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PF REPORTER

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for the Electronic Service Industry

DECEMBER • 1954
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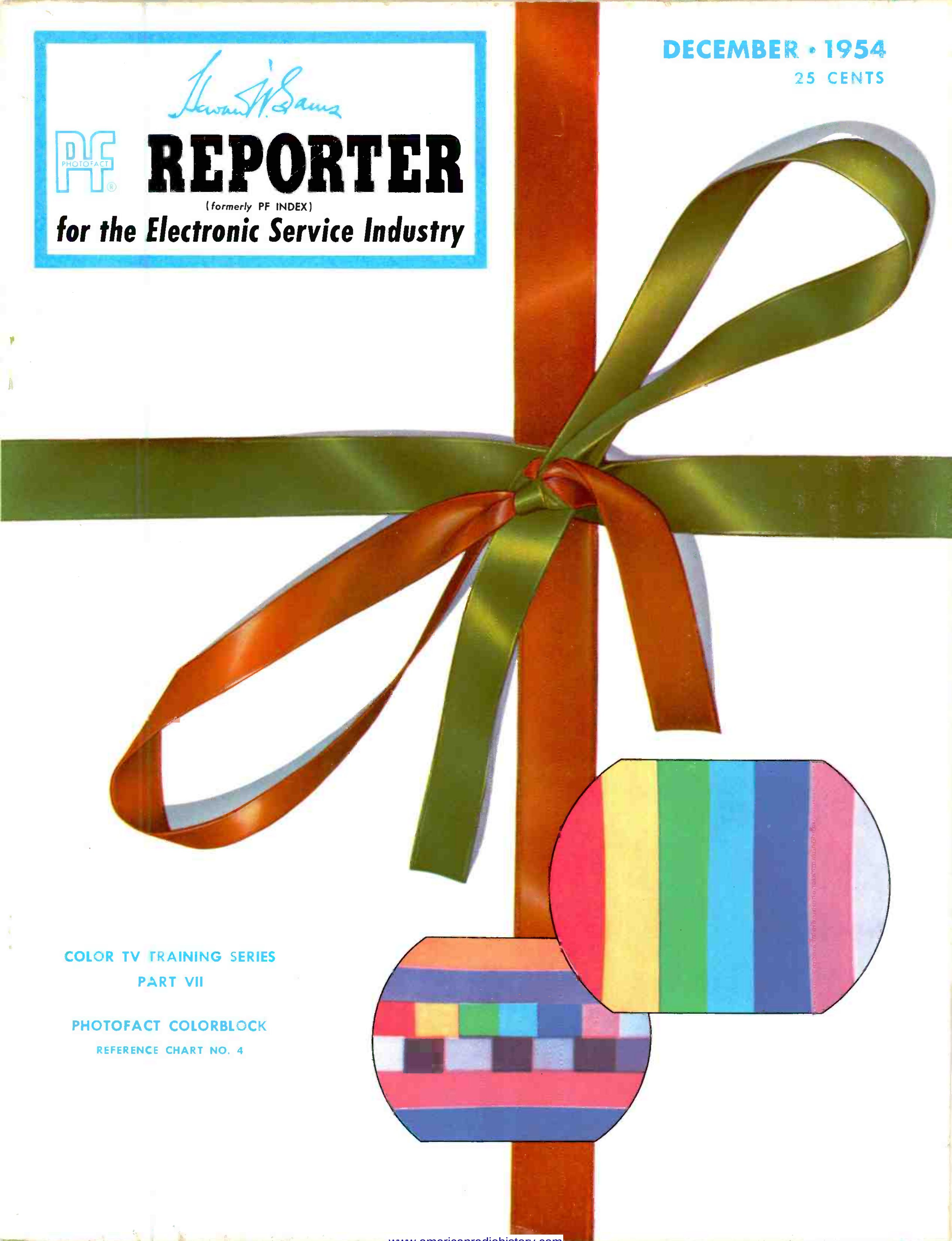

COLOR TV TRAINING SERIES
PART VII

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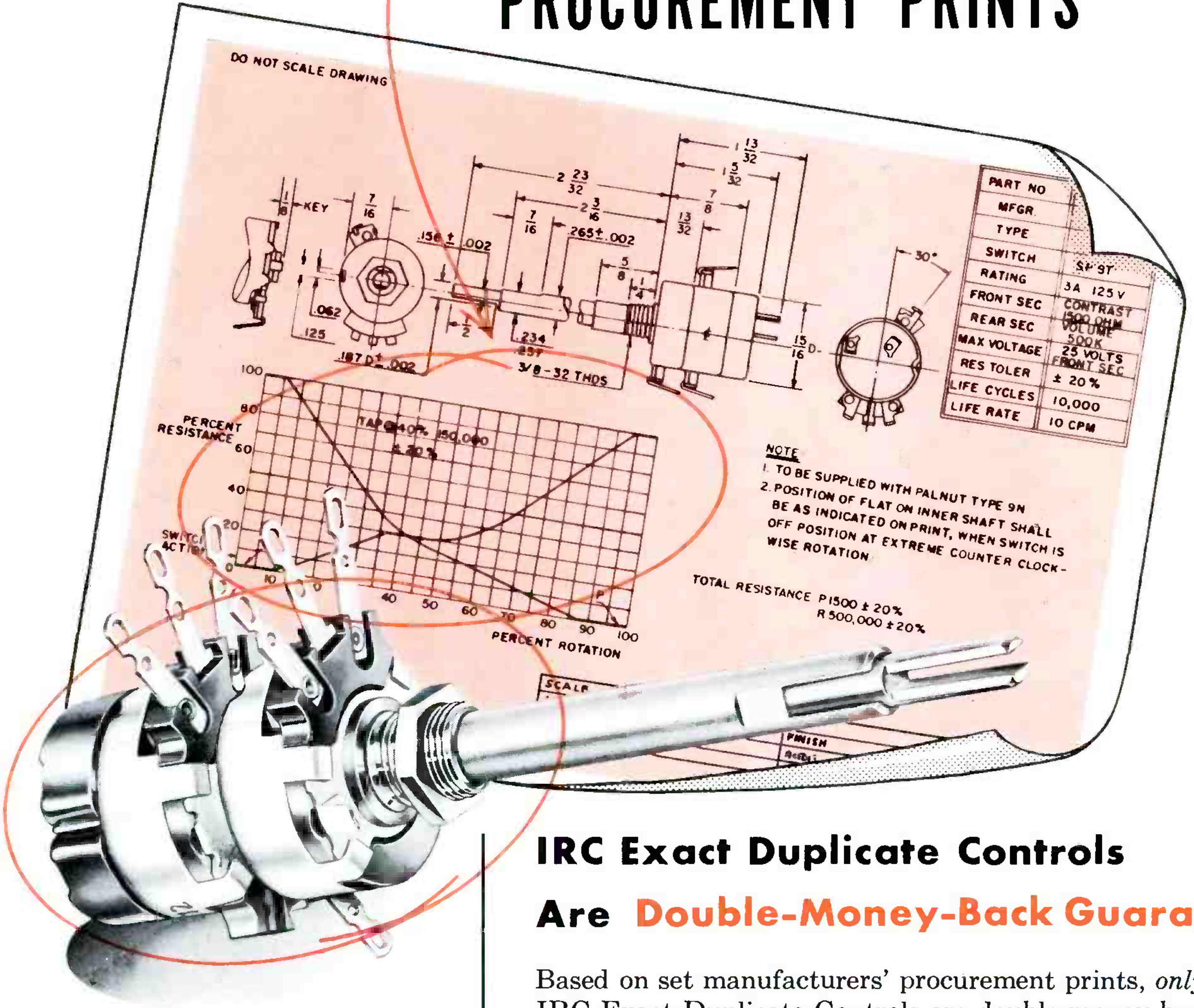

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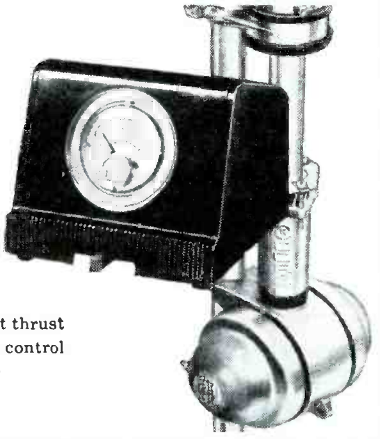
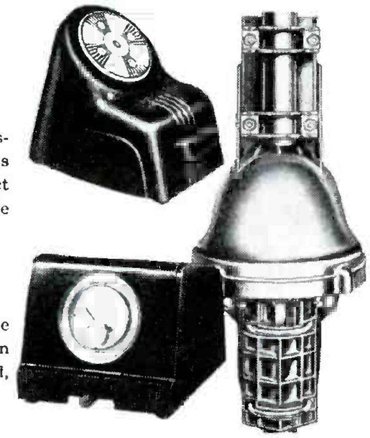


model TR-12
A special combination value consisting of complete rotor including thrust bearing. Handsome modern cabinet with meter control dial, uses 4 wire cable.

model TR-11
The same as the TR-12 without thrust bearing, complete with meter control dial cabinet, uses 4 wire cable



model TR-2
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The heavy-duty rotor complete with handsome, modern design cabinet with meter control dial, uses 4 wire cable.

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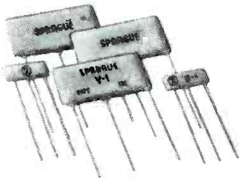

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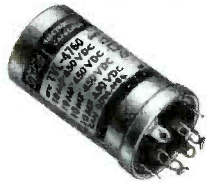

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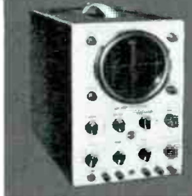

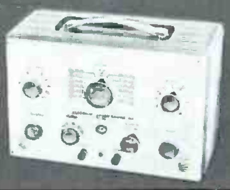

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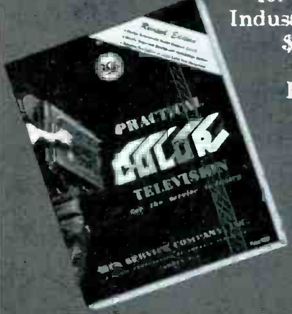

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Audio-Facts

THE ELECTRO-VOICE AMPLIFIER MODEL A-20C

by Robert B. Dunham

Things do change — including amplifiers. When we see what has been accomplished in amplifier design and hear the results that can be obtained from improved amplifiers, we have to admit that changes have been made.

Not so long ago, we knew just about how much power output and how much distortion could be expected from an amplifier if we knew what output tubes and transformer were used. The limitations in power output and performance to be obtained from the conventional circuits, nearly universally used, were very well established.

Now it is a different story. For example, the Electro-Voice Model A-20C amplifier (Fig. 1) which uses a pair of 6V6GT tubes in the output stage, is rated by the manufacturer at 20 watts of power output and 40 watts on peaks. The wide-range response obtained from this small amplifier at higher than normal power levels and with such small percentages of distortion would have been thought impossible not so long ago.

Here are some of the specifications, as given by the manufacturer.

Power Output.
  20 watts rated
  40 watts on peaks

Frequency Response.
  ±0.1 db, 20 to 20,000 cps, at full 20 watts output

Harmonic Distortion.
  Less than 0.5 per cent at maximum rated output

Intermodulation Distortion.
  Less than 0.3 per cent at 5 watts
  Less than 1.5 per cent at 20 watts

Hum and Noise.
  70 db below rated output
  55 db below rated output (magnetic phono)

Feedback.

Loop feedback	16 db negative
Driver plate	2 db positive
Output circuit	19 db negative

Damping Factor.
  Adjustable between 0.1 and 15

Any of these ratings that have been checked in our laboratory have been equalled or bettered.

The A-20C is a complete unit equipped with the circuits and controls necessary to handle most any type of input signal and loudspeaker system. It is small (10 3/4 inches wide by 11 1/4 inches deep by 7 3/8 inches high), as can be seen in Figs. 1 and 2; and the completeness of its circuit can be seen in these illustrations and in the schematic in Fig. 3.

The features that provide the convenient and flexible control of operation will merit the attention to be given them later, but we will concentrate first on the power-amplifier section because of the outstanding results obtained from it.

Before going into the discussion of the circuit of the A-20C, it might be well to review a few points concerning amplifier design. Class A output stages have been employed in most amplifiers used in home music systems because that class of operation provides reasonable amounts of power output with small percentages of distortion. One of the most important requirements of a high quality audio system is that it must operate with a minimum of distortion.

But Class A operation is very inefficient, and high-powered output tubes must be used if very many watts of audio are to be developed. If more power is desired from a pair of output tubes, the more efficient Class AB or Class B types of operation must be used. The added power gained from Class AB or Class B operation has always been offset by the high percentage of distortion developed by these classes of operation because of switching transients set up in the output transformer. Transients occur during the push-pull action when the signal switches from one to the other tube. The pulse or transient distorts the signal waveform by producing a notch in it at the instant of switching.

Electro-Voice employs the Wiggins CIRCLOTRON circuit in the A-20C amplifier to eliminate switching transients and to make greater use of the capabilities of the power-output tubes. The complete schematic is shown in Fig. 3.

The output circuit may appear at first glance to be a conventional

* * Please turn to page 59 * *

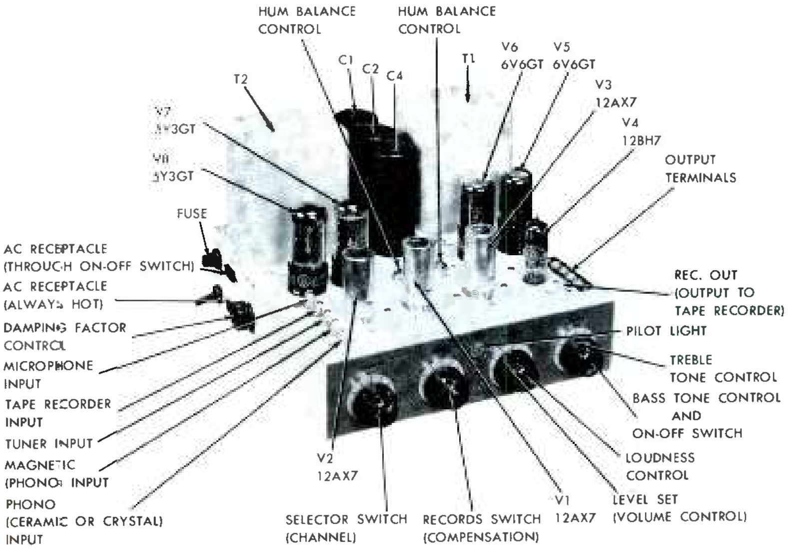

Fig. 1. Top View of Electro-Voice Model A-20C Amplifier.

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COLOR TV
TRAINING SERIES

PART VII
THE COLOR PICTURE SIGNAL

by **C. P. Oliphant** and **Verne M. Ray**

Previous discussions in this Color TV Training Series showed how the chrominance and the CW reference signals are obtained. It was explained that the luminance levels and the sync pulses were removed from the composite signal. This process results in the development of a chrominance signal which is applied to the inputs of the demodulators.

It was also explained that the color-sync section develops two synchronizing signals which differ in phase relationship by 90 degrees. These two signals are maintained at the frequency of 3.58 megacycles and held at the prescribed phase. One CW signal is applied to the I demodulator, and the other is applied to the Q demodulator.

The chrominance signal and the two CW reference signals are required by the demodulator stage. The demodulation process results in the chrominance signal being changed into color-difference signals which are useful in the matrix section of the color receiver.

Several circuits which perform demodulation will be covered in this part of the Color TV Training Series. Shown in Fig. 7-1 is a block diagram of the color-receiver sections which have been discussed previously and those which are to be discussed in this part of the series. The shaded sections represent the stages which have been covered, and the unshaded ones are those which will be covered in the following discussion.

COLOR DEMODULATION

The purpose of the demodulators in a color receiver is the reverse to that of the modulators in a color transmitter. It may be recalled that the latter accept the two independent I and Q color signals and combine them into a single chrominance signal. In order to reproduce the transmitted colors properly, the demodulators must take the chrominance signal and change it back into the I and Q signals.

It has been shown before that the I and Q signals are combinations of the color-difference signals R - Y and B - Y. At the transmitter, the three color signals which represent red, green, and blue are first formed

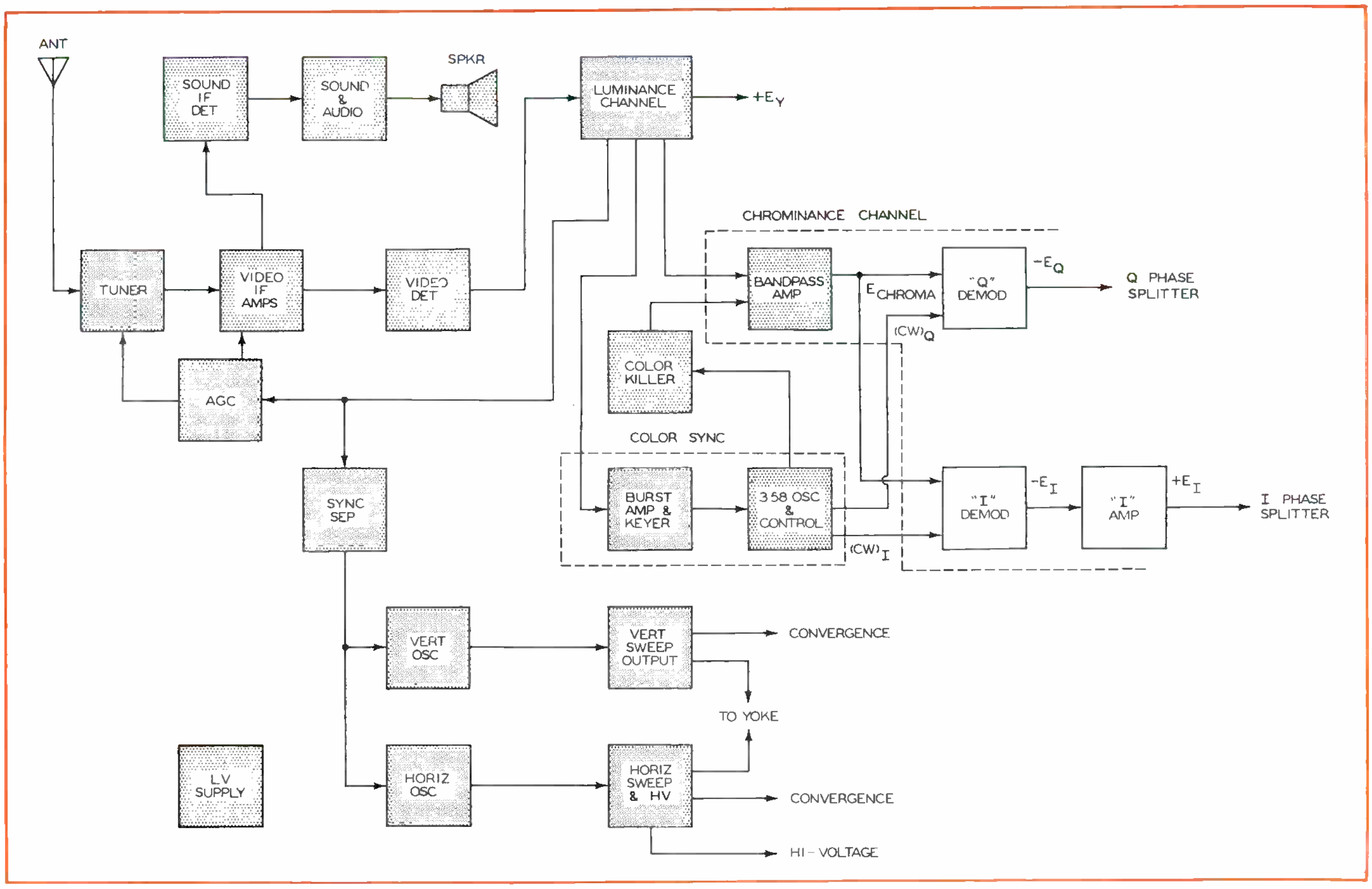

Fig. 7-1. Partial Block Diagram of a Color Receiver Showing Section Previously Discussed and Those to Be Covered in This Issue.

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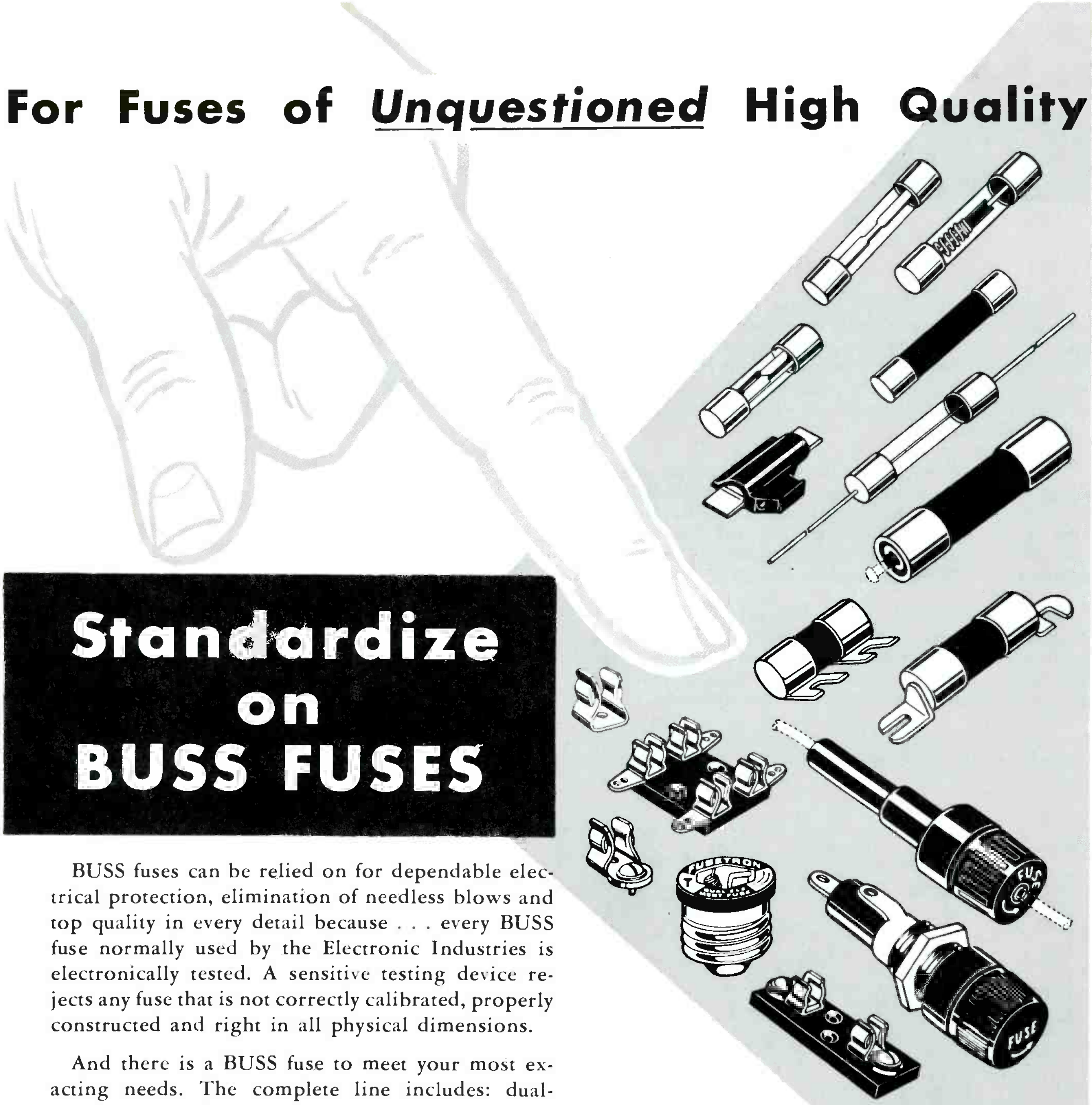

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into the color-difference signals; and then the color-difference signals are formed into I and Q signals. At the receiver, the three original signals for red, green, and blue can be recovered by detecting the I and Q signals or by detecting the R - Y and B - Y color-difference signals. A receiver can be designed so that it demodulates on the I and Q axes, or it can be designed to demodulate on the R - Y and B - Y axes. Some manufacturers incorporate I and Q demodulators, whereas others incorporate R - Y and B - Y demodulators. Both types of circuits will be included in the following discussion.

Synchronous Demodulation

One type of demodulation most commonly used is synchronous demodulation. This type is a process by which amplitude variations of a single phase of a multiphase modulated carrier can be detected. A synchronous demodulator can be compared to the mixer stage in a superheterodyne radio receiver. The main difference is that the synchronous demodulator uses a locally generated reference signal which is of the same frequency as that of the color subcarrier. The synchronous demodulator must be capable of detecting both the amplitude and the phase of the chrominance signal rather than just the amplitude. This is necessary because at the transmitter, the subcarrier was amplitude-modulated at zero phase by the I signal. After the subcarrier was displaced 90 degrees, it was amplitude-modulated by the Q signal. The two modulated signals were then combined into one composite chrominance signal. Basically, this resultant signal contains two sine waves in quadrature; and each is amplitude-modulated. This means that the chrominance signal which is received by the synchronous demodulators in the color receiver is varying both in amplitude and in phase.

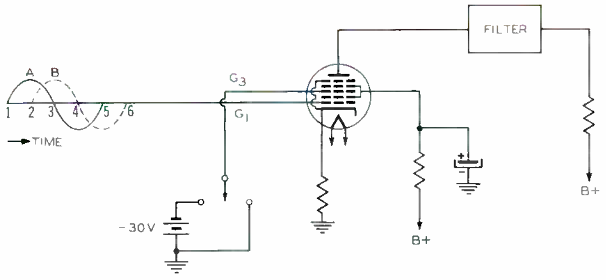
A Simplified Demodulator Circuit

A multigrid type of tube is usually employed in a synchronous-demodulator stage. A simplified circuit of a synchronous demodulator is shown in Fig. 7-2. At control grid No. 1, there are two sine waves which are arriving in quadrature (90 degrees phase difference). Sine wave A is leading sine wave B by 90 degrees. At the time that wave A is at maximum, wave B is zero. These two sine waves could represent the two components of the chrominance signal.

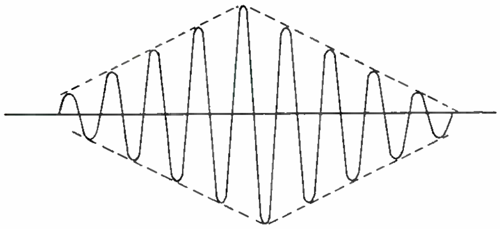
Two supply voltages for grid No. 3 are available in this simplified circuit. One potential is zero, and the other is negative. For normal operation of the tube, grid No. 3 voltage is zero. Plate current will then flow normally. When the grid No. 3 potential is switched to the negative potential, plate current will cease to flow.

Let us assume that sine wave A is being detected by the synchronous demodulator. The grid No. 3 voltage is negative all the time except during time 2. At that time, the grid No. 3 potential is switched to zero volts, which means that plate current will flow during that time only. Notice that the sine wave A reaches its maximum value at the same time. Each time that sine wave A reaches its positive peak, plate current will flow, since the grid No. 3 voltage is zero at the same time. The amount of current that will flow is dependent upon the instantaneous value of the voltage on grid No. 1.

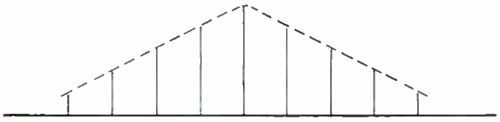
Now let us consider the manner in which the stage operates when sine wave B is fed to grid No. 1. The switching of grid No. 3 will be the same as in the previous case; that is, grid No. 3 will be switched to zero potential during time 2 and to a minus voltage the remainder of the time. This means that the stage can conduct during time 2 only. The amount of current that flows is dependent upon the instantaneous voltage of grid No. 1, which in this case is zero. The amplitude of the plate-current pulses will be less when sine wave B is applied to the stage than when sine wave A is applied. Note that the amplitudes of sine waves A and B are equal. The only difference in their characteristics is a shift in phase. If sine wave A were increased in amplitude, the resultant plate-current pulses would also increase; whereas, the plate-current pulses resulting from the application of sine wave B would remain the same even though the amplitude of B might change, since the signal passes through zero at the time of sampling. This is the basis upon which a demodulator stage operates.



(A) Simplified Synchronous-Demodulator Circuit.



(B) Amplitude-Modulated Carrier.



(C) Pattern of Plate Pulses.

Fig. 7-2. Illustration of Synchronous-Demodulator Action.

* * Please turn to page 33 * *

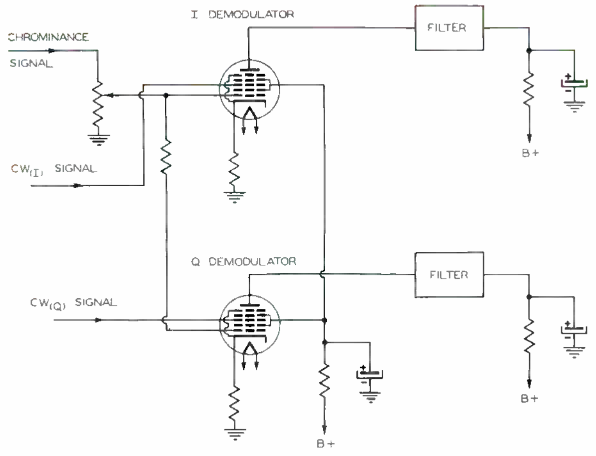


Fig. 7-3. A Commercial Synchronous-Demodulator Circuit.

VEC

A Study of a Mathematical Symbol Which is Appearing More Frequently in the Servicing Field

It is one thing to be able to recognize a vector diagram; it is quite another to be able to understand all that such a diagram means in terms of quantities and operations that are familiar. Until recently, vectors have played a minor role in radio and TV servicing principally because the phase relationships between signals have been of little importance. Color television has changed this situation. Phase must be designated in order to specify accurately a color picture signal, and vector diagrams are used for this purpose. The service technician should be able to recognize a vector diagram when he sees one, and he should be able to interpret its meaning with the same ease as he would an equation in Ohm's law.

Plane geometry and trigonometry form the mathematical basis for any study of vectors; therefore, the reader is advised to brush up on these subjects as a preliminary step. In this article, however, an attempt has been made get by with as little reference to geometry and trigonometry as possible. Only the most basic fundamentals of these subjects are used.

Fig. 1 shows a diagram which is typical of those encountered in color-television work. It is called a color-phase diagram and depicts some of the various signals which are frequently present during tests of color receivers. The purpose of this article is to provide the reader with helpful information about vector diagrams such as the color-phase diagram shown in Fig. 1.

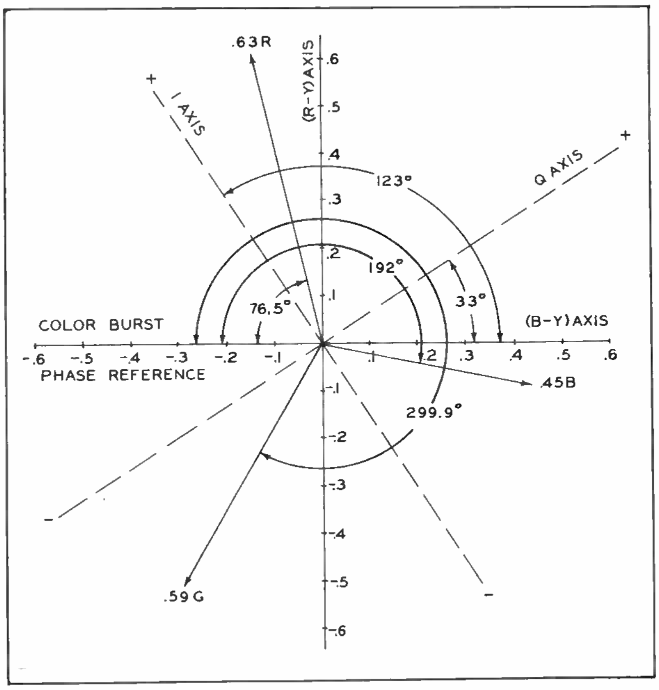


Fig. 1. Color-Phase Diagram.

Definition

A vector is the symbol which denotes a directed quantity; that is, it expresses a quantity which can only be completely described in terms of a magnitude and a direction. Wind velocities, voltages and currents of electricity, and forces of all kinds are directed quantities and therefore can be expressed as vectors. Some quantities do not have the added property of direction, and these are called scalars to distinguish them from vectors. Examples of scalars are: the volume in a container, the resistance in a wire, and the inductance in a coil.

Since the vector symbol must show magnitude and direction, it takes the form of a straight line having a specific length and terminated at one end with an arrowhead. The length of the line represents the magnitude, and the arrowhead indicates the direction of the vector quantity. The specific points at which a vector begins and terminates have no significance; this means that a vector can be equivalently expressed by any line drawn parallel to it and of equal length. The latter characteristic of vectors is an important one and should be kept in mind at all times. It will be demonstrated pointedly in portions of the following discussion.

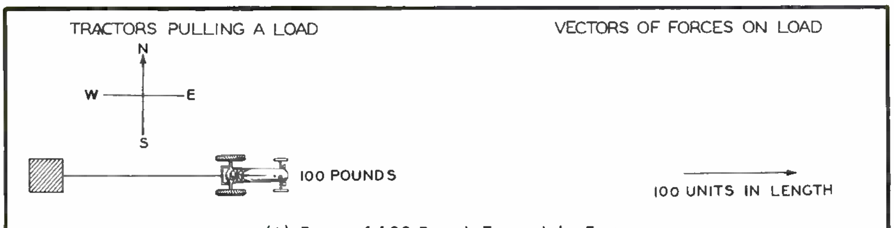
Tractor-and-Load Analogy

As mentioned previously, a force is a directed quantity and can be denoted by a vector. The force with which we are primarily concerned in the electronics industry is voltage, sometimes referred to as electromotive force (emf). Because the force that is voltage is somewhat less tangible than certain other types of forces, it might be well to preface an explanation of voltage vectors by an analogy that is based on a more obvious kind of force.

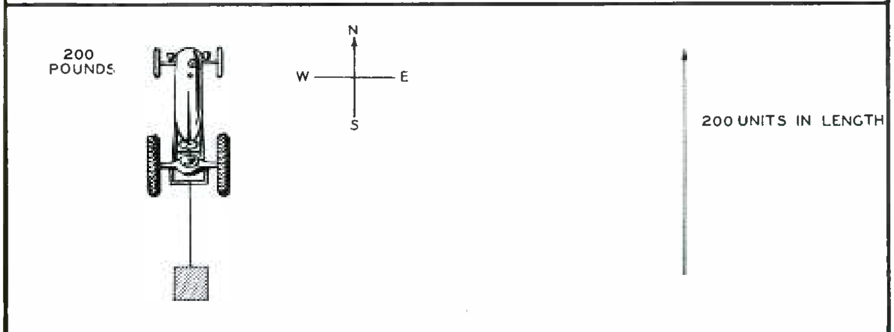
Let us assume that we have a load to which we can connect a tractor.

TORS

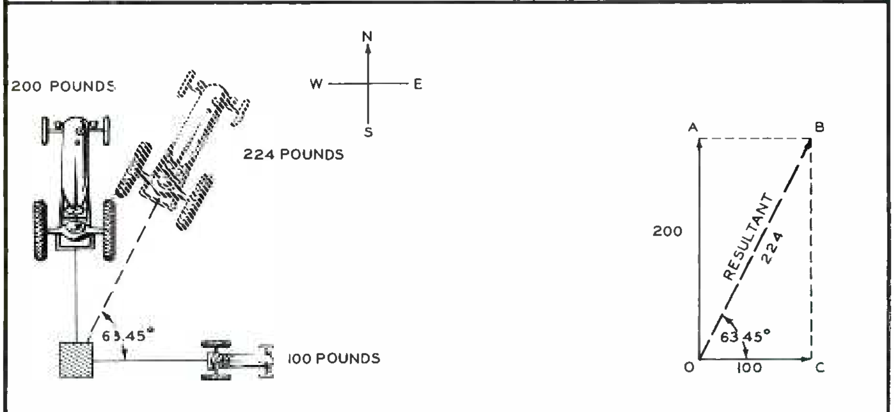
BY GLEN E. SLUTZ



(A) Force of 100 Pounds Toward the East.



(B) Force of 200 Pounds Toward the North.



(C) Forces of 100 Pounds Eastward and 200 Pounds Northward.

Fig. 2. Forces and Their Vectors.

If the tractor is started and the connecting rope or chain is drawn taut, a force will be exerted upon the load. The nature of this force will be dependent upon the pulling power of the tractor and upon the direction in which the tractor is headed. Fig. 2A shows the tractor pulling toward the east with a force of 100 pounds. In the right column of the illustration, the vector which describes this force is drawn. Note that it points toward the right and is 100 units in length. With one unit of length equivalent to a pound of force, the vector can be said to provide a complete description of the force which is exerted on the load by the tractor.

A limiting factor should be introduced at this point. In order to avoid certain misconceptions which would otherwise become obstacles during later stages in the development of this analogy, let us assume in all of the tractor-and-load problems that the load is too great to be moved by the forces exerted upon it. This limitation can be made since forces exist regardless of whether or not they cause movement. A man leaning against a brick wall may not cause the wall to move, but he still exerts a force upon it. Similarly, even though the tractor in these problems does not move its load, it still exerts a force upon the load.

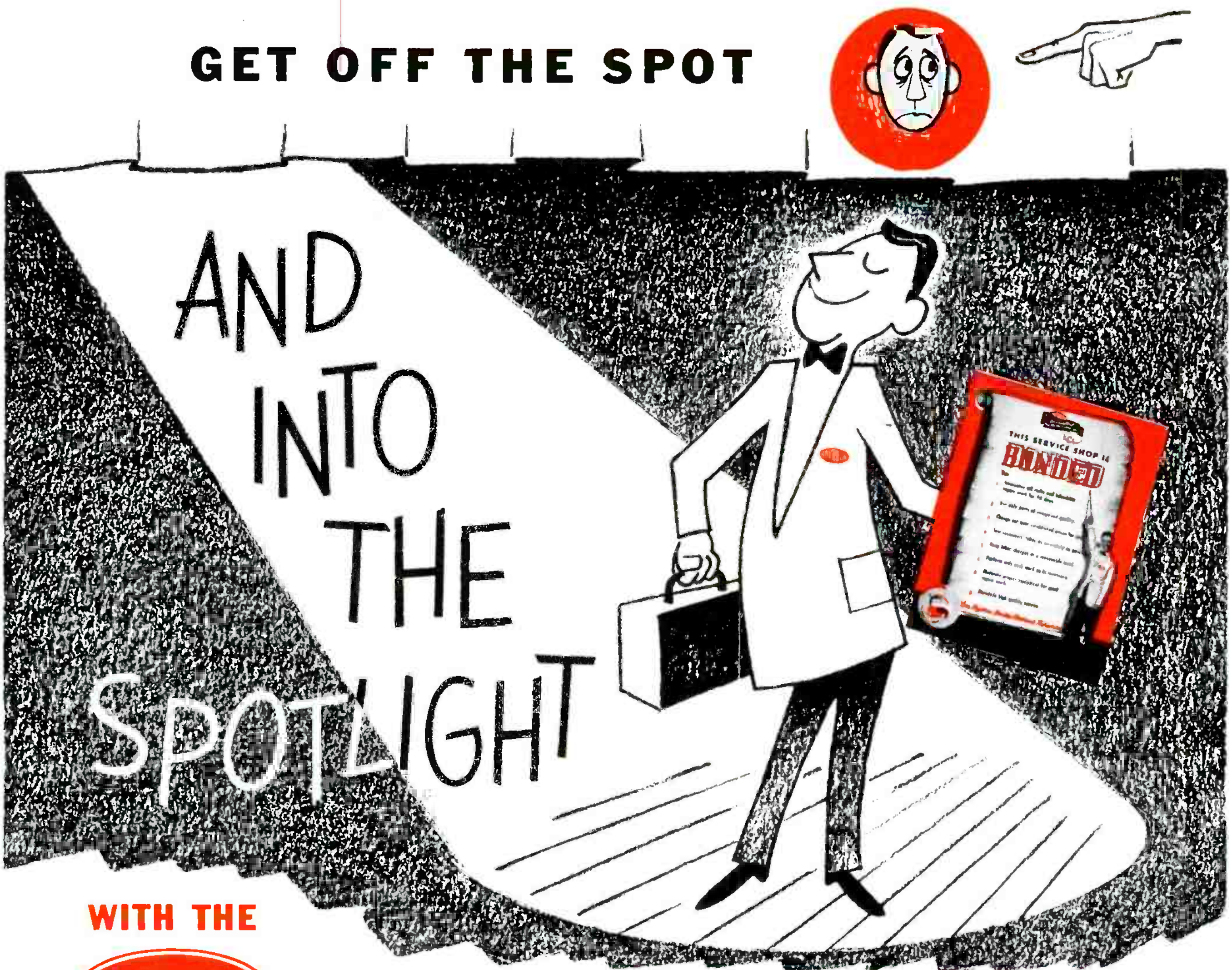
In Fig. 2B, the tractor is shown headed in a northerly direction and exerting a force of 200 pounds on the load. The vector which describes this force is drawn in the right column of the illustration. It points upward and has a length of 200 units.

