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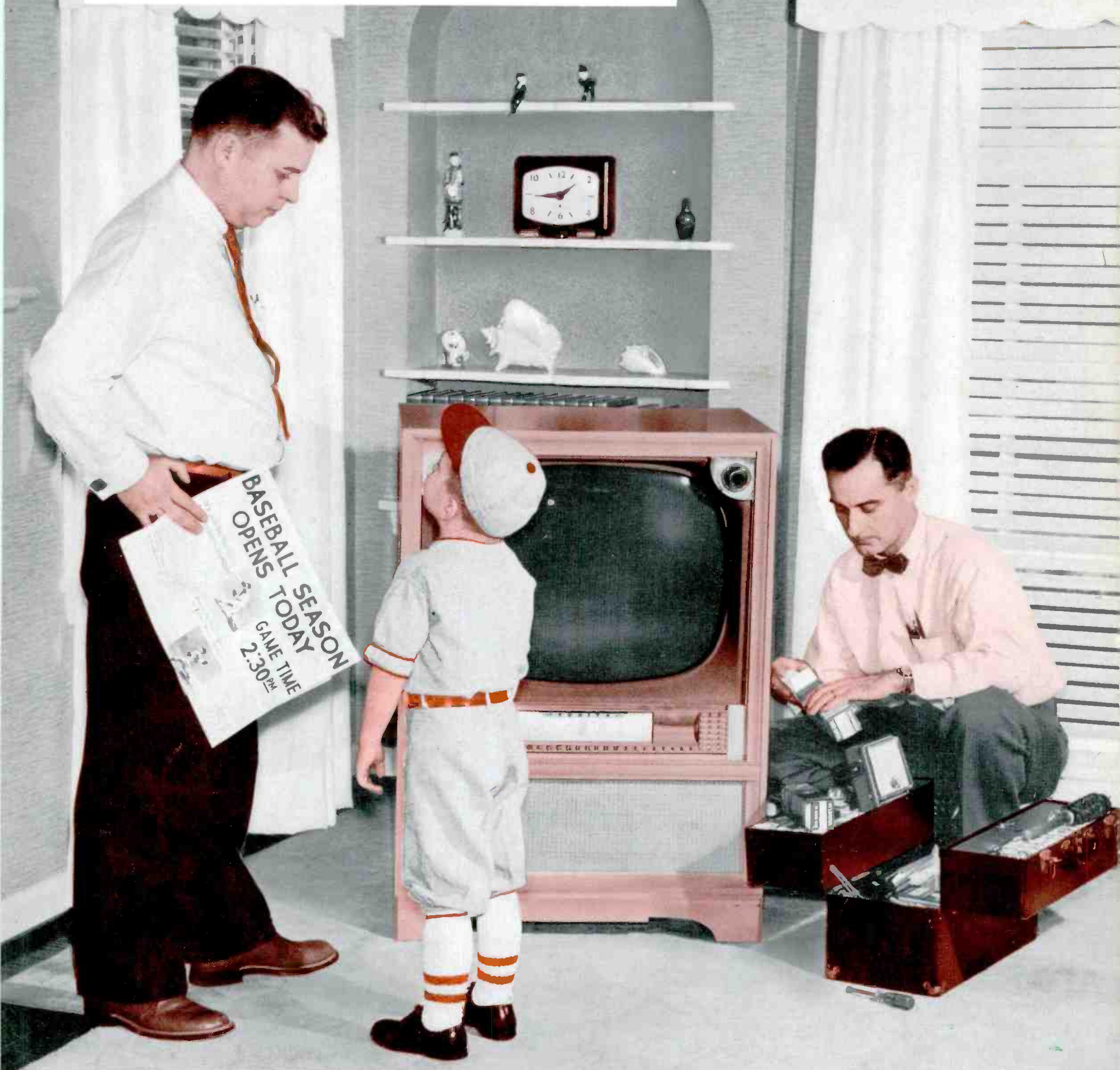

COLOR TV TRAINING SERIES Part XI

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CHECKING HORIZONTAL-OUTPUT TRANSFORMERS

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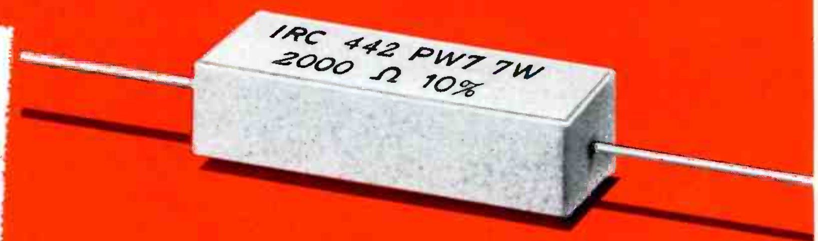

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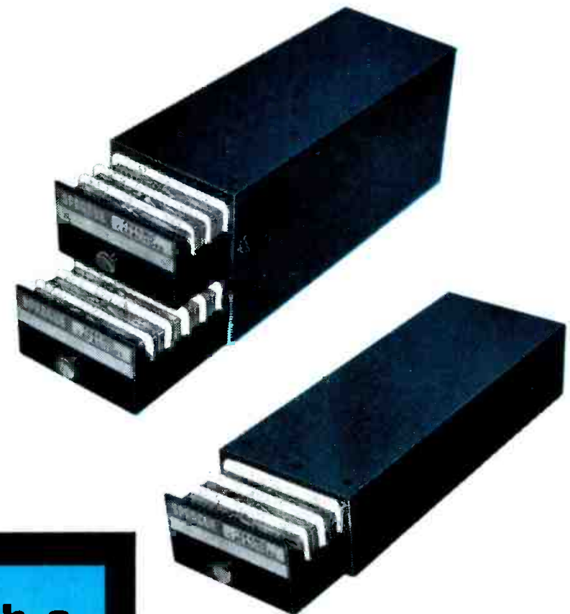

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5	5GA-Q33	5	5GA-T5
5	5GA-Q39	5	5GA-T68
5	5GA-Q47	10	5GA-D1
5	5GA-Q5	5	5GA-D15
5	5GA-Q68	5	5GA-D2
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SUBJECT REFERENCE

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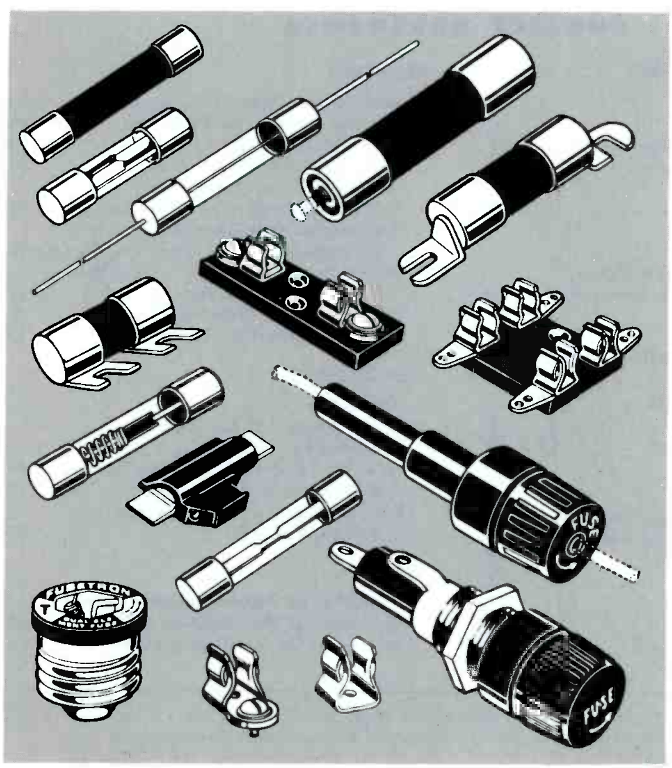

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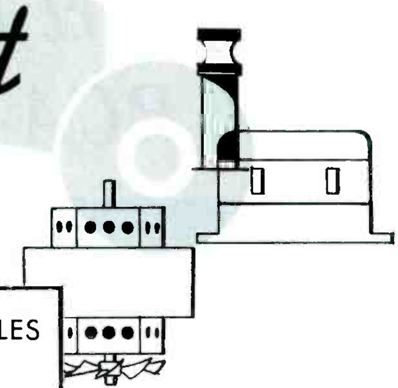
Tape-Transport MECHANISMS



THE FIFTH IN A SERIES OF ARTICLES DEVOTED TO THE PRINCIPLES OF MAGNETIC RECORDERS

by ROBERT B. DUNHAM

Some information about recording heads and tape used on tape recorders has been presented and basic magnetic principles have been discussed in the preceding articles of this series on magnetic recording. Most of the discussions have been concerned with the theories of operation, and they leave a large part of the story of tape recorders untold.

Even though we understand and know how a signal can be recorded and played back when the tape is passed across the heads of the recorder, we cannot actually record and play back until some mechanical arrangement for handling the tape and appropriate circuits to carry the signal are provided. Consequently, a tape recorder is a combination of mechanical and electrical assemblies.

The mechanical section is often called a tape-transport mechanism, which is a very descriptive name, because it handles and moves the tape. The electronic section contains the amplifier, bias, erase, and other circuits.

The mechanical and electrical sections are distinctly different in both physical construction and purpose; but each is dependent upon the other, and they must operate together in order to make recording and playback possible. Working together is so important that many of the operations performed by the separate sections are controlled by mechanical and electrical interlocks in order to ensure proper operation of the recorder. Both sections possess many interesting features, but we will consider the mechanical assembly first and take up the subject of circuits later.

The tape-transport mechanism, its controls, and the tape reels are probably the most noticeable and familiar parts of a tape recorder. The sketch in Fig. 1 illustrates a typical layout found in many machines. Transport mechanisms vary in details, but all operate on the same basic principle.

The erase head, record head, and playback or monitor head are arranged in that order from left to right because the tape moves from left to right during the record and playback modes of operation. See Fig. 1.

In some machines, the record and playback heads are combined into one unit, as was mentioned when heads were discussed in one of the articles in this series. The combination head is used in most of the less expensive home models. Although some compromises must be made when a head is used for both recording and playback, the inability to monitor that which has been recorded on the tape while recording is probably the most outstanding inconvenience caused by using a combination head.

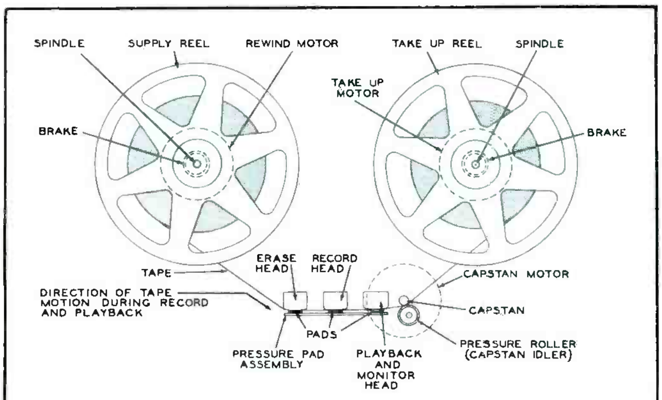


Fig. 1. Sketch Showing Major Parts of Typical Tape-Transport Mechanism.

The spacing of the heads in relation to each other is not critical and usually depends on the space available. Some recorders provide space for mounting additional heads for special applications.

Heads must be held securely in a mount which holds them in correct alignment. In higher quality machines, each head can be adjusted to the position giving the best results. Heads usually are not visible because they are kept covered in order to protect them from accidental damage and to shield them during operation.

Practically all recorders use an assembly of pressure pads to hold the tape in contact with the heads during the record and playback modes. During other modes such as rewind and fast forward, or when the machine is idle, the pads are moved away from the tape to reduce wear on the heads and tape.

A short description of some of the major parts shown in Fig. 1 will be given now, and more details will be given when the different modes of operation are described.

The reel on which the tape is stored when not in use is usually placed on the spindle of the supply and rewind assembly to function as the supply reel. This reel can be any one of the conventional reels that will fit and operate on the recorder. The spindle assembly, sometimes referred to as the turntable, is mounted on the shaft of the rewind motor which turns it in a clockwise direction when power is applied.

The hub of the spindle assembly is equipped with a brake to provide positive braking and to prevent over-

* * Please turn to page 52 * *

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COLOR TV TRAINING SERIES

PART XI
SETUP PROCEDURE

by C. P. Oliphant and Verne M. Ray

In Part X of this Color TV Training Series, the discussion of the color picture tube was concluded. During the complete discussion in Parts IX and X, it was pointed out that there are two types of picture tubes being manufactured for use in color receivers. The first type, which was discussed in Part IX in the February issue, is the picture tube that employs the electrostatic principle for beam convergence. The second type, which was discussed in Part X in the March issue, is the picture tube that employs the electromagnetic principle of beam convergence. Along with the discussion of each type, the external components and the associated circuits were also described and their operation explained.

With the conclusion of the discussion about picture tubes, the coverage of the circuits of the color receiver was completed. We will now begin a coverage on servicing the color receiver, and first we will present the setup procedures for the two types of picture tubes. The setup procedure for the electrostatic type will be given in this issue, and that for the electromagnetic type will be given in the next issue.

The ultimate goal of the setup procedure for either type is to make sure that the picture tube will be capable of producing the correct colors when a color signal is being received and that it will reproduce a black-and-white picture when a monochrome signal is being received. In order to reach this goal, the beams must be controlled so that each one will strike the correct set of phosphor dots and so that the beams will cross correctly at the plane of the aperture mask. With each beam striking the correct set of phosphor dots, color purity is achieved. When the three beams cross at the plane of the aperture mask, convergence of the beams is obtained. After proper purity and convergence are achieved and the intensities of the beams are in balance to produce the proper gray scale, the tube should produce good color pictures as well as good black-and-white ones.

THE ELECTROSTATIC TUBE

The setup procedure for the picture tube which requires electrostatic convergence is presented with the assumption that the circuits of the receiver are operating normally and that the receiver needs only those adjustments that are necessary for the proper operation of the color picture tube.

This would normally be the case when the set is first received from the manufacturer or when it is installed in a customer's home. The adjustments of the picture tube may be disturbed if the set is jarred while it is being transferred to the home. The setup procedure will also need to be performed when the picture tube has to be removed or replaced.

Preliminary Adjustments

Before starting the setup procedure for obtaining purity and convergence, a number of preliminary adjustments should be made. A transmitted signal, preferably a test pattern, is used while making these adjustments. The preliminary adjustments are similar to those which are made while setting up a monochrome receiver for proper operation. The AGC should be set so that overloading is not present. The range of the horizontal-hold control should be adjusted so that the picture will lock in properly.

The electrostatic type of tube is designed to operate with a voltage at the second anode of approximately 19,500 volts. Before making purity and convergence adjustments, it should be determined if the second anode has this amount of voltage present. The high voltage should remain within five per cent of the specified amount as the brightness control is varied through the part of its range that is normally used. If the picture tube is set up while the wrong amount of voltage is available at the second anode, the purity and convergence will not be correct.

All the adjustments that have to do with the size of the raster should be made. These include height, width, horizontal-drive, and linearity adjustments. The raster should also be properly centered both vertically and horizontally and should extend beyond the decorative mask by approximately one-fourth inch.

Following is a list of the preliminary adjustments:

1. Tune in a transmitted signal, preferably a test pattern.

2. Set the AGC so that overloading is not present.

3. If the picture does not properly lock in horizontally, make the necessary adjustments for the correction of this trouble.

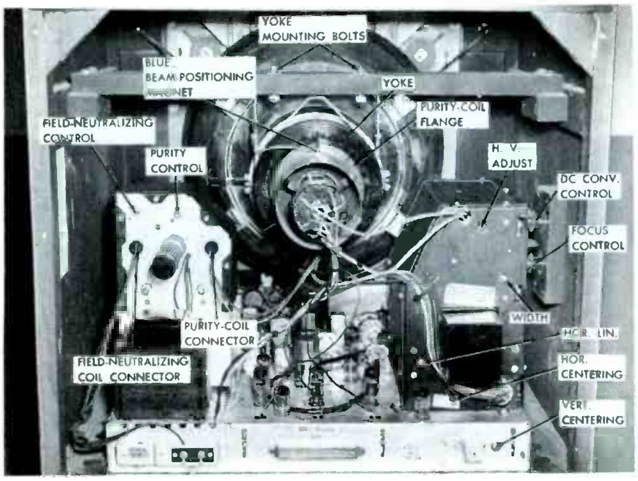
4. With the contrast and brightness controls at minimum, adjust the high-voltage control for approximately 19,500 volts.

5. Vary the brightness control through the part of its range that is normally used. If the high voltage varies more than five per cent of the specified amount, reset the high-voltage control.

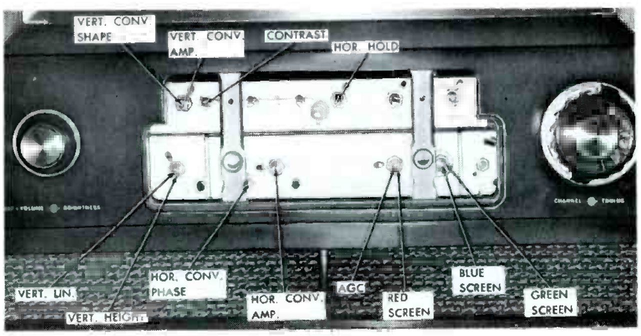
6. Obtain the correct height, width, horizontal drive, and linearity.

7. Center the picture vertically and horizontally.

After these preliminary adjustments are made, the picture tube can be set up so that purity and convergence will be obtained. The picture-tube components and controls which are discussed in the setup procedure for obtaining purity and convergence are shown in the photographs in Fig. 10-1. Fig. 10-1A is a rear view of the RCA Victor Model CT-100 color receiver, and Fig. 10-1B shows the front-panel controls on the same receiver.



(A) Rear View of Chassis and Picture Tube.



(B) Controls on Front Panel.

Fig. 10-1. Picture-Tube Components and Controls Associated With the Setup Procedure. The Receiver Shown Is an RCA Victor Model CT-100.

Purity Setup

One of the main requirements of the color picture tube is to produce pure colors on the screen. This means that when red is supposed to be reproduced, it should be done without the presence of any other color mixed with it. In other words, if only the red gun were turned on and the other two guns were off, the entire area of the screen should be red. The same thing is true for the other two primary colors – when only the green gun is on, the raster should be entirely green; and when only the blue gun is on, the screen should be entirely blue. In order for the picture tube to be able to do this, the beam from the red gun must strike only the phosphor dots which emit red light; the beam from the green gun must strike only the green-emitting dots; and the blue beam must stirke only the blue-emitting dots.

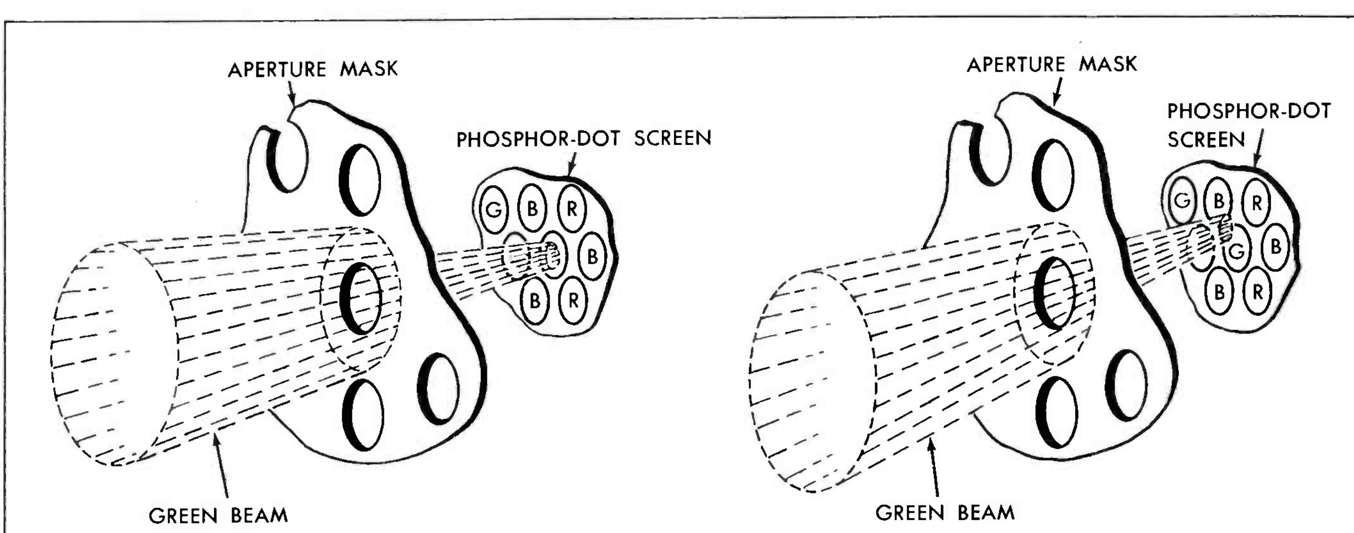
It has been said before that the aperture mask serves the purpose of masking two sets of phosphor dots from the beam that is supposed to strike the third set. However, if the beams are not correctly aligned with respect to the holes in the aperture mask, the beams will partially strike the dots that they are not supposed to strike. The drawings in Fig. 10-2 illustrate the correct and incorrect alignment of the beam from the green gun.

Fig. 10-2A shows that the beam from the green gun is correctly aligned so that it passes through the hole in the aperture mask and strikes the correct phosphor dot in a particular triad. In this case, the beam from the green gun is striking the phosphor dot that emits green light.

When the beam from the green gun is not properly aligned, as shown in Fig. 10-2B, it is striking the green dot but it is also striking a portion of the blue dot. This would result in color contamination. If the green beam were left in this position, the screen would have a bluish-green color at the time a pure green is supposed to be produced.

To achieve proper purity, there are three components which when properly adjusted will cause the beams to stike the correct dots. Two of these components are a purity coil which can be manually positioned and a field-neutralizing coil around the faceplate of the picture tube. The currents through both of these coils can be varied. The third component is the deflection yoke which must be positioned correctly on the neck of the tube. The magnetic shields which are placed around the bell and the neck of the tube prevent stray magnetic fields from interfering with the operation of the beams. These shields help to maintain better purity.

One thing to remember while making purity adjustments is that all three beams are acted upon simultaneously. That is, when the purity coil is adjusted, all three beams are moved an equal amount. In order for the beams



(A) Pure Green.

(B) Impure Green.

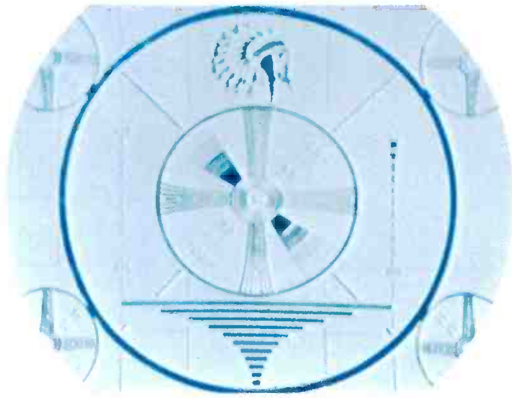
Fig. 10-2. Color Purity of the Green Beam.

REFERENCE PATTERNS FOR SETUP PROCEDURE

COLOR TV TRAINING SERIES

(Captions in Black Indicate Normal Operation)

(Captions in Red Indicate Abnormal Operation)

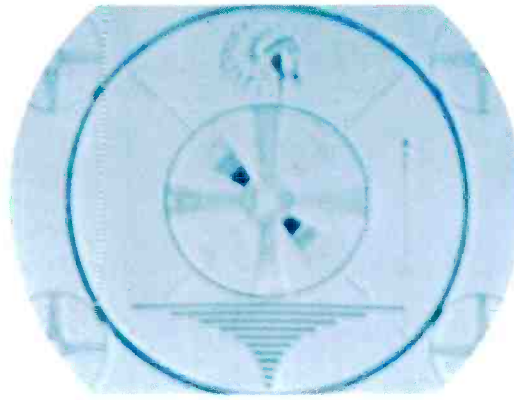


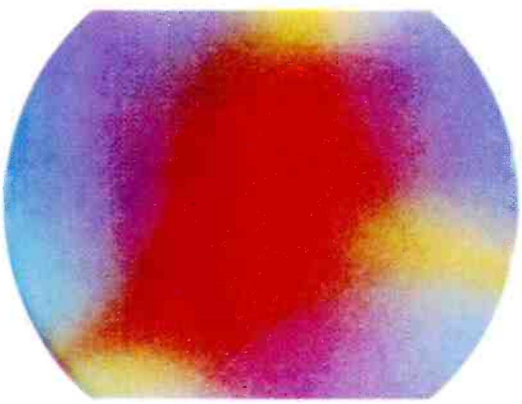
← Fig. A1

Properly Focused Test Pattern on Color Picture Tube.

Fig. A2 →

Improperly Focused Test Pattern on Color Picture Tube.



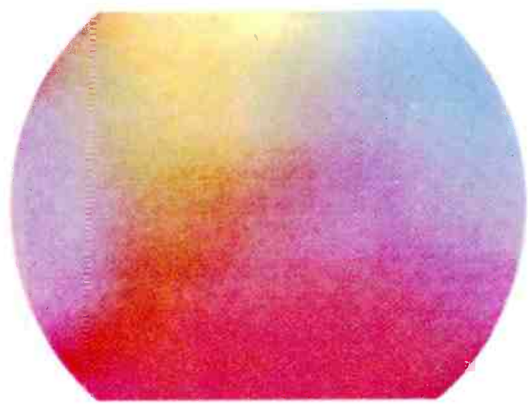


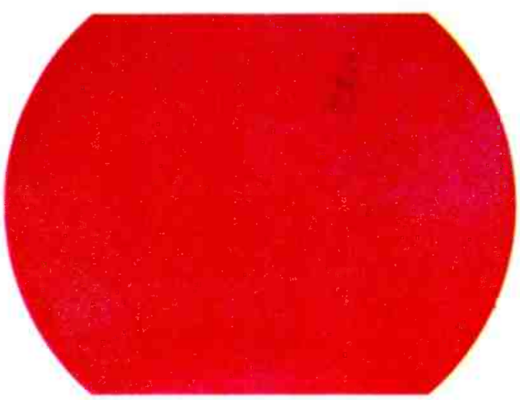
← Fig. A3

Pure Red in Center Indicates Purity Coil Is Correctly Adjusted.

Fig. A4 →

Impure Red in Center Indicates Purity Coil Is Incorrectly Adjusted.



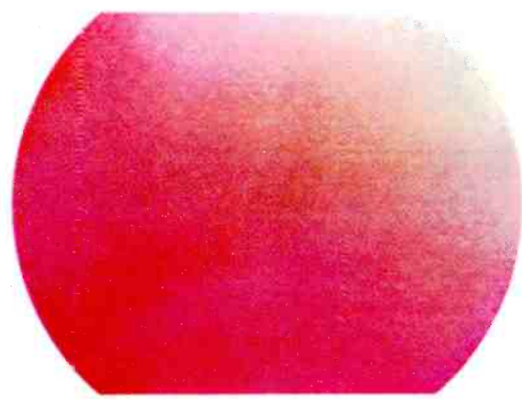


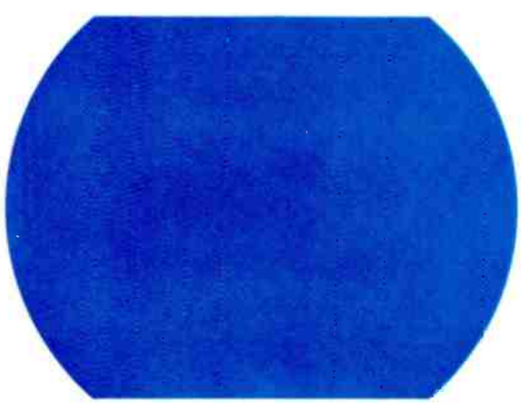
← Fig. A5

Pure Red Screen.

Fig. A6 →

Impure Red Screen Due to Misadjustment of Field-Neutralizing Control.



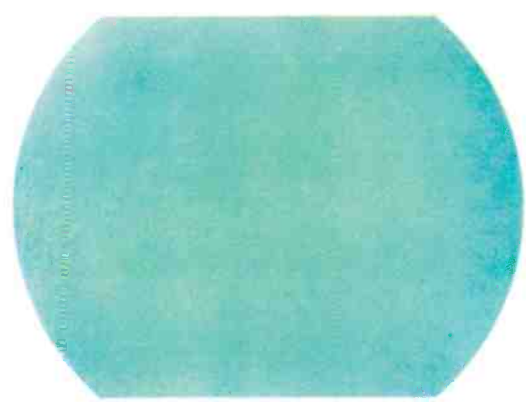


← Fig. A7

Pure Blue Screen.

Fig. A8 →

Pure Green Screen.



REFERENCE PATTERNS FOR SETUP PROCEDURE

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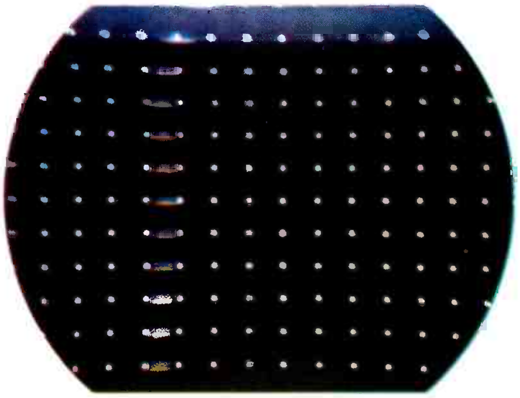


← Fig. A9

White-Dot Pattern Showing Properly Converged Beams.

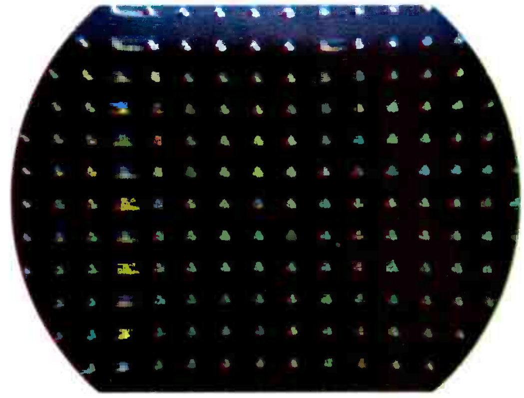
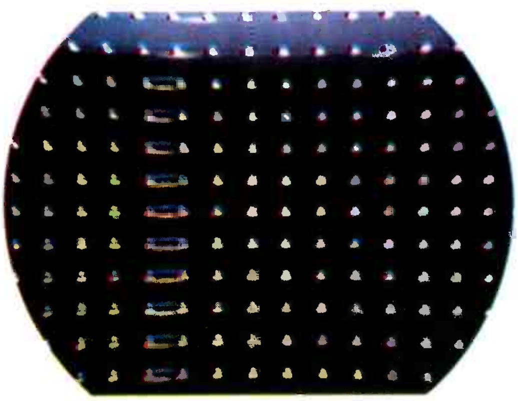


Fig. A10 →

Dot Pattern Showing Under-Converged Condition of Beams.



← Fig. A11

Beams Positioned So That Dots Form Proper Triads.

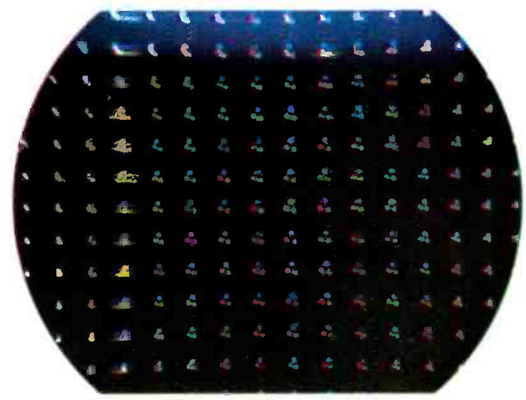
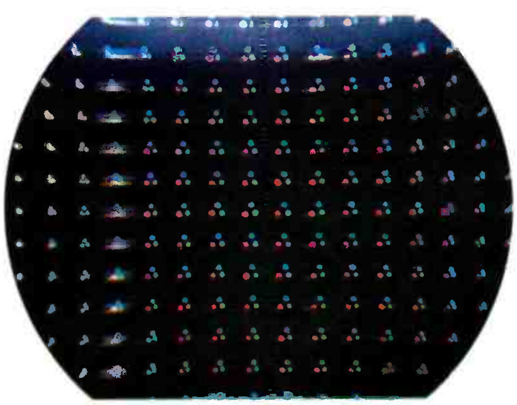


Fig. A12 →

Dots in Triads Incorrectly Placed Because of Misadjustments of Beam-Positioning Magnets.



← Fig. A13

Proper Placement of Dots Within Each Triad in Vertical Row at Center Indicates Correct Vertical Dynamic Convergence.

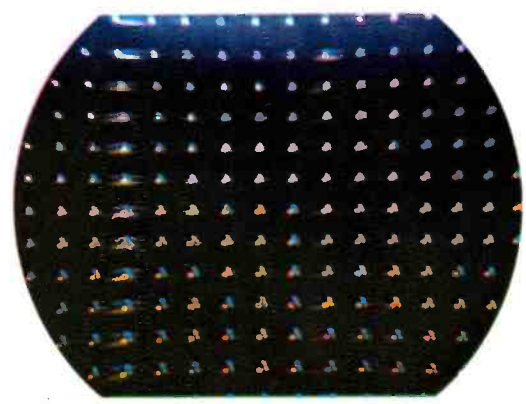
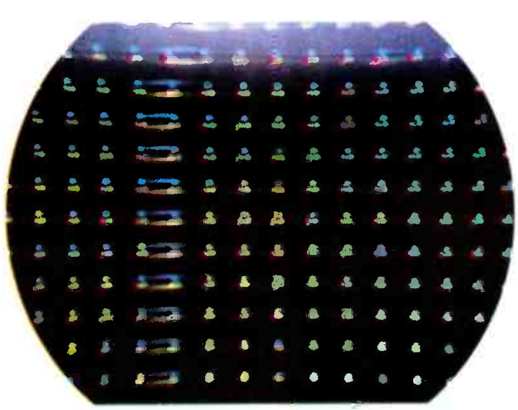


Fig. A14 →

Improper Placement of Dots Within Any Triad in Vertical Row at Center Indicates Incorrect Vertical Dynamic Convergence.



