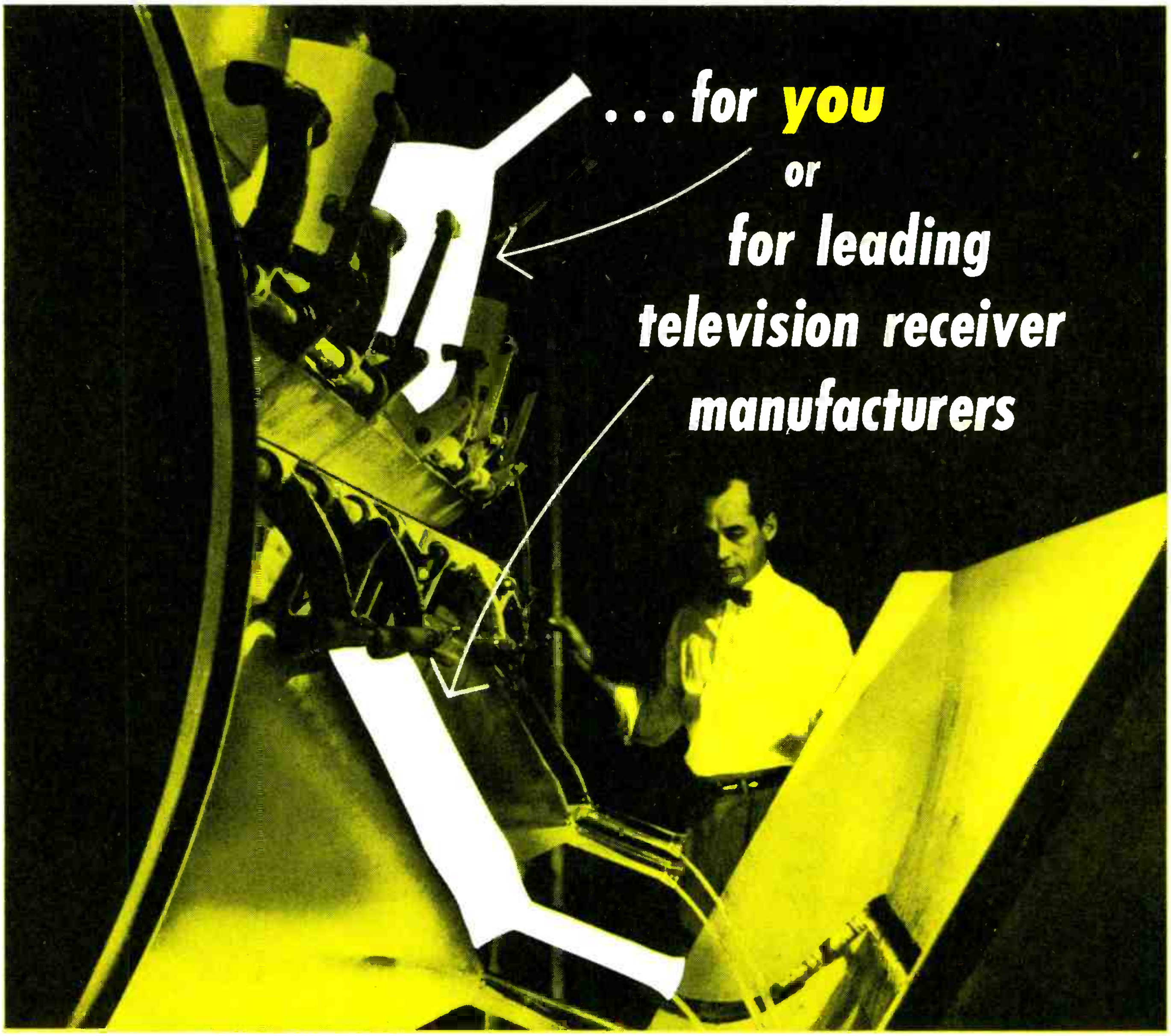

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Standard of Quality...

All Du Mont picture tubes are built to the highest standards of quality – whether for leading TV receiver manufacturers as initial equipment, or for the individual serviceman. The same careful assembly, processing and inspection is done on *every* picture tube bearing the Du Mont name.

Do as leading TV receiver manufacturers do – choose Du Mont initial quality picture tubes for new set performance.

CATHODE-RAY TUBE DIVISION
ALLEN B. DU MONT LABORATORIES, INC.
CLIFTON, N. J.

* Trade Mark

SHOP TICKETS

Layout recommendations suitable for TV and Radio Shops

BY HENRY A. CARTER

Inquiries which we have received make it evident that there exists a need for a good shop-ticket design. Realizing that one ticket could not possibly fill the needs of all shops, we have tried to come up with two designs which should do the job for the majority. At any rate, we hope that the designs presented will aid the reader in making his own design if neither of these suit his specific needs or likes.

While it is true that several types of ready-made shop tickets are available many of these tickets do have deficiencies such as: not enough room to list all of the parts replaced and insufficient space for long serial numbers or for writing in longhand. They may, however, be considered satisfactory by some service shops, especially by those who have become accustomed to using them.

The views and suggestions that are set forth in this article are the results of a survey made of many TV and radio service shops, both large and small. As expected, the answers to the questions were many and varied. After all, there probably are no two repair shops anywhere that operate entirely in the same way; and the likes and dislikes of owners vary greatly. As a result of this survey, the shop tickets presented include items representative of the preferences most frequently expressed by shop owners.

The following is a list of items which might be placed on a shop ticket. Most of the readers will probably not want all of these; consequently, this list may be used more or less as a check list and perhaps may remind the reader of a few things that he had not thought about.

Space for Customer's Name and Street Address.

The identification of the owner of a set is certainly imperative, if no service-call slip is used other than the shop ticket itself. If a service-call slip is also filled out, then at least the number of that call slip should be entered on the shop ticket.

Space for Customer's City and State Address.

The city and state information is not necessary unless the shop is part of a national organization or unless it does service work in several neighboring towns.

Space for Customer's Phone Number.

The phone number is added so that the customer may be called for a delivery appointment.

Spaces for Make, Model, and Serial Number.

Identification of the unit requiring service is of the utmost importance. The make of the unit and its model and serial numbers should be recorded on the shop ticket regardless of the type of ticket used. The model number is most often located on the cabinet and seldom on the chassis; therefore, the man making the pickup should record the model number on the ticket before he leaves the customer's home with the chassis. The model number will be a help to the shop technician when he starts looking for service literature.

Space for Pickup Date.

Knowing the date of pickup provides two advantages. First and foremost, it helps the service technician in the shop to decide which set gets first attention. Secondly, it is common knowledge that a customer loses his sense of time when he has to be without his television receiver; and he is apt to exaggerate when he calls to complain about the long wait. A record of the pickup date is helpful in such situations.

Space for Delivery Date.

The delivery date is important when determing the expiration of a service guarantee in the case of a future call back.

Space for Complaint or Symptoms.

It is very essential to have all the data on the complaint or symptoms. This should include every detail that the service technician notices while attempting repairs in the home. The more he notes on the shop ticket, the quicker the shop man may be able to locate and correct the trouble.

Space for Promised Completion Date.

Entry of the date promised for completion of the work is entirely subject to the preference of the shop owner; but from our survey, we obtained the impression that it is not a good idea to promise a specific completion date except on very rare occasions when the technician knows without a doubt the cause of the trouble and is positive that the set can be returned by the promised time. Such an occasion might be when the chassis has to be taken in for the installation of a new picture tube and the technician knows that there is a replacement in stock at the shop.

Detachable Claim Check.

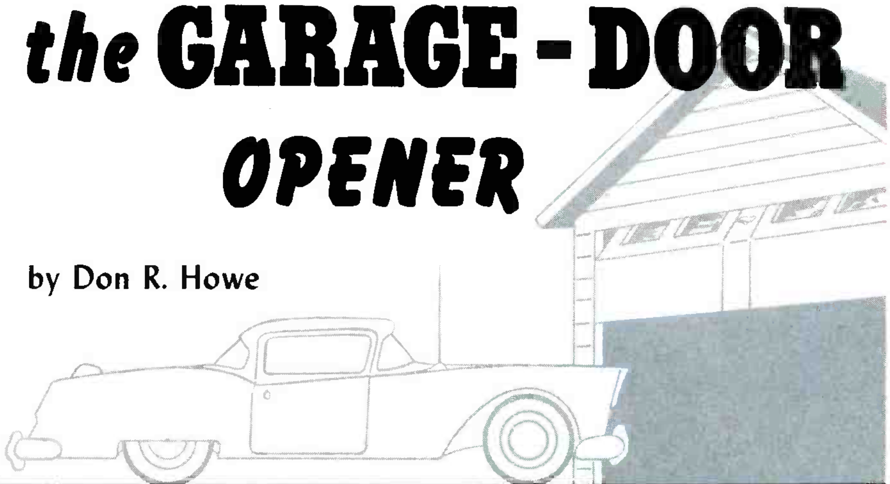
Some shops use customer claim checks, others do not. Both have valid reasons for their positions in this matter. The chief argument against the use of claim checks is that customers are prone to misplace them and are unable to present them when their sets are delivered. This situation is not a good one, because lost claim checks sometimes turn up later in the hands of unscrupulous individuals who try to make fraudulent claims against the service organization. The principal argument in favor of claim checks is that the customer is entitled to some kind of a receipt when his expensive set is taken out of his home. A receipt or claim check gives him more confidence in the service company.

Space on Claim Check for Receiver Serial Number.

Once in a while when a set is returned after repairs, a suspicious customer gets the idea that the set returned is not his. To guard against such misunderstandings, it is a good idea to jot down the serial number of the customer's set on his claim check (as well as on the shop ticket) before taking the set into the shop. Then

* * Please turn to page 82 * *

the GARAGE-DOOR OPENER



by Don R. Howe

TECHNIQUES IN SERVICING AN ELECTRONIC DEVICE OF GROWING POPULARITY

An increase in the variety of items the service technician is called upon to repair requires that he become familiar with these items if he is to take full advantage of the additional business offered by their installation and repair. An example of such an item is the radio-controlled garage-door opener which is becoming very popular.

The Perma-Power Model RC101 is an example of one of the commercial garage-door openers now being marketed. The transmitter, receiver, and antenna associated with this model are shown in Fig. 1. The sizes of these units can be judged by their comparison with a ruler in the photograph. The following discussion of the Model RC101 covers only the units shown in the figure; it does not cover the mechanism which is used in conjunction with these units for raising and lowering the door.

Transmitter Unit

The transmitter shown in Fig. 1 is a tone-modulated, fixed-frequency unit operating at 27.255 megacycles. A crystal is used as the element which determines this frequency. Tone modulation of the RF carrier is provided. This modulation may be at any one of the ten available channel frequencies which are spaced logarithmically between 600 and 4700 cycles per second. The frequency-determining elements for the tone oscillator are contained in a plug-in unit which is easily inserted or removed from the transmitter. A similar unit is used in the receiver and will be described later in this article. The two plug-in units are shown in Fig. 2. The location of the plug-in unit which is installed in the transmitter and the placement of the major components may be seen in the top view (Fig. 3A) and in the bottom view (Fig. 3B).

A reference to the schematic diagram in Fig. 4 will show the circuitry employed in the transmitter. One tube, a 6U8 triode-pentode, is used. The triode section serves as the modulator, and the pentode section functions as the RF oscillator. The output of the modulator V1A modulates the screen of the RF oscillator V1B. A neon bulb is connected in the plate circuit of V1B and may be used to tune the plate tank circuit.

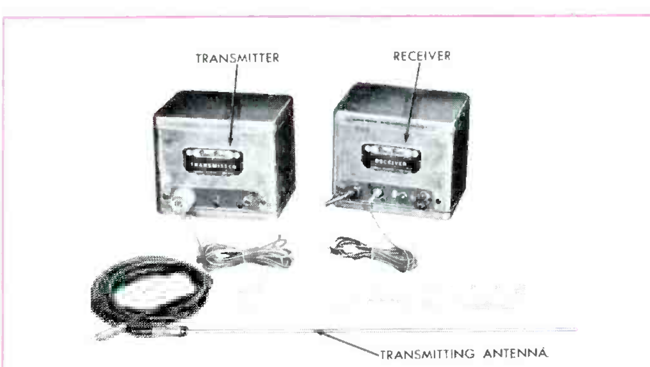


Fig. 1. Units in the Perma-Power Model RC101 Garage-Door Opener.

Fig. 2. Plug-in Tone Units for the Transmitter and Receiver.

The neon lamp also serves a secondary purpose. For maximum stability and ease of starting, the plate tank circuit should be resonant at a frequency slightly higher than the natural frequency of the oscillator. When the oscillator is quiescent, the neon lamp is not fired and the plate tank circuit is tuned to a higher frequency than the natural frequency of the oscillator. When the oscillator is operating, the neon lamp glows and the stray capacitance contributed by the neon lamp becomes greater. This additional capacitance then causes the tank circuit to resonate at a lower frequency, and the result is a more efficient circuit.

The B+ voltage for the transmitter is obtained from a vibrator type of power supply with selenium rectifiers connected in a voltage-doubler circuit. The transmitter is designed for operation on six volts. Operation from a twelve-volt source is possible by using the adapter available for this purpose.

The transmitter is normally installed in the engine compartment of the car, and the antenna is mounted under the splash pan behind the front bumper. The transmitter is conveniently attached to a base plate by four snap fasteners. This arrangement permits the transmitter to be removed from the automobile without the use of tools. The red lead from the plug on the transmitter is connected to a source of six volts DC. This connection must be made to a point where voltage is present only when the ignition switch is closed. This permits the filament of the 6U8 to be on whenever the ignition is on. The green lead from the plug is connected to the push button mounted on the dash. The closing of this switch supplies power to the vibrator and causes the transmitter to operate. The only adjustment that is necessary when installing the transmitter is the slug adjustment in the inductance L1. The slug in the tank coil L1 is adjusted for maximum brilliance of the neon bulb and is then turned counterclockwise for one

* * Please turn to page 84 * *

NEW PATENTED RADAR ANTENNA

53 CLAIMS GRANTED IN 5 U. S. PATENTS — #2,585,670 — #2,609,503 — #2,625,655 — #2,644,091 — #2,661,423

OPENS NEW HORIZONS TO TV VIEWERS

These are the reasons why the "Riviera" is by far the most powerful VHF antenna on the market today!

1. Utilizes 16 elements 60" long, ½" diameter.
2. Utilizes a specially designed, extra low loss four conductor air-dielectric POLYMICALENE transmission line which has up to 50% less loss when wet than the finest conventional transmission lines.
3. The "Riviera" encompasses an electro-magnetic capture volume of well over 650 cubic feet, many times more than conventional antennas.
4. The antenna works on the revolutionary principle that the approaching wave front is elliptically rather than horizontally polarized.
5. The new specially designed 9 position electronic orientation switch, aside from changing directivity, maintains a consistently better impedance match over the entire UHF-VHF spectrum.
6. The above features combine to give the "Riviera" antenna greater usable gain at the TV set antenna terminals than the best of any competitive antennas using rotor motors.

This new wonder antenna, called the "Riviera", is already making history. Beyond any question of a doubt, and on an *unconditional money back guarantee*, it will positively outperform in the field under actual installation conditions, any and all competitive antennas on the VHF channels, with or without rotor motors.

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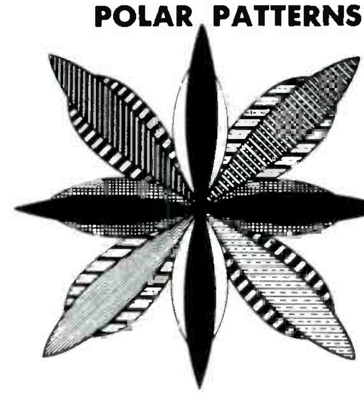
POLAR PATTERNS



only $49.50 LIST PRICE

Price includes: Complete Stacked Array • Stacking Bars • 9 Position Switch • Switch-to-set Coupler • 2 Stand-offs, 7½" • Complete instructions

The polar directivity response patterns show the major lobes of the "Riviera" antenna on VHF. It shows the fullness of coverage in all directions of this remarkable, patented antenna as it is 'turned' through each of the nine switch positions. Each degree of shading constitutes a different switch position. This excellent directivity response, which can be switched at will, plus the extremely high gains, clearly indicate why the Riviera is such a superior performer.

IN UHF-VHF DISTRICTS . . . USE

The* NEW *Super 60

100 MILES VHF • 60 MILES UHF

In the Interest of . . .

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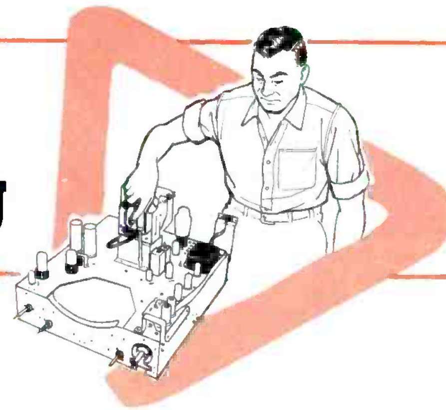

by **Henry A. Carter** *and* **Calvin C. Young, Jr.**

IN THE HOME

EQUIPPING THE SERVICE TRUCK

A very important part of any service business is the service vehicle which may be a panel truck, station wagon, vanette, pickup truck, sedan delivery, or a standard passenger car. The type of vehicle will be determined by the types of service rendered and by the financial status of the business. In television service the panel truck, sedan delivery, and station wagon are perhaps the most satisfactory vehicles for the service organization.

For the small shop, a station wagon is very practical since it may also be used by the owner as the family car. The panel truck is, in most cases, the best vehicle for service since it has ample room on the inside to carry even the largest television receivers. In fact, several receivers may be carried at one time. Along the sides of the panel truck there are rails to which large cabinets can be secured to prevent them from toppling over or shifting about and becoming damaged. The large, level top on the panel truck provides space on which ladders, antenna masts, and other long objects may be carried if a suitable rack is employed. Shops which sell appliances or install antennas or do both will find the panel truck meets most of their requirements for a service truck.

Fig. 2. Containers for Small Parts.

There are some service organizations which do not sell appliances or make antenna installations. These shops may find the sedan delivery to be the ideal vehicle for them. This type of vehicle is smaller and more maneuverable than the panel truck and is usually easier to manage in traffic. If the large carrying capacity of a panel truck is not required, the sedan delivery will serve very well. In all cases, the needs of a particular business should be carefully considered and the best vehicle for the intended use should be chosen.

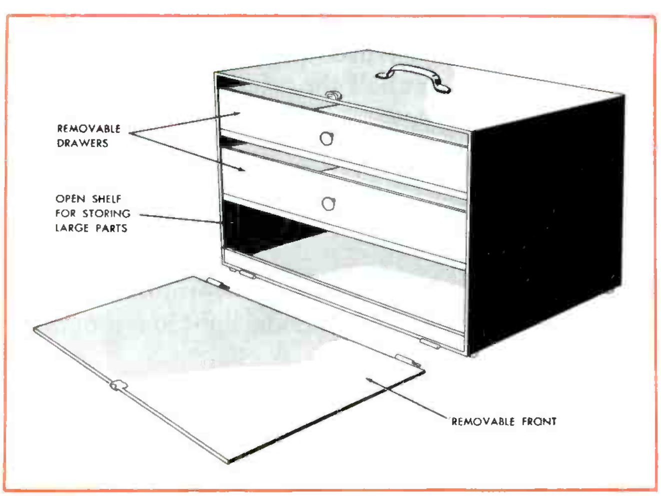

Fig. 1. Parts Caddy.

The equipment and replacement parts carried in the service vehicle are also very important. Their choice will depend upon whether the service company does all phases of servicing such as television, radio, antennas, rotators, and all other allied electronic devices, or whether the service company specializes in television and radio service only.

For TV and Radio Service

Service organizations which specialize in television and radio service should equip the service vehicle with certain basic pieces of test equipment and assorted replacement parts. A technician who is provided with a well-equipped service vehicle should be able to repair in the home, on an average, something over 90 per cent of all the sets he is called upon to service. If minor repairs are completed in the home, the bench technician will have more time to devote to those really difficult repair jobs. Minor repairs consist of replacing weak selenium rectifiers, faulty filament resistors, burnt resistors, shorted capacitors, faulty video-detector crystals, faulty high-voltage wiring, and other repairs of this nature. A service organization may elect to make such repairs in the home rather than to take a set into the shop just to replace a capacitor that is known to be bad or to replace a weak selenium rectifier. The time saved by performing these jobs in the home will more than make up for the difference in service charges.

The replacement parts for home service and the basic equipment given in Table I are needed in addition to the standard service tools and tube caddy normally carried by the technician. Although some of the items listed may already be carried in the

* * Please turn to page 75 * *

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Burton browne advertising

MODEL 631 VOM-VTVM $59^{50} NET

Because—it's TWO-in-One for the price of one! It's a VTVM—It's a VOM with just the flip of a switch!

This one combination instrument will be the serviceman's most frequently used piece of test equipment. No need to invest in two separate testers when one will do his work at half the price—**$59.50** net.

Flip the switch, it's a **V T V M** (completely portable; battery operated—VTVM accuracy not subject to line voltage fluctuations — Input Impedance of 11 megohms).

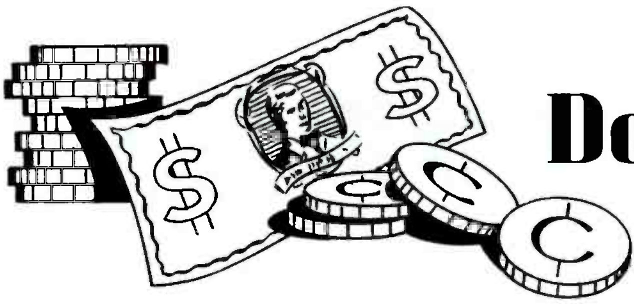
Flip the switch and it's a **V O M** (with the sensitivity to match readings in all the service manuals—20,000 ohms per volt DC, 5,000 ohms per volt AC).

Ranges entirely adequate for servicing needs. All 34 ranges selected by one knob control—minimizes incorrect settings and burnouts. Unbreakable clear plastic meter case front floods light on long, readable scales.

Triplett Model 631 is sold by leading distributors everywhere.

TRIPLETT

TRIPLETT ELECTRICAL INSTRUMENT CO., Bluffton, Ohio



Dollar and Sense Servicing

by *John Markus*

Editor-in-Chief, McGraw-Hill Radio Servicing Library

TAPED CORRESPONDENCE. With tape recorders booming as a means of exchanging spoken messages rather than letters with correspondents all over the world, ingenious names have sprung up for the inevitable clubs of such enthusiasts. Here are a few: Tape Respondents International, The Voicespondence Club, World Tape Pals, Global Recording Friends, and Record-O-Club. It's one swell way to keep in practice with a foreign language that might otherwise become rusty through disuse.

TALKING BOOKS. If a mistake in pronunciation is made while reading a book for disk recording, the entire record must be done over. Knowing this, the reader is under tension and hence tends to make more mistakes than normal. Changing to magnetic tape cuts costs and eases the tension, because a fluffed sentence need simply be repeated. Later scissors and splicing tape will fix things in a jiffy.

TRAFFIC CONTROL. A new frequency just recently made available by the FCC will be used by Chicago police to send coded radio signals out to traffic lights. Purpose is to achieve synchronization of the lights along with different optimum timings for the morning and evening rush hours and with normal settings the rest of the day.

As a starter, eleven heavy-traffic intersections will get antennas, receivers, decoders, and traffic-light controllers. Plans call for eventual radio control of 450 intersections at a cost of about $480,000, as compared to $3,375,000 for a comparable cable-control system.

ELECTRIC TYPEWRITERS "When I sat down to type, all the TV sets as far as half a mile away blanked out," is a story the wife of a good friend of ours can tell, now that the neighbors have been appeased and all is quiet again. To speed up the final typing of his book on TV servicing, our friend had rented an electric typewriter ($25 per month). They're wonderful. Just barely touch the keys and the electric motor does the rest — and still more. The brushes on that motor apparently felt that they should tell the rest of the world about their work, because they surely radiated — on all TV channels. A complaint to the rental agency brought a second machine, which was just as bad. The third, a practically brand-new job, was all right in that it didn't bother the neighbors — just messed up his own TV set.

Unbelieving, the owner of the typewriter agency took one of the machines to his own home. Now he's looking for some other kind of business to get into.

Properly connected filter capacitors and proper maintenance on the machines will stop such radiation, but it has to be done at the factory level. Once you've determined that the typewriter is the source of interference, break the news to your customer and get out quickly. This policy, incidentally, applies to a good many other man-made-interference complaints as well.

TUBES. The next time it takes five minutes to get a tube out from a too-crowded location, give a thought to the radar service technician. It requires just about half an hour to replace a magnetron in a radar receiver-transmitter unit because of the resonant cavities associated with the tube.

EYE CATCHER. When business trips take us to a new town, a flip through the pages of its classified telephone directory gives a quick picture of business and industry there. In Pittsburgh this fall, the ad that really caught our attention was headlined "STOP AND THINK BEFORE YOU TINKER." Combined with a little cut showing the man of the house getting ready to attack his ailing TV set, it effectively gets across the idea that fixing a set is a job for a trained service technician. Though it's just a one-column ad 2 1/2 inches deep, we're sure it's pulling business for Chuck Barofsky who runs Chuck's TV & Radio Service at East Liberty, Penna.

CHILDREN'S HOUR. In Britain where there is only one television station per city, the 5 to 6 p. m. Children's Hour is followed by a long black-out until the weather forecast comes on at 7:25. When Television Digest's editor asked a top BBC official why they went off the air right at the peak of their viewing audience, he replied; "So that the mothers may prepare dinner and put the children to bed without any distraction from TV." The children "have had it." If they know the screen is dark, they make no fuss about staying up for more.

What peace that must be — no supermen or rustlers to interfere with the enjoyment of the evening meal! With Britain as a precedent, we wonder if we could get by with hooking up a time clock that would also darken our screen during that magical hour "Between the dusk and the daylight, when the night is beginning to lower." Just wishful thinking — this is America where the kids run the family and the good wife is on their side in any showdown over TV.

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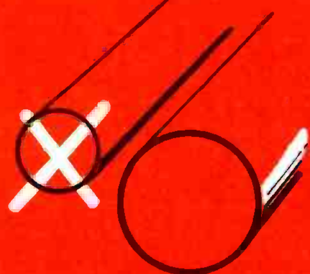
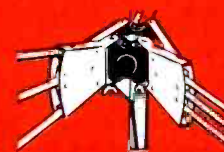
BRAND NEW FEATURES THAT MAKE *TRIO* THE LEADER IN '55



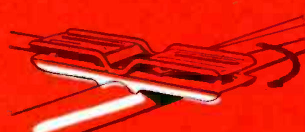
HEAVIEST BOOMS!

Thick - wall, extra - sturdy 1¼" diameter Booms. Nothing approaching them for strength! Now used on **ALL** low-band yagis.



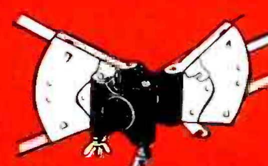
New "VARI-CON" HEAD

Four Hi-strength aluminum adjusting arms. Interlocking Butterfly sections. Heavier snap-action spring assembly. The "Vari-Con" is the only antenna with spring dampeners to lessen vibration and breakage. The "Vari-Con" head also used on the popular TRIO 88 Series.



Sensational INSTA-LOK CLAMP (Good-Bye Nuts)

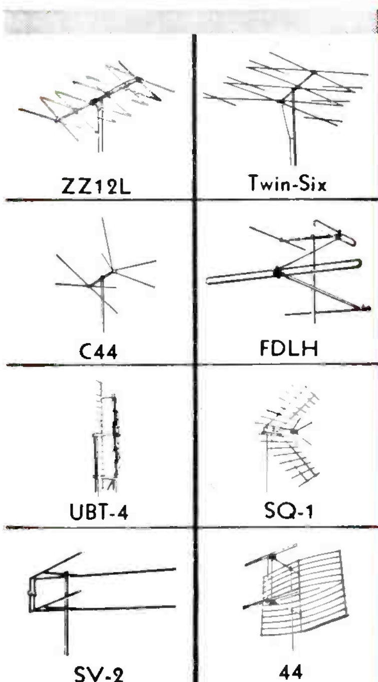
This revolutionary clamp permits instant flip-out assembly, permanent alignment with ultra strength. Nothing stronger — nothing faster! Insta-Lok employed on **ALL** TRIO Antennas that have parasitic elements.



New MINIT-UP CONICAL HEAD

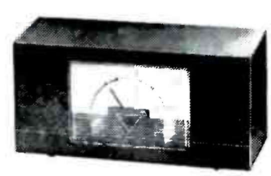
Swing out element mounting plates, fan out elements into snap-fastenings and it's set! Used throughout conical line.

New MYCASTYRENE INSULATORS USED THROUGHOUT TRIO LINE

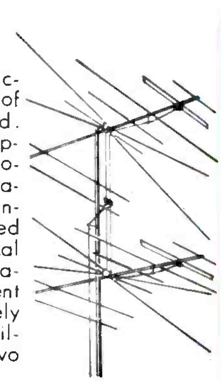


New TRIO ARISTOCRAT ROTATOR

NOW AVAILABLE IN **FOUR** GLORIOUS COLORS!

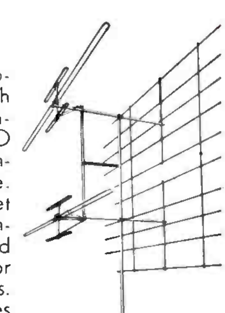


TRIO 88



Far superior construction. Rugged, foolproof — easily installed. Parasitic elements supported by TRIO's revolutionary new "Insta-Lok" clamps. Low channel dipoles supported by the strongest conical head made. No vibration — No element shedding. Completely pre-assembled. Available in single or two bay models.

TRIO 66



Three dipoles provide exceptionally high gain on all VHF channels. Exclusive TRIO grid reflector gives improved performance. Extremely rugged yet lightweight. Pre-assembled — simply unfold and tighten reflector and dipole assemblies. Three vertical braces on reflector screen for increased strength. Available in single or two bay models

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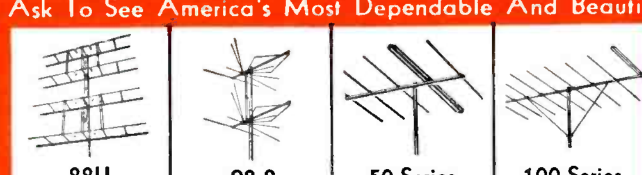

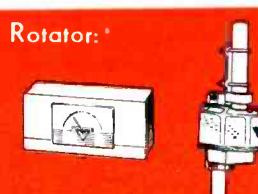

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Color TV Training Series

(Continued from page 9)

transformer at the take-off point of the chrominance signal. The reference signal from the color-sync section is applied to the plate of section A and to the cathode of section B. The output of the R - Y demodulator is present at the junction of resistors R1 and R2.