Two or more vectors can be added to each other just as numbers can be added. The sum in vector addition is called the resultant vector. Fig. 2C shows two tractors attached to a single load but pulling in different directions and with different amounts of force. The problem is to replace the two tractors with one tractor and to keep the total force on the load exactly the same. If vector addition is performed, the resultant vector will specify the magnitude and direction of the force to be provided by the substitute tractor. Vectors OA and OC in the right column of Fig. 2C denote the forces exerted by the two original tractors. These vectors are drawn at right angles to each other and with lengths of 200 and 100 units. The resultant vector is found graphically by completing the parallelogram OABC. Dotted line AB is drawn parallel to vector OC, and dotted line BC is drawn parallel to vector OA. The resultant is the diagonal line OB. Measurement will show its length to be 224 units and its angle with vector OC to be 63.45 degrees. We can say, therefore, that the substitute tractor would have to pull with a force of 224 pounds and in a direction 63.45 degrees north of east in order to satisfy the requirements of the problem.

A trigonometric rather than a graphical solution of the problem in Fig. 2C may be performed. For this method of solution, the vector triangle in Fig. 3 is used. Vectors OA and AB

* * Please turn to page 51 * *

GET OFF THE SPOT



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Shop Talk

MILTON S. KIVER

President, Television Communications Institute

One of the major servicing methods which the technician uses in locating troubles in a television system is that of checking the waveforms present at various points in the receiver. Waveforms are extremely sensitive indicators; revealing impending changes well in advance of any warning signals that might be raised by voltage and resistance measurements alone. In other words, a waveform is the best "health barometer" of a circuit that we could possibly find.

The reason for this importance is not very hard to find. A wave that a circuit produces is a product of the tube, the circuit components, and the applied voltages. Any change in the circuit, from lowered filament emission to a shift in operating voltage or component value, will have an immediate effect on the currents flowing in the circuit. And it is the result of these fluctuating currents that is viewed when you bring the input probe of an oscilloscope into the circuit. In short, what you see is the sum total of every variation (major or minor) affecting the circuit.

Herein lies the power behind waveform observation in a television receiver. It is the only method that gives you the full and complete story all in one glance, all at the same time. Every other method reveals only part of the story

Take voltage measurement, for example. Suppose you find that the grid bias has increased from 1.5 to 2.0 volts. What specifically does this tell you about the effect that the circuit will have on the wave passing through? Nothing, actually, until you find out what the change in bias has done to the operating point of the tube. The best way to determine the effect on the waveform is to take a look at the output signal of this stage.

Or, consider a change in resistance. This is readily detectable with an ohmmeter; but when the change is not gross or excessive, you cannot say for certain how it has affected the shape of any wave passing through the stage until you have actually inspected that wave with an oscilloscope.

Thus, we always come back to waveform inspection. Any other approach reveals only part of the picture; and unless this part represents the major cause for a poorly operating circuit, additional information must be sought until enough of the jig-saw puzzle has been pieced together to reveal the full story. All the facts are laid bare by a single measurement with an oscilloscope.

If the oscilloscope is such a useful instrument, why is it not used more extensively? Part of the answer lies in the fact that not every one is fully familiar with scope operation. The other reason is that waveform inspection can be of value only if the service technician is capable of interpreting what he sees. In other words, if a wave is distorted, the service technician must first be able to recognize that it is distorted and then be able to link the distortion to a specific portion of the circuit. The first step is obviously easier to satisfy than the second; yet, it is through the subsequent analysis of the distortion that the technician is able to track down the defect.

A simple example will serve to illustrate this. In Fig. 1A, we have a resistance-coupled amplifier to which a sine wave is being applied. (The scope can be used to check the input wave to insure that it is a sine wave.) When the same wave is checked again at the output of the amplifier, it is seen to possess the form shown in Fig. 1B. It is evident, from even a cursory glance, that passage through the amplifier has altered the over-all shape of the wave; hence, we know that something in the amplifier caused this alteration or distortion.

The first step in the analysis is to examine the output wave carefully to see where it differs from the input wave. If we place the input and output waves side by side, inverting the output wave to counteract the 180-degree inversion introduced by the amplifier, we note that the bottom half of the output wave is the part affected. This corresponding portion of the input signal drives the grid of the tube negative; and since it has been flattened off in the output, we are led to the conclusion that when the most negative section of this half cycle is active, the tube is driven beyond cutoff. From this, we can readily see that the bias

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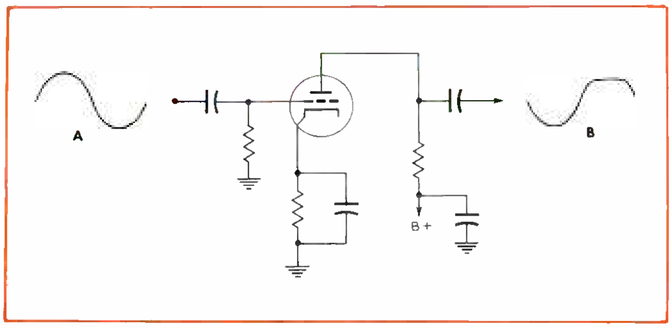

Fig. 1. A Resistance-Coupled Amplifier Showing Input Signal A and Output Signal B.

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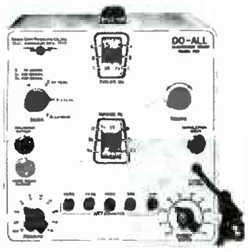

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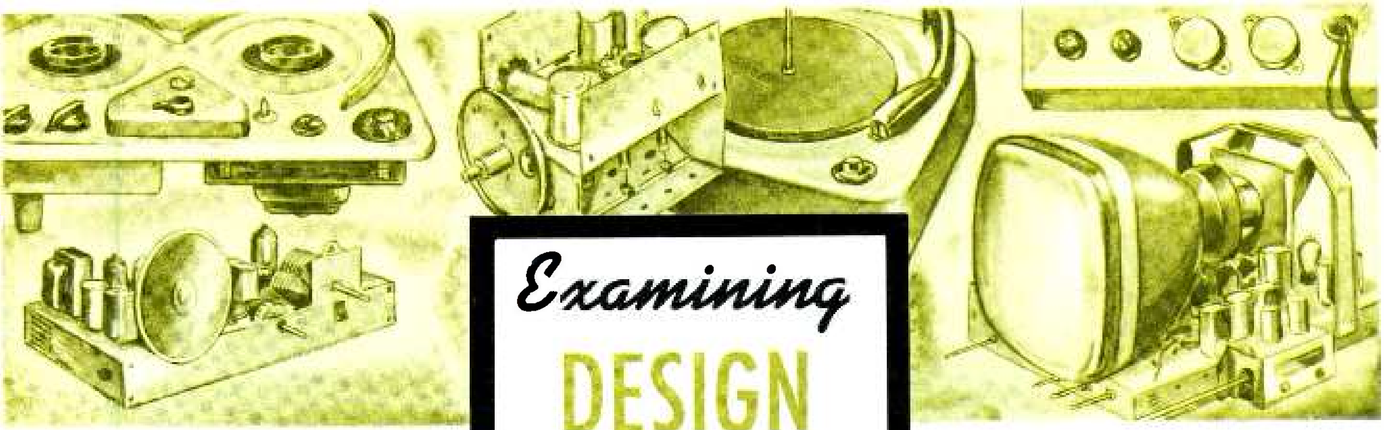

Examining DESIGN Features

by DON R. HOWE

SYLVANIA CHASSIS NO. 1-521-2

An example of recent television receivers in the Sylvania line is the Sylvania Chassis No. 1-521-2 appearing in Fig. 1. This particular chassis is equipped for UHF and VHF reception. The tube complement consists of 21 tubes plus the 21-inch picture tube. There are two types of HaloLight systems available. One is of the fixed-brilliance type, and the other has a control for varying the brilliance. One side of the AC line is connected directly to the chassis. To avoid the risk of receiving a shock when adjusting the controls, the front and rear aprons have been insulated from the main chassis.

The picture tube and associated components are mounted on the chassis. This permits the entire assembly to be removed from the cabinet as a single unit.

Tuners

The VHF tuner is of the switch type and covers channels 2 through 13. A 6BQ7 is used as the RF amplifier. The mixer and oscillator functions are performed by a triode-pentode 6X8. AGC voltage is applied to the RF amplifier to control its gain.

The UHF tuner in this chassis contains a 6T4 oscillator and a 1N82A crystal diode that functions as the mixer. This tuner provides continuous coverage of the UHF channels.

Video IF

The video IF strip employs two 6BZ6 tubes as the first and second IF amplifiers. The third IF amplifier consists of the pentode section of a 6AM8. The 6BZ6 is a relatively new tube designed specifically for IF amplifier service. This tube is of the semiremote-cutoff type and as a result assists in the elimination of distortion caused by excessively strong signals. Transformer coupling is used throughout the IF strip.

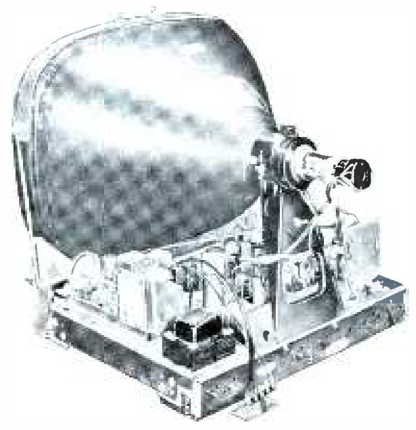

Fig. 1. The Sylvania Chassis No. 1-521-2.

The input circuit to the first IF amplifier contains two traps. One trap is series resonant, and the other is of the absorption type. An absorption trap is also included in the coupling network between the first and second amplifiers. These two amplifiers are controlled by the AGC. The output of the third video amplifier is transformer coupled to the video detector. The primary of this transformer is shunted with a resistance to provide the necessary bandwidth.

Video

The diode section of a 6AM8 is employed as a series detector; the IF signal is fed to the cathode. The sound take-off point is located at the output of the video detector. The composite video signal is fed through a 4.5-mc trap to the grid of the 12BY7 video amplifier. The ground return for the suppressor grid and the cathode is through the contrast control. The output from the 12BY7 is fed to the cathode of the picture tube. The picture tube may be a 21XP4, 21XP4A, 21YP4, or a 21YP4A. The level of DC voltage applied to the control grid is dependent upon the setting of the brightness control.

Sound

A signal from the output of the video detector is fed through a capacitor to the grid of the first sound-IF amplifier. The output of this stage is taken from the cathode and fed through a tuned circuit to the 6AU6 second sound-IF amplifier. The signal from the plate of the 6AU6 feeds the 6AL5 ratio detector. The resultant audio output is coupled through a de-emphasis network to the audio amplifier which is the triode section of a 6AV6. The audio output is derived from a 6AS5 which is driven by the audio amplifier.

AGC

A system of keyed AGC is used in this receiver. The AGC voltage is developed by the triode section of a 12AU7. A positive voltage is applied to the cathode of the 12AU7. The level of this voltage may be varied by adjusting the AGC control. A signal from the sync amplifier is applied to the grid of the triode, and a signal from the horizontal-output transformer is applied to the plate. A portion of the resultant AGC voltage is fed to the IF stages. Another portion of the developed voltage is applied to the RF amplifier in the tuner. A delay voltage is used in conjunction with this AGC. A diode clamper is applied to this line to prevent the grid of the RF amplifier from becoming positive.

Sync

A composite video signal is fed from the video amplifier to the grid of the sync amplifier. Working in conjunction with the sync amplifier is a stage of noise inversion utilizing the triode section of a 12BH7. The resultant signal from the action of these stages if fed to another triode serving

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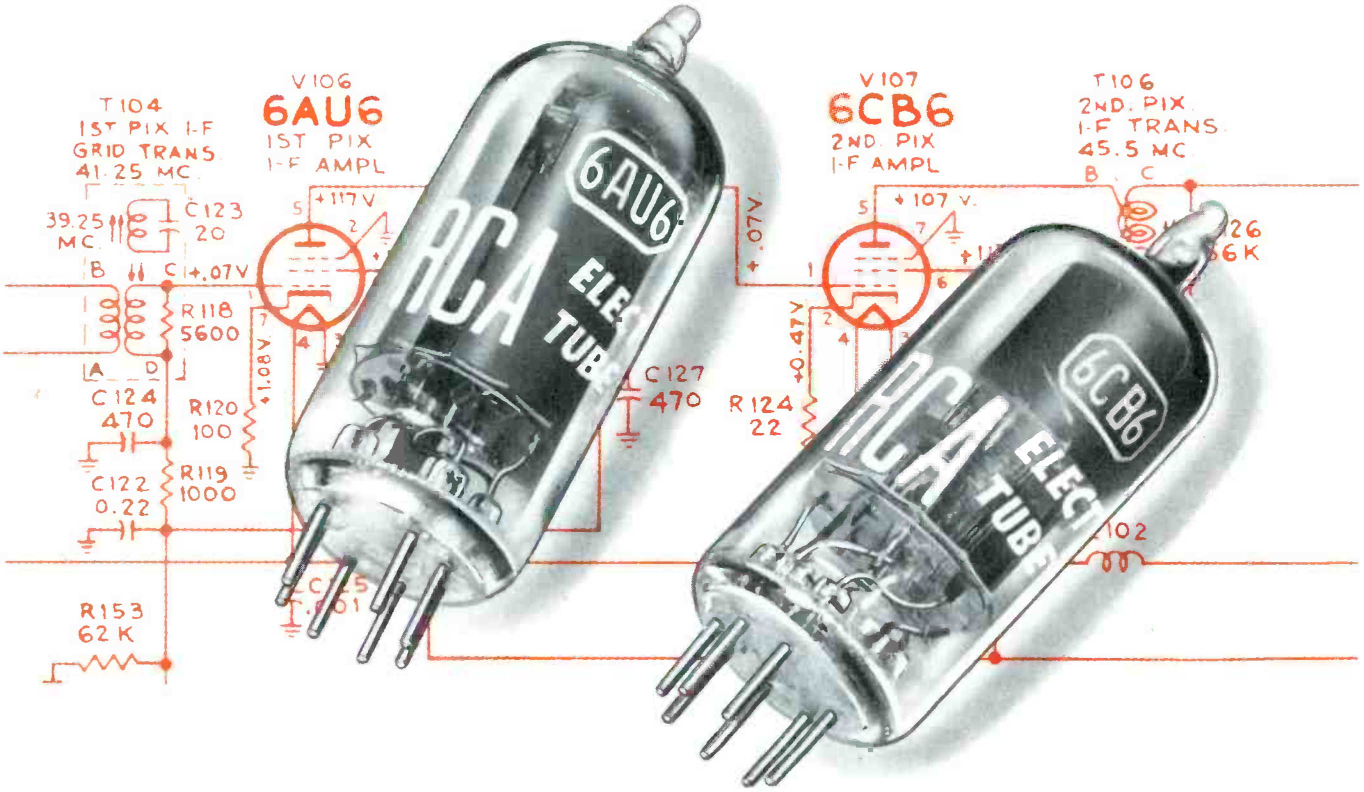

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Notes On TEST EQUIPMENT

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

by Paul C. Smith

THE ELECTRONIC SWITCH

The electronic switch is a device which makes it possible to display two waveforms simultaneously on a single oscilloscope screen. Certain observations can thus be made more easily or conveniently than would be possible without its use. Comparisons can be made between signals at different circuit points to determine the effect of the intervening circuits with respect to phase, frequency, or amplitude differences. Distortion which occurs between two points can be observed. The electronic switch is especially effective when one wishes to determine the results of circuit changes or adjustments while the adjustments are actually being performed. It might be well to mention another means for obtaining dual traces on an oscilloscope through the use of a double-beam, cathode-ray tube. This method is not commonly encountered since it is usually limited to laboratory or special-purpose oscilloscopes. The electronic switch will work with any general-purpose scope, and various models are offered so that there is a model to suit the preferences and pocketbooks of most technicians.

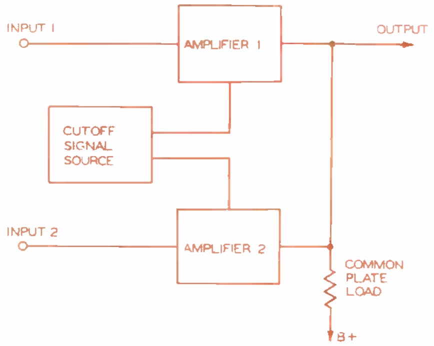

Fig. 1. Block Diagram of an Electronic-Switch Circuit.

Theory of Operation

The basic principle of operation of most electronic switches consists of applying the two signals to be observed to separate amplifier channels in the switching unit and at the same time applying a square-wave signal to each amplifier so that each is alternately driven to cutoff. The output of each channel is developed across a common plate load in the output circuit so that first one and then the other signal appears at the output terminals.

A simplified block diagram of an electronic switch is shown in Fig. 1. The separate channels for inputs 1 and 2 may consist of only a single output stage for each, or they may have such added refinements as additional stages of amplification preceding the output. In some cases, they may have cathode-follower inputs for minimum loading effects when connecting to circuits.

The source for the cutoff signal usually takes the form of a multivibrator circuit or some modification thereof. Operating frequencies may vary over the range from 20 cycles to 100 kilocycles or greater; both step and vernier adjustments are provided for changing the frequency of the cutoff signal. Some models have provision for applying an external sync signal to the multivibrator circuit to lock the free-running frequency of the multivibrator to some multiple or submultiple of the sync-signal frequency. If the switching rate is synchronized in this manner to a frequency which is one half that of the oscilloscope sweep, the two input signals will appear on alternate traces of the beam across the scope. In this case, switching is accomplished during beam retrace and is less noticeable than it would be otherwise.

Another method of synchronization is used in most applications. The synchronizing signal is applied to the oscilloscope rather than to the switching unit. This signal can be obtained from one or the other input signals, and the switching frequency is then adjusted to give the least confusion in viewing the two traces.

High switching rates have the disadvantage that a scope of wide response is required in order to secure the best waveform because the input signals are superimposed on a signal which is essentially a square wave. It is commonly known that a square wave of high frequency requires a wide-band amplifier for accurate reproduction.

If the gains of amplifiers 1 and 2 are reduced to zero, the cutoff sig-

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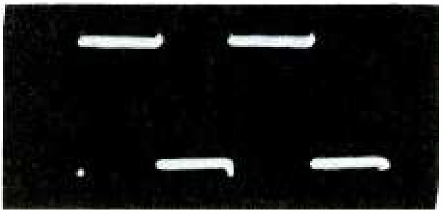

Fig. 2. Output Signal From the Electronic Switch With Both Amplifiers Set for Zero Gain.

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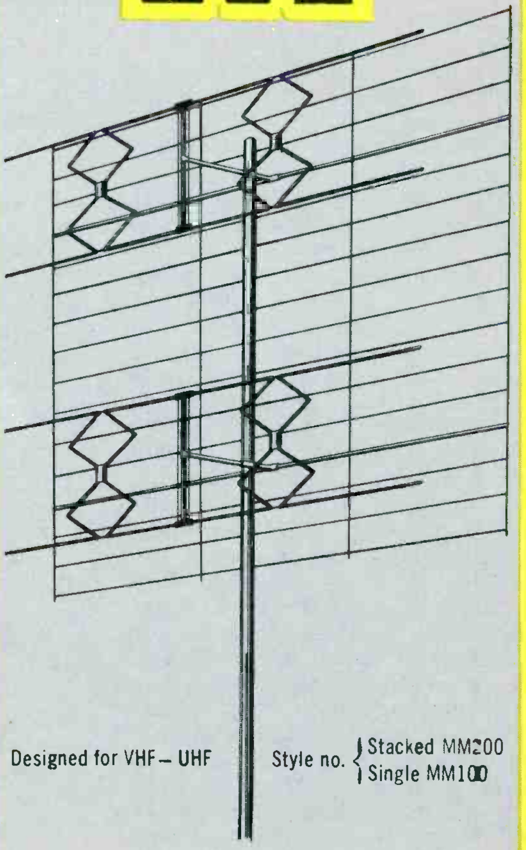

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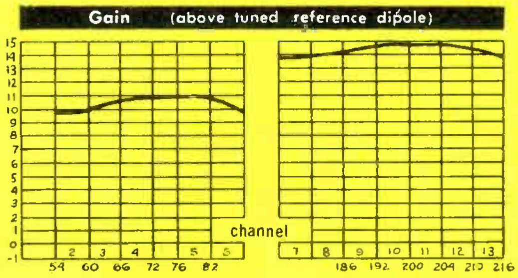

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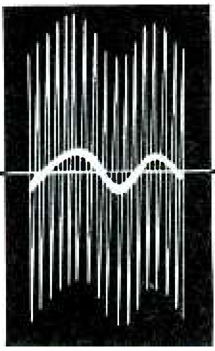


THE SECOND IN A SERIES OF ARTICLES DEVOTED TO THE PRINCIPLES OF MAGNETIC RECORDING

by Robert B. Dunham

In the first article of this series, a simplified version of the process of recording on magnetic tape explained how magnetic patterns are formed on the tape as it moves at a constant speed over the face of the recording head. The patterns on the tape will vary in number and amplitude as the modulation of the signal current flowing through the recording head varies.

If the magnetized tape is played back by passing it over a playback head at the same speed used when the recording was made, the reproduced signal will not be an exact duplicate of the original unless certain precautions were taken during the recording process. Such precautions are necessary because of the peculiar characteristics encountered when a piece of iron or magnetic material like the oxide coating on recording tape is being magnetized. The effect of these characteristics must either be compensated for or eliminated if we are to enjoy distortionless and noise-free, wide-range reproduction.

Hysteresis, which is defined either as the opposition to any change in the magnetized state of a material being magnetized or demagnetized or as a lagging in the amount of change as the magnetizing or demagnetizing force is applied, can be blamed for most of the undesirable effects. Consequently, the amount of magnetism remaining in the tape after it has moved out of the magnetizing field of the recording head does not maintain a constant proportion in relation to the amount of magnetizing force applied by the recording head.

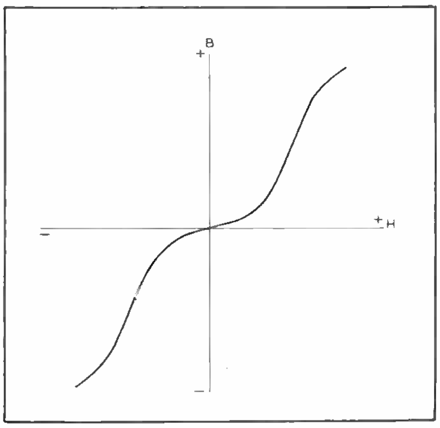


Fig. 1. Curve Showing the Relation of the Amount of Magnetism (B) Remaining in a Tape to the Amount of Magnetizing Force (H) Applied.

A graph plotted to show how much magnetism remains in the tape after it is magnetized in relation to the amount of magnetic force applied by the recording head is shown in Fig. 1. The nonlinearity of the curve is very obvious.

When the signal shown in Fig. 2A is fed into the recording head, it will be recorded on the moving tape in the distorted form shown in Fig. 2B. This excessive amount of distortion cannot be tolerated if the recorded signal is to sound like the original.

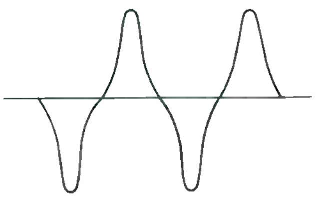
It might be well to mention at this point that in the foregoing and following paragraphs, we are considering the tape to be in a completely demagnetized state before it contacts the recording head.

To minimize the effects of the extremely curved (nonlinear) portions of the characteristic curve shown in Fig. 1, bias is applied to the recording head while a recording is being made so that only the straight (linear) part of the curve is utilized. The application of suitable bias is an important factor responsible for the rapid growth and success of magnetic recording.

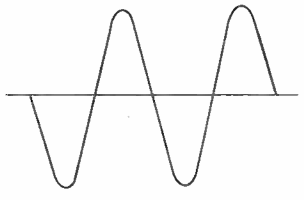
When first encountering the term bias as used in connection with magnetic recording, its purpose and character may be puzzling to some one just becoming familiar with this method of recording sound. But anyone familiar with the operation of vacuum tubes will find that the application of bias to a recording head is very similar to the biasing of a tube. The curve in Fig. 1 bears a great resemblance to the plate-current characteristic curve of a tube. In very much the same manner in which bias is used to obtain the correct operating point on the plate-current curve to achieve effective and undistorted operation of a vacuum tube, so is a suitable bias applied to a recording head so that the operation of the recording head will be over the linear portion of the curve shown in Fig. 1.

Originally, DC bias was used to reduce distortion. This was accomplished by applying a DC voltage to the recording head simultaneously with the audio signal. The fixed amount of DC flowing in the head magnetized the tape to a certain steady level which shifted the recording action to the linear portion of the curve. This method of biasing which magnetized the tape to a certain steady level when no signal was flowing through the head had some disadvantages, however. It is a normal characteristic of tape to produce noise, and this noise increases as the

* * Please turn to page 57 * *



(A) Applied Audio Signal.



(B) Recorded Audio Signal.

Fig. 2. Effect of the B-and-H Curve in Fig. 1 Upon a Recorded Audio Signal.

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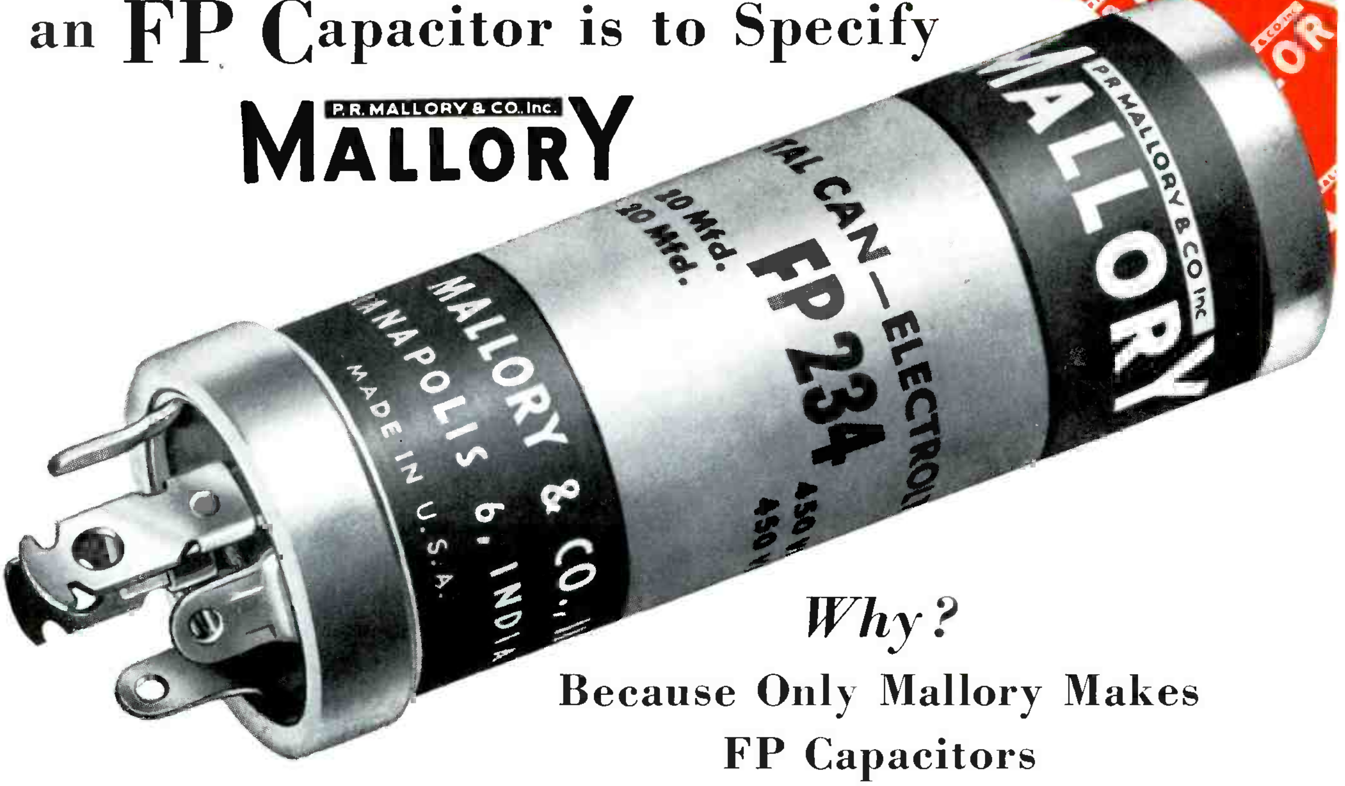

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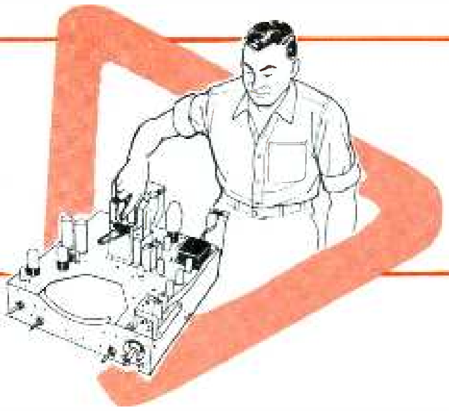

by **Henry A. Carter** and **Calvin C. Young, Jr.**

IN THE SHOP

Servicing the Horizontal Phase Detector and Multivibrator

In past issues, this column has presented a series of discussions about popular circuits in TV receivers, about the problems which may be encountered in these circuits, and about the servicing procedures which have been used successfully in connection with them.

This month a horizontal AFC circuit employing a typical phase detector and multivibrator has been selected. A few of the problems, their symptoms, and solutions are given in the following material. The schematic in Fig. 1 is used as a reference. Each problem is taken from the actual servicing records of a bench technician, and the waveforms and picture-tube displays were obtained by reconstructing the various problems and taking photographs. For reference purposes, the waveforms taken during normal operation of this circuit are shown in Figs. 2A, B, C, and D.

Problem No. 1

The very interesting photograph shown in Fig. 3 illustrates the symptom which the customer tried to describe to the technician on the phone. When the customer said that his set had two pictures, the technician naturally thought he meant two pictures in the vertical direction, since this is a fairly common trouble. When he saw the receiver, he realized his error.

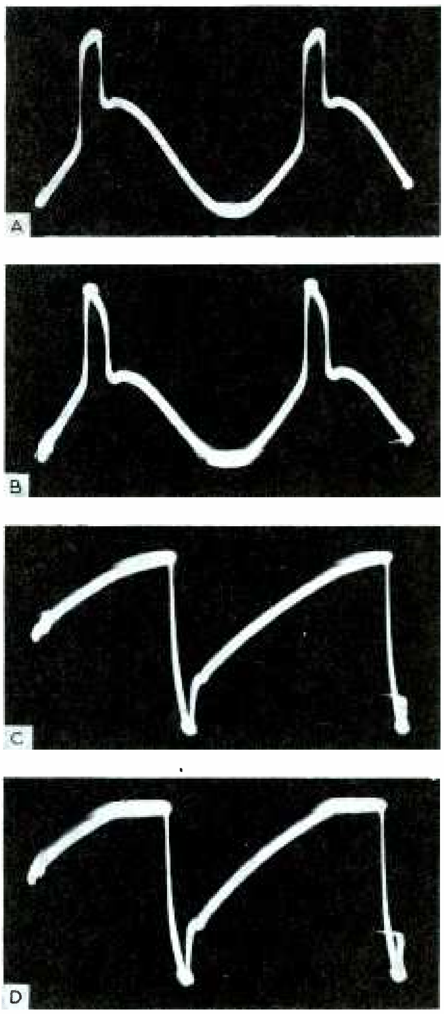

Fig. 2. Normal Waveforms Found in Horizontal Oscillator.

The explanation of the double picture was obvious. The horizontal oscillator was running at half frequency. This meant that the receiver was tracing only a single line of picture information while the camera was tracing out two lines. Consequently, the first sweep of the electron beam in the picture tube traced the first line of the left half of the picture and then blanked out for a short distance. This first sweep continued on and traced out the first line (second line from the camera) on the right half of the screen. The sweep then went back to the left and started over where the second sweep line should have started; but by this time, the camera was on its third line. Therefore, the receiver went on and traced out the third and fourth lines before returning to the left side of the screen again. This sequence continued until the first field was completed. Then, the second field was sandwiched into the first field in the same manner. Hence, the reproduced pictures were interlaced, but they did not appear interlaced because each picture had every other line of information missing.

Turning the horizontal-hold control could throw the picture out of synchronization but could not cause it to lock into a single picture.

The components which could possibly cause this trouble are L1,

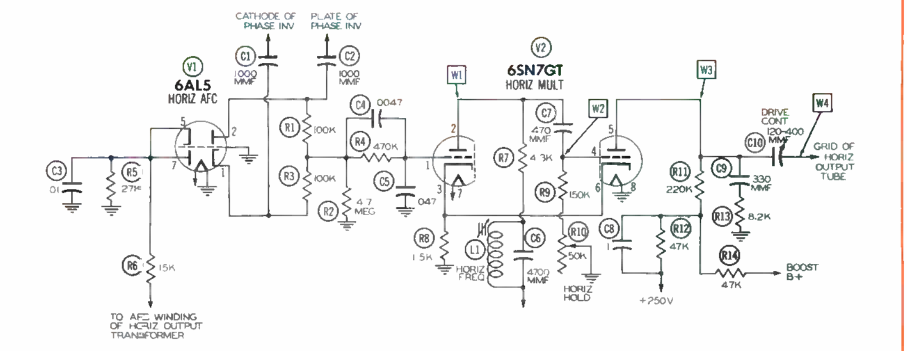

Fig. 1. Partial Schematic of Chassis Discussed.

* * Please turn to page 68 * *

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Does a superior job *far longer*. Special lead glass wards off electrolysis and air-leakage. New ring around filament stops "bowing" and the filament burnouts that result.

NEW 5U4-GA

Huskier. New mica supports, at both top and bottom. New straight-side glass bulb. New double-fin plate, new button-stem base with the many advantages of this construction.

NEW 5Y3-GT

New sturdiness, new long life. Mica supports now brace tube structure at both top and bottom. Double-fin heat-dissipating plate construction. New button-stem base.

NEW 6BQ6-GA

Runs far cooler, because of larger bulb. Handles higher pulse plate voltages. High-melting-point solder keeps cap-terminal in place when removing tube for testing.

NEW 25BQ6-GA

Runs cooler. Handles higher pulse plate voltages. Same extensive improvements as new 6BQ6-GA, including larger bulb, high-melting-point solder for cap-terminal, etc.

NEW SERVICE-DESIGNED 12SN7-GTA

Side-by-side X-ray pictures at right show that G.E.'s new SERVICE-DESIGNED 12SN7-GTA is smaller (28% less bulb height) than ordinary 12SN7-GT's . . . sturdier . . . with the many advantages which button-stem base construction offers.

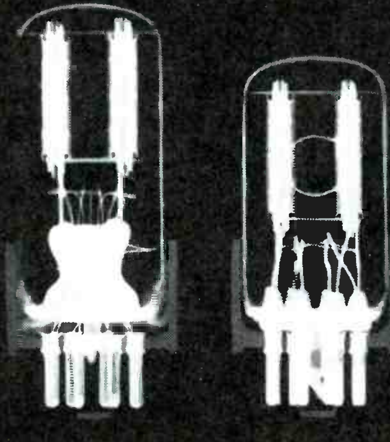
Comparison with the prototype's pressed-stem base, shows that the tube leads now pass through individual seals at bottom of envelope. Prevents loose bases . . . gives shorter leads and better lead separation . . . and brings about better heat conduction, reducing electrolysis and tube leakage. *You get a longer-lived tube than ever before.*

Tube ratings have been substantially increased. Compare below:

	Old 12SN7-GT	New 12SN7-GTA
Max plate voltage	300 v	450 v
Max plate dissip. per plate	3½ w	5 w

And the new 12SN7-GTA is specially tested for dependable operation in all synchro-guide and other circuits! *Every tube* gets a "chopper" pulse test, made at the lowest TV line voltages that will be encountered.

INSIDE STORY of more compact design, new button-stem base!



OLD 12SN7-GT NEW 12SN7-GTA

NEW SERVICE-DESIGNED 6AX4-GT

1. A new "pigtail" winding guards against heater-cathode shorts by interposing a separate insulated barrier between heater wire and cathode. This is much more efficient than other insulating methods used before. *Tube failures are greatly reduced.*

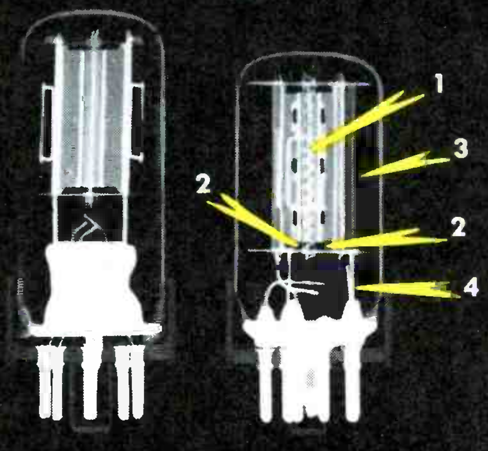
2. Two design features cut down on plate-cathode arc-overs. The plate is notched to avoid any contact with mica spacers in the critical plate-cathode areas. Also, micas are slotted to set up barriers to electrical conduction. Result: *fewer fuse blow-outs in horizontal-deflection circuits*—a common cause of call-backs.

3. Edge of the plate now is flattened out to dissipate electrostatic charge under high-voltage conditions. Stabilizes performance—prevents erratic operation of the tube.

4. New button-stem base adds strength, shortens tube leads, and improves heat conduction . . . increasing tube life. Helps to make possible a new bulb 18% shorter, more compact.

ANOTHER PLUS: new SERVICE-DESIGNED 6AX4-GT's are specially tested for arc-overs at maximum ratings. *Every tube* gets this important test!

INSIDE STORY, why shorts and arc-overs are reduced:



OLD 6AX4-GT NEW 6AX4-GT

NEW SERVICE-DESIGNED 6BX7-GT

1. New "flipper" (criss-cross) apertures in the mica spacers apply a firm 4-corner grip to the grid legs—keep grids locked in place top and bottom. This greatly reduces microphonics that result from changes in tube inter-element spacing . . . *helps prevent vertical picture jitter.*

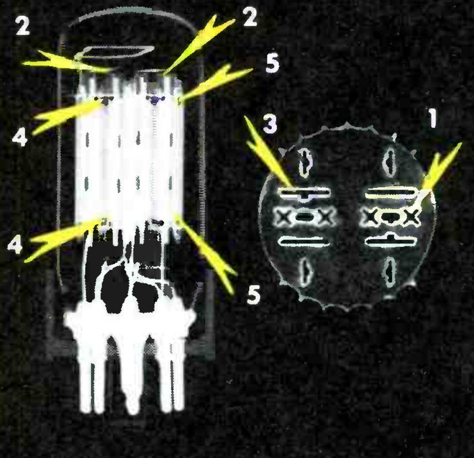
2. Covered "penthouses" (box enclosures) now shield cathode and heater from getter contamination that causes electrical leakage, disturbing the relationship of tube elements.

3, 4. Special slots in mica spacers, and notched plate design, further ward off inter-element arc-overs and leakage.

5. Barrels of the plates now are flared out at ends to avoid disturbing delicate grid wires when tube is assembled. Helps assure uniform tube performance.

ALSO: gold-plated grid wires minimize grid emission, a cause of picture shrinkage and fold-over . . . arc-over test of *every tube* assures dependability of SERVICE-DESIGNED 6BX7-GT's.

INSIDE STORY, why electrical performance is improved.