← Fig. A15

Proper Placement of Dots Within Each Triad in Horizontal Row at Center Indicates Correct Horizontal Dynamic Convergence.

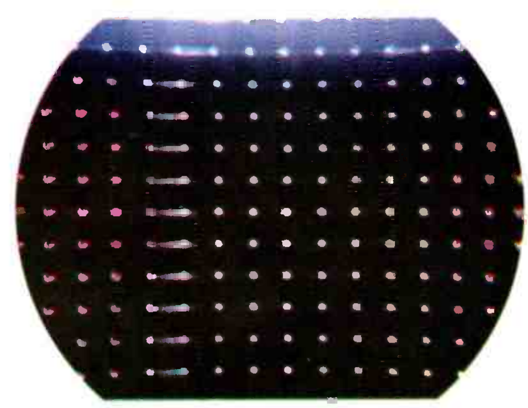


Fig. A16 →

Color Fringing of Dots in Horizontal Row at Center Indicates Incorrect Horizontal Dynamic Convergence.

to strike the correct dots, the central axis of the beams must coincide with the central axis of the tube so that the beams will be aligned properly with respect to the aperture mask and screen. Usually, whenever one color field is pure, the other two will also be pure; therefore, purity adjustments are made while viewing one color field. An entirely pure red field is the most difficult field to obtain; therefore, purity adjustments are made to obtain a pure red field. The receiver does not require an input signal in order for purity adjustments to be made.

Since only the red field is to be viewed while making purity adjustments, the red gun should be conducting at maximum and the green and blue guns should be cut off. It is possible to achieve this by turning the screen control for the red gun to its maximum (clockwise) position and the screen controls for the green and blue guns to their minimum (counterclockwise) positions. If purity is correct at this time, the screen of the picture tube will be entirely red. If colors other than red are present, it is because the beam from the red gun is striking other phosphor dots in addition to the red. The impurity is not due to the other two beams energizing the other colored dots, because these beams have been cut off.

The purity coil, the beam-positioning magnets, and a neck shield together form an assembly. The location of this assembly with respect to the base of the picture tube is specified in the installation instructions for the picture tube. The rear edge of the shield bracket should be approximately one-fourth inch beyond the front edge of the picture-tube base. See Fig. 10-3.

The best purity-coil adjustment is achieved by striving for a pure red in a small area at the center of the raster. The field-neutralizing coil should not have an effect upon the adjustment of the purity coil, therefore, it is prevented from doing so either by removing its connector plug or by setting its control to mid-position. There will be no current flowing through the coil at this time; therefore, there will be no field produced.

It is desirable to have a very weak magnetic field produced by the purity coil. The stronger the field, the more chance it has of interacting with other magnetic fields around the picture tube. Since the strength of the field is determined by the amount of current flowing through the purity coil, this current should be kept as low as possible. The purity-coil control which varies the current through the coil should be set at its minimum position. When the purity coil is properly positioned, it will be necessary to adjust the purity-coil control only slightly.

In order to produce a red area in the central portion of the screen, the deflection yoke is moved to the rear as far as possible. The yoke in this position is shown in Fig. 10-3. Next, the purity control and the position of the purity coil are alternately adjusted until the screen shows a pure red in the central area. The purity coil is rotated by grasping the flange and turning it around the tube, as shown in Fig. 10-4. The red area at the center of the screen should cover approximately one third of the total area of the screen.

The photograph in Fig. A3 of the Color Plate shows the appearance of the screen as pure red in the center when proper adjustment of the purity coil is achieved. Fig. A4 of the Color Plate shows the screen when the purity coil is improperly adjusted. It can be seen in this photograph that the central area of the screen is not a pure red.

After a pure red is obtained in the center of the screen, the yoke is moved forward until nearly all of the raster is red. The yoke in a forward position is shown in Fig. 10-5. The photograph in Fig. A6 of the Color

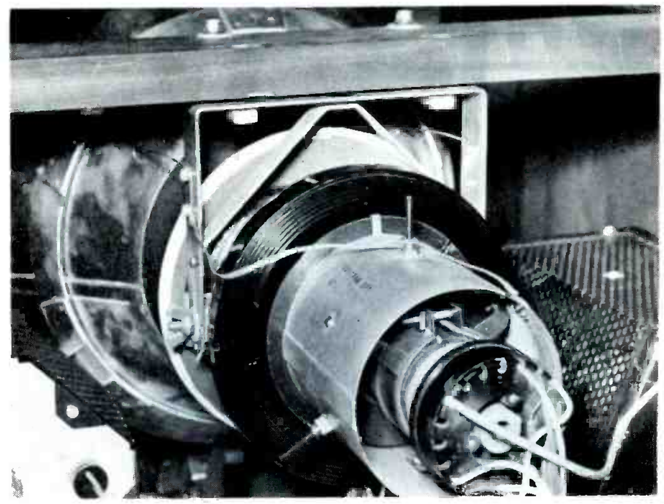


Fig. 10-3. Deflection Yoke Moved to the Rear.

Plate shows the color field produced when the yoke is moved forward. The movement of the yoke will affect the purity setting; therefore, it is necessary to readjust the purity coil slightly in order to obtain better purity. The reason that the color around the edges of the red raster is impure is because the field-neutralizing coil has been previously de-energized and because some stray magnetic fields are disturbing the red beam at the edges of the raster.

In order to obtain pure red on the entire area of the screen, the field-neutralizing coil should be energized. It is placed into operation by reinserting the plug or by adjusting its control either way from mid-position. The current through the coil is varied until the impurities around the edge of the screen are removed. This should produce a pure red screen similar to that shown in Fig. A5 of the Color Plate. The degree of purity achieved will depend upon the particular receiver being adjusted. Some receivers may produce colors that appear more pure than others.

After a pure red field is obtained, the green and blue fields should also be pure. These fields should be checked

* * Please turn to page 45 * *

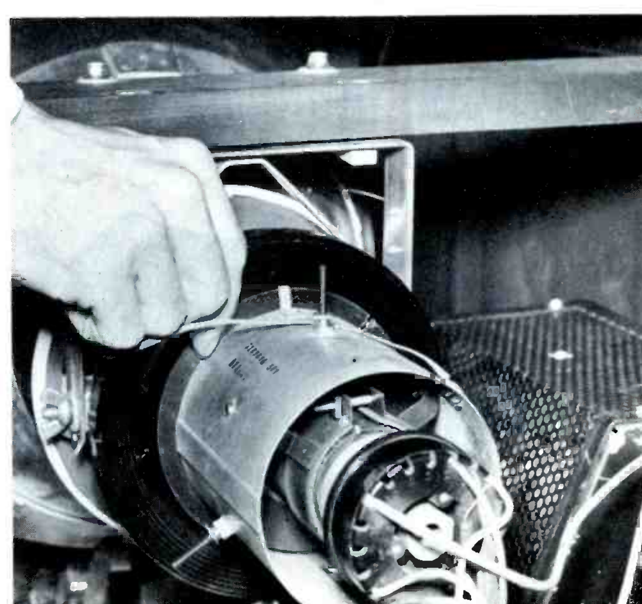
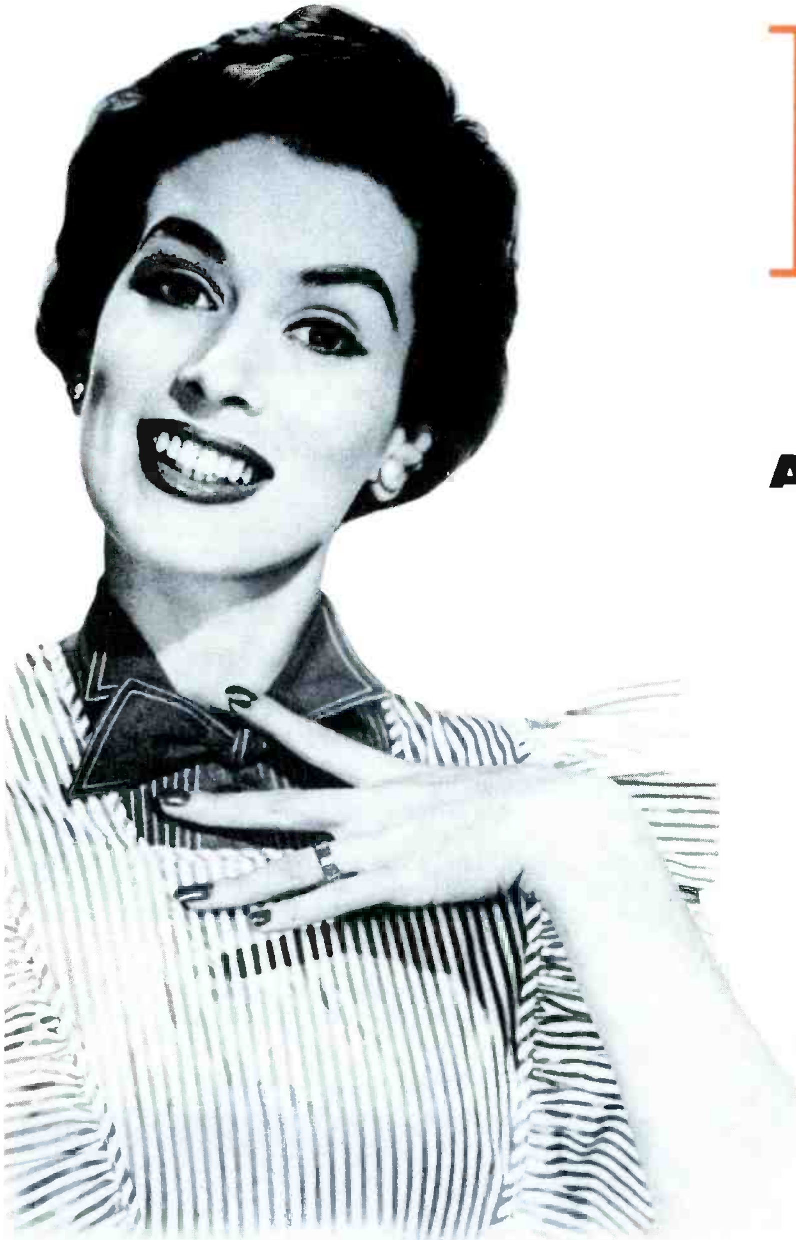


Fig. 10-4. Adjusting the Position of the Purity Coil.

WHO'S THE ONE YOU TALK TO



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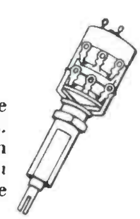

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Shop Talk

MILTON S. KIVER
President, Television Communications Institute

A considerable amount of information on the theory and operation of color television receivers has appeared in the technical press; however, practically no data has been given concerning the actual operation of these receivers in the customers' homes. It may be instructive to study some case histories to see just what difficulties have been encountered. The cases to be discussed are taken from the files of Central Television Service — an organization with which this writer has been associated for a number of years in a consulting capacity.

The manner in which Central Television Service prepared for the advent of color television may be of interest since it exemplifies what has been done to meet this challenge. Back in December of 1953 when the Federal Communications Commission approved the NTSC color system, the supervisory personnel of Central TV held a meeting at which the entire color process was discussed. Those present at this meeting were told how to answer customers' queries about color TV. The answers prepared were short and direct and insofar as possible would give the customers the following "unvarnished" facts:

1. That color TV would be more desirable than black-and-white TV.

2. That eventually a good percentage of first-rate TV broadcasting would be in color.

3. That the first color sets would have small screens and be high priced.

4. That the inventiveness of TV engineers was such that in time all major obstacles would be satisfactorily solved just as they had been solved for black-and-white TV.

The supervisors, in turn, briefed their men; and during the ensuing months when the sales departments of every manufacturer were having a field day issuing daily communiques on color, the customers of Central TV were kept sufficiently informed to enable them to sift truth from fancy.

In the meantime, Central TV was making plans to obtain at least one color set from each manufacturer as soon as it became available. The arrival of these sets made possible the second phase of the operation — namely, instruction of all company service technicians concerning the theory and operation of commercial color TV receivers. Accordingly, a series of Wednesday-evening lectures was initiated by this writer. The lectures started around 8:30 p.m. and generally continued for about two hours, with a 20-minute break at a convenient intermediate point. At the end of each lecture, the meeting was thrown open for general questions about any of the points covered in that particular lecture or in any preceding one.

Installation and adjustment procedures on the sets actually on hand were demonstrated and repeated a sufficient number of times so that all men would know: (1) why a certain procedure was necessary, and (2) how it could be carried out as quickly and as accurately as possible.

The lecture series continued for some eight weeks. Thereafter, the men were referred to published articles to help keep them abreast of current developments in the field.

In the fall of 1954, CBS-Columbia and Motorola appeared with 19-inch color receivers; and a small number (somewhat less than 100) were installed by Central Television men in the Chicago area. Since the number was quite low, only a few service technicians were needed. As more men are needed for color servicing, they will be brought in on the basis of ability and training until eventually all service technicians in the organization will be capable of tackling any type of service call. By that time, too, many of the current "bugs" in color-TV operation should have been eliminated so that less skill will be required for service and installation. By adopting the foregoing approach, the organization assures the customer of better service.

The steps of preparedness by Central TV have been given as an example of what can be done in this line by other service organizations.

The two makes of color receivers with which Central TV dealt chiefly were Motorola and CBS-Columbia sets using the CBS-Hytron 19-inch color tube, and they are therefore the only ones discussed. If other makes had been serviced extensively, they would undoubtedly have had troubles and would have been included, too.

The electrical characteristics of the two color receivers under discussion are, in many respects, considerably different from each other. The CBS receiver contains 40 tubes plus 3 high-voltage rectifiers, 2 selenium low-voltage rectifiers, and 3 crystal diodes. All this is in addition to a 19VP22, 19-inch tricolor picture tube. The Motorola receiver employs 26 circuit tubes, 3 high-voltage rectifiers, 3 selenium low-voltage rectifiers, 3 germanium diodes, and the tricolor picture tube. The significant difference in the number of tubes stems primarily from the different chrominance demodulation methods which each set employs.

In the CBS receiver, the chrominance signal is demodulated along the I and Q axes. Use of this method involves a mixing matrix; and follow-

* * Please turn to page 75 * *

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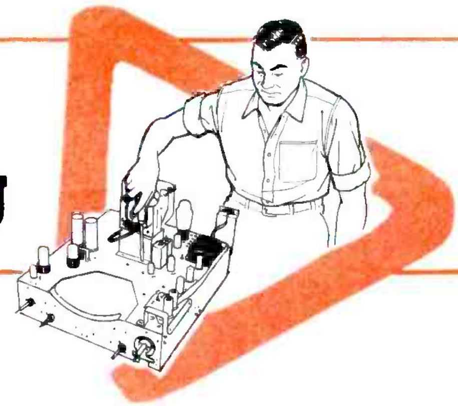

by **Henry A. Carter** *and* **Calvin C. Young, Jr.**

IN THE SHOP

Trouble in One-Tube TV Tuners

The one-tube TV tuner illustrated in Fig. 1 has been known for frequent failure on the high channels (7 through 13). One possible explanation for these failures is that the oscillator is so critical at these high frequencies that conditions in the tuner must be ideal or else the oscillator will cease functioning.

Because of this critical operating characteristic, it might be interesting to cite cases in order to point out the various operations performed in trying to restore normal operation on the high channels.

The first step in an endeavor to restore normal operation to a receiver that was inoperative on the high channels was to replace the 12AT7 tube in the tuner. Although this did not restore the operation on the high band, it did improve the low-band reception. The old tube was checked on a tube tester and found to be very low in mutual conductance; therefore, the new one was left in the set.

The next step was to make a close inspection of the spacing between the tuning plates to see if any of the plates were touching the adjacent coils. None were; but if there had been one, it would have shorted the B+ voltage to ground since the coils are in the B+ circuit and the tuning plates are grounded. This inspection was made by placing a light on the opposite side of the tuner and by looking through the tuner toward the light while rotating the tuning control.

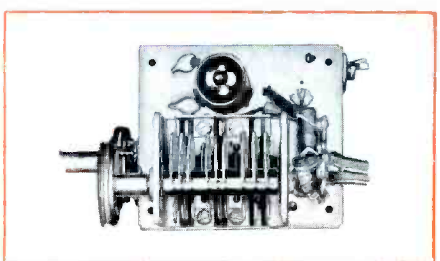

Fig. 1. The One-Tube Tuner.

Since there is approximately 130 volts potential on the coils with respect to ground, it was decided that a careful but thorough cleaning of the coils and tuning plates was in order. This was done while making the inspection, but it did not seem to help the situation.

The next step was to clean all the switch contacts thoroughly with contact cleaner and a brush. As each contact was cleaned, it was checked for proper tension; but the tuner still was inoperative on the high channels.

Hoping that the trouble was a result of a cold solder joint, which is sometimes the case, the technician went through the entire tuner and with a soldering iron heated every joint enough to melt the solder. As a result, the set operated satisfactorily on the high channels. The technician was elated; and most of all, the customer was happy. Three days later, however, the set was back in the shop. The complaint was that there was no reception on the high channels!

The technician decided that the best thing to do was to continue working where he had left off before. Since the voltages in this tuner could be measured without removing the tuner from the chassis, the technician decided to check them. Whenever he made a measurement, he switched the Hi-Lo band switch back and forth to see how the voltages would compare. He quickly found that the plate supply voltage was dropping approximately 30 volts when the switch was in the high-band position.

In an attempt to find the cause of the decrease in voltage on the high channels, the technician chose to measure resistances and compare them to those on the resistance chart in the PHOTOFACT Folder covering this set. Again, he rotated the Hi-Lo channel switch back and forth. There were no differences between the readings on each band, and these readings varied only slightly from the figures given in the resistance chart.

Since there appeared to be no shorts in the tuner, the technician could think of only one other cause for the decrease in voltage — one of the sections of the tube might be drawing too much plate current. If all the resistance readings were satisfactory, the cause for the high plate current might be loss of grid drive. As can be seen in the schematic diagram in Fig. 2, the band switch has no effect upon the grid circuit of the first stage; therefore, the loss of drive would have to be in the grid circuit of the oscillator. By using logic, the technician eliminated as causes of the trouble all of the components in the grid circuit of the oscillator except the tuning coil because the switch changes only the connections of the tuning coil. The other components are always in the circuit, and a trouble in any one of them would appear as a loss of reception on both bands.

The grid coil used in the high-channel circuit was found to be open when the ohmmeter leads were placed across it. Since replacements are no longer available for these coils, efforts were made to repair the defective coil without disassembling the tuner, but to no avail.

The labor cost involved in disassembling one of these tuners and removing a coil for repair would be more than the tuner is worth. Besides that, much time would be wasted if the tuner could not be repaired. When this was pointed out to the customer, and although it was explained to him that the tuner could be replaced

* * Please turn to page 81 * *

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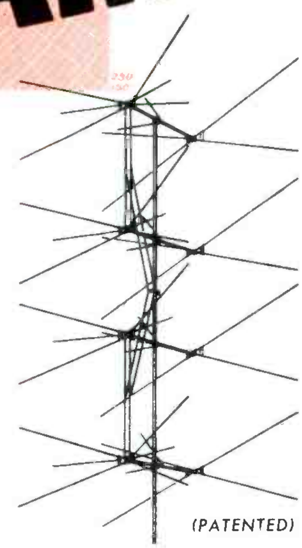

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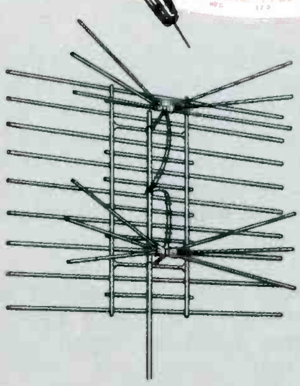

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A GLIMPSE . . . INTO Color SERVICING

PART II

Additional Case Histories of Trouble-Shooting Experiences

BY VERNE M. RAY

In order to furnish the TV service industry with some idea of the problems which can be encountered in servicing color receivers, we have kept records of our experiences with these sets. Three case histories based on these experiences were described in "A Glimpse Into Color Servicing, Part I," which appeared in the February 1955 issue of the PF REPORTER. Four more case histories will be covered in this issue.

Case History No. 1

An indication of trouble in the RCA Victor Model CT-100 was noted when it became impossible to reproduce properly the hues of a color-bar pattern. The operation of the receiver was normal during a monochrome transmission, so it was assumed that the trouble was somewhere in the chrominance channel or

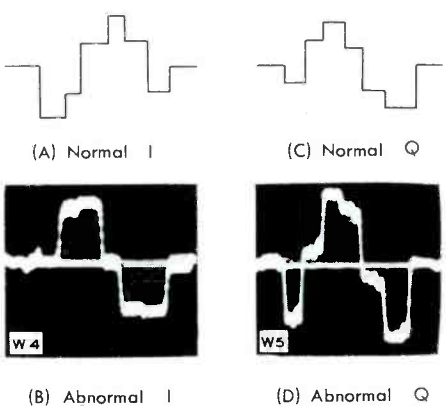

Fig. 1. I and Q Signals From Synchronous Demodulators Referred to in Case History No. 1.

in the color-synchronizing section. The I and Q signals at the outputs of the synchronous-demodulator stages were observed on the oscilloscope. These signals are shown by waveforms W4 and W5 in Fig. 1. The line drawings above these photographs show the normal waveforms which should have been observed at these points. A comparison between the line drawings and the actual waveforms reveals that the trouble was located ahead of these points in the receiver.

The next step was to observe the signals at the inputs of the demodulator stages. The chrominance signal seemed to be normal. The 3.58-mc reference signals applied to these stages could be observed, but it was not possible to determine whether or not they were of the correct phase. Since the chrominance signal appeared normal, it was assumed that the respective phases of the two reference signals were probably incorrect. Such a condition would produce the improper I and Q signals previously observed.

The circuits of the 3.58-mc oscillator and of the reactance tube were checked, but no discrepancies could be located. The idea that the phase of the 3.58-mc oscillator might be incorrect led to a check of the circuit which determines this phase. This circuit is the phase-detector circuit and is shown in Fig. 2.

The signal which was being applied to the detector stages from the burst-amplifier transformer is shown by waveform W6 in Fig. 3. It can be seen that the entire chrominance signal was present at this point. This is a definite indication that the burst amplifier was not operating properly. The burst amplifier is normally biased to cutoff and is keyed during retrace time in order to amplify only the color-burst signal.

Waveform W7 in Fig. 4 shows the signal which was observed at the grid of the burst amplifier. Note that the positive pulse which normally

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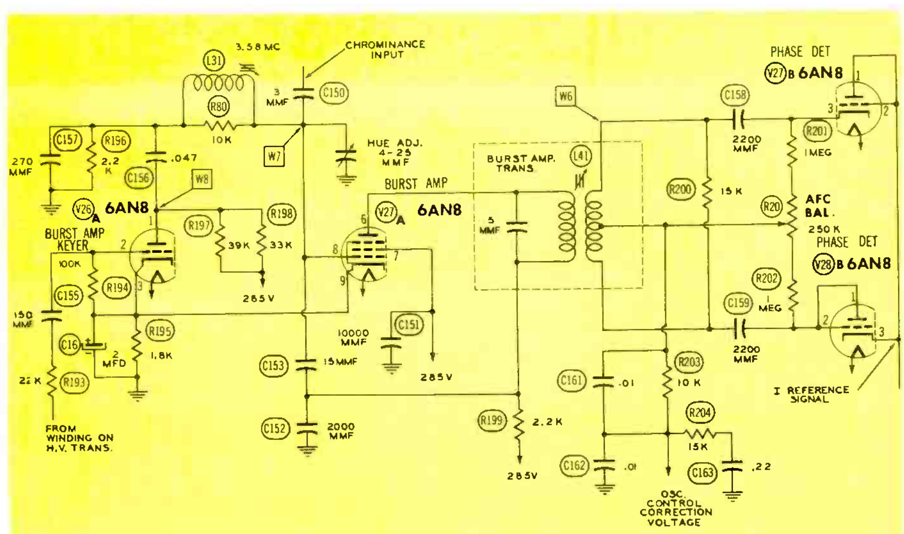

Fig. 2. Partial Schematic of Circuit Under Investigation in Case History No. 1.

Notes On
TEST EQUIPMENT

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

by Paul C. Smith

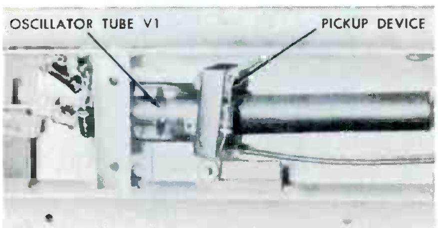

Fig. 1. Section of the Triplett Model 3436 UHF Signal Generator Showing Movable Pickup Device Which Operates As an Attenuator.

ATTENUATORS

The front panels of most test instruments are studded with a variety of controls. Some of these controls require a certain amount of thought or judgment for operation, others may be as simple in operation as the common light switch in the home. Most attenuators fall into the latter classification; their operation is simplicity itself. If the signal generator is putting out too great a signal, the technician turns the attenuator a step or two to reduce the signal strength; if the signal is too small, he turns the attenuator the necessary amount without giving much thought to the matter.

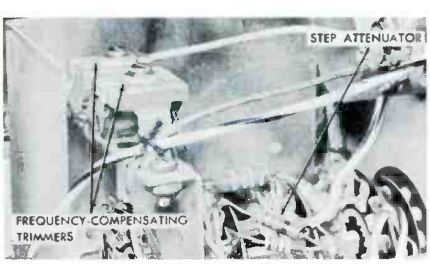

Fig. 2A. Vertical Attenuator of a GE Model 4ST2A3 Oscilloscope.

Simplicity of operation is one of the characteristics of a good test instrument. It frees the operator for the more important uses of his faculties -- servicing and adjusting the receiver or electronic device at hand. This very simplicity is often a direct contrast to the amount of theory and design represented in the circuits behind the control. Let us consider the designs of some attenuators.

One might state very briefly that an attenuator is any device which the technician may use to control the amplitude of the signal with which he is working. The attenuator may be located at any one of several points in an instrument. An oscilloscope is an example of an instrument that has an attenuator in the input circuit. In this case, the attenuator serves to prevent overloading of the succeeding stages by too great a signal. A signal generator is an example of an instrument that has an attenuator located in the output circuit. In this case, the attenuator controls the amplitude of the output signal.

It is desirable to know the amount of attenuation obtained at any particular setting, and many instruments are calibrated to show the attenuation factor at each switch position such as at X1, X10, X100, and so on. Other attenuators are of the continuously variable type, and therefore any amount of attenuation may be obtained within their ranges. An attenuator which is a combination of both the step and the variable types is the most versatile and offers the widest choice of attenuation factors.

The type of attenuator most commonly found in general-purpose instruments functions by means of a voltage-dividing action obtained by a network of resistors. An attenuator that has its action based upon another principle is shown in Fig. 1. It consists of a pickup loop electrically connected to the output terminals of the instrument. This loop and the oscillator circuit are encased in a doubled-shielded compartment. The

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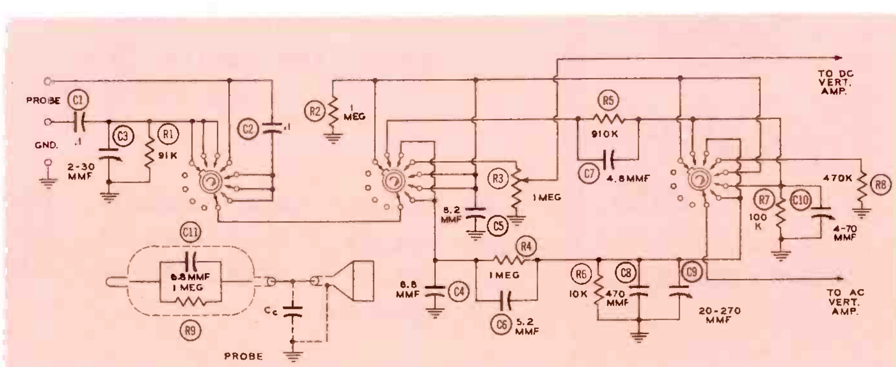

Fig. 2B. Partial Schematic Diagram of Attenuator Shown in Fig. 2A.

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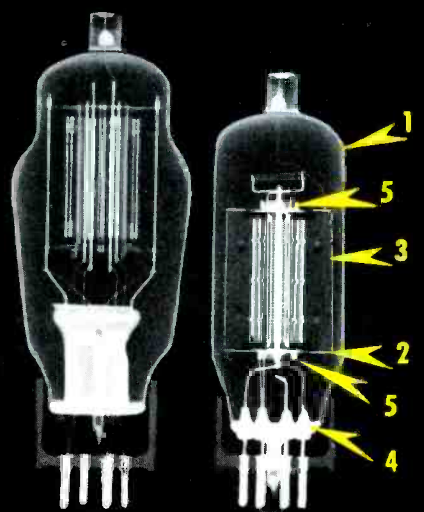
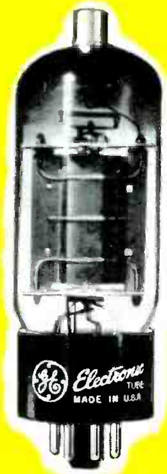


OLD 6BG6-G **NEW 6BG6-GA**

1. New bulb is straight-side, much smaller and sturdier.
2. Bottom mica, as well as top, now contacts the glass all around, for greater rigidity.
3. Redesigned, more shock-resistant structure.
4. Button-stem base gives shorter and better-separated leads; improves heat conduction.
5. New beam shields mask off stray electron bombardment from micas and bulb.

NEW SERVICE-DESIGNED 6BG6-GA

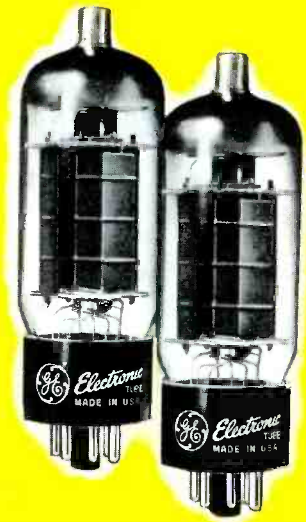


● X-ray pictures at left explain why the new tube is stronger throughout, also more compact. (Note that new straight-side bulb is "necked down" at bottom to take the same diameter base as prototype, so the same ring-clamps can be used when installing.)

Tube performance is much improved. Internal structure and micas have been redesigned to cut down inter-electrode leakage, reducing the chance of horizontal TV-picture shrinkage. The new beam shields, which mask off stray electron bombardment, further increase operating stability.

And *every* 6BG6-GA is high-voltage seasoned—is pulse-treated at absolute max voltage ratings, among other checks!

NEW SERVICE-DESIGNED 6CD6-GA AND 25CD6-GB



● Prototypes gave arc-over trouble, causing horizontal TV-picture streaking. In the new sweep tubes, brand-new mica design corrects this fault.

Also, plate area has been increased for greater dissipation. Ratings are higher:

	PROTOTYPES	6CD6-GA and 25CD6-GB
Plate positive-pulse voltage	6600 v	7000 v
Plate dissipation	15 w	20 w

New tubes are high-voltage seasoned. *Every* 6CD6-GA and 25CD6-GB gets an arc-over test at absolute max ratings!

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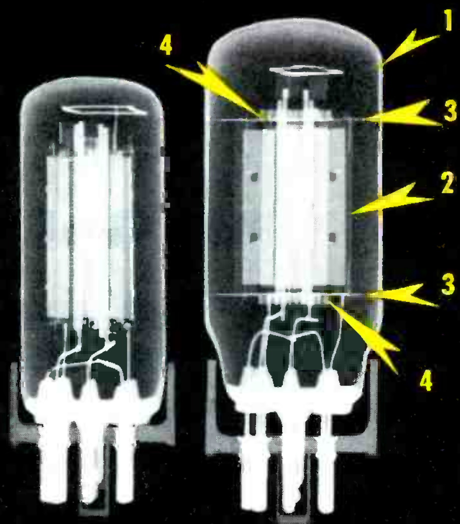

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Redesigned tube elements and structure now give servicemen a whole new deal on this much-used type. With Service-Designed 6J6's, technicians can satisfy their most critical customers.

● **6SN7-GTB** . . . Shows that G-E design improvement is a never-ending process! A brand-new model of the popular 6SN7-GTA, with all the latter's superior performance . . . plus a 600-ma heater with "series-string" warm-up time.

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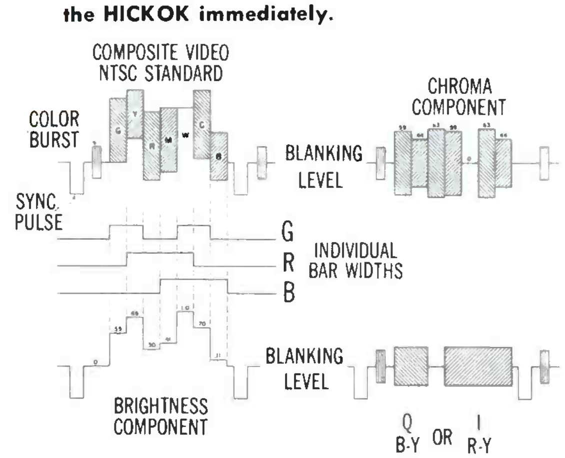
- Output is either R.F. or Video.
- In addition to color bars this instrument generates the necessary signals for I, (In Phase, delayed 57° from color burst), Q, (Quadrature Phase, delayed 147° from burst) R-Y (delayed 90° from burst) and B-Y (delayed 180° from burst) for demodulator alignment.
- Compare the wave form information and sharpness of detail of the 655XC with any other TV color bar generator . . . You'll pick the HICKOK immediately.