The B - Y demodulator is connected in a manner similar to that of the R - Y demodulator. The chrominance signal is applied to the cathode of section A and to the plate of section B of the B - Y demodulator. The signals present at these points are displaced by 180 degrees. The B - Y reference signal is applied to the plate of section A and to the cathode of section B. The output of the B - Y demodulator appears at the junction of resistors R3 and R4.

The magnitude of the output signal from each demodulator is dependent upon the amount of conduction by each section of the demodulator. Whenever the conduction of each section is equal, the output will be zero. For example, when both sections of the R - Y demodulator are conducting equally, a positive voltage will appear at the junction of R1 and the cathode of section A because of the positive charge on C1. A voltage of the same magnitude but of opposite polarity will appear at the junction of R2 and the plate of section B because of the negative charge on C2. Since the charges on C1 and C2 are equal but of opposite polarity and since both C1 and C2 are returned to ground through the chrominance output transformer, a zero voltage is present at the junction of the equal-value resistors R1 and R2. This condition would exist when there is no chrominance signal at the input. Under the same conditions, the B - Y demodulator would perform in the same manner.

Let us now investigate the action of the diode demodulators during the time that a chrominance signal is being received. For example, let us assume that a chrominance signal which is lagging the R - Y reference signal is present at the cathode of section A of the R - Y demodulator. The action of both demodulators is shown by the waveforms in Fig. 7-31. The first pair of waveforms shows the action of section A of the R - Y demodulator. The sine wave marked P is the reference signal at the plate, and the one marked K is the chrominance signal at the cathode. The conduction time is during the period that the plate is more positive than the cathode and is represented by the shaded portion between the sine waves.

The second pair of sine waves in Fig. 7-31 shows the action of section B of the R - Y demodulator. The reference signal appears at the cathode of this section and is represented by the sine wave marked K. It is the same signal that was present at the plate of section A. The other signal of the second pair of sine waves is the chrominance signal and is marked with a P, since it appears at the plate of section B. This chrominance signal is 180 degrees out of phase with that previously discussed, since it is taken off at the transformer secondary. The conduction time of section B is the shaded portion between the two sine waves.

It can be seen that section B conducts more than section A. This will cause the charge on C2 to be greater than that on C1; and because the charge on C2 is negative, a negative voltage is present at the junction of R1 and R2.

The third pair of sine waves in Fig. 7-31 shows the action of section A of the B - Y demodulator. The chrominance signal is sine wave K, and it appears at the cathode of section A. This chrominance signal is at the same phase as that at the plate of section B in the R - Y demodulator. The other sine wave of the third pair is the B - Y reference that appears at the plate of section A. This reference signal is advanced 90 degrees in relation with the R - Y reference signal. The conduction time of section A of the B - Y demodulator is during the shaded portion of the third pair of sine waves in Fig. 7-31.

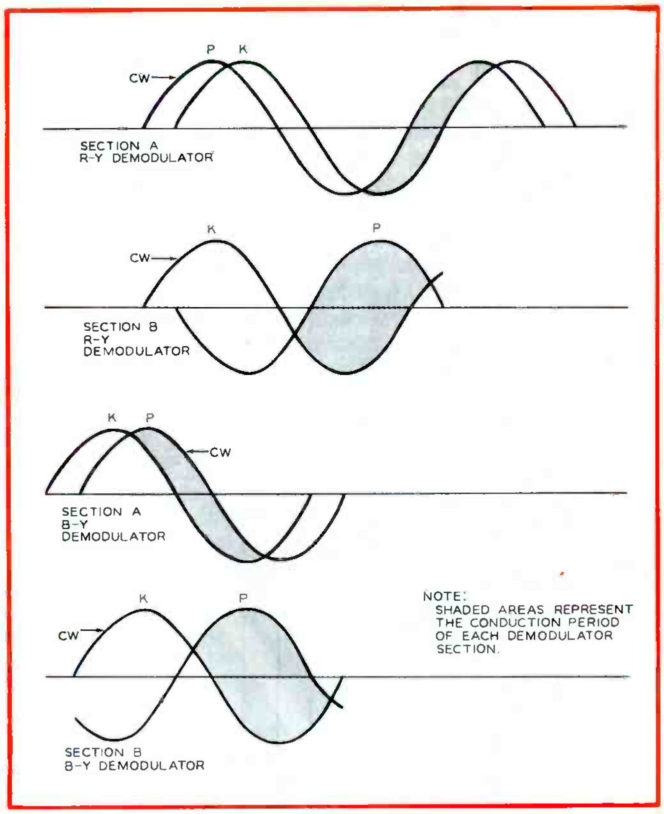

Fig. 7-31. Illustration of Conduction Period of Each Demodulator When the Chrominance Signal Lags the R—Y Reference and Leads the B—Y Reference by 45 Degrees.

The fourth pair of sine waves in Fig. 7-31 represents the action of section B of the B - Y demodulator. In this section, the chrominance signal is applied to the plate and the reference signal to the cathode. Sine wave P is the chrominance signal and is at the same phase as the signal that appears at the cathode of section A in the R - Y demodulator. Sine wave K is the reference signal. The conduction time of section B of the B - Y demodulator is represented by the shaded portion between the two sine waves.

Section B of the B - Y demodulator conducts a greater amount than section A; as a result, there is a greater charge on C4 than on C3. Therefore, the instantaneous output voltage of the B - Y demodulator will be negative in polarity.

For the case just assumed, the chrominance signal lagged the R - Y reference signal by 45 degrees and it led the B - Y reference signal by 45 degrees. The instantaneous output voltage of each demodulator was found to be of negative polarity.

Let us assume that the chrominance signal leads the R - Y reference signal by 45 degrees and leads the B - Y reference signal by 135 degrees. The conduction period of each section of the R - Y demodulator and the B - Y demodulator is illustrated in Fig. 7-32. By inspection of the first two pairs of sine waves, it can be seen

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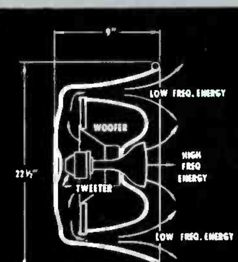

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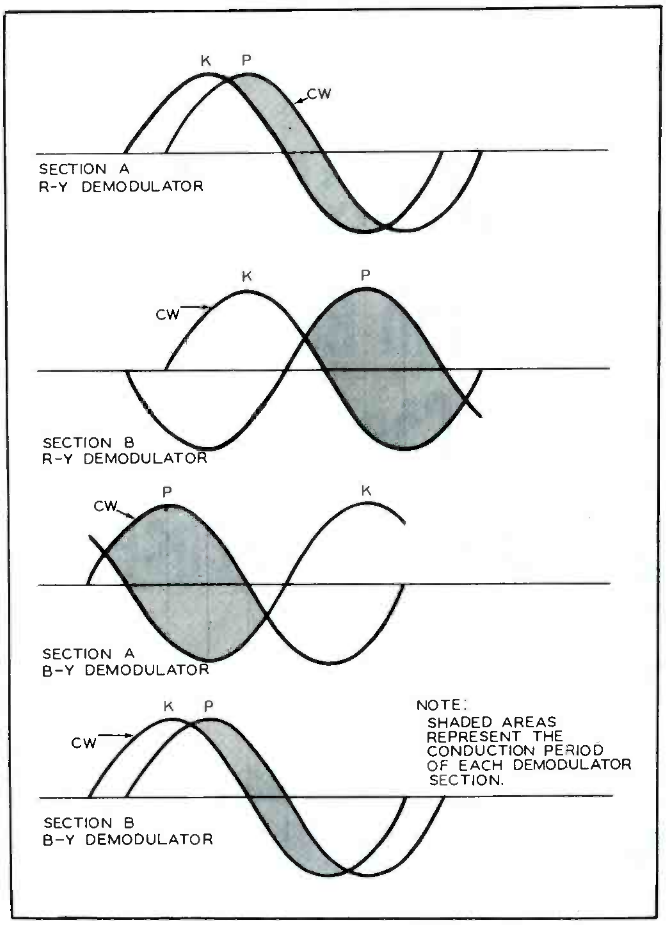

Fig. 7-32. Illustration of Conduction Period of Each Demodulator When the Chrominance Signal Leads the R—Y Reference by 45 Degrees and Leads the B—Y Reference by 135 Degrees.

that section B of the R - Y demodulator conducts more than section A. This will produce an instantaneous voltage of negative polarity at the output of the R - Y demodulator.

The B - Y demodulator will produce an instantaneous output voltage of positive polarity, as can be seen from inspection of the last two pairs of sine waves in Fig. 7-32. Section A of the B - Y demodulator conducts more than section B; thus, the charge on C3 will be greater than that on C4, and the resultant output voltage will be positive.

Let us investigate what happens when the chrominance signal is in phase with the R - Y reference signal. Under this condition, there must be maximum output from the R - Y demodulator and zero output from the B - Y demodulator. The illustrations in Fig. 7-33 show that this is true. There will be no output from section A of the R - Y demodulator, since the chrominance signal is in phase with the reference signal. In section B of the B - Y demodulator, conduction is at maximum because the chrominance signal has been changed in phase by 180 degrees. Maximum output will appear at the junction of R1 and R2, under this condition.

The third and fourth pairs of sine waves in Fig. 7-33 show that the conduction of section A of the B - Y demodulator is equal to the conduction of section B. The charges on C3 and C4 are equal, and the output of the B - Y demodulator will be zero the same as if there were no chrominance signal present.

The vector relationship of the conditions previously discussed is represented in the vector diagram of Fig. 7-34.

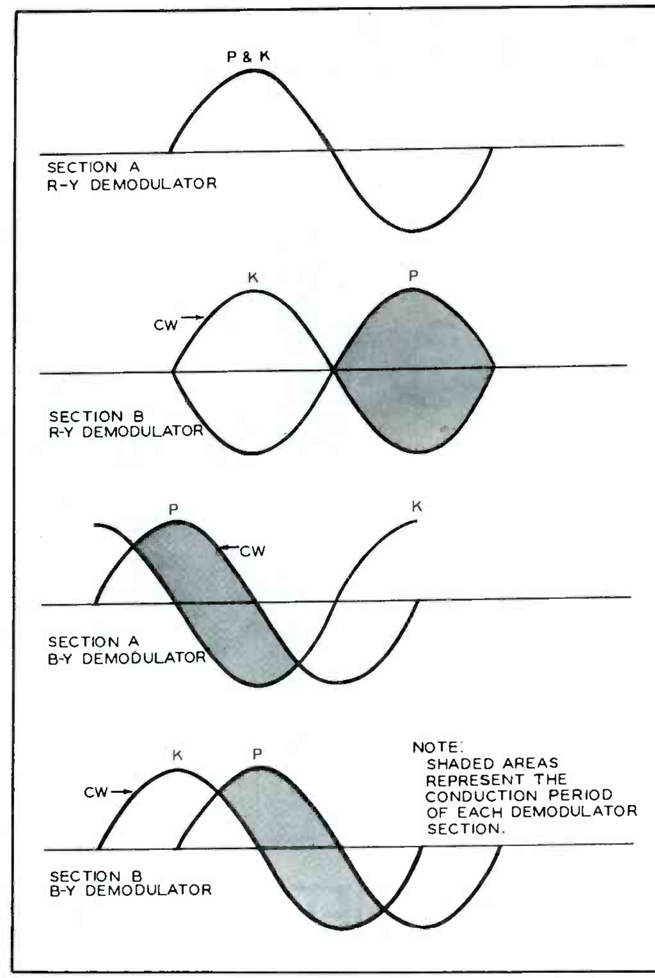

Fig. 7-33. Illustration of Conduction Period of Each Demodulator When the Chrominance Signal Is in Phase With the R—Y Reference.

The first condition in which the chrominance signal lagged the R - Y reference signal and led the B - Y reference signal by 45 degrees is represented by the vector marked chroma 1. A chrominance vector at this position on the phase diagram would represent a color near magenta. This chrominance signal contains a positive R - Y signal and a positive B - Y signal. These are the polarities of the R - Y and B - Y signals when chroma 1 is transmitted.

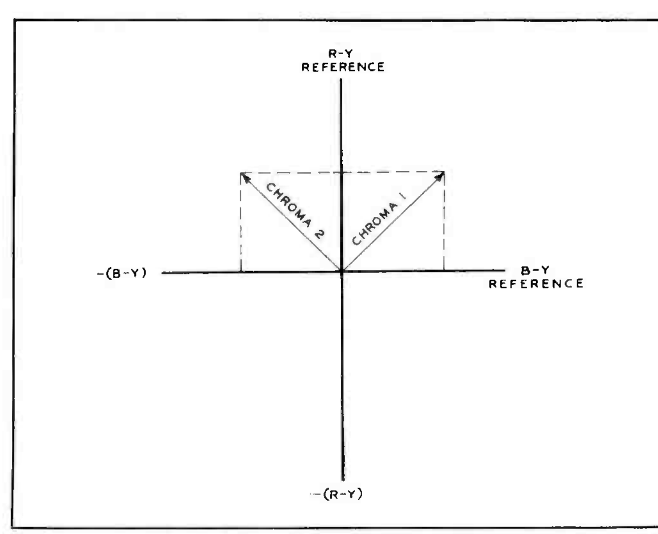

Fig. 7-34. Vector Relationship of the Chrominance Signals With the Reference Signals.

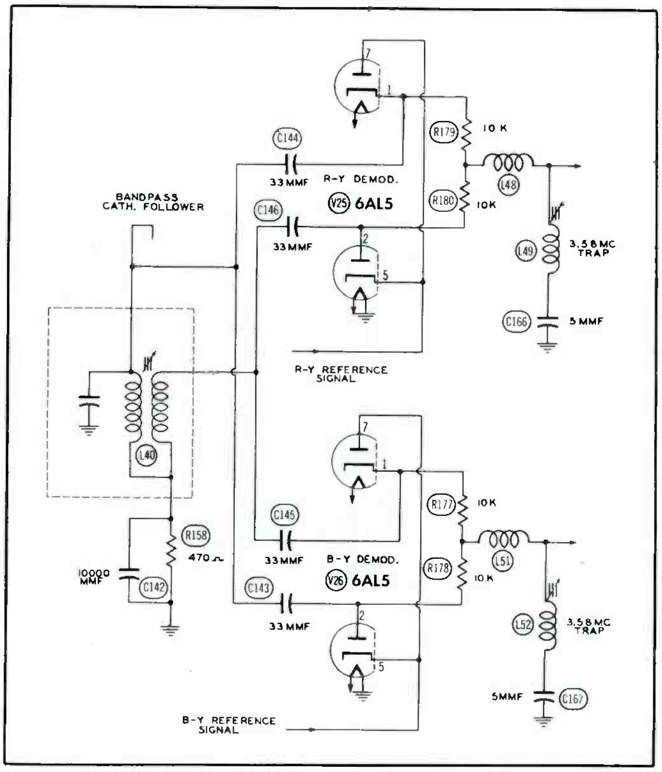

Fig. 7-35. Diode Demodulator Circuit in the Motorola Model 19CT1 Color Receiver.

The vector marked chroma 2 represents the second condition in which the chrominance signal led the R - Y reference signal by 45 degrees and led the B - Y reference signal by 135 degrees. This vector represents a yellow-orange color and contains a positive R - Y signal and a negative B - Y signal. These are the polarities of the R - Y signals and B - Y signals when chroma 2 is transmitted.

The R - Y and B - Y demodulators can be made to produce an output signal of a positive or a negative polarity, depending upon which is desired. Whenever an output signal of a positive polarity is wanted, the demodulator is made to demodulate on the negative reference axis. When one of a negative polarity is desired, the demodulator is made to demodulate on the positive reference axis. Such was the case for the demodulation process previously discussed — modulation was performed on the positive reference axis.

The circuits of diode demodulators that are used commercially are shown in Fig. 7-35. This circuit is employed in the Motorola Model 19CT1 color receiver. Two 6AL5 tubes are used in the demodulator stages. V25 is the R - Y demodulator, and V26 is the B - Y demodulator. The operation of these demodulators is the same as that discussed for the basic circuit in Fig. 7-30. These are R - Y and B - Y demodulators which are of negative polarity; that is, they demodulate along the positive reference axes and produce output signals that are reversed in polarity from the polarities used for modulating the chrominance signal at the transmitter. By passing these signals of negative polarity through an amplifier stage, they are inverted and then become signals of positive polarity.

This concludes the discussion of the demodulation process and the demodulator circuits in color receivers. In this discussion, we have been concerned with the chrominance signal as a modulated signal. We have taken this signal, demodulated it, and changed it into color-difference signals. From this point on, in the discussion of the color-receiver circuits, we will be concerned with these color-difference signals.

THE MATRIX SECTION

At this point in the discussion of color-receiver circuits, three video signals have been described. These are the luminance signal and the two color-difference signals at the output of the chrominance demodulators. It is the function of the matrix section to combine these three signals in the correct proportions so that three color signals are produced. These color signals are then amplified and applied to the picture tube where they represent the hues of an image in terms of red, green, and blue. The block diagram shown in Fig. 8-1 illustrates the

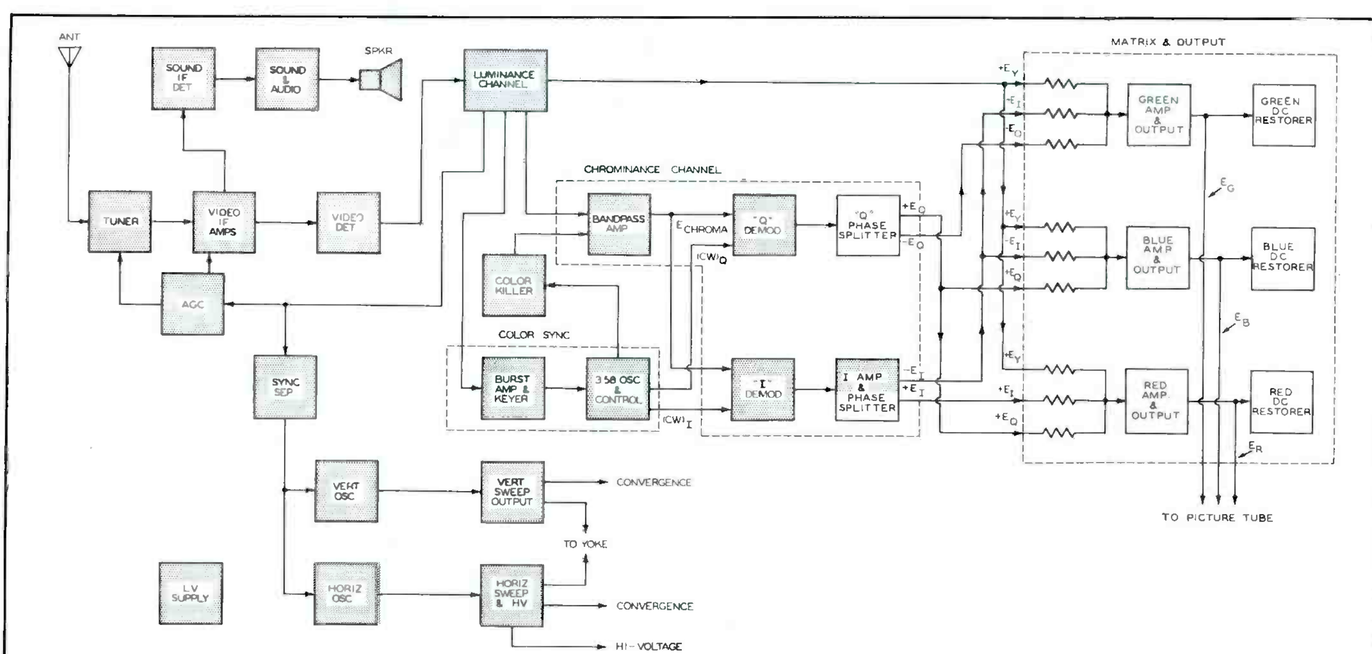

Fig. 8-1. Partial Block Diagram of a Color Receiver Showing Sections Previously Discussed and Those to Be Covered

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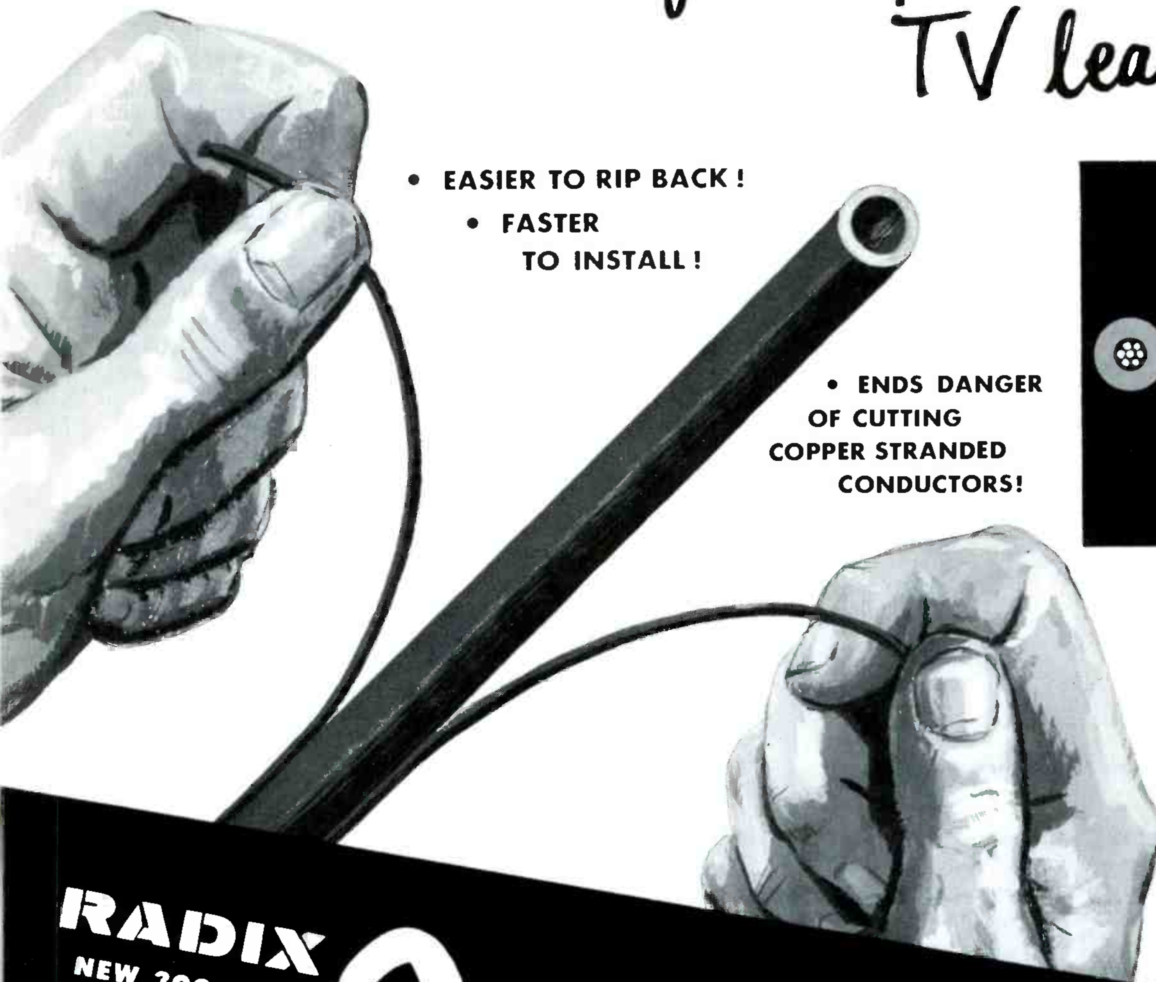

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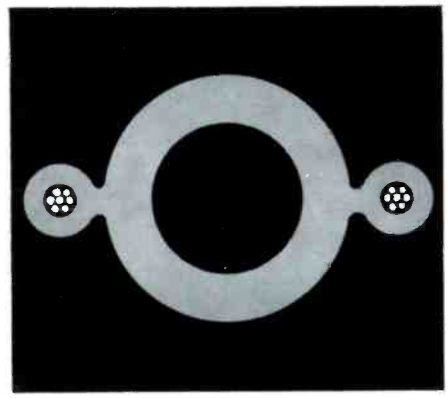

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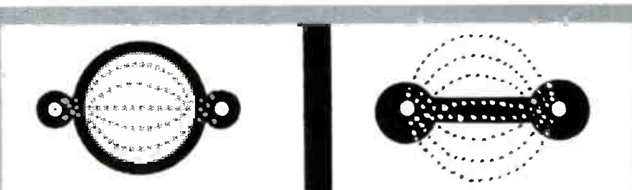

The field of energy between the two 7 stranded 20 gauge copper conductors is kept mainly within the enclosed low loss area, completely unaffected by outside weather conditions.

However, with ordinary flat twin lead, the field of energy is mainly outside, exposed to all weather conditions and dirt, affecting the impedance and resulting in unsatisfactory reception or loss of picture.

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In order to understand how the colors are reproduced, it is necessary to know something about the picture tube. The tube used in the basic color receiver is known as the tricolor kinescope. Three separate electron guns are incorporated in this type of tube in order to accommodate the three color signals. The coating on the face of the tube consists of phosphor dots which are arranged in triangular groups of three. One dot in each trio emits red, one emits green, and one emits blue light.

When operating properly, the electron beam from the red gun activates only the red dots, the beam from the blue gun activates only the blue dots, and the beam from the green gun activates only the green dots. The phosphor dots are closely spaced so that when more than one dot in each trio is activated, the total light emission will blend to form one color. For example, when the light emissions from all three phosphors are equal, the screen appears white. If the red and green phosphors emit equal light, the resultant hue appears to be yellow. The blending into a single hue of the color dots on the picture-tube screen is based upon the principle that the human eye cannot resolve the separate colors at normal viewing distance. As a result, the total light emitted from the dot combination appears as a single color.

The foregoing information should be helpful in understanding the requirements of the matrix section. A detailed discussion of the picture tube will be presented later in the Color TV Training Series.

In order to produce the colors of an image correctly, the matrix section must fulfill certain conditions. For instance, when a fully saturated red portion of the image is to be reproduced, the instantaneous amplitude of the video signal that is applied to the red gun must be at its maximum value and the amplitude of the signals applied to the green and blue guns must be zero. During the time when a fully saturated green is to be reproduced, the amplitude of the signals applied to the red and blue guns must be zero and that applied to the green gun must be at its maximum value. The blue signal must be at maximum and the red and green signals at zero when a fully saturated blue is being reproduced. If white is to be reproduced, the amplitude of all three of the color signals must be at maximum, because white contains all colors.

During the transmission of a composite color signal, the content of the Y, I, and Q signal voltages at the transmitter is known to be:

$$E_Y = .30E_R + .59E_G + .11E_B, \quad (4)^*$$

$$E_I = .74(E_R - E_Y) - .27(E_B - E_Y), \quad (8)^*$$

$$E_Q = .48(E_R - E_Y) + .41(E_B - E_Y). \quad (9)^*$$

From these equations, it can be determined that:

$$E_R = .96E_I + .63E_Q + 1.00E_Y, \quad (13)$$

$$E_B = -1.11E_I + 1.72E_Q + 1.00E_Y, \quad (14)$$

$$E_G = -.28E_I - .64E_Q + 1.00E_Y, \quad (15)$$

where

E_R, E_B, and E_G represent the desired red, blue, and green signal voltages which are to be applied to the picture-tube guns. The mathematical proof for these equations is presented in the footnote.[1]

It can be seen that the voltage combinations needed to produce the color signals consist of plus and minus values of E_I and E_Q. The plus and minus signs designate the polarities of the signal voltages. For instance, the minus sign in the expression $-.28E_I$ indicates an I signal which has a negative polarity. When no sign is used, the polarity is considered to be positive.

Let us suppose that the color-bar pattern shown at the top of Fig. 8-2 is used as the transmitted image. If all of the colors are fully saturated, the relative amplitude of the I, Q, and Y signals used in the make-up of the composite signal at the transmitter will be as shown below the bar pattern. The amplitude of the luminance signal during the reproduction of a white of full brightness is considered as the standard for unity; therefore, E_Y is shown to have an amplitude of 1.00 during the transmission of the white bar.

The amplitudes of the luminance signal and the color-difference signals during the transmission of the color-bar pattern shown are based on this unity figure. For example, when the image is a fully saturated red, the the amplitude of E_I is .60; the amplitude of E_Q is .21; and the amplitude of E_Y is .30. If the color of the image is changed to green, the amplitude of E_I becomes a negative .28; the amplitude of E_Q becomes a negative .52; and the amplitude of E_Y becomes .59. If the polarity of the E_I or E_Q signal is inverted (as through an amplifier stage), the positive levels become negative and the negative levels become positive. The negative polarities of E_I and E_Q are also shown in Fig. 8-2 to provide a convenient reference for the reader.

---

*Equations 4, 8, and 9 were presented in Part III of the Color TV Training Series which appeared in the August 1954 issue of the PF REPORTER.

[1] The content of the I and Q signals is known to be:

$$E_I = .74(E_R - E_Y) - .27(E_B - E_Y), \quad (8)^*$$

$$E_Q = .48(E_R - E_Y) + .41(E_B - E_Y). \quad (9)^*$$

If both sides of equation 8 are multiplied by .41 and if both sides of equation 9 are multiplied by .27, then:

$$.41E_I = .30(E_R - E_Y) - .11(E_B - E_Y),$$

$$.27E_Q = .13(E_R - E_Y) + .11(E_B - E_Y).$$

Adding the foregoing equations, we arrive at:

$$.43(E_R - E_Y) = .41E_I + .27E_Q.$$

Divide by .43, and solve for E_R:

$$E_R - E_Y = .96E_I + .63E_Q$$

$$E_R = .96E_I + .63E_Q + 1.00E_Y. \quad (13)$$

By substituting this value of E_R in equation 8, we find:

$$E_I = .74(.96E_I + .63E_Q) - .27(E_B - E_Y).$$

From the foregoing equation, E_B may be found:

$$E_B = -1.11E_I + 1.72E_Q + 1.00E_Y. \quad (14)$$

It was shown in Part III of the Color TV Training Series that:

$$E_G - E_Y = -.51(E_R - E_Y) - .19(E_B - E_Y).$$

Substituting values of E_R and E_B from equations 13 and 14, we find:

$$E_G - E_Y = -.51(.96E_I + .63E_Q) - .19(-1.11E_I + 1.72E_Q).$$

Solve the foregoing equation for E_G:

$$E_G - E_Y = -.49E_I - .32E_Q + .21E_I - .32E_Q,$$

$$E_G = -.28E_I - .64E_Q + 1.00E_Y. \quad (15)$$

In accordance with equations 13, 14, and 15, certain proportions of the signals shown in Fig. 8-2 must be combined to produce the three color signals. For instance, equation 13 states that .96 of the positive E_I signal, .63 of the positive E_Q signal, and 1.00 of the positive E_Y signal are required to produce the red signal. The amplitudes of the signals shown in Fig. 8-3 are of these proportions. During the transmission of the red bar, the amplitude of $.96E_I$ is seen to be .57 which is .96 of .60. The amplitude of $.63E_Q$ at this time is .13, which is .63 of .21. The amplitude of $1.00E_Y$ during the transmission of red is .30.