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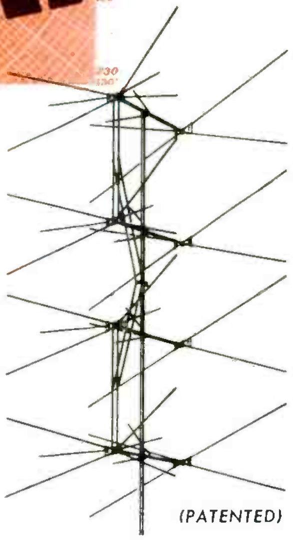
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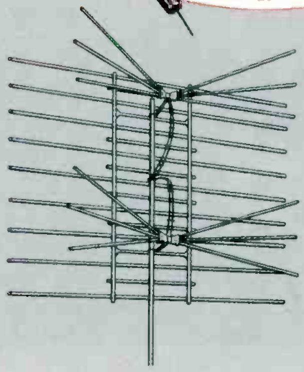

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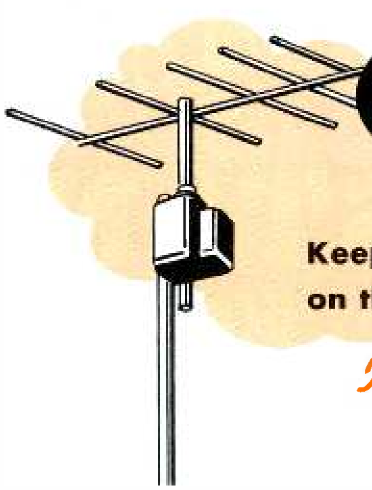

by Calvin C. Young, Jr.

Television service organizations which install and service television antenna systems are presented with many opportunities to service and repair rotators and their allied equipment. While servicing an antenna system for a broken lead-in wire, broken guy wires, or lost antenna elements, the service technician will usually be in a position to check the rotator assembly with very little effort. He should make it a point to inspect the rotator and to check its operation on every call that involves antenna service.

The rotator should be checked for security of mounting, for proper operation to the limits of its cycle in both directions, and for the security and condition of the rotator cable. The control assembly of the rotator should be checked for proper operation which includes proper operation of the indicator meter or other indicator device. These checks require but a very short time and are a service which the customer is sure to appreciate.

If it is determined from these checks that the rotator system is apparently functioning satisfactorily, this fact should be called to the attention of the customer. If it should be determined that the rotator is in need of service or repair, this should also be brought to the attention of the customer. In many cases, the customer may not be aware that the rotator is not operating properly. In any event, an inoperative rotator or one needing some repair presents an opportunity to sell your service to the customer; and after all, service is the primary commodity of all service organizations.

If the customer's house is located in a rural area some distance from the service shop or if the house is two or more stories high, it may prove advantageous to both the customer and the service organization to anticipate repairs to the rotator system and to perform the work which may be deemed necessary at the same time that the antenna system is being serviced. The elimination of a long return trip or of the time needed for a high ladder setup will save the customer money without reducing the profit of the service organization.

The materials required to clean and lubricate most rotators are very few. Those needed are: a good grade of light oil for the motor bearings, Lubriplate for the gear train and rotator bearings, a mineral-spirits cleaner, a small bristle brush, and a pan for the cleaning solution. These items are small and will require only very little space for storage in the service truck.

The weather exerts a seasonal effect upon the operation of a rotator mechanism. In the late spring, summer, and early fall, the hot weather melts the lubricant and rains wash it away. In the late fall, winter, and early spring, the cold weather congeals the lubricant and makes the rotator operate sluggishly. This sluggish condition places a strain on the motor; and this strain, coupled with the fact that the rotator is used more during the fall, winter, and spring, has a tendency over a period of several years to restrict or impair the operation of a rotator to a degree that cleaning and relubrication may be required. In some cases, the wear may be of such extent that it will be necessary to repair the rotator assembly by replacing worn or defective parts.

There are a great many different kinds of rotators on the market. Because of space limitations, hints on all of these different rotators cannot be covered in this one article. Instead, only the Alliance and CDR rotators were selected for coverage. These are representative of a large precentage of the rotators in the field at this time. In order to gather factual data, an Alliance DIR Tenna-Rotor and a CDR TR-2 Rotor which had both been in service for a year or more were obtained. The servicing and lubrication hints contained in this article are results of data obtained while servicing these two rotators.

ALLIANCE TENNA-ROTORS

The Alliance Tenna-Rotors are currently available in three models: the F-4, T-10, and U-83. There are also in current use earlier models of each: the ATR, DIR, and HIR respectively.

The Models ATR and F-4 are the simplest units and do not have a direction indicator. These employ a lamp which lights at each limit of rotation. The Models DIR and T-10 employ a meter as the direction indicator. The Model DIR is shown in Fig. 1.

The Models HIR and U-83 are automatic-control units. That is to say, the desired direction is selected at the control box, and the rotator will turn to that direction and automatically stop. The Models ATR, DIR, and HIR operate at a speed of one rpm and thus require 60 seconds to complete the rotation from one extreme of rotation to the other. The Models F-4, T-10, and U-83 operate at two rpm and thus require only 30 seconds.

The major differences in the Alliance Tenna-Rotors are in the con-

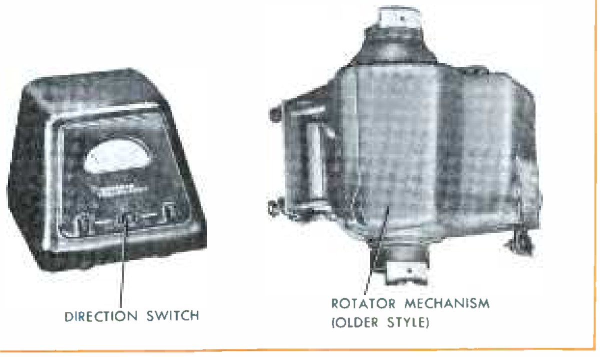

Fig. 1. Alliance Model DIR Tenna-Rotor.

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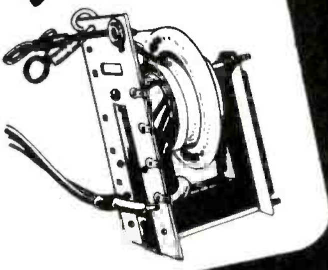

℞ **Patient: Crosley** Super V, **Hallicrafters**

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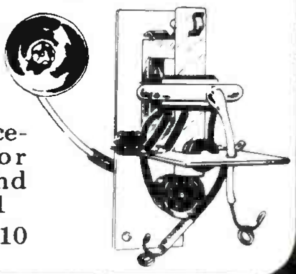

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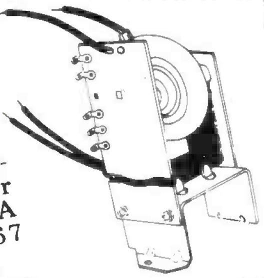

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trol and direction-indicating systems. Schematics of the three models are shown in Figs. 2A, B, and C. Mechanically, the three rotators use the same basic mechanism; one of these rotators is shown in a mounted position in Fig. 3. The thrust-bearing assembly which is shown in this figure is designed to remove the weight and strain from the rotator mechanism and should be used with large antenna arrays.

To assist the service technician in locating troubles in these Alliance Tenna-Rotors, several trouble-shooting hints (for all models unless otherwise indicated) are itemized as follows:

Rotator Inoperative.

1. Check voltage at the control-box terminal strip. In all cases, it should be approximately 24 volts AC.

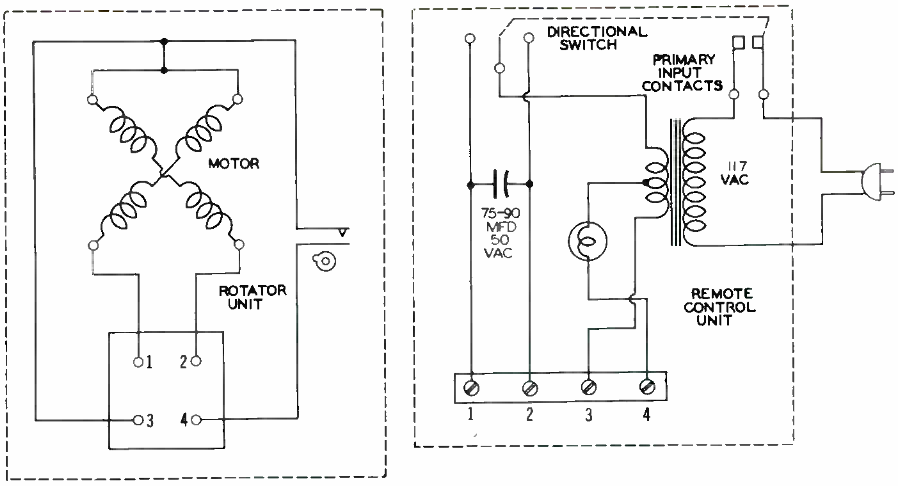
    a. ATR, DIR, F-4 and T-10 models only. Check between terminals 1 and 4 on the control box while the direction switch is in one direction, and check between terminals 2 and 4 while it is in the other direction.

    b. HIR and U-83 models only. Check between terminals 1 and 3 while the direction switch is in one direction and between 2 and 3 while in the other.

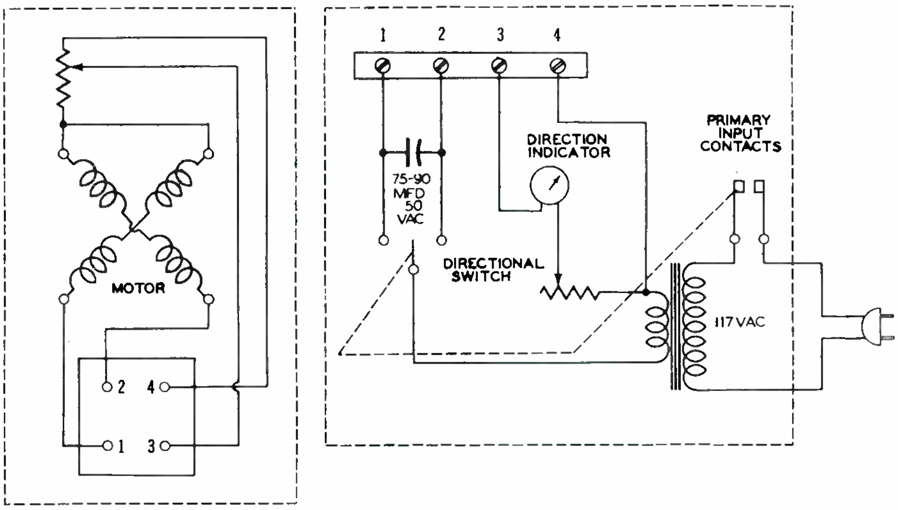
2. Check the rotator cable. This may be done by shorting together two terminals at the rotator and by checking the resistance between those same terminals on the control box. The resistance should read approximately 2 ohms for each pair on a 100-foot rotator cable.

3. Check the motor. It can be checked for an open circuit or for continuity by measuring the resistance between terminals 1 and 2 on the control box. This check applies when the rotator is installed on the antenna mast. The resistance should be approximately 15 ohms.

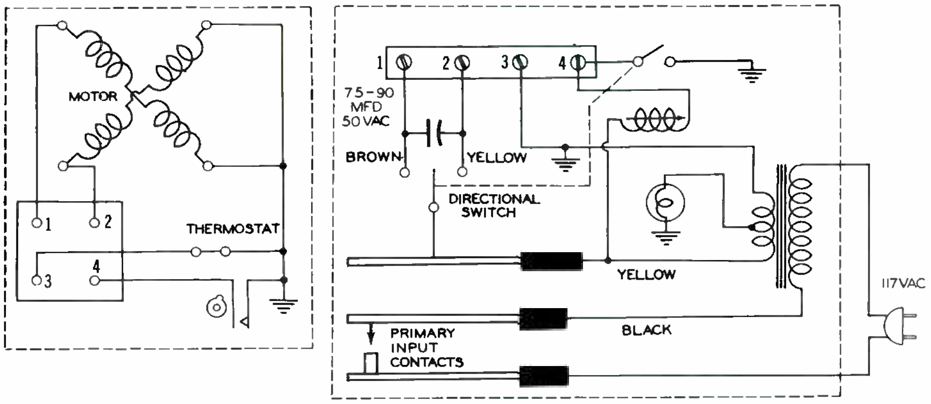
4. Check the capacitor. This may best be done by substitution. In the event that an exact replacement is not available, a suitable unit for the substitution check may be assembled by using two 100-mfd capacitors at 50 volts DC. Connect the two capacitors as shown in Fig. 4. Connect one positive lead to terminal 1 on the control box and the other to terminal 2. For a permanent replacement in case the suspected capacitor is found to be defective, it is recommended that a single AC capacitor of the correct value be used.



(A) Models ATR and F-4.



(B) Models DIR and T-10.



(C) Models HIR and U-83.

Fig. 2. Schematics of Alliance Tenna-Rotors.

5. Check the gear train for worn gears, gummed bearings, and stripped gears.

Rotator Operates Unsatisfactorily.

1. If the rotator operates in one direction but fails to operate in the other, check the direction-switch contacts; check the motor for an open winding; check the control cable for a broken wire; and check the gear train for worn gears.

2. If the rotator operates but the indicator fails to register:

    a. DIR and T-10 models only. Check the meter, the potentio-

* * Please turn to page 73 * *

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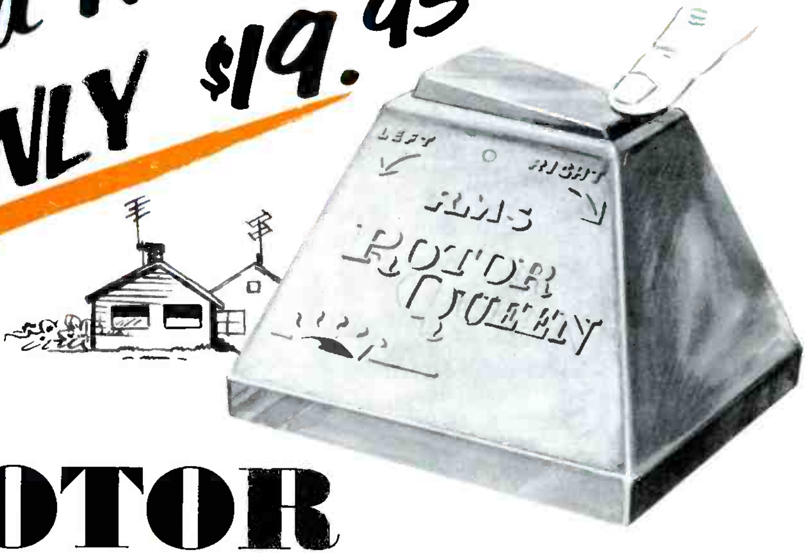

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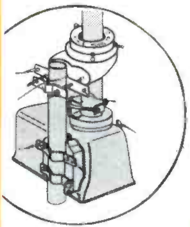

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by *John Markus*

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

MUSEUM RADIO. To help visitors get more out of exhibits as they wander through the halls of the American Museum of Natural History in New York City, each hall broadcasts its own recorded lecture continuously. Small radio receivers having hearing-aid phones are available for those who want to listen. These sets have built-in ferrite antennas sensitive enough to pick up signals from a transmitter in the same room, even though that transmitter is so weak that it requires no FCC license.

Eventually it is planned to have three transmitters per room and receivers giving a choice of three different lectures — one for children, one for adults, and one in some foreign language. The latter can be changed from time to time to serve the different nationalities in the city's melting pot of humanity.

If other museums adopt the idea, it can mean a sizable new market for low-cost receivers, transmitters, and tape recorders; and it can also mean some nice extra income for the service technician who gets in on the ground floor at his local museum. Don't underrate radio in these TV days.

* * *

GUESSING. Individual production figures of leading TV set manufacturers have been close-kept secrets for competitive reasons. Not even the membership of the top ten is known for sure, which leaves the field wide-open for guessing. In Retailing Daily, Chicago financial consultant E. N. Greenebaum, Jr., gives his guesses on the big ten with estimated TV set production of each for 1954 as follows: Admiral 800,000; RCA 800,000; Philco 700,000; Motorola 575,000; Zenith 475,000; Crosley 400,000; GE 325,000; Emerson 300,000; Westinghouse 300,000; DuMont 250,000. These are based on his prediction of 6,700,000 TV sets produced this year, which leaves some 1,775,000 sets to be made by the other 90-odd TV manufacturers. Actual production last year was 7,214,827 TV sets. This means that 1954 will be only slightly lower despite gloomy predictions that premature color publicity would ruin the market for black-and-white TV.

* * *

SETS AT WORK. To determine how many TV sets are actually working in this country, the four major networks got together to foot the bills for a national count. The result showed some 28,450,000 TV sets actually operating as of May 1954, in 27,600,000 homes. This indicates that we have around 850,000 two-set homes, but still have about 20,000,000 TV-less homes.

Like most surveys, the above figures are based on sampling; in this case, they made 11,020 carefully selected interviews throughout the country and then extrapolated the results on the basis of United States census figures and other statistics.

Here are some other interesting figures deduced from the sampling survey. Three out of four people living alone do not have TV; this would seem to be a good untapped market reached by aiming at apartment and rooming houses.

Some 810,000 TV sets and 16,740,000 radios in living rooms of homes are dead but still waiting to be fixed. This service business exists today, waiting for those who ask for it. The right kind of advertising, consistently repeated but in moderation, will bring in such business at a profit. Give the classified advertising section of your local newspaper a fair try, after getting advice on the wording of your ad from the advertising manager of the paper.

The next figures are also interesting, but we can't put a dollar sign on them — 17 out of 20 TV sets and 5 out of 20 radio sets are still in the living rooms of homes. One home in 20 still doesn't have a radio (or threw it out). Of the 100 million radios working, over 26 million are rolling on the roads; this means that one out of every four radios in this country is in a car.

These figures are only an approximation since only once every ten years, when the census is taken, can truly accurate nose-count figures be obtained on such things in so big a country. Even so, they prove quite interesting.

* * *

TRANSISTORIZING. Still a dark horse on the horizon, transistors are nevertheless coming up fast. Odds are against seeing them in 1955 sets, except for a few in high-priced portable radios; but watch out for 1956. Little by little the production bugs are being ironed out and factory rejects cut down, while at the same time the performance is being improved.

Transistors will become economical for TV and radio even when priced higher than tubes because of their smaller size and lower power requirements. With no heat-dissipation problems, sets can be made much smaller, cutting down chassis and cabinet costs. The future in this field is fascinating. Transistors will be no more difficult to trouble shoot, test, and replace than tubes.

* * Please turn to page 55 * *

THIS 980 LINE COMBINATION can save up to 50% of your time

Here are the two famous 980 Line instruments that form the basis of the new Weston simplified method of TV receiver alignment . . . eliminating the troublesome, time-wasting procedures heretofore involved, and enabling servicemen to cut alignment time almost in half. This new method is possible when these two instruments are used with the Weston scope, or scopes with provisions for Z-axis intensity modulation. They also can be used with available test equipment in the conventional method of alignment. For the complete story, write . . . WESTON Electrical Instrument Corporation, 614 Frelinghuysen Avenue, Newark 5, N. J.

WESTON MODEL 985 *CALIBRATOR*

FEATURES

SCALE CALIBRATION: Crystal calibrating points are available at 1.5 and 4.5 megacycles throughout the entire scale. A scale shift knob is provided to align the scale with the crystal calibrating dots.

SCALE PRESENTATION: Slide rule type in which one scale is visible at a time. Ten scale range bands available . . . total scale length of 8¼ ft.

DUAL MARKERS: 4.5 mc side band markers permit simultaneous observation of video and sound carrier.

INTERNAL MARKERS: Special circuitry provides an internal marker of either a positive or negative pulse suitable for Z-axis intensity modulation of the scope pattern. Marker is visible even at the sound trap frequencies.

HETERODYNE DETECTION: With an input sensitivity of 500 microvolts, the local TV receiver-tuner channel oscillator frequency can be determined without tuner disassembly.

BAR PATTERN GENERATOR: Amplitude modulated signals of the band oscillator at 400 cycles and 300 KC are available for linearity checks.

SPECIFICATIONS

Frequency Range (with Variable Frequency Oscillator): 4-110 megacycles in 7 bands. 170-260 megacycles in 3 bands.

Output Attenuator Range: 100% to 1%

Crystal Marker Accuracy: 1.5 mc position ± 0.01%; 4.5 mc position ± 0.01%

Internal Modulation Frequencies: 400 cps, 300 KC, 4.5 mc

Heterodyne Input Sensitivity: 500 microvolts (VFO)

Linearity Adjustment: Horizontal—400 cycles, Vertical—300 KC

Dual Markers: video and sound . . . available for either Z-axis intensity modulation of scope or conventional marker pip display.

WESTON MODEL 984 *SWEEP GENERATOR*

FEATURES

BLANKING: Special circuitry produces a zero output reference base which is essential for relative gain measurements.

RF OUTPUT: Frequency modulated signal, TV channels 2 to 13 inclusive, complete FM coverage available by means of two preset selector positions. *Frequencies are fundamentals of the oscillator frequency.*

IF/VIDEO OUTPUT: Frequency modulated signals ranging to 50 megacycles, continuous tuning, signals free from harmonics.

SWEEP WIDTH: Full 10 megacycles on all channels.

Z-AXIS TERMINAL: For use with the Model 985 Calibrator.

SPECIFICATIONS

Sweep Width: 0-10 Megacycles (continuously variable for both IF and RF)

Output Voltage (RMS): 0.1 Volt . . . sweep is linear

RF Output: TV channels 2 to 13 preset. Complete FM coverage available by means of two additional preset selector positions.

IF/Video Output: 50 Megacycles (continuous tuning)

Horizontal Sweep for Oscilloscope: Phase adjustment range . . . 165° Frequency . . . Power Line 60 cycles per second.

WESTON 980 LINE | ***TV TEST EQUIPMENT***

Examining Design Features

(Continued from page 15)

as the sync separator. The output of the sync separator is then fed to the vertical-sweep section and to the horizontal-sweep section.

Vertical Sweep

The signal from the sync separator is integrated and applied to the vertical oscillator which is a cathode-coupled multivibrator. The vertical-hold control forms an integral portion of this circuitry. Two controls are included in the network that couples the horizontal oscillator to the 6W6GT vertical-output tube. These are the height control and the linearity control. The signal developed in the output circuit of the 6W6GT is then applied to the deflection coils. Retrace blanking is accomplished by applying a portion of the vertical-deflection signal to the control grid of the picture tube.

Horizontal Sweep

A signal from the sync separator is fed to the grid of a triode serving as the horizontal-sync clipper. The cathode return for this tube is through the primary of a transformer. The method in which the primary and secondary are connected permits two signals of opposite polarity to be taken from the clipper circuit. These two signals are fed to the AFC discriminator. This stage incorporates the two diode sections of a 6AL5. A signal is also fed to the AFC discriminator from the horizontal-output circuit. Any resultant correction voltage is applied to the horizontal oscillator, which is a cathode-coupled multivibrator with a resonant circuit in the cathode return path. Three variables are associated with this stage. A trimmer capacitor provides adjustment of the horizontal range. Horizontal frequency is adjusted by a variable inductance. The horizontal-hold control constitutes the third adjustment.

The 6BQ6GT horizontal-output tube is driven by the signal from the horizontal multivibrator. High-voltage rectification is accomplished by a 1B3GT. The damper tube is a 6AX4GT.

Power Supply

The power transformer functions as an autotransformer for development of the high voltage. Half-wave rectification is provided by a selenium rectifier. Two filament windings are used. One of these is for the filament of the picture tube and is connected to a source of approximately 165 volts. This is done to reduce the potential existing between the cathode and the filament of the picture tube.

MAJESTIC MODEL 4P1

The Majestic Model 4P1 shown in Fig. 2 is a portable radio-phonograph with the rather unique feature that the entire unit, including the phono motor is battery operated. The radio portion is a 4-tube receiver covering the standard broadcast band. A battery-saver switch is incorporated in the battery supply to the receiver. The desired type of operation is selected by the push buttons. The function of each push button is shown in Fig. 2.

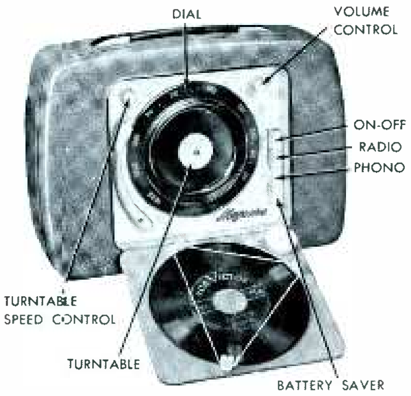


Fig. 2. The Majestic Model 4P1.

The phonograph turntable is mounted concentrically with the tuning dial for the radio. The turntable is driven by a small electric motor. The power for operation of the motor is obtained from four 1.5-volt batteries. These batteries are connected in series to provide a total of six volts. A battery-saver switch is also provided for this supply.

The speed of the turntable may be varied by a mechanical arrangement which moves the drive wheel along the radius of the turntable. This variable-speed adjustment compensates for varying battery voltages.

The compartment for the batteries is in a separate case which is easily removed from the radio.

An AC power supply is available as an accessory item. This supply is contained in a case similar to the case for the batteries. Whenever AC operation is desired, the battery case may be removed and the AC supply installed in its place.

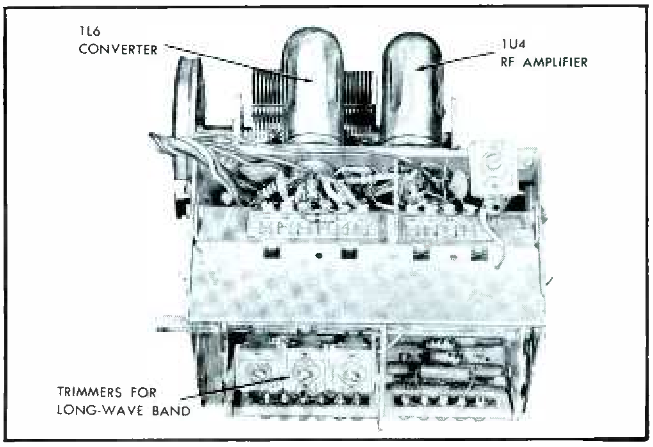
HALLICRAFTERS MODEL TW-2000

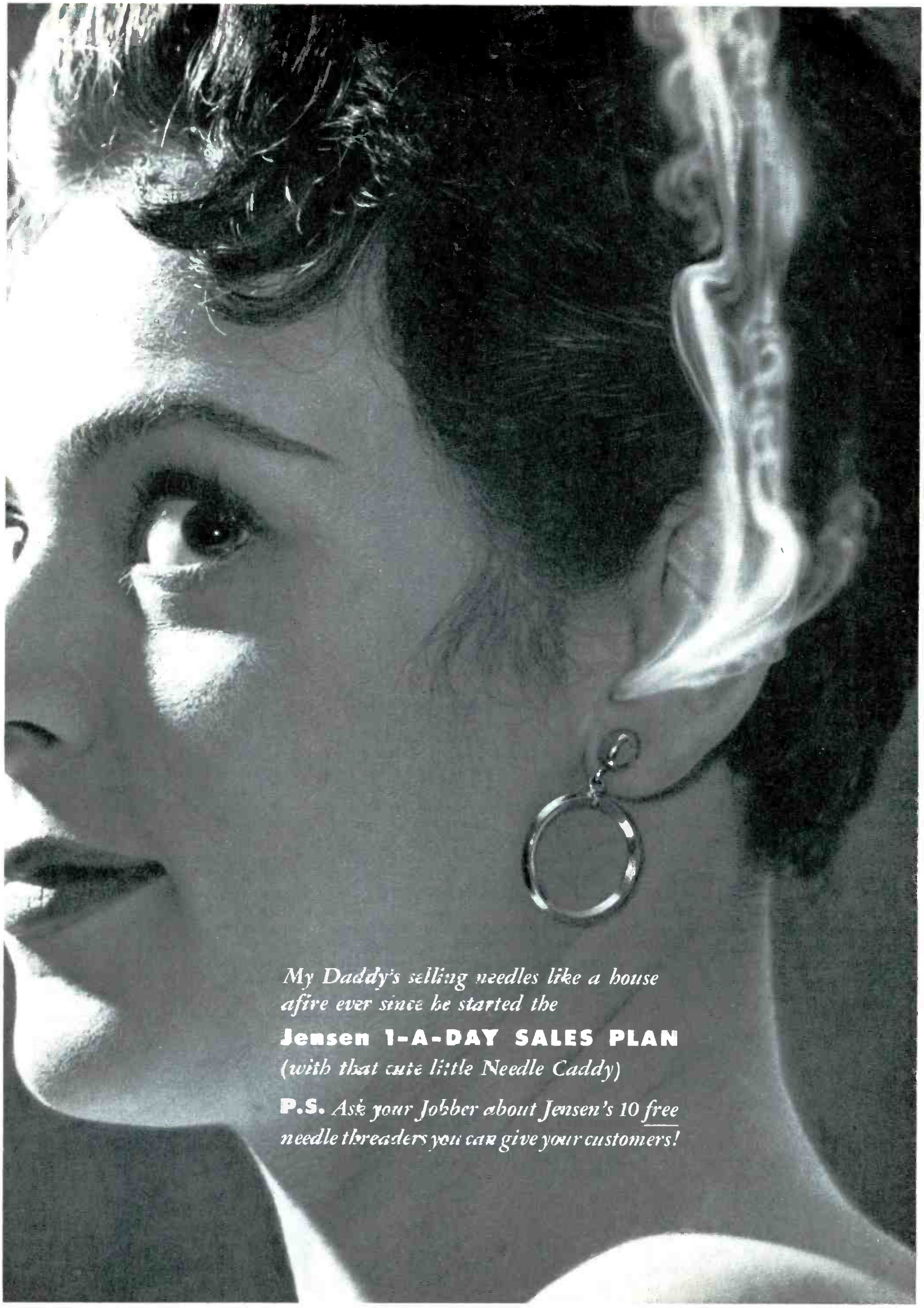
A different approach to bandswitching in multiband receivers has been incorporated in the Model TW-2000 manufactured by the Hallicrafters Company. This receiver has eight bands covering groups of frequencies ranging from 180 kilocycles to 18.2 megacycles. A turret tuner, similar to the type found in television receivers, is employed in the bandswitching network preceding the IF stages. See Fig. 3. The 1U4 RF amplifier and the 1L6 converter are mounted on the tuner. The three-gang tuning capacitor is mounted adjacent to these tubes. There are two snap-in strips associated with each band. One strip contains the antenna coils; the other contains the coils for the RF and the converter stages. Additional capacitance for the long-wave band (180 to 400 kilocycles) is obtained by mounting a third strip for this band. This strip consists of three trimmer capacitors. The output of the tuner is at the IF of 455 kilocycles.

The entire tuner assembly may be removed from the receiver as a single unit, but only the tuner drum need be removed for access to the sockets of the two tubes. The individual strips for each band may also be removed for servicing.

DON R. HOWE

Fig. 3. Turret Tuner Used in the Hallicrafters Model TW-2000.





My Daddy's selling needles like a house afire ever since he started the

Jensen 1-A-DAY SALES PLAN

(with that cute little Needle Caddy)

P.S. *Ask your Jobber about Jensen's 10 free needle threaders you can give your customers!*

Color TV Training Series

(Continued from page 9)

Fig. 7-2B shows an amplitude-modulated carrier. Fig. 7-2C illustrates the plate-current pulses which would result from the application of this wave to grid No. 1 of the stage shown in the simplified circuit, provided that the signal had the same phase as sine wave A. If the signal shown in Fig. 7-2B were of the same phase as that of sine wave B, there would be no change in plate-current pulses because of the modulation, since the wave would always pass through zero during the time of sampling.

In order to recover the modulated signal which would be represented by sine wave B, the composite signal must be fed into another synchronous demodulator. The suppressor grid in this stage would be pulsed during time 3 instead of time 2. At time 3, sine wave B reaches its peak and sine wave A is at zero. The plate-current pulses would then be affected by the modulation of sine wave B, and demodulation of the signal would result.

Demodulation Using a CW Signal

Demodulation of the chrominance signal is not so simple as implied by the preceding discussion which was presented to describe the basic operation of a synchronous demodulator. It would not be advantageous to use a manual switching arrangement for the grid No. 3 voltage. In actual practice, grid No. 3 is controlled automatically by a sine wave which is developed in the color-sync section of the receiver.

A synchronous-demodulator circuit which is employed in color receivers is shown in Fig. 7-3. The control grid for each stage receives the same chrominance signal from the output of the bandpass-amplifier section. Grid No. 3 in each demodulator is connected to a transformer which is located in the output circuit of the color-sync section. The CW reference signal which is present on grid No. 3 of each stage is at a constant amplitude and frequency; however, the phase difference between the two CW signals is 90 degrees. The chrominance signal at the input of each stage is constantly varying in amplitude and in phase with changes of color or saturation of the transmitted scene. A sampling process takes place within the synchronous demodulator in which the chrominance signal is effectively sampled by each demodulator

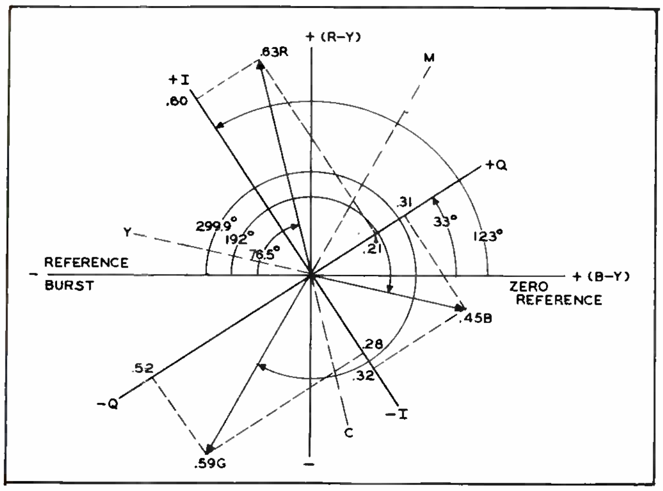
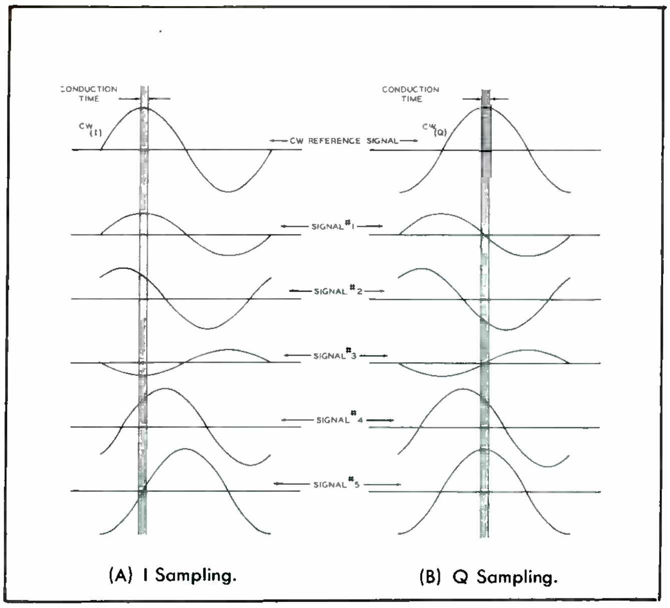


Fig. 7-4. Color-Phase Diagram.



(A) I Sampling.

(B) Q Sampling.

Fig. 7-5. Sampling Process of Random Signals.

Phase and Amplitude of the Chrominance Signal

Before discussing the sampling process, let us review the color-phase diagram of Fig. 7-4 because, from time to time, reference to this diagram will be made. It shows the phase relationship of all the color signals with respect to the reference burst and shows the necessary portions of the I and Q signals to produce the individual colors. For instance, the I signal lags the reference burst by 57 degrees, and the Q signal lags the reference burst by 147 degrees. As an example, the diagram shows that .6 of the I signal and .21 of the Q signal combine to produce the signal representative of the color red. This means that when a fully saturated red is transmitted, the signal representative of this color is a combination of I and Q in the chrominance signal. The I demodulator in the receiver must be able to detect the .6 value of the I signal, and the Q demodulator must be capable of detecting the .21 value of the Q signal.

The values of I and Q may also be negative in polarity. For instance, the color cyan is the complement of red. This means that the values of I and Q will be of the same magnitude as they were for the red signal but that they will be of the reverse polarity. A negative .6 value of I and a negative .21 value of Q combine to produce a signal representative of a fully saturated cyan. As can be seen from the phase diagram of Fig. 7-4, the values of I and Q which combine to form the green signal are both negative values; however, for the blue signal, the Q portion is a positive value and the I portion is a negative value.

Another point to keep in mind is that the CW reference signal which is used by the I demodulator in the receiver is in phase with the I vector (positive or negative) which is shown in Fig. 7-4 and that the Q reference signal is in phase with the Q vector (positive or negative). In any case, the phase difference between the I and Q reference signals is always 90 degrees.

Sampling of the Chrominance Signal

Referring again to the circuit of Fig. 7-3, let us see how the sampling process is accomplished in the demodulators. Remember that the chrominance signal and the CW reference signals consist of continuous sine waves. The chrominance signal is constantly varying in amplitude and phase, and the CW signals are maintained at a constant amplitude and phase. In the following illustrations

THE ONE INSTRUMENT YOU NEED FOR Color

MODEL 712
$395.00
NET

JACKSON COLOR BAR / DOT GENERATOR

Signal Outputs

1. Composite video of either polarity, adjustable amplitude to 2 volts across 90 ohms.
2. Modulated R.F., channels 3 through 5, 0.1 volt across 300 ohms.
3. Horizontal sync., positive polarity, 1 volt across 200 ohms.
4. Color subcarrier, 4 volts across 200 ohms at burst phase.

Synchronizing Signals

1. Horizontal sync. and blanking (F.C.C. standards).
2. Vertical sync., serrated and locked to horizontal.
3. Vertical blanking.
4. Color burst (N.T.S.C. standards).

Video Signals

1. Dots (nominal 108 dots)
2. Crosshatch (nominal 12 by 9)
3. Color bars (5 switch positions)

Position 1—Multi.

8 Bars in the following sequence:

1. White, relative luminance 1.0, chrominance zero
2. Yellow, relative luminance 0.89, chrominance 0.44
3. Cyan, relative luminance 0.70, chrominance 0.63
4. Green, relative luminance 0.59, chrominance 0.59
5. Magenta, relative luminance 0.41, chrominance 0.59
6. Red, relative luminance 0.30, chrominance 0.63
7. Blue, relative luminance 0.11, chrominance 0.44
8. Black, relative luminance zero, chrominance zero

Luminance and chrominance held to 10 percent, phase angles to ±5 degrees

Position 2—Color Difference.

7 Bars of zero luminance in the following sequence:

1. Black, relative chrominance zero.
2. I, relative chrominance 0.25
3. Q. relative chrominance 0.25
4. Black, relative chrominance zero
5. R-Y, relative chrominance 0.25
6. B-Y, relative chrominance 0.25
7. Black, relative chrominance zero

Phase angles held to ±2 degrees.

Positions 3, 4 and 5—Single bars, luminance 0.3, chrominance 0.5, occupying approximately 60% of screen width.

1. Red (position 3)
2. Green (position 4)
3. Blue (position 5)

Sound Carrier, approximately 25% of peak picture carrier, placed 4.5 megacycles from picture carrier.

Panel Controls

1. R.F. carrier tuning, channels 3 through 5.
2. Video output amplitude.
3. Horizontal lock.
4. Standby switch (sound on, sound off).
5. Video output polarity switch.
6. Power switch.
7. Function switch (crosshatch — dots — color bars)
8. Color bar switch (Multi, Color Diff., Red, Green, Blue).

Internal Adjustments

1. Burst amplitude.
2. 3.58 frequency vernier.
3. Sync. lock controls.

Tube Complement

12AT7 — 8	6J6 — 10
12AX7 — 4	5U4-G — 1
6AL5 — 1	6BJ7 — 1

Circuit Operation

1. Color sub-carrier and sound frequencies are determined by crystal oscillators.
2. Color phase angles are determined by an accurate, low impedonce delay line.
3. Direct gating of proper chrominance phase is employed for each color bar to attain maximum stability and reliability rather than usual methods utilizing quadrature encoders.
4. Serrated vertical sync. is maintained an integral divisor of horizontal rate.
5. Luminance and chrominance levels are reliable and stable. No multivibrators are employed in generating color bars.
6. No internal or external adjustments are necessary for proper bar widths, luminance or chrominance levels. For use on 105-125 volts 60 cycle AC.

Physical Characteristics

Dimensions—16½" wide x 9½" high x 10¼" deep. Designed to match other Jackson TV Equipment, both in styling and exterior dimensions.

Weights—27 net pounds. Shipping 32 pounds.

"Service Engineered" Test Equipment

JACKSON
ELECTRICAL INSTRUMENT CO.

16-18 South Patterson Boulevard, Dayton 2, Ohio • In Canada: The Canadian Marconi Company of the sampling process, only one cycle of each signal will be shown.

Fig. 7-5A shows the CW reference signal that is applied to grid No. 3 of the I demodulator. As shown on the drawing, the conduction time of the stage is during the time of the positive peak of the cycle. This is the sampling time and is very short. At any other time of the cycle, the stage is nonconducting. Since current is allowed to flow through the tube only during the sampling period, detection can occur only during such time.