This NTSC standard waveform is to precise scale and is accurately produced in detail by the 655XC when viewed on a high quality wide-band scope (At least 4.5 MC).

THE HICKOK ELECTRICAL INSTRUMENT COMPANY
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APPLYING the FINISHING TOUCH

BY WILLIAM E. BURKE

Suggested Tools, Materials, and Methods for Use in Custom Installations

The service technician who is called upon to make a custom installation, whether it is for a TV receiver or an audio amplifier and tuner combination, should find some means whereby the outward appearance of the installation can be made as neat and complete as possible. This article is presented in the hope that it will aid the present installer in improving his work and that it will influence other service technicians to enter this phase of servicing activities. A glance at any of the present-day magazines which are devoted exclusively to high-fidelity audio should convince a doubtful technician that this is a large and rapidly expanding field. Small service shops which are not swamped with TV service work could derive additional income from custom installations.

A deluxe installation in a fine home probably deserves the professional talents of an interior decorator. In such cases, the technician can concentrate his attention on the interconnection and operation of the equipment. In other instances, a customer who is operating on a tight budget may insist that the service technician installing the equipment should do a finished job. It must be remembered that very often an attractive installation can be made by simply adding a few finishing touches to an assembly of ready-made pieces of equipment. If wood finishing and carpentry are required and if the technician is not skilled in this line of work, he would be wise to have a professional carpenter take a subcontract for this part of the installation operation. The technician can then devote his time to other phases of the job.

The following paragraphs deal with methods and materials which can be applied to improve the appearance of custom installations and which do not require exceptional skills in wood finishing or carpentry.

Aluminum Panels and Cases

Aluminum is a metal which is increasingly popular for use in many pieces of equipment. One form of this metal, "Do-It-Yourself" aluminum, is manufactured by the Reynolds Metals Co., Louisville, Ky. This aluminum is carried by many hardware stores and comes in a variety of shapes and sizes. It is produced in perforated, embossed, and plain sheets and in a variety of fabricated shapes such as tubing, angles, rods, and solid bars. In addition, an assortment of wood screws, machine screws, and rivets are available in aluminum so that they will match the work. All of these aluminum products are made of an alloy which is soft enough to be cut with hand woodworking tools and especially with power tools. A technician who is just slightly talented in the use of tools can produce an almost professional-looking job by using his imagination in the planning and by using care and patience in the construction.

(A) Before.

(B) After.

Fig. 1. An Audio Preamplifier Before and and After the Improvement of Its Appearance.

The photograph in Fig. 1A is that of a preamplifier as it appeared when it was first constructed in our shop several years ago. At the time of construction, it was not intended to use the preamplifier for any length of time; consequently, only a masonite front panel was installed. Since then, the preamplifier has had almost daily use; and changes have been made in the appearance of the unit. Fig. 1B is a recent photograph which shows the extent of the "dressing-up" operation.

The new front panel was formed from a section of a 1/8-inch gray aluminum rack panel which is a standard item carried by most distributors. The knobs, which have been selected for a pleasing appearance, are another standard item. The cover or case was made of Reynolds perforated aluminum sheet and was shaped by using several boards and C-clamps. The seams were secured with small aluminum rivets, and the case was fastened to the preamplifier chassis with self-tapping screws. Control functions and switch positions have been identified by panel lettering.

Panel Lettering

A main requisite of any custom installation is that all controls and

* * Please turn to page 72 * *

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CHECKING HORIZONTAL-OUTPUT TRANSFORMERS

DETECTING SHORTED TURNS BY A RESONANT-FREQUENCY MEASUREMENT

by Calvin C. Young, Jr.

In the November-December 1951 issue of the PF INDEX, we published a procedure for testing horizontal-output transformers in television receivers. For the benefit of our subscribers since that time and for those who may not have read the previous presentation, we are going to cover the subject again because it is felt that the importance of such a procedure is as great now as it was then.

The discussion in the original article concerned the isolated-secondary type of transformer which represented the majority of units in use at that time. Since then, however, many receivers using autotransformers have been produced. In the discussion which follows, autotransformers are taken into consideration and certain tests on deflection yokes are also mentioned.

The horizontal-output transformer is often suspected of being the cause of certain deflection-system troubles, such as insufficient width, poor linearity, and low second-anode voltage. The usual procedure for checking the transformer is first to measure the resistance of the windings and then to check for shorts between the core and the windings and between pairs of windings. Obviously, if there is an open winding or if there are shorts to the core or between the windings, ohmmeter checks will reveal the trouble. There are other defects, however, which may not be revealed by a resistance check alone. In the case of a few shorted turns or even a shorted layer of turns, the resistance readings which are obtained may be well within the range of production tolerances; therefore, the defect may not be discovered. If the resistance readings fail to reveal the trouble, the next step is usually the substitution of a new output transformer. A check is then made of receiver operation. If operation is normal, it can then be assumed that the original transformer is defective.

Although the foregoing procedure of checking is effective, it has certain disadvantages. Quite often after the time-consuming job of substituting a new transformer, it is found that operation is the same and that the trouble is elsewhere in the circuit. The transformers must then be interchanged again, resulting in further loss of time. Moreover, a new unit may not always be at hand for the substitution check, and this causes a delay until one can be obtained.

CHECKING RESONANT FREQUENCY

In addition to the resistance checks previously mentioned, another check can be made to determine whether there are shorted turns in the transformer. This check involves a measurement of the resonant frequency of the transformer.

The resonant frequency of the entire horizontal-output stage is normally about 71 kilocycles. This frequency represents a time of approximately 7 microseconds per half cycle; and during this time, retrace occurs.

The actual resonant frequency of the horizontal-output transformer alone is somewhat lower than 71 kilocycles. The increase to the latter frequency is obtained: (1) when the horizontal-deflection coils are placed in parallel with the output winding of the transformer, (2) when the width coil is placed across a portion of the output winding, and (3) when the distributed capacitance in the external circuit is introduced.

A measurement of the resonant frequency of a transformer is a significant check because this frequency will be abnormally high if shorted turns are present. This effect occurs because shorted turns decrease the inductive reactance of the transformer and thereby increase the resonant frequency of the circuit.

The test equipment and materials that are required in order that the resonant frequency of a transformer may be determined are as follows: (1) an audio signal generator with a range that extends to 100 kilocycles, (2) a VTVM or an oscilloscope, (3) suitable test leads, and (4) two 50K-ohm resistors for isolation. All of these items can usually be found in the average service shop.

The procedure for checking resonant frequency and the significance of the results of the check will be discussed for each of the following types of units: the isolated-secondary type of horizontal-output transformer, the autotransformer, and the deflection yoke.

Transformer With Isolated Secondary

As stated earlier, the windings of the transformer should be checked for continuity and for shorts to the core or to other windings before a check is made for shorted turns. The ohmmeter checks require that some of the leads to the transformer secondary should be removed. Before connecting the test equipment, it is advisable to disconnect the balance of the wires that go to the secondary windings. The high-voltage rectifier should also be removed. This ensures that only the transformer is in the circuit and that the readings will be accurate.

NOTE: It is not necessary to unsolder the filament leads to the high-voltage rectifier tube.

The illustration shown in Fig. 1 is the setup used to determine the resonant frequency of a typical isolated-secondary type of transformer. It may be seen that the audio signal generator is connected across the primary winding and that isolation resistors are used in each lead. The indicating device (a scope or a VTVM) is connected to the same terminals to which the horizontal-deflection coils are normally connected. Adjust the gain of the scope to maximum, or set the selector of the VTVM to the lowest AC range. Turn the frequency control of the audio generator until a maximum reading is obtained. Reduce the output of the signal generator as required in order to keep

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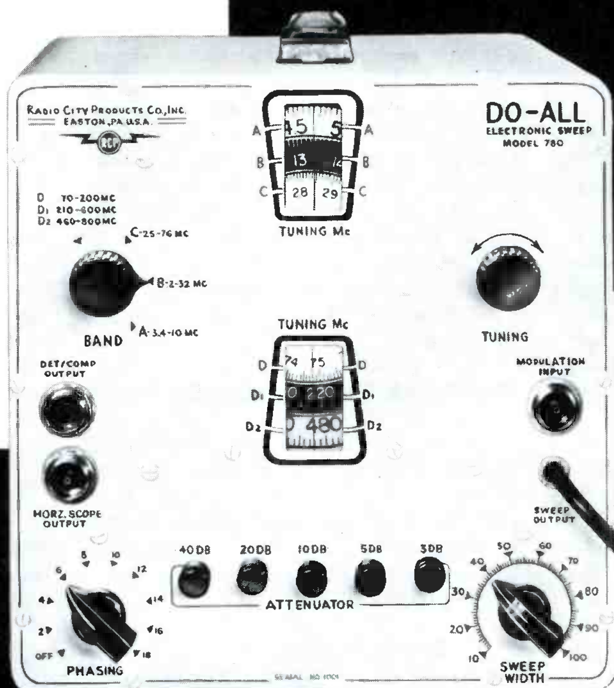

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SPECIFICATIONS

Sweep Linearity: Exceptional high degree of linearity not possibly obtainable in mechanical sweeps.

Band	Linearity Sweep Width Within 2 DB	Linearity Sweep Width Within 4 DB
A	0- 8 mc	Max. 15 mc
B	0-10 mc	Max. 25 mc
C	0-10 mc	Max. 22 mc
D	0- 8 mc @ 70 mc	Max. 25 mc
	0-20 mc @ 200 mc	Max. 30 mc

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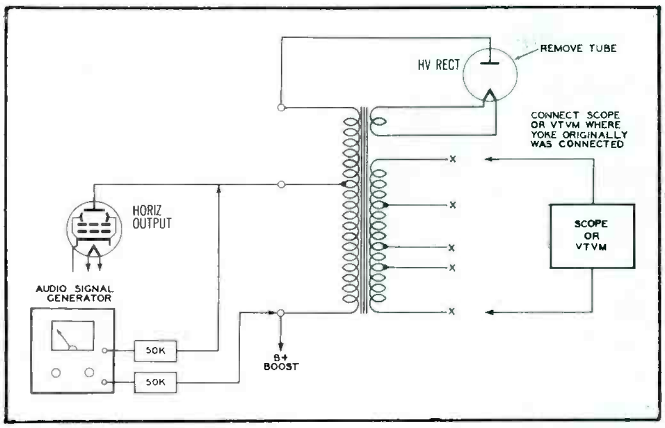


Fig. 1. Setup for Testing Isolated-Secondary Type of Horizontal-Output Transformer.

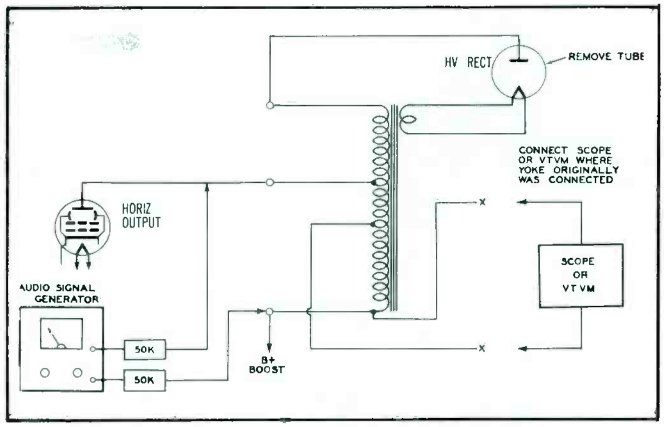


Fig. 2. Setup for Testing Autotransformer Used As Horizontal-Output Transformer.

the indication on the meter or scope within range. This precaution of keeping the output of the signal generator at a low level prevents overloading of the transformer and thus prevents erroneous indications. The frequency at which the maximum reading is obtained is the resonant frequency of the output transformer. This frequency should fall somewhere within the range of 20 to 50 kilocycles. Any shorted turn will cause a considerable increase in this frequency. Any reading that is appreciably above 50 kilocycles indicates a shorted turn or turns.

Autotransformer

As with the isolated-secondary type, the windings of an autotransformer should first be checked for continuity and for shorts. The illustration shown in Fig. 2 is the setup used in checking the resonant frequency of an autotransformer. The signal generator is connected to the plate cap of the output tube and to the transformer terminal that normally connects to the B+ boost line, and the scope or VTVM is connected to the same terminals to which the yoke is normally connected. The rest of the procedure is the same as that which was described for the isolated-secondary type of transformer. The resonant frequency of an autotransformer should fall within the range of 16 to 25 kilocycles. A frequency of 29 kilocycles or higher indicates a shorted turn or turns.

There are cases in which a transformer will have separate windings connected in the same manner as an autotransformer but with the linearity coil in series with the windings. See Fig. 3. In testing transformers of this type, see that the linearity coil and its associated capacitor are left connected, and test as before. The readings should be the same as for other autotransformers.

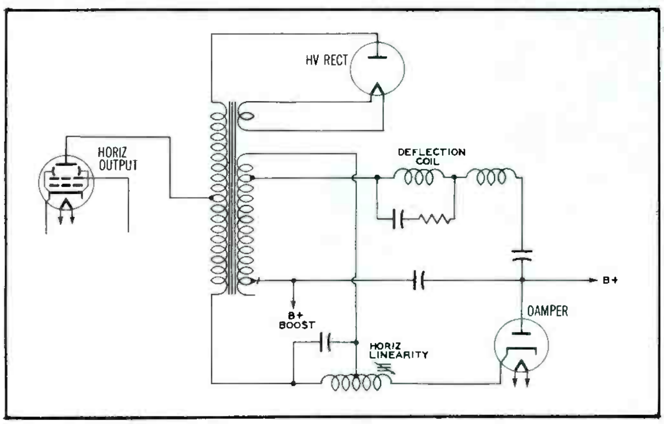


Fig. 3. Transformer and Linearity Coil Connected As an Autotransformer.

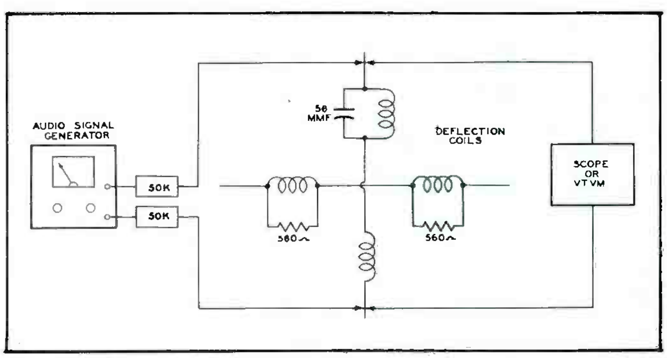


Fig. 4. Setup for Testing Deflection Yokes.

Deflection Yoke

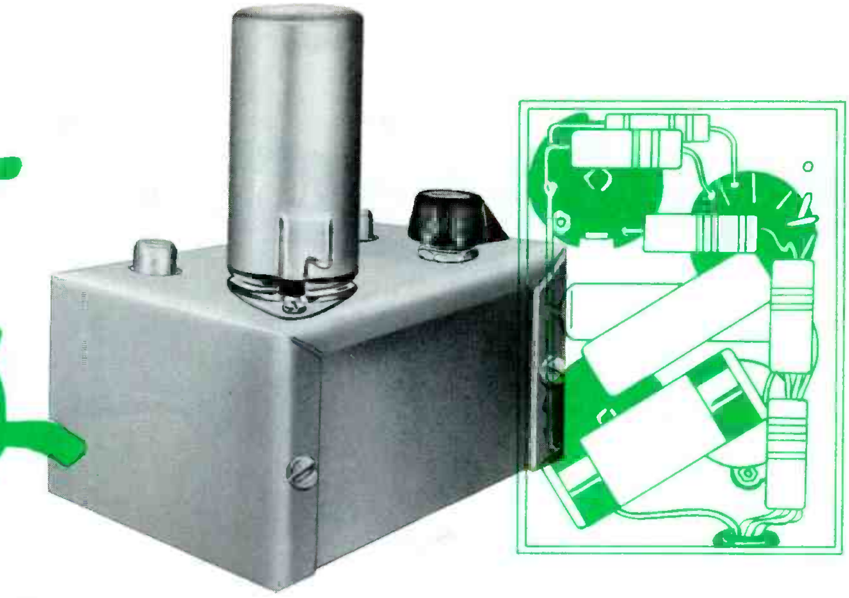
In the course of investigating methods of testing horizontal-output transformers, several yokes were tested for resonant frequency. It was found in yokes which had 10-, 13-, 18-, or 20-millihenry horizontal coils and 40- to 50-millihenry vertical coils that the resonant frequency of the horizontal coils was approximately 90 kilocycles and that the resonant frequency of the vertical coils was 6 to 8 kilocycles. The damping networks in the yokes were left connected during the tests.

In yokes having 30-millihenry horizontal coils and 3-millihenry vertical coils, the following frequencies were recorded: for the horizontal coils, 72 to 80 kilocycles approximately, and for the vertical coils, 48 to 50 kilocycles approximately. As before, the damping networks were properly connected. A diagram of the test setup used is shown in Fig. 4.

Before closing, we want to state that several manufacturers have produced and marketed instruments (commonly called "flyback testers") which will detect shorted turns in horizontal-output transformers and deflection yokes. The circuits in these testers are such that the suspected transformer or yoke is connected as part of the tuned circuit of an oscillator, and an indication of the condition of the unit is read on the good-bad scale of a meter in the tester.

CALVIN C. YOUNG, JR.

Audio-Facts



CASCODE INPUT DEVICE USED TO COUPLE LOW-OUTPUT LOW-IMPEDANCE CARTRIDGES TO PREAMPLIFIERS

by ROBERT B. DUNHAM

CASCODE INPUT UNIT FOR MAGNETIC PICKUPS

Practically every preamplifier, control unit, or similar piece of equipment used in high quality audio systems is equipped with one or more suitable inputs to accommodate magnetic pickups. These inputs are provided because magnetic pickups are very popular and are used in many, perhaps the majority of, audio systems when the best possible reproduction from records is desired.

Under this classification of magnetic cartridges are included the types further classified as variable reluctance, moving coil (dynamic), and ribbon pickups. All of these possess a number of desirable characteristics that contribute to their ability to give excellent reproduction from records, if sufficient amplification and adequate equalization are provided by the preamplifier and amplifier.

Two important characteristics, which all of them share to a greater or smaller degree, are low signal output and low impedance. Both are very low when compared to the high impedance and high signal output of the usual crystal and ceramic cartridges.

The output (with no load on the pickup) and impedance ratings for some popular magnetic cartridges are as follows:

CARTRIDGE	OUTPUT (millivolts)	IMPEDANCE (ohms)
GE RPX-050	10	3270
Fairchild 220A	5	170
Fairchild 215A	3	70
Pickering 120 & 140	50	945
Pickering 220 & 240	30	785
Electro-Sonic	1	1.5
Ferranti (ribbon type)	15	---

Some variation in both output and impedance values can be noted, but none of these values can be called high. When the Pickering carfridges are mentioned as being high-output pickups, what is meant is that the output is high for a magnetic type.

Many of the late-model preamplifiers are capable of providing enough gain and suitable equalization to operate properly with most of the magnetic pickups, but many of the older units do not have enough gain to permit them to take full advantage of the capabilities of some low-output pickups. In such instances, the pickup is usually connected to the input of the preamplifier through an input

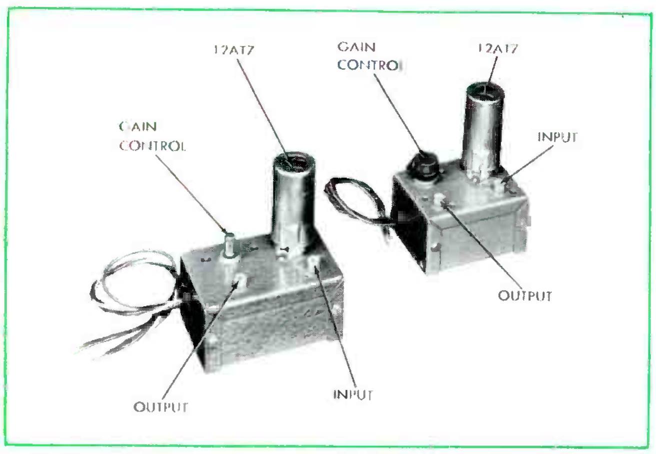


Fig. 1. Top View of Two Cascode Amplifier Units.

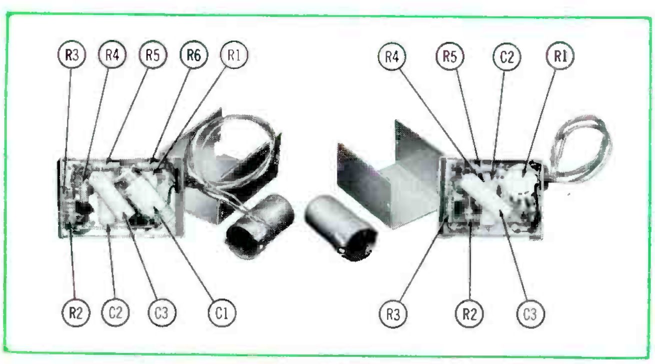
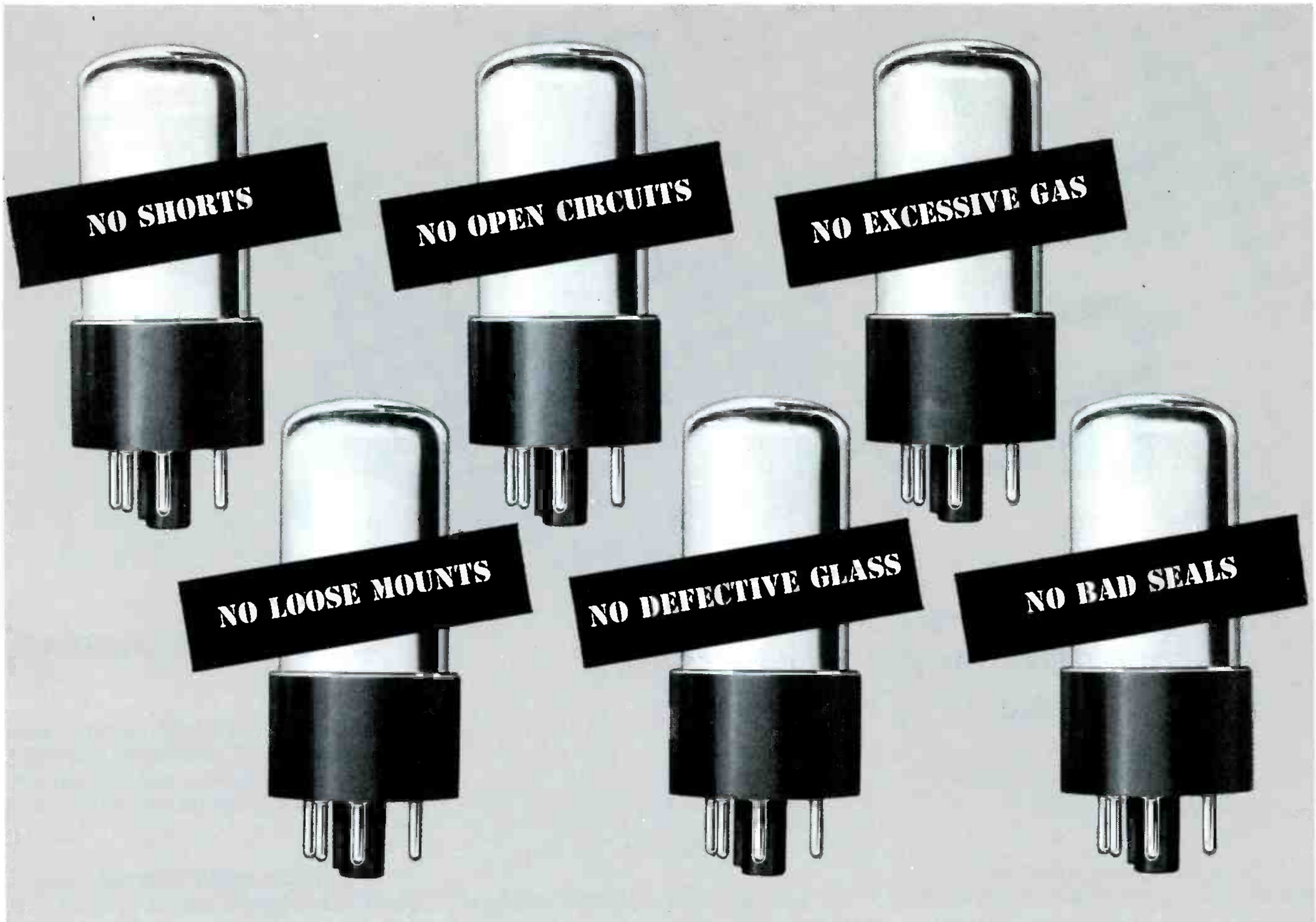


Fig. 2. Bottom View of Two Cascode Amplifier Units.



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And this testing isn't done months before your order is shipped. Just before Westinghouse ships tubes to your Westinghouse distributor, they are "pre-ship" tested to make sure that every one will function properly, operate efficiently.

In effect, your tubes are tested by Westinghouse, one-by-one, just days before they reach your stock. This extra Westinghouse precaution against call-backs will save you money and time every month.

Why put up with call-back complaints and extra handling of rejected defectives? You don't have to! Provided you stock and use Westinghouse receiving tubes. Because the Westinghouse "pre-ship" test policy virtually eliminates those irritating field failures. Call-backs cost you hard cash. Don't let them rob you of any more profit. See your Westinghouse distributor and stock up on Westinghouse receiving tubes—the tubes "pre-ship" tested to guarantee dependability and top performance.

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transformer in order to obtain the necessary increase in gain.

The step-up in signal level provided by a suitable input transformer reduces the possibility of excessive noise and hum detracting from otherwise excellent reproduction. The noise and hum would appear when the transformer is not used because the gain controls would have to be turned to very high operating levels to obtain enough volume. An input transformer also provides a very satisfactory method of matching the low-impedance pickup to the input of a preamplifier. Consequently, it is recommended that a transformer be used in most cases when certain cartridges such as the Ferranti are used.

The author has not developed the aversion to the use of input or interstage transformers that some experimenters and constructors seem to have formed. The dependable and consistent performance provided by the large number of such transformers used in high quality commercial and professional equipment surely proves their value.

Probably some of the reasons why constructors and audio enthusiasts sometimes hesitate to use low-level transformers are: (1) good transformers are comparatively expensive; (2) it is sometimes difficult to locate and orient them properly to prevent hum pickup; and (3) under certain conditions, peaks in frequency response are developed if the secondary circuit of the transformer is not loaded or damped properly. These undesirable conditions (other than the price) can be avoided by using care and thought when designing and constructing the equipment and by making proper adjustments.

In searching for some simple and economical method to match a low-impedance pickup to the input of a preamplifier and still obtain sufficient gain without excessive noise, we investigated the possibilities of the cascode amplifier circuit. Knowing that the cascode circuit has been used in television tuners because of its high gain, low noise, very high input impedance, and low input capacitance made it seem the logical choice for our purpose.

We found that the Fairchild Model 240 preamplifier uses a typical cascode amplifier in the phono input circuit. In fact, the very quiet operation and high-gain characteristics of the Model 240 can be attributed to a great extent to the cascode input stage. The rated voltage gain of 68 db will drive most any power amplifier to full output with an input of one millivolt.

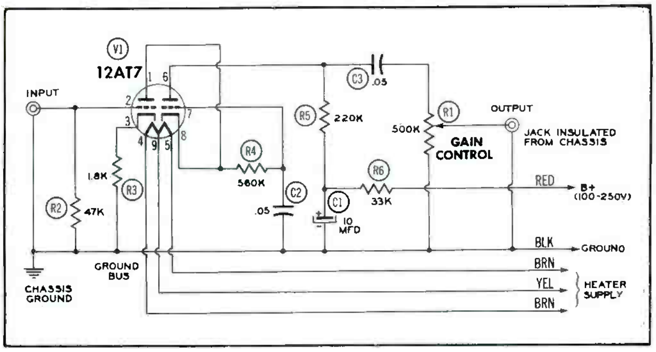

Fig. 3. Schematic Diagram of Cascode Amplifier Unit.

The result was that we adapted the circuit to our needs and constructed the two small units shown in Figs. 1 and 2. Various values of resistance and capacitance were tried, but we followed the specifications of the Model 240 very closely and used the same type tube, a 12AT7. The circuit is shown in Fig. 3.

The two units shown in Figs. 1 and 2 are practically identical and use the same circuit. Some resistance values differ, and smaller capacitors are used in one unit; but, as mentioned previously, no difference in operation can be detected. The only major difference is that the decoupling capacitor C1 and resistor R6 are not included in the smaller of the two units.

This input circuit could be added to an existing preamplifier by building it directly on the chassis because of the small amount of space required for the very small number of parts. We constructed these in this form so that they could be used with any audio system.

The input and output jacks and extended leads permit the unit to be connected into an audio system with a minimum of disturbance or change. The pickup is connected to the input, and the output of the unit is plugged into the magnetic phono input of the preamplifier. The B+ (or red) lead can be connected to any suitable point

* * Please turn to page 56 * *

PARTS LIST

Tube

V1	12AT7

Capacitors

	CAPACITANCE (mfd)	VOLTAGE (volts)	MALLORY	PYRAMID	SANGAMO
C1	10	450	TC 72	TD-10-450	MT-4510
C2	.05	600	PT 615	IMP 6-S5	330615
C3	.05	600	PT 615	IMP 6-S5	330615

Control

	RESISTANCE (ohms)	IRC	CLAROSTAT	CENTRALAB	MALLORY
R1	500,000	Q11-133	A47-500K-S FKS-1/4(shaft)	B-59	U-50

Resistors

	RESISTANCE (ohms)	WATTS	IRC
R2	47K	1	BTA-47K
R3	1800	1	BTA-1800
R4	560K	1	BTA-560K
R5	220K	1	BTA-220K
R6	33K	1	BTA-33K

Miscellaneous

1	Aluminum case (Flexi-Mount or Minibox). (Small is 2 3/4 inches by 2 1/8 inches by 1 5/8 inches; large is 3 1/4 inches by 2 1/8 inches by 1 5/8 inches.)
2	Phono jacks.
1	9-pin Noval socket with shield.
	Terminal strips, grommet, machine screws, etc.

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Safeguarding radio and TV sets has long been a Clarostat responsibility. Clarostat ballast resistors, line-voltage regulators and fuse-type resistors are found in many sets and installations today. Necessarily *expendable* in providing protection, these items should be included in your parts inventory. Refer to the latest Clarostat catalog for details.

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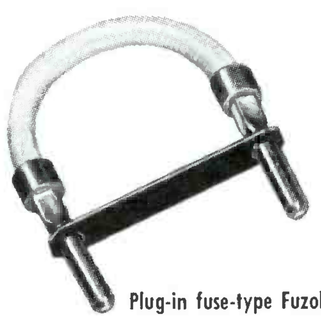

Plug-in fuse-type Fuzohm* resistors provide protection from overloads.

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VERTICAL NONLINEARITY and FOLDOVER

by WILLIAM E. BURKE

The repair of a television receiver which has vertical nonlinearity or foldover can sometimes become very involved. Quite often the preliminary trouble-shooting steps such as tube substitution and control adjustment will not cure the trouble, and the service technician must resort to a mental evaluation of the circuit operation in order to achieve some idea of the source of the trouble. To aid the technician in this task, this article covers the basic theory and the servicing of vertical-output circuits.

PURPOSE OF OUTPUT STAGE

An appreciable amount of power is required in order to swing the electron beam in the cathode-ray tube through an arc which is large enough to scan the tube from top to bottom. This power usually cannot be derived from the vertical-oscillator circuit because the oscillator would then be very unstable. An output stage is used in order to isolate the oscillator and to provide a source of driving power for the yoke.

The power supplied by the output stage consists of a high saw-tooth current which varies at a linear rate during the scanning period so that the electron beam moves across the screen at a linear rate. A high-current, low-impedance source is provided by the vertical-output tube and the transformer. By means of the transformer, the high plate impedance of the tube is matched to the low impedance of the vertical coils in the yoke. (The windings in the modern yoke are of the low-impedance type in order that the voltages developed across the windings will be low; and consequently, the electrostatic coupling between the vertical and horizontal coils is kept at a minimum.)

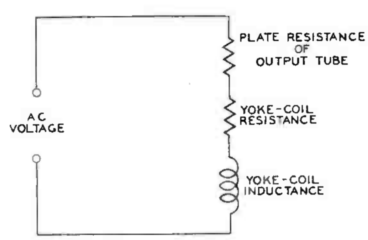
OPERATION OF OUTPUT STAGE

It was mentioned previously that a saw-tooth waveform of current is needed in the yoke. Vacuum tubes, however, demand a voltage input; so, let us see which kind of a voltage waveform on the grid of the output tube will produce a current waveform of the proper shape in the yoke.

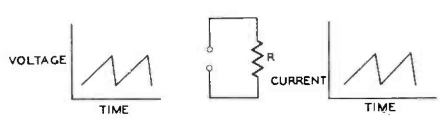
Since the impedance of the yoke consists of resistance and inductive reactance, the load reflected through the transformer into the plate circuit of the output tube also consists of resistance and inductive reactance. The equivalent plate circuit of the tube is shown in Fig. 1A.