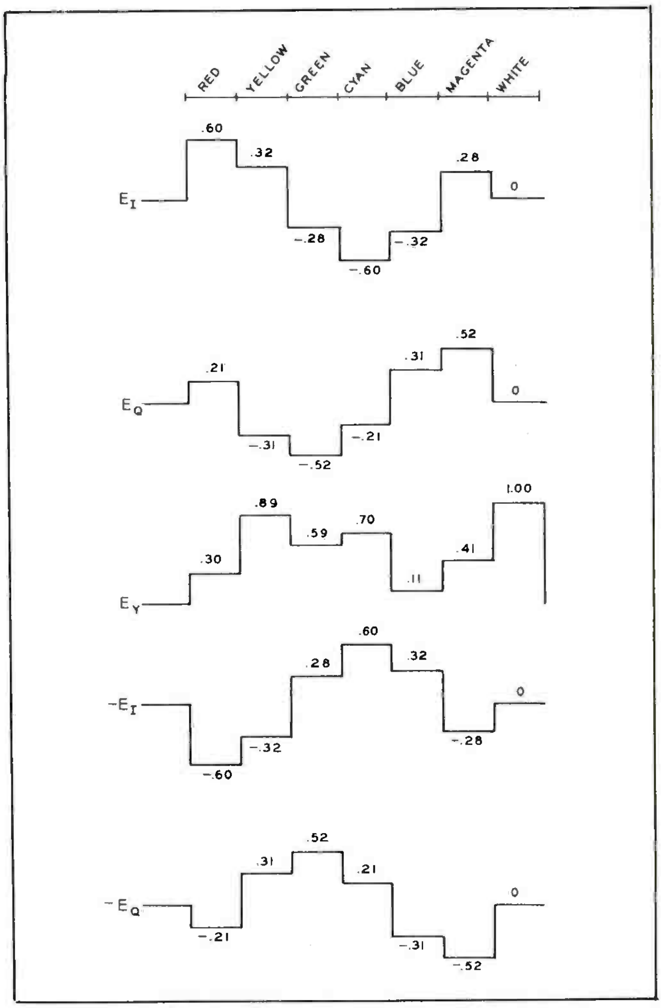


Fig. 8-2. Video Signals Developed in a Color Receiver During a Color-Bar Transmission.

During the scanning time of the red bar, the amplitudes of the I, Q, and Y voltages that are combined in the red matrix section have a ratio of .57 to .13 to .30, respectively. Since the addition of these amplitudes totals unity, the amplitude of the red signal is at maximum when red is being reproduced. If the same procedure is followed for all seven bars, it will be seen that the red signal will also be at maximum during the reproduction of yellow, magenta, and white. The instantaneous amplitudes during the scanning time of green, cyan, or blue will add up to zero; therefore, the red signal does not contribute to the reproduction of these colors.

The voltages determined by equation 14 are graphically shown in Fig. 8-4. These values are combined in the blue matrix section to produce the blue-signal voltage. The addition of instantaneous amplitudes shows E_B to be at maximum for cyan, blue, magenta, and white; and E_B is at zero for red, yellow, and green. This is the desired result, since E_B contributes to the colors which contain blue and does not contribute to the colors which are void of blue.

The values of the three signal voltages applied to the green matrix section were obtained from equation 15 and are shown in Fig. 8-5. The green signal represented by E_G is obtained by adding the instantaneous values of these three signals. The resultant signal is shown to have a maximum amplitude for yellow, green, cyan, and white. This indicates that the green signal contributes to the reproduction of each of these colors. E_G is at zero amplitude during the scanning time of red, blue, and magenta; therefore, the green-signal voltage does not contribute to these colors.

A comparison of the three color-signal voltages shows how the individual color bars are produced on the viewing screen. During the scanning time of the red bar, the red signal is at maximum and the blue and green are

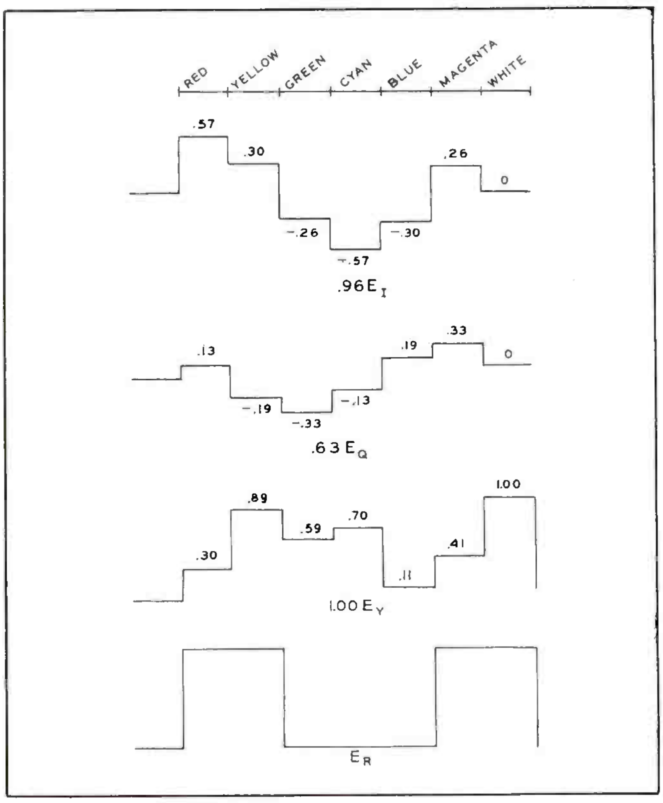


Fig. 8-3. Specific Amplitudes of E_I, E_Q, and E_Y Needed to Produce the Desired Red-Signal Voltage.

at zero. Only the red phosphor is illuminated, and a saturated red is produced on the screen. When the yellow bar is being scanned, both the red and green signals are at maximum and the amplitude of the blue signal is at zero. The red and green phosphors are both activated; however, the eye cannot see these colors separately. Instead, the total light emitted appears to be yellow. Cyan is produced when the light emissions from the blue and green phosphors are equal. When the light outputs from the red and blue phosphors are equal, the eye will see a fully saturated magenta.

The only time when all three color signals are at maximum is during the reproduction of white. This is to be expected, since white contains all colors. It is interesting to note that during the scanning time of the white bar, the amplitudes of E_I and E_Q at the input of the matrix sections are at zero. The amplitude of the E_Y signal is

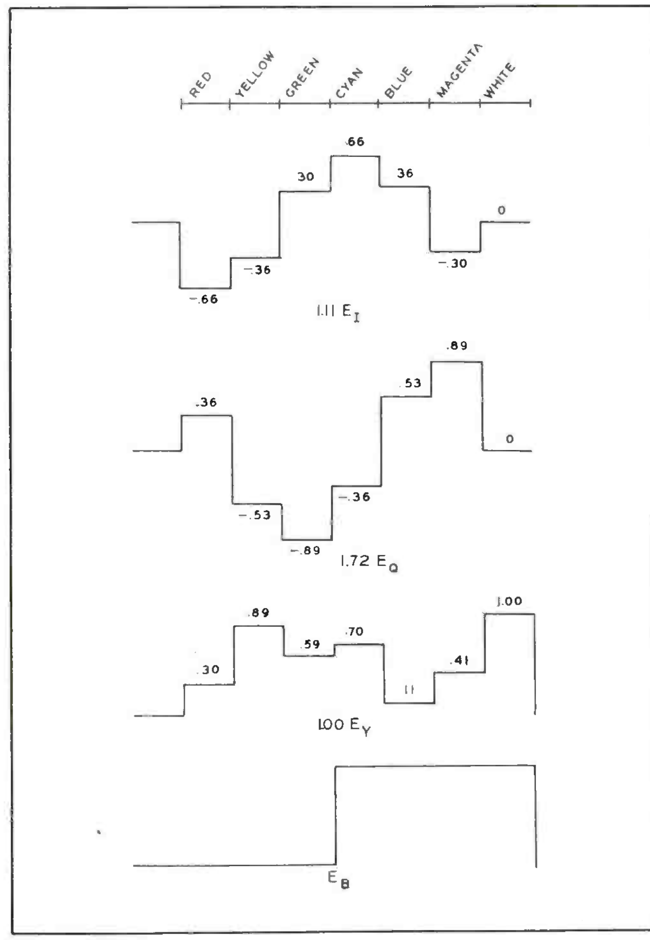


Fig. 8-4. Specific Amplitudes of E_I, E_Q, and E_Y Needed to Produce the Desired Blue-Signal Voltage.

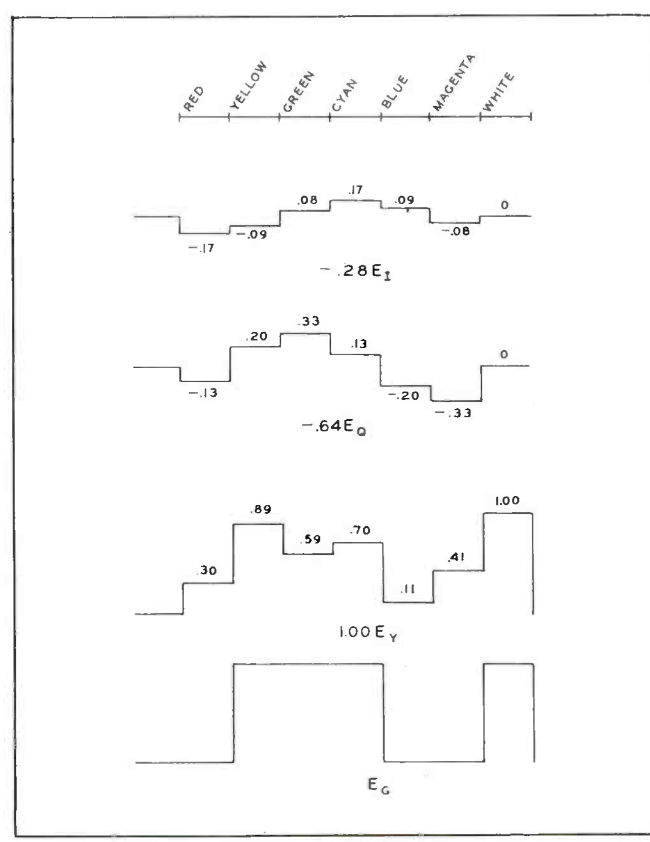


Fig. 8-5. Specific Amplitudes of E_I, E_Q, and E_Y Needed to Produce the Desired Green-Signal Voltage.

at maximum in each case, which indicates that white is represented by the luminance signal only.

Theory in Practical Application

Now that the purpose of the matrix is known, let us examine some actual circuits. The schematic drawing shown in Fig. 8-6 shows the matrix circuit used in the RCA Victor Model CT-100. The triode sections of two 6AN8 tubes are used as phase splitters. A negative polarity of E_Q from the output of the Q demodulator is applied to the grid of V10B. As a result, a positive polarity of E_Q is available at the plate of this stage; whereas, a negative polarity of E_Q is obtained from the cathode. Since the polarity of the I signal from the I demodulator has been reversed through the I amplifier stage, the signal at the grid of V32B has a positive polarity. The polarity of E_I at the plate of this stage is negative, and the polarity at the cathode is positive. During a typical color-bar transmission, these signal voltages are like those shown by the waveforms in Fig. 8-7.

Refer to Fig. 8-6, and note that the positive E_Q signal is fed to the red and blue matrix circuits and that the negative E_Q signal is applied to the green matrix. The negative E_I signal is fed to the green and blue matrix networks, and the positive E_I signal is applied to the red matrix. A positive E_Y signal from the output of the luminance channel is applied equally to all three matrix networks. Note that the signals applied to each matrix network have the proper polarity to produce the three color signals. Now, let us see how the specific amplitudes of E_I, E_Q, and EY are obtained.

The E_Y signal is applied to each of the matrix circuits through R239, R250, and R261. All three of these resistors are equal in value; therefore, if the grid resistance to ground at each amplifier stage is assumed to be the same, the amount of Y voltage to each of these stages will be the same. The amplitude of the chrominance signal at the output of the bandpass amplifier will have a fixed relationship with the luminance signal. This is because the contrast adjustment which controls the gain of the bandpass amplifier is ganged with the contrast adjustment which controls the gain of the luminance-channel output.

The amount of chrominance signal which is applied to the synchronous detectors can be varied through the use of the color-saturation control. Since this control will vary the amplitude of the E_I and E_Q signal outputs, it can be adjusted so that the amplitude of the negative E_Q signal at the input of the green amplifier has the desired relationship to the E_Y signal at this point (see Fig. 8-5). The amplitude of the positive E_Q signal is determined by the gain of V10B and by the value of the load resistor R223. The value of R223 was selected so that the amplitude of the positive E_Q signal at the input of the blue amplifier has the desired relationship to the E_Y signal (see Fig. 8-4).

The gain control in the cathode circuit of the I amplifier (not shown) can then be adjusted for the desired amplitude of the positive E_I signal at the input of the red amplifier. The amplitude of the negative E_I signal at the plate of the I phase-splitter stage will then depend on the gain of V32B and the value of the plate-load resistor R237. The value of R237 is such that the amplitude of the negative E_I signal has the desired amplitude at the input of the blue amplifier.

A certain amount of the negative E_I signal is also required at the input of the green amplifier; however, the amplitude of the signal at the plate of the I phase splitter

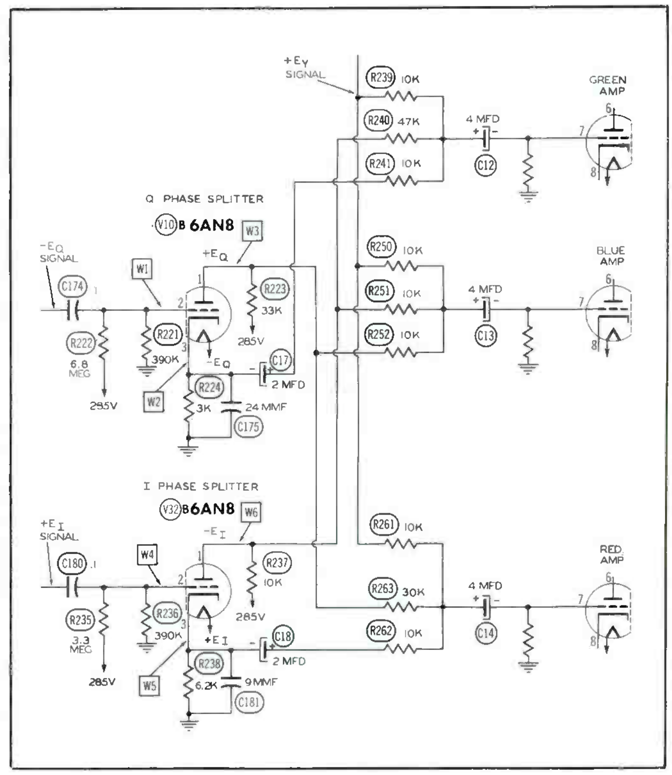


Fig. 8-6. Matrix Circuit Used in the RCA Victor Model CT-100 Color Receiver.

is more than four times the desired amount. The 47K-ohm resistor R240 and the resistance from the grid of the green amplifier to ground form a voltage-divider network. The same is true for the 10K-ohm resistor R251 and the resistance from the grid of the blue amplifier to ground. It was originally assumed that the resistance from grid to ground was equal at each amplifier stage; consequently, the amount of negative E_I signal developed across the grid resistance of the green amplifier will be much less than that developed at the input of the blue amplifier. The value of R240 was chosen so that the voltage division would produce the correct amount of negative E_I at the input of the green amplifier.

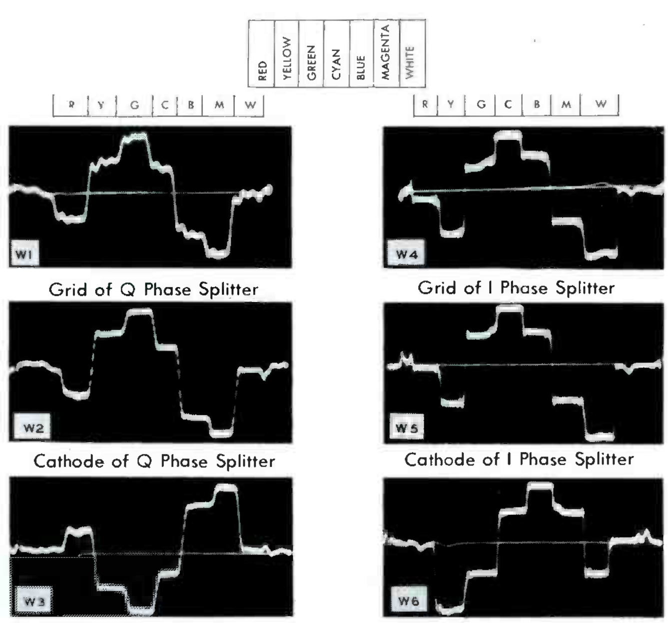
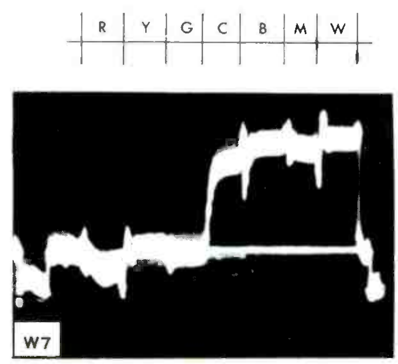


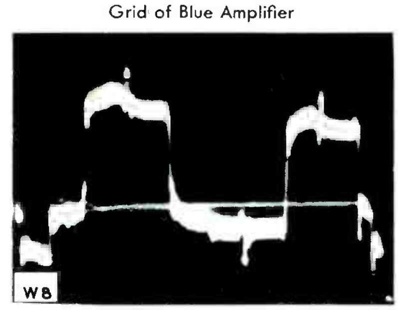
Fig. 8-7. Signal Voltages Present at the I and Q Phase-Splitter Stages During the Transmission of the Color-Bar Pattern Shown.

The proper voltages needed to produce the blue and green signals have been developed. A specified amount of positive E_Q voltage to the red amplifier will complete the voltages needed to produce the red signal. Since the amplitude of the positive E_Q signal at the plate of V10B is considerably greater than the amount needed ($1.72E_Q$ was required at the input of the blue amplifier), the voltage-division principle is again applied. The 30K-ohm resistor R263 causes the division in the proper ratio to produce the desired amount of E_Q signal at the input of the red amplifier.

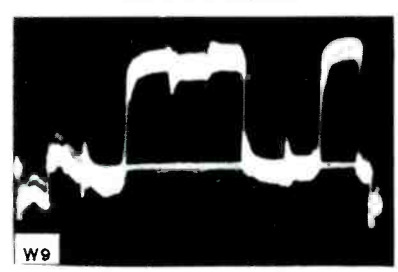
In actual practice, proper matrixing in this receiver can be accomplished by adjusting the hue, contrast, color saturation, and I gain controls. The grid resistance at each of the amplifier stages is a common load for the



Grid of Blue Amplifier



Grid of Red Amplifier



Grid of Green Amplifier

Fig. 8-8. Color-Signal Voltages at the Input of the Matrix Amplifiers When the Circuits Are Correctly Balanced.

three signals applied to each matrix circuit. For this reason, a change in one signal amplitude will affect the amplitude of the other two signals across the same load circuit. As a result, the foregoing adjustments must be repeated several times before the matrix circuits are balanced.

Following this procedure, a color-bar signal is fed into the receiver; and the controls are adjusted while observing the results on an oscilloscope. When the blue signal is balanced, as shown by waveform W7 in Fig. 8-8, the red and blue signals should then appear as shown in waveforms W8 and W9. These two signals will automatically balance when the blue signal is correctly adjusted, since a prearranged relationship exists between the three matrix circuits. It can be seen that these three wave forms conform to the requirements for proper color reproduction.

Cathode-Follower Matrix Circuit

The circuit drawing in Fig. 8-9 shows the matrix circuits used in the Arvin Model 15-550. The demodulator action is essentially the same as that described for the other receivers; however, the phase of the Q reference signal is such that a positive Q signal is available at the output of the Q demodulator stage. A negative I signal is produced in the output of the I demodulator stage. These signals are applied respectively to the grids of the G - Y and the R - Y matrix amplifiers.

These two stages function as cathode followers; consequently, positive Q and negative I signals are developed across the common cathode resistor R214. This combination of signals is applied to the cathode of the B - Y matrix amplifier. The signals will experience no polarity inversion through this stage; therefore, positive Q and negative I signals are produced at the output of V35B. These signals are of the proper polarity to produce a positive B - Y signal.

A positive Q signal is applied to the grid and a negative I signal is applied to the cathode of the G - Y matrix amplifier. The polarity of the Q signal is reversed through this stage; however, the polarity of the I signal is not inverted. A negative I and a negative Q signal appear at the output of this stage. These are the necessary polarities for producing a positive G - Y signal.

The specific amplitudes which are developed in the output of each of the matrix amplifiers are governed by the various bias levels on these stages. The relative signal amplitudes obtained from the demodulator stages and the plate voltages applied to the matrix amplifiers are also important factors in this operation. The values chosen for the parts in the matrix circuit are such that the proper amplitude of the I and Q signals are combined to produce the ghree color-difference signals.

Video peaking is provided for each of the color-difference signals in the plate circuits of the matrix amplifiers. Since the DC component is lost when the signals are applied through the coupling capacitors, DC restoration is provided. The color-difference signals are then fed to the respective control grids of the picture tube.

A previous section of this series discussed a luminance channel which provided at the output a negative Y signal. It can be seen that the circuit in Fig. 8-9 utilizes such a signal. By applying a positive color-difference signal to a grid of one of the guns in the tricolor picture tube and a negative Y signal to the cathode of the same gun, the matrix operation is completed. This can be more clearly understood if it is considered that a negative signal at the cathode of a tube will provide the same action as a positive signal of the same amplitude applied to the grid.

Matrixing in the R-Y, B-Y Receiver

The schematic diagram in Fig. 8-10 shows the matrix circuit used in the Westinghouse Model H840CK15 color receiver. The fact that this receiver demodulates along the R - Y and B - Y axes simplified the matter of combining signals. An R - Y signal and a positive E_Y signal are combined at the input of the red amplifier, and a B - Y signal and a positive E_Y signal are combined at the input of the blue amplifier.

It has been mathematically proved that a G - Y signal can be formed by combining a negative R - Y and a

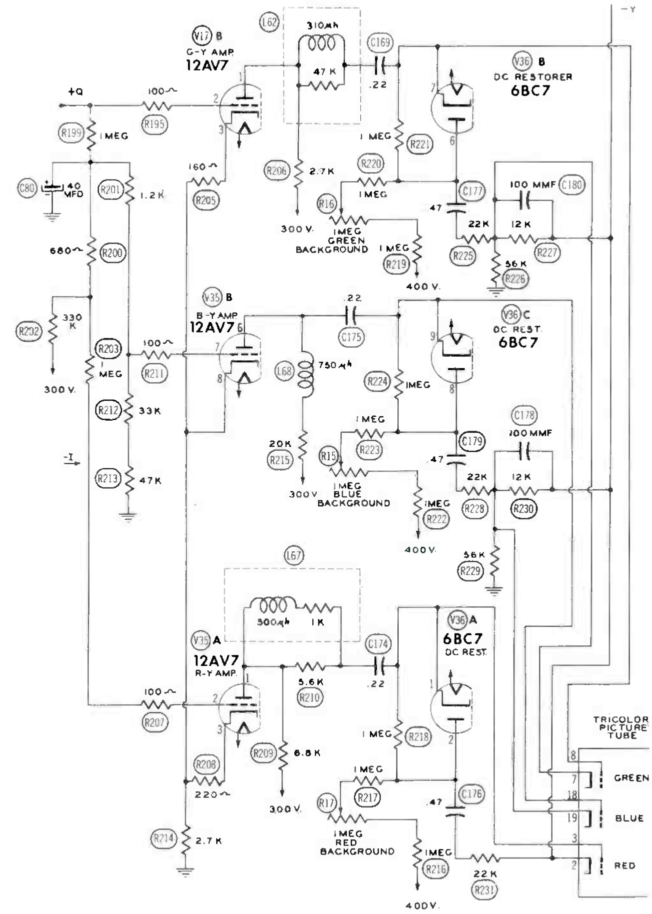


Fig. 8-9. Matrix Circuit Used in the Arvin Model 15-550 Color Receiver.

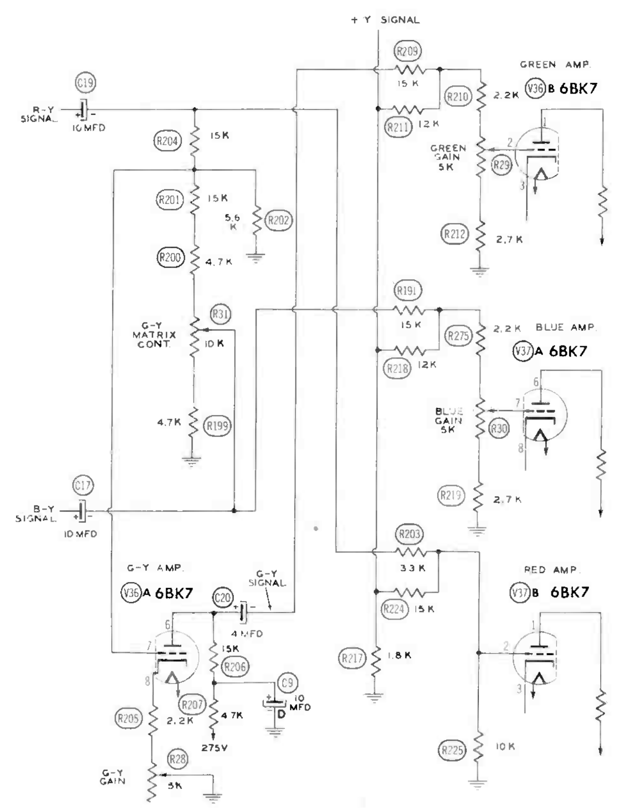


Fig. 8-10. Matrix Circuit Used in the Westinghouse Model H840CK15 Color Receiver.

negative B - Y signal in the ratio of .51 to .19. This receiver combines positive values of R - Y and B - Y in the proper ratio to produce a negative G - Y signal which is then applied to the grid of the G - Y amplifier. As a result, the signal voltage available at the plate of this stage is a positive G - Y. This signal is combined with a positive E_Y signal at the input of the green amplifier.

In order to reproduce the three color signals properly, the luminance and color-difference signals must be combined in a specific ratio. For a given amplitude of the luminance signal, the amplitudes of the R - Y and B - Y signals can be adjusted through the use of the color saturation and B - Y gain controls (not shown in Fig. 8-10). The G - Y matrix control can be adjusted for a ratio of R - Y and B - Y which will produce a negative G - Y signal. The gain control in the cathode circuit of the G - Y amplifier can be adjusted so that the proper amplitude of G - Y voltage is combined with a given amount of positive E_Y signal.

AMPLIFIER AND OUTPUT STAGES

The analysis of the matrix circuit used in the RCA Victor Model CT-100 color receiver assumed that the grid resistances of the amplifier stages were equal. As seen in Fig. 8-11, this is not actually the case, because the grid-load circuits of the blue and green amplifiers are shunted by the blue and the green gain controls. The reason for this is that in order to produce the same light output from all three phosphors, more signal voltage is required to excite the red phosphor than is required to excite the blue and green phosphors. The blue and green gain controls are used to adjust the amplitudes of the signal voltages so that the emissions from the three phosphors are equal.

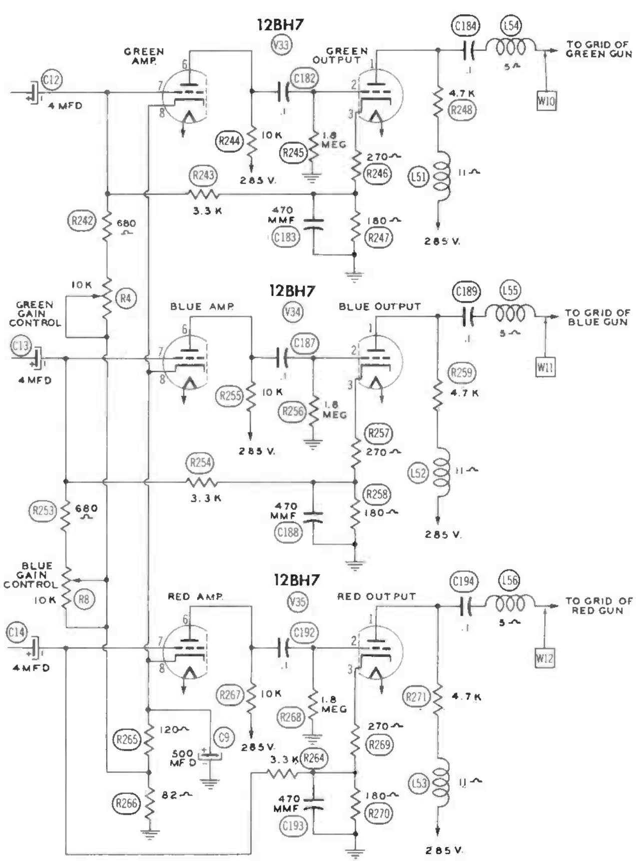


Fig. 8-11. Matrix Amplifier and Output Stages in the RCA Victor Model CT-100 Color Receiver.

The ratios of the voltages in the individual matrix circuits are not affected by the adjustment of these controls. That is, if the blue gain control is varied, the amplitudes of the I, Q, and Y voltages which are developed in this grid circuit will vary; but the percentage of change in each signal is the same, and the ratio between each signal amplitude and the total amplitude does not change.