Any one of the other five signals shown in Fig. 7-5A is representative of the chrominance signal that might appear on the control grid of the demodulator. The input signal may be at any amplitude and at any phase with respect to the CW signal. It is also shown that the chrominance signal can either be positive or negative during the time that sampling takes place.

Signal 1 is in phase with the CW signal; therefore, it is sampled at the peak of the wave. The signal that is representative of the phase and amplitude of signal 1 is passed through the tube to the output.

If the chrominance signal takes the form of signal 2, it will be detected as being a signal which leads the CW signal by 45 degrees and which has a specific amplitude. This signal is detected by the demodulator as being a different signal than signal 1. The output will be a pulse representative of the instantaneous voltage present on grid No. 1 during the sampling period.

Signal 3 represents a chrominance signal that is 180 degrees out of phase with the CW reference signal. Signal 4 occurs 45 degrees behind the reference signal. Signal 5 is a signal that occurs 90 degrees out of phase with the reference signal. During the time that sampling of signal 5 takes place, the chrominance signal is going through zero; therefore, no variations in the output result, regardless of the amplitude of the signal.

Now let us consider the operation when signals 1 through 5 are present at the Q demodulator. The CW reference signal for the Q demodulator is shown in Fig. 7-5B. It is 90 degrees out of phase with the I demodulator CW signal and is shown as such. The sampling time of the Q demodulator occurs during the positive peak of the CW cycle. There are 90 degrees between this time and the time that the I demodulator performs its sampling process. This means that when one demodulator is sampling, the other is not conducting.

During the time that either signal 1 or 3 is present on the control grid of the Q demodulator, it passes through zero when the sampling pulse is present on grid No. 3. This simulates a condition in which no input signal is present.

As a result of signals 2, 4, and 5, the plate-current pulse will be decreased or increased. Signal 2 leads the CW signal by 135 degrees and is sampled when it is going in the negative direction. This will decrease the pulse current, and a positive voltage will be developed in the output. Signal 4 is 45 degrees ahead of the CW signal and is sampled when it is going in the positive direction. Signal 5 is in exact phase with the CW signal; therefore, it is sampled at its most positive peak. The phase and amplitude of each of these signals are sampled during the conduction time of the Q demodulator, and an output is produced that represents the phase and amplitude of the input signal.

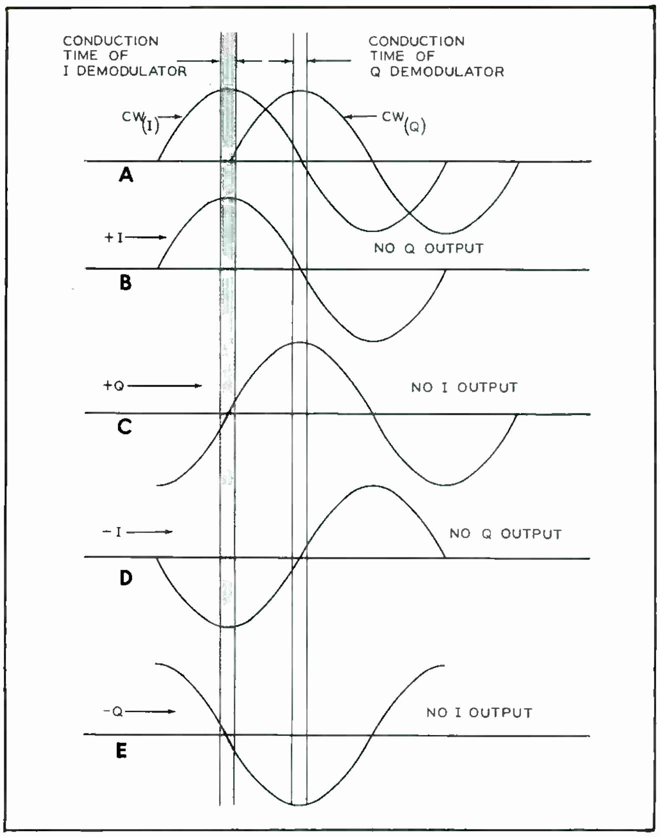


Fig. 7-6. Sampling Process of Signals Containing Only I and of Signals Containing Only Q.

Under the conditions shown in Figs. 7-5A and 7-5B, the output signals will be negative in polarity; that is, the signal in the output of the demodulator will be of the opposite polarity of the original I and Q signals at the transmitter. This is true because of the 180-degree phase reversal within the tube. Whenever a positive signal at the output of the demodulator (or an output signal of the same phase as the original I and Q signals at the transmitter) is wanted, the phase of the CW signal is shifted 180 degrees before it is applied to the demodulator stage.

The signals shown in Fig. 7-5 were not intended to show a particular condition at the time a specific color was being transmitted. They were intended to show various signals that might occur at the input of the de-

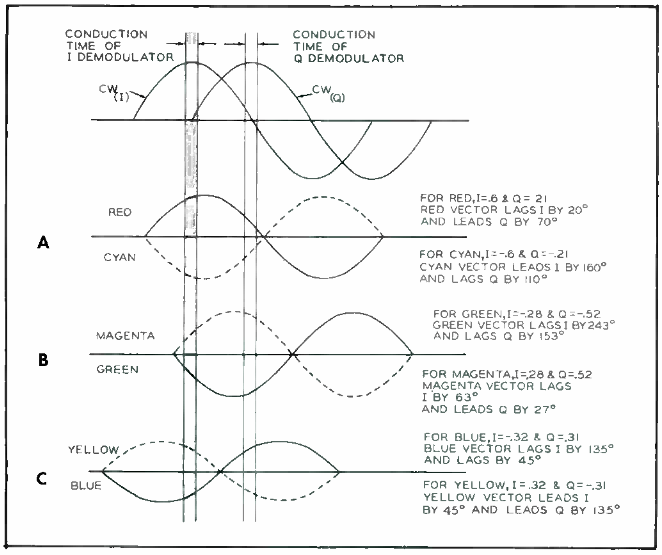


Fig. 7-7. Sampling Process of the I and Q Demodulators for Each of the Primary Colors and Their Complements.

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the World's Best TV-RADIO SERVICE DATA

PHOTOFACT Service Data is the *only* service information based upon first-hand examination of the actual production-run receivers and equipment. It is authentic, uniform service data, based on actual study and analysis by service engineers in the Howard W. Sams' Laboratories. PHOTOFACT is the *only data* prepared from the practical point of view of the Service Technician.

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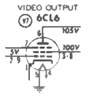
1. Famous "Standard Notation" uniform symbols are used in every schematic.
2. The same standard, uniform layout is used for each schematic.
3. Diagrams are clear, large, extremely easy to read.
4. Wave forms are shown right on the TV schematics for quick analysis by 'scope.

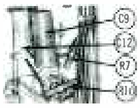
5. Voltages appear on the schematics for speedy voltage analysis.
6. Transformer lead color-coding is indicated on the schematic.



7. Transformer winding resistances appear on the schematic.
8. Schematics are keyed to photographs and parts lists.

FULL PHOTOGRAPHIC COVERAGE

9. Exclusive photo coverage of all chassis views is provided for each receiver.
10. All parts are numbered and keyed to the schematic and parts lists.



11. Photo coverage provides quicker parts identifications and location.
12. Photo coverage helps identify burned-out or missing parts.

ALIGNMENT INSTRUCTIONS

13. Complete, detailed alignment data is standard and uniformly presented in all Folders.
14. Alignment frequencies are shown on radio photos adjacent to adjustment number—all alignment adjustments are keyed to schematic and photos.

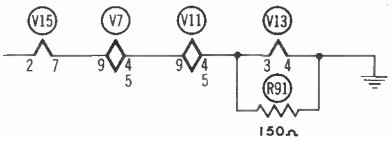
TUBE PLACEMENT CHARTS

15. Top and bottom views are shown. Top view is positioned as chassis would be viewed from back of cabinet.
16. Blank pin or locating key on each tube is shown on placement chart.

17. Tube charts include fuse location for quick service reference.

TUBE FAILURE CHECK CHARTS

18. Shows common trouble symptoms and indicates tubes generally responsible for such troubles.
19. Series filament strings are schematically presented for quick reference.



COMPLETE PARTS LISTS

20. A complete and detailed parts list is given for each receiver.
21. Proper replacement parts are listed, together with installation notes where required.
22. All parts are keyed to the photos and schematics for quick reference.

FIELD SERVICE NOTES

23. Each Folder includes time-saving tips for servicing in the customer's home.
24. Valuable hints are given for quick access to pertinent adjustments.
25. Includes tips on safety glass removal and cleaning.

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26. Includes advice for localizing commonly recurring troubles.
27. Gives useful description of any new or unusual circuits employed in the receiver.
28. Includes aids, hints and advice for each specific chassis.

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29. Each and every PHOTOFACT Folder, regardless of receiver manufacturer, is presented in a standard, *uniform* layout.
30. PHOTOFACT, is a *current* service—you don't have to wait a year or longer for the service data you need. PHOTOFACT keeps right up with receiver production.
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modulators and the point at which they are sampled by the CW reference signals. The following illustrations and discussion show the conditions of the signals during the time that specific colors are contained in the chrominance signal.

One important point to remember about the operation of synchronous demodulators is that at the time one demodulator stage is in operation, the other one is nonconducting. This results from the fact that the CW signals which control the operation of the stages are 90 degrees out of phase. The stages are also allowed to conduct only for a very short time, which is during the most positive peak of the CW cycle. This means that the plate-current pulses will occur in only one of the demodulators at a time.

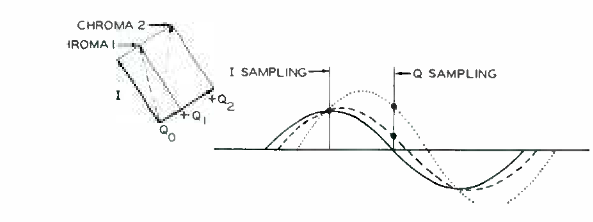
Demodulation With Only I or Q Present

Shown in Fig. 7-6 are conditions under which there is an output signal from one demodulator and not from the other. In section A of this figure, the two CW signals are shown in the same drawing so that a comparison of their conduction time can be made. Sine waves B, C, D, and E are for different chrominance signals on the input grids of the demodulators. Waveform B is in phase with the I reference signal; therefore, an output signal is produced in the I demodulator. There will be no output signal from the Q demodulator because the signal is going through zero during the sampling time of the Q demodulator. Whenever a color that is represented by a positive I signal and by the zero Q signal is being transmitted, the chrominance signal will be of the phase of waveform B. Since it is going in the positive direction at the time of sampling by the CW signal, it will be detected at the peak of the positive cycle.

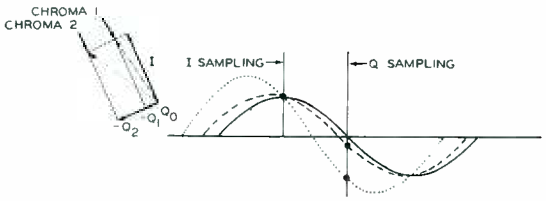
Waveform D represents a negative I chrominance signal. It is 180 degrees out of phase with the I reference signal; therefore, the output signal of the I demodulator will be of the reverse polarity of the output signal when waveform B is being demodulated. There will be no output signal in the Q demodulator, since this signal goes through zero at the time of Q-demodulator sampling.

Sine wave C represents a chrominance signal in which only a Q signal is present. Sine wave C is in phase with the Q reference signal and is 90 degrees out of phase with the I reference signal; therefore, it reaches its peak during the sampling time of the Q demodulator. There will be an output signal produced by the Q demodulator but none from the I demodulator. The same thing is true in the case of sine wave E, except that this signal represents a negative Q signal. It is at its negative peak during the sampling time of the Q demodulator. As in the case of sine wave C, sine wave E is passing through zero during the sampling time of the I demodulator; therefore, no output signal is produced by the I demodulator.

The waveforms shown in Fig. 7-6 are representative of chrominance in which only I or Q signals are present. This condition exists when certain colors are being transmitted. The I axis represents colors from an orange to a cyan. With the vectors plotted as shown in Figs. 7-4, the orange is represented by the positive I vector. The cyan is represented by the negative I vector. The Q axis represents colors from a reddish-blue to a yellow-green. The reddish-blue is conveyed by a positive Q signal, and the yellow-green color is represented by a negative Q signal; therefore, signals B and D of Fig. 7-6 would convey an orange and a cyan color, respectively. Signals C and E would convey a reddish-blue and a yellow-green color, respectively.



(A) Q Changes in Positive Direction.



(B) Q Changes in Negative Direction.

Fig. 7-8. Sampling Process When the I Signal Remains Constant and When the Q Signal Varies in Positive and Negative Directions.

Demodulation With Both I and Q Present

Now let us investigate the sampling process of the I and Q demodulators for each of the primary colors and their complements. Chrominance signals which represents these colors are shown in Fig. 7-7. The CW reference signals are again shown at the top of the illustration. In order to reproduce the primary colors, there must be an output signal from both of the demodulators for each color. This means that some of the original color from the output of the color camera is conveyed by the I signal and that the remaining portion is conveyed by the Q signal. Then the two were combined by the modulator stages in the transmitter into a complete chrominance signal; therefore, the chrominance signal at the input of the demodulators in the receiver must be sampled at two points within the cycle in order to recover the entire color signal.

Drawing A of Fig. 7-7 is the chrominance signal which represents the primary color red and its complementary color cyan. The sine wave for cyan is shown in dotted lines because it is actually a different signal from that of red. It is shown in this way to illustrate that the complementary color is of the same amplitude but of

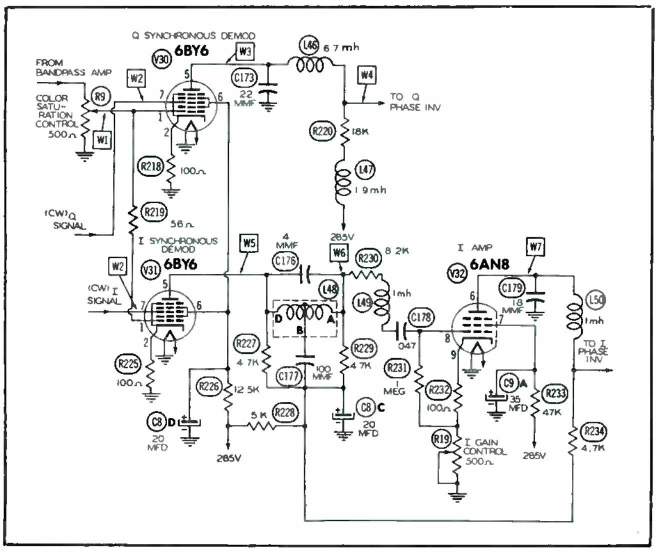
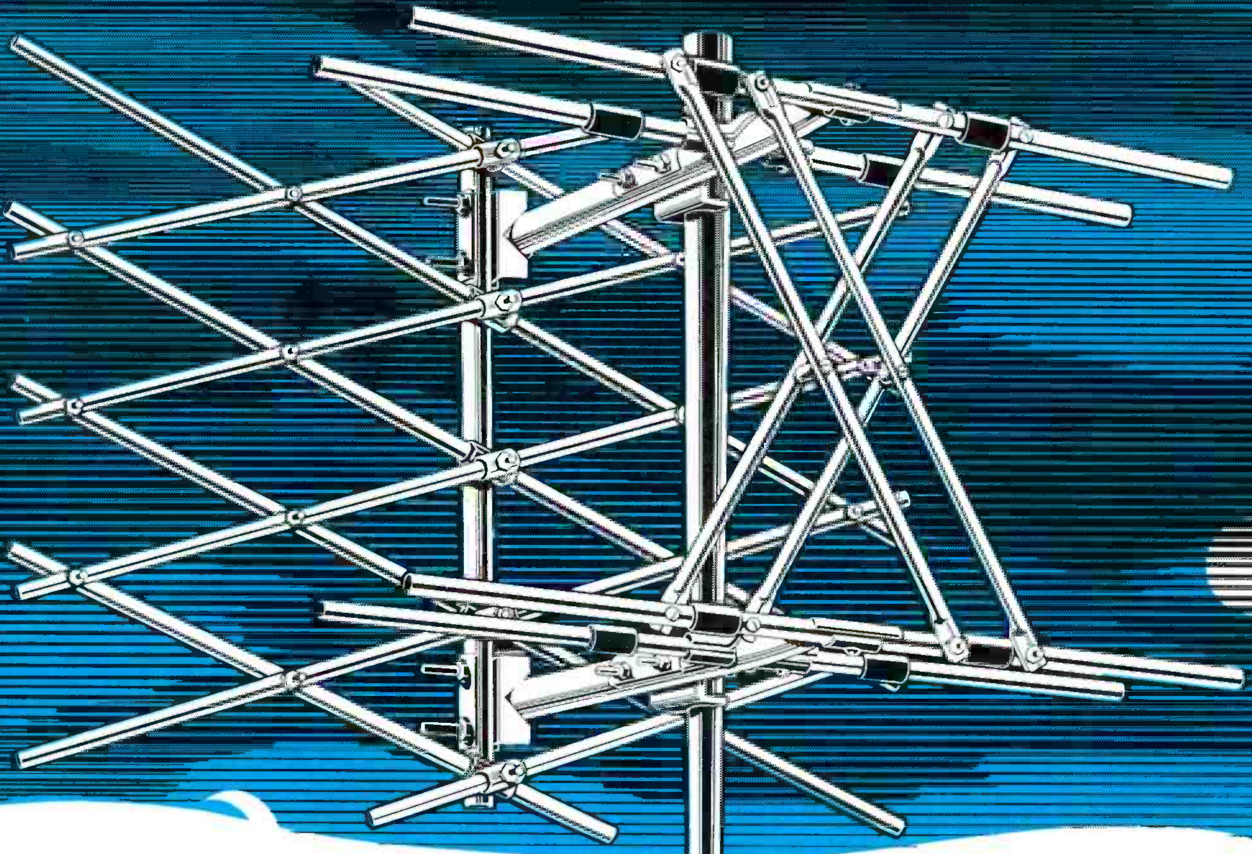


Fig. 7-9. Synchronous-Demodulator Circuit in the RCA Victor Model CT-100 Color Receiver.



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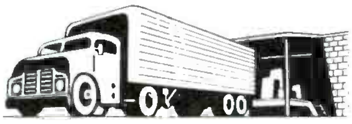

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opposite phase from that of the primary color. In the case of red, the chrominance signal lags the I reference signal by 20 degrees and leads the Q reference signal by 70 degrees. It is sampled by the I demodulator at an amplitude of .6 and by the Q demodulator at an amplitude of .21. Each time a chrominance signal which has a phase relationship like that shown in Fig. 7-7 appears, the color red is being conveyed. When the chrominance signal is of the opposite phase, the color cyan is being conveyed.

Drawing B of Fig. 7-7 shows the conditions when either the primary color green or its complementary color magenta is being conveyed. For green, the chrominance signal lags the I reference signal by 243 degrees and lags the Q reference signal by 153 degrees. The I portion of the signal is sampled at an amplitude of negative .28 and for the Q portion at an amplitude of negative .52. For the magenta color, the I and Q portions are sampled at the same amplitude but at the reverse polarity.

The waveforms in drawing C are the chrominance signals for the primary color blue and its complementary color yellow. The signal which represents the color blue lags the I reference signal by 135 degrees and lags the Q reference signal by 45 degrees. It is sampled at an amplitude of negative .32 for I and at positive .31 for Q. As was true in the cases of two of the other primaries, the waveform for yellow is just the opposite to that for blue; thus for yellow, the I portion of the chrominance signal is positive in polarity, and the Q portion is negative in polarity.

It has been shown that the I and Q signals can be contained in the chrominance signal in any combination. The chrominance signal can contain only an I signal, either positive or negative; or it can contain only a Q signal, either positive or negative. Furthermore, it can be made up of both I and Q signals with each being positive or negative, or the I and Q signals can be of different polarities.

To illustrate the fact that the chrominance signal can be representative of any combinations of I and Q, let us consider a case in which the value of I remains constant and the value of Q is varied. This fact is illustrated in Fig. 7-8. Shown in Fig. 7-8A is the condition when the I signal remains constant and the Q signal is increased in positive value. The vector drawing shows the resultants when Q is increased from zero to Q_1 and Q_2. The I vector can represent the signal when orange is being conveyed. The resultant vector called chroma 1, can represent the color red; and chroma 2 can represent a bluish-red color. These three conditions are resolved in the sine waves below the drawing of the vectors. With the chrominance signal containing only I, the resultant sine wave is shown as the solid curve. This chrominance signal would be in phase with the reference signal and would be sampled at the peak of the sine wave. In the other two conditions, the I portion of the chrominance signal must be sampled at the same time. When the chrominance signal consists of I and Q_1, the sine wave results in the waveform shown by a dashed line. The resultant sine wave increases in amplitude and lags the solid curve. Note that the I portion of the signal is sampled at the same amplitude as it was in the solid curve and that a positive value of Q is present.

When the chrominance signal consists of I and Q_2, the resultant sine wave is shown as the dotted line. The I portion of the signal is still sampled at the same amplitude, but Q_2 is at a higher amplitude than in the previous case.

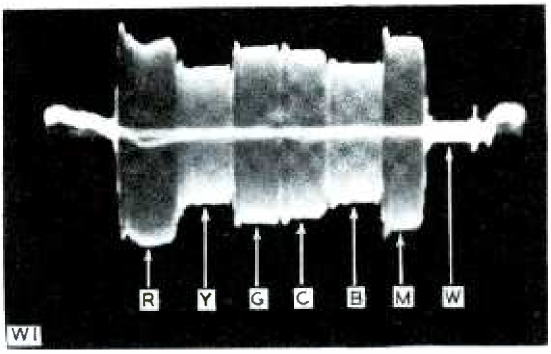


Fig. 7-10. Chrominance Signal at the Control Grids of the Demodulator Stages in Fig. 7-9.

The drawings of Fig. 7-8B illustrate the condition when the Q signal increases in the negative direction and when the I signal is still remaining constant. The resultant vector chroma 1 can represent the signal when a yellowish-orange color is being conveyed, and chroma 2 can represent a yellow color. The sine wave which represents the condition when I is present and Q is zero is the solid curve which is equal to the one that was shown in Fig. 7-8A. When the signal contains a negative Q_1, the chrominance signal takes the form of the dashed sine wave shown in Fig. 7-8B. The I component is sampled at the same amplitude, and Q_1 is sampled at a negative point on the curve. This curve leads the sine wave that contained only an I component. It is also of a high amplitude.

When the chrominance signal contains a negative Q_2, the sine wave which is shown as a dotted curve leads the other two curves and is higher in amplitude. The Q portion is sampled at a more negative point than it was in the previous sine wave. Here again, the I signal was sampled at the same amplitude as before.

An important point that must be remembered about the chrominance signal is that it is a sine wave. Even so, any combination of I and Q, whether negative or positive, can be portrayed by the chrominance signal by varying the amplitude and phase of the signal. The variety of chrominance signals shown in Fig. 7-8 should illustrate this fact.

I and Q Demodulator Circuits

Shown in Fig. 7-9 is the color-demodulator circuit used in the RCA Victor Model CT-100 color receiver. Two 6BY6 tubes are used as synchronous demodulators. The chrominance signal is taken from the saturation control R9 and applied to the control grids of the two stages. The CW reference signals are applied to grid No. 3 of both the stages. Waveform W1 in Fig. 7-10 is the chrominance signal, and waveform W2 in Fig. 7-11 is the CW signal. Both CW signals have the same appearance on

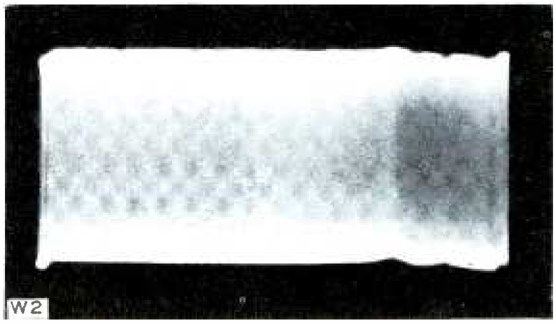
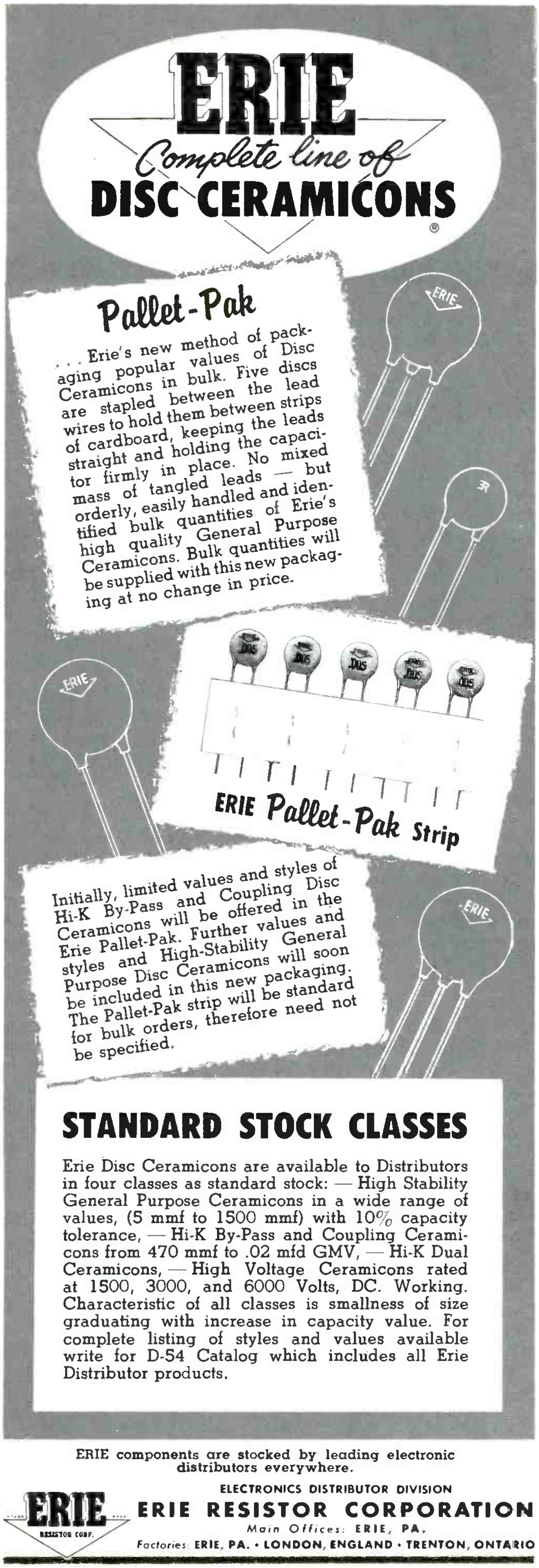


Fig. 7-11. CW Reference Signal in the Circuit of Fig. 7-9.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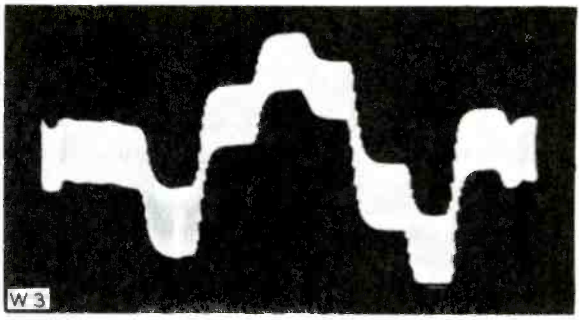

Fig. 7-12. Signal at the Plate of the Q Demodulator in Fig. 7-9.

the scope. The chrominance signal is detected for the Q component of the signal by the Q demodulator V30, and the I component of the signal is detected by the I demodulator V31 by means of the synchronous demodulator process previously discussed.

The sequence of color bars shown in the waveform of Fig. 7-10 is red, yellow, green, cyan, blue, magenta, and white. The same sequence will be present in all the waveforms that follow.

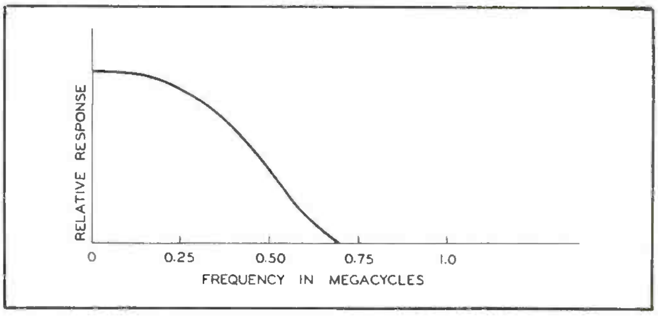

Fig. 7-13. Passband of the Q Channel in the Circuit of Fig. 7-9.

The output of the Q demodulator V30 is waveform W3 shown in Fig. 7-12. The plate signal follows the modulation that was afforded by the Q component of the chrominance signal. The thick appearance of the trace is caused by the unfiltered 3.58-mc component at the plate. This 3.58-mc signal is filtered out by the network consisting of C173, L46, R220, and L47. This filter network also limits the bandwidth of the signal to .5 megacycles. The bandpass characteristics of the Q channel are shown in Fig. 7-13.

After the signal passes through the filter network, it appears as waveform W4 which is shown in Fig. 7-14. This is the signal that is fed to the Q-phase-inverter stage where it is inverted in phase before being applied to the matrix section.

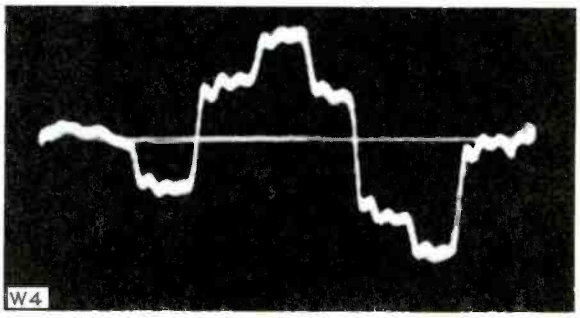

Fig. 7-14. Q Signal After the 3.58-Mc Signal Has been Filtered.

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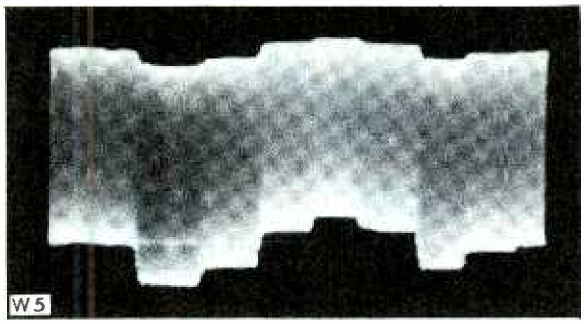


Fig. 7-15. Signal at the Plate of the I Demodulator in Fig. 7-9.

Shown in Fig. 7-15 is waveform W5 which is the signal that appears at the plate of the I demodulator V31. This signal contains the detected I components of the chrominance signal. The increase in amplitude of the 3.58-mc component over that present in the Q demodulator results from the wider bandpass characteristics of the filter in the plate circuit of the I demodulator. After passing through this band-limiting filter, the 3.58-mc signal is filtered out, and the signal is limited to a bandwidth of 1.5 megacycles. The band-limiting filter network consists of C176, L48, and C177. This filter also offers to the signal a time delay which is sufficient to delay the signal so that it arrives at the matrix at the same time that the luminance signal and the Q signal arrive. This time delay is necessary because the bandwidth of the I channel is wider than that of the Q channel. Since time delay is inversely proportional to the bandwidth of the circuit, the I signal passes through the I channel faster than the Q signal passes through the Q channel; therefore, the I signal is purposely delayed. Shown in Fig. 7-16 are the bandpass characteristics of the I channel.

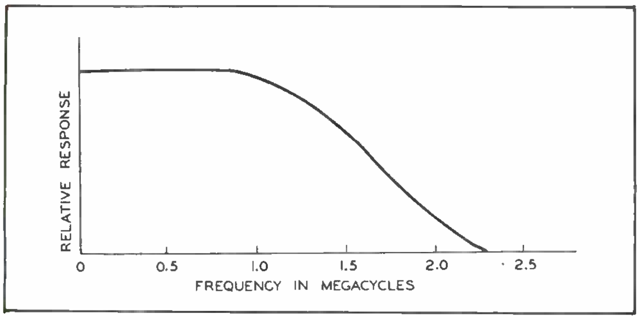


Fig. 7-16. Passband of the I Channel in Fig. 7-9.

Waveform W6 shown in Fig. 7-17 is the I signal after it has passed through the filter network. It is then coupled to the input of the I amplifier stage V32 by capacitor C178. Added gain for the I signal is provided by this stage. Since the I signal suffers a loss of gain because its bandwidth is wider than that of the Q signal, it is passed through the amplifier stage in order to bring it up to the desired level. The gain of the I amplifier is controlled by the I gain control R19 in the cathode circuit.

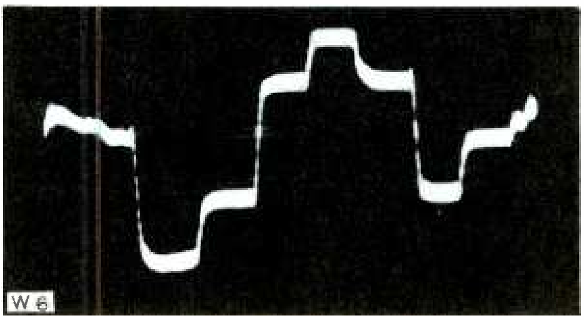


Fig. 7-17. I Signal After the 3.58-Mc Signal Has Been Filtered.

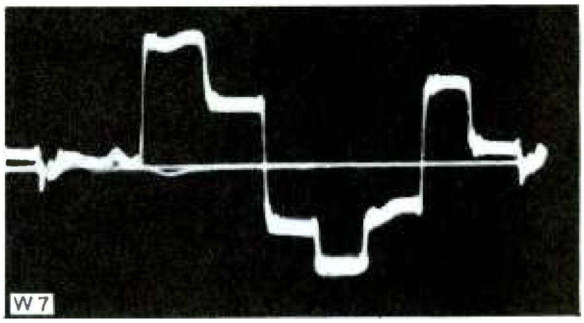


Fig. 7-18. Signal at the Plate of the I Amplifier.

The output signal is waveform W7 shown in Fig. 7-18. This signal is coupled to an I phase inverter where a positive and a negative I signal are obtained. The positive and negative I signals are to be used in the matrix section.

The Q phase inverter and the I phase inverter will be discussed when the matrix section is covered.

R-Y and B-Y Demodulator Circuits

It has been stated before that some receivers demodulate on the R - Y and B - Y axes instead of on the I and Q axes. This is possible, since the I and Q chrominance signals are made up of specific proportions of the color-difference signals R - Y and B - Y. The following equations for the I and Q signals point out this fact.

$$E_I = -0.27\ (E_B - E_Y) + 0.74\ (E_R - E_Y).$$

$$E_Q = 0.41\ (E_B - E_Y) + 0.48\ (E_R - E_Y).$$

These equations show that the color-difference signals were first formed and then mixed in the proportions shown to form the I and Q signals. Therefore, if the reference signals developed by the color-sync section in the color receiver are at the same phase relationship as the R - Y and B - Y axes, the color-difference signals will be ex-

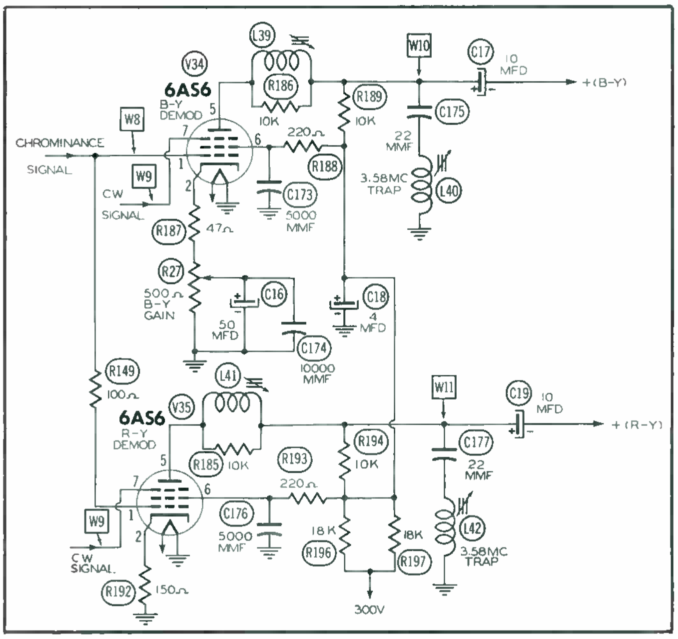
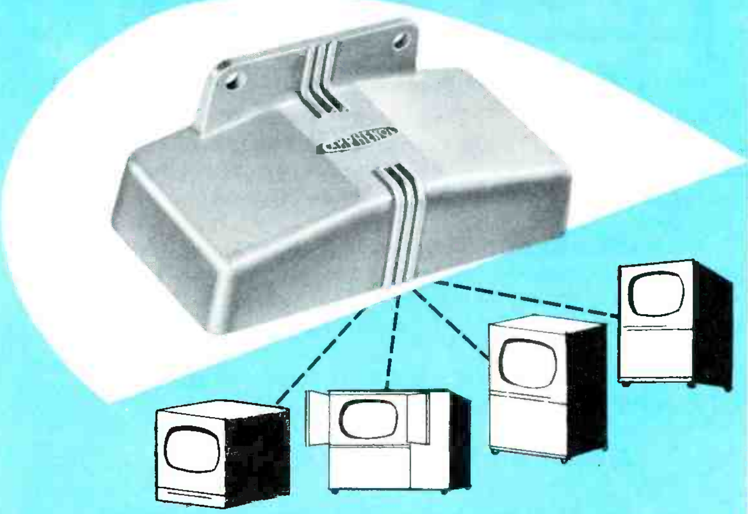


Fig. 7-19. Synchronous-Demodulator Circuit in the Westinghouse Model H840CK15 Color Receiver.



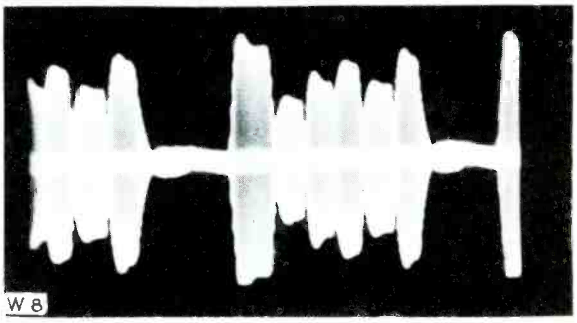


Fig. 7-20. Chrominance Signal at the Control Grids of the Demodulator Stages in Fig. 7-19.

tracted from the chrominance signal by the demodulators. Note from the color-phase diagram of Fig. 7-4 that the B - Y axis is in phase with the zero-reference axis and that the R - Y axis is displaced 90 degrees. The I and Q axes are rotated 33 degrees farther.

In order for the demodulators to obtain the R - Y and B - Y signals, the color-sync section must be designed to produce a CW signal that is in phase with the zero-reference axis and another CW signal which is 90 degrees out of phase with it. The CW signal that is in phase with the zero reference is applied to the B - Y demodulator, and the other CW signal is applied to the R - Y demodulator.

Shown in Fig. 7-19 is a synchronous-demodulator circuit which demodulates on the R - Y and B - Y axes. This circuit is used in the Westinghouse Model H840CK15 color receiver. Two 6AS6 pentode tubes are employed as the demodulators. The chrominance signal from the output of the bandpass-amplifier circuit is applied to the control grids. The CW reference signals from the color-sync section are applied to the suppressor grids. Waveform W8 shown in Fig. 7-20 is the chrominance signal which is present at the input grids. Fig. 7-21 is waveform W9 which is the CW signal. Only one CW signal is shown because the two CW signals have the same appearance on the scope.

The circuit of Fig. 7-19 appears at first glance to be quite similar to the demodulator circuit previously discussed. The chrominance signal is applied to the control grids, and the CW signals are applied to the suppressor grids (No. 3 grids) in the same manner as in the previous circuit. The demodulation process of the two circuits is basically the same. The main difference between the two circuits, however, is that the CW reference signals are at different phases. This results in output signals that are at different phases. This results in output signals that are different from those of the I and Q demodulators, because the chrominance signal is sampled at a different point than it is in I and Q demodulators. Fig. 7-22 shows the sampling times of a chrominance signal during I and

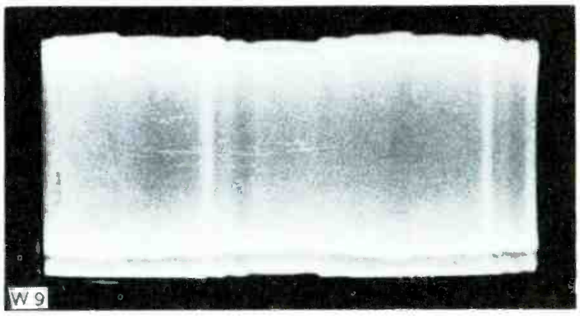


Fig. 7-21. CW Reference Signal in the Circuit of Fig. 7-19.