If a circuit is purely resistive, the current in that circuit will be identical in phase and shape to the voltage in that circuit; therefore, a linear saw-tooth voltage is required in order to produce a linear saw-tooth current in the resistive circuit.

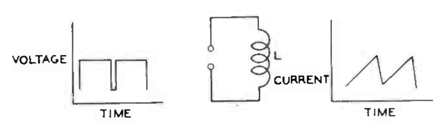
If a circuit is purely inductive, the AC voltage that is required to produce a saw-tooth current must have a rectangular shape. This shape is necessary because, in order to force a saw-tooth current through a pure inductance, the voltage must rise instantaneously to its maximum value and must remain at this value as long as the linear rise in current is needed. This current and voltage relationship is shown in Fig. 1C. If the applied voltage were saw-tooth shaped, the current in the inductance would increase in a nonlinear fashion.



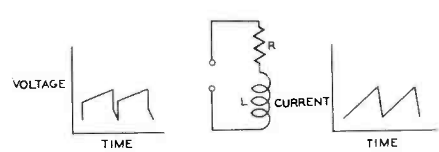
(A) Equivalent Circuit of Typical Vertical-Output Stage.



(B) Voltage and Current in Pure Resistance.



(C) Voltage and Current in Pure Inductance.



(D) Voltage and Current in Series Combination of Resistance and Inductance.

Fig. 1. Voltage and Current Relationships Which Are Applicable to Vertical-Output Stages.

It has been stated that a deflection yoke presents both resistance and inductive reactance to the current in the plate circuit of the output tube; therefore, the yoke circuit is a combination of the circuits shown in Figs. 1B and 1C. To develop a saw-tooth current in the yoke, the voltage waveforms in Figs. 1B and 1C must be combined as shown in Fig. 1D. The saw-tooth portion of the applied voltage produces a saw-tooth current through the resistive part of the load, and the rectangular portion of the applied voltage produces a saw-tooth current through the inductive part of the load.

Voltage waveforms similar to the one shown in Fig. 1D are applied to the control grids of most vertical-output tubes. The production of this trapezoidal waveform is the function of the vertical oscillator and the wave-shaping network. Essentially, the output of a vertical oscillator is a voltage with a rectangular waveform; however, the wave-shaping network (a capacitance and a resistance in series) changes the shape of this waveform so that the desired trapezoidal voltage is made available at the grid of the output tube.

Deflection yokes are constructed with a variety of inductance values.

* * Please turn to page 59 * *

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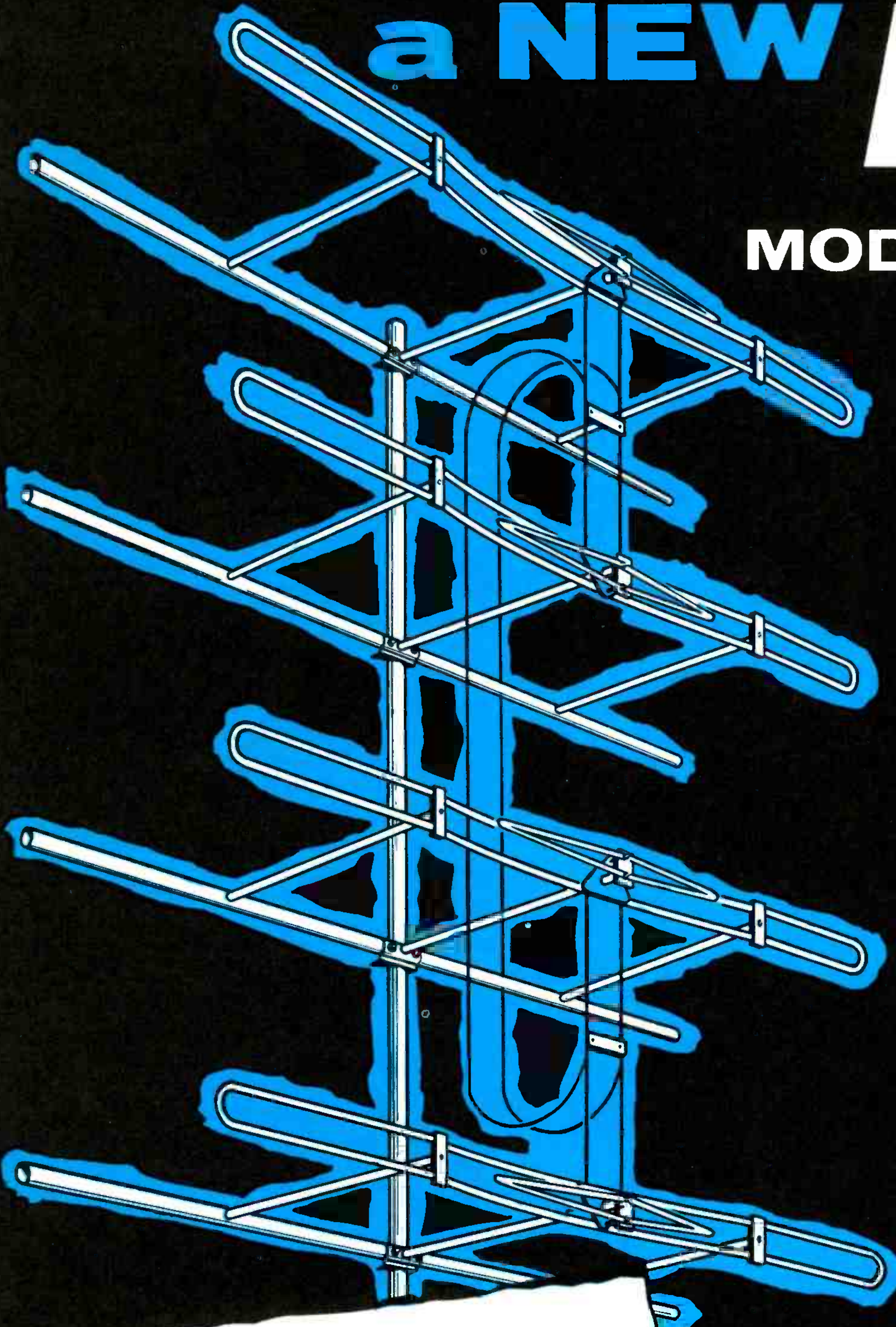

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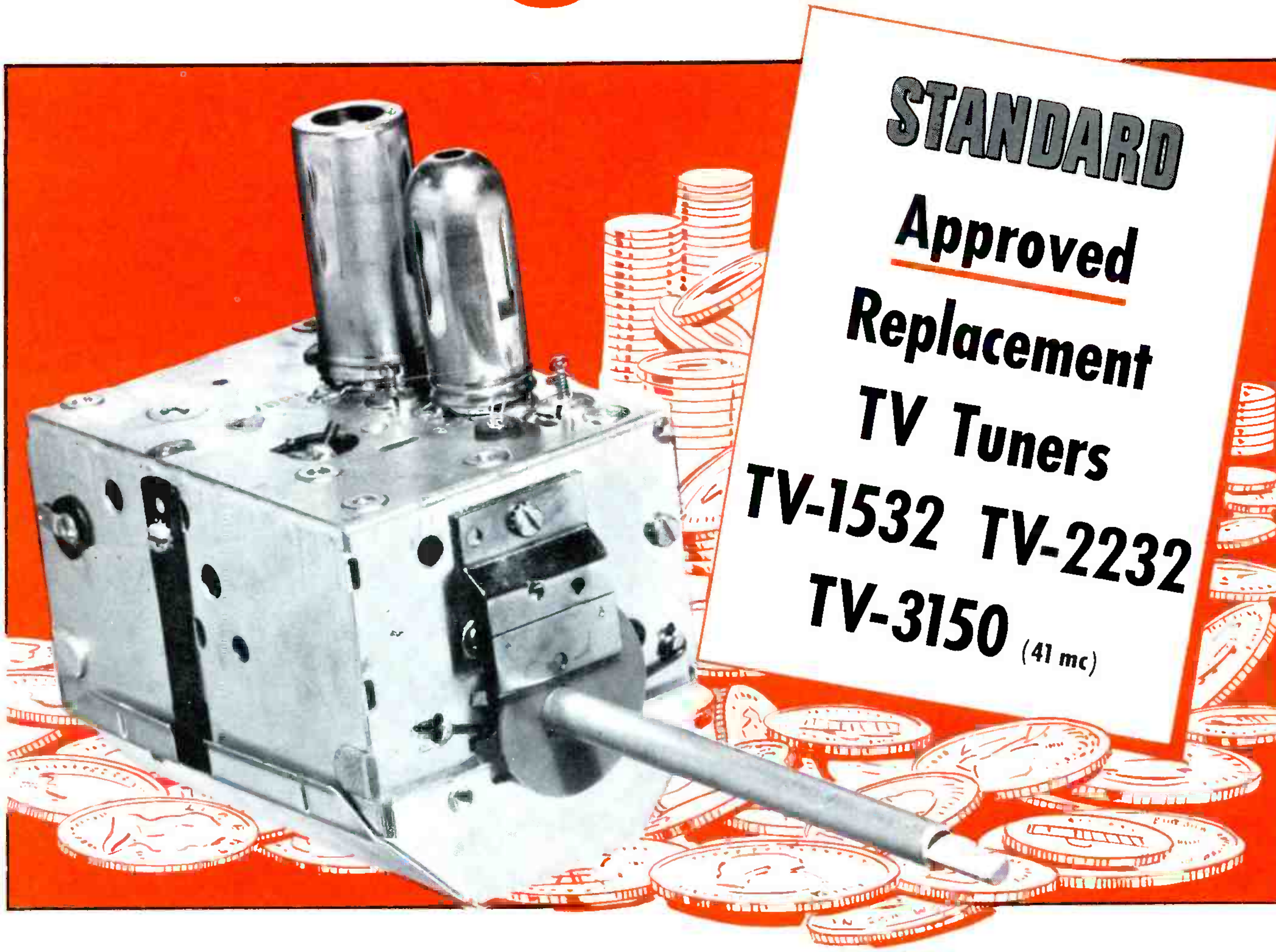

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In TV it's Standard

Dollar and Sense Servicing

by *John Markus*

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

IMPROVEMENT. In many service organizations, the talents of good technicians are being wasted for lack of proper management supervision. Most men need motivation in order to do their best work. This means that management must learn how to motivate men so they will want to do what pays off the best for both.

Close supervision is just as important in servicing as it is in a factory. If management is already overloaded, as is so often the case, there are at least three paths open for action:

1. Delegate some of the management responsibilities to a qualified service technician.

2. Consider taking on an assistant at executive level — a good leader of men, though not necessarily technical.

3. Give some thought to a partner for sharing of executive duties, one chosen to fill in the weak points in existing management.

Men who feel they're part of a working team, sharing the confidence of management and participating fairly in business profits, will work twice as hard and yet not get half so tired. Good morale means money for all.

LAUGHS. To laugh or not to laugh — that is the question bothering sponsors of filmed TV programs these days. Separate laugh tracks that match the program are easy enough to make by showing the film to a studio audience and holding up a card marked "LAUGH" each time this sound effect is desired, while a tape recorder catches it all. Just watch a few filmed programs, and notice how well they've synchronized the laughs with the action.

Audience reaction surveys are being made continually to try to find out whether or not the great American public wants laughs with its TV, but a yes-or-no answer seems unlikely here. Some programs definitely need a laugh track to tell people which parts are supposed to be funny. Other programs are good enough so that any audience can recognize and enjoy the funny parts without prompting.

FIGURES. Call it 33,500,000 now for TV sets in use. Seven out of ten U.S. homes now have TV. Set sales last year hit a record 7,300,000 at an average retail price of around $200 despite the industry's seemingly perpetual 3D's — discounts, distress, and dumping.

RINGING. When your phone rings more than three times before it's answered, the chances are ten to one that the caller is annoyed. People expect business firms to answer their phones promptly during business hours. Even worse is not answering the phone at all; this generally means a lost customer.

For quick answering without leaving the bench to go up front, how about having an extension phone installed right on the bench. The cost is surprisingly low in relation to the value of a customer.

To take care of phone calls when you have to leave the shop unattended for any reason, you can either use a telephone-answering service or arrange for some nearby housewife to come over and take the phone calls on an hourly basis or in exchange for keeping her radio and TV sets working.

PHONOGRAPHS. Television has forced people into buying phonographs and listening to records. Why? Because at the end of World War II when TV started, there were only 16 million turntables in use; whereas, now there are over 25 million. This may not be a legitimate conclusion because in that same period transistors were invented and perfected, Marilyn Monroe made her bid for fame, and a lot of other things happened as well; but the fact remains that 25 million turntables are spinning, and most of them need new permanent needles. How many service technicians carry with them a kit of replacement needles?

One trend in the phonograph field is toward marketing of three separate matching cabinets — one with the turntable, one with the amplifier, and one with the speaker — for placing on a floor, table, or shelf side by side. They're easily linked together electrically, sell for as little as $200 per group, and give the dealer a nice profit at the discount figure of around 33 per cent. Tuners or tape recorders are easily added to expand the system. Here's another good item for the up-front sales room of a service shop.

INVESTMENTS. The more books you read and study, the more people you meet and learn from, the more experiences you have, the greater is your investment in yourself and the greater will be the return. Consider each new book on servicing not as an expense, then, but as an investment that you'll be getting back with interest. And don't forget that technical books are deductible on your Federal income tax return; hence, they would cost you only about three-fourths of what you pay.

* * Please turn to page 57 * *


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A Glimpse Into Color Servicing

(Continued from page 19)

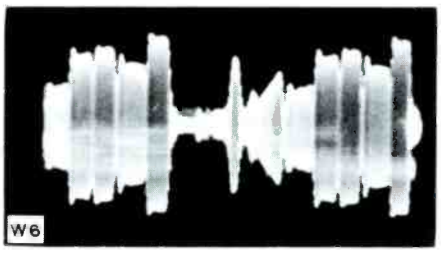


Fig. 3. Waveform W6 Indicating Abnormal Condition Ahead of Phase Detector, As Discussed in Case History No. 1.

coincides with the color-burst information appears to be chopped off. Waveform W8 at the plate of the keyer stage is also shown in Fig. 4, and the distortion in the positive pulse is apparent.

A check of the signal at the grid of the keyer stage indicated that a good-sized pulse was being applied from the winding on the high-voltage transformer. A measurement of the voltage at the plate of the keyer tube showed that its value was only 50 volts, whereas the supply voltage had a normal value of 285 volts. The DC potential at the junction of C156 and R196 measured 25 volts and led to the reasoning that C156 might be defective. An ohmmeter placed across the terminal ends of C156 resulted in a reading of about 2,000 ohms. This led to the conclusion that the capacitor was leaky, since the parallel path through the B+ supply in this circuit would normally measure about 20,000 ohms. A replacement of C156 restored the operation of the receiver to normal.

The defect in this capacitor placed a positive voltage on the grid of the burst-amplifier tube. As a result, this stage was not biased to cutoff, and all of the signal information applied to the grid was amplified and passed on to the phase-detector circuit. Since all of the signals which make up the chrominance signal have the same 3.58-mc frequency but have various phases, the phase-detector circuit could not operate normally. As a result, the oscillator was locked in at the wrong phase.

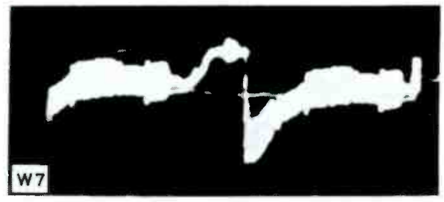
Knowing the nature of the waveforms to expect at various points was most helpful in locating this particular trouble. The proper waveforms are furnished in most service literature.

Case History No. 2

Another defect which developed in the RCA Victor Model CT-100 was noted during a monochrome transmission. The areas of the picture which would normally be reproduced in various shades of gray appeared instead as shades of greenish blue. At first, it was thought that the background controls and the screen controls associated with the picture tube had been misadjusted. Such misadjustment would interfere with the ability of the receiver to reproduce a monochrome picture. An attempt to adjust these controls for proper reproduction in black and white soon disproved this theory; it was impossible to obtain white or any shade of gray.

When a color-bar signal was applied to the receiver, certain facts became very evident. The hues in the pattern could be varied through shades of green or blue, but the color red could not be reproduced. The color bars which should contain red were completely void of this color. The red bar was almost black, the magenta bar was a shade of blue, the yellow bar appeared green, and the white bar was a greenish blue.

The scope was used to observe the signal at the grid of the red gun. Refer to the schematic diagram in Fig. 5. Waveform W9 which was observed at the grid of the red gun is shown in Fig. 6. The peak-to-peak amplitude of this waveform should be approximately 86 volts, according to the service literature; but the amplitude actually measured 18 volts. Signal tracing indicated that the signal was also abnormally low at the grid



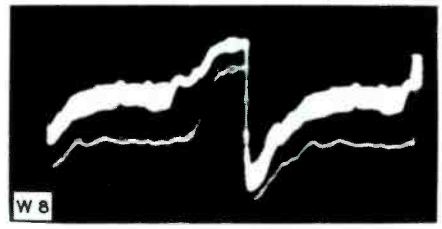


Fig. 4. Waveforms W7 and W8 Indicating Abnormal Condition in Burst-Keyer Stage, As Discussed in Case History No. 1.

of the red-output tube and at the plate of the red amplifier; however, the signal at the grid of the red amplifier was normal.

A measurement of the DC plate voltage of the red amplifier produced a reading of only 40 volts. The 285-volt supply was checked and found to be normal. In addition, the resistance of R267 was measured and found to be within tolerance. Then a voltage reading was taken at the grid of the red-output tube. A meter reading of 40 volts positive at this point was a strong indication that C192 was shorted. This suspicion became a fact when an ohmmeter check showed the resistance of this capacitor to be absolute zero.

Since the failure of C192 had placed a relatively high DC voltage on the grid of the red-output stage, the associated components of this stage were checked as a routine precaution. This action proved to be worth while. The value of R271 had increased to twice its normal value because of the heavy current flow through the tube. It was further found that the half of V35 used as the red-output tube was defective. Replacing the faulty components restored the operation of the receiver to normal.

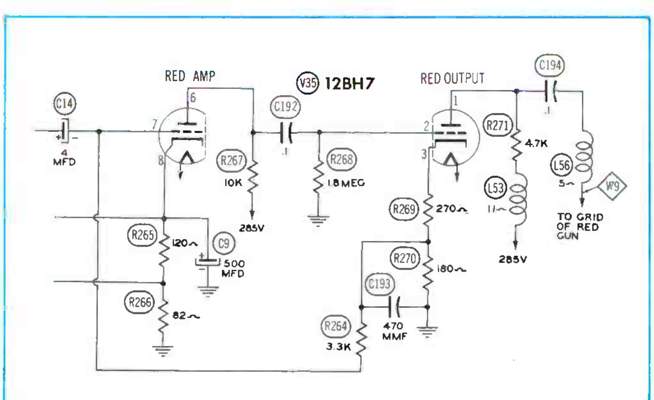


Fig. 5. Partial Schematic of Circuit Under Investigation in Case History No. 2.

Case History No. 3

The color receiver in this case was a Motorola Model 19CT1. Although reception was normal during a

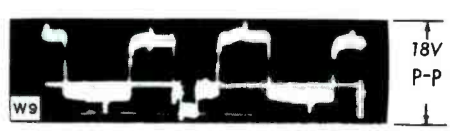


Fig. 6. Waveform W9 Indicating Abnormal Condition Ahead of the Grid of the Red Gun, As Discussed in Case History No. 2.

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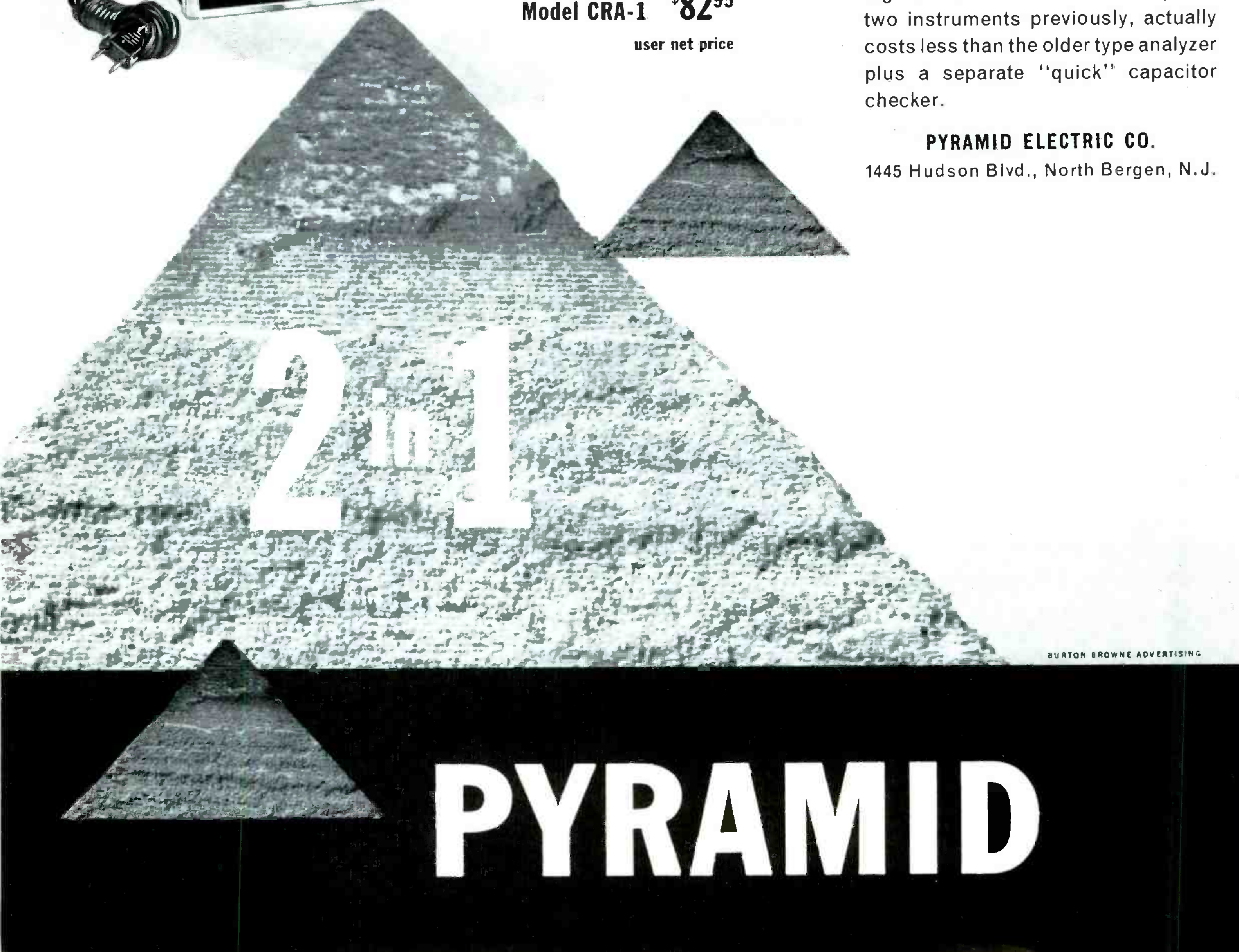

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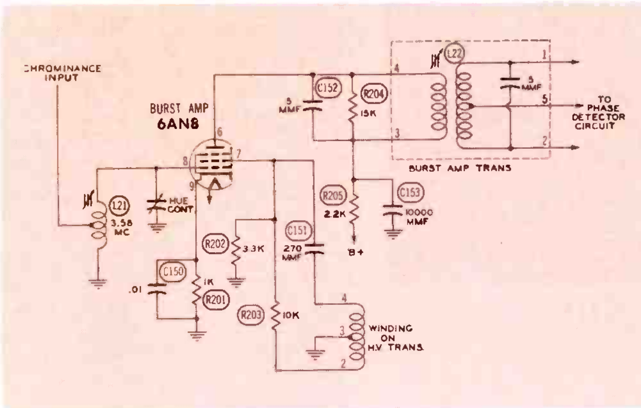

Fig. 7. Partial Schematic of Circuit Under Investigation in Case History No. 3.

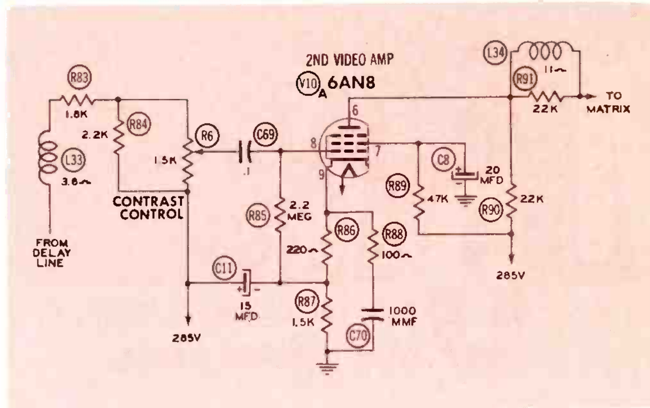

Fig. 9. Partial Schematic of Circuit Under Investigation in Case History No. 4.

monochrome transmission, a complete loss of color synchronization was evident when a color-bar signal was observed. The symptom for this condition can best be described as a series of diagonal streaks of color across the picture. When the chrominance or saturation control was turned down, a normal reproduction in black and white was obtained.

Loss of color synchronization will occur if for any reason the 3.58-mc oscillator is not locked in step with the color burst. The oscillator will then operate at a frequency that is determined by the tuned circuits associated with the oscillator. Naturally, this condition will alter the frequency of the reference signals that are used in the demodulation process; and without a reference signal of fixed frequency and phase, proper demodulation cannot take place.

Through the use of an oscilloscope, the trouble in this receiver was confined to the circuit shown in Fig. 7. Although the chrominance signal at the grid of the burst amplifier was observed to be normal, there was no burst signal in evidence at the input of the phase detector nor at the plate of the burst amplifier.

A measurement of the voltages applied to the burst amplifier revealed that no potential existed between plate and ground. Further use of the voltmeter disclosed that a normal voltage

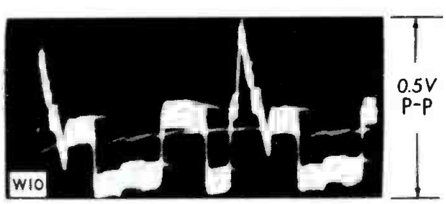

Fig. 8. Waveform W10 Indicating Abnormal Condition in Luminance Channel, As Discussed in Case History No. 4.

was present on the B+ side of resistor R205 but that no voltage was present at the junction of this resistor and C153. A close visual examination of R205 showed that it had cracked in half. A resistance measurement across C153 revealed that C153 had shorted. This condition had caused a heavy current to flow through R205, and the heat which had been produced had cracked the resistor in two.

It should be mentioned that this particular model of color receiver does not incorporate a color-killer circuit which is used in some receivers in order to bias the color channel to cutoff when there is no color burst at the phase detector. In a receiver which uses a color killer, the symptom of the trouble described in this case history would probably be a complete loss of color instead of a loss of color synchronization.

Case History No. 4

The RCA Victor Model CT-100 served as the source for another service experience. The symptom was that all of the hues in a color-bar pattern seemed to have a muddy appearance. The yellow bar was brown, and the white bar was gray. In general, all of the colors were lacking in brightness. The reproduction of a monochrome transmission from one of the local stations was also very poor; the image was somewhat smeared and lacking in contrast.

From these symptoms, it was determined that the trouble must be somewhere in the luminance channel because the chrominance channel in this receiver is normally inoperative during a black-and-white transmission.

The signal which was observed at the output of the luminance channel is shown by waveform W10 in Fig. 8. A measurement of the signal amplitude at this point revealed that the peak-to-peak voltage was only 0.5 volt. Actually, the waveform shown in Fig. 8 is not the luminance signal at all; it is a feedback of the I and Q signals from the matrix section.

The matrix section was eliminated as a source of trouble because the loss of brightness was common to all colors. The suspected circuit was narrowed down to the one shown in Fig. 9 by observing the signals at the plate and then at the grid of the second video amplifier V10A. The amplitudes of the signals at these points were practically the same, and this discovery led to the assumption that V10A was not affording normal amplification to the signal.

A replacement of V10A did not help the situation, but a measurement of the voltages applied to the tube revealed that the grid was 20 volts positive with respect to ground. Service literature specified that the voltage on the grid should normally be 10 volts. Excessive positive voltage on the grid led to a suspicion that either C1 or C69 was leaky. These components were checked, and it was found that C69 had a leakage resistance of 10,000 ohms. Replacement of this capacitor cured the trouble in the receiver.

It may be that some of our readers will be called upon to service a color receiver which displays one of the same symptoms described in the preceding case histories. This does not mean necessarily that the faulty component will be the same; but in most cases, the trouble will be confined to the same section of the receiver. Knowing what each section does and how it operates will be deciding factors in properly diagnosing the symptoms.

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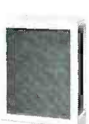

Model CT-100

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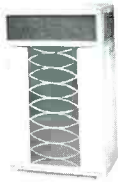

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Color TV Training Series

(Continued from page 11)

for good purity before progressing to the next step in the setup procedure. The green can be checked by turning the screen control for the red gun to its minimum (counter-clockwise) position and the screen control for the green gun to maximum (clockwise). The blue screen is checked by turning the screen control for the green gun to minimum and the screen control for the blue gun to maximum. If either the green or blue fields are not pure, the purity adjustments will need to be made again. In some cases, it may be necessary to make a compromise on the setting of the purity adjustments for all three fields and to make slight readjustments in order to give the best simultaneous red, green, and blue fields. Figs. A7 and A8 of the Color Plate show a pure blue screen and a pure green screen, respectively.

When the purity adjustments are completed, the yoke must not be moved. Its mounting bolts should be tightened so that the yoke will be securely mounted. If the yoke is moved, the purity of the fields will be affected.

After the purity adjustments are completed, the screen controls should be set to provide a low-level gray raster. The brightness control is set at maximum (or clockwise) position, and the contrast control is set at the minimum (or counterclockwise) position. Starting with three screen controls turned fully counterclockwise, turn up the screen control for the red gun until a red raster of a low brightness level appears. Green is added to the red by turning up the screen control for the green until the raster becomes yellow. Then blue is added by turning up the screen control for the blue until the raster becomes gray.

A check on the size and centering of the raster should also be made after purity adjustments are performed. Apply an input signal to the receiver. It may be necessary to readjust slightly the size and centering controls, particularly the latter, since the setting of the purity controls may have changed the centering of the raster.

Following is a step-by-step procedure for setting up the electrostatic picture tube to obtain proper purity:

1. Turn the screen control for the red gun to maximum and for the green and blue to minimum.

2. Pull out the plug for the field-neutralizing coil, or set its control at mid-position; and turn the purity control to minimum (fully counterclockwise).

3. Loosen the mounting bolts of the deflection yoke, and slide the yoke to the rear as far as possible.

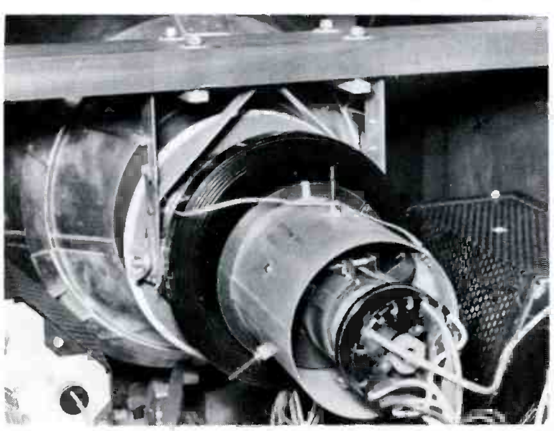

Fig. 10-5. Deflection Yoke Moved Forward.

4. While watching the central portion of the screen, alternately rotate the purity coil and adjust the purity control until the screen shows a pure red in the center.

5. Move the yoke forward until nearly all the area of the raster is red.

6. Reconnect the plug of the field-neutralizing coil, if it had been removed. Adjust the field-neutralizing control until there is no color contamination around the edges of the screen.

7. Check the purity of the green and blue fields.

8. When the best purity is achieved, tighten the mounting bolts of the deflection yoke.

9. Adjust the screen controls for a low-level gray raster.

10. With an input signal applied to the receiver, check the size and centering of the picture.

Converging the Beams

After proper purity is obtained, the next step is to make adjustments that will cause the three beams to converge properly at the aperture mask. The adjustments for convergence are made so that the three beams will cross at each successive hole in the aperture mask as the beams move across the screen. If the beams are not properly aligned to obtain convergence, they may strike the phosphor dots incorrectly, as shown in Fig. 10-6. Note that the green and the blue beams are crossing correctly at the plane of the aperture mask but that the red beam is out of convergence with the other two beams and is passing through an adjacent hole and is striking a red phosphor dot that is in a different triad. In this case, the red beam must be moved so that it will pass through the same hole as the other two beams.

During the purity adjustments, the three beams were acted upon simultaneously; however, during the convergence adjustments, the beams can be separately controlled. In order for the beams to be converged properly, they must be aligned before they reach the converging field so that they are equidistant from each other and are equidistant from the central axis of the tube. The purpose of the beam-positioning magnets is to position the beams so that they enter the converging field in the correct relationship.

The proper procedure for the convergence setup is first to control the beams under a static condition and then to control them under a dynamic condition. When the beams are in a steady state, they are in a static con-

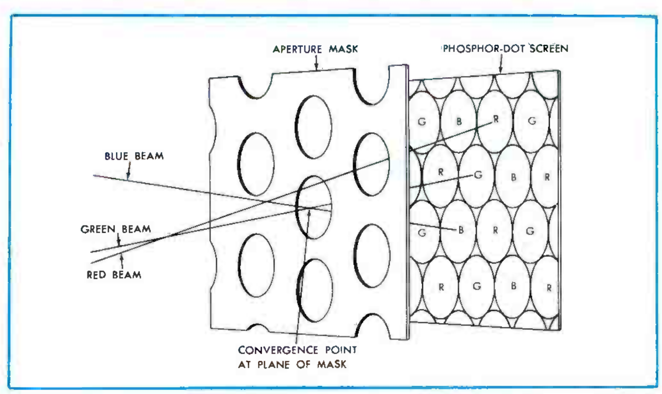

Fig. 10-6. Misalignment of the Red Beam Due to Misadjustment of Its Beam-Positioning Magnet.