Further examination of the circuit shows that degenerative feedback is applied from the cathodes of the output stages to the grids of the amplifier tubes. The 470-mmf capacitor in each cathode circuit causes the degeneration to be greater at the low frequencies. These capacitors also cause the gain through the output stages to be greater at the higher frequencies. The gain of each color signal is thereby stabilized over the video-frequency range. Shunt and series peaking are provided in order to maintain uniform video response. The signals at the grids of the red, blue, and green guns during a typical color-bar transmission are shown by the waveforms in Fig. 8-12.

DC RESTORATION

The DC component of three color signals has been blocked by the coupling capacitors between the various amplifier stages. If the correct DC level is not restored, these signals will not accurately reproduce the background illumination. Instead, the background illumination will be represented by the average amount of voltage of the AC signals.

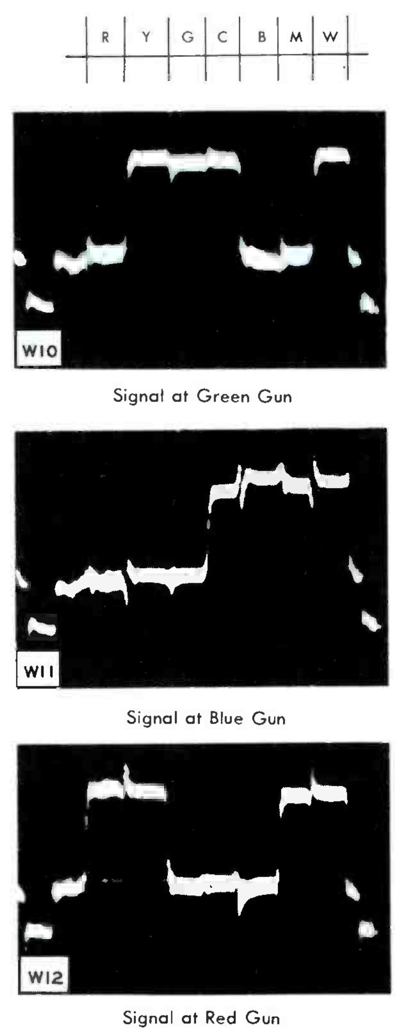


Fig. 8-12. Color-Signal Voltages at the Control Grids of the Tricolor Kinescope During a Color-Bar Transmission.

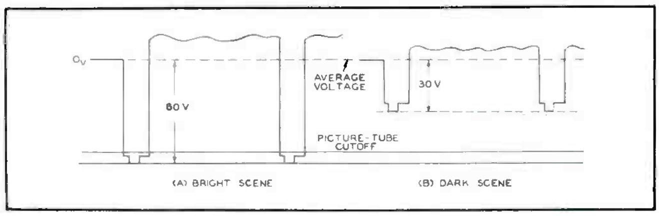


Fig. 8-13. Loss of the DC Component in the Video Signal.

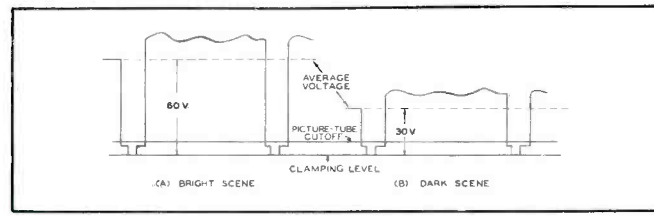


Fig. 8-14. Video Signals With the DC Component Restored.

The drawing shown at A in Fig. 8-13 is representative of a scene which has a high-brightness level. The brightness control has been adjusted so that picture-tube cutoff is just above the blanking level. If a signal representing a low-brightness scene is now transmitted, a condition like that shown at B will exist. The average bias on the picture tube does not change; consequently, the background illumination is still the same. In addition, the blanking level will not reach the cutoff level of the picture tube, and the retrace lines may be seen in the picture.

The desired condition at the grid of the picture tube is illustrated in Fig. 8-14. The sync tips are shown to be clamped at a predetermined DC level so that cutoff is effected by the blanking pedestal regardless of the peak-to-peak amplitude of the signal. It can be seen that the average voltage at the grid of the picture tube will be equal to the DC clamping level plus the average voltage produced by the AC signal.

One method of obtaining the foregoing condition is through the use of the circuit shown in Fig. 8-15. This circuit is used in the RCA Victor Model CT-100 color receiver to restore the DC level to the red signal. The restoration circuits for the blue and green signals are identical to the one shown. If no signal is present at the output of V35B, the voltage at the plate is approximately 215 volts. Let us assume that the brightness control has been adjusted so that the potential at the plate of V36C is a positive 20 volts with respect to ground. This voltage will also be present at the cathode and at the top side of R277; consequently, C194 and C195 will each be charged to a potential of 195 volts. The polarity of these charges will be as shown in the drawing. Since the diode will conduct only from cathode to plate, the voltage at the negative side of these capacitors can increase but cannot decrease.

Let us suppose that the signal representing a bright scene in Fig. 8-13A is present at the plate of V35B. During the negative excursions of the signal, the voltage at the positive side of C195 will decrease by 60 volts. The voltage at the negative side of this capacitor will try to decrease by the same amount; however, this action causes the diode to conduct, and the charge across C195 is reduced by 60 volts.

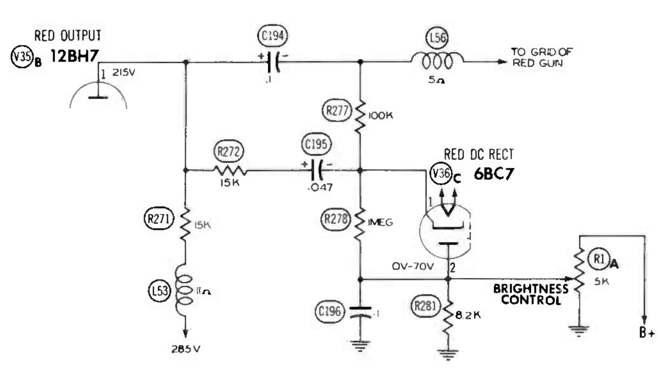


Fig. 8-15. DC-Restorer Circuit Used in the RCA Victor Model CT-100 Color Receiver.

When the signal at the plate of V35B goes in a positive direction, C195 will try to charge to a higher value; however, the time constant of C195 and R278 is nearly 800 times the scanning time of one horizontal line. As a result, the charge across C195 will remain fairly constant until the brightness level of the scene changes. The voltage at the negative side of the capacitor will follow the signal variations at the positive side; consequently, the voltage at the grid of the red gun will have an average value which is equal to the average value of the signal plus the voltage at the plate of the diode. The negative peaks of the signal are clamped at the DC level determined by the setting of the brightness control. Note that this condition conforms with that shown at A in Fig. 8-14.

Let us see what happens to the same circuit when the signal representative of a dark scene is being received. During the negative excursions of the signal, the voltage at the plate of V35B will decrease by 30 volts. The voltage at the negative side of C195 cannot decrease, so the potential across the capacitor is reduced by 30 volts. (The discharge path is through the diode.) The result of this action maintains the voltage on the negative side of C195 at the DC level determined by the setting of the brightness control during the time that the signal at the plate of V35B is at a maximum negative level.

When the signal goes in a positive direction, C195 tries to charge to a higher level but does not have sufficient time to do so. (The signal is positive for approximately 60 microseconds; whereas, the time constant of C195 is 47,000 microseconds.) As long as the brightness level of the signal remains the same, the charge across C195 will be held at a relatively constant level. When the signal at the plate of V35B traverses from the negative peak to the positive level, the voltage at the negative side of C195 will increase by the same amount. As a result, the negative peaks of the signal at the cathode of the diode are clamped at a specific DC level, as shown at B in Fig. 8-14.

The 15K-ohm and 100K-ohm resistors R272 and R277 isolate the clamping action of the diode from the plate circuit of V35B. The charging and discharging action across C194 is much the same as that across C195, since C194 is essentially connected in parallel with C195.

As mentioned previously, a DC-restoration circuit is employed in the grid circuit of each of the guns. The plates of all of the DC-restorer diodes are connected together so that all three signals will be clamped at the same level.

In the next issue, we will begin the discussion of the color-picture tubes and will discuss their associated convergence circuits.

In order to give the reader an opportunity to test himself on the material in this issue, we are including on the insert a few questions that are answered in this discussion.

BY C. P. OLIPHANT *and* VERNE M. RAY

Notes on Test Equipment

(Continued from page 19)

into the receiver by rotating the output control in a clockwise direction. The VTVM pointer will move across the scale; and when it has reached the mark on the lower scale which corresponds to the one noted previously on the upper scale, the noise figure of the receiver can be read on the db meter. The noise generator is so designed that, for the conditions just mentioned, the signal fed in from the diodes is just enough to double the noise power at the video detector.

For those readers who may wonder why the instrument is set up to operate in this manner (that is, through a doubling of the noise power), the following explanation is offered. The noise factor (NF) of an amplifier can be defined as the actual noise-power output that is due to input resistance and amplifier noise divided by the noise-power output that is due to input resistance only. This relationship can be conveniently referred to the amplifier input terminals in terms of the rms noise current of a noise diode. If the noise source is matched to the amplifier input throughout the bandwidth of the amplifier, the noise factor may be found from the following expression:

$$NF = \frac{.02\ IR}{n - 1}$$

where

I = noise-diode current in ma,

R = amplifier input impedance,

n = noise power from the amplifier when the diode is on divided by noise power from the amplifier when the diode is off.

By adjusting the output of the noise diode until the receiver output doubles, n can be made equal to 2; and n - 1, of course, becomes 1. The meter which measures diode current I can then be calibrated to read the noise factor directly; and since by definition the noise factor is a power ratio, the scale divisions can be in decibel units.

Contrast the method which uses the Hickok Model 755 to determine the noise figure with another method that is sometimes used to evaluate how well a receiver will pick up weak signals. First, the antenna terminals are shunted with a resistor of value equal to the input impedance of the receiver (usually 300 ohms). An AC VTVM is connected across the point of signal input to the picture tube, and the reading is noted. The contrast control should be at maximum setting for all readings. If the reading is greater than 3.33 volts rms, the receiver sensitivity is reduced to obtain this reading by applying the necessary amount of fixed bias to the AGC line. In a receiver which employs keyed AGC, the AGC section should be disabled unless fixed bias is applied as just mentioned. The receiver check should be made with the tuner set to that channel on which it is expected to receive the weakest signal, and the fine tuning must be accurately adjusted. This can be accomplished by applying a sweep signal to the antenna terminals at the channel frequency and an RF marker signal at the exact frequency of the channel video carrier. A scope connected across the video detector will then display the over-all response of the receiver, and the fine tuning should be adjusted to place the marker at the point recommended for correct alignment. This will usually be at 50 per cent in the video slope of the curve.

After the receiver tuning has been correctly adjusted in this manner, the sweep generator is removed and the marker signal alone is applied. This signal is maintained at its previously determined frequency and is modulated 30 per cent with an audio signal. The generator used for the marker signal must be one which has an accurately calibrated attenuator. The level of output from the generator is adjusted to obtain a 20-volt peak-to-peak reading of the audio modulating signal on the VTVM which is connected to the modulated element of the picture tube. This level of output will provide a relative evaluation of the ability of the receiver to pick up weak signals.

The choice of the 3.33-volt and 20-volt standards in the foregoing procedure is based on the following reasoning. A 20-volt peak-to-peak signal at the picture tube is generally considered to be the minimum for an acceptable picture. Satisfactory synchronization will usually be obtained for a value even lower than this; therefore, the picture quality can be considered as the limiting factor. A one-to-one ratio of signal to noise is also generally accepted as the minimum for acceptable viewing, and this would mean that the noise peaks should be limited to 20 volts or less. The average reading for random noise with 20-volt peaks is about 3.33 volts, as read on the AC rms scale of the VTVM. Therefore, a 3.33-volt rms noise reading and a 20-volt peak-to-peak signal indicate that the signal-to-noise ratio is established at a value of one to one. This value satisfies the minimum conditions for acceptable picture quality.

It can readily be seen that the foregoing procedure is rather involved when compared to the direct approach afforded by the noise generator. In addition to the ease with which the noise generator may be operated, another advantage of the instrument is the fact that the noise figure is obtained without regard to the response characteristics of the receiver.

Manufacturers of receivers and amplifiers should find an instrument of this type useful in checking the noise characteristics of their products. Large service shops, particularly those in fringe-reception areas, should also find use for this instrument. For example, a receiver may be brought into the shop with the complaint that there is excessive snow in the picture. A check may reveal that the set does not have abnormally low sensitivity. This would indicate that some stage is introducing an unusual amount of noise.

Any circuit component can be suspected of contributing excessive noise. Resistors and capacitors can become noisy in time, and this noise will be especially noticeable if the components are in a part of the circuit where the B+ voltage is applied. More often than not, a noisy tube may be the offender, and this can be easily checked by substitution.

In the majority of cases, the input stages of an amplifier will contribute much towards a high noise level because any noise developed in them undergoes a higher amplification than noise introduced at later stages. The following example will serve to illustrate how the selection of tubes for the tuner section of a receiver may lower the noise figure of the entire receiver. A receiver was checked using the Model 755 noise generator and was found to have a noise figure of 16.5 db. The tuner employed a 6J6 mixer-oscillator tube. Three new 6J6 tubes were substituted and the results are shown in the following table.

TUBE	Noise Figure (db)	Triode No. 1 (μ mhos)	Triode No. 2 (μ mhos)
1	16.5	2500	2100
2	15.0	5000	5000
3	12.5	3900	4700
4	11.5	4600	4600

The No. 1 tube was in the set originally and was also the one which gave the highest noise figure. As a matter of information, the tubes were checked for transconductance in a tube checker to see if that tube characteristic might bear any relation to the noise figure. It can be seen that the No. 1 tube was considerably weaker in transconductance than the others. A value of 3,000 micromhos was listed as normal on the tube checker. The No. 4 tube afforded an improvement of five db in the noise figure. No apparent relation between the transconductance and the noise figure could be seen. All these tests were made inside a screen room in order to exclude outside noise. When a test was made outside the screen room, the noise figure using the original 6J6 jumped from 16.5 db to over 19 db which is the maximum indicated on the scale of the db meter. Incidentally, although a screen room would be desirable for exact measurements, a relative comparison between receivers can be made without the use of a screen room. No attempt was made to check the sensitivity of the receiver while substituting tubes to lower the noise figure; however, a decrease in the noise figure will usually be accompanied by an increase in sensitivity.

In checking a variety of receivers, the technician might find that representative noise figures would fall into the following ranges: 9 to 16 db for receivers with pentode tuners and three to four IF stages, 6 to 14 db for receivers with cascode tuners and three to four IF stages. Individual receivers in each group might occasionally give an even lower figure. A noise figure near the upper limits of these ranges should lead the technician to suspect that some improvement might be obtained either by tube substitution or by other means such as realignment.

It is quite possible that noise may be originating within the receiver in sources other than the amplifier circuits being measured. Such sources could be a high-voltage supply with corona leakage, a sweep circuit that is disturbing the video stages, or other sources having RF leakage or hum coupling. Possibly noise measurement can be used as an aid in determining if this type of noise is present and in tracking it down. If the technician is unable to lower the high noise figure in a receiver by working with the RF and IF stages, he should check to see whether these other sources are contributing to the noise in the set.

Locating Hard-to-Find Tube Shorts

While checking a tube recently for suspected shorts, we accidentally came upon a procedure which might prove helpful in some of those stubborn cases. Usually, the procedure in checking a tube with any make of tube checker is to check first for shorts and then, if none are found, to proceed with a merit check and other tests. This precludes the risk that a shorted tube might damage the tube checker if other checks were made before the shorts test.

Some shorts will not show up unless the tube is at a high operating temperature like that attained during actual use. A shorts test is usually performed with only the filament voltage applied for tube operation. (A voltage is also applied to make the shorts indication, but this does not contribute towards heating the tube.) The tube temperature can be raised considerably by the following procedure. First, make the shorts test as a safety precaution; then, if no indication is obtained, make the merit test, prolonging it somewhat more than necessary for the actual reading. Immediately, before the tube has a chance to cool, make another shorts test. The added heat may be sufficient to cause the short to appear, and thus it can be located. Some tube checkers are designed so that it is possible to make a quick change from a shorts test to a merit test. On other checkers, this change may require a little more time.

The above procedure might prove helpful in checking for gas in tubes, because this condition is one which is also aggravated by heat.

Calibrating the Hickok Model 690 Crystal-Controlled Marker Calibrator

Recent correspondence indicates that some technicians may be a little uncertain concerning the exact location of the proper calibration points when calibrating the Hickok Model 690 marker calibrator on the lowest range (4.25 to 11 mc). This uncertainty arises from the fact that apparently two peaks of electric-eye closure are obtained within a fraction of a megacycle of each other at the calibration points. This aspect of calibration is covered briefly in the Hickok manual of operating instructions, Note 1, page 3. When the technician understands fully the significance of these indications, it will be seen that calibration is extremely accurate.

Calibration of the instrument is accomplished through the use of a 2.5-mc crystal furnished with the Model 690, or a crystal of the technician's own choosing can be used in one of the spare positions. When the 2.5-mc crystal is used, the marker signal can be calibrated at all points which are multiples of 2.5 mc. These points are indicated by indentations on the dial scale.

Signals from the crystal oscillator and the RF variable oscillator of the instrument are applied to a mixer stage and heterodyned together. The result is an audio beat difference, and this difference is fed to a two-stage audio amplifier having a gain of approximately 800. The amplified audio beat difference is then applied to a diode rectifier and filter stage with the result that a filtered DC output is available for the grid of the tuning-eye tube. Application of this DC voltage causes the tuning eye to close to a certain extent, depending upon the setting of the sensitivity control of the indicator. The audio amplifier has a normal audio response which falls off at the high- and low-frequency ends. Above and below these points, the beat frequency will have little effect on the eye. When the generator is tuned to approach the calibration point, a high beat frequency is obtained first; and this is gradually lowered in frequency as the tuning continues. When the generator tuning reaches the exact point of calibration, the beat frequency has fallen to zero; and further tuning in the same direction will cause the beat frequency to rise and go through all the previous frequencies but in reverse order.

A graph of the audio-amplifier response to the beat frequency might appear somewhat as in Fig. 3. Since the response falls off at the extreme high and low audio frequencies, there

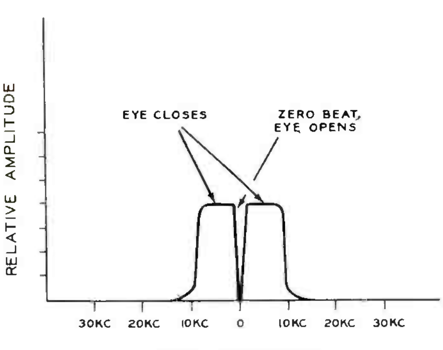


Fig. 3. Response of the Audio Beat-Frequency Amplifier in the Hickok Model 690 Marker Calibrator.

will be a dip in the response at the zero-beat point with a peak occurring on either side. This graph could also serve to represent the DC voltage applied to the tuning eye, with the two peaks representing closure of the eye and the dip representing the open condition. The entire range of response of the audio amplifier extends from approximately 10 kc on one side through zero beat to approximately 10 kc on the other side. The RF generator must be tuned through approximately 20 kc to cover this range.

On the low-frequency range (from 4.25 to 11 mc) of the generator, this 20-kc tuning is covered by a very small rotation of the tuning control; therefore, slow and careful tuning is necessary to set the control to zero-beat position. On the high-frequency ranges, the tuning is even sharper; and the only visible indication of zero beat will be a faint flutter of the eye as the generator is tuned through the point of minimum shadow angle. In either case, the flutter or opening of the eye between the two peaks of eye closure indicates the exact center of the calibration point; and it is to this point that the generator should be tuned for calibration purposes.

RECENT RELEASES

Sylvania Type 403 Oscilloscope

This new Type 403 oscilloscope by Sylvania Electric Products Inc., was designed with particular attention to the needs of the television service industry and has the following features:

DC coupling for both horizontal- and vertical-deflection amplifiers.

Vertical sensitivity, 20 millivolts rms per inch.

Linear sweeps from 5 cycles to 50 kc; two preset television sweeps, 30 and 7,875 cycles.

Horizontal and vertical response, flat to -2db from 0 to 500 kc.

Six-volt rms calibrating voltage and a saw-tooth sweep voltage are available at the front panel.

Frequency-compensated attenuator.

Seven-inch cathode-ray tube.

Other specifications include vertical impedance of one megohm and 26 mmf and horizontal impedance of one megohm and 53 mmf. Provision is made for internal or external synchronization of either positive or negative polarity. Horizontal and vertical amplifiers are push-pull.

Over-all dimensions are 17 1/16 inches high by 11 3/8 inches wide by 19 1/2 inches deep. Weight is 43 pounds.

Sylvania Type 301 Polymeter

This Type 301 vacuum-tube voltmeter is a recent addition to the line of polymeters made by Sylvania Electric Products Inc. Among its features are: a 7-inch meter movement illuminated for viewing in poorly lighted locations, 17-megohm effective input resistance, peak-to-peak scale for measurement of complex waveforms, shielded AC lead, screw-on connectors, and a patented linearity circuit for greater scale accuracy.

The following scales are provided for each of the indicated functions:

Peak-to-peak meter, 6 ranges from 0 to 2800 volts.

AC voltmeter, 6 ranges from 0 to 1000 volts.

DC voltmeter, 6 ranges from 0 to 1000 volts.

Ohmmeter, 6 ranges from 0 to 1000 megohms.

DC ammeter, 6 ranges from 0 to 10 amperes.

Decibel meter, 6 ranges from -20 to +61.4 decibels.

The input impedances are:

AC ranges, 2.7 megohms shunted by 40 or 125 mmf when using the shielded lead.

DC ranges, 17 megohms including one megohm in the probe.

Over-all dimensions are 8 3/4 inches wide by 11 3/16 inches high by 6 15/16 inches deep. Weight is 12.5 pounds.

Accessories supplied with the Sylvania Model 301 are:

One DC test probe.

One shielded AC-volt, DC-current, and ohms test lead.

One common test lead.

Sylvania Type 302 Polymeter

The Sylvania Type 302 is a deluxe version of the Type 301 polymeter and includes all of its features. An additional feature is the inclusion of an RF probe which is an integral part of the new Type 302. This probe is of the vacuum-tube type and is equipped with a shielded cable and a coaxial connector. Spring clips provide for convenient mounting of the probe on the front panel when the probe is not in use.

PAUL C. SMITH

Dollar & Sense Servicing

(Continued from page 31)

TV IN BOOTHS. From a Washington news letter, we learn that a restaurant in Paramus, N. J., practically in our own back yard, has installed TV sets in individual booths. Half a dozen phone calls failed to locate the restaurant, but we still like the idea. Here's why.

For booths a 10-inch screen is ideal, since viewers are close up. What better use could there be for those 10-inch trade-ins gathering dust in your back room or basement. You'd have to catch the restaurant at remodeling time, or talk them into moving the booths out from the wall far enough to accommodate the depth of the sets. Some may prefer outright sale, with or without a yearly service contract; whereas others might prefer leasing at so much a month including service.

Don't go into something like this too fast, however. Remember that the sets will have to bring the restaurants enough EXTRA business to give enough extra profit to pay for what you charge for the sets. You've gotta be prepared to show that these sets will pay for themselves and then some in a place that probably has one big set over the bar already.

Perhaps coin-in-the-slot attachments for the sets will be the answer in some places; you can buy these quite reasonably now and then from such surplus firms as Herbach and Rademan Inc., 1204 Arch St., Phila.7, Pa. Ask to get on their mailing list for monthly catalogs, if you're not already getting them. The bargains are mixed in with items of regular price so you'll have to hunt.

FOLLOW THE LEADER. When RCA needed half a dozen special new electronic assemblies in a hurry to meet opening dates for a new Cinemascope feature, their industrial TV system saved the day by eliminating training time entirely. A camera was mounted in position over a workbench where a specialist assembled the needed unit, and six receivers were placed on production benches right in front of the other workers. Each watched the screen and followed the movements of the leader while listening to his verbal instructions, completing the job in time to make the deadline.

JOHN MARKUS

Transistor Radio Is Here

(Continued from page 13)

complete with battery weighs only 12 ounces. The case is made of polystyrene plastic and is available in a variety of colors. The schematic of the Model TR-1 is shown in Fig. 1 and should be of real interest.

Technical Features

The assembly process starts with the printed-circuit board shown in Fig. 2. This board serves as the chassis of the receiver. All of the components are mounted on the board, and all connections are soldered simultaneously in one dipping operation.

Converter Stage

The antenna in the Model TR-1 is in the form of a coil which has a ferrite core providing a tuned circuit of high Q. Hand capacitance has very little detuning effect on this coil, and the receiver is not exceptionally directional; these are two good features in a portable receiver of such a small size. A low-impedance winding on the antenna coil couples the received signal to the base of the converter transistor. Like the three other transistor stages in the receiver, the converter stage is biased in such a way that the input impedance is low (about 500 ohms).

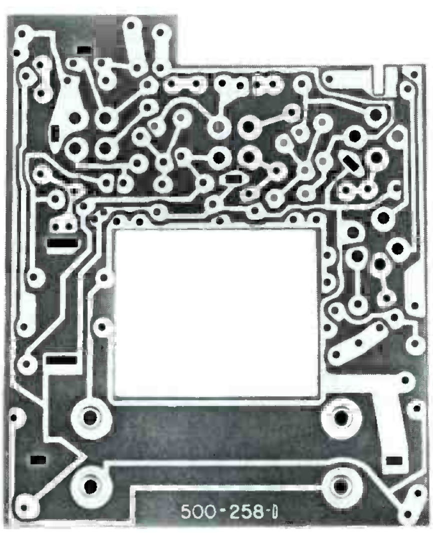


Fig. 2. Printed-Circuit Board Used in the Regency Model TR-1.

The oscillator injection voltage is derived from a tuned circuit which is inductively coupled to a coil in the collector circuit. The entire converter stage is similar in operation to the vacuum-tube converter circuit shown in Fig. 3, a circuit which has been used in conventional receivers. As in any superheterodyne receiver, the IF transformer accepts the proper frequency from among the multitude of frequencies in the output circuit of the converter and passes this frequency to the first IF stage.

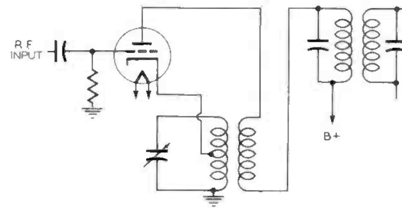


Fig. 3. Equivalent Vacuum-Tube Converter Circuit.

IF Stages

The IF transformers used in this receiver are of the tuned-primary, untuned-secondary type; and they resonate at 262 kc. The secondaries are wound with very few turns so that proper matching to the low input impedances of the IF transistors is obtained. The primary of each transformer is paralleled by a capacitor of fixed value, and variable tuning is accomplished with the threaded iron core.

The two IF stages are almost identical, and they are both connected as grounded-emitter circuits. Since the three-element transistor is the analogue of the triode vacuum tube, and since triodes must be neutralized when they are used at other than audio frequencies, the two IF transistors must also be neturalized in order to prevent stray oscillations. In this receiver, the neutralization of each stage is accomplished by a series capacitor-resistor combination which feeds a portion of the output signal back to the input of the stage.

Only the first IF stage is controlled by AVC. This is derived from the output of the diode detector, is filtered, and is then supplied to the base of the transistor in the first IF stage. When the received signal increases, the negative AVC voltage which is fed back to the base of the first IF transistor increases and reduces the gain of this stage. The opposite condition prevails when the signal strength decreases.

The second IF stage derives its base bias from the emitter of the audio output transistor. The bias resistor in the output-emitter lead is bypassed by a large value of capacitance in order to stabilize the voltage across the resistor. This voltage is further bypassed by an .05-mfd capacitor and is fed to the low side of the secondary of transformer T2. A resistor in the emitter lead of each of the IF transistors develops a voltage which biases the emitter properly.

The diode-detector stage, in which the manufacturer uses either a Raytheon CK706A or a Tungsol TS117 crystal diode, is connected directly to the volume control. The low resistance (1,000 ohms) of this control is necessary for a proper impedance match to the input of the audio transistor.

Output Stage

The output transistor is connected in a grounded-emitter circuit, and bias for the emitter is obtained by a series resistor. Bias for the base is obtained by a voltage divider from the positive line. These two bias arrangements assure that variations in ambient temperature and in battery voltage will not adversely affect the operation of this transistor. The collector impedance of this transistor is approximately 10,000 ohms, a value considerably lower than that which is characteristic of most transistors of this general type.

The output transformer matches the 10,000-ohm impedance of the output transistor to the 12- to 15-ohm impedance of the speaker. The speaker, which is only 2 3/4 inches in diameter, provides reasonable fidelity and volume for so small a unit. A hearing-aid type of earphone is available as accessory equipment for the Model TR-1, and the earphone plug can be inserted into a small jack on the side of the receiver. The speaker is silenced when this plug is inserted into the jack.

Power Supply

The entire power requirements for this receiver are fulfilled by one hearing-aid battery that provides 22.5 volts. The current drain from this battery is only 4 ma when a local station is being received, and the life expectancy of the battery is rated at 20 to 30 hours depending upon frequency and duration of use.

One important fact to remember is that it is physically possible to reverse the battery when inserting it into the clips. Warnings are given about this in the literature accompanying the receiver and inside the receiver case. The transistors will not be harmed by a reversal of battery polarity; but the electrolytic capacitor connected between the positive battery lead and ground will be damaged if the battery is reversed.

A photograph of the receiver shown in Fig. 4 has been included to give a general idea of the way the components have been mounted. Note in particular the small size of the IF transformers, audio output transformer, and the tuning capacitor. The use of these miniature components together with the use of transistors instead of tubes contribute to the compactness of the receiver.