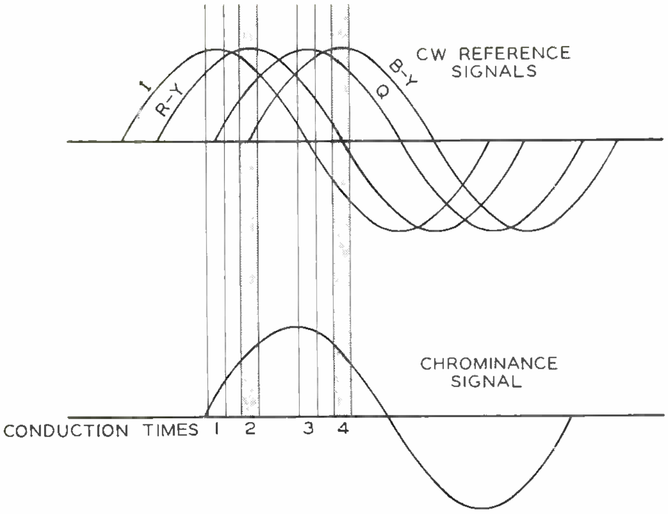


Fig. 7-22. Comparison of Sampling Times for I and Q Signals and R-Y and B-Y Signals.

Q demodulation and during R - Y and B - Y demodulation. The signal is sampled at times 1 and 3 in the I and Q demodulators and at times 2 and 4 in the R - Y and B - Y demodulators.

The output signal of V34 is a signal that represents the color-difference signal B - Y, and the output of V35 is a signal that represents the color-difference signal R - Y. These two output signals are both limited in bandwidth to .5 megacycles. The bandpass filter for the B - Y channel consists of L39 and R186. The bandpass filter for the R - Y channel consists of L41 and R185. The response curve for both channels is shown in Fig. 7-23. Since both channels have the same bandwidth, the response curve for each channel is the same.

The 3.58-megacycle signal is removed by traps from each output signal before these signals are coupled to the amplifiers. The 3.58-megacycle trap for the B - Y signal is composed of L40 and C175. The 3.58-megacycle trap for the R - Y signal is composed of L42 and C177. After the 3.58 signal has been trapped out, the B - Y output signal appears as waveform W10 which is shown in Fig. 7-24. The R - Y output signal appears as waveform W11 which is shown in Fig. 7-25.

The cathode circuit of the B - Y demodulator contains a B - Y gain control R27. The purpose of this control is to provide a variable means of controlling the gain of the B - Y demodulator. The gain of this stage can be set so that it is at the proper ratio with the gain of the R - Y demodulator. The B - Y gain control is bypassed with an electrolytic capacitor C16. In parallel with C16 is capacitor C174 which counteracts the internal inductance of C16.

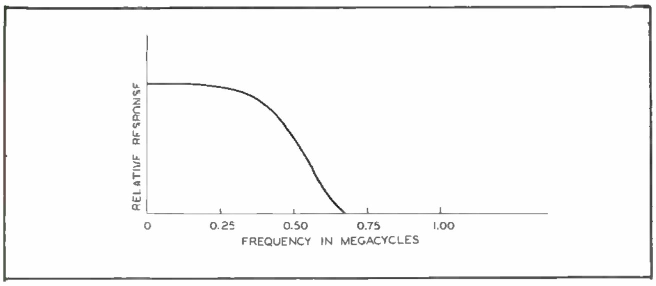


Fig. 7-23. Passband of the Circuit in Fig. 7-19.

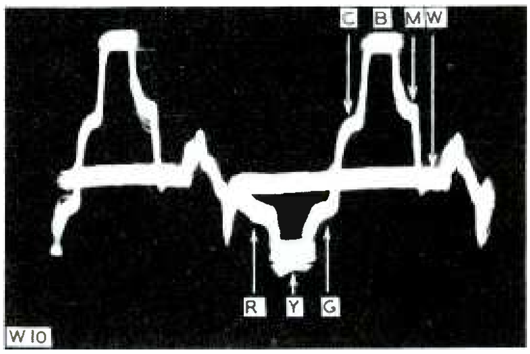


Fig. 7-24. Output Signal of the B-Y Channel in Fig. 7-19.

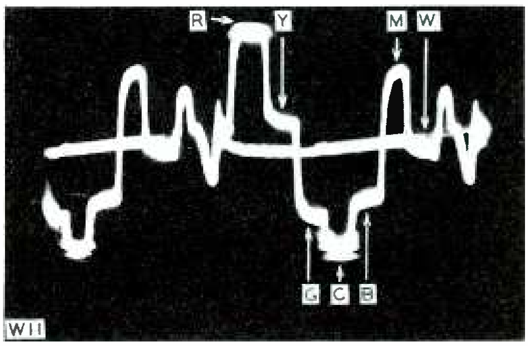


Fig. 7-25. Output Signal of the R-Y Channel in Fig. 7-19.

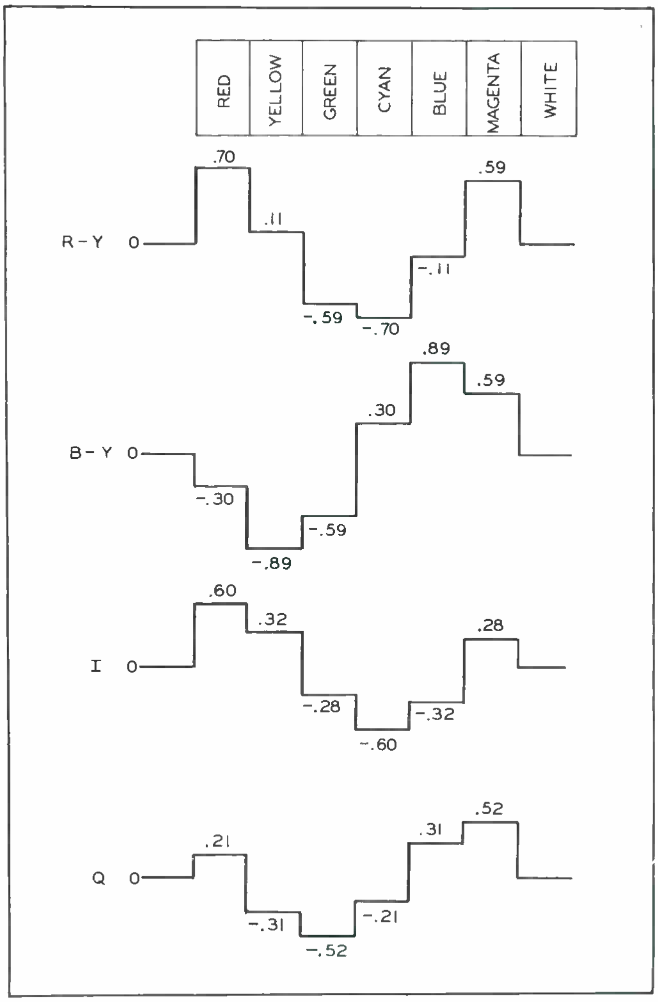


Fig. 7-26. Comparison of R-Y, B-Y, I, and Q Signals.

The output signal of each demodulator circuit in Fig. 7-19 is positive in polarity. A signal of positive polarity is needed because in the matrix section of this particular receiver, these signals are mixed with a positive luminance signal in order to recover signals representative of each of the primary colors red, green, and blue.

It has been stated before that the output signals produced by the R - Y and B - Y demodulators are different from the output signals of the I and Q demodulators. For a comparison of the differences, refer to Fig. 7-26 which illustrates the demodulated signals that will be produced when a color-bar pattern such as that indicated at the top of the figure is being scanned. Whenever the demodulators operate on the R - Y and B - Y axes, the output signals will take the form of the two top waveforms in Fig. 7-26. If the demodulators operate on the I and Q axes, the output signals will take the form of the last two waveforms in Fig. 7-26. All these signals are positive in polarity. If the output signals of the demodulators were negative, the waveforms of Fig. 7-26 would be reversed in polarity. This means that the values shown as being positive would then be negative, and those which are negative would then be positive. In the R - Y signal, for example, the polarities of the various color signals would be as follows: red, yellow, and magenta would be negative and green, cyan, and blue would be positive.

In the next issue, we will continue the discussion of demodulator circuits. Furthermore, the operational theory of the matrix section will be discussed and several commercially used matrix circuits will be covered.

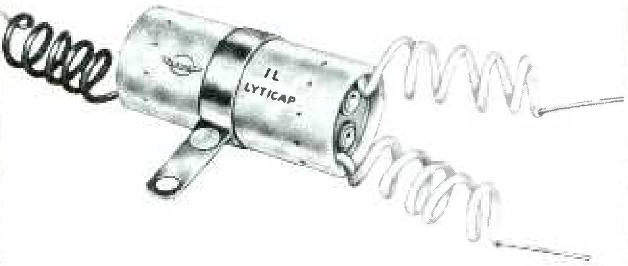
In order to give the reader an opportunity to test himself on the material in this issue, we are including a few questions that are answered in this discussion.

Questions

1. What is the basic principle of operation of a synchronous demodulator?
2. How is a demodulator circuit gated so that it samples the chrominance signal properly?
3. What is the difference between the chrominance signals that are representative of a primary color and its complement?
4. How does the CW reference signal that is applied to the I demodulator differ from that applied to the Q demodulator? How do the R - Y and B - Y reference signals differ from each other?
5. How do the CW reference signals that are applied to I and Q demodulators differ from those applied to R - Y and B - Y demodulators?
6. What would be the result if the CW reference signal that is being fed to a demodulator should be reversed 180 degrees in phase?
7. What are the bandpass characteristics of I and Q channels?
8. Which of the signals, I or Q, is purposely delayed? Why?

BY C. P. OLIPHANT

***and* VERNE M. RAY**



Notes on Test Equipment

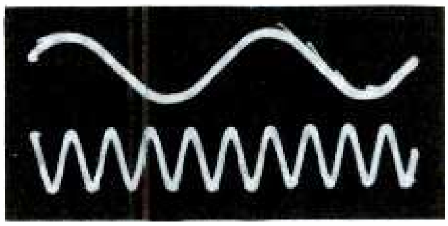
(Continued from page 17)

nal may appear on the scope with proper synchronization (as shown in Fig. 2). As the gains of the amplifiers are increased, the two input signals will appear superimposed on the upper and lower portions of the square wave. Proper selection of the switching frequency will cause both traces to appear as if they are continuous, one above the other. A control variously called BALANCE, AXIS SHIFT, POSITIONING, or the like provides for separation or merging of the two traces or base lines. This is illustrated in Figs. 3A and B. Thus, two waveforms may be displayed, one directly above the other; or they can be caused to merge into one trace for more exact comparison.

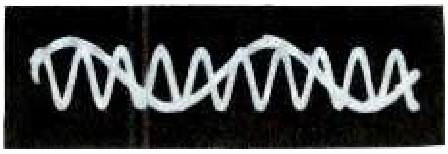
The coarse frequency adjustment for the switching rate operates to change the RC value in the grid or plate circuit of the multivibrator tube. This is usually accomplished by switching different values of capacitance into the circuit for each frequency step. The fine frequency adjustment is obtained by making the resistance in the RC circuit variable.

Applications

A few examples and waveforms are given to show some of the many applications for this type of instrument. First, let us consider its use in frequency comparisons. Let us assume that we have a signal of unknown frequency and a signal generator as a calibrated source of known frequencies. It is desired to find the frequency of the unknown signal. The unknown signal can be connected to one input of the electronic switch, and an oscilloscope can be connected to the output. The internal sweep of the scope should be set to a rate which will result in several cycles appearing on the screen. A portion of the unknown signal should be applied to the external-sync connection on the scope for proper synchronization. The comparison signal from the signal generator is then applied to the other input of the electronic switch. If the generator is adjusted to give a cycle-to-cycle correspondence of the two traces, the frequency of the unknown signal can be read directly from the dial of the signal generator. In cases in which the range of the signal generator does not permit a direct one-to-one comparison, the generator can be adjusted as nearly as possible for that condition. Then the ratio between the numbers of cycles for the two signals can be multiplied by the generator frequency to obtain the unknown frequency. For example, with a stationary pattern of 8 cycles for the unknown and 10 cycles for the generator frequency, the unknown frequency would be 8/10 of the frequency indicated on the generator dial.



(A) Axes Separated.



(B) Axes Merged.

Fig. 3. Effect of Axis Shift Control.

This method of frequency measurement has distinct advantages over the method using Lissajous figures. In the latter case, an 8-to-10 ratio would be quite difficult to interpret; in fact, unless the generator frequency were maintained at the exact setting required, the figures on the scope screen would be a meaningless, shifting blur. If the electronic-switch method is used and the frequency of the generator approaches a whole number ratio (such as 4 to 5, 7 to 9, or 8 to 10) with that of the unknown frequency, a definite number of cycles can be seen on the generator trace. If the ratio is not exactly a whole number, the waveform will appear to shift slowly with respect to the other trace. Even though it is slowly shifting, it can usually be slowed to the point where the cycles can be counted and the ratio established. This will give for the unknown frequency a value which is very close to the true value.

In the audio field, the electronic switch can be used to advantage in frequency determinations, phase comparisons, checking of tone-control and equalization circuits, and checking for proper phase inversion. Fig. 4 illustrates its use in checking the tone-control circuits of a preamplifier. One input was connected to a point ahead of the tone-control circuits, and the other input was connected to a point following the tone controls. Let us call the first input A and the second input B. The output from a sweep-frequency record was applied to the preamplifier, and the equalization controls were adjusted for a response as nearly flat as possible at input A. This appears as the lower trace in Fig. 4. When the tone controls were adjusted for treble boost and bass cut, the input to B resulted in the upper trace. With this direct comparison, the effects of the tone-control adjustment are instantly apparent.

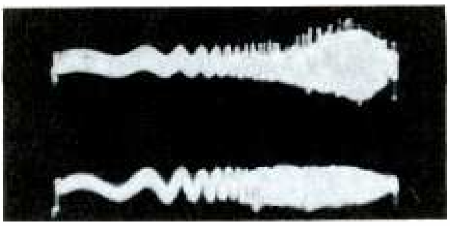


Fig. 4. Tone-Control Check of a Preamplifier. Lower Trace From a Point Ahead of Tone-Control Circuits. Upper Trace From a Point After the Tone-Control Circuits.

By connecting the switch inputs to each side of the equalization circuits, the effect of the latter on the input signal can be judged just as easily.

A comparison of the amounts of distortion that are present at two different points in a test amplifier is shown in Fig. 5. Some differences in distortion are so subtle that they would go unnoticed except by a direct comparison of this sort. In this case, however, the differences between the two waveforms are rather obvious. The phase difference between the two signals is approximately 180 degrees. The signal input to the amplifier was reduced to eliminate the visible distortion, and the tone controls were rotated through their range. As the tone controls were rotated, a slight shift of the two traces with respect to each other indicated a change in relative phase.

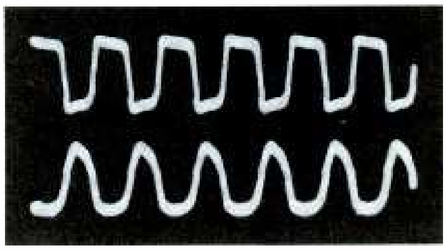


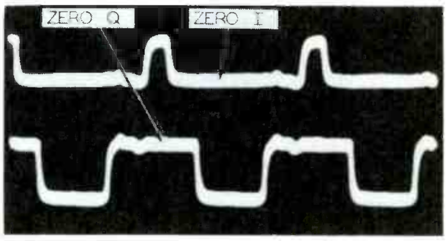
Fig. 5. Different Amounts of Distortion at Separate Points in an Overloaded Amplifier.

Color-Receiver Adjustments

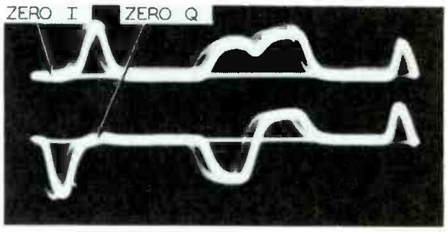
Several adjustments and checks of color TV receivers can be made more conveniently through the use of the electronic switch. One of these is the correct adjustment of the hue phase control together with the checking and adjustment of the quadrature transformer. Ordinarily, this requires that the oscilloscope be transferred back and forth between the I and Q channels (or the R - Y and B - Y channels, if the receiver is of that type). This situation is a "natural" for the electronic switch. By connecting input A to one channel and input B to the other, this type of manual switching is avoided and the total effect of each adjustment can be seen at once. The responses obtained during such an adjustment are shown in Figs. 6A, B, and C. The receiver used was of the I and Q type. Input A which gives the upper trace was connected to the Q channel; whereas, input B which gives the lower trace was connected to the I channel. The I and Q signals of a color-bar generator were applied to the first video amplifier grid, and the waveform in Fig. 6A was observed. For correct adjustment of the hue phase control and of the quadrature transformer, the result would be a signal showing no Q component in the I channel and no I component in the Q channel. This condition is shown in Fig. 6A; whereas, a misadjustment of the hue phase control results in the response of Fig. 7A which shows that both the I and Q signals are present in both channels. The recommended procedure for this receiver was to set the hue phase control for a zero Q-signal response in the I channel and then check for I response in the Q channel. When this was done, a slight trace of I signal remained, indicating that the quadrature transformer was in need of adjustment. A slight adjustment of the quadrature slug removed the trace of I signal from the Q channel.

Another make of color-bar generator provides an I and a Q signal and an R - Y and a B - Y signal at the same setting of its controls. The principle of application and adjustment using this signal is the same as before. The response using this generator appears in Figs. 6B and 7B. Since both types of signals are provided at one setting, the operator has only to observe the part of the signal corresponding to the type of receiver being adjusted and should disregard the other portion when making any adjustments.

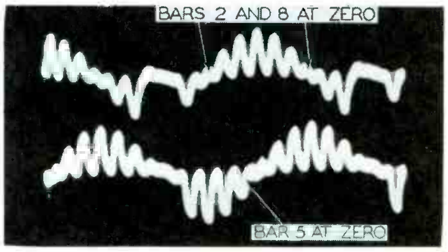
The use of a third type of color-bar generator resulted in the waveforms which appear in Figs. 6C and 7C. This generator provides a pattern of ten color bars, each having



(A) Using Hickok 655XC Color Bar Generator.

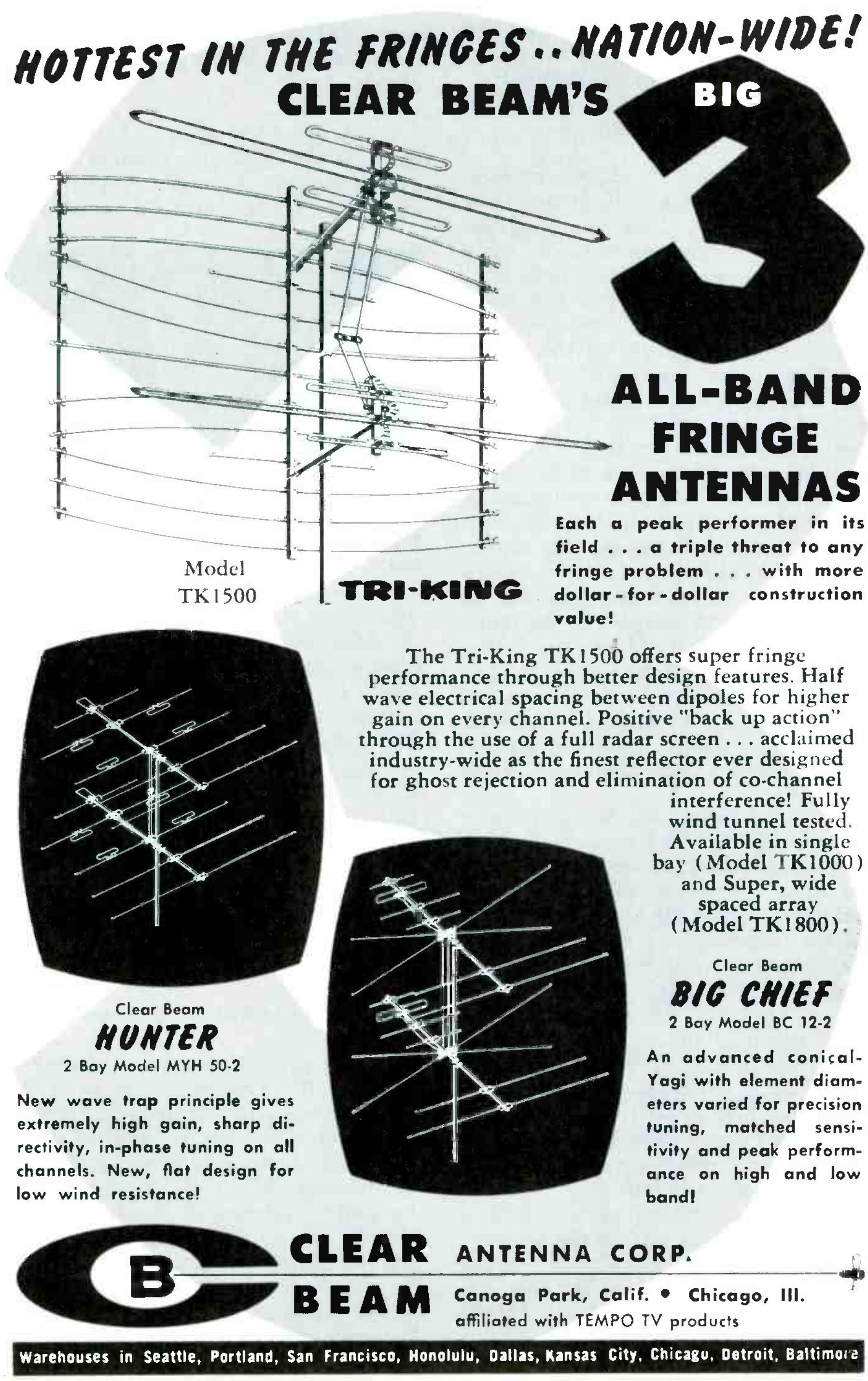


(B) Using Jackson Model 712 Color Bar/Dot Generator.



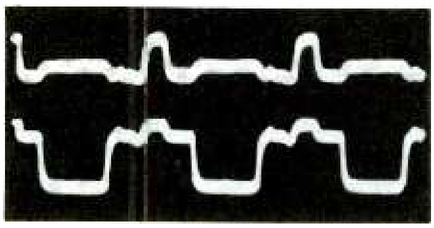
(C) Using RCA Model WR61A Color Bar Generator.

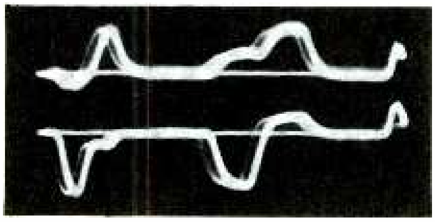
Fig. 6. Response Indicating Correct Adjustment of the Hue Phase Control and the Quadrature Transformer in an I and Q Color Receiver.



an average phase difference of 30 degrees from the adjacent bar. The colors run from yellow-orange through various shades of red, magenta, and blue to green. With this type of signal, correct adjustment of the hue phase control is indicated when the fifth color-bar signal is on the axis as illustrated in the lower trace of Fig. 6C. At the same time, since the Q channel demodulates at 90 degrees with respect to the I channel, the third bar on either side of bar No. 5 (three 30-degree bars equal 90 degrees) should appear on the axis in the Q channel as shown in the upper trace. This indicates proper adjustment of the quadrature transformer. Misadjustment of the hue phase control is indicated in Fig. 7C.

Checks and adjustments of the matrixing section can be performed in a manner somewhat similar to the foregoing examples. The red gun should not contribute toward the production of green, blue, and cyan bars; the green gun should not contribute toward the red, blue, and magenta bars; and the blue gun should not contribute toward the red, green, and yellow bars. With a color-bar generator connected to supply the proper color signals, matrixing adjustments are made for the most desirable response at each color gun. These adjustments usually take the form of a compromise — that is, they are somewhat interactive; and reduction of one color response results in the reduction or increase of another. Because of this action, it is an advantage to be able to view the signals at two guns simultaneously in order that the best compromise can be achieved. Indeed, it would be even more helpful to view all three gun signals at once, and this can be accomplished by using two electronic switches of proper design.


(A) Using Hickok 655XC Color Bar Generator.


(B) Using Jackson Model 712 Color Bar/Dot Generator.

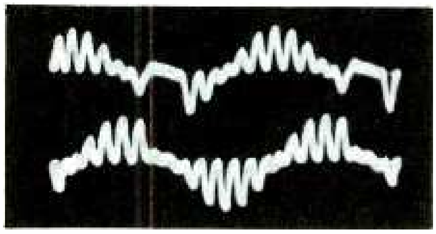

(C) Using RCA Model WR61A Color Bar Generator.

Fig. 7. Response Indicating Incorrect Adjustment of the Hue Phase Control in an I and Q Color Receiver.

The Electronic Switch As a Square-Wave Source.

It should be mentioned that in addition to its intended function as an electronic switch, the instrument can also be used as a source of square-wave signals having good quality and a frequency range equal to that of the switching function. The amplitude of

this square-wave signal can be adjusted by means of the control which shifts the axes.

There are a few points to remember when operating the electronic switch:

1. Usually it is best to synchronize the oscilloscope sweep to one of the input signals rather than to the switching rate.

2. Under the condition described in the first item, the switching rate should not be too close to the signal frequency. This is avoid a pulling tendency.

3. The switching rate should neither be too low nor too high for the frequency response of the oscilloscope used because distortion of the square wave will result.

4. Some electronic switches have no blocking capacitor in the output circuit; and in this case, one should be used for connecting to the oscilloscope, provided that a blocking capacitor is not already included in the input circuit of the scope. There is also a slight shock hazard to be kept in mind when using electronic switches of this design.

5. If a blocking capacitor is used, it should be of large enough value to pass the lowest switching rate without distortion.

JACKSON MODEL 712 COLOR BAR/DOT GENERATOR

The Jackson Model 712 Color Bar/Dot Generator (Fig. 8) is designed to provide a variety of signals suitable for testing, adjusting, and servicing color TV receivers. Linearity adjustments of monochrome TV receivers also may be performed.

Fig. 8. Jackson Model 712 Color Bar/Dot Generator.

Video and modulated RF signals are provided, each at separate output jacks; and the RF signal is tunable through channels 3, 4, and 5. In addition to having calibration points for channels 3, 4, and 5, the front-panel tuning dial is marked with a reference scale so that the pointer may be reset to any position. A function switch permits selection of CROSS HATCH, DOT, or COLOR BAR patterns. The COLOR BAR SELECTOR switch allows a choice of five different color-bar patterns; MULTI, COLOR DIFF, RED, GREEN, and BLUE. A three-position switch may be set at STAND BY, SOUND ON, or SOUND OFF positions. The last two positions either apply or remove a sound carrier from the RF signal. Color-subcarrier and sound-carrier frequencies are crystal controlled. A sync signal for oscilloscope synchronization may be obtained from the SYNC OUTPUT jack. The VIDEO POLARITY switch provides for choice of either a positive or a negative video signal. The video output level may be varied by means of the VIDEO GAIN control. A signal at the color-subcarrier frequency can be obtained from a pin jack on the rear of the chassis.

The color signals provided are: (1) MULTI — white, yellow, cyan, green, magenta, red, blue, and black.

These colors are for 100 per cent saturation. (2) COLOR DIFF — I, Q, R, R - Y, and B - Y. (3) RED. (4) GREEN. (5) BLUE. The red, green, and blue signals have a luminance value of 0.3 and a chrominance value of 0.5.

Oscilloscope waveforms of the three types of color signals (the MULTI, the COLOR DIFF, and the single color bar) are shown in Figs. 9A, B, and C.

The impedance of the video output is 90 ohms; and that of the RF output is 300 ohms, balanced to ground.

Signal output levels are:

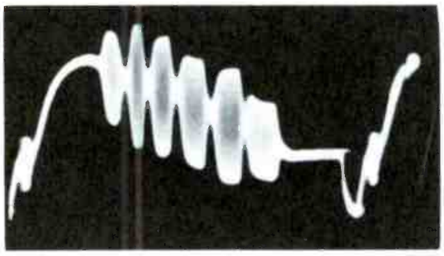
1. Composite video -- adjustable to 2 volts across 90 ohms.

2. Modulated RF — 0.1 volt across 300 ohms.

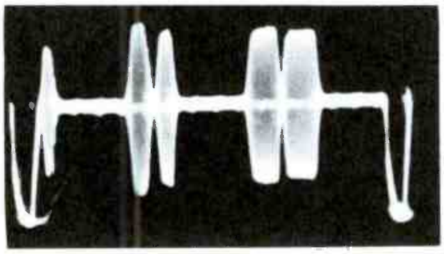
3. Horizontal sync — 1 volt across 200 ohms.

4. Color subcarrier — 4 volts across 200 ohms at burst phase.

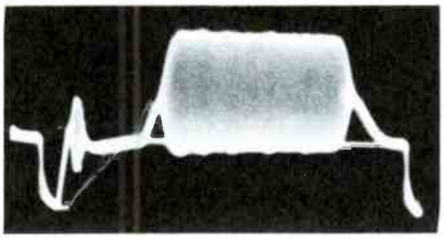
The dot pattern is comprised of 9 horizontal rows of 12 dots each, and the crosshatch pattern is made up of 9 horizontal lines by 12 vertical lines.



(A) Multi-Bar Pattern.



(B) Color-Difference Pattern.



(C) Single-Bar Pattern.

Fig. 9. Color-Bar Signals From the Jackson Model 712 Color Bar/Dot Generator.

Tube complement:

12AT7 — 7

12AX7 — 4

6J6 — 9

5U4G — 1

The appearance of the instrument matches other instruments in the Jackson line. Physical dimensions are 16 3/4 inches long, 10 inches high, and 11 inches deep.

SECO VT GRID CIRCUIT TESTER MODEL GCT-1

The Seco VT Grid Circuit Tester (Fig. 10) is designed to supplement existing conventional types of tube checkers in locating hard-to-find tube troubles such as grid emission and high-resistance shorts between grid and cathode or between heater and cathode. These troubles occurring in the AGC chain of tubes may be troublesome to locate, and considerable time may be consumed if a replace-and-wait procedure is followed.

According to the manufacturer, the aforementioned tube troubles often cause many of the following symptoms: bending in the picture; pulling of the picture; tearing of the picture; buzz in the sound; excessive gain or snow in good signal areas; poor picture quality due to lack of gray tone; presence of certain types of small ghosts; and other malfunctions of AGC, video, and audio circuits.

The manufacturer states that the following tube conditions will be indicated by the opening of the electric eye to the width of the black bar; an opening further than this would indicate a faulty tube.

1. Grid-emission current of .15 microamperes.

2. Grid-to-cathode short of 300 megohms.

Fig. 10. Seco VT Grid Circuit Tester Model GCT-1.

3. Cathode-to-heater short of 15K ohms.

A 7-pin miniature socket is provided for testing pentodes, two 9-pin miniature sockets are for testing the 6- and 12-volt duo-triodes commonly encountered, and a spare may be wired to test other types. The instruction manual lists the following types that can be tested:

12-Volt Duo-Triodes			
12AT7	12AV7	12AY7	12BH7
12AU7	12AX7	12AZ7	
6-Volt Duo-Triodes			
6BK7	6BQ7	6BZ7	
6-Volt Pentodes			
6AG5	6AR5	6BC5	6CB6
6AH6	6AS6	6BD6	6CF6
6AK5	6AU6	6BH6	
6AK6	6BA6	6BJ6	

In the illustration shown in Fig. 10, an octal socket was wired into the spare position in order to check a suspected 6BL7GT for grid emission. This tube had been removed from a receiver having unstable vertical hold. The tube was indicated as bad in the tester, and a replacement cured the trouble. Preheating of tubes in the set is recommended before placing them in the tester.

Operation of the tester is simple. After a brief warm-up period, the electric eye shows green and the zero setting is adjusted until the eye just closes. The tube to be tested is then placed in the proper socket, and the indication of the eye is noted. Some indications will be immediate, whether the tube is warm or cold; others will require a warm-up time or a preheating period, as was just mentioned.

In addition to the Model GCT-1, the manufacturer also supplies a Model GCT-3 which is similar in operation but which is designed for portability.

SIMPSON HIGH-VOLTAGE PROBE

A new high-voltage probe has been announced by the Simpson Electric Co., Chicago.

The new 50,000-volt high-voltage probe is in addition to the recently announced 40,000-volt probe for the Simpson Model 260 VOM and is designed for use with the same instrument.

The new probe may be ordered from electronic parts distributors and is priced at $12.50.

PAUL C. SMITH

Vectors

(Continued from page 11)

represent the forces exerted by the two tractors. Remember that vector AB can assume the position which it has, because a vector specifies magnitude and direction only — not point of action. Triangle OAB is a right triangle; therefore, by trigonometry:

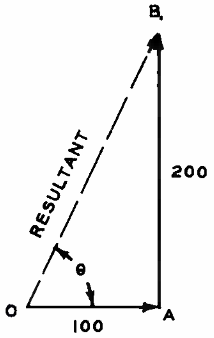


Fig. 3. A Second Method of Adding the Vectors of Forces in Fig. 2C.

$$\tan\ \theta\ =\ \frac{200}{100}.$$

From a table of trigonometric functions.

$$\theta\ =\ 63.45^{\circ}$$

To find the length of the resultant vector OB, use the expression:

$$\sin\ 63.45^{\circ}\ =\ \frac{200}{\text{vector OB}}$$

Solving, we find:

$$\text{vector OB}\ =\ \frac{200}{\sin 63.45^{\circ}}\ =\ \frac{200}{.894}$$
$$=224.$$

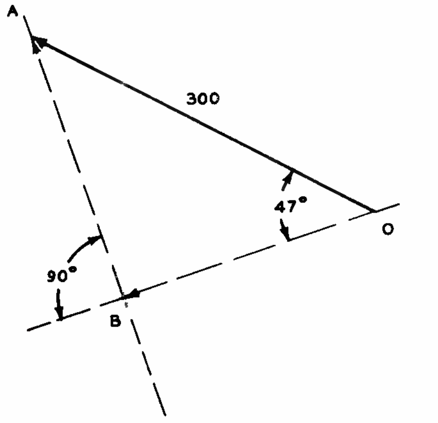


Fig. 4. The Rectangular Components of a Vector.

If desired, the reverse of the foregoing operation can be performed. In other words, a vector may be broken into two or more component vectors which, when added together, produce the original vector. In Fig. 4, the vector OA is given with a length of 300 units. Let us break this vector into rectangular components along the axes specified in the drawing. Triangle OBA is a right triangle; therefore,

$$\sin\ 47^{\circ}\ =\ \frac{\text{vector BA}}{300}.$$

Solving, we find:

$$\text{vector BA} = 300\ \sin 47^{\circ} = 300 \times .731$$
$$= 219.3.$$

Furthermore, by using the relation:

$$\cos\ 47^{\circ}\ =\ \frac{\text{vector OB}}{300},$$

we can find the other rectangular component:

$$\text{vector OB} = 300\ \cos 47^{\circ} = 300 \times .682$$
$$= 204.6.$$

In a similar manner, any number of pairs of rectangular components can be found for the vector OA in Fig. 4, depending upon the axes selected. Axes that are horizontal and vertical are very commonly used.

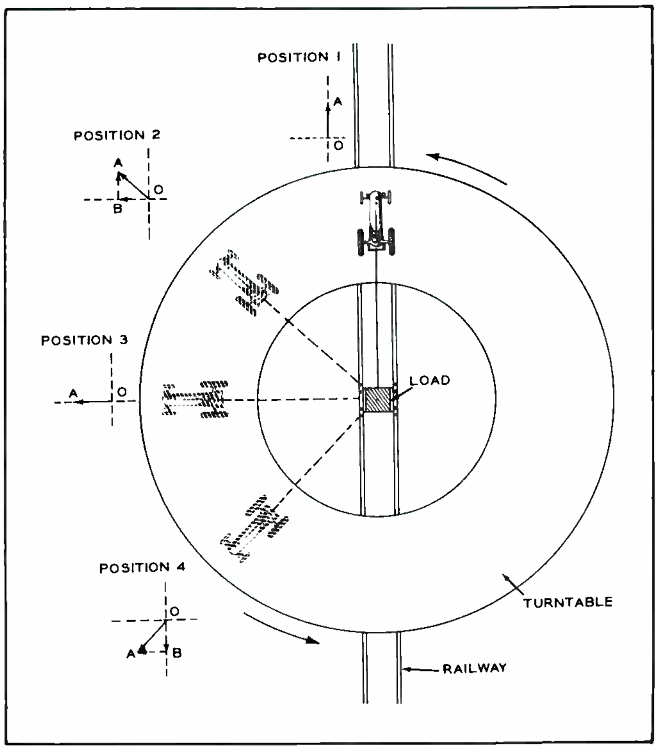
Rotating Vectors

Up to this point, we have been discussing vectors which have remained static or unchanged with the passage of time. As a matter of fact, however, the vectors which depict many electrical quantities are dynamic; that is, they vary regularly with time. One such vector is the rotating vector which constantly changes its direction by revolving about its point of origin. AC voltage is an example of a quantity that is best described by a rotating vector.

As a start toward understanding the rotating vector, an enlargement of the tractor-and-load analogy may be helpful. In Fig. 5, the tractor is shown on a large turntable which revolves counterclockwise. The load is on wheels which rest on a straight pair of tracks. The magnitude of the pulling force exerted by the tractor is assumed to be fixed, and the turntable rotates at a constant speed. In order to avoid certain problems which are incidental to this analogy, the load must be considered immovable in any direction despite the facts that it rests on a railway and that it has a force exerted upon it. The immobility of the load can be tolerated, since we are primarily interested in that component force which tries at least to move the load along the railway.

When the tractor is in position 1, the total force exerted on the load is in the direction of the railway. This is indicated by vector OA in the vector diagram for position 1. When the tractor is in position 2, the vector diagram for that position shows that the force which is in line with the railway is the rectangular component BA. In position 3, the total force is exerted at right angles to the railway; therefore, there is no component in the direction of the railway. The last position that is shown on the drawing is position 4. The vector diagram for this position indicates that the rectangular component OB lies in the direction of the railway.

Fig. 5. Tractor and Load Arranged to Illustrate a Rotating Vector.



Let us replace the railway with an electrical conductor and substitute an AC voltage in place of the pulling tractor. In Fig. 6, the AC voltage is represented by the vector OA which rotates about point O as a center and which has a speed of rotation that corresponds to the frequency of the alternating voltage. For example, if the frequency is one megacycle, the vector rotates at a speed of one million revolutions per second. As vector OA rotates, the force that is effective in trying to produce current flow in the conductor is represented by the rectangular component BA which lies in the direction of the conductor. This component changes in magnitude and reverses direction as vector OA rotates. If the variation in component vector BA is plotted graphically with respect to time, the sine wave on the right side of Fig. 6 is formed. The latter, of course, can be recognized as a very conventional way of illustrating an AC voltage. Once every revolution or cycle, the vector OA assumes the position that is shown for it in the vector diagram. At this instant in every cycle, the voltage in the conductor has a magnitude equal to the length of component vector BA and is conventionally assigned a positive polarity. It may be noted that whenever the AC voltage vector OA assumes a position in line with the conductor, a peak of voltage occurs in the conductor. On the other hand, whenever the AC voltage vector OA lies perpendicular to the conductor, there is zero voltage in the conductor.

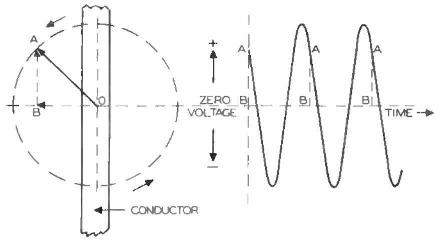


Fig. 6. AC Voltage Represented by a Rotating Vector.

Suppose that there are both AC and DC voltages in the conductor.

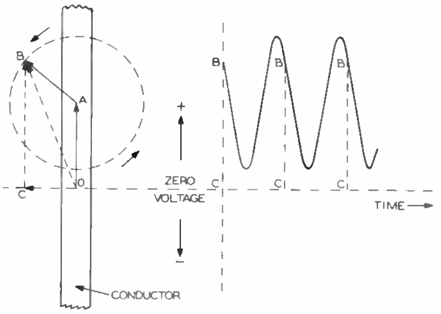


Fig. 7. DC and AC Voltages Represented by Fixed and Rotating Vectors Respectively.