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Export Division: Rocke International Corp., 13 East 40th St., N. Y., N. Y. In Canada: Charles W. Pointon, 6 Alcina Ave., Toronto 10, Ontario dition which is represented by the beams at the center of the screen. When the beams are in a changing state, they are in a dynamic condition which is represented by the beams as they scan to the edges of the screen.

When the beams converge properly at the center and at the edges of the screen, over-all convergence is achieved. Fig. A9 of the Color Plate shows a white-dot pattern produced by a picture tube that has been set up for proper convergence. The dots in this pattern are small illuminated areas of the screen and are caused to appear by the application of a special video signal to the input circuits of the picture tube.

(EDITOR'S NOTE: Henceforth in this discussion of setup procedure, the term "dots" will be used to designate these illuminated areas on the screen and should not be misinterpreted to mean the phosphor dots which form the surface of the screen.)

The significance of the white-dot pattern in Fig. A9 of the Color Plate is that it represents a superpositioning of three color-dot patterns -- namely, a red-dot pattern produced by the red beam, a blue-dot pattern from the blue beam, and a green-dot pattern from the green beam. When the three color-dot patterns conform to each other at all points and are identically positioned on the screen proper convergence is indicated by the white-dot pattern thus formed. This is the result that is desired when performing the convergence adjustments.

A white-dot generator is needed to provide the required input signal. A number of these generators are currently available to the service technician. The one that was used for our color photographs was the Hickok Model 650C video generator.

Static Convergence

During the setup for static convergence, attention should be directed to the center of the screen only; therefore, any adjustments that are made for static convergence will be for the purpose of obtaining correct convergence at the center without considering what happens to the convergence at the edges. If the beams are aligned so that they can be made to converge at the center of the screen by adjusting the DC convergence control, the setup for static convergence has been properly made.

The signal from a white-dot generator is connected to the receiver, and the receiver is tuned until the dots become stationary on the screen. By observance of these dots, it can be determined whether the beams are converging properly and what adjustments have to be performed in order to have proper convergence.

It was stated previously that when the three beams are converging properly, the dots on the screen will be white. If some of the dots contain color, the beams are out of convergence. When the controls for static convergence are being set, the three beams should be separated so that they produce separate colored dots on the screen. This is done by turning the DC convergence control until red, green, and blue dots appear. When the DC convergence control is varied, the voltage applied to the convergence anode of the picture tube is changed. Adjustment of the DC convergence control also affects the focus of the beams. It is necessary to readjust the focus control after each setting of the DC convergence control.

Fig. A10 of the Color Plate shows the triads formed by adjustment of the DC convergence control. In this case, the beams are converged after passing through the aperture mask (under-converged) because the convergence voltage is too high. If the convergence voltage were set too low, the beams would be converged before reaching the aperture mask (over-converged), and the dots would appear on the screen in positions opposite those shown in Fig. A10 of the Color Plate. The blue dot in each triad would be below; the red and green would be interchanged.

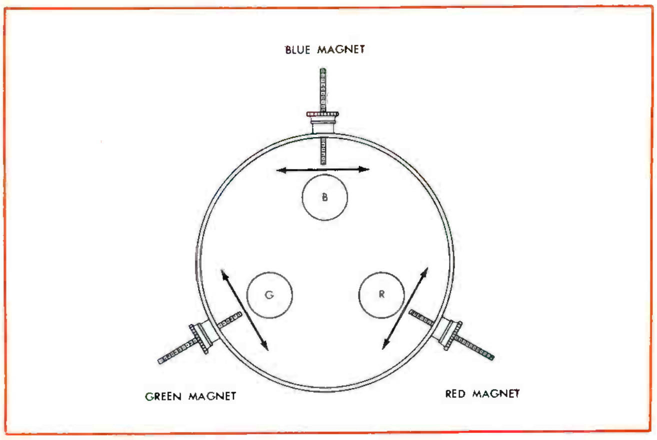

Fig. 10-7. Location of Beam-Positioning Magnets and Directions in Which the Beams Can Be Moved.

The beam-positioning magnets are employed to form the triad of dots nearest the center of the screen into an equilateral triangle. For proper static convergence, the triads in the central area of the screen are the ones that should be correctly formed. Fig. A11 of the Color Plate shows the triads after the beam-positioning magnets have been properly adjusted. Note the equilateral triangles formed by the triads at the center of the screen. Fig. A12 of the Color Plate shows the effect of improper adjustment of the beam-positioning magnets. The dot triads in this case are not formed into equilateral triangles, and it would therefore be impossible to make them converge properly by means of the DC convergence control.

The magnets which are mounted on the neck shield, with one magnet above each gun, are adjusted by turning them in or out of their threaded holders. The directions in which the beams can be moved as a result of adjusting the magnets are shown in Fig. 10-7. The adjustment of the magnet for one beam will slightly affect the other two beams; therefore, a minimum amount of adjustment should be made. If a magnet has insufficient range of adjustment, it can be removed from its mounting and reinserted in the opposite direction.

After equilateral triads are formed in the center of the screen, it should be possible to converge the dots in each triad into a single white dot by adjustment of the DC convergence control. Whenever convergence in the central area of the screen is achieved, the beam positioning magnets can be considered to be adjusted correctly. Readjustment of the focus control will need to be made after each adjustment of the DC convergence control.

Following is a step-by-step procedure for obtaining static convergence:

1. Connect a signal from a white-dot generator to the receiver. Tune the receiver until the dots become stationary on the screen.

2. Turn the DC convergence control counterclockwise until the red, green, and blue dots are separated. Adjust the focus control for proper focus of the dots.

3. Adjust the three beam-positioning magnets until equilateral triangles are formed by the dots in the triads located in the center of the screen.

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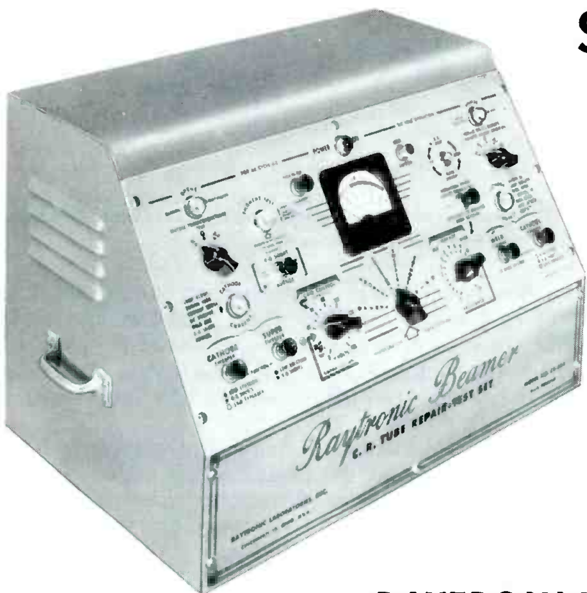

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4. After the correct triads are formed in the center of the screen, it should be possible to converge the dots in each triad into a single white dot by adjustment of the DC convergence control followed by adjustment of the focus control.

Dynamic Convergence

After static convergence is achieved, the next adjustments are those which provide dynamic convergence of the beams. Dynamic control of the beams causes them to converge properly as they are deflected toward the edges of the screen. As the angle of deflection increases, there must be less convergence force. If the convergence force were to remain unchanged as the beams were deflected, the beams would properly converge only in the center of the screen. As a result of misconvergence, there would be color fringing in areas other than the center.

Dynamic control of convergence is placed upon the beams by applying a modulating voltage to the DC potential on the convergence electrode. This modulating voltage, which is derived from the vertical- and horizontal-output stages, causes the resultant convergence voltage to vary in amplitude at the horizontal and vertical rates during the scanning process. The resultant convergence voltage has instantaneous values which are maximum at the time the beams reach the edges of the screen and minimum when the beams are at the center of the screen. The force that converges the beams is determined by the difference of potential that exists between the second anode and the convergence electrode. The potential of the second anode is a fixed value; therefore, when the instantaneous convergence voltage is minimum, the convergence force is maximum. When the voltage is maximum, the force is minimum. For a more detailed discussion of the dynamic convergence voltage, refer to Part IX of the Color TV Training Series in the February 1955 issue of the PF REPORTER.

When the dynamic convergence voltage is of the correct amplitude and phase, the beams will converge properly over the entire screen. The same circuit supplies both dynamic convergence and dynamic focus voltages to the picture tube. When the adjustments for dynamic convergence are correct, the dynamic focus will also be correct. The setup procedure for obtaining dynamic convergence consists of making adjustments that will produce correct dynamic voltages both for vertical and horizontal convergence.

A white-dot generator is again employed in the setup procedure for dynamic convergence the same as it was employed in the procedure for static convergence. Obtaining vertical dynamic convergence is the first step.

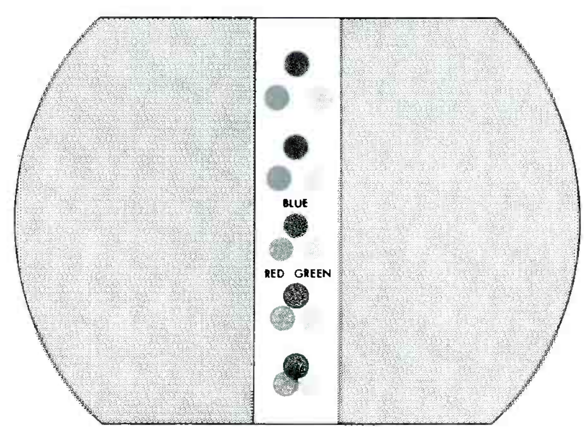
While the adjustments for vertical convergence are being made, only the triads of dots in the vertical center row should be of concern. (Remember that the triads can be made to appear by misadjusting the DC convergence control. The triads shown in the illustrations with this discussion were observed with the beams under converged.) Proper adjustment of vertical dynamic convergence is indicated by uniform equilateral triads in the vertical center row, as illustrated in Fig. A13 of the Color Plate. Whenever there is a difference in the sizes of the triads in the vertical center row, the adjustment for vertical dynamic convergence is not correct. Fig. A14 of the Color Plate illustrates the appearance of the screen when there is improper vertical dynamic convergence.

There are available on the color receiver two controls which are for use in obtaining vertical dynamic convergence. These controls are named vertical convergence amplitude and vertical convergence shape. They are potentiometers and are usually found on the front of the chassis.

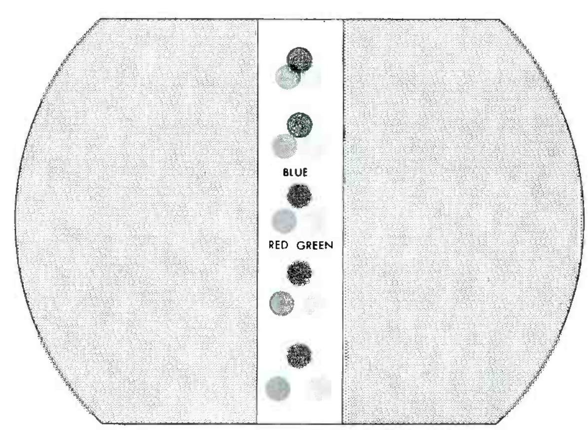
The control for vertical amplitude is first set at its maximum (fully clockwise) position. Then the control for vertical shape is adjusted to make all the triads in the vertical center row as nearly the same size as possible. If triads are still not uniform, the control for vertical amplitude can be reduced slightly and the shape control can be readjusted. Alternate adjustment of the two controls will result in the attainment of optimum dynamic convergence.

Fig. 10-8 is presented to show the effect of the shape control on the vertical center row of triads. Part A of the figure illustrates the appearance of the row when this control is set at its minimum (fully counterclockwise) position; whereas, part B shows the row when the control is set at its maximum (fully clockwise) position. In Fig. 10-8A, note that the size of the triad at the top of the screen is the largest and note that the sizes of the rest of the triads diminish with the smallest one at the bottom of the screen. Fig. 10-8B illustrates the reverse. The best setting of the shape control is at some point between the two extremes.

While making adjustments for vertical convergence, it is advisable to keep the dots in optimum focus by repeated adjustments of the focus control. When uniform triads in the vertical center row are obtained and when the triads can be converged into white dots by the DC convergence control, the vertical dynamic convergence is properly set up.



(A) Shape Control at Minimum Position.



(B) Shape Control at Maximum Position.

Fig. 10-8. Effect of the Control for Vertical Shape on the Vertical Center Row of Triads.

After the adjustments are made for dynamic convergence in the vertical direction, the next adjustments to be made are those for obtaining dynamic convergence in the horizontal direction. While the adjustments for horizontal convergence are being made, only the horizontal center row of triads should be of concern. Uniform equilateral triads in the horizontal center row are an indication that the triads can be converged properly into white dots when the DC convergence control is adjusted, and these uniform triads can be seen in the photograph of Fig. A15 of the Color Plate.

Whenever the triads of the horizontal center row are unequal in size, the adjustment for horizontal dynamic convergence is not correct; and if the triads are converged by means of the DC convergence control, some of the white dots thus formed will appear to have color fringing. See Fig. A16 of the Color Plate.

There are two controls which are used to obtain horizontal dynamic convergence. These controls are named horizontal convergence amplitude and horizontal convergence phase. Both are usually found on the front panel of the chassis. The amplitude control is a potentiometer, and the phase control is an adjustable coil.

The control for horizontal amplitude is first set at the minimum (fully counterclockwise) position. Then the control for horizontal phase is adjusted so that there will be larger triads at the middle of the horizontal center row and smaller triads at the ends of the row, as illustrated in the drawing of Fig. 10-9.

Next, the amplitude control is adjusted so that all the triads in the horizontal center row will be as nearly equal in size as possible. If equal size cannot be obtained by using the amplitude control, it will be necessary to readjust the phase control slightly. By alternately adjusting the amplitude and phase controls, a horizontal center row of uniform equilateral triads can be obtained. It is necessary to keep the dots in focus while making this adjustment for convergence.

After the adjustments for horizontal convergence have been properly made, it should be possible to converge the dots over the entire area of the screen by means of the DC convergence control. If some of the dots on a particular area of the screen do not converge correctly but can be made to converge by misadjustment of the DC convergence control, the adjustments for dynamic convergence are not at their optimum settings. Slight readjustments should be performed after it has been determined what corrective measures are necessary.

A black-and-white picture provides a good check of the purity and convergence adjustments. Any color

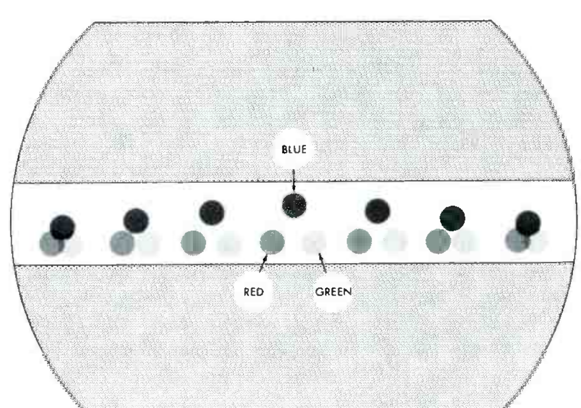


Fig. 10-9. Triads in Horizontal Center Row After Initial Adjustment of the Control for Horizontal Phase.

fringing or contamination will be easily noted in such a picture. Fig. A1 of the Color Plate shows a black-and-white test pattern on a color receiver which had been adjusted for color purity and convergence. Fig. A2 of the Color Plate shows the same pattern, but the focus is out of adjustment.

The step-by-step procedure for making adjustments for vertical and horizontal dynamic convergence can be summarized as follows:

1. Set the control for vertical amplitude at maximum (fully clockwise) position.

2. Adjust the control for vertical shape until the dot triads in the vertical center row are as uniform and as equilateral as possible.

3. Change slightly the setting of the control for vertical amplitude, and repeat step 2 to improve the vertical dynamic convergence.

4. Repeat steps 3 and 2 alternately until optimum vertical dynamic convergence is obtained. See the photograph in Fig. A13 of the Color Plate.

5. Converge the dots by adjusting the DC convergence control.

6. Refocus the dots by adjusting the focus control.

7. If the dot triads in the vertical center row do not converge into white dots, steps 1 through 6 will need to be repeated.

8. Set the DC convergence control so that the beams are under-converged, and set the control for horizontal amplitude to its minimum (fully counterclockwise) position.

9. Adjust the control for horizontal phase so that the triads at the center of the horizontal center row are larger and so that the triads at the ends of the row are smaller.

10. Adjust the control for horizontal amplitude to obtain equilateral triads that are as uniform as possible in the entire horizontal center row.

11. Slightly readjust the control for horizontal phase to obtain optimum horizontal dynamic convergence. See the photograph in Fig. A15 of the Color Plate.

12. Converge the dots by adjusting the DC convergence control, and focus them by means of the focus control.

13. If the dot triads in the horizontal center row do not converge into white dots, make slight readjustments of the controls for horizontal amplitude and horizontal phase as needed.

14. Check the appearance of the white dots over the entire area of the screen. They should be properly converged, as illustrated in Fig. A9 of the Color Plate.

Thus far, we have presented the setup procedure for obtaining purity and convergence in the picture tube which employs the principle of electrostatic convergence. In the next issue, the setup procedure for the picture tube which employs electromagnetic convergence will be presented.

Questions are included on the insert to provide the reader with an opportunity to test himself on the material in this issue.

C. P. OLIPHANT and VERNE M. RAY

Tape-Transport Mechanisms

(Continued from page 5)

running and tape spillage when the mechanism is turned off or stopped. This brake is usually operated mechanically; but in some machines, electrical dynamic braking of the rewind motor is employed. Since the brake must be applied or released at just the right instant, it is mechanically and electrically interlocked with all appropriate controls and switches.

The take-up reel can be any one of the standard reels which will fit on the take-up spindle and will hold the tape being fed to it from the supply reel. Mechanically and electrically, the take-up assembly is very similar to the rewind assembly. The biggest difference is that the take-up motor turns the take-up reel in a counterclockwise direction.

The capstan pulls the tape across the faces of the heads; therefore, the speed of the tape is determined by the diameter of the capstan and the speed at which it revolves. In this instance, the capstan is the shaft of the capstan drive motor. In many recorders, particularly the professional models, the capstan is driven directly by the motor shaft in a similar manner. Some machines employ an idler-wheel assembly to couple the motor to the capstan. Tape speed is changed by changing the speed of the motor or by changing the ratio of the diameter of the idler wheel to that of the drive pulley.

The capstan must turn very smoothly and steadily, because any variation in speed will show up as wow and distortion in the reproduced sound; consequently, very good drive motors must be used. Hysteresis synchronous motors are employed in professional recorders because of the noise-free operation provided by these constant-speed motors.

The capstan drive motor usually runs all of the time when the machine is turned on and when a tape is properly threaded on it. This serves the good purpose of keeping the motor warmed up and ready to be put into operation in the record or playback mode at any time. The mechanical and electrical controls that put the recorder in and out of the different modes of operation must function with precise and positive action. All actions must be timed and performed so smoothly that the tape will not be broken, stretched, spilled, or damaged in any way.

Electrical and mechanical interlocks are utilized where necessary to ensure proper sequence of control actions and to prevent operation of the recorder in more than one mode at a time. This is necessary because of the number of circuits that must be switched and because of the mechanical action that must be started or stopped.

Some of the manually operated controls move levers, slides, cams, or gears to do such things as apply brakes and throw appropriate switches. These mechanical operations and switching sequences are sometimes push-button controlled. When the appropriate push button is pushed, the proper relays are energized to select the desired circuits and to actuate solenoids which engage or disengage mechanical assemblies.

Record and Playback Modes

When a tape recorder is put into operation in the record or playback mode, many operations are put into action simultaneously or in rapid order to bring operating speeds and processes up to normal operating levels without delay. Record and playback modes differ mostly in the circuits selected, but here we will be concerned with the mechanical operation which is practically identical in both modes.

In the record and playback modes, the pressure-pad assembly presses the pressure pads against the tape to maintain a constant and adequate contact of the tape to the faces of the heads. The capstan idler or pressure roller, which usually has a rubber-tired surface, is pressed against the capstan with enough pressure to cause the spinning capstan to pull the tape across the heads.

While the capstan is pulling the tape across the heads, the take-up motor which is operating at reduced torque is taking up or winding the tape on the take-up reel. The brake is released on the take-up spindle assembly to allow the motor to turn without drag, but the torque of the motor is reduced (usually accomplished by inserting a resistor in the motor circuit) to such an extent that it can maintain tension on the tape but cannot develop any really strong pull. The tape is wound on the take-up reel because the take-up motor revolves in a counterclockwise direction.

The rewind motor is also operating at reduced torque and is trying to turn the supply reel in a clockwise direction. This action results in a tension being maintained on the tape because the capstan overcomes the pull of the rewind motor very easily. Proper tension must be maintained on the tape to prevent flutter and other disturbances from distorting the signal being recorded or played back.

When the recorder is stopped while recording or playing back, the pressure on the pressure roller and pads is released. The rewind and take-up motors are switched off, and the brakes are applied to stop all tape motion. As mentioned before, the capstan usually continues to run; but the tape does not move because the pressure exerted by the pressure roller is released.

Rewind

The recorder is operated in the rewind mode in order to rewind the tape on the supply reel. In this mode, the brakes are released on the supply and take-up reels and power to the rewind motor is switched on. No power is applied to the take-up motor, and it is free to turn. No pressure is applied to the pressure pads and roller; consequently, the tape is wound on the supply reel at high speed. Excessive wear of the tape and heads is prevented by the precaution of not allowing any pressure to be exerted on the tape by the pressure pads during rewind.

When the machine is stopped while in the rewind mode, the power is removed from the rewind motor and the brakes are applied on both the rewind and take-up reels to stop all motion of the tape.

Fast Forward

On those occasions when it is desirable to reach a portion of the tape which is some distance from the start and when normal speed would be too time consuming, the fast-forward mode is used.

When the recorder is put into fast-forward operation, the brakes are released on both the take-up and rewind motors. No pressure is applied to the pressure roller and pads. Power is applied to the take-up motor which turns in the counterclockwise direction in order to wind the tape on the take-up reel. Since no power is applied to the rewind motor, the tape will be wound on the take-up reel at high speed.

To stop the recorder, the power to the take-up motor is switched off and the brakes on the rewind and take-up reels are applied to stop the tape.

The preceding paragraphs have given an illustration of the method by which three motors can be used to operate a tape-transport mechanism. This is a very satisfactory method and is used in most professional and semiprofessional types of tape recorders, but many recorders use only one or perhaps two motors. By using arrangements of pulleys and belts or wheels and mechanical assemblies, one motor can be utilized to operate the recorder in any mode.

Manufacturers have worked out different methods to accomplish the desired results. Various refinements are featured in the different machines, but all of them operate on the basic actions and principles described.

The tape-transport mechanism of the Concertone Model 1502 tape recorder will be discussed in detail in the next article of this series. Three motors are used in this recorder. One four-pole induction motor drives the supply reel, and another turns the take-up reel. A two-speed, direct-drive, hysteresis synchronous motor drives the capstan. The motor is referred to as direct drive because the shaft of the motor serves as the capstan.

The supply and take-up reel assemblies are equipped with mechanical brakes. Interlocks protect the mechanical assemblies and electrical circuits. Combination electrical and mechanical controls provide complete control of all modes of operation.

A description of this particular unit should be appropriate because its construction and operation follow very closely the basic principles discussed in this article.

ROBERT B. DUNHAM

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 '55 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 '55 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.

	46-55 Models	52-55 Models
1B3GT	40	44
1X2	5	1
1X2A	4	5
c1X2B	-	-
c*3A3	-	-
*3BC5	-	-
*3BN6	-	-
*3CB6	-	-
*5J6	-	-
c5U4G	47	49
*5U8	-	-
5V4G	7	-
5Y3GT	4	2
6AB4	3	2
6AC7	7	8
c#6AF4	3	3
6AG5	30	9
6AG7	2	3
6AH4GT	3	4
6AH6	7	9
6AK5	4	3
c6AL5	74	75
6AL7GT	5	-
c*6AM8	-	-
#6AN4	-	-
c*6AN8	-	-
6AQ5	13	14
6AQ7GT	2	2
6AS5	2	2
c6AS6	-	-
6AT6	4	3
c6AU4GT	-	-
6AU5GT	4	4
c6AU6	128	119
6AV5GT	2	3
c6AV6	16	17
*6AW8	-	-
6AX4GT	9	8
6AX5GT	1	2
6BA6	13	10
6BC5	9	7
c*6BC7	-	-
c*6BD4	-	-
6BE6	6	7
6BG6G	12	6
6BH6	7	-
6BJ6	1	-
c*6BJ7	-	-
6BK5	2	3
6BK7	3	6
6BK7A	1	2
6BL7GT	5	8
6BN6	4	4
6BQ6GT	18	26
6BQ7	6	13
c6BQ7A	4	4
c6BY6	-	-
6BZ7	6	7
6C4	10	9
c6CB6	105	138
c6CD6G	9	10
c6CL6	1	2
6CS6	1	1
*6CU6	-	-
c*6DC6	-	-
6J5	3	3
6J5GT	1	1
6J6	32	30
6K6GT	15	10
6S4	9	10
6SH7GT	2	-
6SL7GT	3	2
c6SN7GT	71	78
6SN7GTA	4	4
6SQ7	2	2
6SQ7GT	2	2
#6T4	-	-
6T8	14	14
c6U8	7	10
6V3	2	3
6V6GT	20	19
6W4GT	28	30
6W6GT	6	11
6X5GT	1	1
6X8	4	6
6Y6G	3	1
7N7	2	-
c12AT7	14	14
c12AU7	45	31
12AV7	3	4
12AX4GT	2	4
12AX7	4	5
12AZ7	-	2
c12BH7	9	12
12BY7	4	5
12BZ7	2	-
*12L6GT	-	-
12SN7GT	6	4
*12W6GT	-	-
19BG6G	3	-
*25BK5	-	-
25BQ6GT	3	4
*25CU6	-	-
25L6GT	5	5
25W4GT	1	1
5642	2	2

A stock of these tubes should be maintained in UHF areas.

* New tubes recently introduced.

c Tubes used in color television receivers.

Audio Facts

(Continued from page 33)

in the preamplifier, amplifier, or power supply. We have used sources supplying less than 100 volts and others supplying more than 250 volts, with normal operation resulting in every instance. Plate current never exceeded 0.8 milliampere.

Separate leads were connected to pins 4, 5, and 9 on the tube socket so that 6.3 or 12.6 volts AC or 300 or 150 milliamperes DC could be used to heat the tube. For instance, when the unit was used with one preamplifier which operates with DC on the tube heaters, the yellow lead to pin 9 was not used. One brown lead was connected into the DC filament string, and the other brown lead was connected to ground to obtain 12 volts DC at 150 milliamperes for the heater of the 12AT7.

It is surprising how quietly the 500,000-ohm gain control R1 operates and how effectively it controls the signal. The control is so effective that no difficulty has been experienced in handling the output of any cartridge tried thus far.

Low-noise resistors, such as the IRC Precistors, would normally be used in this unit because it is a low-level input stage. We would recommend that low-noise resistors be used as the plate load R5 and as the cathode resistor R3; but in these two units, we used standard composition resistors of 1-watt rating as a matter of trial and have been unable to hear any noise whatsoever. One-watt units were used because they stand up under prolonged use and can better withstand the heat applied to them by a soldering iron when they are installed. Resistors of lower-wattage ratings are more prone to become noisy and to change value under such conditions.

The usual construction procedures were followed. The ground bus was grounded to the chassis only at the input jack. The output jack was insulated from the chassis by a large insulating washer.

We have been unable to detect any hum pickup when the tube shield and bottom cover of the chassis are in place, even though the unit has been operated in the powerful magnetic fields of power transformers and turntable motors.

For those who would like to construct this unit, refer to the Parts List which gives the standard components available at your Parts Distributors.

ROBERT B. DUNHAM

Dollar & Sense Servicing

(Continued from page 39)

SHOCKING ADVICE. One hand in "pockey," no get "shockey." — GE Ham News.

GOOD TURN. For a real lift, try a white lie now and then as you get to know the people in your community. If the little old lady who's living on a $40-a-month teacher's pension needs two new tubes in her radio, install them and tell her apologetically that you'll have to make a 25-cent charge for soldering a loose wire. If the picture tube goes out in a 10-inch TV set that's the only source of entertainment for a widow's five children, check the picture tubes in the trade-in sets which you may have on hand. Find a tube with some life left in it, and install it. Just charge the widow for a 6SN7. The small charge is essential, because the poorest people are the proudest and insist on paying even if it means living on bread and potatoes for the next week.

COLOR. Production of color sets is just about all shut down these days, in response to public demand — or lack of it. Around 20,000 sets have been made to date, but way less than half of these have been sold.

What'll happen to these sets is anybody's guess; 15-inchers that sold for $1200 and cost way more than that to build aren't even moving much at special press or trade prices under $300, chiefly because of the tube-cost bugaboo. If the 15-inch tube goes bad, a new one'll still cost plenty even if the manufacturer lets you have it at his actual cost. Just isn't worth the gamble when there are so few color programs on the air.

But picture-tube cost isn't the answer by far to public acceptance; even if a color tube were to cost no more than a black-and-white tube of the same size, the price of the color set couldn't be dropped more than a few dollars. Apparently what the public wants is a price tag of $500 or less on large-screen color sets. Keep studying color-circuit theory, though; color will come, just as black-and-white TV did.

HIS MASTER'S VOICE. Once upon a time there lived a fox terrier named Nipper, who was devoted to his master but indifferent to other people. The master died, and Nipper went to live with his master's brother, Francis Barraud, who was an artist. This was in 1899 in the days when wax cylinders were used on phonographs. Barraud noticed how the dog cocked his ears and listened intently whenever the phonograph talked. Whether one of the voices resembled that of the dog's old master is not known, but Nipper's pose gave Barraud the idea for his painting showing Nipper looking into the big morning-glory horn.

Thinking it might interest phonograph manufacturers, the artist took the painting first to a company selling wax-cylinder machines. They weren't interested. Next he offered it to the Gramaphone Co., who asked him to substitute a disc gramaphone since that was what they were selling. He did, and so they adopted the painting as the trademark of the Gramaphone Co. Since then, this painting has been reproduced millions of times all over the world. In the United States, it is RCA Victor's trademark for their phonograph line.

In presenting this little story, Radio Times of India concludes as follows: "The strong appeal of the picture lies probably in the fidelity of the dog. It is appropriate, therefore, that this quality of fidelity has been the keynote of 'His Master's Voice' products ever since."

PHOTOGRAPHY. One way to get a good photo of a person watching a program on a TV set is to use a black mask and take two exposures. Cut from construction paper or other dull black paper (even roofing felt will do) a mask big enough to cover the entire screen of the TV set. Take the first exposure with the scene illuminated by floodlights and with the person and mask in position. Then, without disturbing the camera, turn off all room lights, remove the mask from the screen, and let the model go for a walk. Take a second exposure just for the TV picture. An exposure meter will give the correct exposures in each case. This is how professional photographers get such good pictures of TV sets — when they don't pull that old stunt of pasting a photo right over the screen.

STRICTLY BRITISH. "Grab the loudhailer, and tell that bloke to move the crab dolly over by the vision mixer." Using British Marconi's catalog as guide, this would translate into: "Pick up the power megaphone, and tell the cameraman to move his dolly next to the video mixer."

COMMERCIALS. One TV set in New York City shows only commercials all day long. It's used by the J. Walter Thompson advertising agency in a channel-3 closed-circuit system for pre-testing commercials. The camera output is sent over wires to an auditorium two blocks away, where television clients watch different ways of advertising their products and choose the ones they feel will be most effective. This has proved much cheaper than filming all of them and then throwing away the costly unwanted films.

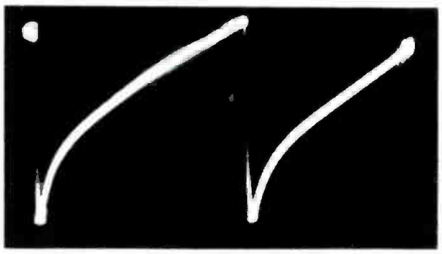
JOHN MARKUS

Vertical Nonlinearity and Foldover

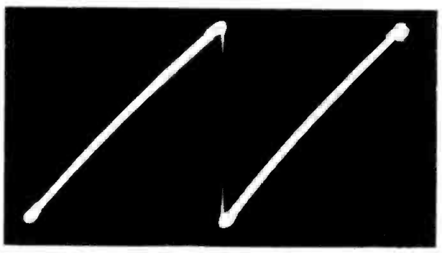
(Continued from page 35)

A receiver which uses one particular type of yoke will require a particular waveform on the grid of the vertical-output tube. Another receiver which uses an entirely different type of yoke will require a different waveform on the grid. When servicing a receiver which has vertical nonlinearity, a clue as to the proper grid waveform may possibly be obtained from the rated yoke inductance and the plate resistance of the output tube.