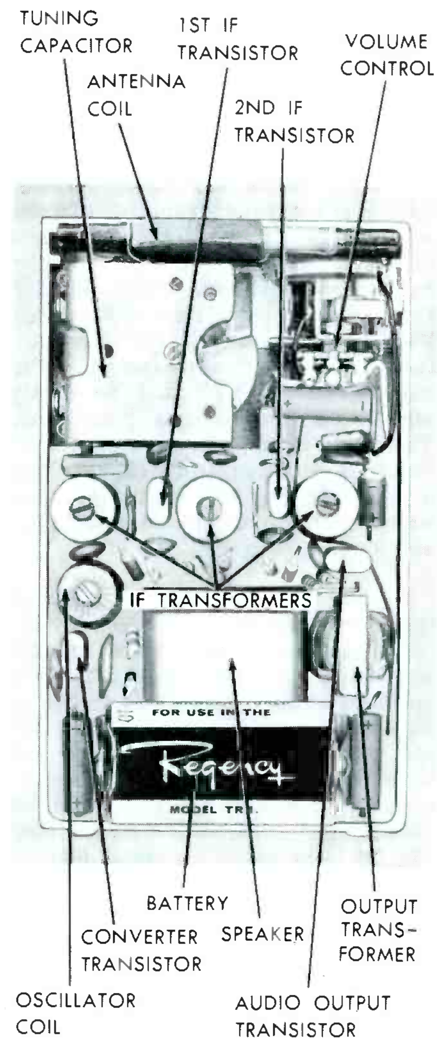


Fig. 4. Rear View of Regency Model TR-1 Showing Layout of Components.

We want to acknowledge the very kind cooperation of the Regency Division of I. D. E. A., Inc., in supplying information for this article and in making it possible for us to view the units in production.

WILLIAM E. BURKE

EDITOR'S NOTE: For those who would like to review general transistor theory, it is suggested that reference be made to "The Transistor Story, Parts I and II," which appeared in the September-October 1953 and in the February 1954 issues of the PF INDEX, predecessor of the PF REPORTER.

Audio Facts

(Continued from page 11)

The sectional chassis is unique and convenient in that, besides being prepunched, many of the components can be mounted and partially wired on the separate sections before the chassis is completely assembled.

The chassis furnished with the Triad HF-3 preamplifier kit is shown assembled in Fig. 3. The decals have been applied, but no components have been mounted.

Preamplifier and Equalizer Kit

The schematic of the self-powered preamplifier which can be constructed with the Triad HF-3 preamplifier and equalizer kit is shown in Fig. 4.

Any one of the four inputs provided for convenient and flexible operation can be connected into the circuit by the input selector switch. The two phono inputs (magnetic and crystal) channel the signal through the preamplifier section. The two halves of the 12AY7 tube V1 operate as a two-stage phono preamplifier with an equalizing network which is controlled by the 9-position record compensation switch connected between them. Correct compensation for satisfactory reproduction from most any record can be obtained by selecting the proper playback curve from the nine different ones provided by the record compensation switch. The tuner and microphone inputs are channeled around the phono preamplifier section by the input-selector switch and connected directly to the volume control R1.

Fig. 3. Triad HF-3 Chassis Assembled With Decals Applied.

All signals are amplified by the first section of the 12AU7 tube V2 and then fed into the second section of V2 which is the tone-control stage. The degenerative tone-control circuit provides a wide range of boost or droop of both high and low frequencies. A flat frequency response is maintained when the tone controls are set in mid-position because this point on both controls is effectively at signal (AC) ground potential, and no boost or droop is produced. If R29 and R30 are equal in value, the signal voltages at opposite ends of R2 and R3 are equal but are of opposite polarity.

When the movable contact of R3 is moved to the end of the control connected to the plate of V2, maximum bass droop will be produced. If the control is turned to the end connected to the cathode, L1 will be shunted across R29 and maximum bass boost

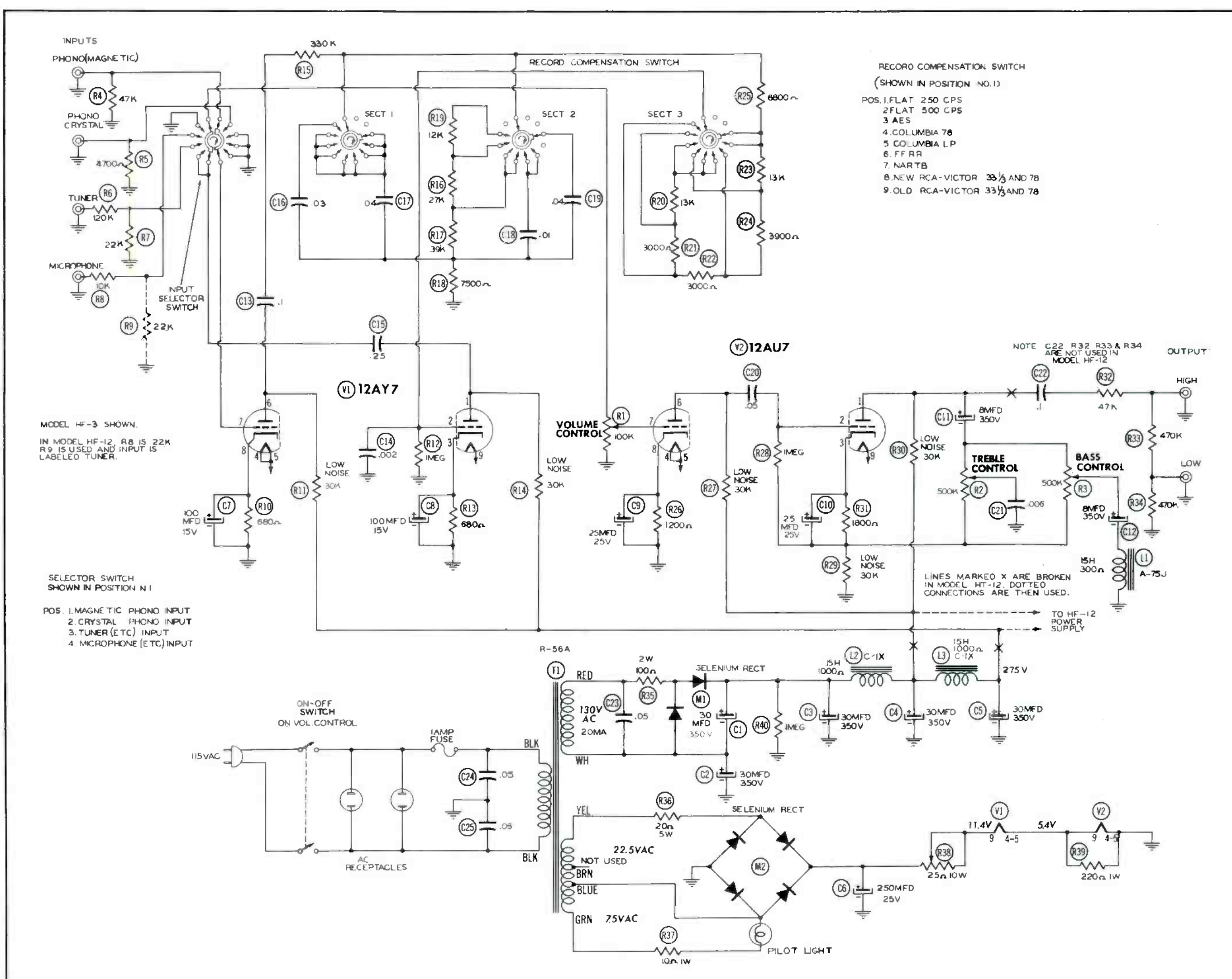


Fig. 4. Schematic of the Triad HF-3 Preamplifier and Equalizer Kit.

will be obtained. The same effect will be produced on the treble response if the treble control R2 is moved in a similar manner. The 8-mfd electrolytic capacitors C11 and C12 prevent the DC from flowing to ground.

Personal experience with this type of tone control has convinced us that the objections raised against the use of inductors in tone-control circuits can be discounted. We have never been troubled with such things as transient distortion and instability caused by the presence of an inductor in the tone circuit. Hum pickup is no problem when a unit such as the A-75J tone choke with its 45-db shielding and hum-bucking construction is used. Sufficient signal is available at the output of this preamplifier and equalizer to operate any amplifier used in the usual audio system.

A selenium rectifier M1 operating in a voltage-doubling arrangement and the filter formed by C3, C4, C5, L2, and L3 supply the well-filtered B+ voltages. The full-wave bridge type of selenium rectifier M2 and filter capacitor C6 supply DC for heating the tube filaments. Voltage adjustments can be made by moving the slider on the adjustable resistor R38. The R-56A power transformer T1 was designed for this type of application where selenium rectifiers are employed.

A 10-Watt Amplifier Kit

The preamplifier section of the Triad HF-12 10-watt amplifier kit is identical to the HF-3 preamplifier and equalizer kit except for the common power supply. Since they are similar, the data covered in the discussion on the HF-3 preamplifier will not be repeated here. A schematic of the HF-12, less the preamplifier section, is shown in Fig. 5.

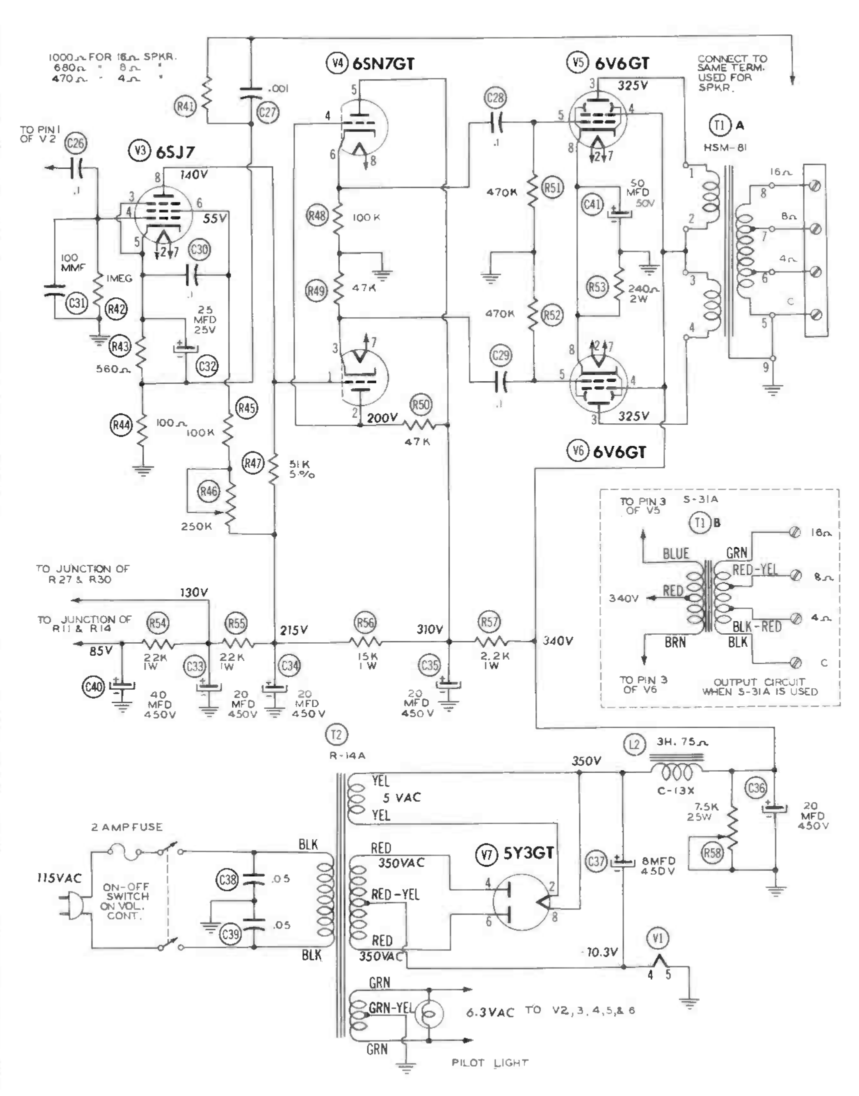


Fig. 5. Schematic of the Triad HF-12 10-Watt Amplifier Kit.

The layout of parts and controls of the HF-12 amplifier kit, which is a single unit, follows the same general pattern as that used in the HF-3; but a slightly larger (8-inch by 12-inch) chassis is used. The output from the preamplifier section feeds into the grid of the 6SJ7 (V3) which is in the first stage of the power-amplifier section. The potentiometer in the screen circuit of V3 serves as a balance control and is adjusted to obtain the correct bias on the phase-inverter stage V4 which is coupled directly to the plate (pin No. 8) of V3.

The phase inverter is cathode-coupled to the push-pull 6V6GT output stage. Note that C28 and C29 are the only coupling capacitors used in the power-amplifier section. Negative feedback is provided by the connection of C27 and R41, in parallel, from the secondary of the output transformer T1 to the junction of R43 and R44 in the cathode circuit of V3.

The schematic shows the Triad HSM-81 output transformer connected as T1 (A) and the Triad S-31A output transformer connected as T1 (B) in the partial schematic. This is done because the HF-12 kit can be obtained with any one of four different output transformers supplied as follows:

KIT	TRANSFORMER	OUTPUT (ohms)
HF-12	S-31A	16/8/4
HF-12A	HSM-81	16/8/4
HF-12B	S-32A	500/250/125
HF-12C	HSM-82	500/250/125

The power supply is conventional in most ways. Probably the most unusual feature is the manner in which DC is supplied to heat the filament of the 12AY7 tube V1. The heater (pins 4 and 5) of V1 is connected into the negative return lead of the high-voltage supply. The amount of current flowing through the heater of V1 can be adjusted by moving the adjustable contact on the bleeder resistor R58.

The Triad HF-18 and HF-40 are also available in kit form. These kits feature the same type of assembly and mechanical construction methods used in the HF-3 and HF-12 kits.

The HF-18 kit contains the basic parts for constructing a conventional Williamson amplifier using KT66 (or 5881, 807, 1614, or 6L6) output tubes. An audio output of 16.5 watts is obtained with triode operation, or an output of 20 watts is obtained when the screens of the output tubes are connected to screen taps on the primary of the output transformer.

KIT	TRANSFORMER	OUTPUT (ohms)
HF-18	S-148A	16/8/4
HF-18A	HSM-189	16/8/4
HF-18C	HSM-190	500/250/125

A 40-watt amplifier suitable for use in auditoriums or theaters can be constructed from the basic components furnished in the HF-40 kit. This high quality of amplifier features 6146 output tubes and a regulated power supply.

KIT	TRANSFORMER	OUTPUT (ohms)
HF-40	S-42A	16/8/4
HF-40A	HSM-94	16/8/4
HF-40C	HSM-95	500/250/125

ROBERT B. DUNHAM

Capacitors

(Continued from page 5)

We have mentioned dielectric constant, and this can be considered to be the third determining factor of capacitance. Specifically the derivation of this factor lies in the nature of the material that is used as a dieelectric, and the dielectric constant can be stated as the ratio between the capacity of a capacitor using a given material as the dielectric and the capacity of a capacitor of equal plate area but using air as a dielectric. The formula given for this is:

$$K = \frac{C_S}{C_a},$$

where

C_S = the capacity with the material in question,

C_a = the capacity with air as a dielectric.

We do not have to concern ourselves with this formula other than to know what is meant when we refer to dielectric constant. We should know that this constant is a variable which depends upon the composition and purity of the material used, that it is affected somewhat by temperature, and that it will vary to a certain extent with the frequency of the applied voltage. A table of constants of dielectric strength for the most commonly used materials can be found in almost any of the electrical engineering handbooks, should this information be desired.

TYPES

All capacitors are roughly classfied as to whether they have a fixed or variable value. These terms are self-explanatory; but if we want to give a more definite explanation, we can define a fixed capacitor as one in which the plates are permanently positioned in relation to each other and in which the capacity remains constant. If the plates can be moved relative to one another or if the dielectric can be displaced to change the capacitance, then the capacitor is said to be variable.

Capacitors are also designated according to the dielectric that is used. For this reason we have capacitors which are known as mica, ceramic, and paper capacitors. If we investigate further, we find that the mica capacitors have metal-foil plates separated by thin sheets of mica insulation. For silvered mica capacitors, the metal-foil is eliminated and a silver coating is deposited directly on opposite sides of the mica sheets to serve as electrodes. Almost without exception, this type of capacitor is enclosed in a molded-bakelite cover as protection against dirt and moisture.

The insulation between the plates of a ceramic capacitor is composed of a special ceramic material. The procedure is to mold this material into a thin rectangular wafer, a cylinder, or a disc and bake until it becomes very hard. Each side is then coated with a thin film of silver, and these sides act as the plates. Leads are soldered to crimped-on end terminals or directly to the silver, and the entire unit is covered with an insulating covering.

Paper capacitors are the most common of all the capacitor types. They are constructed with thin strips of metal foil as plates and use one or more thicknesses of wax-impregnated paper as insulation. A foil strip is placed between two paper strips, and the combination is then wound into a tight roll in order to occupy a minimum amount of space. This roll is then inserted in a tubular cardboard or metal container. In some cases, the capacitor is enclosed in a housing of molded plastic.

The capacity of paper capacitors can be increased in several different ways. The foil area can be increased by widening or lengthening the roll with a corresponding increase in overall size, or a thinner paper insulation can be used. When the thickness of the insulation is decreased, the capacitor will break down more easily; consequently, this method of increasing capacity is limited to the lower voltage ratings.

Paper capacitors are also made with a metallic film deposited on one side of each paper strip so that the films on alternate strips act as the electrodes. This type is referred to as a metalized-paper capacitor and has the advantage of being somewhat self-healing although, as will be seen later, it is inferior to the electrolytic capacitor in this respect. Self-healing is possible because the thin metalized coating burns away when a short occurs, leaving in the electrode a bare spot which tends to isolate the flow of current. Fig. 2 is a photograph showing examples of the capacitor types that have just been discussed.

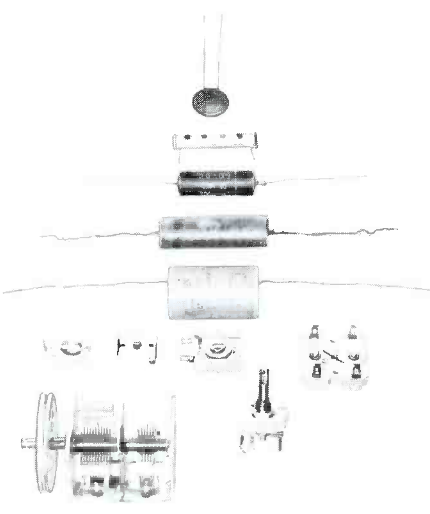


Fig. 2. Common Types of Capacitors.

ELECTROLYTIC CAPACITORS

The component parts of an electrolytic capacitor are essentially the same as those in any capacitor. It has electrodes and a dielectirc medium between them. It also performs the basic function of storing and releasing static electricity. Electrolytic capacitors do possess some functional and structural differences which warrant placing them in a class of their own.

We have said that when mica is used as a dielectric, the capacitor is known as a mica capacitor; when ceramic is used, it is called a ceramic capacitor, and when paper is used as a dielectric, we refer to it as a paper capacitor. This terminology would lead us to believe that in an electrolytic capacitor, the electrolyte is the dielectric. Such is not the case. Actually, the electrolyte in an electrolytic capacitor serves as an ion-conducting medium and as one of the electrodes. The dielectric material or medium is an extremely thin oxide film which is deposited on the anode or positive plate.

Oxide Film

The exact nature and composition of the film which forms the dielectric are not too well-known; but this is not too important, since the formation and action of this film are understood and can be explained in rather simple terms. One characteristic of aluminum and a few other metals is that they will acquire a nonconducting film of metallic oxide when they are inserted into an electrolyte and when current is caused to flow from the electrolyte to the metal. This film will oppose the flow of current. If two pieces of aluminum are inserted into the proper electrolyte and if a difference of potential is applied between them, a high current will flow at the instant that the voltage is applied. If the voltage is left on, the current will gradually taper off until little or no current is flowing in the circuit. This process is known as "forming," and the action takes place while the film is being established on the plate to which the positive potential is connected. The film that is formed retards the flow of current in one direction only. If the polarity of the applied voltage is reversed, high current will again flow. From this, we can see that the film acts as an insulation only as long as the polarity of the forming voltage is maintained. This is the reason that, with most of the electrolytic capacitors we use, we must be careful to adhere to the proper polarity when connecting them into a circuit.

The dielectric constant of the film which is formed will vary with the magnitude of the forming voltage. In other words, for a given plate area, a capacitor formed at a low voltage will have a higher capacity than one with the same plate area but formed at a higher voltage. It is easy to understand that the higher voltage will form a thicker film; and since capacity is inversely proportional to dielectric thickness, the capacitor that is formed at the highest voltage would have the lowest value of capacitance. There is, moreover, a limit to the voltage at which these capacitors can be formed without increasing the dielectric thickness to such a point that the principal advantage (large capacity) of the electrolytic type is lost. Thus, we seldom find electrolytic capacitors which operate above 600 volts; and when we desire to use them for higher voltage ratings, it is necessary to connect two or more units in series.

The electrolyte that is used determines another characteristic of the electrolytic capacitor, inasmuch as it governs the maximum voltage at which the film can be formed and maintained. This holds within a fairly rigid limit. If a potential of more than 300 volts is applied to a capacitor using an electrolyte rated at 300 volts, the film may be punctured and in severe instances permanently damaged. When the surge voltage of a capacitor is rated at 400 volts, this means that the maximum momentary voltage that can be applied without puncturing the dielectric film is 400 volts.

Leakage Current

There will be small imperfections in any of the oxide films; and because of this, there will be a small amount of current flowing at all times. This is referred to as "leakage current." For a good quality electrolytic, it is very small, probably some fraction of one milliampere. The exact value of the leakage is determined by the condition of the film on the plate and the length of time that the capacitor has been without a polarizing voltage. Because the film tends to deteriorate when the capacitor is not used, a certain amount of time is required to form the film again after the capacitor has been stored or left idle. This will also apply to a new unit that has never been used. As an illustration, leakage current was taken on a new 40-mfd, 250-volt capacitor that had been in stock for an undetermined length of time. A potential of 250 volts DC was applied to this capacitor, and the leakage current was recorded for the length of time necessary for the current to level off and reach a normal

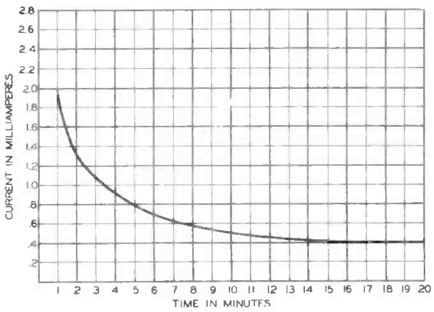


Fig. 3. Graph of Leakage Current Versus Re-Forming Time for a New 40-Mfd, 250-Volt DC Capacitor.

value. The leakage current versus time is shown in the graph of Fig. 3.

After a capacitor is put into use and the necessary time has elapsed, the leakage current will remain fairly constant unless the applied voltage exceeds the forming voltage. When the forming voltage is exceeded; the leakage current will exhibit a sudden and great rise in value. The exact amount of the forming voltage is seldom known, but it is safe to assume that it will be at some value slightly above the rated maximum voltage of the capacitor. In order to see just how sharp this rise of current could be, another series of tests were made. The same 40-mfd, 250-volt capacitor was used; but in this case, the test started with 100 volts of applied voltage and the potential was gradually increased to a value of 350 volts. The leakage current was recorded for each step of the increase. If the resultant graph shown in Fig. 4 is analyzed, it can be seen that the current remained practically constant over the range from 100 to 200 volts. Between 200 and 240 volts, there was an increase from .1 to .3 ma; but from 240 to 350 volts, the leakage current jumped from .3 ma to 6 ma, or an increase of 2,000 per cent. A close examination of the graph will show that the current began a really noticeable rise at 250 volts, which was the voltage rating of the capacitor. All of this shows that it is necessary to keep the applied voltage at or below, preferably below, the rating of the capacitor. If a capacitor is operated above it's voltage rating, the life of the unit will be materially reduced.

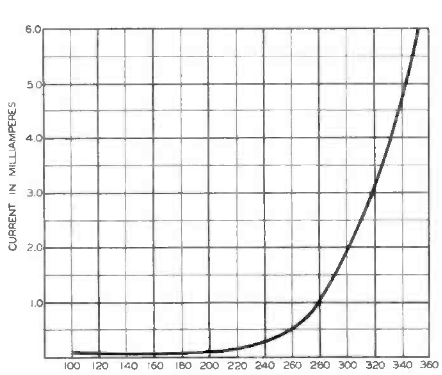


Fig. 4. Graph of Leakage Current Versus Applied Voltage for a New 40-Mfd, 250-Volt DC Capacitor.

Construction

In the physical construction of an electrolytic capacitor, the true cathode is the electrolyte; the oxide film is the dielectric; and the anode or second electrode is the metallic member on which the film is formed. A second metallic plate is required in order to establish a good electrical contact with the electrolyte. In practice this is called the cathode, although it serves primarily to distribute the current into the electrolyte. For the purpose of explanation, we will follow this accepted terminology and refer to the second plate as the cathode. Almost without exception, the anode is constructed of aluminum; and in most cases the cathode is also, although the aluminum used in the cathode construction is usually a cheaper grade. In some instances, such as in the wet electrolytic capacitor where the can serves as the cathode, an aluminum-plated or a copper can may be found.

The electrolyte that is used in electrolytic capacitors can be either in a liquid or paste form. If it is a liquid, the capacitor is a wet electrolytic capacitor. If the electrolyte is a paste pressed into paper, gauze, or other absorbent material, then it is a dry electrolytic capacitor. Both of these capacitors operate in a similar manner, and each possesses certain advantages. The dry electrolytic capacitor will not spill nor leak and may be mounted in any position and in any type of container; whereas, with the wet capacitor, there is always a possibility of leakage resulting in a partial or complete loss of the electrolyte. In a dry electrolytic capacitor, the electrolyte offers a high resistivity which makes it simple and easy to mount more than one capacitor in one container in order to conserve space. With wet capacitors, the possibility of stray currents through the low-resistance electrolyte makes much more difficult the mounting of several sections in one container, especially if we desire a considerable potential difference between them. As a rule, the leakage current of a wet electrolytic capacitor is greater than that of the dry type, but it will have better self-healing properties.

Fig. 5 is a diagram which shows the basic components of the polarized electrolytic capacitor. As is shown in the diagram, this type of capacitor has an insulating film deposited on only one of the electrodes so that the current is restricted in one direction only. Most of the capacitors in use will be of this type. However, there

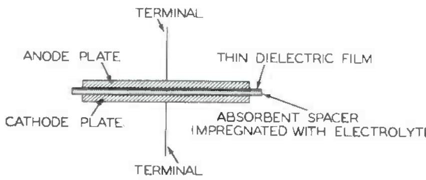


Fig. 5. Component Parts of a Polarized Dry-Electrolytic Capacitor.

are cases in which nonpolarized AC electrolytic capacitors are used, mostly for rather special applications such as the starting capacitor for a capacitor-start motor. Since, in all probability, a large number of this type will not be encountered, few details will be necessary regarding its construction and characteristics. The major difference between this capacitor and the polarized electrolytic is in the electrodes, both of which are provided with dielectric films. The film on each electrode is effective only during the half cycle when the electrode is positive. During the negative half of the cycle, the dielectric properties are reduced to a small value.

Advantages

There are several inherent advantages, along with some severe disadvantages, of the electrolytic capacitor over the nonelectrolytic type. Foremost among the advantages is the large value of capacity that can be provided by an electrolytic capacitor of a given physical size. This is possible because the thickness of the dielectric is not limited as it is in the other types. As has been pointed out, the capacity of a capacitor is dependent upon the area of the plates and upon the dielectric constant of the dielectric used; and it will increase with a decrease of the dielectric thickness. With the nonelectrolytic capacitor, this dielectric thickness is the governing factor which limits the capacity that can be obtained without increasing the plate area so much that the finished capacitor is too large for practical use. For example, in a paper capacitor, it is difficult to make insulating paper thinner than 0.0003 inch; hence, it is the usual procedure for the manufacturer to use at least two sheets of insulation in order to avoid shorts that are caused by unavoidable pinholes and to conductive particles in the paper. Even if a chance were taken and only one layer of paper were placed between the foils of a capacitor, thus limiting it to low voltage use, the absolute minimum spacing would be 0.0003 inch. This would set the limit to the capacitance per unit area for this type of dielectric, no matter how low the voltage rating of the unit.

With an electrolytic capacitor, this limit does not apply. The dielectric film is formed electrochemically on the electrode, and its thickness can be controlled down to less than one-millionth of an inch. Since the forming voltage controls the dielectric thickness, a variation of this voltage will produce capacitors with wide capacitance and voltage ratings; and all of these capacitors could be housed in cans of the same dimensions. The enormous difference in capacitance between electrolytic and nonelectrolytic capacitors can be seen when we consider that an electrolytic capacitors can be seen when we consider that an electrolytic capacitor designed for use in a unidirectional circuit and rated as 2,000 mfd at 5 to 10 volts can be housed in a container of approximately 5 cubic inches; whereas, a nonelectrolytic capacitor of the same voltage rating and occupying the same space will have a capacitance of only a few microfarads.

We have already mentioned that certain types of paper capacitors are self-healing, within limits. We have also seen that the dielectric film of an electrolytic capacitor is formed by a chemical action on the plate when voltage is applied and current flows. This forming action of electrolytic capacitors makes them far superior in self-healing properties to any of the nonelectrolytic capacitors, since they will tend to heal themselves by reforming the film as long as there is a direct-current voltage applied. This does not mean that these capacitors cannot be permanently damaged. If the electrolyte-impregnated material of the dry electrolytic capacitor is repeatedly punctured, it will lose its insulation qualities and a continuous short results. However, the wet electrolytic capacitor with its liquid electrolyte will practically always heal itself after a brief surge of current or a momentary overload.

Disadvantages

To offset these advantages, several disadvantages are apparent in an electrolytic capacitor. We have already shown that the leakage current in this type of capacitor is great, much more than with the nonelectrolytic type. This is equivalent to saying that the insulation resistance per microfarad is less. We know that the insulation resistance for a nonelectrolytic capacitor may be hundreds, even thousands of megohms per microfarad; whereas, in an electrolytic capacitor, this resistance usually amounts to only a few megohms. Because of this, the loss due to power factor in the former type is much less than it is in the electrolytic capacitor. For example, the power factor of a waxed-paper capacitor is usually less than one per cent, while it is several per cent for the best electrolytic capacitor and may even run as high as 10 per cent.

In addition, the temperature characteristics of the electrolytic capacitor are inferior to those of any of the other types; since the capacitance, power factor, and leakage current are all affected by temperature. At very low temperatures, the capacitance may be reduced to a fraction of its normal value; and at high temperatures, the leakage current is so great that it may lead to complete failure of the unit. The wet electrolytic capacitor will become inoperative if the electrolyte freezes, although it will return to a near normal condition after it has regained its normal temperature.