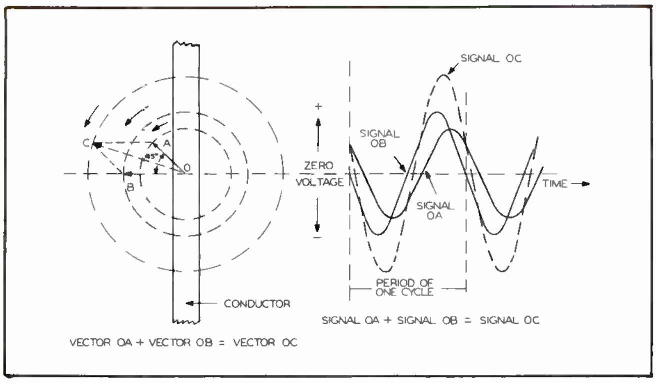


Fig. 8. Two AC Voltages As Rotating Vectors.

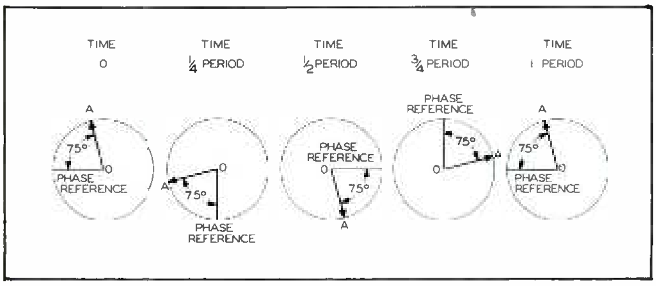


Fig. 9. Vector and Phase Reference at Five Times During Rotation.

Fig. 7 shows the vector and sine-wave representations under this condition. The vector OA denotes the DC voltage; this vector does not rotate since its direction does not vary with time. The vector AB depicts the AC voltage and rotates about point A. Vector OB is the result of adding vectors OA and AB, and the rectangular components of vector OB are given as vectors OC and CB. Of primary interest, as far as the voltage in the conductor is concerned, is the rectangular component CB. If plotted against time, component vector CB produces the sine wave at the right in Fig. 7. The point of minimum positive voltage in each cycle is reached when the rotating vector AB directly opposes the DC voltage vector OA. The point of maximum positive voltage in each cycle is reached when the rotating vector AB is in line with and aids the DC-voltage vector OA.

Under certain conditions, there may be two AC voltages present in a conductor. This situation is illustrated in Fig. 8. Vectors OA and OB represent the two AC voltages which, in this case, have the same frequency although they are separated in phase.

Phase

The matter of phase should be discussed before going further in this study. Phase becomes important in the case of rotating vectors only; fixed vectors such as those used to denote DC voltages have no phase. Strictly speaking, phase is the position of a rotating vector during its period of rotation and is expressed in relation to the starting position or to some assumed standard position. It has become customary, however, to use the term phase to mean the phase difference between two vectors which are both rotating. In Fig. 9, two vectors are shown at five different times during one period of rotation. Both vectors are moving at the same

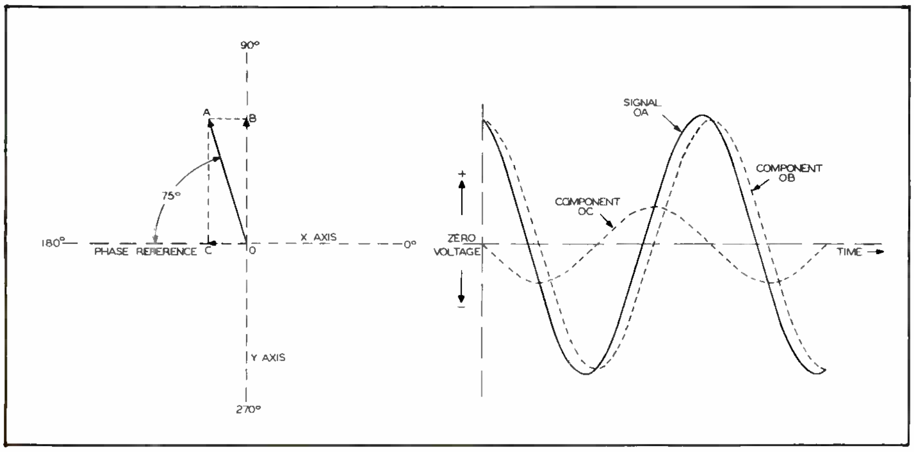


Fig. 10. Rotating Vector and Its Rectangular Components Along Axes X and Y.

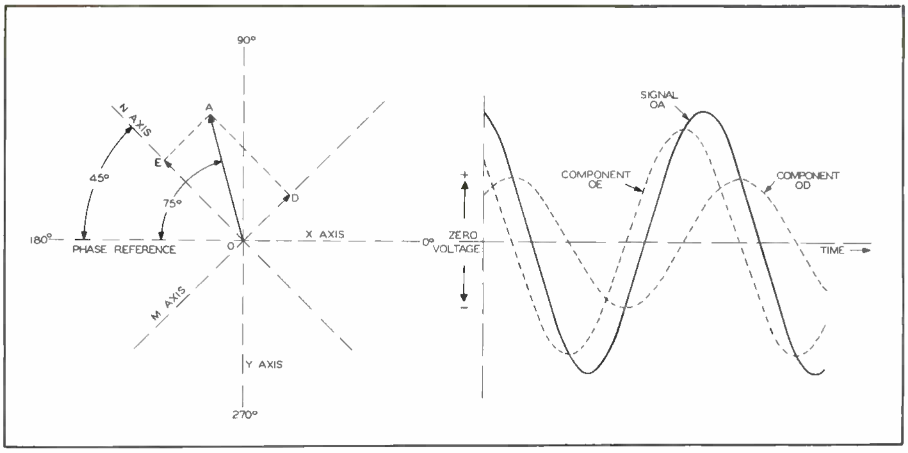


Fig. 11. Rotating Vector and Its Rectangular Components Along Axes M and N.

speed. The one labled phase reference may or may not have a specific magnitude (note the absence of an arrowhead) because its most important property is that of direction. It is used so that the phase of other vectors in a diagram can be stated with respect to it. In Fig. 9, for example, the vector OA can be said to have a lagging phase of 75 degrees. Note that this angle is preserved throughout rotation. In nearly all vector diagrams, the rotating vectors are pictured at an instant when the phase reference assumes a horizontal position. Thus, the usual vector diagram shows rotating vectors in positions corresponding to those at zero time and at half-period time in Fig. 9. No matter which position may be pictured, the diagram still shows that vector OA lags the phase reference by 75 degrees.

Refer again to Fig. 8. If vector OB is considered as the phase reference in this vector diagram, then vector OA can be said to have a lagging phase of 45 degrees. Vector OB, of course, is at zero phase. Vector OC is the resultant of adding vectors OA and OB. All three rotate at the same speed since they represent signals having the same frequency. The signals differ in magnitude and in phase.

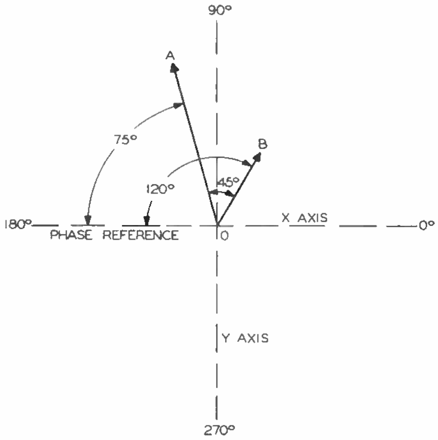


Fig. 12. Vector Diagram Which Describes Signal Conditions in a Circuit at Different Times.

A rotating vector can be broken into rectangular components both of which will rotate at the same speed as the original vector. Fig. 10 shows the vector OA together with its components OC and OB which lie along the X and Y axes respectively. The signal that vector OA represents and its two component signals are shown as sine waves at the right side of the illustration.

Fig. 11 shows how the same vector OA can be separated into rectangular components which lie along a different set of axes. The M and N axes have their positions specified by the 45-degree angle between the N axis and the phase reference. Vectors OD and OE are rectangular components of vector OA and lie on these axes. A sine-wave illustration of the vectors is included in the figure.

Sometimes one vector diagram is used to show the nature of two or more signals that appear singly at different times in a circuit. The color-phase diagram in Fig. 1 is this type of diagram. A simpler example is given in Fig. 12 which shows the nature of two signals represented by vectors OA and OB. The mere fact that both signals appear on the same vector diagram means that they have the same frequency. Their magnitudes are disclosed by their lengths, and their phases are given by the angles shown.

Your attention is directed to the Photofact COLORBLOCK Reference Chart No. 4 appearing on the insert at the back of this issue. It is devoted to a breakdown of the color-phase diagram with explanations of the various signals which are specified in the diagram.

GLEN E. SLUTZ

Dollar & Sense Servicing

(Continued from page 29)

$1,500 SITTER. Electronic baby sitters employing the Dage industrial TV system have been repriced at $1,500 by Thompson Products. This includes a camera on an adjustable pedestal for setting alongside the crib and aiming at baby, plus a monitor receiver and connecting cable. The camera alone is $845. Though this application has been featured in national advertising by the firm recently, the ad also shows a much more logical and economical use for catching shoplifters in retail stores.

A dozen of these $1,500 private eye systems in a department store could well pay for themselves the first year. One keen-eyed store detective could watch all twelve monitor screens, since he'd need to concentrate only on those showing suspicious action. This would save salaries of detectives on the floor and cut losses from theft because more shoplifters would be detected. Shoplifters learn to spot floorwalkers and stay away from them, but they would seldom know when they were being observed through a concealed camera. Here is a terrific and as yet largely untapped potential of sales and service business for Industrial TV.

* * *

SLUMBER: The newest RCA clock radio allows the user to doze off to soft slumber music from one station and then be roused out of bed by the loud let's-get-up music of a different station next morning. The timer of the clock also gives a different preset volume for the morning station.

* * *

FIGHT. Despite two postponements and an 11-p.m. starting bell, the Marciano-Charles heavyweight title bout grossed more from theater TV ($500,000) than from the turnstiles at Yankee Stadium ($350,000). Furthermore, those in theaters got a far better view of the fight than did most at the stadium because of the favored positions of the TV cameras and the ability to switch among cameras at will for the best view of the action.

In the early days of TV, news photographers facing the TV camera overloaded the camera tube each time they set off a flash and thereby ruined the picture for a few seconds, oftentimes causing permanent damage to the camera tube. Today, however, you see the photographers snapping away at ringside without even causing a flicker on the screen, yet they're still using flash. Here's how the problem was solved.

Before the fight, each photographer takes his electronic flash guns, usually three or more, to the fight ring where they are mounted above the ring at the positions he designates. At fight time, the photographer goes to his assigned position at ringside with his camera and the electronic power supply and hooks them up to his cord that was run down from the overhead guns. The flashes go off each time he triggers his camera, but TV viewers don't see them because none are aimed directly into a TV camera. The increased illumination on the boxers is not noticed because this lasts for only a few microseconds and hardly affects more than just one scanning dot of the picture.

* * *

ECHOES. Multiple-speaker installations in large areas such as stadiums often run into problems because of the slowness at which sound travels. As a solution to this, Kay Electric Co., Pine Brook, N. J., offers its Echo-Vox, a variable AF time-delay unit that can be connected into the line of the speaker farthest away. It is adjusted to delay the electrical AF signal by a time equal to that for sound from the nearest speaker to travel through air to the farthest speaker.

For broadcast studios or for those making recordings, the unit can be used in the opposite way to introduce desired echo effects for special purposes.

* * *

SERVICING. Volume of servicing business amounted to $1.4 billion in 1953 and will grow steadily to around $2.7 billion by 1957, predicted RCA president Frank Folsom. Contrast this to the estimate of only $145,000,000 for 1946 when TV was just getting started.

COLOR SERVICING. Color sets will require twice as many service calls as black-and-white TV, and each call will take twice as long, predicts Motorola service chief Russ Hansen. He estimates 10 calls for the first year of color, as compared to 4.56 calls for monochrome. Each service technician will complete an average of only 4 color calls a day, as against 8 for black-and-white sets.

* * *

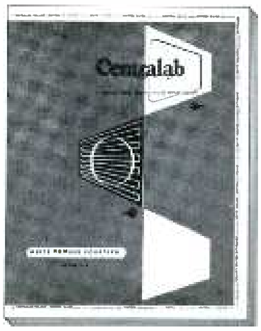
RADAR. For testing radar equipment in factories without having a flight of planes come over the plant and for keeping watchers alert at radar screens of early-warning stations on land and on floating islands at sea, the Reflectone Corp., in Stamford, Conn., makes some "cute" radar signal generators. One of these will fool the smartest looker by being set to generate a signal imitating a pip coming in at range limit and moving across the screen at any predetermined course and speed. Any number of these generators can be fed into one radar, to simulate a whole flight of planes coming over.

There's nothing duller than watching a blank radar screen hour after hour. Recognizing this, the military is installing the generators at each station in order to give the boys something to look at and report accurately; if they miss a fake signal, there'll be a lot of explaining to do.

Another use is that of simulating a dozen or so planes coming in for attack at different speeds and altitudes. This is done to give experience in selecting the most dangerous target for shooting down first.

* * *

TOONWISSELS. The front cover of the September 1954 issue of Radio Electronica plugs an article on high-fidelity "Toonwissels," but what they are we can't find out. Intriguingly in Dutch, the article praises them as the "laatste woord . . . speakercombinatie" and ends up with "dank aan de trouwe lezers" as if they'll "make all our troubles over." Anyway, from the titles and diagrams it looks as if service technicians, radio amateurs, and audio enthusiasts in Holland are getting a very fine monthly magazine. What's a toonwissel?



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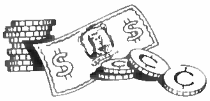
WHISTLING. Just as the old-time milkman whistled to keep his horse moving down the street as he cut across lawns, so now can the modern food-handling expert in a supermarket warehouse whistle to his tractor to make it move on to the next row of shelves. It's done by audio tones selected by pushing buttons on a tiny transmitter hanging from his belt.

The entire rubber-tired tractor-train serves as the antenna for the receiver that translates these whistles into start, right-turn, and left-turn commands. When no button is pressed, the tractor comes to a smooth halt. The manufacturer of these radio-controlled tractors is Barrett-Cravens, Northbrook, Ill. They operate under FCC low-power rules and hence require no license. Cost of the radio gear for a tractor is around $1,400.



POOL ALARM. For those who like out-of-the-ordinary work once in a while and appreciate the beauties around swimming pools, there are dollars to be made. Look into a new swimming-pool alarm that goes off when someone falls in accidentally. A sensitive float and an electric-control box at poolside react to any unusual motion of the water, setting off the alarm. It keeps ringing until help comes, but it can be disconnected temporarily during normal use of the pool. The manufacturer is Modern Design Engineers, Los Angeles, Calif., and the price of a system is $125.

Our first thought was that you need only a bathroom-tiolet float, a Micro Switch, and a locking relay; but reconsideration points to some tricky design problems that would have to be "licked" so there'd be no false alarms from wind-blown waves.

BIG FOUR. Only four types of tubes are today selling more than a million a month each. Best seller is the 6CB6. Next in order are the 6SN7GT-GTA, 6AU6, and 12AU7, respectively. Factory sales of all types of receiving tubes are averaging about 40 million tubes per month this year.

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Bias for Magnetic Recording

(Continued from page 19)

level to which the tape is magnetized is increased. The least amount of noise is generated when the tape is in a completely demagnetized state. So, a biasing method which keeps the tape in a magnetized condition produces noisy recordings.

Various systems using DC bias were developed in an effort to reduce noise and distortion produced during the process of recording, but none were entirely satisfactory. One such system using DC erase in conjunction with DC bias had the effect of demagnetizing the tape almost completely when no audio signal was present. The poor signal-to-noise ratio, the amount of distortion produced, and the limits of modulation in the various DC-bias systems caused them to be discontinued in favor of an AC-bias system.

AC Bias

In the AC-biasing method, a high-frequency current together with the audio signal being recorded is fed to the recording head during the recording process. Very low levels of distortion and high signal-to-noise ratios can be maintained with this method when certain conditions are fulfilled, although there is continued controversy concerning the manner in which these conditions accomplish the desired results.

Probably one of the simplest explanations of recording with AC bias is illustrated in Fig. 3. In this illustration, the AC bias and audio signal are shown in relation to the magnetization curve. The application of the correct amount of high-frequency bias allows the audio signal to operate on the linear portion of the curve. Although this is a very simplified explanation, it does show how distortion can be avoided.

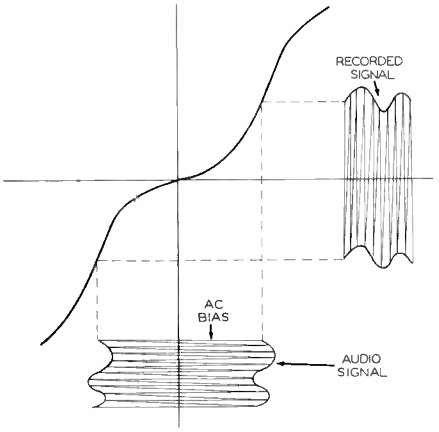

Fig. 3. Graph Showing Absence of Distortion When Recording With AC Bias Under Optimum Conditions.

This method of biasing is also called "supersonic" because the frequency used can be any one within the approximate range of 25 to 150 kc which is beyond the audible range. The frequency selected depends upon the requirements of the recorder. Some of the less expensive home types use a frequency near 25 or 30 kc; whereas, most professional types of machines use bias frequencies ranging from 60 to 150 kc. As a general rule, a bias frequency at least five times higher than the highest audio frequency to be recorded is selected so that there will be no intermodulation effects produced by the higher audio-frequency harmonics interacting with the bias. The exact bias frequency is not critical, but it must be kept within a suitable range.

In addition to reducing distortion, AC bias is instrumental in providing an increased signal-to-noise ratio. The noise reduction is brought about by the demagnetizing effect of the bias current flowing through the recording head as the tape moves over the face of the head. The demagnetizing action is effective because of the previously mentioned characteristic of tape to produce less noise as the level of magnetization in the tape is decreased.

The tape is demagnetized as it leaves the magnetic field of the recording head which is energized by the bias current. If no audio signal is present, the tape will be nearly completely demagnetized. This action is similar to the familiar method used to demagnetize a magnetized object by passing it through an alternating magnetic field.

It is important that the waveform of the bias be pure and symmetrical; for if it is not, a DC component will be formed which will cause noise and distortion to be recorded on the tape. The bias is of such high supersonic frequency (above audibility) that it does not register on the tape unless the waveform is distorted.

In actual practice, the bias current is many times greater than the maximum audio-signal current. This last statement makes the term bias appear to be incorrect when it is thought of in terms of vacuum-tube applications. The correct amount of bias in recording must be used because its level has a great effect upon distortion, noise, signal output, and frequency response.

Low values of bias tend to increase distortion and reduce signal output. The bias level is usually adjusted to the point where a maximum audio signal is recorded. If the bias is increased above this level, distortion and signal output will decrease until the point of magnetic saturation of the tape will be reached. Overloading occurs at the saturation point, and an excessive amount of distortion is produced.

The amount of bias required for best recording depends upon the characteristics of both the recorder and the tape. On the less expensive home types of machines, the bias level is usually fixed. This does not permit adjustment of the bias level to compensate for variations in the recording characteristics of different tapes.

Professional tape recorders are equipped with bias-level adjustments, and there are provisions for making quick checks or for monitoring the amount of bias used at any time. The correct bias-adjustment procedure is given in the operating instructions included with most professional recorders. Usually, an audio signal of some specified frequency is fed into the input of the recorder, and the bias-level adjustment is set for maximum audio-signal output.

Various types of oscillator circuits are used to generate the necessary amount of high-frequency current for supersonic bias. No matter which circuit or method is used, it must produce a symmetrical signal of pure waveform in order to keep noise and distortion down to minimum levels.

Bias in the Ampex Model 600

The schematic in Fig. 4 of the recording output stage and of the bias-and-erase oscillator section of the Ampex Model 600 tape recorder illustrates how the AC-bias problem is handled in this high quality unit. The audio signal is fed from the plate of the recording amplifier tube V1 through capacitor C3 directly to the recording head. The 12AU7 tube V2 functions with C7, C8, C9, R6, R7, R8, and T1 as a push-pull oscillator operating at a frequency of approximately 100 kc. The high-frequency current output from the oscillator is connected from the secondary of the bias-and-erase transformer T1 through capacitor C6 directly to the erase head. A portion of the output (to be used as recording bias) is fed from C6 through the bias-adjustment capacitor C5 to the recording head.

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The bias-level adjustment is made by feeding the output of an audio oscillator functioning at 500 cps to the line input of the recorder and by operating the machine in the recording mode. While the recorder is recording on tape, the bias-adjustment trimmer is adjusted to the position giving the maximum reading on a VTVM connected across the output of the recorder.

The oscillator is adjusted by means of the noise-balance potentiometer R8 for maximum symmetry of output waveform. The balancing adjustment is made with a tape threaded on the recorder which is operating in the recording mode but which has the recording level controls set to minimum. With headphones plugged in and a VTVM connected to the recorder output, the noise-balancing control is adjusted for minimum noise in the headphones and a minimum reading on the VTVM.

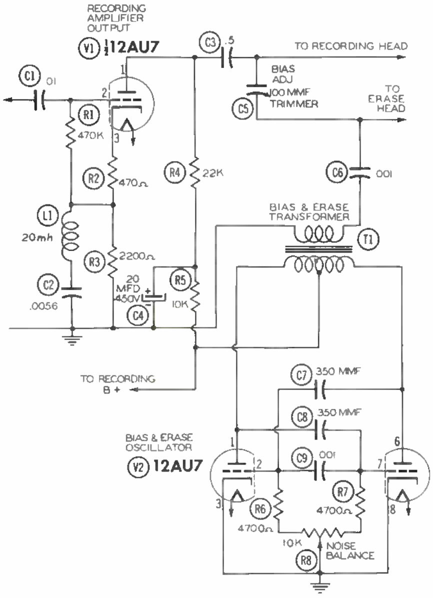

Fig. 4. Bias-and-Erase Oscillator and Recording Output Stage of the Ampex Model 600 Tape Recorder.

After the noise-balance adjustment has been made the bias-level adjustment should be rechecked and readjusted if necessary.

It can be noted that the source of bias current is also the source of erase current. This is a common arrangement and will be discussed in more detail in a later issue under the subject of erase procedures.

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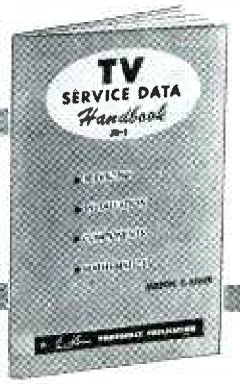

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Audio Facts

(Continued from page 5)

cathode-coupled output arrangement, but a closer look will reveal that it is not. It is a bridge circuit which removes the heavy DC from the output transformer and eliminates the unwanted switching transients. Note the separate power supplies and the negative returns connected to the cathodes of the 6V6GT's because they age unusual and play important parts in the operation of the circuit.

To give some idea of how the circuit operates, we will start at the plate (pin No. 3) of output tube V5. The plate of V5 is connected to the screen (pin No. 4) of the other 6V6GT output tube V6 to the positive side of one power supply. The cathode (pin No. 8) of V5 is connected to the negative side of the other power supply and to the blue lead of the output transformer. If we start tracing the circuit at the plate (pin No. 3) of output tube V6, we find that the same pattern is followed as was used with V5 but in what might be called opposite phase.

The supply end of the driver-plate-load resistor R45 is connected to the screen (pin No. 4) of V5 and to the plate (pin No. 3) of the other output tube V6. The other driver-load resistor R46 is connected in the same manner but to opposite points.

Now all of this might sound complicated because it is rather involved, but the manner in which the screens and plates are cross connected and the driver plates are fed is important because these connections provide feedback and stability.

If this were a conventional cathode-coupled output circuit, no signal would be present on the plates and screens of the output tubes. Instead, it is a bridge circuit using two separate power supplies, and a signal is present on the output plates and screens and across the two supplies because the center tap of the output transformer primary is connected to ground. Of course, the 40-mfd filter capacitors are effective; and no signal is present across either individual supply, that is, across capacitors C1B or C2B.

The important thing to understand is that this is a bridge circuit in which the signal is developed across the points mentioned with no heavy current flowing through the primary of output transformer T1. With this circuit arrangement, feedback is developed in the output circuit and in the driver-plate circuit because the signal phase is correct on the plates, screen, and cathodes, allowing high output levels to be reached with stability and low distortion.

We do not know how or why Electro-Voice arrived at the name of CIRCLOTRON for the circuit; but if it has anything to do with the signal going 'round and 'round, it must be all right, for it surely seems to come out at the right place.

The amount of damping applied to the loudspeaker is controlled by varying the amount of feedback fed from the output back to the cathode circuit of the first section of V3 by two feedback loops.

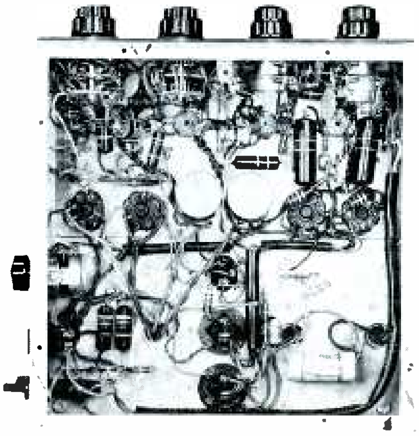

Fig. 2. Bottom View of Electro-Voice Model A-20C Amplifier.

Negative feedback is developed by the voltage-feedback loop connecting from the top or 16-ohm tap of the output transformer through feedback resistor R49 to the cathode of V3. The cathode resistor is an 1800-ohm wire-wound potentiometer R5A which is part of the DAMPING FACTOR control. When the sliding contact is moved to the top or cathode side of the control, negative feedback will increase to maximum; and maximum damping action will be produced.

The 1800-ohm potentiometer R5A is ganged with the 1-ohm control R5B which is connected in series with it, and both must move together.

Negative-current feedback is developed in the circuit connecting from the common loudspeaker tap labeled C through the 1-ohm R5B to ground. As negative-current feedback is increased, the damping effect is reduced. When the slider of R5B is moved toward the top or cathode side, negative-current feedback will decrease because the resistance is reduced toward zero as R5B is progressively shorted out to ground.

When the DAMPING FACTOR control is moved to maximum, then the maximum negative feedback produces the desired maximum damping factor and no current feedback is produced because that section of the control R5B is shorted out.

When the damping control is set to the minimum position, then minimum negative-voltage feedback is developed and the damping factor is reduced. But in this minimum position, maximum negative-current feedback is produced and this in turn also reduces the damping factor. This action makes it possible to obtain the range of 0.1 to 15 in the damping factor.

Electro-Voice lists the correct factor for use with each of the loudspeaker systems of their own manufacture. The control is set for the most pleasing reproduction when other loudspeakers are used. How much loudspeaker damping should and can be used, how effective it really is, and the most satisfactory way to obtain and control the damping have been the subjects of considerable controversy. Although there has been no unanimous agreement on the subject, turning the damping factor control on the A-20C presents a setting at which the reproduction sounds better. Therefore, it must be admitted that the control works and has merit.

In addition to the output taps which provide proper matching for 4-, 8-, and 16-ohm loudspeakers, a 600-ohm balanced output (orange, and white leads on primary of T1) is provided for feeding a line or a recorder cutting head.

A negative DC supply furnishes the fixed bias for the output tubes.

An output jack is connected through capacitor C26 to the junction of resistors R39 and R40 in the cathode side of the split-load phase inverter. This output is suitable for feeding a signal (1.5 volts at full output) to the high-impedance input of a tape recorder. When the signal to be recorded is fed into the amplifier, it is subject to all appropriate control and equalization circuits in the amplifier before it reaches the REC OUT jack. This output proves to be very convenient and satisfactory for making tape recordings from broadcast programs or from records.

Let us now move to the front end of the A-20C. We will start at the five inputs and follow through the remainder of the circuit.

The PHONO input is intended for use with a ceramic or crystal cartridge and is rated as having a sensitivity of 0.5 volts, an impedance of 9 megohms, and a maximum input of 4 volts. This input feeds through the selector switch S1 to the grid (pin

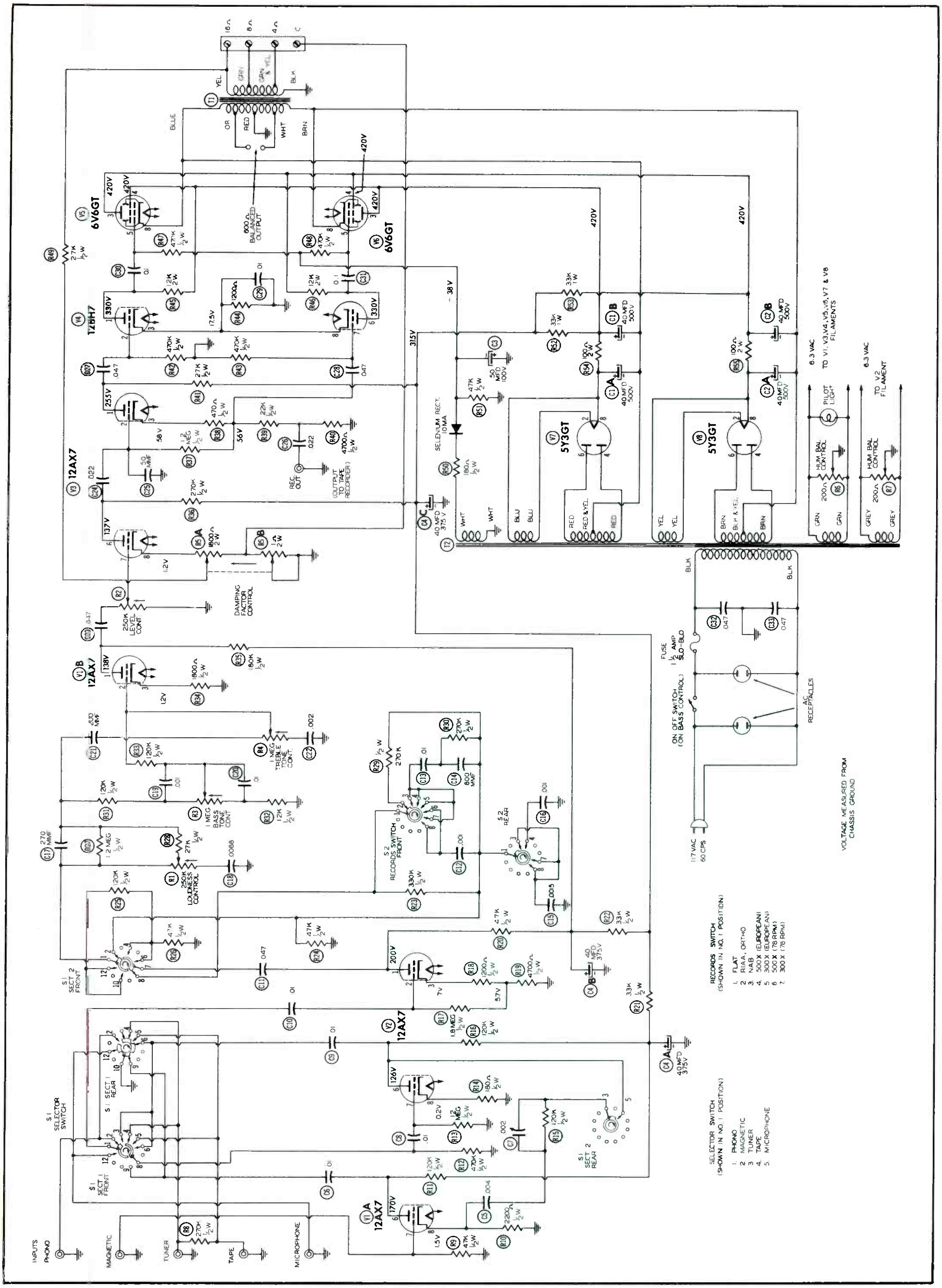

Fig. 3. Schematic of Electro-Voice Model A-20C Amplifier.

No. 2) of V2 and bypasses the first sections of V1 and V2.

The MAG input is for use with magnetic pickups and is rated at a sensitivity of 25 millivolts at 1 kc, an impedance of 47K ohms, and a maximum input of 200 millivolts at 1 kc. Feeding through the selector switch S1 to the grid (pin No. 7) of V1, this channel uses all of the tubes in the amplifier. Compensation for the characteristics of a magnetic cartridge is supplied by the frequency-selective feedback circuit (C5, C7, and R15) which is connected from the plate (pin No. 6) of V2, through section 2 rear of selector switch S1, to the cathode (pin No. 8) of V1A.

When the selector switch is in either of the two phono positions, the RECORDS switch S2 is connected into the circuit. Suitable equalization for obtaining satisfactory reproduction from most any record is selected by the RECORDS switch which provides compensation following six different playback curves.

The TUNER (or TV) and TAPE (or TV) inputs are identical high-impedance inputs connected to different switch positions. It is interesting to see how resistor R8 serves as the input resistor for both channels. As the unwanted input signal is grounded through section 1 rear of the selector switch S1, R8 is placed across the wanted input signal and ground as the inputs are switched. These inputs are connected to the grid (pin No. 2) of V2 through switch S1, bypassing the first two stages as was done in the PHONO (ceramic) position. Both inputs are rated at a sensitivity of 0.5 volts, an impedance of 240K ohms, and a maximum input of 4 volts.

The MIC input connects to the grid (pin No. 7) of V2 through the selector switch, bypassing the first section of V1. This input is intended for use with a high-impedance microphone and is rated at a sensitivity of 7 millivolts, an impedance of 470K ohms, and a maximum input of 80 millivolts.

All signals are channeled through the loudness and tone-control circuits. The loudness control R1 is adjusted for the most pleasing response at normal listening levels, and the level-set control R2 is used as a volume control to change the listening level whenever desired.

The loudness control is a filter network composed primarily of resistors R1, R27, and R28, and capacitors C17 and C18. No loudness compensation is produced when control R1 is turned to the maximum clockwise position where the movable contact is at the high end of the control. This end is connected to R27 and C17. When the control arm is turned in the counterclockwise direction (toward C18), the filter network becomes increasingly effective in attenuating the middle frequencies. In the maximum counterclockwise position of R1, the maximum attenuation of the middle frequencies results in a frequency-response curve which slopes from the lowest frequency to a maximum attenuation of approximately 20 db near 1500 cps and then rises again. This operation results in tones that are more effective in the low bass and high treble ranges than those in the middle range in order to compensate for the loudness characteristic of the listener's ear.

The bass and treble controls, mounted concentrically, make use of conventional RC tone-control circuits to provide a wide range of bass and treble boost or droop.

The Model A-20C amplifier may be small, but it performs in a big way.

ROBERT B. DUNHAM

CORRECTION

The first paragraph on page 35 of the October issue of the PF REPORTER should read as follows:

Notice in Fig. 2 that the electrons can pass from the cathode to either of the plates. Before the electron stream emerges from either of the openings in the accelerator structure, it is acted upon by the focus electrode and the control grid. The focus electrode serves to converge the electrons into the required sheet beam; whereas, the conventional grid No. 1 structure which surrounds the cathode governs the intensity of the beam. The internal shield located between the two plates acts to suppress the interchange of secondary-emission electrons between the plates. The suppression and focus electrodes are internally connected to the cathode.

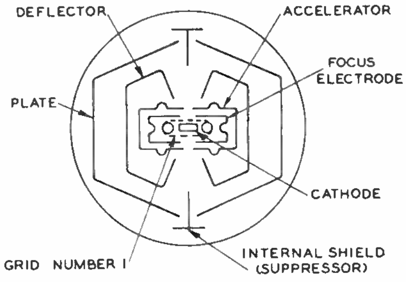

Fig. 2. Cross-Section of the 6AR8.

Shop Talk

(Continued from page 13)

on the tube is too negative. This has brought the operating point of the tube so close to cutoff that the tube is easily driven into nonconduction, and there is distortion in the output wave.

The foregoing illustration was purposely kept simple in order to reveal how an analysis of waveform distortion can lead to the source of the trouble. It might be that in a voltage check of this amplifier, the slightly increased negative bias could easily have been overlooked. But when you observe the wave on the scope screen, the distortion stands out like a red flag. Even the most inexperienced beginner could not miss it. Ease in detecting trouble is thus a very marked advantage of waveform observation.

Every departure from the original wave shape will have a definite and often a noticeable effect upon a picture. A change in video-signal content will alter the picture in appearance — perhaps in the shading or in the shape of an object. A variation in deflection waveform will affect the manner in which the picture is being laid out on the screen. Thus, we should not only be able to associate waveform distortions with the defects that cause them; but it is often just as important to be able to work from the other end — that is, from the affected picture to the distorted waveform. In fact, this is usually the first step.

In television receivers, which are of principle concern here, a wide variety of wave shapes are found in the various sections of the circuitry. This is in rather sharp contrast to a radio receiver where the only waveform of interest is that existing along the signal path. It is true, of course, that at the input to the set and throughout the RF and IF systems we find a fully modulated signal; whereas in the audio stages, we have the audio signal. The difference is not a fundamental one, since the same audio voltage that is found in the audio stages is present in the modulated signal in the RF and IF sections. It matters little what happens to the RF and IF signal carriers so long as the intelligence (the audio signal) which these voltages carry is not affected.

In a television receiver, there is also a general signal path; and throughout this path, essentially the same signal is present. There are also many important side paths, and the waveforms existing in these side paths differ considerably from those found in the signal stages. To this extent, television-receiver servicing is more complicated; however, the same basic principles underlie all waves, and so it may not be amiss to make a brief general inspection of waves and the end results of their variations.

To start, let us consider a simple video signal such as the one shown in Fig. 2. This signal has three levels: A to B, C to D, and E to F. Let us take this signal and apply it to the control grid of a picture tube. The frequency of the wave is 15,750 cycles per second. Therefore, the time required for the signal to go from A to F is equal to the time it takes the electron beam to travel from the left-hand side of the screen to the right-hand side.

What will be the visual effect of this voltage on the screen? Since the wave, as shown in Fig. 2, has A to B as its most positive level and E to F as its most negative level, fewer electrons would enter the scanning beam when voltage A to B was active than when voltage E to F was active. For the intermediate level C to D, the beam would possess and intermediate number of electrons.

Since the light output of the screen is directly related to the number of electrons present in the scanning beam, the screen image produced by the foregoing voltage variation will consist of three distinct bars, each occupying a third of the total visible screen area. The bar produced by the voltage A to B will be bright and uniform in light intensity from start to finish. When point B is reached, the voltage drops abruptly to C and thereafter remains steady at the C to D level. Hence, we would expect to find a correspondingly sharp drop in light output at the end of the white bar, with the pattern becoming gray and remaining gray throughout the next third of the screen.

Finally, when point D is reached, there occurs still another sharp drop in light output; and for the final third of the screen, we have a black bar. At point F, the blanking voltage takes over; and during the blanking interval the beam is quickly brought back to the left-hand side of the screen in preparation for the next scan.

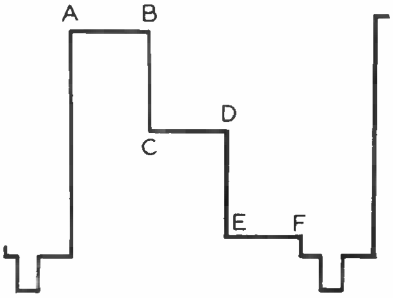

Fig. 2. A Simple Video Signal.

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Let us suppose that the wave of Fig. 2 had been distorted as it passed through one of the video amplifiers and that, when it finally did reach the picture-tube grid, its shape had been altered to the extent shown in Fig. 3. The light pattern it would then produce on the screen would differ from its former pattern.

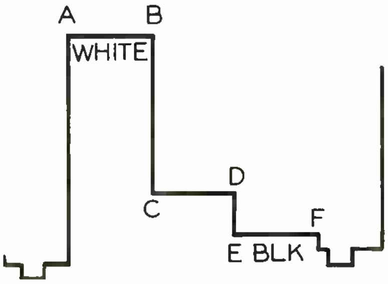

Fig. 3. The Video Signal of Fig. 2 After It Has Suffered Partial Compression.

Is it possible to predict how this light pattern would appear? Yes, it is possible because the manner in which the wave affects the scanning beam is understood. From A to B, the voltage is still highly positive and a white bar would be produced. However, the relative distance between B and C has been materially increased, and hence the change in light output of the screen would be altered to a greater extent. The bar produced by voltage C to D will be darker or grayer than it was previously. Furthermore, voltage E to F is in this case only slightly less negative than C to D, and the change in light intensity will be similarly small.