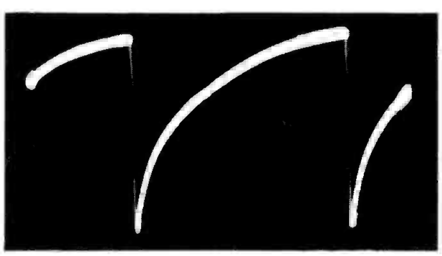
As a rule, the grid waveform on the output tube of a receiver using a yoke of very low impedance (3 to 4 mh) will have a rectangular component which is large by comparison with



(A) With a 12W6GT and 46-Mh Yoke.



(B) With ½ 6BX7GT and 40-Mh Yoke.



(C) With ½ 12BH7 and 38-Mh Yoke.

(D) With a 6W6GT and 42-Mh Yoke.

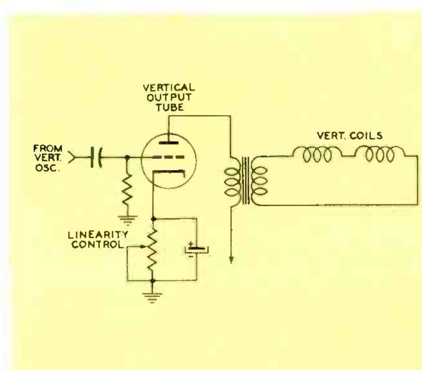
Fig. 2. Various Grid Waveforms in Different Kinds of Vertical-Output Circuits.

the saw-tooth component. A receiver using a yoke of high impedance (35 to 45 mh) will have a grid waveform which is composed almost entirely of saw-tooth voltage.

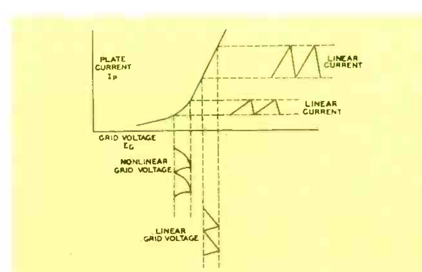
The output tube that is used and the way in which it is connected will modify the requirements of the grid waveform. An output stage using a beam-power or pentode tube will usually have very little rectangular voltage in the grid waveform. A triode tube or a multigrid tube which is connected as a triode will have a grid waveform similar to that required by a low-impedance yoke. The photographs in Fig. 2 show some of the variations which can be found in the grid waveforms of vertical-output stages.

SAW-TOOTH LINEARITY

If a linear saw-tooth current is to be developed in the yoke, the saw-tooth portion of the grid waveform should be very nearly linear and the output tube should be operating along the straight-line portion of its characteristic curve. In practice, however, the saw-tooth portion of the grid waveform departs somewhat from good linearity; and a control for vertical linearity is employed to compensate for this departure.



(A) Schematic Diagram With Linearity Control in Cathode Circuit.



(B) E_g — I_p Curve Showing That a Shift in Operating Point Corrects for Nonlinearity.

Fig. 3. The Vertical-Linearity Control and Its Effect.

The schematic diagram in Fig. 3A is that of a basic vertical-output stage with a variable cathode resistor. Variation of this resistance will produce a variation of the cathode voltage and consequently of the operating bias. The variation in the grid bias will shift the operating point of the tube along the $E_g - I_p$ curve shown in Fig. 3B and will change the operation of the tube from linear to nonlinear. If the input waveform cannot be made linear, the operating point of the tube can be shifted so that the nonlinearity of the tube will counteract the nonlinearity of the input waveform; and therefore the output waveform will be linear, or nearly so. This is the principle of the operation of the vertical linearity control in a television receiver.

It can be seen from Fig. 3B that the amplitude of the output current undergoes a marked change when the operating point is changed. This means that the vertical-height control, which establishes the amplitude of the input signal at the grid of the output tube, requires readjustment when the setting of the vertical-linearity control is altered.

SERVICING

In order to provide a reference for the troubles to be discussed, the schematic diagram shown in Fig. 4 has been selected as a representative example of a vertical-sweep section of a television receiver. Included in Fig. 4 are the normal test pattern displayed by the receiver and three waveforms which can normally be found in the vertical-sweep section.

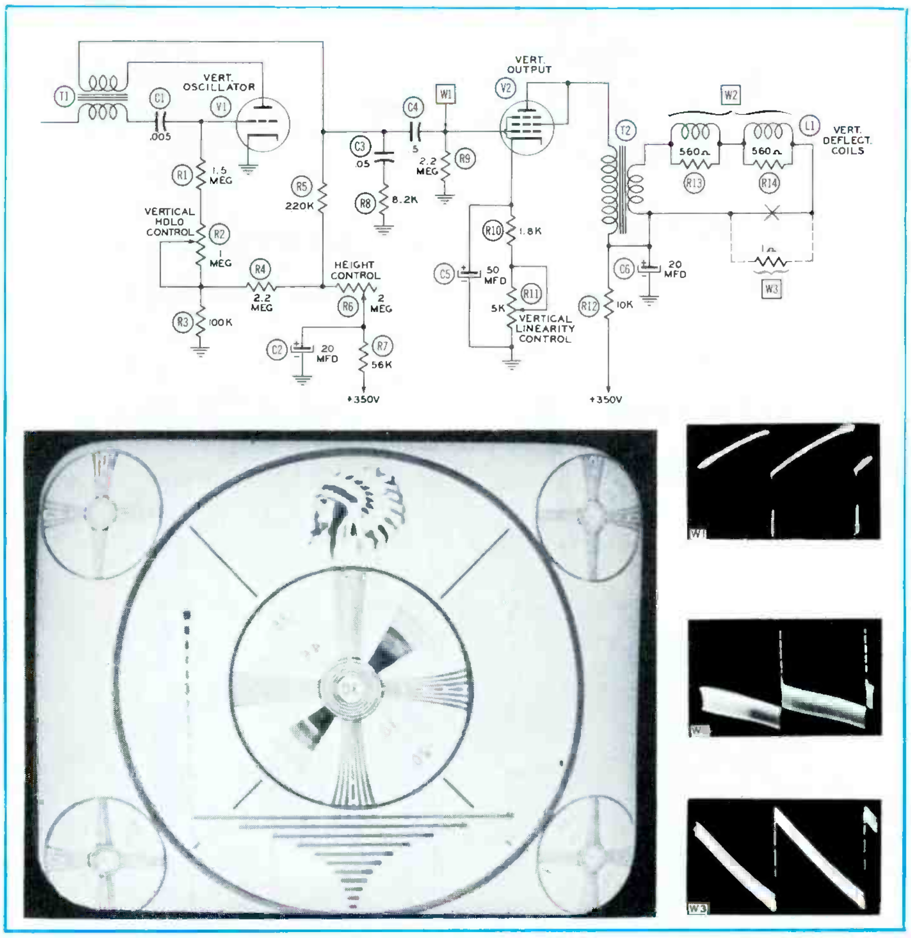
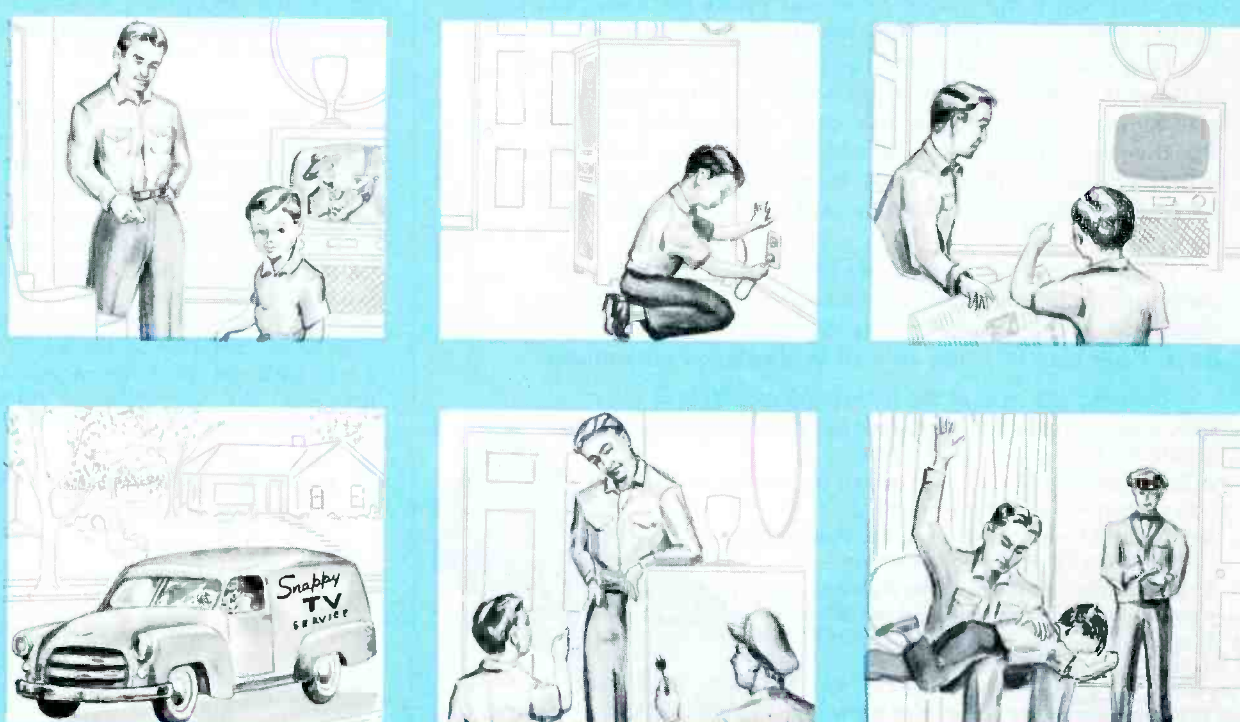


Fig. 4. Schematic Diagram of Typical Vertical-Output Stage and Vertical Oscillator. Normal Picture Display and Normal Waveforms Are Shown.



APRIL FOOL

Waveform W1 is the trapezoidal voltage which is applied to the grid of the output tube. This waveform is useful in determining whether the oscillator or the output stage is at fault when nonlinearity or foldover is encountered.

Waveform W2 is the voltage which is applied to the deflection yoke, and waveform W3 is the current which is developed by that voltage. In these waveforms and in those that follow, it is very evident that a saw-tooth current in the yoke coils is produced by a trapezoidal voltage across the coils.

Waveform W2 is observed across the yoke instead of from the high side of the yoke to ground. This is done in order to protect the input circuits of the oscilloscope from excessive voltage. This precaution is not necessary in vertical circuits which utilize low B+ voltages. If the technician follows our example, the metal case of the oscilloscope will be at B+ potential; and he should therefore be mindful of the consequent shock hazard.

Waveform W3 is obtained first by opening the return lead of the vertical coils, by inserting a carbon resistor of small value, and then by connecting the oscilloscope across this resistor. The value of this resistor will depend upon the circuit which is being investigated and upon the sensitivity of the oscilloscope which is being used. A one-ohm resistor was used to obtain the waveforms shown. A carbon resistor is necessary because a wire-wound resistor has too much inductance and will distort the waveforms.

The troubles to be discussed are representative of those that might be encountered during normal servicing procedure; however, for the purpose of obtaining the photographs and waveforms which appear in this article, troubles were simulated by introducing them into a receiver. The technician should realize that some degree of variation in the waveforms and patterns may be encountered during the servicing of different receivers.

Low Transconductance in the Output Tube

The vertical-output tube in the average television receiver operates almost at the limit of its capabilities. For this reason, any slight change in component value may introduce nonlinearity into the vertical sweep. The most common change occurs in the output tube itself. In some very critical circuits, several new output tubes

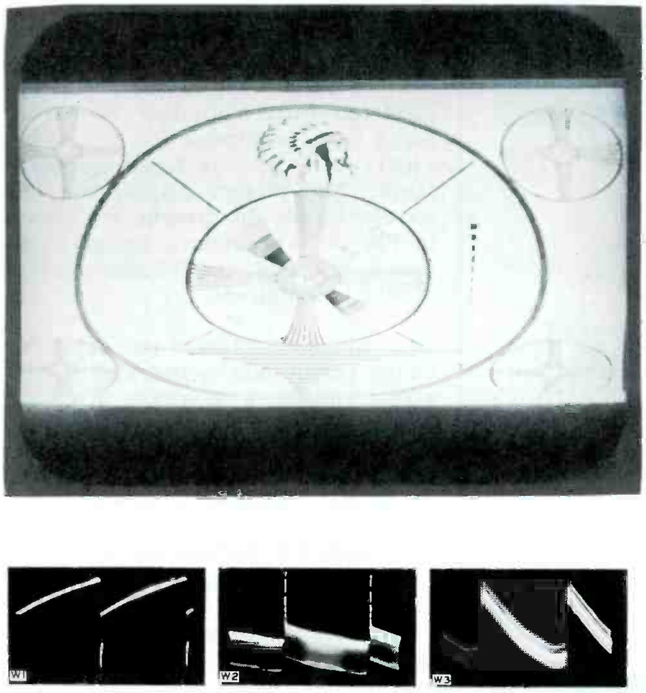


Fig. 5. Picture Display and Waveforms Resulting From Low Transconductance in Output Tube.

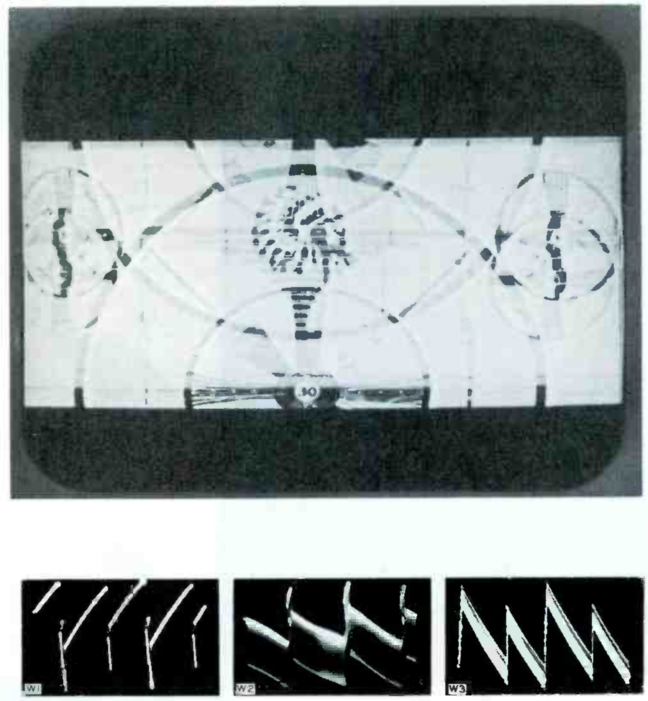


Fig. 6. Picture Display and Waveforms Resulting From Low Transconductance in Vertical-Oscillator Tube.

should be tried; and the one giving the best performance can be selected as the replacement tube. If a tube substitution does not remedy the defect, the other components in the circuit should be tested.

Although waveforms normally are not checked when a tube is suspected as being weak, they are shown in Fig. 5 for any benefit that they might be to the service technician. The picture display and the waveforms indicate the conditions in the circuit when the transconductance of the output tube has dropped to a low value. Note that the trouble is most evident in the test pattern which shows nonlinearity at the bottom and an overall decrease in height. The current waveform W3 shows a marked change from the normal condition, W2 shows a slight change, and W1 shows no change at all since it was taken at a point in the circuit ahead of the source of trouble.

Low Transconductance in the Vertical-Oscillator Tube

The vertical-oscillator tube can also lose a portion of its transconductance. The photographs in Fig. 6 show the resultant picture display and waveforms associated with a trouble of this nature. In this case, the oscillator has changed frequency (as evidenced by the double image on the test pattern); and alternate oscillations are weaker than the others.

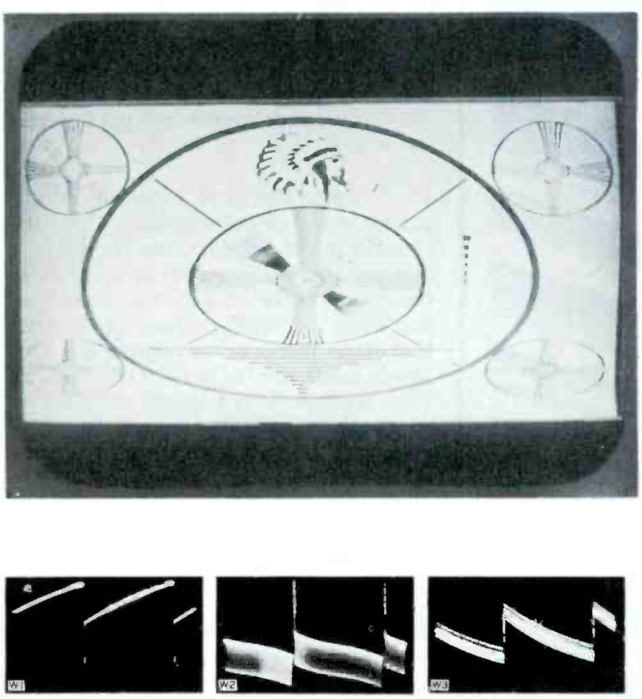


Fig. 7. Picture Display and Waveforms Resulting From Low B+ Voltage to the Vertical Oscillator.

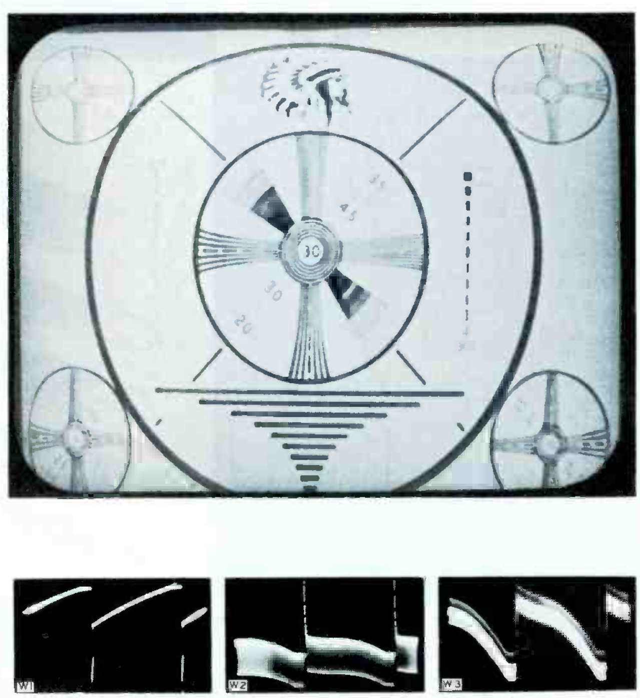


Fig. 8. Picture Display and Waveforms Resulting From Low B+ Voltage to the Vertical-Output Stage.

Low B+ Voltage to the Vertical Oscillator

A trouble which will produce a distorted pattern similar to that of Fig. 5 is a condition of low B+ voltage applied to the vertical-oscillator stage. The picture display and the waveforms for this trouble are shown in Fig. 7. The picture shows a decrease in height, and W1 shows a decrease in amplitude.

Since a portion of the grid bias on the output tube is provided by the signal voltage, a decrease in signal amplitude will lower the bias on the output tube and will introduce nonlinearity in the pattern. This is shown by the curve in the trace portion of W3.

Low B+ Voltage to the Vertical-Output Stage

When the B+ voltage to the vertical output stage decreases, the picture display and the waveforms might appear as shown in Fig. 8. Nonlinearity is evident over the entire picture, and the bottom is stretched enough to project past the edge of the mask. In this case, the change in plate voltage has shifted the bias of the tube along the characteristic curve to a point where the amplification is higher but is distorted. The nonlinearity is very evident in waveforms W2 and W3.

Changes in Resistor Values

Changes in resistor values can cause troubles in vertical-oscillator and vertical-output stages. The photographs in Fig. 9 show the results of an increase in the value of the plate-load resistor in the oscillator circuit. The picture display reveals that the height has decreased but that the linearity has changed only slightly. All of the waveforms in Fig. 9 verify these facts.

When the grid resistor of the output stage decreases in value, the results might appear like the picture display and the waveforms shown in the photographs of Fig. 10. Note that nonlinearity appears only at the bottom of the picture;. waveform W3 also shows nonlinearity only at the bottom. This trouble is not likely to occur in an average receiver since the grid resistor does not dissipate an appreciable amount of power.

The picture display in Fig. 11 shows what seems to be a case of extreme nonlinearity. Actually, a careful inspection of the waveforms will show that the vertical sweep is linear, or nearly so, and that all of the waveforms have increased amplitudes. These clues should point to the fact that the height of the picture is excessive. A readjustment of the

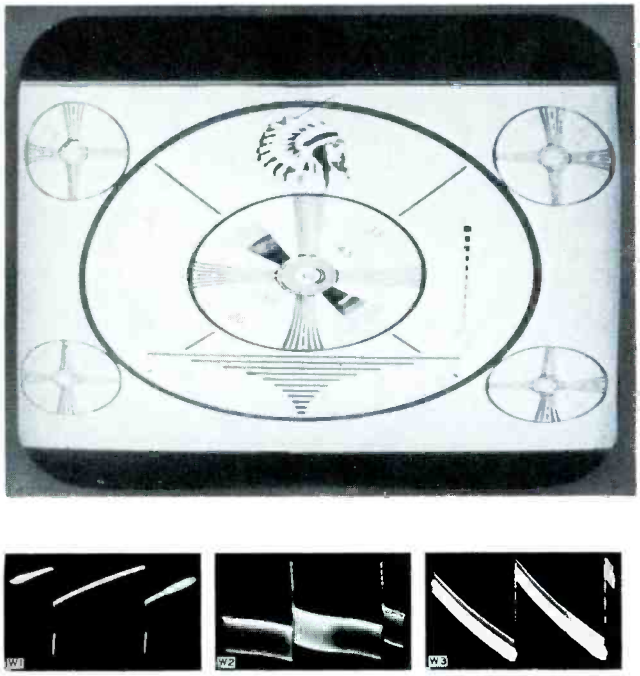


Fig. 9. Picture Display and Waveforms Resulting From Increased Value of Plate Resistor in Vertical-Oscillator Circuit.

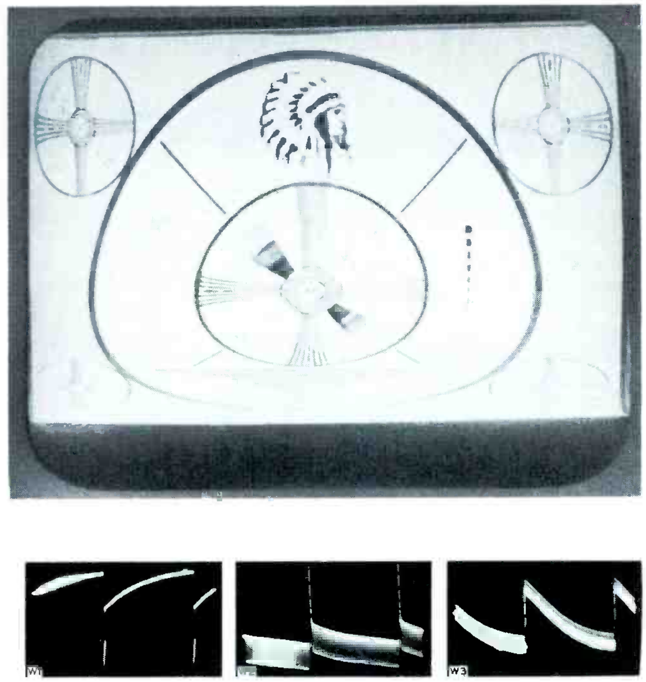


Fig. 10. Picture Display and Waveforms Resulting From Decreased Value of Grid Resistor in Vertical-Output Stage.

height control should remedy this situation.

Capacitor Failures

Capacitor failures can cause troubles in the vertical-oscillator and vertical-output stages. The picture display and the waveforms in Fig. 12 show an extreme case of foldover, as evidenced by the white line across the pattern and the abrupt changes in direction in the saw-tooth voltages in each waveform. A trouble of this nature is fairly common and is caused by a leaky coupling capacitor between the oscillator stage and output stage. The white line on the pattern is caused by a cessation or a reversal of the yoke current and of the sweep. Note that waveform W3 of the yoke current shows this reversal of current.

Another fairly common trouble is an open bypass capacitor in the cathode circuit of the output tube. The resultant picture display and waveforms are shown in Fig. 13. Note that waveform W3 of the yoke current is nonlinear and that the majority of the saw-tooth portion of waveform W2 of the yoke voltage is missing.

AC Hum

AC hum can enter a vertical circuit and cause a great variety of picture displays and waveforms. The AC line voltage can and does vary in frequency. Its frequency and the phase difference between its frequency

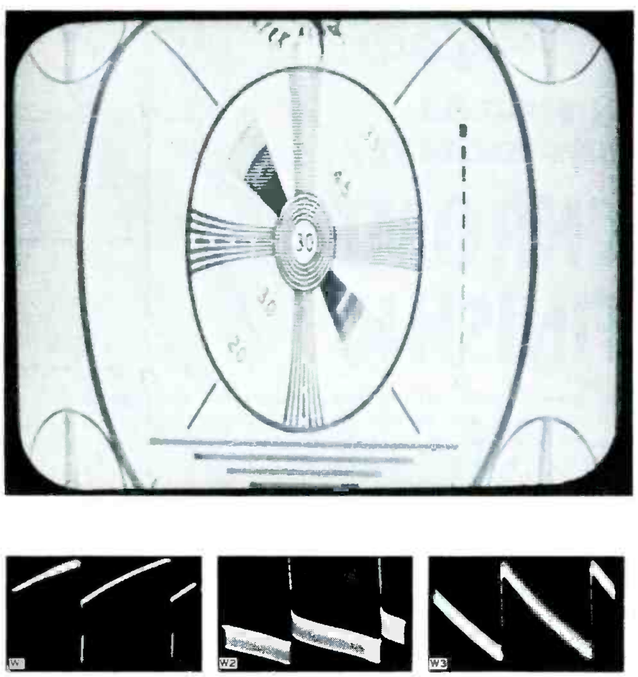


Fig. 11. Picture Display and Waveforms Resulting From Misadjustment of Height Control.

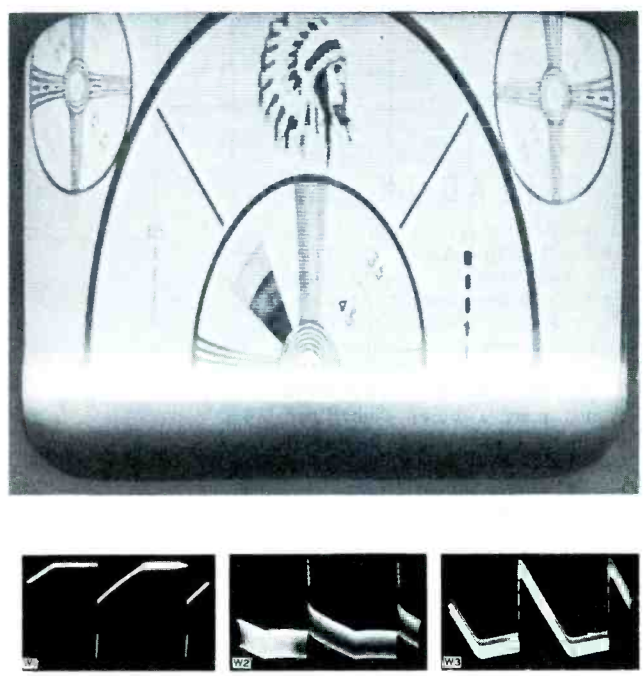


Fig. 12. Picture Display and Waveforms Resulting From a Leaky Coupling Capacitor Between the Oscillator and Output Stages.

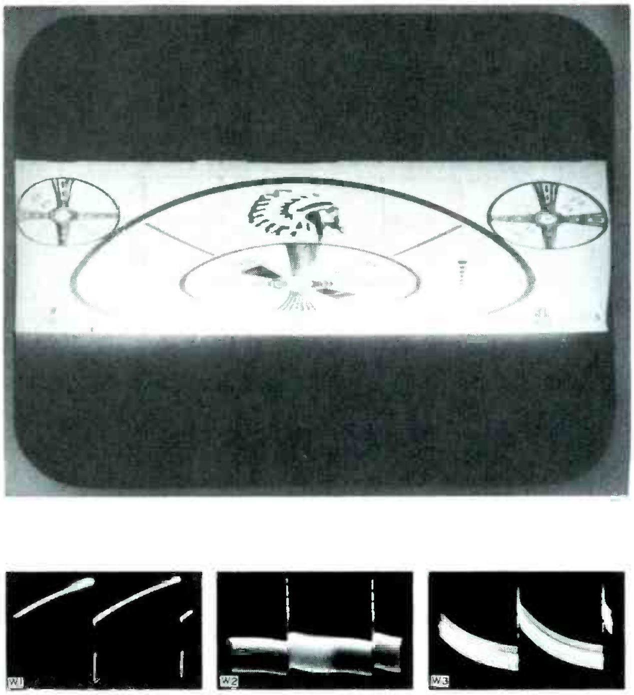


Fig. 13. Picture Display and Waveforms Resulting From an Open Bypass Capacitor in the Cathode Circuit of the Output Tube.

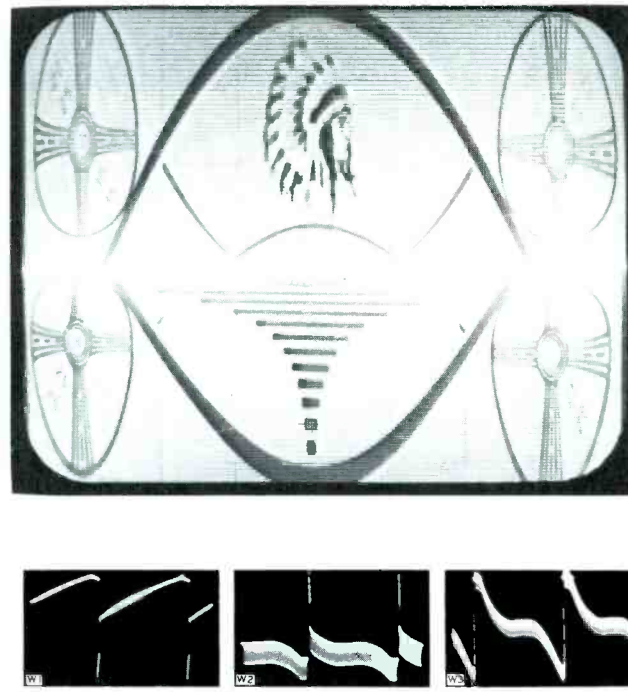


Fig. 14. Picture Display and Waveforms Resulting From a Heater-to-Cathode Short in the Vertical-Output Tube.

and the oscillator frequency will determine the nature of the symptoms.

Fig. 14 presents the picture display and the waveforms resulting from a heater-to-cathode short in the vertical-output tube. The horizontal portion in the center of waveform W3 of the yoke current shows that the current stays at a steady value near zero for a short time. This condition in the sweep current is evidenced by the foldover in the center of the pattern.

WILLIAM E. BURKE

Notes on Test Equipment

(Continued from page 21)

covers of the double shield have been removed to show the oscillator tube and the pickup device. No direct connection is made to the oscillator section of the instrument; therefore, the amplitude of the signal available at the output depends upon the position of the loop with respect to the oscillator tube V1. When the loop is close to the oscillator tube, as in Fig. 1, a large amount of signal is fed to the output; and when the loop is moved farther away from the tube, the output signal is reduced.

Frequency Compensation

The ideal attenuator would have no effect upon the signal except to control the amplitude. This ideal is difficult to approach since some frequencies will be attenuated more than others. This results from the capacitances of associated circuits being in parallel with the attenuator network. For example, if the attenuator network is connected to an amplifier stage, the input capacitance of the stage is in parallel with the attenuator. This capacitance bypasses some of the signal around the network. The amount of bypassing increases as the frequency increases.

To correct for this frequency discrimination, compensating networks are used. Two examples of attenuators employing frequency compensation are shown in Figs. 2 and 3. Fig. 2 is the vertical-attenuator section of the General Electric Model

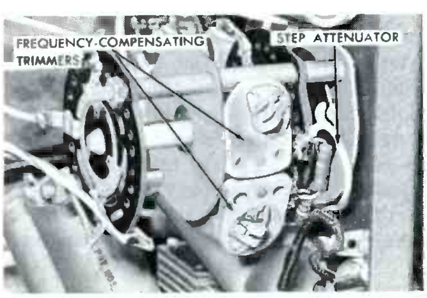


Fig. 3A. Vertical Attenuator of a Jackson Model CRO-2 Oscilloscope.

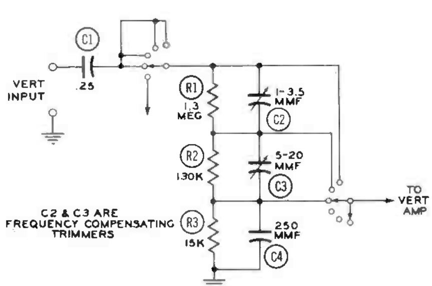


Fig. 3B. Partial Schematic Diagram of Attenuator Shown in Fig. 3A.

4ST2A3 oscilloscope. Fig. 3 is the vertical-attenuator section of the Jackson Model CRO-2 oscilloscope. The A sections of each figure show the actual appearance of each attenuator, and the B sections are the schematic diagrams for each attenuator. The frequency-compensating trimmers are indicated on the photographs.

Fig. 2B includes a schematic diagram of the low-capacity probe furnished with the GE oscilloscope. Although it is not designed for that purpose, the probe does have some attenuation associated with its use; therefore, frequency compensation is provided for it in addition to that incorporated in the vertical attenuator.

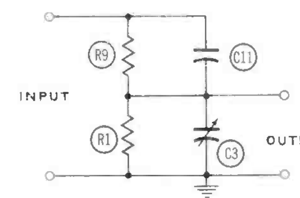


Fig. 4. Simplified Schematic Diagram of a Frequency-Compensated Voltage Divider.