The application possibilities of electrolytic capacitors are especially limited because of their low power factor. The low power factor of the capacitor causes a high I^2R loss within the capacitor. Whenever power is dissipated in this manner, heat will be generated and will cause a weakening of the dielectric. The leakage current will increase because of the loss of dielectric, and more heat will be generated. This cycle of events is cumulative and can lead to an eventual failure of the unit. For this reason, the use of electrolytic capacitors should be avoided where ambient temperatures are excessive or the alternating-current component is high. The latter condition is apt to generate more heat than is permissible. As a general rule, if a nonpolarized electrolytic capacitor is used with pure alternating current, the operation should be limited to intermittent service in order to allow for cooling between cycles.

Service and Testing

Almost all of the electrolytic capacitors that service technicians will encounter will be of the polarized or unidirectional type. With few exceptions, they will be dry electrolytic capacitors and may be either the multiple- or single-section, metal-can type or the tubular, paper type.

Occasionally, it will be necessary to replace an upright can type, which is mounted on the top of the chassis, with a tubular capacitor that must be attached to the underneath side of the equipment. This usually happens because the technician does not have an identical replacement unit and does not want to wait while ordering one. Whatever the reason, when the occasion does arise we should remember that electrolytic capacitors are sensitive to heat; and care should be taken to make sure that the replacement is mounted in as cool a place as it is possible to find. Avoid placing these capacitors near voltage-dropping resistors, voltage-dividing networks, and other parts which emit considerable heat. Because of its metal housing, the can type of unit will dissipate more heat than will the tubular capacitor. Should these units be operated at excessive temperatures, their life will be shortened, regardless of capacity and voltage ratings.

Because of their high leakage current and high capacitance values, electrolytic capacitors are not so easily tested for faulty operation as are some of the other types of capacitors. While an ohmmeter check will show when a capacitor is shorted, excessive leakage current cannot be determined with this method. Probably the best test for these units is to replace them in the circuit with capacitors of equal or slightly greater values. In order to save time on this operation, some service technicians prefer to have units equipped with alligator clips for this purpose. Then it is a simple matter to disconnect one lead of the suspected capacitor and clip the replacement into the circuit. An adequate selection of capacitors for testing purposes would probably include those with an 80-mfd, 150-volt; a 50-mfd, 150-volt; a 20-mfd, 450-volt; and a 10-mfd, 450-volt rating. If these capacitors are equipped with clips and kept on hand, it is possible to check quickly and accurately by substitution practically all of the electrolytic capacitors in use. These test capacitors should be replaced periodically with fresh capacitors, lest they lose too much of the oxide film and develop excessive leakage current. Another solution would be to place them periodically across a direct-current voltage for periods of 10 or 15 minutes.

The information herein given has been more or less general in nature. However, it is hoped that it will give the service technician a better understanding of capacitors, particularly electrolytic capacitors and their limitations and applications.

JAMES M. FOY

Examining Design Features

(Continued from page 21)

balanced ratio detector is coupled to the grid of the 6AU6 audio amplifier. Feedback from the output stage is applied to the cathode of the first audio amplifier. Amplification in the audio output stage is accomplished by a 6AR5 or a 6AQ5 tube.

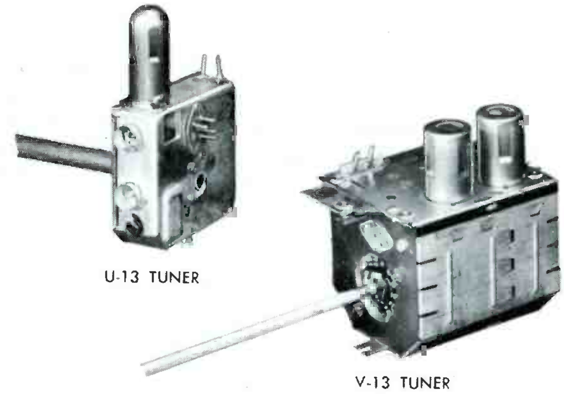


Fig. 3. Sarkes Tarzian U-13 and V-13 Tuners.

AGC

A system of keyed AGC is used in this receiver. The keyer tube is a 6AU6. The signal from the plate circuit of the first video amplifier is applied to the grid of the keyer by DC coupling; consequently, B+ voltage will be present on this grid. In order to reduce the potential existing between the grid and cathode of the keyer, the cathode is returned to a source of B+. The AGC voltage is developed and filtered in the conventional manner and is then applied to the first and second IF amplifiers. AGC for the tuner is delayed by application of a positive potential. A clamper is employed to prevent the AGC voltage to the tuner from becoming positive.

Sync

A composite signal from the output of the first video amplifier is fed to the 6AU6 sync separator. The output signal resulting from the action of the sync separator is coupled to the 6C4 phase inverter. The inverter stage provides sync signals of opposite polarities for use in the sweep systems. One signal is taken from the cathode circuit and fed to the vertical-sweep section. Since two signals of opposite polarity are required in the horizontal section, one signal is taken from the cathode circuit of the 6C4 and one is taken from the plate circuit.

Vertical Sweep

The sync signal from the phase inverter is fed through an integrator network before application to the vertical multivibrator. The cathode-coupled multivibrator circuitry employs a 12AU7. Two controls are associated with this stage, namely, the height control and the vertical-hold control. The vertical output tube is a 6W6GT with its cathode bias adjustable by means of the vertical-linearity control. A signal is taken from the vertical-output transformer and applied to the cathode of the picture tube to accomplish retrace blanking.

Horizontal Sweep

Two signals of opposite polarity are taken from the sync separator and applied to the horizontal-phase comparator. The two diode sections of a 6AL5 are used in this application. A signal from the horizontal-output stage is also applied to the 6AL5. The output of the phase comparator is applied to the horizontal multivibrator as a correction voltage. A 6SN7GT is used in the horizontal-multivibrator circuit. The output of this stage drives the 6AU5GT horizontal-output tube. High-voltage rectification is obtained by the use of a 1B3GT. Damper action is furnished by a 6W4GT.

Power Supply

The power supply consists of a 5U4G rectifier connected in a conventional circuit. A series of dropping resistors are used to provide the outputs of 320, 250, and 150 volts. The power supply may be operated by a local or a remote switch. The remote switch actuates a 6-volt AC relay which connects the power line to the power-transformer primary. A separate transformer is used to supply the 6 volts for the relay. The use of 6 volts for the remote switch eliminates the need of running the line voltage to the remote switch.

SARKES TARZIAN TUNER UV-13

The Sarkes Tarzian Model UV-13 tuner is a combination of the V-13 VHF tuner and the U-13 UHF tuner. The two tuners shown in Fig. 3 are mounted coaxially and plug into each other. The tuners feature solderless pin connections for all leads in order to permit easy removal of the tuners from the receiver. Tuning of the UV-13 is accomplished by three concentric knobs. This arrangement eliminates the use of extraneous gears, pulleys, and dial cords. The combined UHF and VHF tuners from a unit comparable in size to conventional VHF tuners. This is shown in Fig. 4. Another feature of this tuner is the simplicity with which the UHF tuner may be added in the field.

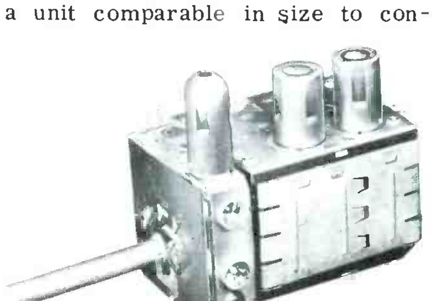


Fig. 4. Sarkes Tarzian UV-13 Tuner.

The V-13 is a switch type of tuner covering channels 2 through 13. The RF amplifier is a 6BZ7. The oscillator-mixer section employs a 6U8. The V-13 is designed for use with a 41-megacycle IF strip.

The U-13 is a continuous tuner covering channels 14 through 83. The oscillator employs a 6AF4. A crystal diode serves as a mixer. Tuning of the UHF circuits is through the use of capacitance-tuned resonant cavities.

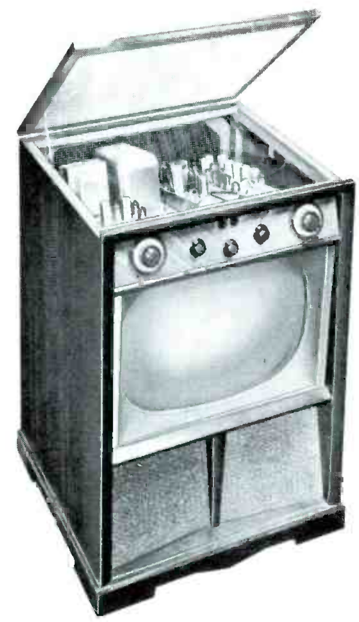


Fig. 5. Setchell-Carlson Model 552 TV Receiver Showing Chassis Mounted Above the Picture Tube.

SETCHELL-CARLSON MODEL 552

Ease of servicing is reflected in the design of the Setchell-Carlson Model 552 television receiver. The receiver is constructed on small subchassis which are plugged into a base containing the interconnecting wiring. This is similar to the system employed in previous Setchell-Carlson receivers. A unique method has been employed for mounting the chassis in the cabinet. The chassis is mounted above the picture tube. The top of the cabinet is hinged so that it may be raised as shown in Fig. 5. When this is done, the top of the chassis is completely exposed to provide access to the plug-in subchassis and the tubes. This greatly facilitates removal and replacement of these items and should prove particularly beneficial for servicing in the customer's home.

DON R. HOWE

Shop Talk

(Continued from page 15)

unwary eye to indicate greater directivity.

That which is true of the forward lobe is just as true of the backward lobe. On a power curve, any lobes to the rear — representing the tendency of the antenna to pick up rear signals — will appear smaller than they would on a voltage plot. But since television receivers utilize the signal voltage rather than the

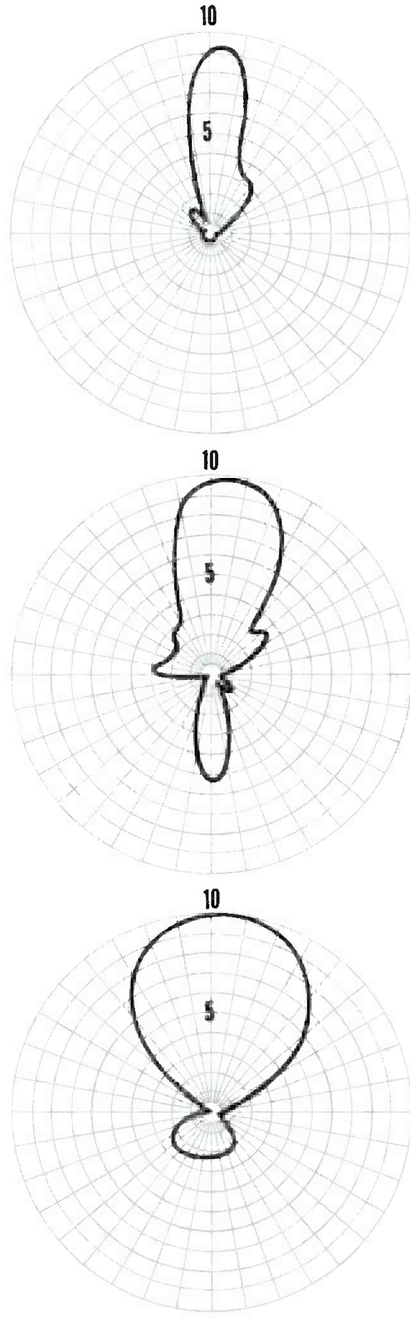


Fig. 2. Response Curves Which Are More Indicative of Actual Antenna Operation Than Those in Fig. 1.

signal power, it is the voltage curve with which we are concerned.

In view of the foregoing discussion, it can be appreciated why most antenna manufacturers present their polar response curves in power form unless otherwise indicated. There is, of course, nothing harmful in this practice; but too often the service technician who is unaware of the differences between voltage and power curves is misled.

While we are on the subject of antennas, it might not be amiss to consider them in the light of color television. As most readers of the PF REPORTER know, the color portion of the signal resides principally at the upper end of the channel bandpass. In addition to the color sidebands, there is also the color-subcarrier burst which can be considered even more important than the sidebands. Whereas it is possible to lose some but not all of the color in a picture when portions of the sidebands are lost, it is impossible to develop and maintain a suitable color picture when the color burst is lost. The NTSC color system is based on the arbitrary use of a color reference signal which is called the color burst. This burst may be considered the "key" which unlocks the information contained in the chrominance signal. Once the key is lost, automatic color synchronization in the receiver becomes impossible. It is thus of the utmost importance that the key be retained.

Let us see what difficulties the antenna may present in this respect. The amount of signal which an antenna develops at any one frequency not only depends upon the direction in which the antenna is pointing but also upon the gain of the antenna at that frequency.

Typical gain curves versus frequency for a widely used VHF antenna are shown in Fig. 3. Both the high and low bands are included; and as we examine these curves, we see that there is a considerable variation in gain, particularly across the low band. Notable in this respect are channels 2, 5, and 6. On the high band, gain is fairly uniform with the principal exception of channel 13.

For most uniform results in color reception, the gain curve should be as flat as possible. Desirable limits of variation should not exceed 10 per cent or 1 db. With this in mind, let us return to the curves of Fig. 3. Channels 3 and 4 conform very nicely because the gain varies less then 1 db from one end of the channel to the other. On channels 5 and 6, there is almost a 2 1/2-db or 3-db variation from end to end of each channel; and furthermore, the high end of the band where the color information is contained receives the least amount of gain. This would work to the detriment of the color signal; and it is entirely possible that although black-and-white reception would be enjoyable, color would not. This condition could be further aggravated by additional attenuation in the antenna system or the receiver. One reduction by itself, unless excessive, will seldom prove fatal; but the combined effects of several could.

The situation on channel 2, where there is a 2-db variation, is still not so bad as it is for channels 5 and 6. For one thing, the color signal is on the rising side of the curve. Secondly, the curve tends to flatten out somewhat near the high end of the channel, and this is also desirable. Hence, one would expect to obtain good color reception on channel 2, all other factors being equal.

On channel 13, there is an intermediate situation which approaches that of channel 6. The high end of the band is down, but the drop is not excessive.

It is needless to say that yagis and other high-gain, sharply directional arrays are especially critical in regard to color reception. Substantial attenuation of the high video frequencies may pass unnoticed on a black-and-white set; but since these high frequencies carry color information during color transmission, loss of color may occur in a color receiver.

The antenna is not the only component in the antenna system. Present, too, are RF boosters and distribution amplifiers. Any attenuation inflicted by these items will add to antenna loss, and the total may suppress the color signal below the point of usability. Particular caution will have to be observed in tuning RF boosters. If the passband of a booster is too narrow, the booster will have to be replaced with one possessing a wider-channel response. This situation has already been encountered in apartment-house distribution systems.

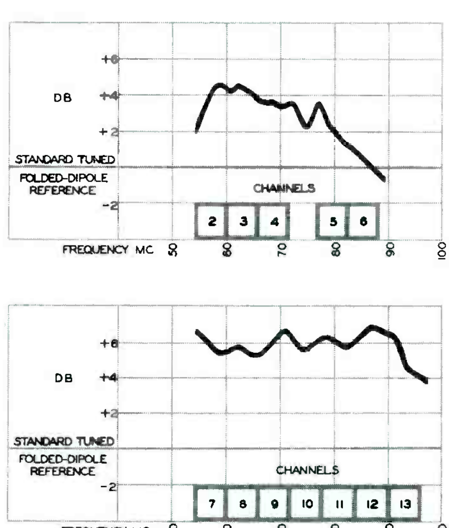


Fig. 3. Gain Curves of a Popular Television Antenna.

Contrary to the idea expressed in some ads which have appeared in technical magazines, our belief is that an antenna by itself cannot be responsible for the loss of color. The trend in recent years has been toward use of antennas with characteristics that have been fairly uniform over individual channels. High gain achieved at the expense of bandwidth has been made more or less unnecessary by the increase in broadcast power and the marked improvement in receiver sensitivity. Hence, the antenna might be a contributing factor to color deficiency, but it is seldom the sole factor. This means that a technician, answering a complaint of no color, will have to possess some means of checking over-all color performance of the set. One approach to this problem is by means of a color-bar generator. This can be connected to the set; and if a full color picture is not obtained, it can be presumed that the set is not functioning normally. Trouble is then indicated in the set, and it is probable that the antenna system is not at fault. In the absence of this information, it could very well be that the service technician will needlessly attempt repairs to the antenna before he discovers his error.

REVIEW

The trend toward the use of more completely automatic machinery in the fabrication of electronic devices has spread from radio sets to television receivers. In Admiral's latest black-and-white television sets, fully half of the tubes operate in printed circuits which were partially or fully constructed without the assistance of human hands. When a trend is thus so firmly established and shows every indication of gathering even greater acceptance than it has at present, then it is time for the technician to become as familiar with the techniques of servicing these circuits as he is with the systems which have been used up to the present time.

Admiral has recently released a 6-page manual, No. S559, which is entitled "Printed Circuits — Service and Repair." In it, the technician will find full servicing instructions not only for Admiral printed circuits but for many other printed circuits wherever found. In this review, we will attempt to cover the highlights of the practices outlined in this publication.

The first item of interest to the technician is, "What tools will I need specifically for printed circuits?" In the manual, eight items are listed. These are:

1. Low-wattage soldering iron with a small point or wedge. (The rating of the iron should not exceed 35 watts.)

2. Small wire brush, such as a suede shoe brush.

3. Low-temperature 60/40 solder with a rosin core. (This is made with 60 per cent tin and 40 per cent lead. Ordinary solder is 40 per cent tin and 60 per cent lead. The latter is not recommended.)

4. Diagonal wire cutters and long-nosed pliers.

5. Thin-bladed knife.

6. Small wire pick or soldering aid.

7. Clear lacquer and brush or Krylon acrylic spray.

8. A solvent (such as Xylene, lacquer thinner, or denatured alcohol) for silicone resin.

The reason for some of the special tools can be found in the precautions which should be observed when servicing. For example, overheating should be avoided because it can cause the bond between the laminated plastic board and the copper foil to break. The copper foil represents the wires of the circuit, and any break in foil continuity will have the same effect circuit-wise as a severed conductor. If soldering becomes necessary, it should be done carefully; and any excess solder should be brushed away with the small wire brush.

Items 4, 5, and 6 in the foregoing list are designed to help in the removal of circuit components such as resistors, capacitors, coils, and transformers. One of the features of printed circuits is compactness, and sharp-edged tools make the job of repair that much easier.

After a solder connection has been made, a coat of lacquer or Krylon should be applied over the area to prevent dust or moisture from causing short circuits. Initially, when the chassis was constructed, it received

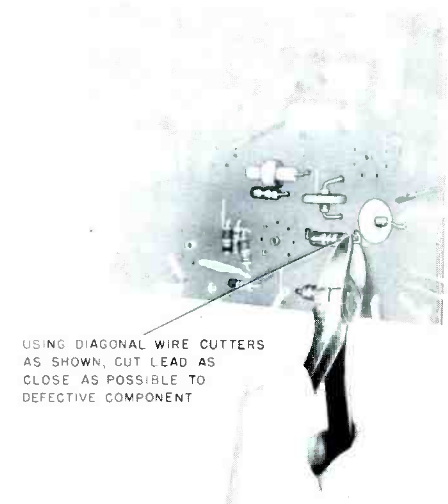


Fig. 4. Cutting a Defective Resistor Free of the Printed-Circuit Board. (Courtesy of Admiral Corp.)

a coat of silicone resin as a protective coating. In repair, the resin must be removed and then subsequently replaced with a coat of lacquer or Krylon. If the Krylon spray is used, it will be necessary to cover the tops of the tube sockets and the ground connections of the chassis with masking tape to prevent the contact surfaces from becoming coated.

Note that because of the protective coating, a probe with a needle point should be used for circuit checking. The varnish coating must be penetrated to make the desired contact.

The major portion of the manual is devoted to specific instructions for replacing various components. The most important features will be summarized to indicate the best procedure to follow.

1. Capacitors, Resistors, Couplates, and Peaking Coils.

In the replacement of component parts, it is desirable not to have to unsolder the component leads where they make connection to the printed wiring. Toward this end, if the leads from the defective part are long enough, cut the leads where they enter the component. See Fig. 4. Clean off the ends of the remaining leads. Then make a small loop in each lead of the replacement component and slide the loops over the remaining leads of the part removed. Finally, make a secure solder connection using as little solder and as little heat as possible. Too much heat may cause the original lead to fall out of the board and complicate the replacement job.

If the original component does not present sufficient lead length, then it is suggested that the defective part be cut in half. Then cut through each half of the unit until it is broken away from its lead. See Figs. 5 and 6. By performing this procedure carefully, enough extra lead (inside the component) will be gained to permit a secure connection to the replacement part.

The remaining alternative is used when the part is so mounted that neither of the foregoing methods can be employed. Then it becomes necessary to unsolder the defective unit and the following shows the best way to accomplish this.

Heat the connection on the wiring side of the board with the small soldering iron. Brush away the solder

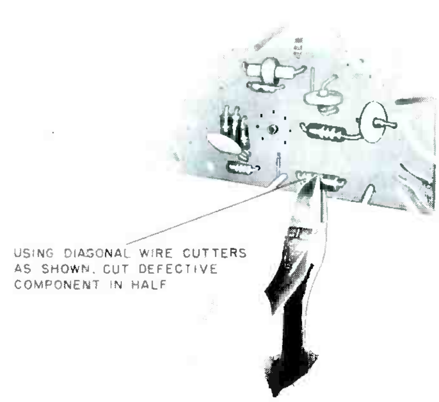


Fig. 5. Cutting a Defective Resistor Apart. (Courtesy of Admiral Corp.)

when it becomes melted. See Fig. 7. Then insert a knife blade between the wiring foil and the bent-over component lead and bend up the lead. Apply the iron again, and wiggle the component until the lead can be pulled back through the chassis board. Remove any small particles of solder imbedded in the silicone resin by using a clean cloth dipped in solvent.

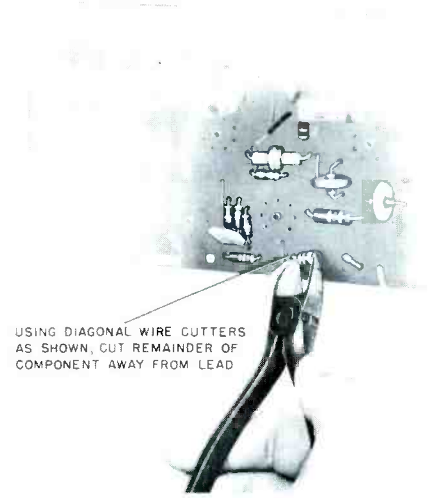


Fig. 6. Removing Resistor From Leads. (Courtesy of Admiral Corp.)

The replacement part is next placed in position, and its leads are passed through the same holes used by the original part. If a thin film of solder remains over the hole, heat the area; and then push through the leads from the replacement unit.

Cut off any excess lead length, and then bend the remaining lead ends over the copper foil. Solder carefully using the low-temperature 60/40 solder. Finally, cover with a coat of lacquer.

2. Coil Replacement.

The removal of one coil and the substitution of another does not present any unusual problems because

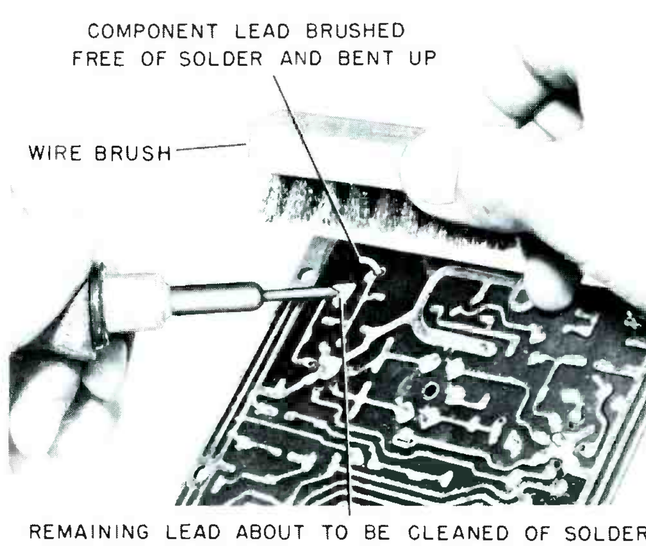


Fig. 7. Brushing Away Excess Solder. (Courtesy of Admiral Corp.)

Admiral does not bend over the terminal lugs of these components against the foil. Thus, heat the coil lugs, one at a time, and gently wiggle the coil back and forth until the unit can be pulled free of the board. Then the replacement is inserted and its terminal lugs resoldered in position. All excess solder should be brushed away.

3. Tube Sockets.

A tube socket is a component which requires a major operation for removal, and accordingly considerable space is devoted to it in the Admiral service manual. The exact approach is governed by the particular placement of the socket — whether it is mounted on the wiring side or on the component side of the board. In either instance, the general approach is as follows.

First, break all connections to each of the socket lugs by carefully heating each in turn, and then brush away all excess solder. A knife blade will assist in separating leads from lugs where these are physically joined together.

The same treatment is accorded grounding lugs, if these are present and used. (The tube sockets are of the miniature type with an additional grounding lug extending to the tubular center shield at the bottom of the socket.) The grounding lug is generally the last item to be unsoldered; and as the heat melts the solder, the socket is gently lifted away from the board. Then the area left by the socket is cleaned free of solder particles, and the replacement socket is carefully placed in position. Its lugs are then bent over and soldered.

On some boards, the sockets are mounted upright on the wiring side; consequently, tube-pin numbers must be counted in a counterclockwise direction. The clockwise direction is the usual practice when the socket is viewed from the bottom.

By now, the major aspects of working with printed circuits should be quite evident to the reader. Work carefully using as little heat as possible, remove all excess solder quickly and completely, and use new solder as sparingly as if it were rationed. Never use too large an iron.

MILTON S. KIVER

Quicker Servicing

(Continued from page 29)

tube caddy by some service technicians, these items could very well be carried in the service truck; and the space in the tube caddy could be filled with parts and tools that are more frequently used.

For maximum convenience and portability, most of the listed parts and equipment may be stored in a large additional caddy. A unit, similar to the one shown in Fig. 1, with several drawers and a removable side would probably be the best type for this application.

Small plastic containers or empty 35-mm film cannisters, such as those shown in Fig. 2, may be used to hold the small parts. These containers may be stored in the drawers of the caddy. The larger parts and

TABLE I

EQUIPMENT AND PARTS FOR SERVICE TRUCKS USED ONLY IN TV AND RADIO SERVICE CALLS

Equipment

1. VOM.
2. Cross-hatch linearity generator.
3. Tube checker, if desired.
4. Five-inch TV-receiver check tube 5AXP4. (See "A TV Receiver Check Tube," an article in this issue.)
5. Small hand drill and drill bits.
6. Extension leads for yoke, picture tube, high voltage, and other uses deemed necessary.
7. Solder gun and solder.

Parts and Materials

1. Seldom-used tubes that are not in the tube caddy and extras of the often-used tubes.
2. Selenium rectifiers: at least two of each of the 300-, 350-, and 400-ma sizes.*
3. Negative-temperature-coefficient resistors. These have applications in the filament and B+ circuits in GE and other receivers.*
4. Crystal diodes, video-detector type.
5. Resistors: 1/2-, 1-, and 2-watt assortments.
6. Capacitors:
   a. Molded-plastic tubulars (MPT), 600-volt assortment.
   b. Disc-ceramic assortment.
   c. Mica and ceramic tubular assortment, for critical sync and coupling applications.
   d. Universal-mount type of high-voltage filter capacitors: 500 mmf, 20-30 kv.
7. High-voltage wire, tape, and spaghetti.
8. Replacement anode leads.
9. Krylon spray.
10. Assorted wire and spaghetti of the standard type.
11. Replacement AC interlocks.
12. Assorted screws and washers.
    a. Sheet-metal, self-tapping screws.
    b. Machine screws and nuts.
    c. Flat and lock washers.

*PF REPORTER, July 1954, p. 23.

TABLE II

EXTRA EQUIPMENT AND PARTS FOR SERVICE TRUCKS USED IN MAKING ANTENNA SERVICE CALLS

Equipment

1. Portable field-strength meter (desirable especially for the one-man operation).
2. Sound-powered phone set.
3. Two or three-section extension ladder.
4. Large cutters and pliers to handle guy wires.
5. Crimping tool for chimney straps.
6. Device for measuring wire length (a small hand unit).
7. A set of wrenches for work on antenna towers and rotators; 3/8-inch to 1-inch open-end or box-end type. (It may be advisable to have two of each of the 7/16-, 1/2-, 9/16-, and 3/4-inch sizes.)
8. Adjustable wrench for odd-sized nuts and bolts.
9. Light oil for rotator motor bearings.
10. Lubriplate for rotator gears and thrust-bearing assemblies.
11. Mineral-spirit solvent to clean rotators.
12. Pan to hold solvent for cleaning parts.
13. Brush for cleaning.
14. Aluminum paint.
15. Paint brush.
16. Rags for wiping.

Parts and Materials

1. Antenna lead-in wire.
2. Guy wire.
3. Rotator-control wire with 4 and 8 conductors.
4. Chimney mount and universal mount.
5. Assorted hardware such as guy-wire eyes; screw eyes; turnbuckles; guy rings; and assorted nuts, bolts, and washers.
6. Antenna masts: 5- and 10-foot sections.
7. Replacement elements for conical antennas.
8. Ground wire and ground rods.
9. Lightning arrestors.
10. Standoff insulators.

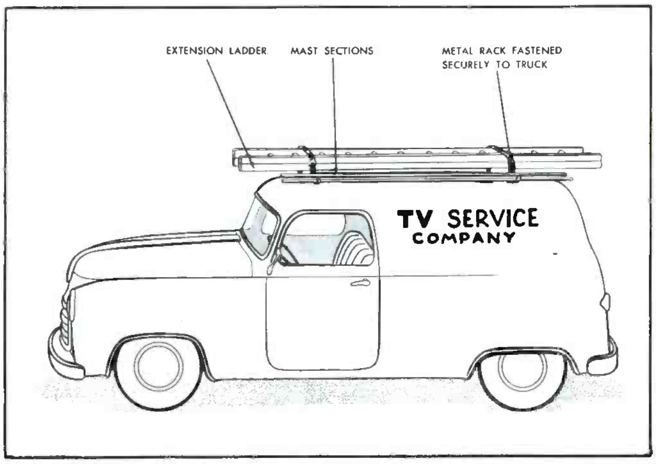


Fig. 3. Top Carrier for Service Truck.