(The interval C to D has not been labeled in Fig. 3 because, while it is no longer the same shade of gray as formerly, it is still not black. Perhaps dark gray would be more appropriate; but to avoid confusion, it has been left unnamed.)

An alternate situation (shown in Fig. 4) is one in which the white portion of the signal has been compressed, whereas the rest of the signal remains essentially like that in Fig. 2. The visual consequence of this action is readily predictable. The white bar will no longer be as bright as before; rather, it will move closer to the shading of the second bar. The third bar, however, will remain as dark as ever.

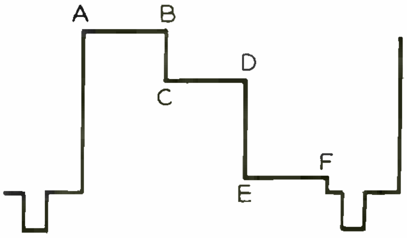

Fig. 4. The Video Signal of Fig. 2 With Compression of Its Brighter Elements.

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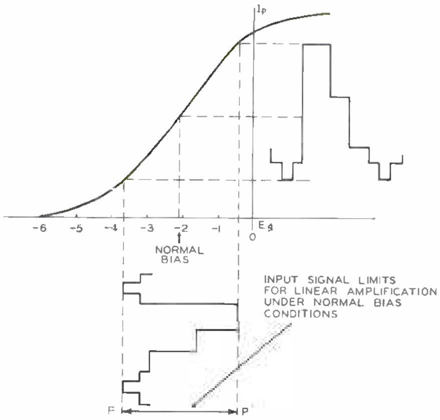

Fig. 5. Characteristic Curve for a Tube and the Input Signal Limits for Linear Amplification.

Typical video signals are seldom as simple in form as those which we have just discussed, but that which has happened to these simplified signals can and does happen to normal video signals. In Fig. 3, for example, there was signal compression at the black level; in Fig. 4, the compression took place at the white level. In both instances, distortion occurred; and inspection of the screen would have made this fact evident. The task of the service technician is made easier if he first correlates the screen presentation with the abnormal variation of voltage and then proceeds from that point to the localization of the defective component itself. This is logical and direct. Excessive time consumption occurs only when the attack is aimless and haphazard.

In the present case, after viewing the signal being fed to the picture tube and noting the compression, the technician would next check the signal at the video second detector. If the compression were still evident, then it would indicate that the trouble was being caused by some prior stage, either in the video IF system or the RF section. On the other hand, a normal signal at the detector would direct the technician to the video-amplifier section following the detector.

Once the proper choice of direction is made, the next step is to pinpoint the exact location of the trouble. This calls for an understanding of circuit behavior and the manner in which amplitude distortion (compression, in this case) is brought about. When part of a signal is compressed or elongated with respect to some other portion, such distortion can only be caused by a nonlinear component such as a vacuum tube or a crystal diode. No capacitor, resistor, nor inductor, by themselves or in any conceivable combination, can achieve this effect. All that linear components may do is to subtract or attenuate portions of a signal; they cannot compress or elongate.

In a tube, a change in operating condition will have a very direct effect on what that tube does to the signals it passes. For example, so long as our video amplifier is biased to -2 volts (Fig. 5) and the amplitude of the incoming signal does not exceed the limits P to P', then we obtain at the output a close replica of what we put in.

On the other hand, suppose the bias value becomes more negative, say -4 volts. What happens to the incoming signal is clearly shown in Fig. 6. The black portion of the signal, which is forced to operate along the lower curved portion of the response curve, tends to become compressed. In other words, a certain voltage variation over this region will not cause as much current change in the tube as the same variation would cause over the central region of the curve. This leads to proportionately less output-voltage variation, and the signal is said to be compressed. The rest of the signal, operating over a more favorable portion of the curve, develops a greater output voltage.

Fig. 7A. Video Signal with 60-Cycle Hum.

In the illustration of Fig. 6, the phase of the applied signal was such that the black portion suffered compression. With a reversal in phase, it would have been the white portion which would have suffered. The compressing agent, however, was the tube in both instances.

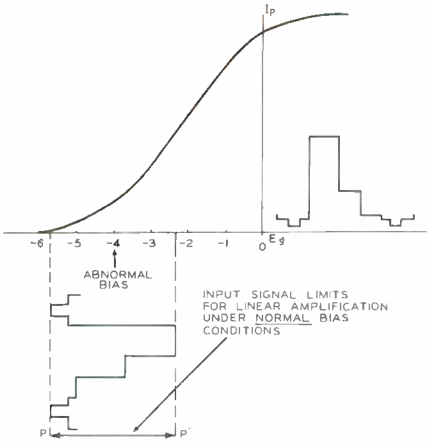

Fig. 6. Nonlinear Operation Resulting From Abnormal Bias.

The next question is: "What will cause the tube to act this way?" For one thing, a change in grid bias will do so. This was discussed in the foregoing. A decrease in plate or screen voltage will also cause the tube to act this way since these, too, will affect the extent of the characteristic curve. Another factor is the plate-load resistor, and still another factor is lowered emission in the tube. Last but not least, there is a condition which is taking place every day — a marked increase in received signal strength. Remember that in order to obtain linear amplification, the incoming signal must remain within the limits of P to P' of Fig. 5. If these boundaries are exceeded, the signal moves into the nonlinear sections of the curve and distortion will follow. Generally, too strong a signal will result in simultaneous compression of both black and white levels; whereas, a change in bias will affect only one level. These are not hard-and-fast rules, and there are exceptions.

Another situation that is encountered is illustrated in Fig. 7B. The picture exhibits a very prominent bend, accompanied by a variation in

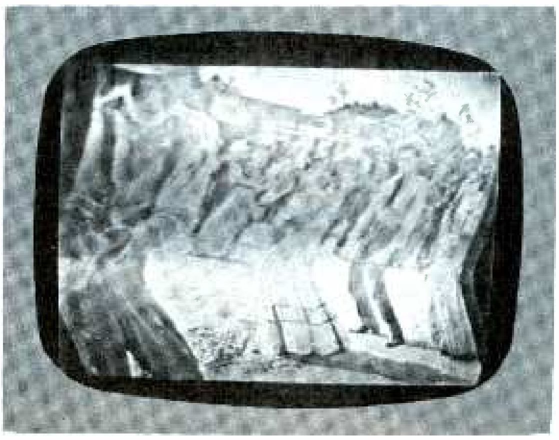

Fig. 7B. Distorted Picture Caused by 60-Cycle Hum in Video. (Courtesy of DuMont Service News.)

brightness from top ot bottom. The video signal which is producing this picture is shown in Fig. 7A. Note that the large value of AC ripple or hum voltage present exceeds that of the video signal itself. The AC voltage is obviously the agent which is causing the brightness variation from the top of the screen to the bottom, and it is the same AC voltage which is apparently disturbing the sync and sweep circuits sufficiently to cause the bend in the picture. Again, analyzing a picture in terms of the possible signal voltages that might be causing it can lead to a much quicker solution.

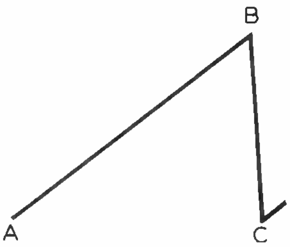

Fig. 8. A Saw-Tooth Wave.

In the foregoing discussion, we have seen the effect of signal variation at the control grid of the picture tube. Now let us turn our attention to the vertical- and horizontal-deflection systems in which saw-tooth deflection voltages are applied to the control grids of both output amplifiers. The effect, in this case, is not a variation in beam current but a guided motion of the electron beam. A saw-tooth wave in which the voltage rise from A to B is straight (Fig. 8) will result in a beam notion which is linear. Any departure from linearity in section A to B will have a correspondingly disturbing effect on the manner in which the beam travels over the face of the screen. For example, in the wave shown in Fig. 9A, beam travel will be normal from A to A' and then quite slow from A' to B. The effect on a picture is shown in Fig. 9B.* Note how the right-hand side of the image is crowded together because of the slower beam motion. It may also be found that this portion of the picture is somewhat brighter because of the fact that the beam moves more slowly and thus produces a greater light output.

It is also necessary, in analyzing picture distortions, to distinguish between vertical and horizontal direction. For example, the wave in Fig. 9A is controlling the left-to-right motion of the beam. Therefore, point A corresponds to the instant when the beam is at the left-hand side of the screen; whereas, at point B, the beam is at the right-hand edge of the picture. The saw-tooth wave in the vertical system controls the up-and-down movement of the beam. Point A corresponds to the beam position when it is at the top of the screen, and point B corresponds when it is at the bottom of the screen.

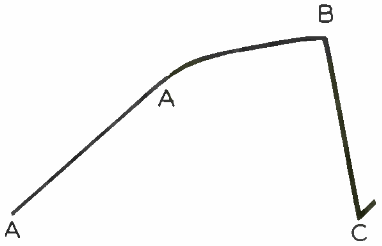

Fig. 9A. A Distorted Saw-Tooth Deflection Wave.

Some important aspects, then, of waveform analysis are not only to be watchful of the shape and amplitude of a wave but also to appreciate that the same wave may produce very different results in different circuits.

---

*The nonlinearity of the picture shown in Fig. 9B is caused by a malfunction in the receiver and does not reflect upon the quality of the picture transmitted by station WFBM-TV.

Fig. 9B. The Effect of the Deflection Wave in Fig. 9A on a Picture.

In the signal circuits of a television receiver, it is necessary to think in terms of light intensity and to decide whether or not the objects produced will be clearly defined. On the other hand, in the deflection circuits, the end result is the control of the electron-beam motion; and any departure from normal in the waveforms in these sections must be considered in respect to their effect on this beam motion.

MILTON S. KIVER

A STOCK GUIDE FOR TV TUBES

The following chart has been compiled to serve as a guide in establishing proper tube stocks for servicing TV receivers. The figures have been derived by combining (1) a production factor (the number of models and an estimate of the total number of receivers produced by all manufacturers) and (2) a depreciation factor (based on an average life of six years for each receiver, and the figures are reduced accordingly each two months).

1. The figures shown are based on a total of 1,000 units. This was done in order to eliminate percentage figures and decimals. The figure shown for any tube type then represents a percentage of all tubes now in use. For example, a figure of 100 would imply that that particular tube type constitutes 10 per cent of all tube applications.

2. Some consideration should be given to the frequency of failure of a particular type of tube. A tube used in the horizontal-output stage will fail much more frequently than a tube used as a video detector. Thus, even though the same figure may be given for both tubes, more of the horizontal-output type should be stocked.

3. The column headed '46 to '54 is intended for use in those areas where television broadcasting was initiated prior to the freeze. Entries in this column include all tubes used since 1946 except those having a value of less than one, which is the value of the minimum entry in this chart. The '52 to '54 column applies to the TV areas which have been opened since the freeze. Since the majority of receivers in these areas will be of the later models, only the tubes used in these newer sets are considered in this column. The minimum value of one also applies to this column.

4. The listing of a large figure for a particular tube type is not necessarily a recommendation for stocking that number of tubes. The large figure does indicate that this tube is used in many circuits and emphasizes the necessity for maintaining a stock sufficient to fill requirements between regular tube orders.

	46 - 54 Models	52 - 54 Models
1B3GT	40	44
1X2	5	2
1X2A	4	6
c1X2B	-	-
c3A3	-	-
5U4G	46	48
5V4G	7	-
5Y3GT	4	2
6AB4	3	2
6AC7	8	8
c#6AF4	2	2
6AG5	32	9
6AG7	2	3
6AH4GT	3	4
6AH6	7	9
6AK5	4	4
c6AL5	75	76
6AL7GT	5	-
*6AM8	-	-
#6AN4	-	-
c*6AN8	-	-
c6AQ5	13	13
6AQ7GT	2	2
#6AS4	-	-
6AS5	1	2
6AT6	4	3
c6AU4GT	-	-
6AU5GT	4	4
c6AU6	131	121
6AV5GT	2	4
c6AV6	15	17
6AX4GT	7	6
6AX5GT	1	2
6BA6	14	10
6BC5	10	7
c*6BC7	-	-
c*6BD4	-	-
6BE6	6	7
6BG6G	13	6
6BH6	7	-
6BJ6	1	-
6BK5	2	3
6BK7	3	6
6BK7A	1	1
6BL7GT	5	8
6BN6	4	3
6BQ6GT	18	26
6BQ7	6	13
c6BQ7A	4	4
c*6BY6	-	-
6BZ7	5	6
6C4	10	10
c6CB6	100	138
c6CD6G	8	10
c6CL6	-	2
c*6DC6	-	-
6J5	3	3
6J5GT	1	1
6J6	33	30
6K6GT	16	10
6S4	8	10
6SH7GT	1	-
6SL7GT	3	3
c6SN7GT	74	81
6SN7GTA	2	2
6SQ7	3	3
6SQ7GT	2	2
#6T4	-	-
6T8	14	14
c6U8	6	9
6V3	2	4
6V6GT	21	19
6W4GT	30	32
6W6GT	7	11
6X5GT	1	1
6X8	4	6
6Y6G	3	1
7C5	1	-
7N7	2	-
c12AT7	14	14
c12AU7	45	31
12AV7	3	4
12AX4GT	2	3
12AX7	4	5
12AZ7	-	2
c12BH7	9	12
12BY7	3	4
12BZ7	2	-
12SN7GT	6	5
19BG6G	3	-
*25AX4GT	-	-
25BQ6GT	3	4
*25C5	-	-
*25CD6G	-	-
25L6GT	5	5
25W4GT	1	2
5642	1	2

A stock of these tubes should be maintained in UHF areas.
* New tubes recently introduced.
c Tubes used in color television receivers.

In the Interest of Quicker Servicing

(Continued from page 21)

C6, C7, R7, R8, R9, R11, R12, or R14; however, most of them were very unlikely causes in this case.

Checking the waveforms at the output of the oscillator and in the oscillator itself seemed like a good idea; consequently, that was the first thing done. The first signal viewed was at the grid of the output tube. The waveform in Fig. 4A shows this signal; and at first glance, this waveform does not appear significant. Note the difference, however, when it is compared to waveform W4 in Fig. 2D, which illustrates the correct waveform. Note that the flat portion at the top of the waveform in Fig. 4A is much longer than that in Fig. 2D and that the portion at the top of the rise in Fig. 4A is much more curved than that in Fig. 2D. Another point of interest is the fact that the sweep frequency of the oscilloscope had to be reduced from 7,875 cps to 3,937.5 cps in order to obtain two cycles of the waveform. This further proved the theory that the oscillator was running at half frequency.

Next, the oscilloscope lead was placed on the plate (pin No. 2) of V2, and the signal shown in Fig. 4B was the one found. Compare it with the waveform W2 in Fig. 2B. You will notice that although the pulse is badly distorted, the sine wave is considerably more distorted than the pulse.

With this much to go on, a technician can feel confident that the trouble lies somewhere in the plate circuit of the first half of the multivibrator stage.

The next step taken was to check the voltages. The first voltage that was measured was found to be far off the proper value. It measured 75 volts instead of the approximate 210 volts that it should have measured. The voltage on the B+ side of R7 checked correctly. This meant that R7 must have increased in value. When disconnected and measured with the ohmmeter, it was found to measure 33K ohms instead of 4.3K ohms.

Problem No. 2

The complaint in this case was loss of horizontal hold. As may be seen in the photograph of Fig. 5, the picture did not resemble most cases of loss of horizontal synchronization. The edge of the picture seemed to have a torn effect. It resembled a very extreme case of pie-crust effect.

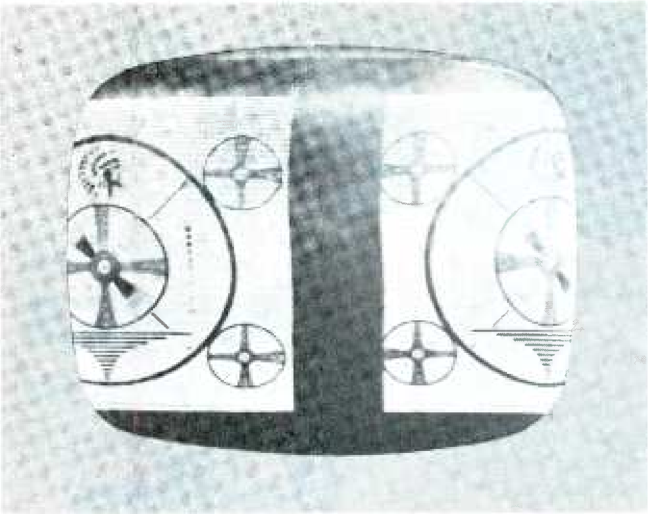

Fig. 3. Symptom of Trouble Discussed in Problem No. 1.

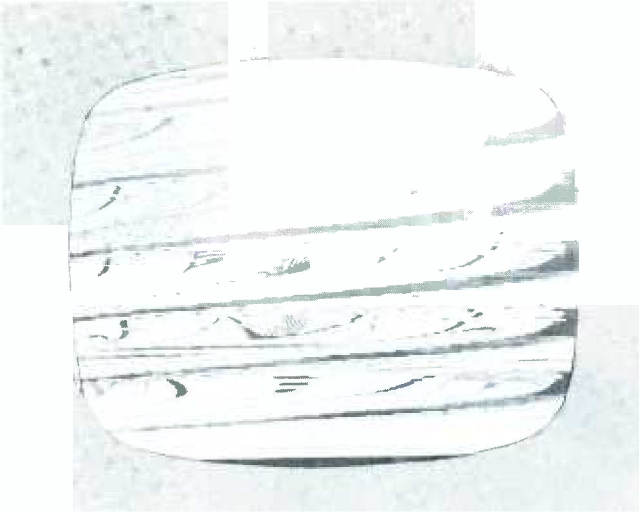

Fig. 5. Photograph of Trouble Discussed in Problem No. 2.

When the technician attempted to take waveforms, he obtained the results shown in Figs. 6A and 6B. Fig. 6A is a photograph of the waveform at the grid of the horizontal-output tube. The waveform of Fig. 6B was taken at the plate of the first half of the oscillator. Obviously, these signals were very unstable.

By this time, the technician was sure that the trouble was in the AFC circuit and not in the oscillator. Therefore, the scope lead was moved to the input grid of the oscillator to observe the output of the AFC circuit. At this point, where there should be nothing but a DC voltage, he found a signal that was so unstable that he could not lock it in on the scope. Knowing that there should be no signal at this point, he realized that the AFC filter must be bad. When substitution was made for C5, the trouble was cleared up.

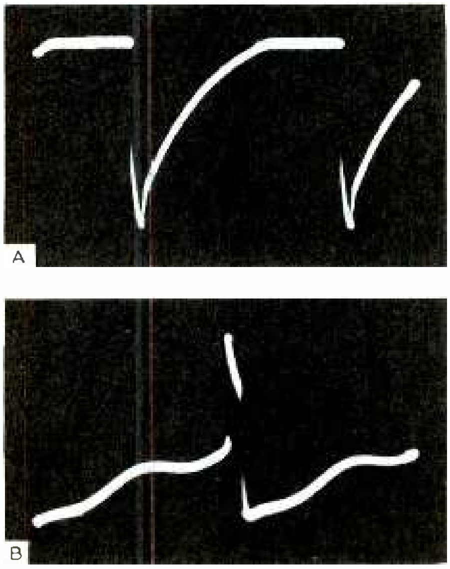

Fig. 4. Waveforms Discussed in Problem No. 1.

This was a case in which the technician could probably have saved a little time by simply following through with his first belief that the picture looked like an extreme case of pie-crust effect.

Problem No. 3

Loss of horizontal hold was the complaint about this set. The hold control could not pull the picture into synchronization.

The symptoms led the technician to believe that the trouble was somewhere in the horizontal oscillator and was not caused by a deficiency in the sync pulses. With this in mind, the technician decided to check waveforms in the oscillator section. A photograph of the waveform found on the grid of the second half of the oscillator may be seen in Fig. 7. By comparing it with the proper signal at this point, shown as W2 in Fig. 2B, you will note that there was a reduction in the sine-wave portion of the signal so that the pulse was actually greater in amplitude than the sine wave.

The next step taken was to check the voltages in the oscillator circuit. The voltages on the grid and plate of the first half of the tube were satisfactory, but the voltage on the second grid was off considerably. Instead of measuring -8 volts, it measured -3.5 volts. A check of C7 with an ohmmeter showed a leakage resistance of 4.5 megohms. This naturally prevented the oscillator from functioning properly.

Problem No. 4

The set had suddenly gone out of horizontal synchronization, and the customer could not lock it in with the hold control. The technician could lock it in by adjusting the horizontal-frequency control, which was the ringing coil; but it was not very stable. The picture kept shifting back and forth and falling out of synchronization.

The technician thought that the trouble was in the sync section. Therefore, he checked the AFC section and found that the sync pulses were present. He then started checking the oscillator section with the oscilloscope, and he received a surprise. The reason can be seen in Fig. 8A which shows the waveform on the second grid. The signal on the plate of the first section was about the same. The scope lead was next moved to the second plate (pin No. 5) of the oscillator and then to the grid of the horizontal-output tube. The waveform at both points looked like that of Fig. 8B. Is it any wonder that the technician was surprised?

Since he had never before encountered any waveforms that looked like these, the technician could not

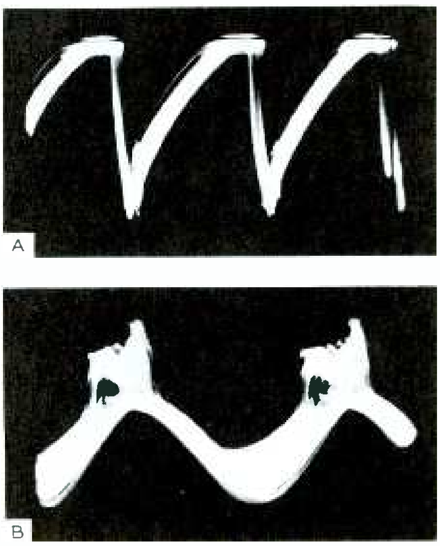

Fig. 6. Waveforms Discussed in Problem No. 2.

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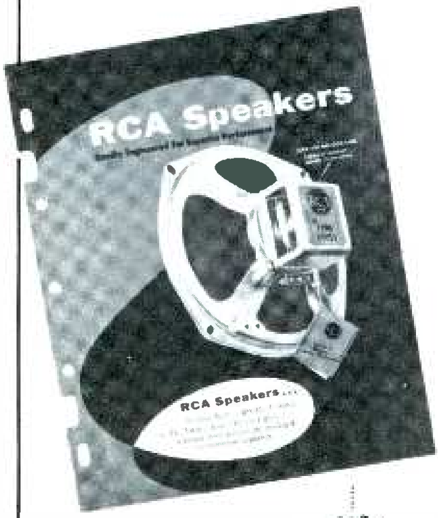

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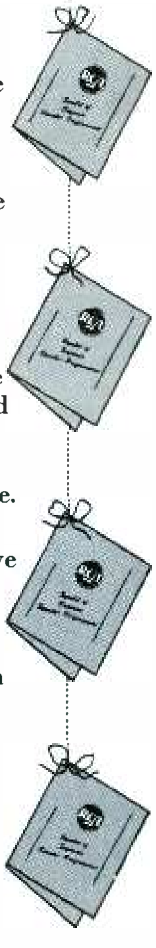

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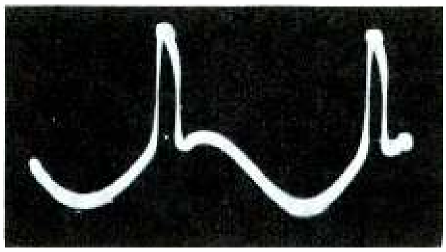

Fig. 7. Waveform Discussed in Problem No. 3.

draw any direct conclusion from them alone. Therefore, he decided to check voltages in an attempt to locate some clue as to what could be causing such an effect. All voltage readings were satisfactory, with the exception of the output plate of the oscillator (pin No. 5). This measured 300 volts instead of the 110 volts that it should have measured. This very high plate voltage meant that either the tube was cut off so that the plate voltage would increase to B+ level or that the discharge circuit was open. The tube could not be cut off since a raster was present; therefore, only the latter possibility was left. A check with the ohmmeter showed R13 to be satisfactory. Substitution was made for C9. That fixed the set.

Problem No. 5

The set had lost horizontal hold. The hold control could not bring back into synchronization. In addition, rotation of the hold control to one extreme resulted in a Christmas-tree effect.

Realizing that the trouble was in the horizontal oscillator, the technician proceeded to check this section with the oscilloscope. When the scope lead was placed on the first plate

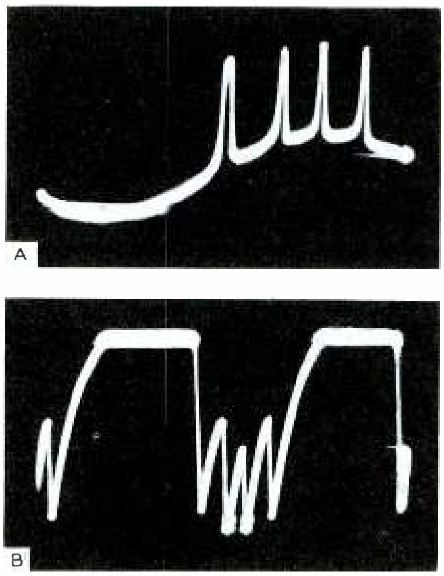

Fig. 8. Waveforms Discussed in Problem No. 4.

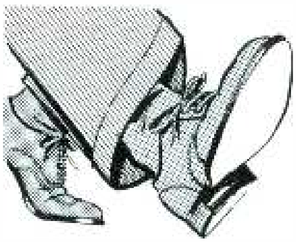

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Fig. 9. View of TV Chassis Supports.

(pin No. 2), only the pulse was found; the sine wave was missing.

This indicated that the trouble was in the ringing-coil tank circuit. The coil could not have been open; if it had been, the oscillator would not operate because of the loss of plate voltage. The coil could have a short, however, which could best be proved by substitution; but since it was much easier to substitute a new capacitor for C6, that was done first. It proved to be the cause of the trouble.

Thus, a trouble was located with only the use of the oscilloscope.

TV Chassis Supports

Those who become irritated because of TV chassis which cannot be rested upon their sides can now obtain a product known as a Barb City TV Chassis Support. These are available at most parts distributors. A view of two of these supports may be seen in Fig. 9.

The Barb City TV Chassis Supports are designed for simplicity and strength. They are easily slipped under the edge of the chassis from the underside with the lip and wing screw on the inside of the chassis, and then the screw is tightened with the fingers. Fig. 10 shows these supports in use.

IN THE HOME

Home service calls can be made faster in many cases through the use of certain "gadgets" or "gimmicks." The gadgets may be tools or special items to improve receiver operation under certain conditions, or they may be things for the convenience of the service technician. Whatever classification these items have, only those which will perform satisfactorily without impairing receiver operation should be used or sold to the customer.

Fig. 10. View of TV Chassis Supports in Use.

Signal Attenuator

In many of the larger cities, television stations have increased their power to the maximum authorized by the FCC. This increase in power gives the stations increased coverage and makes reception better in suburban and fringe areas. Another effect of this increased power is that some receivers which are located very near to the transmitter site may become overloaded. At the receiver, indications of this trouble may be a very dark distorted picture and distorted sound. The insertion of an attenuator pad of the proper value into the antenna input line will usually remedy this trouble. The step attenuator shown in Fig. 11 has four different steps of attenuation: 10 db, 20 db, 30 db, and 40 db, plus one position which allows the signal to go straight through and which provides no attenuation. This attenuator is made up of four balanced H-pads (printed circuits with numbers PCH-10, PCH-20, PCH-30, and PCH-40 and manufactured by Centralab) and a 2-gang rotary switch. These units have proved very satisfactory and may be used where several different degrees of attenuation are required.

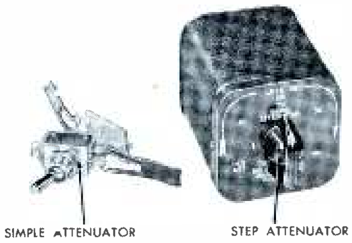

Fig. 11. Two Attenuators.

Because of the cost of these units, it may be desirable in cases in which only one step of attenuation is required to use an attenuator which has only the desired degree of attenuation. Such a unit may be constructed, using a DPST switch and an H-pad of the desired attenuation. A unit that uses this type of construction is also shown in Fig. 11. The electrical hookup is shown in Fig. 12. It can be seen from this hookup that in one position of the switch the H-pad is shorted out, thus providing a direct coupling of the signal. In the other position, the switch is open; hence, the signal is passed through the pad, and the desired amount of attenuation takes place. This arrangement permits the more distant stations to be received without being attenuated. To use the fixed attenuator shown in Fig. 11, it will be necessary to know just how much attenuation is required to reduce the signal to a level the receiver can handle. The step attenuator may be used as a test instrument to determine the required attenuation. In choosing the type of attenuator, care should be taken to get a unit that has high quality and is balanced. This will insure against introducing any distortion by the installation of an attenuator.

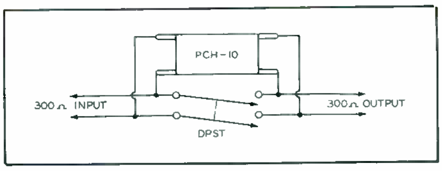

Fig. 12. Electrical Hookup of Simple Attenuator.

Phantom Feed Through

Many times, one of the most difficult parts of an antenna installation is making an opening into the house for the lead-in wire. When installing an antenna on a brick or stone house, it has sometimes been necessary to drill a hole through the wall into the basement or crawl space. Then, it was necessary to drill a hole in the floor and run the lead-in to the customer's receiver. This same thing applies for the installation in any house which has metal-casement windows.

All of this procedure is laborious and time-consuming. Installation requires more labor and material and thus costs the customer more money. In view of these things, several

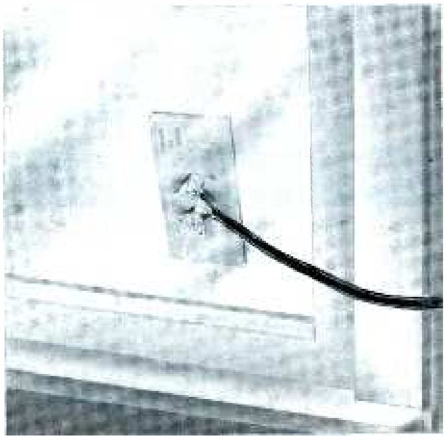

Fig. 13. Phantom-Feed-Through Device.

Fig. 14. Antistatic Picture-Tube Cleaner.

manufacturers have produced phantom-feed-through devices.

These units consist of metal plates which can be cemented on each side of the window pane. The size of the plates is such that sufficient capacity is developed between them to couple the signal into the house with but a minimum of distortion. In Fig. 13 one of these units is shown properly installed and with lead-in wire attached.

These phantom-feed-through devices are supplied with an adhesive or cement to fasten them to the window pane. In using these units, no undue strain should be put upon them. The lead-in wire should be supported with a suitable standoff insulator near the window.

Picture-Tube Cleaner

There are still in service a great many television receivers using safety glass which is not removable from the front. To clean the screen on some of these, it is necessary to remove the chassis from the cabinet and to remove the ion trap, centering device, focus assembly, and yoke from the picture-tube neck. After these items are removed, the picture tube may then be removed and the safety glass and picture tube cleaned. The picture tube and its associated assembly must then be reassembled and properly adjusted. To date, we have not been able to find a faster or easier method than the one outlined for cleaning the picture tube and safety glass in receivers of this type; however, certain steps may be taken to reduce the frequency of these cleanings.

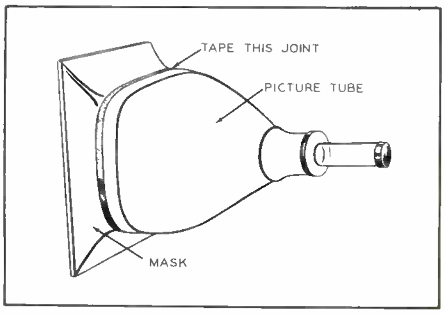

Fig. 15. Details for Sealing Crack Between Picture Tube and Mask.

Fig. 16. Plastic Bottle for Cleaner Solution for Controls and Contacts.

The Walsco Electronics Corporation has developed an antistatic cleaner for picture-tube faces and safety glass in order to help reduce the frequency of these cleanings. It comes in a handy, plastic, spray bottle and is shown in Fig. 14.

First, clean the picture tube and safety glass with this cleaner. Then, seal the crack between the picture tube and mask with a wide strip of masking tape. Cleaning and sealing will make it almost impossible for dust to collect on the face plate and safety glass. See the example shown in Fig. 15. If the receiver uses a metal picture tube, the tape should not be applied because the leakage path across the tape might disrupt the high voltage; however, the use of the antistatic cleaner will help reduce the frequency of cleaning the picture-tube face and safety glass.

Cleaner for Controls and Contacts

The cleaner for controls and contacts comes in either a glass bottle with dropper or in a pressure-loaded spray can. For the home service technician, neither of these two containers is entirely satisfactory. With the bottle and dropper, there is always the danger of breaking the bottle in the tool kit, thus making a considerable mess. The pressure can is large, and it may be difficult to find a place in the tube caddy for it. These problems can be eliminated by putting the cleaner into a small flexible-plastic bottle similar to that of Fig. 16. One that had contained a deodorant or some other substance should be thoroughly cleaned first. To use the cleaner, the bottle is simply squeezed and the spray is directed onto the contact or control to be cleaned.

HENRY A. CARTER
and CALVIN C. YOUNG, JR.

Rotator Repair

(Continued from page 27)

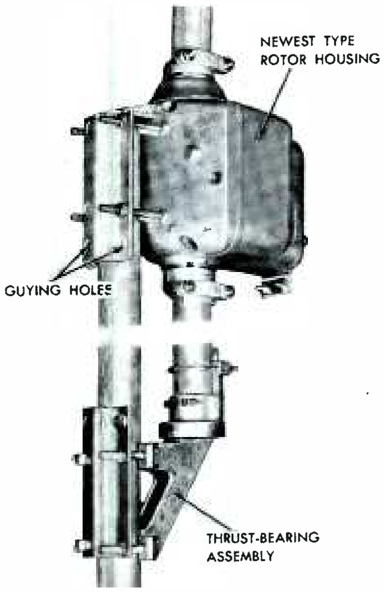

Fig. 3. Alliance Tenna-Rotor and Thrust-Bearing Assembly.

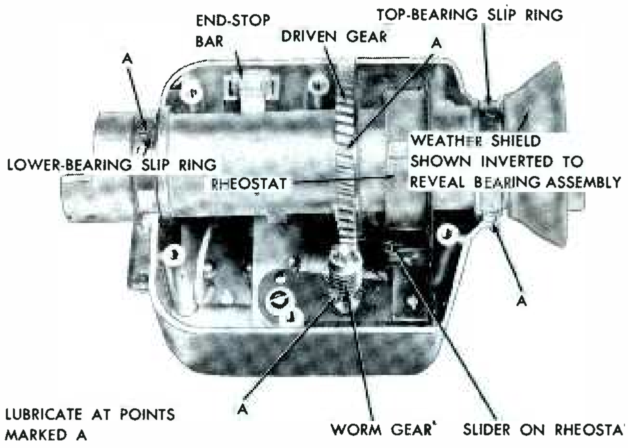

Fig. 5. Mechanism in Alliance Rotator.

meter in the control box, the rotator cable, and the rheostat and slider in the rotator assembly.

b. ATR and F-4 models only. Check the bulb for failure. Check the limit-switch contacts in the rotator.

c. HIR and U-83 models only. Check the switch and cam assembly in the rotator; check the solenoid, ratchet, and the switch assembly in the control box.

A basic rotator mechanism with one half of its cover removed is shown in Fig. 5. Lubrication with a film of Lubriplate is required at points marked A in this illustration. Should this unit require service, it would be advisable to clean all gears completely; to inspect for wear; and to relubricate the entire unit as required. A good grade of SAE-10W oil should be used on the motor bearings. To guard against excessive oil on the motor bearings, use only one drop on each one. This may be done by dipping a small screwdriver blade into the oil. Only about one drop will adhere to the blade; apply this drop to the bearing.

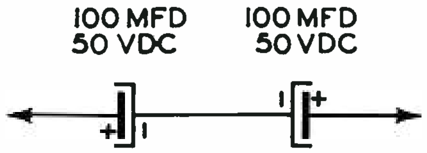

Fig. 4. Hookup for Double-Capacitor Substitution Unit.

CDR ROTATORS

The CDR rotators may be divided into two classes, the heavy-duty rotators and the light-duty (or Cub) rotators.

I. The CDR Heavy-Duty Rotators.

One class of these rotators is made up of the heavy-duty rotators, Models TR-2 and TR-4, each of which has a built-in thrust bearing. The basic rotator mechanism used in these two models is shown in Fig. 6. The thrust-bearing assembly which consists of a plate with six ball bearings above it and six below is indicated in the same figure. This thrust-bearing assembly, which is lubricated by the factory for the life of the rotator, makes it possible for this rotator to handle antenna arrays that weigh up to 150 pounds without undue strain on the rotator mechanism.

The Models TR-2 and TR-4 CDR Rotators should turn from one extreme of their rotation to the other in approximately 42 seconds. Should this time be appreciable longer, such as 60 seconds, it would be a very good indication that service of one kind or another is needed.

The major differences between the CDR Models TR-2 and TR-4 are in the control box and the method of indication. Mechanically, the rotators are the same. The schematic of the TR-2 is shown in Fig. 7A, and that of the TR-4 is shown in Fig. 7B.

If the permanent lubrication has to be removed because of contamination or for any other reason during servicing, the unit should be completely cleaned and relubricated with a grease which has a constant viscosity such as Lubriplate. This will insure satisfactory all-weather operation.

To aid the service technician in locating troubles in the Models TR-2, and TR-4, several trouble-shooting hints are listed. These apply to both models unless otherwise specified.

Rotator Inoperative.

1. Check the voltage at the control-box terminal strip. For both models, it should be approximately 30 volts AC.

    a. TR-4 model only. Check the voltage between terminals 1 and 4 on the control box while the direction switch is in one direction; check between terminals 2 and 4 while it is in the other.

    b. TR-2 model only. The voltage should be measured between terminals 5 and 8 and between 6 and 8.

2. Check the rotator cable for a broken lead or leads.

3. Check the rotator motor and the capacitor.

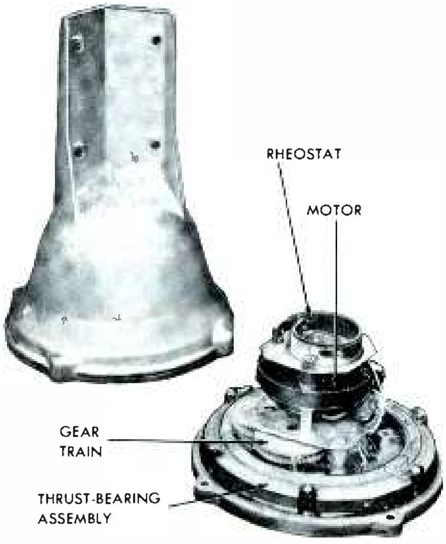

Fig. 6. Mechanism in CDR Heavy-Duty Rotators.