The probe circuit can be represented as in Fig. 4, and this diagram serves to illustrate the prinicple of frequency compensation of a voltage divider. C1 has been disregarded because its reactance is very low at the frequencies involved. When the value of R9 times the value of C11 equals the value of R1 times the value of C3, the voltage division between the input and output is independent of frequency. C3 is made variable so that this condition can be easily obtained. The capacitance of the probe cable C_c is effectively in parallel with C3 and must be considered in making the calculations. In addition to the compensation of the probe, compensation of the attenuator is used and is provided by trimmers C9 and C10. These trimmers are adjusted at the factory so that the oscilloscope will give the best square-wave response on the various ranges.

Impedance-Matching Considerations

Another feature of the ideal attenuator would be that the attenuator would cause little or no change in the impedance of the circuits with which it is associated as it is adjusted to various degrees of attenuation. This is especially important when high frequencies are involved, as is the case when a TV sweep signal is applied to the input terminals of a TV receiver.

For best results, the input impedance of the attenuator should match the impedance of the circuit at the point to which the attenuator is connected; also, the output impedance

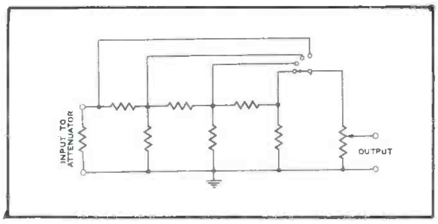


Fig. 5. Ladder Type of Attenuator.

of the attenuator should be matched. This should be true for all ranges of the attenuator. The addition of a continuously variable section at the output of the attenuator alters the the attenuator impedance so that it is not the same for all settings of the attenuator. Improper impedance terminations in a sweep generator result in changes in the response curve and also result in changes in the attenuation factor.

A form of attenuator that is frequently used is the ladder type shown in Fig. 5. When the values of the resistances shown are properly chosen, very good matching properties are obtained at any setting of the attenuator. The values are commonly chosen to give a ratio of ten to one between steps. Any fraction of the output signal at a given switch position can be obtained through the use of the variable potentiometer at the output of the attenuator.

The impedance of the output cable used with an RF or sweep generator should match the output impedance of the attenuator as closely as possible so that there will be no reflections on the cable. Such reflections are manifested by a change in response as the cable is grasped or moved. When the output circuit of the attenuator includes a vernier control, the impedance match can be exact at only one setting of this control; and slight mismatching will be obtained for other settings. For this reason, some manufacturers prefer to place the vernier control at the output end of the cable so that fewer reflections will result. The output cable for the General Electric Sweep Generator, Type ST-4A, employs this

Fig. 6. Output Cable With Vernier Attenuator for the GE Sweep Generator, Type ST-4A.

type of vernier attenuation. A photograph of the cable and termination box appears in Fig. 6.

Shielding

Practically all present-day RF signal generators are heavily shielded to prevent unwanted radiation. The signal-generating section of the instrument is commonly shielded by a single- or double-shield box; and in some cases, a triple-shield box may even be used. In order not to lose the advantage gained by this shielding, the attenuator should also be shielded. The generator signal is usually fed to the attenuator at full strength and could be radiated from all sections of the attenuator if no shielding were used.

The step-attenuator section of a Hickok Model 695 TV-FM alignment generator is shown in Fig. 7. The shield case which houses this ladder type of attenuator has been

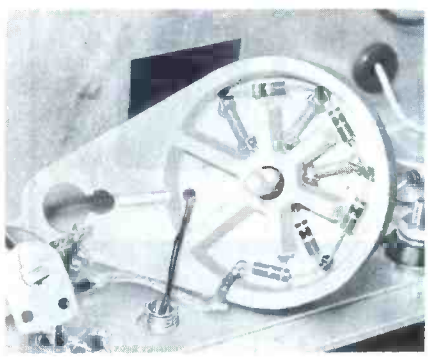


Fig. 7. The Output Attenuator of the Hickok Model 695 TV-FM Alignment Generator.

detached from the front panel and turned on its side so that the individual sections of the attenuator are visible. Each individual section of the attenuator is partially shielded from the next, and the whole assembly is shielded by the attenuator case itself. Shielding becomes more important as the signal attenuation becomes greater and greater. If no shielding were used, a level might eventually be reached where radiation from the entire attenuator would be greater than the signal developed across the output of the attenuator.

Formulas for calculating the attenuation factors and impedance-matching characteristics of attenuators may be found in various textbooks. These attenuators include the L-section, the T-section, and the more complicated multiple-section attenuators. Examination of the formulas will show that attenuator design is not exactly simple. As was pointed out near the beginning of this article, the simplicity of operation of a control is often in direct contrast to the amount of thought expended in the original design of the control.

PYRAMID MODEL CRA-1 CAPACITOR-RESISTOR ANALYZER

The Pyramid Model CRA-1 capacitor-resistor analyzer is a product of the Pyramid Electric Company, North Bergen, New Jersey; and it affords a variety of checks for the condition of capacitors and resistors. A photograph of the Model CRA-1 appears in Fig. 8. The instrument will measure resistance and capacity. It will also measure leakage, power factor, and insulation resistance of capacitors. In addition, there is provided a QUICK CHECK feature with which a capacitor can be checked for an open or shorted condition while still in the circuit and under operating voltages.

Capacitance and resistance values are obtained through the use of bridge circuits. Bridge balance is indicated by the opening of an electronic eye. The electronic eye also indicates the open or shorted condition of capacitors during a QUICK CHECK test.

Fig. 8. Pyramid Model CRA-1 Capacitor-Resistor Analyzer.

Leakage indications and insulation resistances are shown by a front-panel meter. The leakage scales are from 0 to 5 ma and from 0 to 50 ma. Measurements of the insulation resistance can be made up to 20,000 megohms in two ranges. The meter is also calibrated with scales from 0 to 60 volts and from 0 to 600 volts in order to measure the voltages applied to capacitors during leakage tests. Any voltage within these ranges can be selected by use of the ADJUST VOLTS knob.

Capacitance measurements may be made from 10 micromicrofarads to 2,000 microfarads in four ranges. Resistance measurements may be made from 100 ohms to 25 megohms in two ranges. A QUICK CHARGE feature provides for fast charging of capacitors of large value when making checks for insulation resistance. One position of the function-selector switch provides for discharging the capacitor after testing. Readings of the power factor can be obtained from 0 to 75 per cent.

Two sets of test leads are supplied; one for the QUICK CHECK tests and the other for all the rest of the tests.

Dimensions of the instrument are 14 by 9 1/4 by 5 1/2 inches. Weight is 15 pounds.

PHAOSTRON MODEL 555 MULTIMETER

The Phaostron Model 555 multimeter shown in Fig. 9 is a product of the Phaostron Company, 151 Pasadena Ave., South Pasadena, California.

The meter movement is enclosed in a shatterproof, antimagnetic metal case which protects the movement from stray magnetic fields. The meter scale is 4 7/8 inches, and the entire instrument measures 6 1/8 by 4 5/8 by 2 1/8 inches.

The Phaostron Model 555 is designed to indicate voltages and cur-

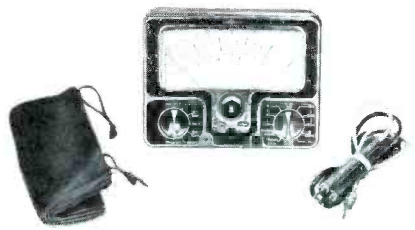


Fig. 9. Phaostran Model 555 Multimeter.

rent for both AC and DC, to indicate output in decibels, and to indicate resistance. The fact that current measurement for AC is provided is of particular interest, inasmuch as this function is not commonly found in multimeters. The sensitivity rating of the instrument is 20,000 ohms per volt on DC ranges and 2,000 ohms per volt on AC ranges. Accuracy of the meter is stated as being three per cent on DC ranges and four per cent on AC ranges.

Voltage ranges for both AC and DC are provided as follows: 0 to 1.5, 5, 15, 50, 150, 500, and 1500 volts. Current ranges for DC only are provided as follows: 0 to 5, 150, and 500 microamperes; 0 to 1.5, 5, 15, 50, 150, 500, and 1500 milliamperes; and 0 to 15 amperes. Current ranges for AC are the same as those for DC except that the three ranges for microamperes are not provided.

Four positions for resistance measurements cover the range from .25 ohm to 10 megohms. The positions are marked: R x 1, R x 100, R x 1K, and R x 10K.

Six ranges provide for output measurements from -10 db to +56 db. The zero-db reference level into a 500-ohm line is 1.73 volts.

The seven positions of the function-selector switch are marked OUTPUT, A.C.V., A.C.AMP., D.C.V., D.C.AMP., OHMS, and TRANSIT. When the switch is in the position last mentioned, the meter movement is shunted for protection when the meter is not in use or is being transported.

Fig. 10. Phaostran Model 555 Multimeter in Leather Carrying Case.

The dial is calibrated with scales of different colors for ease in selection of the proper scale.

The meter is supplied with a flannel carrying case, and a leather carrying case with a leather shoulder strap is available as an accessory. The test leads may be stored in a compartment of the case, as illustrated in Fig. 10.

There is also available a panel-mounting adapter which makes it possible to panel mount the instrument if desired.

NEW TUBE-TESTER ROLL CHART FOR EICO TUBE TESTERS

EICO announces the availability of a new roll chart for EICO tube testers. This chart (number 625-04) contains listings of the latest tubes released by leading tube manufacturers. The chart may be obtained from EICO jobbers or by sending $1.00 direct to EICO, the Electronic Instrument Co., Inc., 84 Withers St., Brooklyn 11, New York.

PAUL C. SMITH

Applying the Finishing Touch

(Continued from page 25)

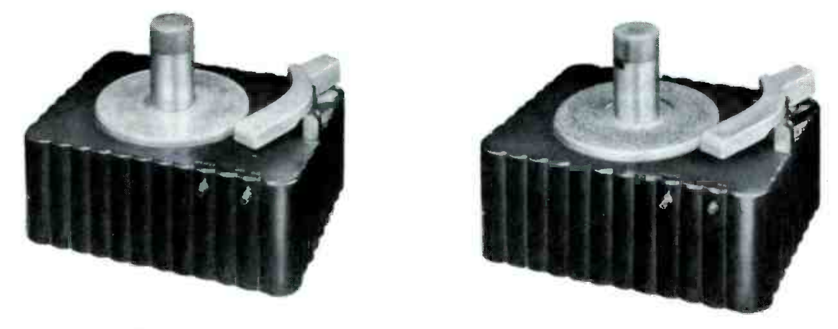
switches should be identified as to their functions. Not all commercial equipment is labeled; therefore, identification of control functions is necessary with those units which lack it. When units made by various manufacturers are assembled into one installation, it may be desirable to replace the several different styles of identification with one uniform style.

Probably the easiest way to provide lettering for identification of equipment and panels is to use decalcomanias or decals, as they are commonly called. Representative examples are the "Electronic Equipment Decals" produced by the TEKNI-LABELS Co., 732 S. Victory Boulevard, Burbank, California. These are produced in a variety of letter and background colors so that they may be applied to almost any piece of equipment. Some of the available combinations are: white letters on a transparent background, black letters on a transparent background, white letters on a black background, and gold letters on a transparent background.

A great variety also exists in the titles which are reproduced in these decals. These titles cover such a wide range of control functions that only rarely is it necessary to make up a new word from single letters.

Decals are especially useful to those service technicians who construct some of their own test equipment and like to have the equipment appear as neat as possible. Fig. 2 is a photograph of a remote-control unit which was constructed in our laboratories for use in controlling our color and monochrome transmitting equipment. All switch functions have been identified clearly through the use of decals with white letters on a trans-

Fig. 2. Decals Used for Panel Lettering.



(A) Before. (B) After.

Fig. 3. Record Changer Before and After the Application of Flocking Material.

parent background, and the unit has a neat appearance.

Felt Flocking

A flocking gun, originally intended to be used for reflocking phonograph turntables, can be used for many other purposes. Flocking material is composed of felt fibers and has excellent sound-absorption qualities. Speaker cabinets, phonograph compartments, and other cavities can be lined with this material in order to reduce sound reflections and resonances. In addition, flocking material comes in a variety of colors so that the color which is selected can complement the rest of the installation. Many decorative designs can be achieved by using multiple layers of various colors of this material.

Re-covering a turntable which might be scratched and peeling can restore a player or changer to a useful and neat-appearing condition. Fig. 3A is a photograph of a 45-rpm record changer as it was received for repair. The plastic cover on the turntable had warped and had peeled away from the turntable, and it was decided to apply flocking material to the turntable instead of attempting to replace the plastic cover. Fig. 3B shows the changer after the flocking operation had been completed.

Since the flocking material adheres only to the areas where the cement is applied, removal of the turntable from the changer is unnecessary. Any holes which might allow the flocking material to penetrate to the inside of the changer must be covered, and this is best accomplished with masking tape. Any holes in the sides of the changer base must also be masked, because the changer must be stood on end so that the turntable surface will be vertical. Cement is applied to the area on which the flocking is desired, and the material is sprayed on. It is advisable to provide a backing board behind and a box underneath the work area so that the excess flocking can be collected and reused.

The photograph in Fig. 4 shows the arrangement used to apply the flocking material. A cardboard box was cut to provide an area which would collect the excess flocking material.

The use of a flocking gun produces a very even coating of felt, but the gun itself is not absolutely essential. A presentable job can be done with a shaker type can.

Knobs and Door Pulls

The careful selection of control knobs and door pulls can do much to add to the beauty of a custom installation. A uniform knob style should be considered when the various pieces of equipment are of different manufac-

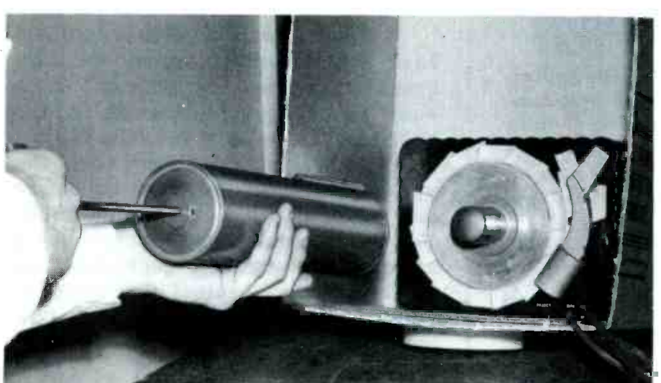


Fig. 4. Typical Arrangement When Applying Flocking Material.

ture. There should be many sizes, shapes, and colors of knobs available from your distributor or from various companies. Hardware stores stock a variety of door and drawer pulls, and a style might be found to complement the rest of the installation. When new items are being added to existing equipment, new knobs can be procured from the manufacturer of the original equipment. In this way, all knobs will be identical.

Grilles

In a custom television installation, the selection of the grille cloth to use is limited only by the desired color. In a high-fidelity audio installation, care should be taken so that the grille cloth does not suppress the higher frequencies.

Grilles can also be fabricated from expanded and perforated metal. Copper and aluminum wire like that used for window screening might even be used if the grilles are confined to small areas and are stretched tightly. With any metal grille, care should be taken so that mechanical resonances are not induced by the speaker. The material of the grille can be disguised when desired by application of a very light coat of flocking material. A heavy coat can obstruct the passage of the higher audio frequencies and should not be used.

Renovation of Old Receivers

Many service shops receive requests to renovate or replace the radio chassis or the record player in an old receiver having a beautiful cabinet which the customer wants to use. Such requests may be refused because of lack of time and occasionally because of lack of experience. The following discussion is intended to show that renovations of this type may not be especially difficult.

The customer can select from a catalog his choice of a tuner, amplifier, record changer, and speaker if desired. Most tuners or tuner amplifier combinations which are sold for replacement purposes have dial escutcheons in the kits. If the dial of the new tuner is larger than the original radio dial, it is a simple operation to enlarge the dial opening in the cabinet and to mount the new tuner and its escutcheon. If the dial of the new tuner is smaller than the original radio dial or has a far different shape, then the escutcheon panel of the cabinet will have to be replaced. The latter operation is not an easy one, but it can be done.

The mounting templates which are included with record changers sold for replacement purposes will enable the technician to determine quickly whether or not a new mounting board will be required. Enlarging or reshaping the cutout in the original mounting board should be easy, but replacement of the mounting board when it is glued in place is not easy. Extensive modification of a cabinet should be done by an experienced carpenter or cabinet maker.

The majority of console cabinets have the mounting board for the speaker fastened by screws. It is easy to remove these screws and the board and to enlarge the hole to fit a larger speaker. Modification of the speaker enclosure for best accoustical performance is an art in itself. For information about this and about an actual renovation project which was performed on a cabinet, the reader is referred to "Audio Facts" in the March 1954 issue of the PF INDEX.

WILLIAM E. BURKE

Shop Talk

(Continued from page 15)

ing the matrix, it requires amplifiers and a DC restorer for each primary color. See Fig. 1.

In the Motorola receiver, the R - Y and B - Y system of demodulation is employed, permitting the set designer to use the color picture tube itself as the combining or matrixing agent. This does away with a considerable amount of receiver circuitry. By having direct coupling between the color demodulators and the control grids of the picture tube, DC restorers can also be eliminated.

Another section where there are fewer tubes in the Motorola receiver is in the dynamic-convergence network. In the CBS receiver, two duo-triodes and half of a third tube are employed in this section; in the Motorola receiver, no tubes are used for dynamic convergence.

(In the foregoing comparison, we are concerned only with the resulting effects of the design upon servicing each of the receivers. No attempt is being made to justify or criticize one design as compared to the other. Both designs possess certain advantages as well as disadvantages.)

Case History No. 1

A CBS-Columbia Model 205 color receiver could not develop a color picture. Whenever a color program was on the air, all that the set could produce was a black-and-white picture. On black-and-white transmissions, set operation was normal. From this behavior, the following positive statements could be made:

All of the circuits which would noticeably affect picture-tube operation were operating as they should. This included the low-voltage and high-voltage power supplies, the vertical- and horizontal-deflection stages, the dynamic-convergence section, the RF and IF systems, the audio section, and the first and second video amplifiers. We also knew that the picture tube was properly adjusted insofar as purity and convergence were concerned. (It is far more difficult to develop a good black-and-white image on a color picture tube than a color image.)

The initial observation enabled us to eliminate a substantial portion of the receiver. We could also eliminate all of the color video amplifiers (and the DC restorers) following the resistive matrix. The latter elimination was possible because black-and-white signals must pass through these stages, and any defect

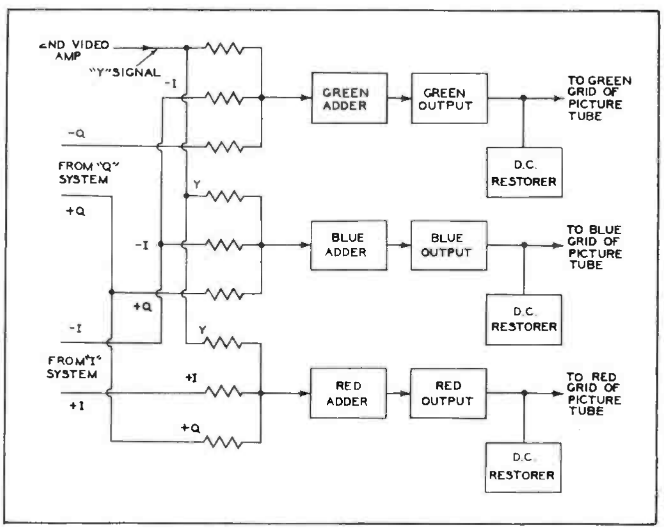


Fig. 1. The Matrix and Color Video Output Stages of the CBS-Columbia Model 205 Color Television Receiver.

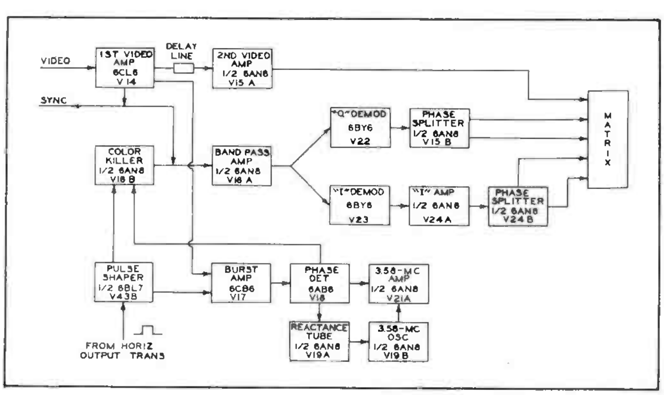


Fig. 2. Partial Block Diagram of CBS-Columbia Model 205 Color Receiver.

in them would prevent the appearance of a normal black-and-white image.

The trouble then must lie in those stages which were not eliminated, and they include those in the chrominance section (up to the matrix) and in the color-sync section. In Fig. 2, the stages in these sections use the following tubes: V16A, V16B, V17, V18, V19A, V19B, V21A, V22, V23, V24A, V24B, V15B, and V43B.

The next question is, "How many of these stages can we eliminate by logical reasoning?" The answer is, "At least 5." Let us see why.

The stage we seek for the defect must be one which, when defective, will prevent a color signal from reaching the resistive matrix. This cannot be done by either the I or Q demodulators or their amplifiers alone, and it is doubtful that troubles in both sections would develop at the same time. This could happen, of course, but it is not usual. Hence, V22, V23, V24A, V24B, and V15B may be eliminated from our suspect list.

All of the remaining tubes (and stages) are possible suspects because a defect in any one could be responsible for no color on the screen. Had the reactance stage employed a separate tube, it could have been included with the last group to be eliminated. This is because trouble in this circuit would not prevent the oscillator from functioning, even though the 3.58-mc oscillations so produced would not provide the proper colors on the screen. Still, colors would appear; however, V19A and V19B are sections of the same tube and hence must be considered together.

The first step in defect localization — especially in the home — would be tube testing. This was done; and V16, a 6AN8, was found to be defective. When this was replaced with a good tube, color images could be developed on the screen.

If the tubes had proved to be good, then voltage checks in the home would be next in order. In the shop, signal tracing with a wideband oscilloscope would have been more fruitful.

Case History No. 2

One owner of a Motorola Model 19CT1 color receiver complained of intermittent arcing in the receiver. This was cleared up by re-dressing the high-voltage leads.

Accelerating voltages in large-screen color receivers are about

25,000 volts, which is considerably more voltage than we find in present black-and-white sets. Any lead-dress problems are, therefore, correspondingly greater in the high-voltage circuits of color receivers. Arc-over is a fairly common occurrence, particularly on humid days; hence, lead dress should be given more than a passing amount of attention.

It was also found that openings no larger than a pin prick in the insulation of the high-voltage lead can produce arcing. This trouble can usually be corrected by covering the hole with some plastic electrical tape.

As a general rule, Central Television service technicians were instructed to check beam convergence whenever any defect was encountered in the high and low-voltage systems and in the vertical and horizontal-deflection circuits. A certain amount of correction was frequently found to be necessary; and with experience, the procedure could be carried out in short order.

REVIEW

One of the criteria by which high-fidelity amplifiers are judged is the amount of audible hum appearing at the loudspeaker. In a well-designed system, hum level will be approximately 70 decibels or more below rated output. When the level is this low, hum is no problem and can be ignored; however, because of component deterioration in all amplifiers or because of poor design in some amplifiers, an objectionable amount of hum may appear. Then the question is, "How can the hum level be reduced?"

An article which does an admirable job of providing some answers to this problem appeared in the January 1954 issue of Audio Engineering. This article is one of a series entitled "Handbook of Sound Reproduction" and was written by Edgar M. Villchur.

Audio Engineering magazine is published monthly by Radio Magazines, Inc., 204 Front Street, Mineola, New York. Subscription rate for the United States, its possessions, and Canada is $3.00 per year. Single copies are 35 cents each.

Probably the first logical step to take in hum minimization is to determine just how much hum is appearing initially across the voice coil of the loudspeaker. The measurement procedure is as follows. Disconnect the voice coil from the amplifier, and substitute an equivalent resistor of the proper wattage rating. In the usual case, this might

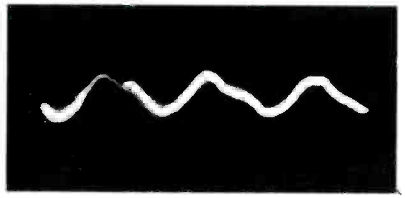


Fig. 3. Hum Voltage Obtained at Output of Audio Amplifier.

be an 8- or 16-ohm resistor with a wattage rating of perhaps 10, 20, or 30 watts, depending upon the amplifier output. Then, with nothing connected to the input of the amplifier and with the volume control wide open, measure the hum voltage appearing across the load resistor. This can be readily done with an oscilloscope, and the waveform might appear as shown in Fig. 3. (A VTVM can also be used to measure the hum output if the VTVM is sensitive enough or if the hum voltage is large enough. The scope is the preferred method, however.)

If the value of the hum power is desired, take the square of the hum voltage (rms value), and divide it by the load resistance. The result is hum power. Then, by the use of the formula:

$$db = 10 \log \frac{P_1}{P_2},$$

where

P_1 = rated-power output,

P_2 = hum-power output,

you can obtain the number of decibels by which the hum level is below rated output.

After the actual hum power or voltage has been measured, the next step is hum localization and hum reduction. In any amplifier system, the low-level stages require the greatest protection. Seldom is it true that hum voltage introduced in the output stage reaches sufficient proportions to cause annoyance. An old, reliable procedure for localizing the point of hum entry is to ground the grid of each tube successively, starting with the output stage and working back to the input. When you reach the point at which grid grounding does not kill the hum output, then you know that the hum is being developed in that particular stage.

For hum that is developed in the power supply, a useful instrument of detection is an oscilloscope. Insert a .1-mfd (or larger) capacitor in series with the vertical-input terminal of a scope, and use this as a probe. In order to be considered harmless, the 60-cycle or the more usual 120-cycle voltage present on the B+ line should be about .01 per cent of the B+ voltage or less. Components which can cause excessive power-supply ripple consist generally of the filter capacitors and the voltage rectifier. The latter is checked most readily by substitution; the capacitors can be checked by bridging them with comparable units known to be good. Any decided hum reduction is an indication of a defective component.

There is also the possibility that not enough filtering capacitance was employed in the original design. If this is the case, then additional capacitance is in order. The simplest approach to this problem is to replace the existing units with capacitors of higher value.

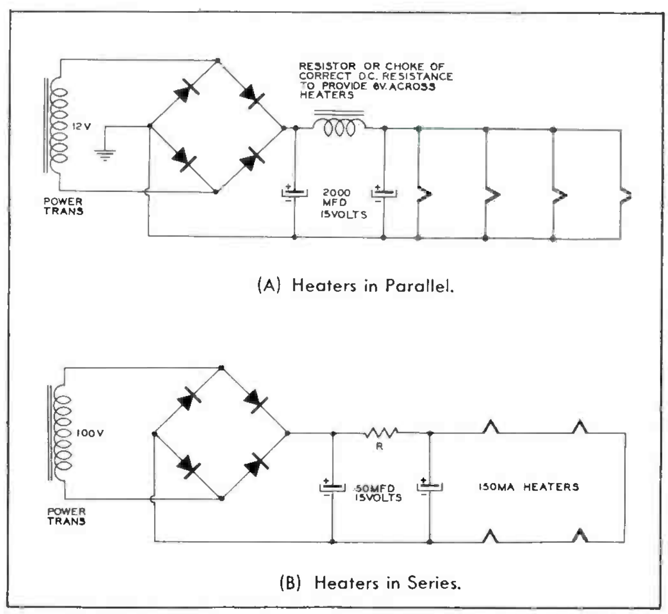


Fig. 4. DC Supplies for Heaters.

A fairly common source of hum which most markedly affects low-level stages is a 60-cycle signal introduced into the grid circuits via the tube heaters. All vacuum-tube elements are affected to a certain extent by the field of the heater. Transfer of energy from the heater to the rest of the tube takes place via electrostatic or electromagnetic coupling. There are, in addition, high-resistance leakage paths of direct connection between the tube elements and the heater. Two such paths would be created by leakage in the mounting supports of the tube or leakage in the tube-socket material. Thermionic emission from the heater to the cathode provides still another path for leakage.

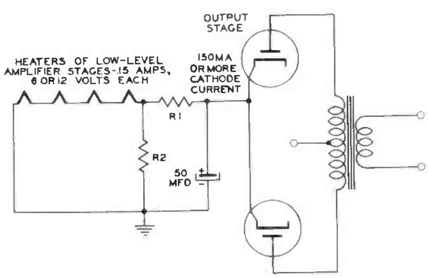
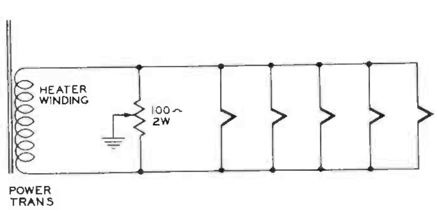
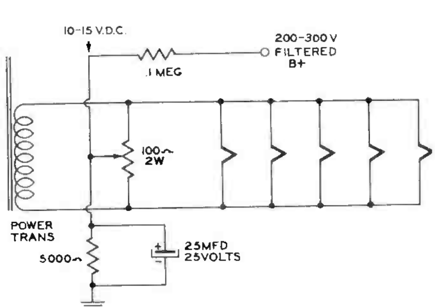


Fig. 5. Method of Providing DC to Heaters of Tubes in Low-Level Stages.

There are several ways of reducing or eliminating hum caused by heaters. The best method is to employ a low-voltage DC supply for the heaters. Two suitable circuit arrangements are shown in Fig. 4. R in Fig. 4B provides the correct voltage drop for the tube heaters and is preferably of the negative-temperature-coefficient type. Another approach is demonstrated in Fig. 5. The heaters of the low-level stages are



(A) Using Potentiometer With Grounded Arm.



(B) Using Potentiometer With Low DC Voltage on Arm.

Fig. 6. Two Methods of Reducing Hum Caused by AC-Operated Heaters.

connected in series with the cathodes of the output stage. This network forms part of the bias resistance for that stage. The value of R_1 should be such that the total bias voltage is kept at the correct level. R_2 serves to shunt the filament supply and to keep the heater current at 150 milliamperes. The AC components of the signal are kept out of the heater string by the 50-mfd bypass capacitor.

Considerable hum reduction from AC heaters may also be achieved by one of the methods shown in Fig. 6. In Fig. 6A, a 100-ohm potentiometer is shunted across the 6.3-volt heater winding, and the center tap is adjusted for minimum hum output from the amplifier. The effect is this: when the tap is properly set, the voltage on one side of the heater winding is equal and opposite to the voltage on the other side. Cancellation then occurs between the opposing electrostatic fields in the tube.

In Fig. 6B, application of a small positive DC voltage to the heater prevents emission from heater to cathode and thereby nullifies this avenue of entry for AC leakage currents.

Aside from hum induced via leakages from heater to cathode or grid, another significant source of hum is the chassis itself. It is common radio and television practice to make ground connections by soldering the particular component or socket terminal directly to the chassis.

In the case of low-level audio amplifiers, the use of the chassis as a grounding lead can cause audible hum. When wires are haphazardly grounded, the ground ends of the cathode and the control-grid resistors might not be terminated at the same point on the chassis. If the distance between the two grounding points were several inches (as shown in Fig. 7), then any AC currents circulating through the chassis would develop a minute AC voltage drop in the chassis. This voltage would then be effectively placed in series with

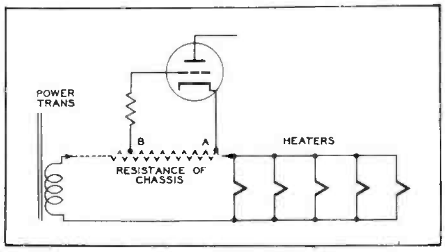


Fig. 7. Alternating Current Through Chassis Introduces Hum Voltage.

the grid signal. Voltage drops may also be created by current induced in the chassis. The chassis is a one-turn coil sometimes called a "ground loop."

(It is apparent that the foregoing minute AC voltages will prove to be significant only in low-level stages. In high-level stages, the degree of subsequent amplification is small, the existing signal level is high, and little damage results from extraneous AC signals.)

To correct this condition, the cathode and grid-resistor ground returns are connected to the same point. Somewhat more effective is the use of a tinned-copper bus bar (No. 12 or No. 14 wire) extending from one end of the chassis to the other. All grounding connections are then made to this line. The bar itself is insulated from the chassis except at one point, usually at the input end. In this way, all chassis currents are eliminated.

Additional pointers toward the reduction of hum are:

1. Carefully place, relative to AC fields, all conductors carrying low-level signals. Power-supply components and low-level stages should be kept far apart, preferably on separate chassis.

2. Shield all power components and audio transformers.

3. Be careful to mount inductive components such as transformers and chokes so that they will make 90-degree angles with each other.

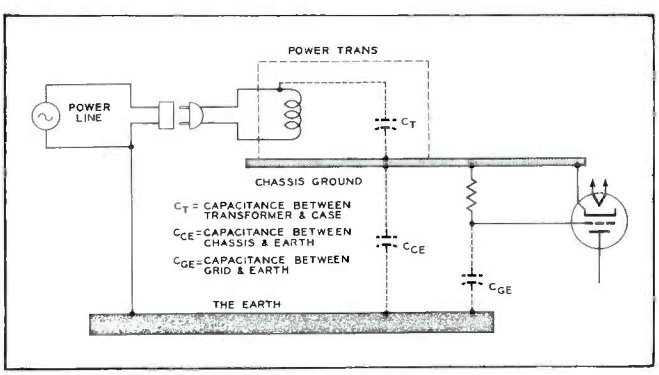


Fig. 8. AC Voltages Coupled by Stray Capacitances Introduce Hum.