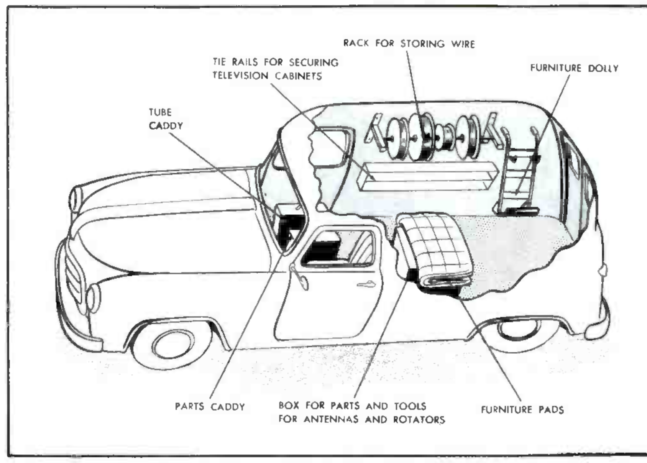


Fig. 4. Inside Layout of Service Truck.

tubes may be stored in the open-shelf compartment below the drawers.

To insure that the parts caddy is always fully stocked, the parts that are taken out should be replaced each day. The parts lists on the service tickets may be used for this purpose. An inventory of the parts caddy should also be made weekly since there may have been occasions when replacement parts were not available on the day they should have been re-stocked. A weekly inventory before going to your distributor will insure that the parts caddy will be kept completely equipped.

For Antenna Service

The shops which service and install antennas and rotators as well as television and radio sets will find it helpful to outfit the service truck or trucks so that any type of call can be completed without having to use haste in assembling the ladders, wire, hardware, and equipment needed for the installation or repair of antennas. The equipment and materials which will, for the most part, be satisfactory for making service calls for antenna and rotator repairs are presented in Table II.

Although there are numerous items of equipment and material, most of them are not bulky; and if they are properly stored, they will actually occupy only a small part of the area in a service truck. The extension ladder and mast sections of antennas may be carried on a suitable rack which can be fastened to the top of the service truck. See Fig. 3. The balance of the tools and materials may be stored on the inside of the service truck.

A rack for spools of antenna wire, rotator wire, guy wire, and any other type of wire needed can be constructed. By using large washers and lengths of garden hose between each wire spool, a minimum of noise will be generated by rattling of the wire reels or spools during transit.

By combining the equipment and material given in the two foregoing lists, a service organization can equip a service truck for complete service.

To assist service technicians and organizations in equipping a service vehicle, a sample layout of the inside of a fully equipped service truck is shown in Fig. 4. This layout should prove to be very effective, but many variations which would work equally as well are possible. Therefore, this layout is intended only to serve as a guide and to give you ideas about equipping your present or proposed service truck.

As mentioned before, a properly equipped service truck is a very valuable part of the service organization and can do much toward reducing your operating costs and increasing customer satisfaction with on-the-spot service.

IN THE SHOP

Since high-fidelity audio systems have gained so much popularity recently, many new models of AM-FM tuners and audio amplifiers are being produced. These employ circuits that are more complicated than those found in the average five- or six-tube AC-DC receivers. Examples of such circuits are: special phase inverters, feedback circuits, and tone-control systems. A technician not accustomed to working with these circuits may run into some difficulties. For that reason, it was considered a good idea to point out some of the possible troubles which may and occasionally do occur. These troubles will be covered in much the same manner as the troubles in television receivers were covered previously in this column.

First of all, it may be well to point out one very important aspect connected with the servicing of high-fidelity equipment. The technician should learn to be very critical of the quality of performance of such equipment. If his ear is not able to detect slight distortions in the output signal, he should use test equipment which will detect distortions of this nature. An intermodulation meter, a square-wave generator, and an oscilloscope are instruments which can be very useful in the servicing of high-fidelity audio systems. If a shop does much work in this field, it would not take an instrument such as an intermodulation meter long to pay for itself.

The following four problems should serve as examples of the kinds of trouble which may be encountered in high-fidelity equipment. These particular problems could be found and corrected with ordinary test instruments. Problem No. 1 illustrates an intermittent condition of an unusual nature; problem No. 2 shows a case of trouble in the tuning-eye circuit; whereas, problems No. 3 and No. 4 have to do with tone-control difficulties.

Problem No. 1

The unit in question was an AM-FM tuner and amplifier. The complaint was that the sound quits momentarily, particularly when the unit was jarred by someone walking across the floor or slamming the door. The same condition could be duplicated by tapping the chassis.

After the tubes had been checked and found to be in good condition, an insulated probing tool was used to move components in an effort to localize the source of trouble. If the sound could have been made to quit for a longer period, the technician would have been able to locate the trouble by signal tracing. Since this was not the case, however, he was obliged to use the probe.

Note the partial schematic which is shown in Fig. 5. It was found that the movement of capacitor C50 caused the sound to quit; therefore, one end of the capacitor was disconnected, and a capacitor checker was used to check it. Tests showed that it was good even when moved about. The capacitor was then soldered back into the circuit so that further tests could be made.

One lead of an ohmmeter was placed at the junction of C50 and R41, and the other lead was connected to the chassis. The capacitor was moved again, and the meter suddenly dropped to a reading of zero. An examination of the circuit wiring did not disclose any short circuits between the leads from these components and the chassis.

Once again, C50 was disconnected. This time it was removed from the circuit completely, and a through examination was made of the capacitor itself. The source of trouble was found to be a small piece of metal which projected through the coating at the outside edge of the capacitor. This had been intermittently touching the chassis and shorting the signal. A file was used to remove this piece of metal, and the set returned to normal operation.

Mention of this trouble has been made to point out that there can occur in these instruments the same odd defects that occur in television receivers. The problem emphasizes

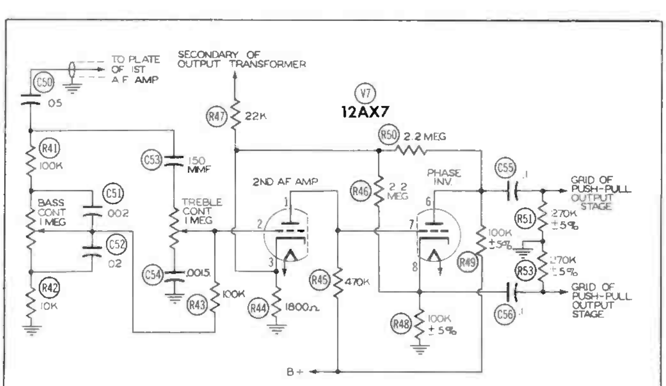


Fig. 5. Partial Schematic of an AM-FM Tuner and Amplifier.

the importance of physical inspection as an early step in any trouble-shooting procedure.

Problem No. 2

This trouble developed in an AM-FM tuner unit which employed a tuning-eye indicator. The circuit which was involved is shown in Fig. 6. The symptom was an absence of indications on the tuning eye during the reception of AM signals. The eye operated properly for FM reception. When the technician began checking the instrument, he noticed that there was also a loss of AVC action during AM reception.

The first step toward locating the trouble was to try substituting the 6U5 tuning eye. When this failed to help, a check of the operating voltages on the tube was made. The voltages on pins 2 and 4 were normal, but the grid voltage on pin 3 measured a negative 0.8 volts and did not change when the set was tuned through the AM band. Upon checking the circuit, it was found that the eye obtained its grid signal from the AVC line. The AVC voltage was checked, and it also remained steady when the set was tuned from station to station. In this manner, the trouble was localized to the AVC line.

Tracing the circuit in Fig. 6, the technician saw that the AVC voltage during AM reception is obtained across the detector load resistor R35. The signal developed by this resistor is filtered by R54 and is fed to the IF tubes and to the grid of the tuning eye.

A check with a voltmeter showed that signal voltage was present across R35; therefore, the chief suspect was logically resistor R54. An ohmmeter measurement showed that R54 was open. Replacing this resistor returned the set to normal operation.

The significance of this problem is that it shows the value of step-by-step logical reasoning that is based upon a knowledge of circuit theory and operation and upon the wise use of test instruments.

Problem No. 3

The treble control in the amplifier under investigation did not seem to have as much effect over its entire range as it should. It reduced the high frequencies only slightly at its minimum setting. Normally, this control can cut out the high frequencies almost completely when it is turned all the way down. In the

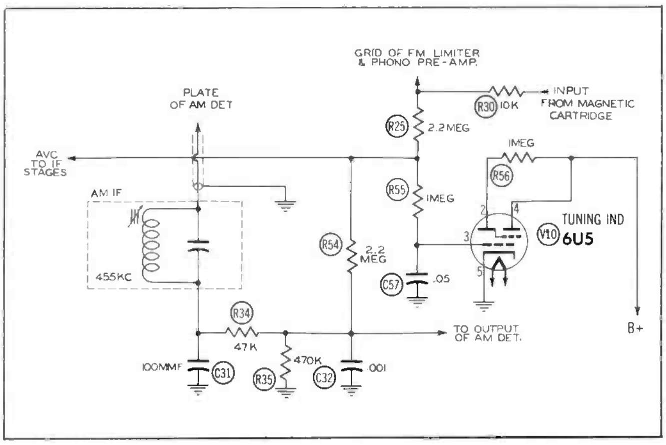


Fig. 6. AVC and Tuning-Eye Circuits in AM-FM Tuner.

amplifier shown in the schematic of Fig. 5, the tone-control circuit is a part of the input to the second audio amplifier. This circuit will be used as the reference in our discussion of this problem.

In checking the operation of the controls, the technician noticed that the bass control seemed to function properly. This fact indicated that the trouble must be somewhere in the treble-control portion of the tone-control network. The theory of operation of the treble control is given in the following paragraph.

The coupling capacitor C53, with a value of 150 micromicrofarads, offers a very low impedance to the higher audio frequencies. C54 has a value of .0015 microfarads and is also a low-impedance path for high frequencies. Hence, for these high audio frequencies, the bottom tap of the treble control is effectively at AC ground potential. The high frequencies are developed across the one-megohm control and are tapped off as wanted.

The technician checked the control and the two capacitors individually, and he found that C54 was open. This condition accounted for the abnormal operation of the treble control. It can be seen that, without C54 in the circuit, the voltage-dividing property of the treble control is greatly lessened by the fact that resistors R43 and R42 improperly constitute a branch of the dividing network.

Problem No. 4

The schematic in Fig. 5 can be used to illustrate this problem. The symptom was that the bass control was acting abnormally. Instead of varying the bass response as it should, the bass control was changing the volume as if it were a volume control. The action of the treble control seemed normal, and so did that of the regular volume control which is situated ahead of the first audio amplifier. This volume control is not shown in the schematic of Fig. 5. Trouble was indicated in the bass section of the tone-control circuit.

The action of the bass control can be explained as follows. Note the two capacitors C51 and C52 across the bass control. These capacitors offer a high impedance to the bass frequencies and a low impedance to the higher audio frequencies. The result is that the low bass tones are developed across the one-megohm control and are tapped off as desired. Because of the shunting effect of capacitors C51 and C52 at the middle and high frequencies, the load presented by the bass-control circuit at these frequencies should remain relatively constant despite changes in the setting of the control. In other words, when it is operating normally, the bass control should not act like a volume control.

When the individual components in the bass-control circuit were tested, C52 was found to be open. With this defect in the circuit, varying the bass control caused the portion of the control between the arm and the bottom tap to appear as a variable impedance at all frequencies. Hence, the bass control actually changed the volume level in the output.

This problem was an interesting one and was characteristic of the type of problem that may be encountered in the tone-control circuits of an amplifier.

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A TV-Receiver Check Tube

(Continued from page 17)

causes some difficulty in making voltage measurements at the tube bases. This is particularly true of the tubes mounted near the deflection yoke and those mounted underneath the picture tube. If the 17-inch tube is removed from the chassis and the 5AXP4 tube is substituted for it, all of the tube sockets are readily accessible. This is illustrated in Fig. 3, which shows the same chassis with the check tube mounted in position. Although it is possible to service the receiver with the picture tube removed from the chassis, certain symptoms which might be exhibited by the picture tube during the servicing procedure would not be present with the tube removed. Since the small check tube does present a picture, any symptoms which are exhibited while making voltage measurements or performing waveform analysis might present information that would be useful in servicing the set.

Fig. 4 shows the tube being mounted in a TV chassis. The size of the tube can be noted by comparing it with the technician's hands. After

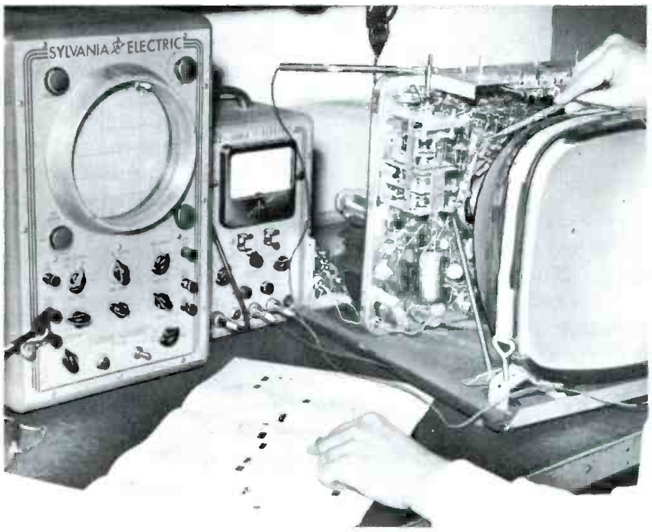


Fig. 2. Measuring Voltages on a Vertical-Chassis Receiver.

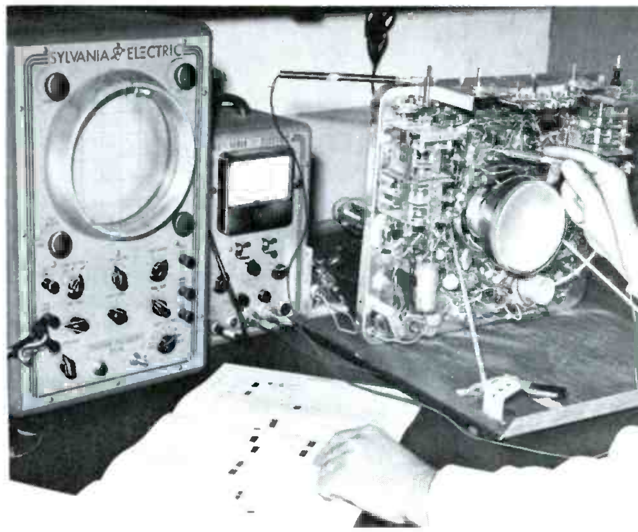


Fig. 3. TV-Receiver Check Tube Mounted in a Vertical-Chassis Receiver.

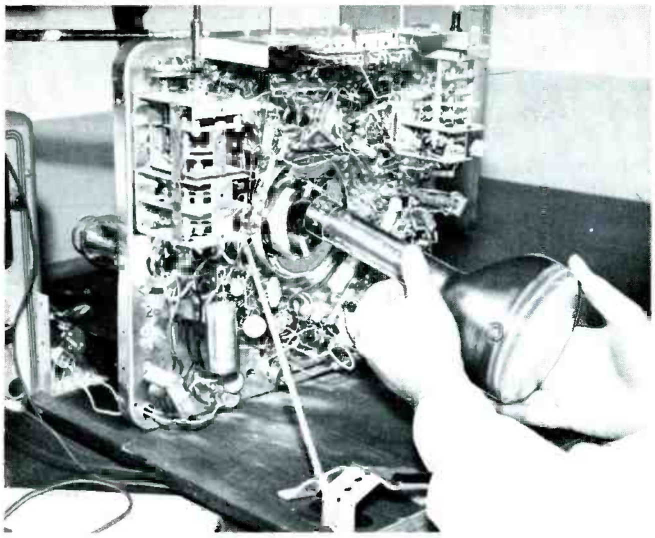


Fig. 4. Installing the 5AXP4 in a TV Receiver.

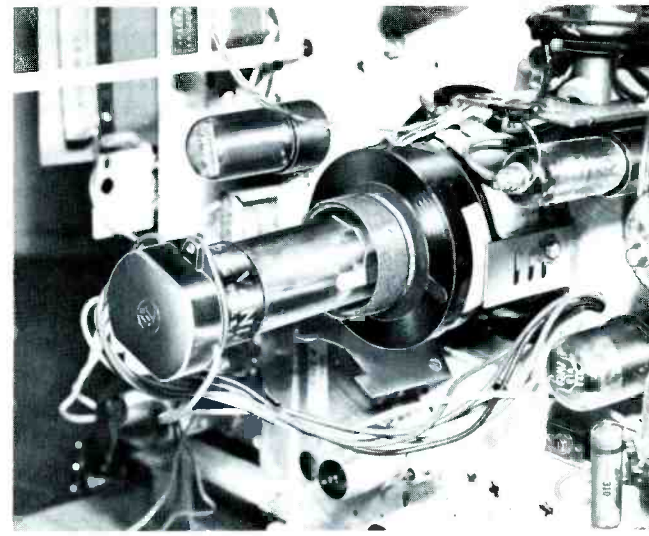


Fig. 6. Modified Centering Assembly in Place on the Neck of the Tube.

the tube is inserted in the yoke, several methods may be employed for holding it in position. Probably the simplest method involves the use of a centering-magnet assembly such as that employed on many picture tubes. The centering magnets are removed from the assembly so that they will not affect the operation of the tube. Fig. 5 shows such an assembly after the centering magnets have been removed. These assemblies are readily available at parts distributors,

Fig. 5. A Centering-Magnet Assembly With the Centering Magnets Removed.

and they work very satisfactorily in holding the 5AXP4 in position. To use this assembly, slide it over the neck of the tube after the tube has been inserted in the yoke and move the assembly forward on the neck of the tube until it comes in contact with either the chassis or the back of the yoke, whichever the case might be. Fig. 6 shows the assembly in position. There is sufficient tension to prevent the tube from sliding forward, and it is thus held in position.

The 5AXP4 can be mounted permanently in a box with a deflection yoke mounted on its neck for use as a test assembly in the service shop. Such an assembly would be extremely helpful in shops that specialize in the servicing of a particular type of receiver. If such is the case, the yoke leads can be extended and terminated with the proper plug so that it can be plugged into the receiver under test. It should be pointed out that such an arrangement would not be completely universal, since the variation in the inductances in the horizontal and vertical windings of the yoke vary considerably among receivers. One means of overcoming this would be to mount the tube permanently in a box so that the neck of the tube is free from any mounting brackets. The yoke of the receiver under test can then be quite easily slipped over the neck of the tube, and the servicing can be efficiently performed. Of course, it would be necessary to provide for extension of the high-voltage lead as well as the leads to the base of the tube, but this presents no great problem.

As was stated previously, the 5AXP4 is self-focusing and therefore does not require any external focus assembly. In those receivers which have the focus assembly mounted directly to the yoke in such a way that it cannot be removed, some defocusing of the picture will be experienced. It is usually not so severe, however, that it prevents satisfactory operation of the tube.

The characteristics and ratings of the 5AXP4 are such that it works equally well over a wide range of voltage inputs. This makes the tube a truly universal unit. The quality of picture which is obtainable through the use of a 5AXP4 is illustrated in Fig. 7. It should be pointed out at this time that final linearity adjustments should be performed on the picture tube which is installed permanently in the receiver. However, approximate adjustments can be made while the 5AXP4 is mounted in the chassis. Only slight touch-up adjustments are then required when the large tube is reinstalled.

Normally, a picture tube would not be considered as a tool; but the 5AXP4 is just that. During certain tests, it can provide very conclusive results which heretofore have been a sort of hit-and-miss proposition.

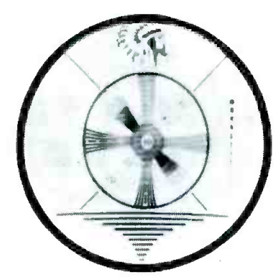


Fig. 7. Test-Pattern Display on the 5AXP4 Mounted in a Receiver Having 90-Degree Deflection.

This is particularly true when the tube is used to substitute for a suspected picture tube. The use of the 5AXP4 eliminates the necessity for removing cabinet-mounted picture tubes, and thus considerable time is saved. Because of its small size and weight, the 5AXP4 can be used in place of the large picture tube to make the receiver chassis lighter and more manageable during the servicing operation. The use of the 5AXP4 lessens the implosion hazard and eliminates any risk of damage to the customer's picture tube.

These are only a few of the many applications for the 5AXP4 tube. Its versatility will undoubtedly result in its application in an even greater number of servicing operations.

W. WILLIAM HENSLER

Shop Tickets

(Continued from page 25)

when the set is returned and the customer claims it is not his, let him check the serial number himself.

Space for Technician's Initials.

Most of the technicians interviewed in our survey seemed to approve of this entry when the ticket is used in shops where there are more than two men. It seemed to be the general consensus of opinion that the technician who makes the service call should first initial the shop ticket when he removes the set so that he can be assigned the return job. The shop technician should initial the ticket in case the man who delivers the set has some question about the job and also in case the chassis has to be returned to the shop for additional work.

Space to List Tubes and Parts Used and Their Prices.

It goes without saying that the parts used must be listed on the shop ticket regardless of the type of system used. In addition, the prices of the parts may be recorded on the ticket if it is to be used as the bill or income record.

Space for Description of Labor Performed and the Labor Charge.

If the ticket is not to be used as a bill, the shop technician can use this space to enter the length of time he works on the set and possibly a brief word or two about the nature of the repair. If the ticket is to serve as a bill or income record, the labor charge is entered in place of the time spent on the job.

Space for Pickup and Delivery Charge.

If it is standard procedure for the company to make a separate charge for pickup and delivery and if the shop ticket acts as the bill or income record, the job of making out the ticket would be simplified if a special space on the ticket were set aside for the charge made for pickup and delivery.

Tickets Numbered in Sequence.

If the shop tickets are used as service-call slips, they should be printed with consecutive numbers. On the other hand, if they are to be used in conjunction with regular service-call slips, they can be given the same number as the call slip. In the latter case, there should be a specific space allocated on each sec-

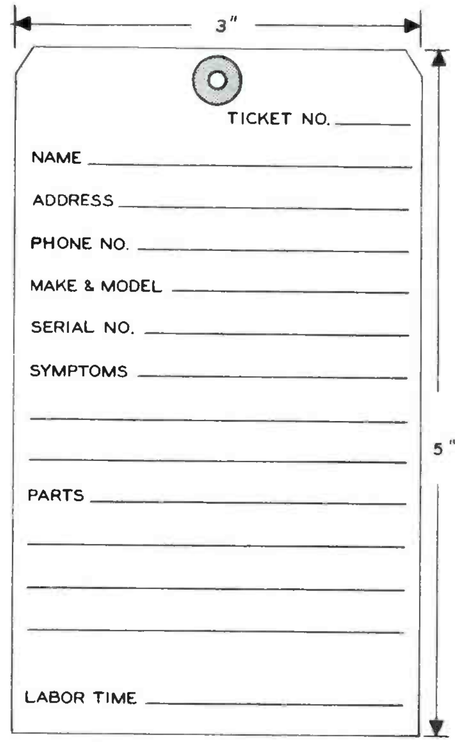


Fig. 1. Simple Shop Ticket to Be Used for Chassis Identification.

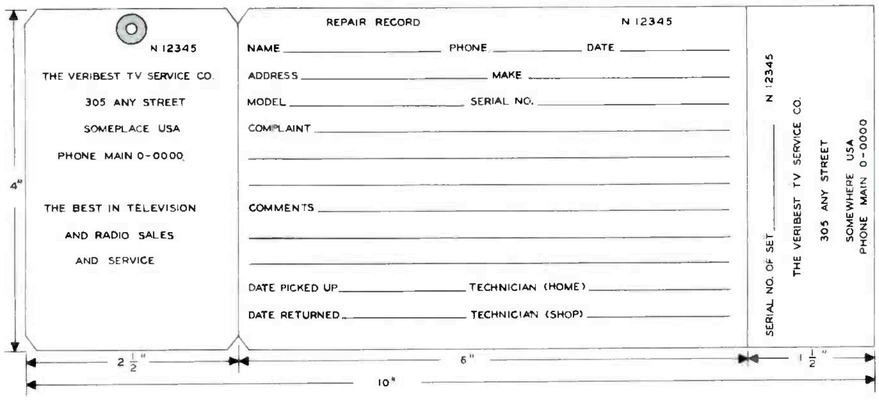


Fig. 2A. Front Side of Shop Ticket With Record Section Suitable for Filing.

tion of the shop ticket for the insertion of such a number.

Size of Ticket.

The size of the ticket will naturally depend upon the quantity of information that you wish to use on it. The size also depends upon the manner in which the shop tickets are to be used; that is, if they are to be discarded when the set is fixed or if they are to be kept as a record. If the latter is the case, it would be advisable to have them made in a handy size for filing. One size of file card is 3 by 5 inches; however, if many items are to be recorded on these tickets, this size is too small. A much more appropriate size for the main section of the ticket would be 4 by 6 inches. It may cost a little more to have this size printed, but the larger size would be well worth the additional expense.

Space for Purchase Date of a Set in Warranty.

The purchase date of a customer's set is important in computing the warranty status of parts. For shops which engage in a considerable volume of warranty work, it might be advantageous to provide a space on the shop ticket for the date of purchase or for the date of warranty expiration. In other cases, it should not be necessary to set aside a special space for this information. The warranty status can be indicated in the space provided for listing the parts replaced.

Space for Expiration Date of Service Contract.

In shops that do a great deal of service business on the contract basis, space can be set aside on the shop ticket for any necessary data concerning the customer's service contract.

Sample Tickets

With these ideas and suggestions to go on, two types of shop tickets have been developed. The first design, which may be seen in Fig. 1, is a simple shop ticket. It is intended to be used by shop personnel to identify chassis and to have something on which the parts used and the work done can be listed. Once a set has been returned to the home, the ticket may be removed and discarded. In other words, this simple shop ticket is to be used when there is no desire to keep the ticket for a record.

In order to simplify this ticket further, the customer identification can be left off if a system is employed whereby the chassis is identified by the call-slip number which is placed on the shop ticket in place of the regular printed number. The chief advantage in having the name and phone number of the owner on these tickets is for the convenience of the shop man if he finds it necessary to call the customer about the set.

The more elaborate ticket shown in Fig. 2 is designed to serve a broader purpose. It has three sections: a customer's claim check, a file card, and a shop identification tag.

The first section is the customer's claim check. It contains the name, address, and phone number of the shop as well as a ticket number corresponding to the numbers on the other two sections. It also provides a space for the technician to write the serial number of the chassis before removing it from the home. We believe that this is good for customer relations. It will most assuredly put a stop to accusations that the wrong set was returned. Such erroneous claims, incidentally, do happen occasionally.

The center section measures 4 by 6 inches, which is a file-card size. This means that it is a good size for filing as a permanent record. This size is also large enough for all the necessary information without having the writing too small to be legible. While on the subject of keeping records, it is suggested that a service record be kept on shop work and on service calls completed in the home. This may best be done by using the main section of the shop ticket to record all the information from the completed service call and by filing the card section along with the regular shop tickets at the end of the day. This makes a much better filing system, since a card is much easier to file than the slip of paper that is usually used as a service-call slip. The file provides complete records as well as a complete mailing list which may be used for any type of mail advertising.

The third section of the shop ticket may be removed from the chassis and tied to the back of the cabinet when the set is reinstalled in the customer's home so that he has your shop name and phone number handy the next time he needs service.

It is our belief that this shop-ticket design will fill the needs of the average radio and television service shop; however, for those who desire a slightly different design, some items can be eliminated and others added to suit the individual shop.

HENRY A. CARTER

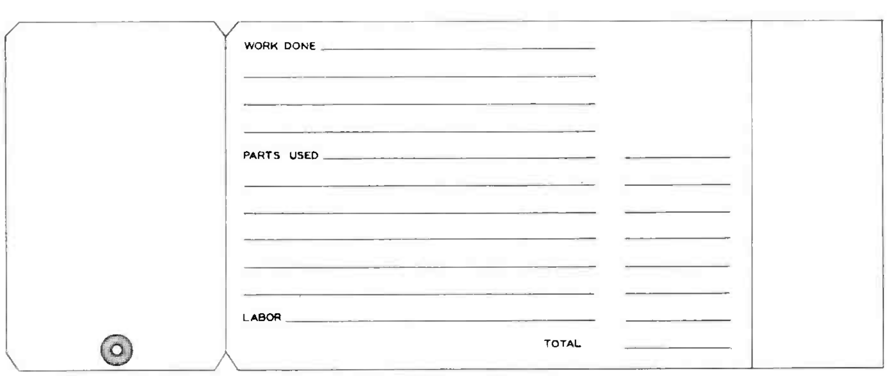
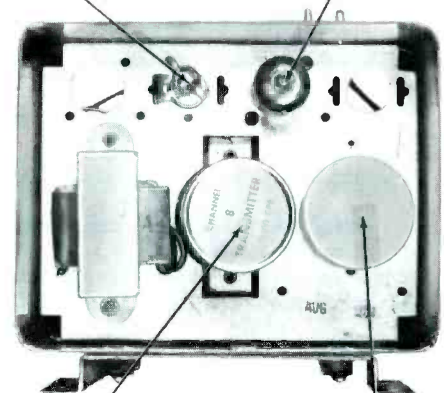


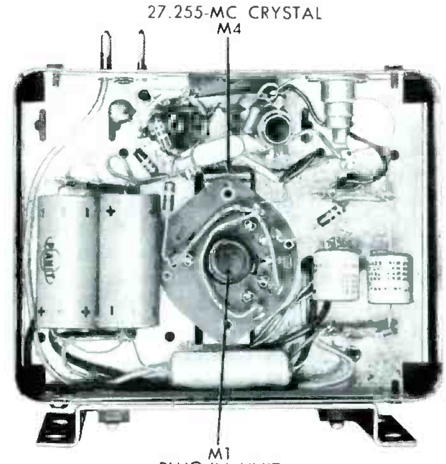
Fig. 2B. Back Side of Shop Ticket Shown in Fig. 2A.

The Garage-Door Opener

(Continued from page 27)



(A) Top View.



(B) Bottom View.

Fig. 3. Transmitter in the Perma-Power Model RC101.

quarter of a revolution to resonate the circuit at a frequency slightly higher than that of the oscillator. No attempt should be made to alter the length of the antenna lead. Particular care should be taken to see that the leads to the transmitter do not interfere with the normal operation of the automobile.