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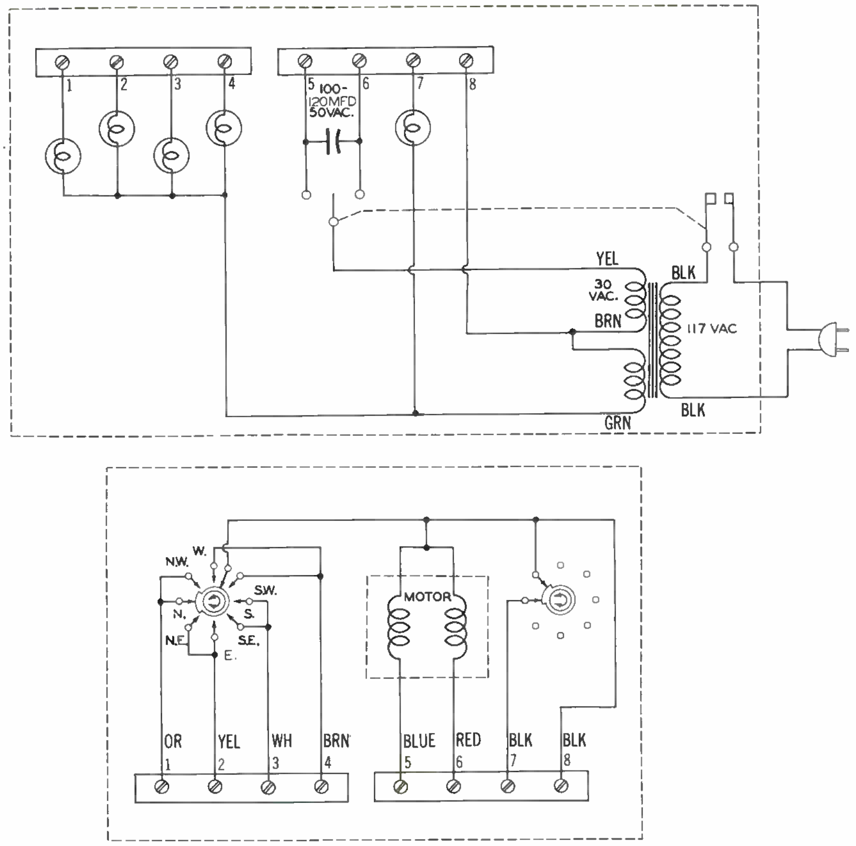
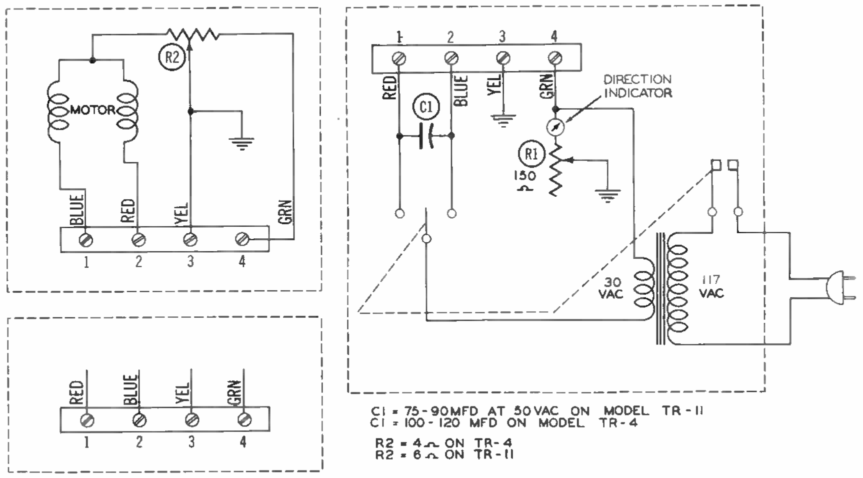


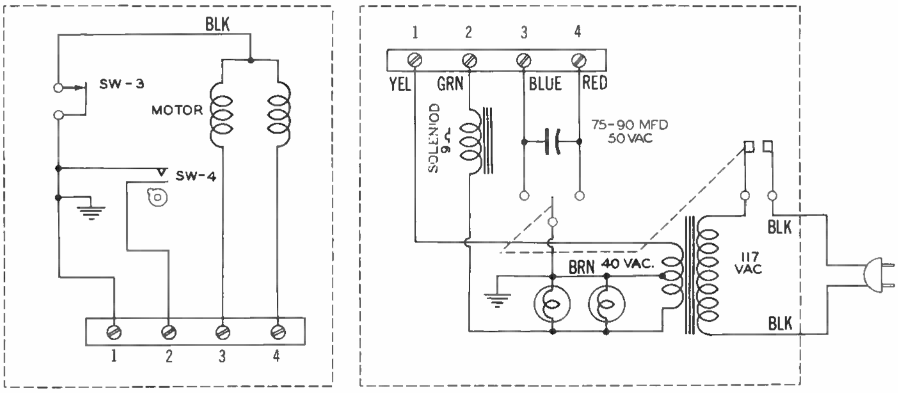
(A) Model TR-2.



ROTOR WIRE COLOR CODE FOR MODEL TR-11

C1 = 75-90MFD AT 50VAC ON MODEL TR-11
C1 = 100-120 MFD ON MODEL TR-4
R2 = 4 Ω ON TR-4
R2 = 6 Ω ON TR-11

(B) Models TR-4 and TR-11.



(C) Model AR-1.

Fig. 7. Schematics of CDR Rotators.

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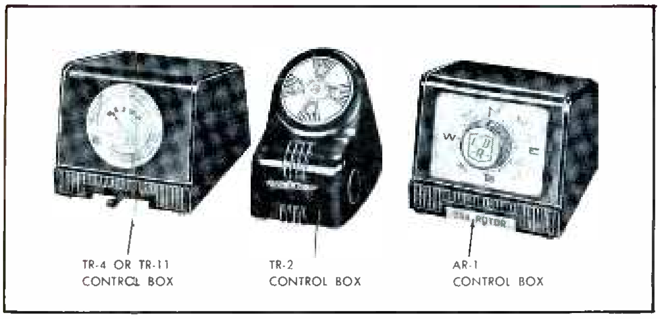

Fig. 8A. Cabinet Views of Control Units for CDR Rotators.

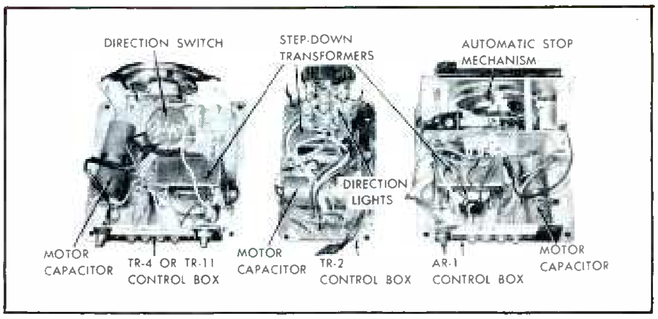

Fig. 8B. Chassis Views of Control Units for CDR Rotators.

4. Check the gear train for broken or stripped gears.

Rotator Operates Unsatisfactorily.

1. If the rotator operates in one direction but fails to operate in the other, check the direction-switch contacts. Check the rotator motor for an open winding. Check the gear train for proper operation.

2. If the rotator operates too slowly, check the line voltage, motor, capacitor, and gear train.

3. If the rotator operates but the indicator fails to register:

   a. TR-4 model only. Check the potentiometer and meter in the control box, the rheostat and slider in the rotator, and the rotator cable.

   b. TR-2 model only. Check the 6-volt winding on the power transformer. Check the pilot lights, the control cable, and the switch assembly in the rotator housing.

II. The CDR Cub Rotors.

The two other rotators in the CDR line are the Models TR-11 and AR-1 which use the light-duty or cub rotor mechanism. This type of rotor mechanism, shown in Fig. 9, is designed for use with small antenna arrays weighing up to 20 pounds. The mast length above the rotator should be limited to a maximum of 5 feet in order to use this unit without a thrust bearing. If the antenna is larger or heavier than a two-stack conical, use a thrust bearing. For long mast lengths or for heavy or large antennas, a thrust-bearing assembly designed for use with these light-duty CDR models should be used.

The Models TR-11 and AR-1 require approximately 45 seconds to turn from one extreme of their rotation to the other. The Model TR-11 uses the meter control box which is similar to that of the TR-4 control box, and the AR-1 uses an automatic-stop control box. The three different types of control boxes used in CDR rotators are shown in Fig.s 8A and 8B.

The electrical wiring of the Model TR-11 is the same as that for the Model TR-4; therefore, refer to the schematic diagram of the TR-4 shown in Fig. 7B for wiring details. The schematic of the Model AR-1 is shown in Fig. 7C.

The trouble-shooting data given in the following list has been prepared to assist the service technician in locating troubles in the Models AR-1 and TR-11 CDR Rotors. Unless otherwise stated, these hints apply to both models.

Rotator Inoperative.

1. Check the voltage at the control-box terminal strip.

   a. TR-11 model only. Check between terminals 1 and 4 while the direction switch is in one direction, and check between terminals 2 and 4 while it is in the other. The voltage should be approximately 30 volts AC.

   b. AR-1 model only. Measure the voltage between terminals 1 and 4 and between 1 and 3. Voltage should be approximately 40 volts AC.

2. Check the rotator cable for a broken lead or leads.

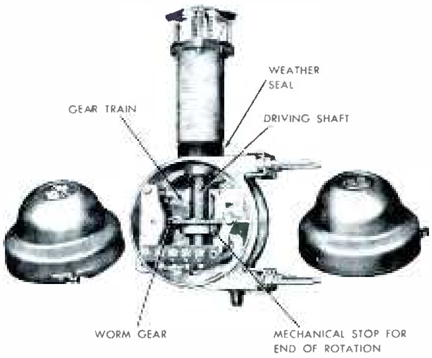

Fig. 9. Mechanism in CDR Light-Duty Rotators.

3. Check the rotator motor and capacitor.

4. Check the gear train for broken or stripped gears.

5. On Model AR-1, check switch 3 which is the thermal-overload switch.

Rotator Operates Unsatisfactorily.

1. If the rotator operates in one direction but fails to operate in the other, check the direction-switch contacts. Check the motor for an open winding, the rotator cable, and the gear train.

2. If the rotator operates too slowly, check the line voltage, motor, capacitor, power transformer, and gear train.

3. If the rotator operates but the indicator fails to register:

   a. TR-11 model only. Check the potentiometer in the control box, the meter, the control cable, and the rheostat and slider in the rotator assembly.

   b. AR-1 model only. Check switch 4 with its associated cam, relay 1, and the ratchet and switch assembly in the control box.

The manufacturer recommends that you should refer to the CDR service bulletins before attempting to repair any of the CDR rotators.

SUMMARY

Servicing rotators is practical and can be profitable to the service dealer. Whenever you are called to service an antenna system, a complete check which includes the rotator mechanism, the lead-in wires, and the control unit will convince the customer of your sincere desire to render the best possible service.

CALVIN C. YOUNG, JR.

Howard W. Sams

PF PHOTOFACT® REPORTER

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+ More or Less —

We have had the opportunity of reviewing some very interesting predictions regarding the future of our industry. These predictions appeared in the October issue of "Radio Age," a quarterly publication by the Department of Information of the Radio Corporation of America, reporting on a September 23 speech, in Chicago, by Frank M. Folsom, President of Radio Corporation of America. Because we think they are of general interest, and because they were made by an individual who is as well prepared as any in the industry to forecast development, excerpts applying particularly to the field of our readership are repeated here.

From a report on the results of a survey covering sales and estimated sales of electronic products over a 12-year period beginning in the postwar year of 1946; "Total annual sales of the electronics industry grew from $1.6 billion in 1946 to $8.4 billion in 1954. Further growth is projected as follows: 1954, $8.8 billion; 1955, $9.5 billion; 1956, $10.9 billion; 1957, $11.8 billion."

Pointed out is the fact that the range of the electronic field is so great, and its rate of development so rapid, that it now represents five times the market that it did in 1946, only eight short years ago.

Mr. Folsom has provided a breakdown of the market for individual categories of equipment or services, as follows:

"Home and Portable Radios: This field once represented the chief source of revenue in our business. Today, because of television and changing habits of the people, sales are declining gradually, from a post-war peak of $600 million in 1957 to an estimated $109 million in 1956."

"Auto Radios: Relatively stable sales somewhat in excess of $100 million annually."

"Black-and-White Television: Post-war growth was spectacular, with sales increasing from $1 million in 1946 to $1.4 billion in 1950. Sales in 1953 totaled $1.2 billion, and nearly $1 billion is expected in 1954. A drop to $388 million is projected by 1957, due to the shifting of the mass market from black-and-white TV to color."

"Color Television: Following commercial introduction in 1954, increased volume is expected to more than offset reduced sales of black-and-white television, reaching $264 million in 1955, $767 million in 1956, and $952 million in 1957. This would mean a total of nearly $2 billion (at factory prices) during color television's first three years." Further breakdown into units supplies the following estimates. "During the rest of this year and next year, it is estimated that more than 350,000 color sets will be produced and sold by the industry. During 1956, unit sales should reach 1,780,000; during 1957, 3,000,000 in 1958, about 5,000,000. These annual sales add up to the very satisfactory estimate of more than 10,000,000 color sets in American homes by 1959."

"Repair Parts (chiefly renewal tubes): Steady growth is expected to continue in support of increased receivers in service. Volume amounted to $217 million in 1953, and is estimated at $454 million by 1957."

"Servicing and Installation: This important element has grown from $145 million in 1946 to $1.4 billion in 1953. Continued growth to $2.7 billion by 1957 is indicated."

(For the sake of brevity, figures on the industrial, and similar markets outside the nominal electronic maintenance field, are not included.)

Study the foregoing statistics and draw your own conclusions as to their effect upon your own activity. Consider particularly the factor of the type of equipment which now predominates in your services because of preference or location versus the pattern which may be expected nationally in the future. After our own study of these figures, we can think of no better closing line than that which was employed in Mr. Folsom's speech, as follows:

"We have complete confidence in the future of electronics as a science, art, and industry."

J.R.R.

PF REPORTER Subject Reference Table

The following Subject Reference Table for the PF REPORTER is intended to provide a ready reference to subjects in the various articles that have appeared in the 1954 issues.

The table has been divided into major-subject headings in common usage in the electronics field. These are listed in alphabetical order, and a descriptive breakdown of the material is then given under these classifications. Under the subject listing, the name of the article appears in italics and is followed by the issue of the PF REPORTER in which it was published.

All subjects which are treated extensively enough in the text to be helpful in servicing or in understanding the operation of a circuit are listed in this Subject Reference Table.

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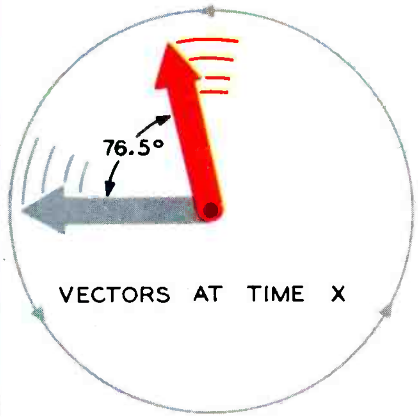
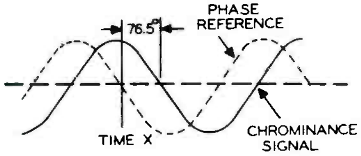
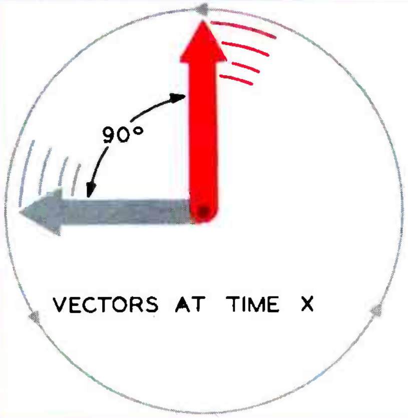
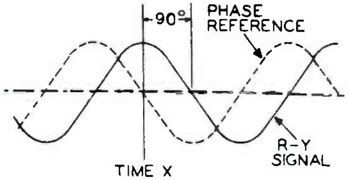




1. RED

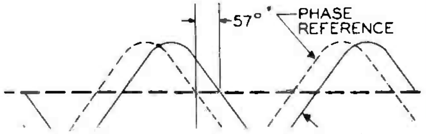
When red is transmitted, the chrominance signal may be represented by a vector which lags the phase-reference vector by 76.5 degrees. The magnitude or length of the vector for fully saturated red is 0.63.

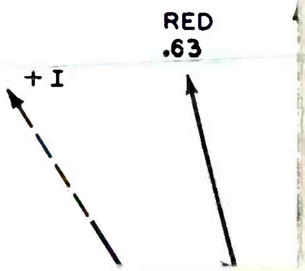


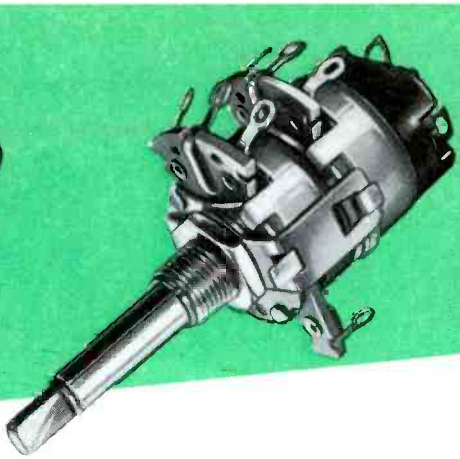


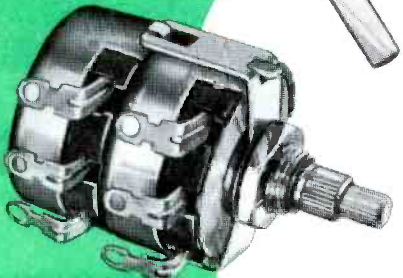
2. R-Y

During testing, an R - Y signal may be encountered. This signal may be represented by a vector which lags the phase-reference vector by 90 degrees. The fact that the R - Y vector has no prescribed magnitude is indicated on the phase diagram by the dotted portion of the vector.









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COLORBLOCK
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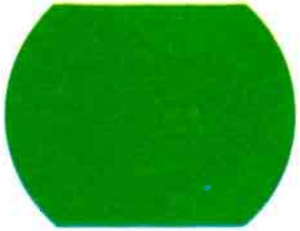
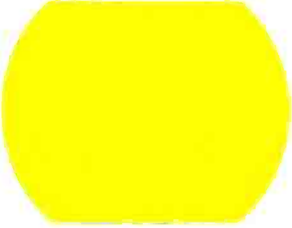
6. BLUE

7. CYAN

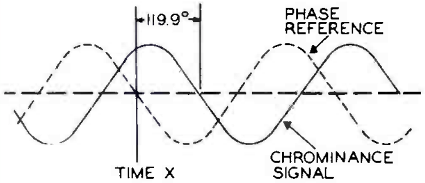


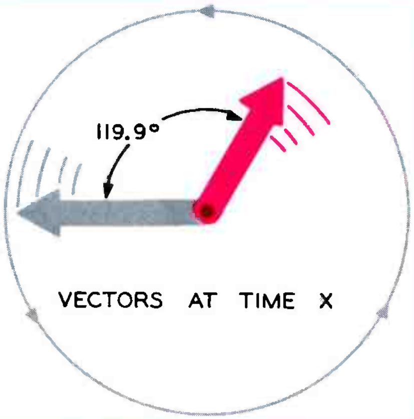
8. GREEN



9. YELLOW

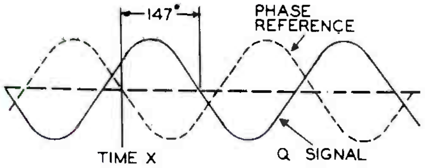
10. I

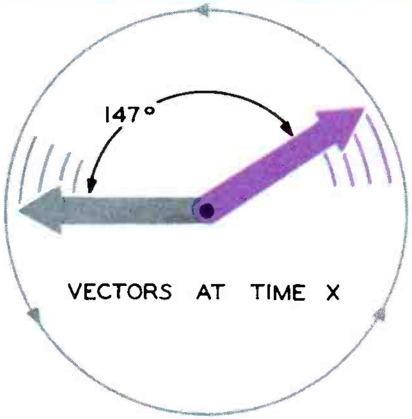




3. MAGENTA

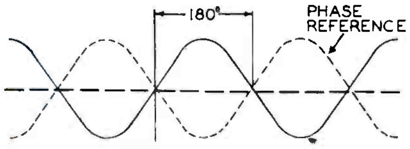
When the secondary color magenta is transmitted, the chrominance signal may be represented by a vector which lags the phase-reference vector by 119.9 degrees. The magnitude or length of the vector for fully saturated magenta is 0.59.

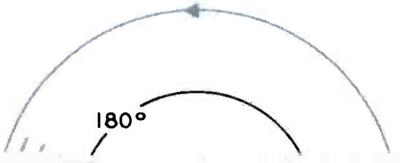


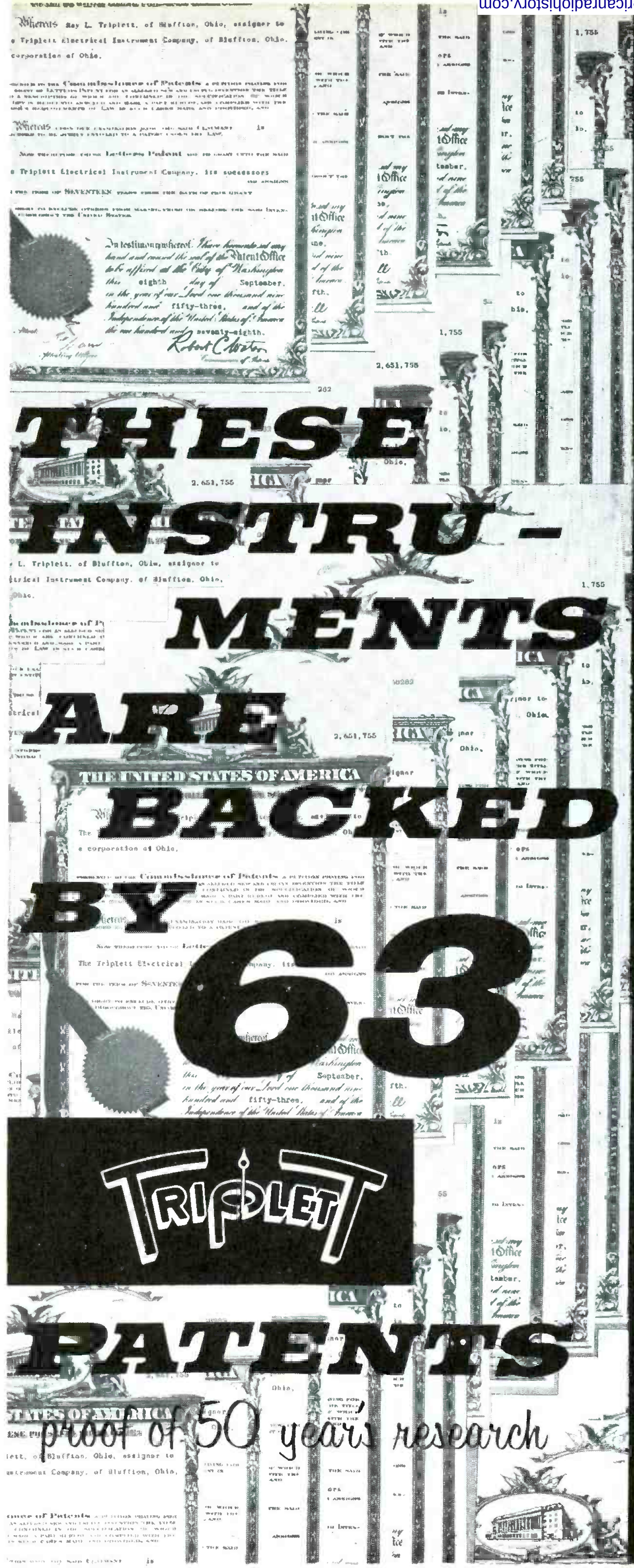


4. Q

During testing, a Q signal may be encountered. This signal may be represented by a vector which lags the phase-reference vector by 147 degrees. The fact that the Q vector has no prescribed magnitude is indicated on the phase diagram by the dotted portion of the vector.







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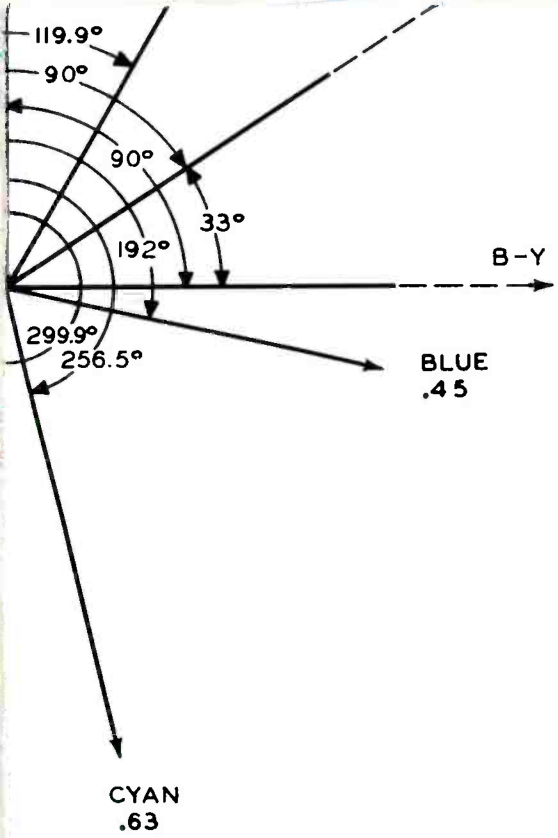
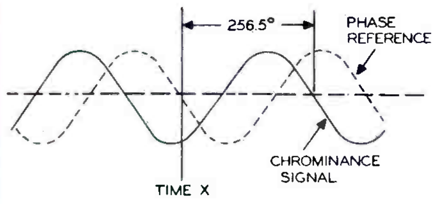
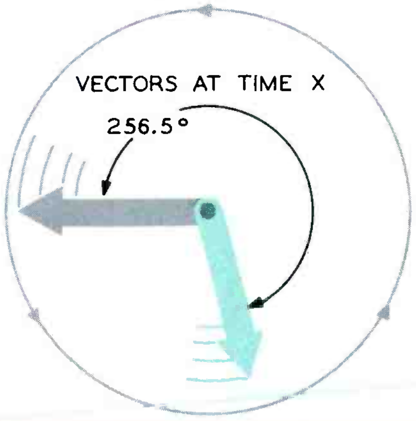




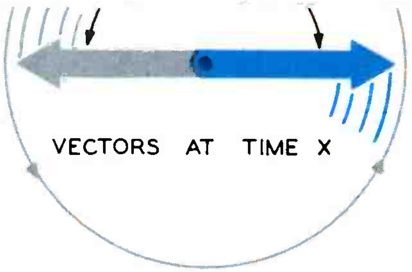
7. CYAN

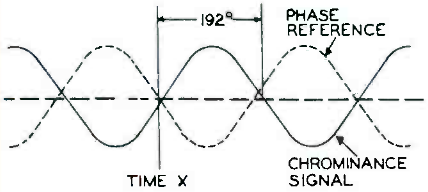
When the secondary color cyan is transmitted, the chrominance signal may be represented by a vector which lags the phase-reference vector by 256.5 degrees. The magnitude or length of the vector for fully saturated cyan is 0.63.



5. B-Y

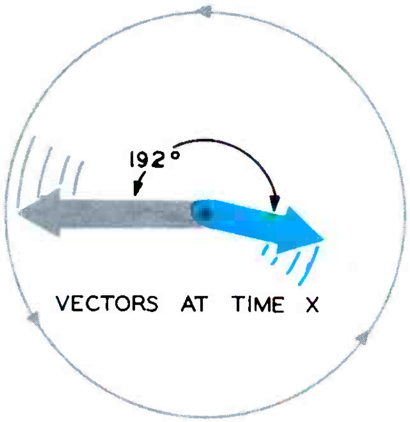
During testing, a B - Y signal may be encountered. This signal may be represented by a vector which lags the phase-reference vector by 180 degrees. The fact that the B - Y vector has no prescribed magnitude is indicated on the phase diagram by the dotted portion of the vector.





6. BLUE

When blue is transmitted, the chrominance signal may be represented by a vector which lags the phase-reference vector by 192 degrees. The magnitude or length of the vector for fully saturated blue is 0.45.



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*TRADE MARK

Reference Chart No. 4

A COLORBLOCK Which Defines the Various Parts of the Color Phase Diagram and Which Portrays Each Color Signal and Its Associated Picture-Tube Display.

PF REPORTER for the Electronic Service Industry December, 1954

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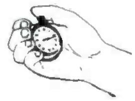
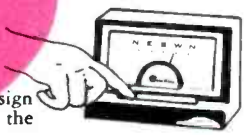


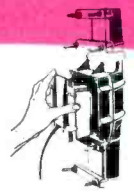
1 STOP WATCH TUNING ACCURACY

Pinpoint control system is unsurpassed in consistent accuracy of indication. Stops antenna instantly within ½ degree of desired position. No drift or ambiguity.



2 SMARTLY STYLED CONSOLE WITH PIANO TUNING

The striking control console is designed for beauty of design as well as ease of operation. Actuates the rotator with the slightest touch. Available in mahogany or ivory cabinet.



3 REPLACEABLE FACTORY SEALED CARTRIDGE UNIT

Sealed power drive unit eliminates the former need of dismantling the antenna when servicing. Simply loosen 3 screws to remove the sealed unit.

4 POWERFUL INLINE DESIGN

Supports direct dead weight load of largest stacked array. Resists downthrust and bending moment. Built-in thrust bearings. No extra parts to buy. No breakable offset bearings.

5 COLORFUL "CARRY-ALL" CARTON

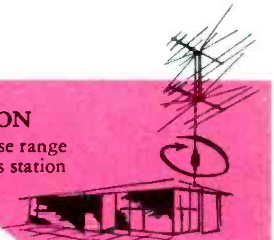
Safely protects Roto-King en route . . . eases on-the-job carrying of units . . . comes in handy in the shop or around the home. A JFD merchandising extra at no extra cost.

6 AUTOMATIC VOLTAGE COMPENSATION

Advanced circuitry achieves automatic voltage compensation for stability and exactness of indication despite line voltage fluctuations.

7 BALANCED POWER

Close tolerance 3200:1 reverted gear drive (within .002 in. tolerance) efficiently transmits 100% of developed power. No inherently weak worm gears.

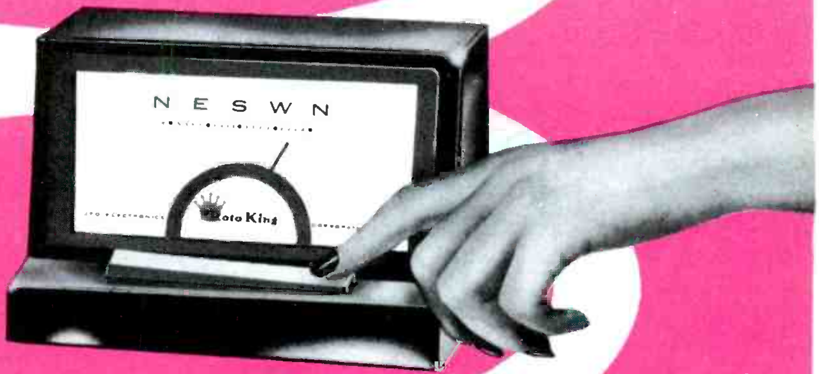


8 390 DEGREE ROTATION

390 degrees — the broadest traverse range now in use — speeds and simplifies station selection beyond standard 360 degree revolution.

Roto King®

is **rocking** the rotator market!

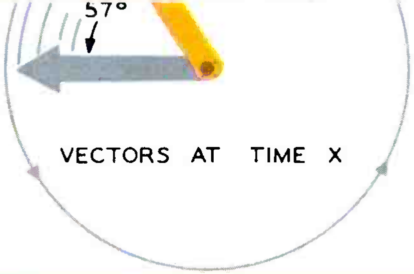


Model	Style	List
RT100-M	*Mahogany*	**$44.95**
RT100-IV	*Ivory*	**$44.95**

Write for 8-page *Roto-King* engineering brochure No. 288.

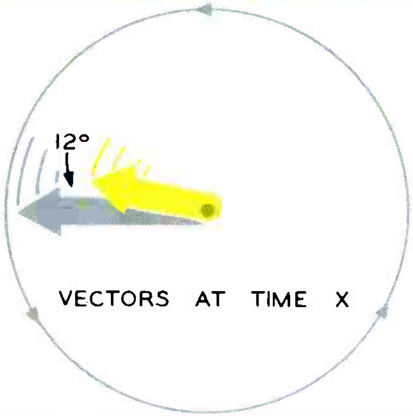
Look to JFD for Engineering Leadership!

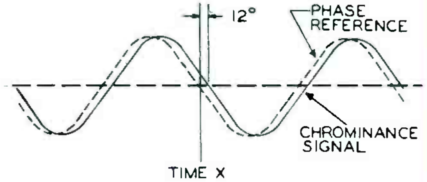
JFD MANUFACTURING CO., INC.
6101 16th AVENUE, BROOKLYN 4, N. Y.
INTERNATIONAL DIVISION: 15 Moore Street, New York 4, U.S.A.



10. I

During testing, an I signal may be encountered. This signal may be represented by a vector which lags the phase-reference vector by 57 degrees. The fact that the I vector has no prescribed magnitude is indicated on the phase diagram by the dotted portion of the vector.





9. YELLOW

When the secondary color yellow is transmitted, the chrominance signal may be represented by a vector which lags the phase-reference vector by 12 degrees. The magnitude or length of the vector for fully saturated yellow is 0.45.

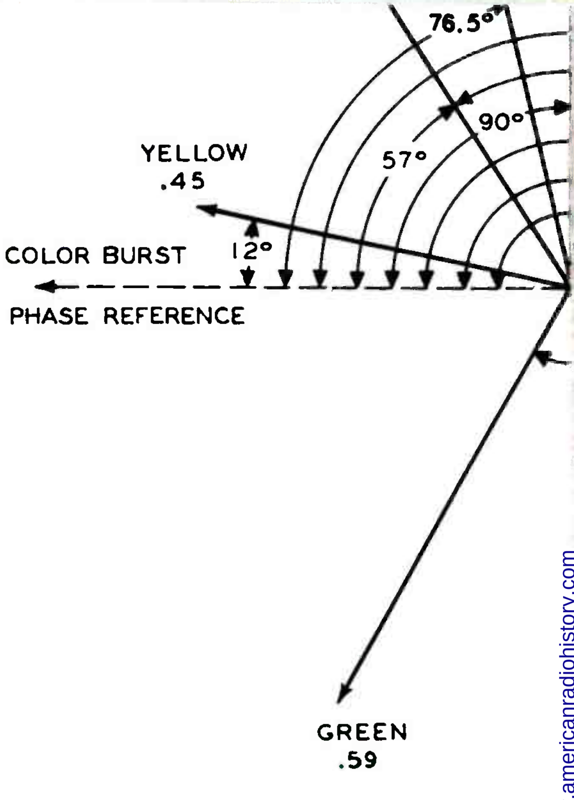
GENERAL NOTES

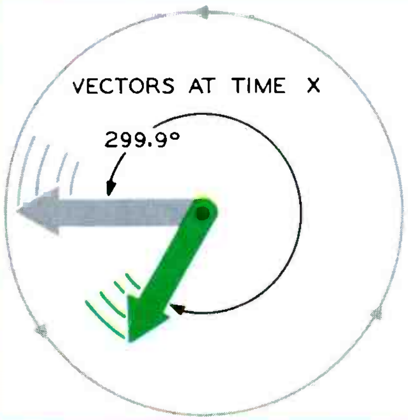
1. All vectors on this chart rotate at a speed of 3,579,545 revolutions per second. This rotational speed corresponds to the color-subcarrier frequency of 3.579545 megacycles.

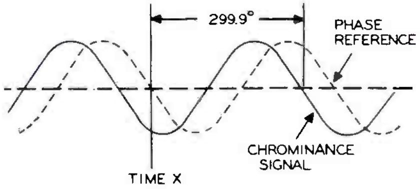
2. Time X during any one cycle is the instant at which the phase-reference vector assumes the position shown in each of the vector diagrams.

3. On the color-phase diagram, a decimal number appears with each of the vectors associated with the primary and secondary colors. Each number is the magnitude of the vector for that fully saturated color and indicates the peak amplitude of the chrominance signal when related to the difference in levels between black and white in the luminance signal. The latter difference is considered to be unity. Example: the peak amplitude of the chrominance signal for a fully saturated red is .63 times the amplitude of the luminance signal during a transmission of white.

4. The color-burst signal, which is transmitted only during a portion of the horizontal-blanking interval, is represented by a vector that coincides with the phase-reference vector for proper color reproduction.



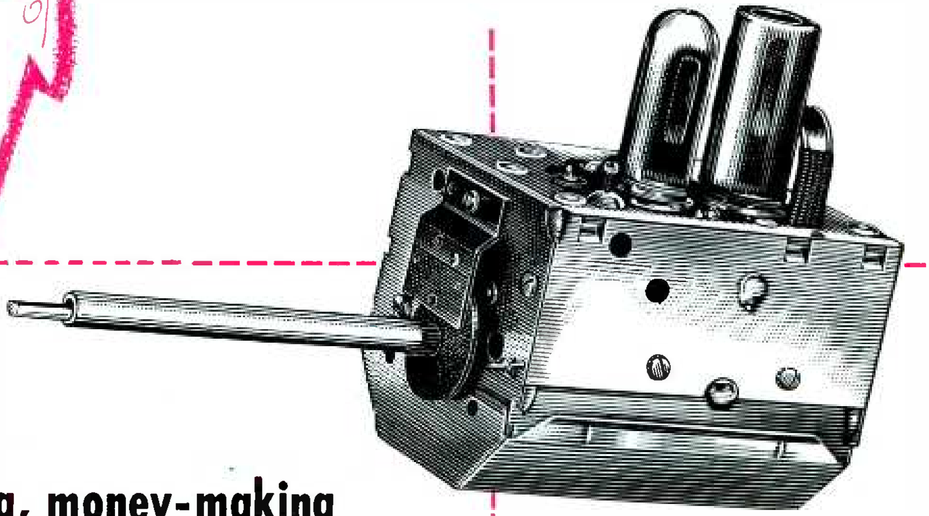




8. GREEN

When green is transmitted, the chrominance signal may be represented by a vector which lags the phase-reference vector by 299.9 degrees. The magnitude or length of the vector for fully saturated green is 0.59.

NOW! Any TV serviceman may ADD $60, $100 OR MORE A WEEK TO GROSS PROFITS!



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Hundreds of TV set owners in your community will welcome the sharper, stronger pictures afforded by newer, more powerful Standard cascode and pentode tuners. And a completely new Standard replacement tuner often costs your customer *less* than the parts and labor required for a major repair to the original tuner.

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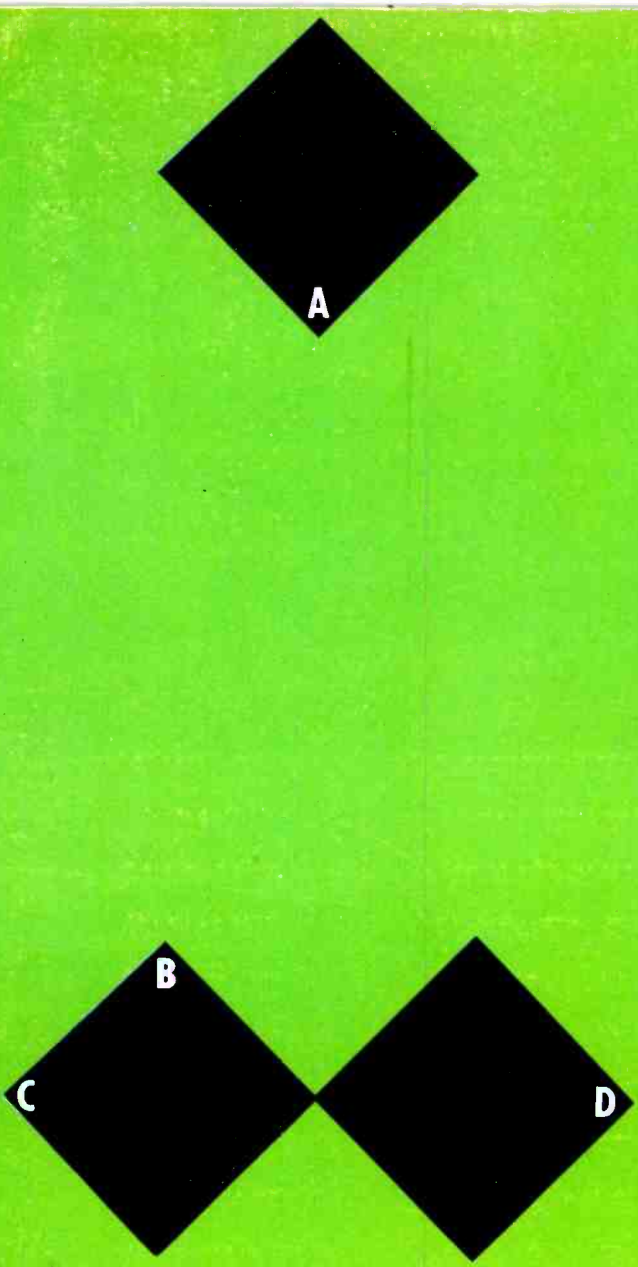
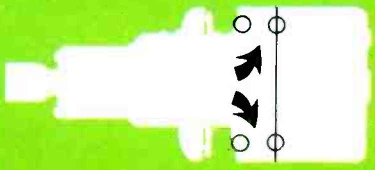


THINGS ARE NOT AS THEY SEEM...

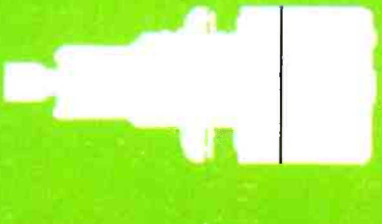
The distance AB is the same as the distance CD

These two fuse extractor posts look alike
BUT they are not

This fuse post is waterproofed to Signal Corp specifications by the addition of the sealing "O" rings indicated.



This fuse post lacking the "O" rings is for general purpose applications.



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