Servicing of the transmitter is not difficult, and the normal trouble-shooting procedures may be used. If trouble is experienced with an installation, one of the first checks to be made is to see if the neon bulb on the transmitter glows when power is applied to the unit. If the neon bulb does not glow and the vibrator supply seems to be operating, a slight readjustment of the slug in L1 may cause the transmitter to operate. The 6U8 is most easily checked by substitution. The antenna and its connecting cable may be checked when these preliminary tests do not isolate the trouble. This may be done by unplugging the antenna cable and tuning L1 for an indication. Failure of the neon bulb to ignite when the antenna is disconnected isolates the trouble to the transmitter, and the transmitter may be removed from the automobile for more thorough testing.

A rapid and efficient check of transmitter performance may be made with the aid of a communication receiver tuned to 27.255 megacycles. This method also permits an audible indication of the modulation on the RF carrier and is very useful for this reason.

Bench servicing of the transmitter involves the usual procedure of checking voltages and resistances. A grid-dip meter is a very useful item when servicing transmitters. The resonant frequency of the tank circuit in the RF oscillator may be determined very easily by using this instrument. When checking the RF oscillator, the crystal should not be overlooked as a possible source of trouble. The grid-dip meter is of value in testing the crystal for activity. It is necessary to remove the crystal from the transmitter for this check. When removing or installing the crystal, care should be taken not to damage it as a result of the heat generated by the soldering operation; moreover, the crystal should not be subjected to excessive shock. After the crystal has been removed, a small loop made from hookup wire is connected across the leads from the crystal. The grid-dip meter is inductively coupled to this loop and tuned through 27.255 megacycles. If the crystal is good, a dip should occur at the resonant frequency. The grid-dip meter should be tuned very slowly, because the high Q of the crystal causes a very sharp dip on the meter.

The modulator is of such a nature that it should not prove difficult to service. The operation of the modulator may be checked by connecting an oscilloscope to the screen grid of the RF oscillator and by checking for the presence of the tone signal. No attempt should be made to service the plug-in unit used in the modulator circuit. If the unit is defective, a replacement unit should be obtained from the manufacturer.

The power supply in the transmitter employs conventional circuitry and may be serviced in the same manner as any vibrator type of power supply.

Receiver Unit

The Model RC101 receiver used in conjunction with the aforementioned transmitter employs two 6U8 tubes and operates from a self-contained AC power supply. The major components and the parts placement may be seen in Fig. 5, which shows a top and a bottom view of the unit.

The receiver is tuned during manufacture to a frequency of 27.255 megacycles. The control relay in the receiver will not operate, however, unless the received signal is modulated at the correct frequency. As previously mentioned, the frequency of the tone modulation on the RF carrier is chosen by means of a plug-in unit in the transmitter. The receiver also has a similar unit which must correspond in frequency to the unit in the transmitter. The chance of the door mechanism being actuated by an unwanted signal is virtually eliminated by this system. In order to understand how this is accomplished, we shall investigate the receiver circuitry by means of the schematic diagram in Fig. 6.

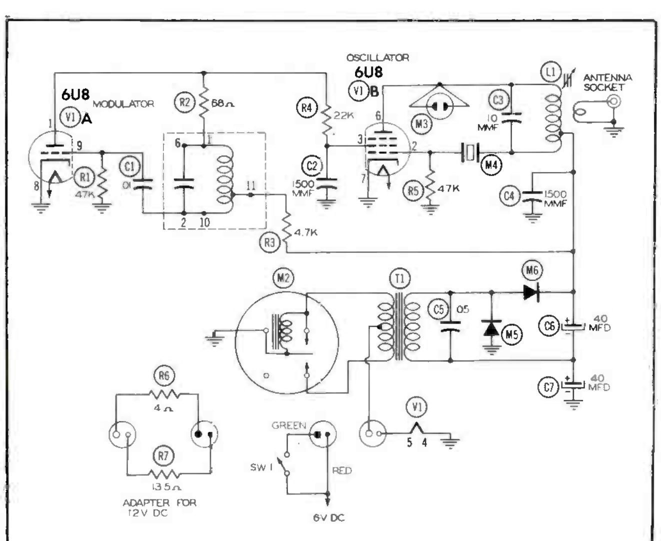
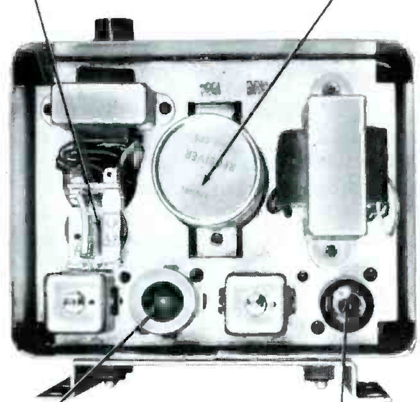


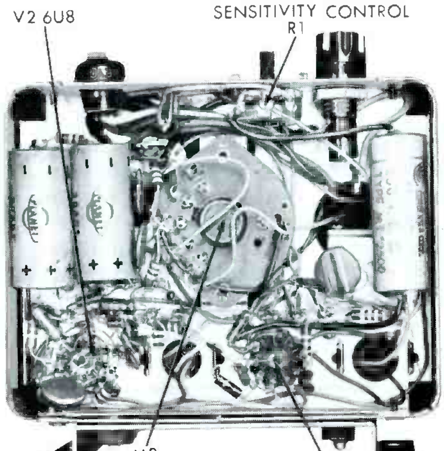
Fig. 4. Schematic Diagram of the Transmitter in the Perma-Power Model RC101.

A sensitivity control R1 is provided for adjusting the input to the first stage of amplification. The first stage employs the pentode section of a 6U8. Tuned circuits are used at the input and output of this stage. Gain of the amplifier is controlled by the application of AVC.

The second stage of amplification also employs the pentode section of a 6U8. The schematic shows that this stage is connected as a reflex amplifier. The signal at the plate of this stage is a 27.255-megacycle signal containing the tone modulation.



(A) Top View.



(B) Bottom View.

Fig. 5. Receiver in the Perma-Power Model RC101.

This signal is applied to a detector circuit employing a 1N64 germanium diode. The output of the detector is applied to the grid of the reflex amplifier V2A through R10. The amplified tone signal is taken from the screen grid which acts as the plate of a triode. The use of a reflex amplifier permits the pentode to serve the dual purpose of amplifying the 27.255-mc signal and of amplifying the tone signal as well. The output of

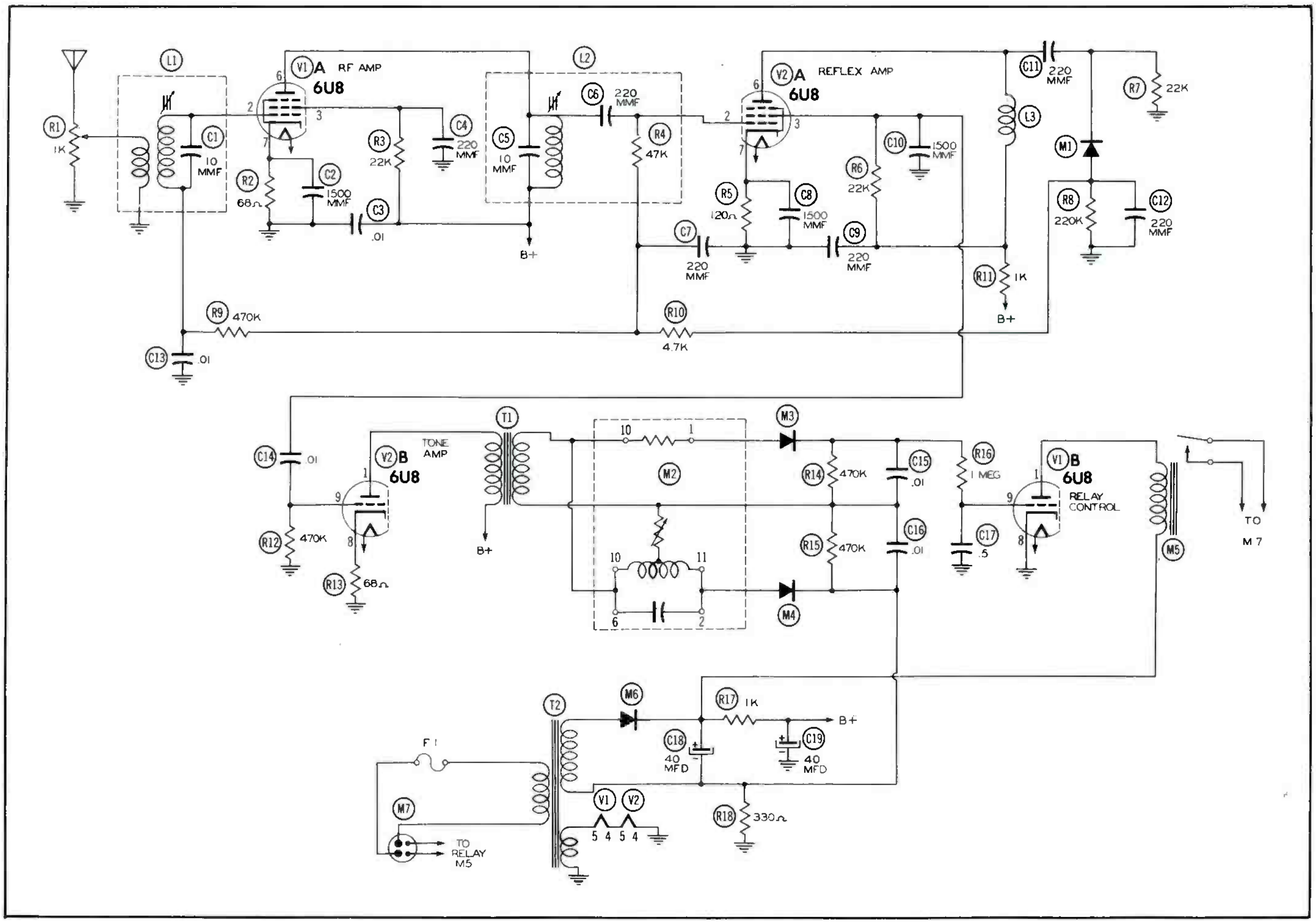


Fig. 6. Schematic Diagram of the Receiver in the Perma-Power Model RC101.

the detector is filtered by resistor R9 and capacitor C13 and is used as AVC on the first amplifier V1A.

The tone signal from the screen grid of V2A is fed through capacitor C14 to the grid of the triode section V2B where it is again amplified. The output of this stage is transformer coupled to the decoding network which contains the plug-in unit. It is necessary at this point to consider the triode section V1B. With no output from the decoder unit, the triode is cut off by the application of a negative voltage taken across resistor R18. During this quiescent state, no plate current will flow and the contacts on relay M5 are open.

The plug-in unit is used in conjunction with two minature selenium rectifiers and contains two channels. One channel is merely resistive and has no frequency-selective circuit. The other channel is a band-stop circuit tuned to the frequency of the tone signal.

If a signal other than the proper tone signal is applied to the decoder network, very little attenuation is offered in either channel of the plug-in unit. The two outputs of the rectifiers M3 and M4 will then combine across resistors R14 and R15 in such a manner that the bias on the grid of the triode V1B will not be appreciably affected, and the tube will remain cut off.

If, however, the frequency of the signal is the same as the resonant point of the band-stop filter, a much larger output is obtained from the resistive channel than from the band-stop channel. The voltage developed across resistor R14 will cancel the bias on the triode grid, and the tube will conduct. Current then flows through the relay, and the relay contacts close. The door-opening mechanism is activated by the closed contacts of the relay.

In order to reduce the risk of actuating the relay by a momentary signal occurring at the tone frequency, resistor R16 and capacitor C17 are used to form a time delay of approximately one-half second.

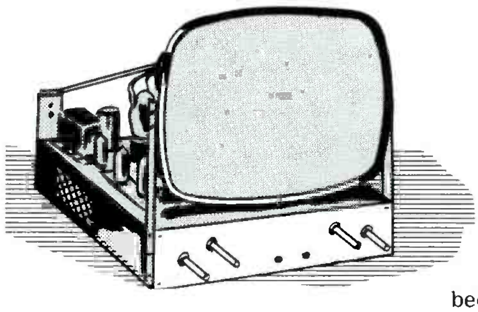
In trouble shooting the receiver, it is convenient to isolate the trouble to a particular stage first. This may be done with the use of an audio signal generator and an RF signal generator.

The tone amplifier, the decoder network, and the relay-control stage may be easily checked by connecting an audio generator to the grid of V2B and applying a signal at the proper tone frequency. If this is done, the relay should close. Tuning of the audio generator to either side of the tone frequency should cause the relay to open. The triode section of the reflex amplifier may be checked in a similar manner by connecting the generator to the grid of V2A.

The over-all performance of the receiver, as well as the RF amplifiers and detector, may be checked by feeding into the receiver at the antenna terminal a 27.255-megacycle signal that is modulated at the tone frequency. An audio generator tuned to the tone frequency can be used to modulate the signal from the RF generator.

DON R. HOWE

Stocking the Tube Kit



SUGGESTED MINIMUM STOCK REQUIREMENTS FOR DELUXE OR STANDARD TUBE KITS

A suggested list for stocking the tube kit appeared in the January 1954 issue of the PF INDEX. Since that time, some variations have occurred in the tube complements of television receivers. These variations should be reflected in the stock of tubes carried in the tube kit. It is for this reason that a revised list has been prepared. Chart I contains the list for the deluxe kit. A tube list for the standard kit is shown in Chart II.

As color television receivers become more prevalent, additional tube types will have to be carried by the service technician. Among these are the 3A2, 3A3, 6AN8, 6BC7, 6BY6, 6CL5, and 6BD4 tubes.

The development of new tubes for use in series-string circuits will also be reflected in the types of tubes carried in the tube caddy. When the receivers using these tubes become more popular, the service technician may augment his tube stock with the appropriate types. The series-string tubes used in current models are listed in Chart III.

CHART I

Tube Complement for the Deluxe Kit

TUBES TYPES	TV MODELS 46-55	52-55	TUBES TYPES	TV MODELS 46-55	52-55	TUBES TYPES	TV MODELS 46-55	52-55	TUBES TYPES	TV MODELS 46-55	52-55	TUBES TYPES	TV MODELS 46-55	52-55
1B3GT	3	3	6AQ5	2	2	6BK5	1	1	6S4	1	1	12AU7	3	2
1X2A	2	2	6AQ7GT	1	1	6BK7A	2	2	6SL7GT	1	1	12AV7	1	1
5U4G	4	4	6AS5	1	1	6BL7GT	1	1	6SN7GTA	4	4	12AX4	1	1
5V4G	1	0	6AT6	1	1	6BN6	1	1	6SQ7(GT)	1	1	12AX7	1	1
5Y3GT	2	1	6AU5GT	1	1	6BQ6GT	3	3	6T4*	1	1	12AZ7	0	1
6AB4	1	1	6AU6	4	3	6BQ7A	2	3	6T8	2	2	12BH7	1	1
6AC7	2	2	6AV5GT	1	1	6BZ7	1	1	6U8	1	1	12BY7	1	1
6AF4*	2	2	6AV6	2	2	6C4	2	2	6V3 (A)	1	1	12SN7GT	1	1
6AG5	2	1	6AX4GT	1	1	6CB6	3	4	6V6GT	2	2	25BQ6GT	1	1
6AG7	1	1	6AX5GT	1	1	6CD6G	2	2	6W4GT	3	3	25L6GT	1	1
6AH4GT	1	1	6BA6	1	1	6CL6	0	1	6W6GT	1	1	25W4GT	1	1
6AH6	1	1	6BC5	2	1	6CS6	1	1	6X5(GT)	1	1	5642	2	2
6AK5	1	1	6BE6	1	1	6J5(GT)	1	1	6X8	1	1			
6AL5	2	2	6BG6G	2	2	6J6	3	3	6Y6G	1	1			
6AN4*	1	1	6BH6	1	0	6K6GT	2	1	12AT7	2	2			

*For UHF areas

CHART II

Tube Complement for the Standard Kit

TUBES TYPES	TV MODELS 46-55	52-55	TUBES TYPES	TV MODELS 46-55	52-55	TUBES TYPES	TV MODELS 46-55	52-55	TUBES TYPES	TV MODELS 46-55	52-55	TUBES TYPES	TV MODELS 46-55	52-55
1B3GT	2	2	6AN4*	1	1	6BG6G	1	1	6J6	2	2	12AT7	1	1
1X2A	1	1	6AQ5	1	1	6BK5	1	1	6K6GT	1	1	12AU7	1	1
5U4G	2	2	6AQ7GT	1	1	6BK7A	1	1	6S4	1	1	12AV7	1	1
5V4G	1	0	6AS5	1	1	6BL7GT	1	1	6SL7GT	1	1	12AX4	1	1
5Y3GT	1	1	6AT6	1	1	6BN6	1	1	6SN7GTA	2	2	12AX7	1	1
6AB4	1	1	6AU5GT	1	1	6BQ6GT	1	2	6SQ7(GT)	1	1	12AZ7	0	1
6AC7	1	1	6AU6	2	2	6BQ7A	2	2	6T4*	1	1	12BH7	1	1
6AF4*	1	1	6AV5GT	1	1	6BZ7	1	1	6T8	1	1	12BY7	1	1
6AG5	1	1	6AV6	1	1	6C4	1	1	6U8	1	1	12SN7GT	1	1
6AG7	1	1	6AX4GT	1	1	6CB6	2	2	6V3 (A)	1	1	25BQ6GT	1	1
6AH4GT	1	1	6AX5GT	0	1	6CD6G	2	2	6V6GT	1	1	25L6GT	1	1
6AH6	1	1	6BA6	1	1	6CL6	0	1	6W4GT	2	2	5642	2	0
6AK5	1	1	6BC5	1	1	6CS6	1	1	6W6GT	1	1			
6AL5	1	1	6BE6	1	1	6J5(GT)	1	1	6X8	1	1			

*For UHF areas

CHART III

Tubes Appearing in Series-String Receivers

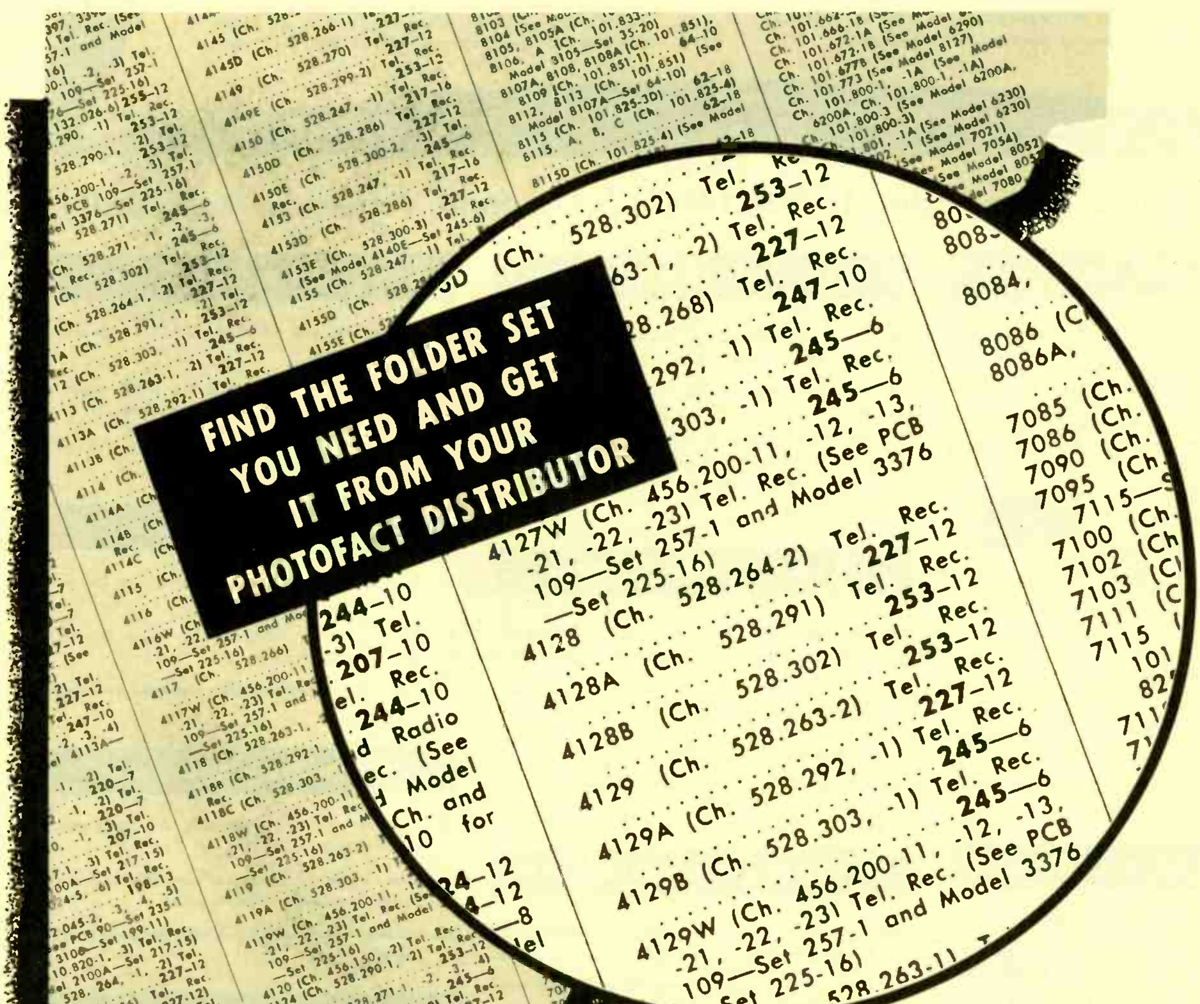
TUBES TYPES	TV MODELS 46-55	52-55	TUBES TYPES	TV MODELS 46-55	52-55	TUBES TYPES	TV MODELS 46-55	52-55	TUBES TYPES	TV MODELS 46-55	52-55	TUBES TYPES	TV MODELS 46-55	52-55
2AF4			4BQ7A			5J6			12BQ6GT			25CD6G		
3BC5			5AM8			5U8			12CU6					
3BN6			5AN8			5X8			12L6GT					
3CB6			5AV8			6AW8			12W6GT					

Cumulative Index

No. 48

JAN.-FEB. 1955

COVERING **PHOTOFACT FOLDER** SETS 1 THRU 263



THIS INDEX IS YOUR ANSWER TO SERVICE DATA REQUIREMENTS

THIS INDEX CURRENT ONLY UNTIL MARCH 15th, 1955

Cumulative Index to PHOTOFACT FOLDERS

No. 48 · Covering Folder Sets Nos. 1 through 263 · World's Finest Electronic Service Data

HOW TO USE THIS INDEX

To find the PHOTOFACT Folder you need, first look for the name of the receiver (listed alphabetically below), and then find the required model number. Opposite the model, you will find the number of the PHOTOFACT Set in which the required Folder appears, and the number of that Folder. The PHOTOFACT Set number is shown in bold-face type; the Folder number is in the regular light-face type.

IMPORTANT—1. The letter "A" following a set number in the Index listing, indicates a "Preliminary Data Folder." These folders were designed to provide immediate basic data on TV receivers. Many of these were later superseded by regular Photofact Folders. In those cases where short production runs and/or limited distribution prevented availability of a sample chassis the "A" designation has been retained.

2. Models marked by an asterisk (*) have not yet been covered in a standard Folder. However, regular PHOTOFACT Subscribers may obtain Schematic, Alignment Data or other required information on these models without charge by supplying make, model or chassis number and serial number. (When requesting such data, mention the name of the Parts Distributor who supplies you with your PHOTOFACT Folder Sets.)

3. Production Change Bulletins contain data supplementary to certain models covered in previously issued PHOTOFACT Folders, and are listed in this Index immediately preceding the listing of the original coverage of the model or chassis. These Bulletins should be filed with the Folders covering the models to which the changes apply.

NOTE: PCB Denotes Production Change Bulletin. Production Change Bulletin Nos. 1 Through 63 Are All Contained in Set No. A-200. ● Denotes Television Receiver.

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NOTE: PCB Denotes Production Change Bulletin. Production Change Bulletin Nos. 1 Through 63 Are All Contained in Set No. A-200. ● Denotes Television Receiver.

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NOTE: PCB Denotes **P**roduction **C**hange **B**ulletin. Production Change Bulletin Nos. 1 Through 63 Are All Contained in Set No. A-200. ● Denotes Television Receiver.

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NOTE: PCB Denotes Production Change Bulletin. Production Change Bulletin Nos. 1 Through 63 Are All Contained in Set No. A-200. ● Denotes Television Receiver.

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- ●53-U2226 (Code 123) (Ch. 81, H-1, H-1A) (For TV Ch. see PCB 83—Set 224-1 and Model 53-T1824—Set **201**-7, for UHF Tuner see Model UT21A—Set **223**-9)
- ●53-U2227 (Code 123) (Ch. 81, H-1, H-1A) (For TV Ch. see PCB 83—224-1 and Model 53-T1824—Set **201**-7, for UHF Tuner see Model UT21A—Set **223**-9)
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- ●53-U2266, L (Code 126) (Ch. 91, J-1) (See PCB 66—Set 203-1, FCB 82—Set 223-1 and Model 53-T1853—Set **185**-10)
- ●53-U2266 (Code 128) (Ch. 91, J-2) (See PCB 66—Set 203-1, PCB 82—Set 223-1 and Model 53-T1853—Set **185**-10)
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- ●53-U2271 (Code 128) (Ch. 91, J-2) (See PCB 66—Set 203-1, PCB 82—Set 223-1 and Model 53-T1853—Set **185**-10)
- ●53-U2272 (Code 123) (Ch. 81, H-1, H-1A) (For TV Ch. see PCB 83—Set 224-1 and Model 53-T1824—Set **201**-7, for UHF Tuner see Model UT21A—Set **223**-9)
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NOTE: PCB Denotes Production Change Bulletin. Production Change Bulletin Nos. 1 Through 63 Are All Contained in Set No. A-200. ● Denotes Television Receiver.

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NOTE: PCB Denotes Production Change Bulletin. Production Change Bulletin Nos. 1 Through 63 Are All Contained in Set No. A-200. ● Denotes Television Receiver.

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1—RETMA Production Source Code (Jan. 1, 1954)	**246**
2—RETMA Production Source Code (Supplement)	**258**
3—TRADE DIRECTORY—Parts Manufacturers	**12**
4—National Electrical Code on Antennas	**88**
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6—Mica Capacitor Color Codes	**48**
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10—Certificate entitling subscriber to PHOTOFACT Volume Labels for Vols. 1-10	**62**
11—Certificate entitling subscriber to PHOTOFACT Volume Labels for Vols. 11-20	**102**
12—Alliance Model ATR Rotator	**216**
13—Alliance Model DIR Rotator	**240**
14—Alliance Model F-4 Rotator	**250**
15—Alliance Model HIR Rotator	**242**
16—Alliance Model T-10 Rotator	**254**
17—Alliance Model U-83 Rotator	**256**
18—Photofact Television Course appearing serially in	**38-51, 54**
19—CR Tube Dimension Chart	**112**
20—CR Electromagnetic Tube Characteristics Chart	**112**
21—CR Tube Interchangeability Chart	**112**
22—NPA maintenance and repair information	**130**
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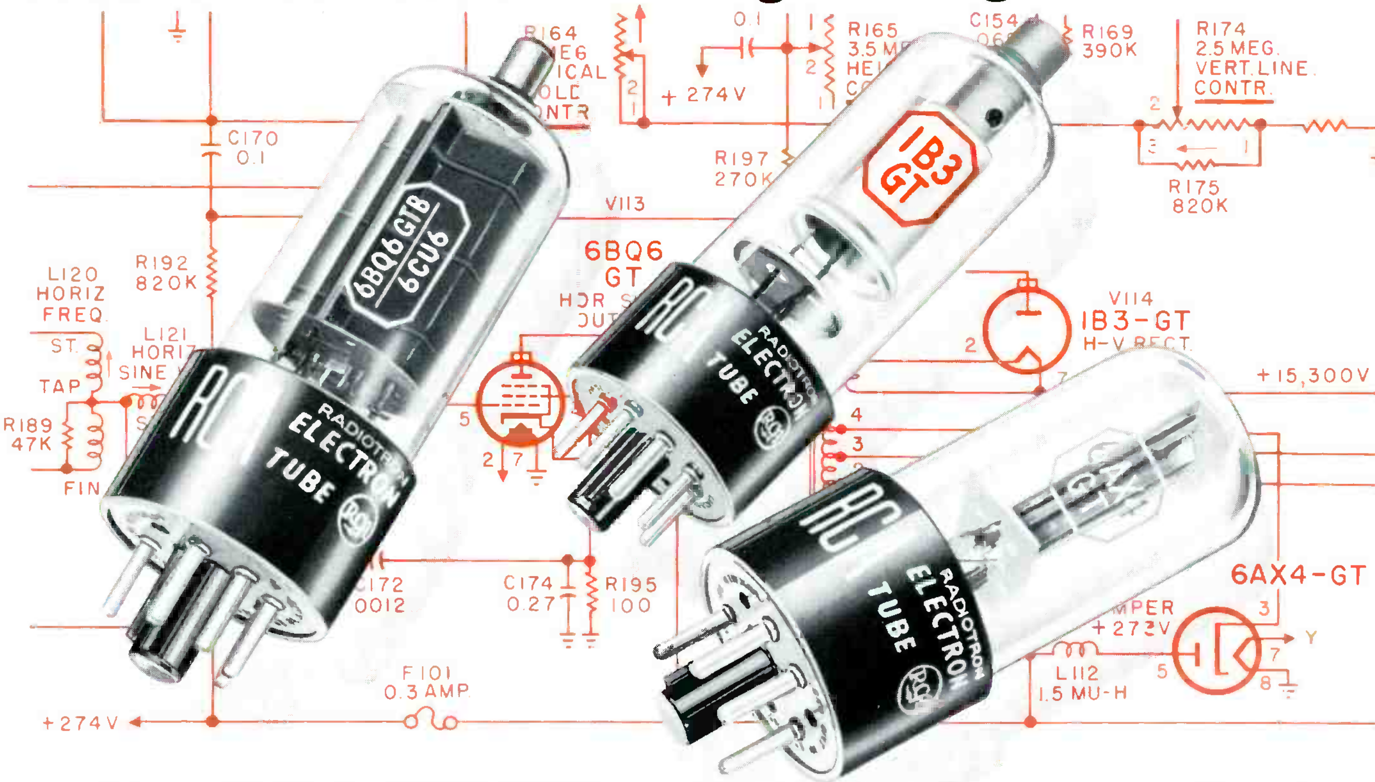

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