This keeps unwanted energy transfer between circuits at a minimum.

4. Use metal shields, and use grid-cap shields whenever grid caps are used. (NOTE: Aluminum shields are nonmagnetic and therefore deflect electrostatic fields only.)

5. For field cancellation, twist each pair of wires carrying AC current.

6. Shield all critical leads.

7. Connect chassis to actual ground (earth).

The effect of the latter connection is for the purpose of eliminating capacitive hum pickup from the AC line through the power transformer. The path for this hum is shown in Fig. 8, and the connection of a lead between chassis and earth serves to short the capacitance (C_{CE}) between these two points and to break up the voltage-divider arrangement through which the line AC is brought to the grid of the amplifier.

Incidentally, as the author of the article points out, a test for hum due to this source is made by noting the tendency of the hum amplitude to change when your hand is brought close to or in contact with the chassis.

From time to time, the service technician will come across instances in which the hum is due to several sources. The only way to avoid aimless (and time-consuming) search is to start with the output stage and work toward the input, cleaning up each stage before the next one is tackled. A good way to prevent prior stages from affecting the stage being worked on is by tube removal. If the hum is created by the currents flowing in these low-level stages, then the tubes may be left in their sockets; but the signal from these stages should be grounded.

Knowing the frequency of the hum signal will often prove helpful in furnishing a clue to its source. Hum stemming directly from the AC line will be 60 cycles and will produce a single cycle on the scope screen when the instrument is properly set up. (A proper setup is made when a line-frequency signal is used to control the horizontal time base.) Hum arising from the power-supply output will be 120 cycles per second and will develop 2 cycles on the scope screen. In general, 60-cycle hum will be far more prevalent than 120-cycle hum.

MILTON S. KIVER

In the Interest of Quicker Servicing

(Continued from page 17)

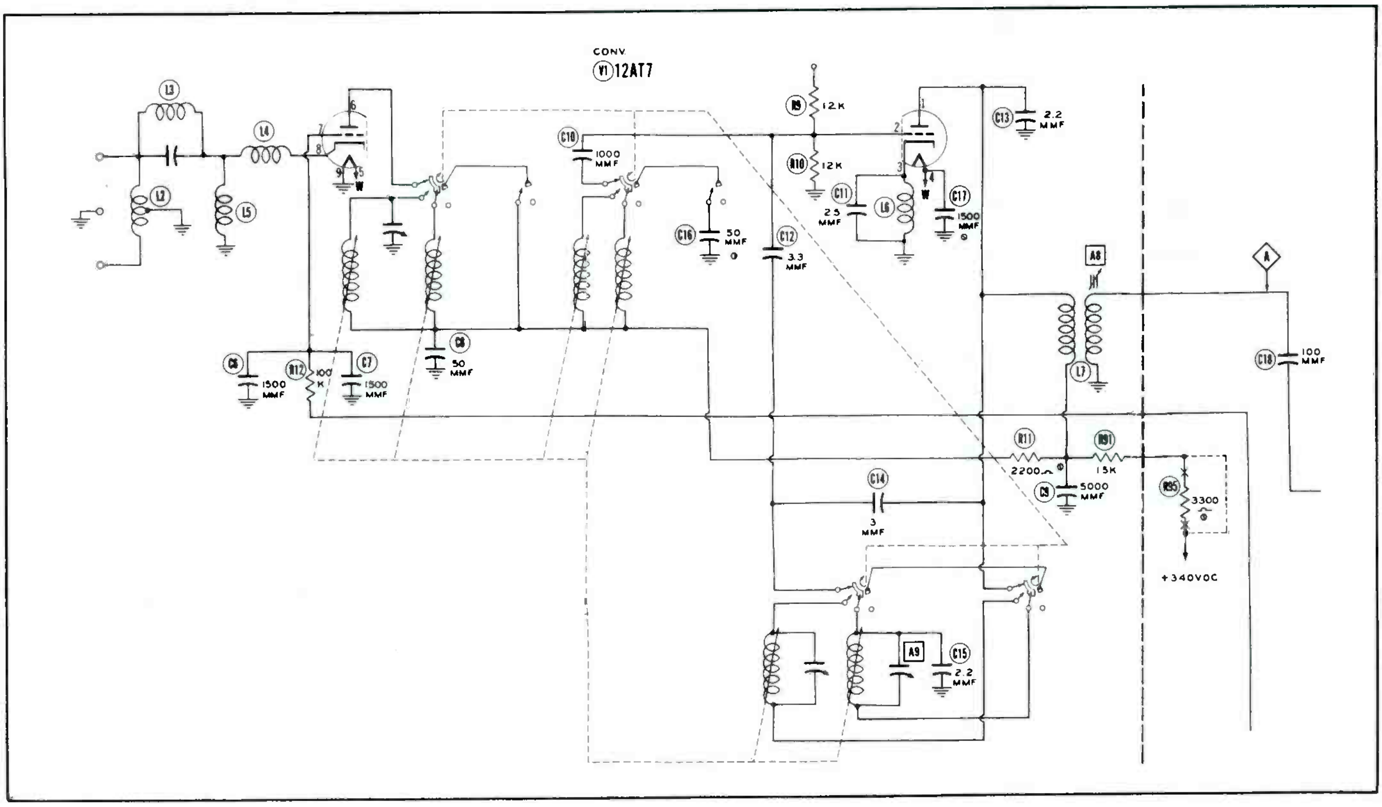


Fig. 2. Schematic Diagram of the One-Tube Tuner.

with one of a different make, he decided that he would continue using the set only on the stations on the low channels.

A short time after this incident, another set of the same manufacture was brought into the shop with the same complaint. This set also employed a one-tube tuner.

Remembering the last case, the technician immediately measured the high-band oscillator coil for continuity. It was open, as the one had been in the other set. The customer was called and told what the trouble was and how much it would cost to replace the tuner. He consented to the work.

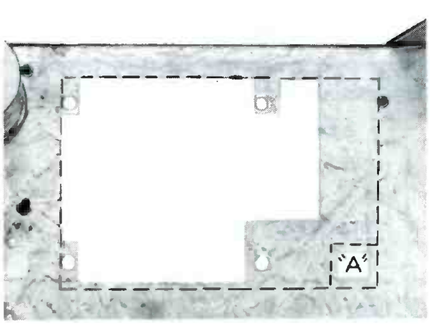


Fig. 3. Photograph of the Chassis Marked for Cutting.

The technician's next task was to select a substitute tuner that would give good results. There were three things to consider in choosing a tuner:

1. It had to be in the 21-mc IF range.

2. It had to use approximately the same operating voltages as the original.

3. It had to be small enough to fit into the available space. The tuner that the technician was able to locate was a pentode type manufactured by the Standard Coil Products Co., Inc.

A step-by-step outline of the procedure used by the technician in making this installation is given in the following:

Once the tuner was selected, it was measured for width and length. The original tuner was removed. Since the replacement tuner was much larger than the original, the area to be cut out was marked off on the chassis, as shown in the photograph of Fig. 3. Note that most of the cutting was confined to one end and one side of the original hole. The small square marked "A" is the place where the technician cut a starting hole for the hacksaw. This was done with a chassis punch which was one-inch square. The hole could have been made with a round drill of sufficient diameter, but starting the hacksaw would then have been difficult.

After the chassis was marked and the starting hole was punched, the technician proceeded to make the cut-out with an ordinary hacksaw; however, the job would have been simpler with a keyhole or compass type of hacksaw because these types have no frame to get in the way when they are used in a confined area such as this. After the cut was completed, the edges were filed to eliminate the burrs and roughness. This was followed by the filing of notches to provide room for the detent spring on the side of the tuner and for the wires coming out of the side of the tuner. These notches may be seen in Fig. 4.

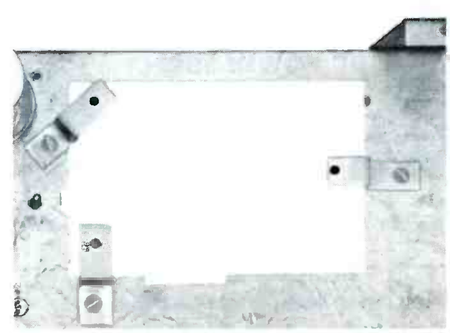


Fig. 4. The Finished Cutout and the Mounting Brackets.

The next step was to provide some method of mounting the tuner so that the top of its chassis would project 3/4 inch above the main chassis. This projection was necessary because of the depth of the tuner.

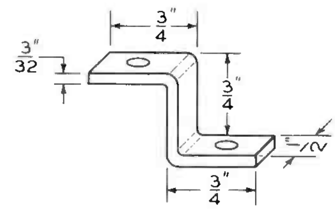


Fig. 5. Construction Details of the Mounting Brackets.

The amount allowed gave sufficient space underneath for the bottom shield which covers the turret or drum.

The method devised called for the use of three brackets made in the form of the one shown in Fig. 5. These were made from strips of aluminum 3/32 inch thick. They were then drilled for No. 6 mounting screws.

The photograph in Fig. 4 shows the complete brackets in place after the hole had been cut and filed and was ready for the tuner. The completed installation of the new tuner is shown in Fig. 6.

The new tuner was wired into the circuit exactly as the old one had been. The reception was not so good as expected, therefore the technician measured the plate supply voltage supplied to the tuner and found it to be very low. He then realized that the voltage would naturally be lower than it would have been with the one-tube tuner because of the higher plate currents drawn by the new tuner. By paralleling the 10,000-ohm, 5-watt resistor R91 with a 5,000-ohm, 5-watt resistor, the technician found that he was able to obtain the desired voltages on the plates of the tubes in the tuner.

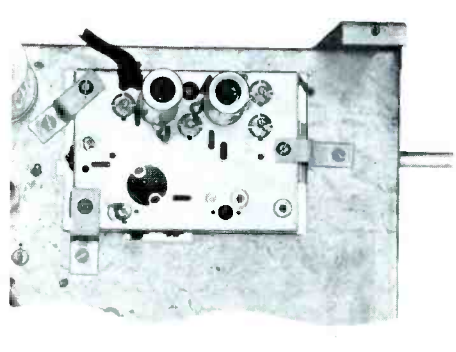


Fig. 6. The Completed Installation.

The picture quality was still less than it should have been. The technician spent several minutes examining the schematic diagram of the tuner before he discovered the cause. In the original tuner, there was no IF coupling capacitor; instead, it was in the grid circuit of the first IF amplifier. The replacement tuner, however, contained a coupling capacitor; therefore, this meant that there were two capacitors in series, thus cutting the capacitance in half. The fact that this capacitance was reduced resulted in a high impedance to the signal, thus cutting down its amplitude. After removing the capacitor in the IF circuit, the only thing left to do was to adjust the slug in the oscillator coil for each channel. The set then operated like a new one.

The technician found it necessary to replace the old knobs with a new set that was manufactured for use with the Standard Coil tuner. These he obtained from his local parts dealer.

Before ending this discussion, we would like to add this statement. Although neither of the two tuners which we have discussed here could be repaired, we do not wish to imply that none of them can be repaired. On the contrary, repair may be possible simply by following the same trouble-shooting procedure which this technician used. A great deal of time may be saved by checking the continuity of the coils immediately after tube substitution has been tried. If the coil is found to be open, then replacement is advisable.

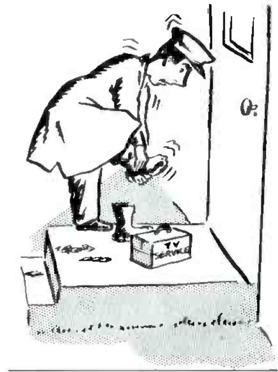
IN THE HOME

Pleasing the Customer

In making home service calls, the technician must give customer satisfaction. Not only must the customer be satisfied that the receiver is operating properly, but he must also be convinced that the technician performed his job in a business-like manner. A pleasing personality is of great assistance in the latter. The following discussion presents some ideas and a procedure which should help to ensure complete customer satisfaction.

It would be well to remember that the customer may at the time excuse the technician for tracking mud on the rug, for breaking a vase, or for making a scratch on some furniture; but when needing service again, he will remember those things and may as a result call another service company.

When it is bad weather with rain or snow, it is a good practice for the service technician to wear overshoes which can be taken off and left at the front door so that the customer's rugs will not be soiled. This is very important since it is expensive to have rugs or especially wall-to-wall carpeting cleaned.



Everything should be removed from the top of the television receiver before service procedure is started. This applies to all lights, boosters, and any decorative gadgets the customer may have located on the receiver. These gadgets may not be expensive but may be very important to the customer. Of course, if an indoor antenna is employed, it will be necessary to leave this connected and located on top of the receiver; but care should be taken that the antenna is not upset and thus damaged or that it does not cause damage to the set or any other object.

If the set is a table model, be careful of the legs of the table on which the television receiver is resting. The best policy is to remove the television receiver from the table; relocate the table in order to provide work space, and then replace the television receiver on the table. Follow the same procedure after the set has been serviced. This care on the part of the technician may prevent damage to the table or even to the receiver which might be damaged if the table should collapse.

If it becomes necessary to take a chassis or even a complete receiver into the shop when it is raining, sleeting, or snowing, adequate covering should be used to prevent spotting of the cabinet or damage to the chassis components by moisture. The same applies to returning a chassis or receiver in bad weather.

When transporting a chassis or television receiver between the shop and the customer's home, care should be taken to secure it so that it will not be damaged or cause damage to some other receiver if the truck should make a sudden stop or a sharp turn.

When it becomes necessary to remove a chassis in the customer's home, cover the floor with a large drop cloth on which to set the chassis when it is removed. If a drop cloth is not available, obtain some old newspapers to use instead. This will prevent soiling the customer's rug with the chassis which is often very dirty. A bill for cleaning the customer's carpet can wipe out a considerable portion of a week's profit or salary. This also applies to hardwood floors because they have a tendency to be scratched. In the actual process of servicing a television receiver, it is a great temptation to lay tools, screws out of the back, high-voltage covers, hot tubes, knobs, and other assorted items on top of the set. Avoid this temptation because a scratched or blistered cabinet will not make the customer appreciate your work. A container in which to place the knobs and miscellaneous screws should be used. Place it on the floor where it cannot be upset in the process of servicing the set.

After a set has been repaired, always make it a practice to replace all screws and other hardware that you may have removed. All shields such as those for the high-voltage section, the IF section, and the tubes should be replaced with all of the screws securely fastened. This is necessary to make certain that the shielding will be satisfactory.

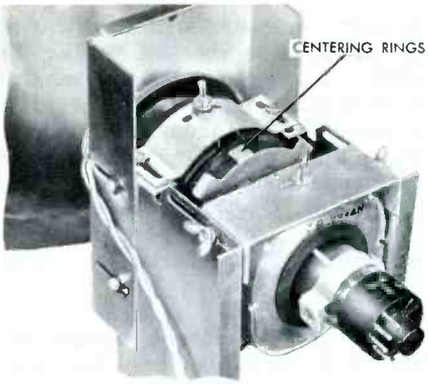


Fig. 7. Centering Device.

If the picture-tube face and safety glass are dirty enough so that the dirt can be seen, always clean them if this can be done simply by removing the front glass or the chassis. If the picture tube is cabinet mounted, mention the price for cleaning the screen while you are there. This will be governed by your company's policy. A clean picture tube will often show up as a bigger improvement than the replacement of a weak tube, at least it may appear to do so to the customer.

There are a great many times when the more experienced technician will be able to remove the back from a receiver, replace a tube, and remedy the customer's complaint all in a matter of about 10 minutes. On calls such as these, it would be well for the service technician to stop and consider the customer and his probable attitude about hasty calls. If the customer has had little or no trouble with his set, he may not think anything about the short time which was taken to repair his set; however, if he has experienced trouble more often or has had other trouble just prior to this call, he may feel that he is not getting good service or is not getting his money's worth. In any case, it is good business to take a little time to check the operation of the controls; to check for microphonic tubes; and to adjust the focus, centering, picture size, and linearity. Using a pattern generator or test pattern, the technician can complete all these checks in about 10 to 15 minutes.

The fact that the technician has taken the time to make these checks will create and maintain good customer relations; and in addition, the checks may indicate that other components are in a weakened condition. When this is pointed out to the customer, the technician may be able to sell some further service. We repeat that an integral part of each service call should be a complete adjustment of the receiver.

On each service call, always check the low-voltage rectifiers for age. If these rectifiers are more than a year old and if the trouble with the receiver involves a stage that uses considerable power (such as the horizontal-output, vertical-output, audio-output, or video-output stages), it would be a good idea to replace the rectifiers. This will help to prevent call backs. If the set uses selenium rectifiers, check their voltage output. If the voltage is 15 per cent low, these units should be replaced.

In adjusting television receivers for proper operation, there will arise occasions when neck shadow is very difficult or even impossible to eliminate. This applies only to receivers using electromagnetic focusing and in which the focus coil is moved to center the picture. In these cases, check the low-voltage power supply for proper output voltage, because insufficient voltage can cause this trouble. If the low voltage is satisfactory, there are available magnetic rings that can be installed between the yoke and the focus coil. These rings should make centering much easier. A

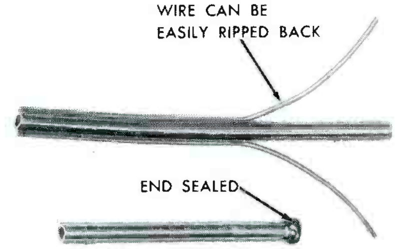


Fig. 9. STRIP-EASE Tubular Twin Lead.

photograph of such a setup is shown in Fig. 7.

Carrying Handles

The carrying handles shown in Fig. 8 are manufactured by Barb City Industries, Inc., DeKalb, Illinois; and they are items which should prove useful and welcome to the home-service technician. These carrying handles, when properly used, can protect the service technician's hands from the sharp edges which are often found on some television chassis. In addition to this, they will make it much easier to carry the heavy chassis which is used in some large sets. These carrying handles are so constructed that the weight of the TV chassis keeps them firmly secured in position, and there is little or no danger of the handles slipping or otherwise becoming disengaged.

New Lead-in

The twin lead shown in Fig. 9 is a new tubular type which is manufactured by the Radix Wire Co., Cleveland, Ohio. This twin lead is more flexible than earlier types of tubular lead-ins and is easy to work with because of its "Strip-Ease" feature

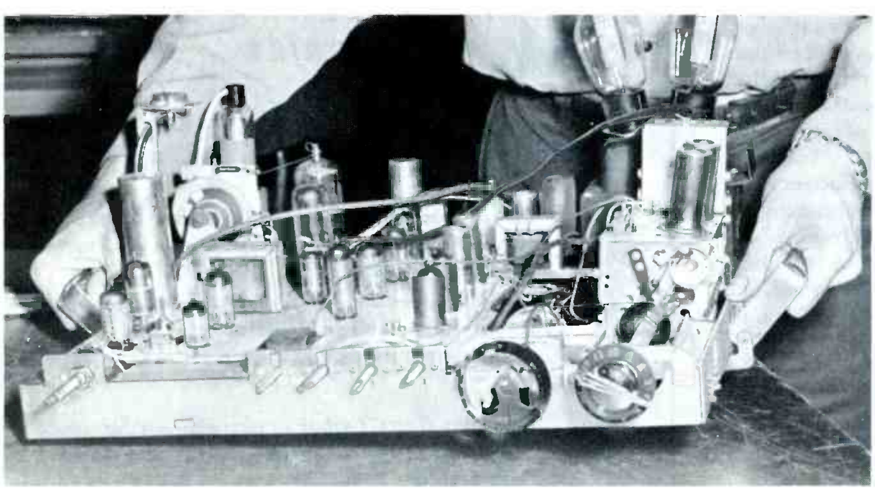


Fig. 8. Chassis Carrying Handles.

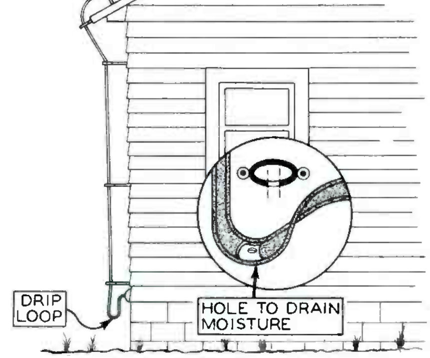


Fig. 10. Drip Loop.

which makes the conductors easy to separate or rip back. Any end at which moisture could enter the lead should be sealed, as shown in Fig. 9. This may be done by igniting the end of the piece to be sealed, by letting it burn for a short time, and by blowing out the flame. The heat will cause a sufficient amount of the insulation material at the center to melt so that the end will seal as shown. About two minutes are required for the melted material to cool and become a solid.

In using this or any other tubular lead-in, a drip loop (such as that illustrated in Fig. 10) is required in the lead-in before it enters the building. A small hole should be drilled in the lowest part of this loop to allow any moisture to drain out.

Audio Output Stage as a Voltage Divider

The author recently made a call to service a Motorola Model 21T18R for which the complaint was that there was no raster and that the sound was weak and distorted. The back of the set was removed, a "cheater chord" was connected, and the receiver was turned on for a preliminary check. It was noticed that the plate structure of the 6W6 audio output tube became cherry red after about 60 seconds of operation. Substitution of the 6W6 tube failed to correct this trouble.

Stopping to analyze the situation, the author remembered that the audio output stage was sometimes used in a voltage-divider network. A simplified block diagram of such a network

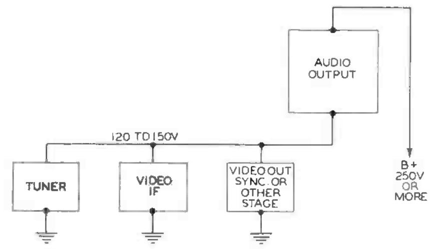


Fig. 11. Block Diagram of Voltage Divider.

is shown in Fig. 11. Since any tube which was supplied from the 140-volt line could short and cause the 6W6 tube to draw excessive current, the author proceeded to remove the video output tube (a 12BY7) which had its screen grid connected to the 140-volt line. The moment that the 12BY7 was removed, the raster appeared, the sound cleared up, and the plate of the 6W6 returned to its normal color. Installation of a new 12BY7 cured the trouble. Since excessive current had been caused by the shorted tube, the chassis was removed and the components associated with the 6W6 and the 12BY7 were checked. Either the 12BY7 or any of the other tubes that were supplied from the 140-volt line could be removed from this receiver, since this particular model used a filament transformer to supply all of the tubes. Obviously, in a series-filament set, the tubes would have to be substituted or checked on a tube checker.

Voltage-divider networks of the type shown in Fig. 11 have been used in a large number of receivers and were used as far back as 1950 in some Crosley models. Most Crosley models since 1950, most Motorola models since 1952, most Muntz models, most Trav-Ler models since 1950, many Silvertone models since mid-1952, some Hoffman models in 1953 and 1954, some Sylvania models in 1953 and 1954, and some of the models of other manufacturers have used voltage-divider networks. The trend toward simpler and more efficient television sets (such as those using the new vertical chassis and having 14 to 16 tubes in one 600-ma series-filament string) will cause this type of divider network to be used more and more.

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

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1. What is the goal of the setup procedure?
2. Describe the step for setting the high-voltage control. When should it be performed?
3. What are the two adjustments associated with the purity coil?
4. What kind of picture-tube display indicates that the purity coil is properly adjusted?
5. What happens to the picture-tube display when the deflection yoke is moved forward during the setup procedure for purity?
6. At what point in the setup procedure should the field-neutralizing control be adjusted, and what is the indication on the picture-tube screen?
7. What is meant by static convergence and dynamic convergence?
8. In which directions do the beams move when the beam-positioning magnets are adjusted?
9. What kind of picture-tube display indicates proper static convergence?
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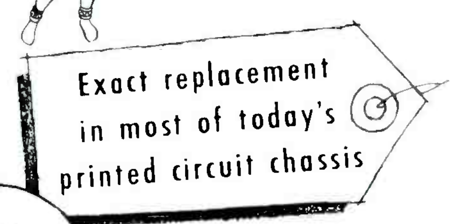

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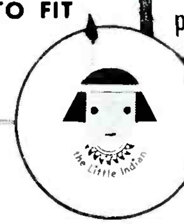

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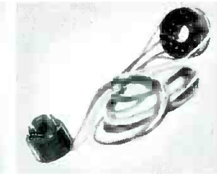

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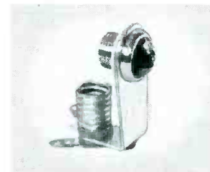

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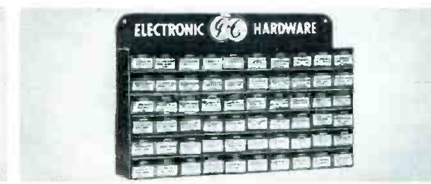

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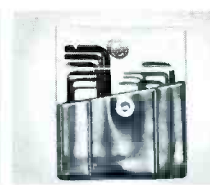

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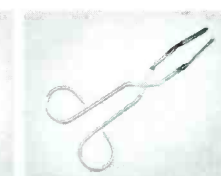

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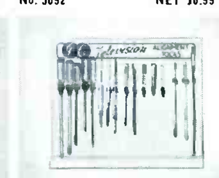

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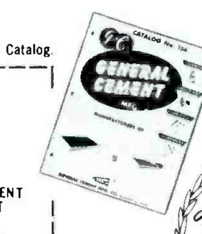

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Fig. 1. Hickok 655XC Color-Bar Generator.

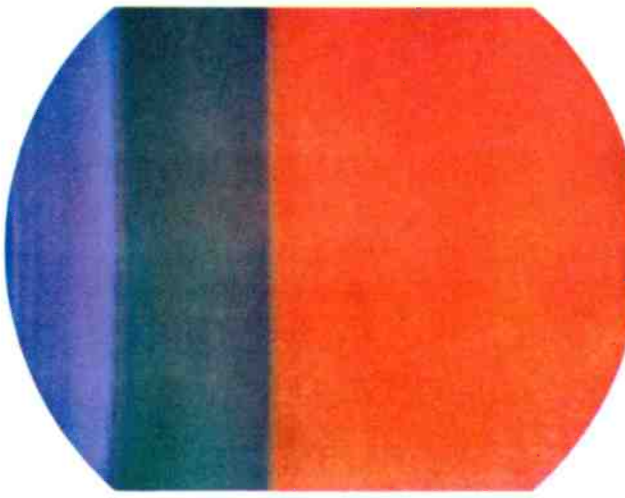

Fig. 2. Pattern Produced by the Q and I Signal.

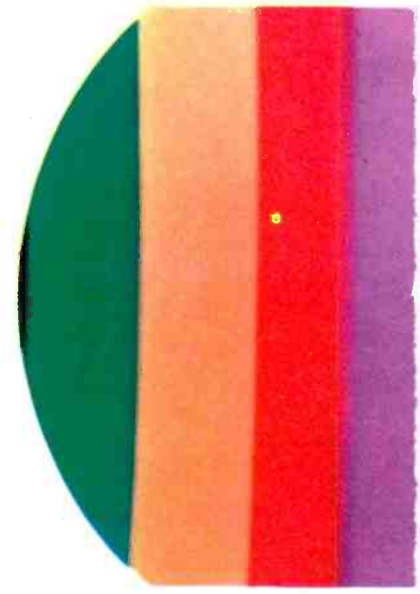

Fig. 3. Pattern Produced

GENERAL DESCRIPTION

The Hickok Model 655XC color-bar generator is designed to produce various test signals that conform to the NTSC standards. These signals enable the technician to check on the operation of a color receiver and to adjust the various circuits so that color will be reproduced properly. The generator is housed in a portable carrying case so that it can be conveniently carried into the home whenever necessary. The lid is removable to make the generator equally adaptable to bench work. Fig. 1 shows the instrument with the lid removed.

SIGNALS PROVIDED

Three composite signals are provided by the generator. These are: (1) Color bars composed of 100-per-cent saturated primary and complementary colors plus white, (2) Q and I signals, and (3) B - Y and R - Y signals. The color-bar pattern, as produced on a normally operating receiver, is shown in Fig. 3. The Q and I signals and the B - Y and R - Y signals produce patterns like those shown in Figs. 2 and 4, respectively. Proper brightness and chrominance levels in the color-bar signal are generated. The Q, I, B - Y, and R - Y signals are produced at equal chrominance amplitudes and at the black level. A horizontal-sync pulse and a color burst, both at proper amplitudes, are provided in all signals. Fig. 5 shows a composite video waveform of the color-bar signal. Fig. 6 illustrates the make-up of the Q and I composite video signal, and it also illustrates the B - Y and R - Y composite video signal.

Output signals are available as video signals or as modulated RF signals. The video signals can be reversed in polarity, and the RF signals can be set at channels 4, 5, or 6. The amplitude of the video signal across a 100-ohm load is variable from zero to 1 volt peak to peak. The RF signal is variable from 200 to 1,000 microvolts.

There is also provided a sound carrier which is displaced 4.5 mc from the picture carrier. This relationship is maintained at all times by a crystal-controlled circuit. The sound carrier may be turned on or off by means of a switch. Switches are also provided to turn off the luminance signal, the chrominance signal, the Q or B - Y signal, and the I or R - Y signal. By setting the generator to produce a color-bar pattern and then by turning off the chrominance signal, a signal is produced which conveys only brightness information. Fig. 7 illustrates the signal that is produced under these conditions. Such a signal can be used to set up or check the gray scale of a color receiver.

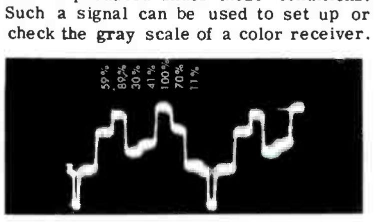

Fig. 7. Luminance Signal Only.

During certain tests, it is sometimes advantageous to turn off the Q or I (or B - Y or R - Y) signals. As previously mentioned, this function is provided through the use of individual switches.

Stable operation is assured through the use of delay lines and crystals. Three crystals are used and have the following frequencies and functions: (1) 3.579545-mc subcarrier generator, (2) 4.5-mc sound-carrier generator, and (3) 78.75-kc horizontal-sync timing generator.

Obtaining RF Signal Output

To set up the generator to provide a modulated RF signal, set the switches as follows:

SWITCHES	POSITION
MODULATION	ON
VIDEO POLARITY	+
SOUND	ON
Y	ON
CHROMA	ON
I or R - Y	ON
Q or B - Y	ON
FUNCTION SELECTOR	As desired

The RF tuning slug is preset at the factory for channel 5. If it is advantageous to use channel 4 or 6, the slug may be readjusted as follows. Turn CHROMA switch to the OFF position. Connect the RF output cable to a crystal-controlled calibrator (such as the Hickok Model 690), and adjust the slug to the video-carrier frequency of the desired channel. After the adjustment is made, turn the CHROMA switch to the ON position.

Obtaining Video Signal Output

To set up the generator to provide a video signal, set the switches as follows:

SWITCHES	POSITION
MODULATION	OFF
VIDEO POLARITY	As desired (usually negative)
SOUND	OFF
Y	ON
CHROMA	ON
I or R - Y	ON
Q or B - Y	ON
FUNCTION SELECTOR	As desired

CHECKING RECEIVER OPERATION

Turn on the generator, and allow a 15-minute warm-up period. Connect the RF output of the generator to the antenna terminals of the receiver under test. Set switches in the generator to provide a modulated RF signal. Set the FUNCTION SELECTOR switch at the COLOR BAR PATTERN position and set the RF OUTPUT ATTENUATOR to provide maximum signal. Set the channel selector of the receiver at the same channel at which the generator has been preset. Adjust the fine-tuning control to provide a clear picture with a minimum 920-kc beat in the picture. After the fine-tuning control is adjusted, the SOUND switch may be turned OFF.

Adjust the brightness, contrast, saturation, and hue controls in an attempt to produce the proper pattern which is illustrated in Fig. 3. The sequence of color bars is green, yellow, red, magenta, white, cyan, and blue. If the receiver produces a satisfactory pattern, its operation can be considered normal.

If a satisfactory picture cannot be produced by adjusting the operating controls, analyze the symptoms in order to determine what section of the receiver is not operating properly. All color troubles will fall into these three main categories: (1) loss of color, (2) wrong color, and (3) loss of color sync. After determining the proper category for the symptom, substitute tubes in the stages involved. If no improvement is noted, proceed as outlined in the servicing section.

SERVICING

The operation of all of the color stages can be checked with the signals provided by the Hickok Model 655XC color-bar generator. In every case, it is assumed that the receiver operates normally when receiving a monochrome transmission.

NO COLOR

If no color can be produced by injecting an RF signal at the antenna terminals, set the switches of the generator to provide a video signal and then feed a video signal across the video-detector load. If color can be obtained by injecting the signal at this point, the trouble must lie in the IF stages or in the tuner. Do

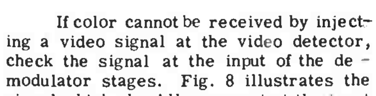

Fig. 8. Chrominance Signal at Input of Demodulators.

not overlook the possibility that the tuning range of the tuner might be insufficient. Reconnect the RF output of the generator to the antenna terminals, and check the setting of the fine-tuning slug or trimmer. If color cannot be received even though the fine-tuning range is known to be correct, check the alignment of the tuner and IF amplifier.

If color cannot be received by injecting a video signal at the video detector, check the signal at the input of the demodulator stages. Fig. 8 illustrates the signal which should be present at the input of the demodulators. If the signal is not present, check the operation of the bandpass amplifier and locate the point at which the signal is being lost. If the receiver employs a color-killer stage, check to see that this stage is not cutting off the

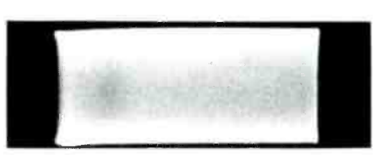

Fig. 9. CW Signal at Input of Demodulators.

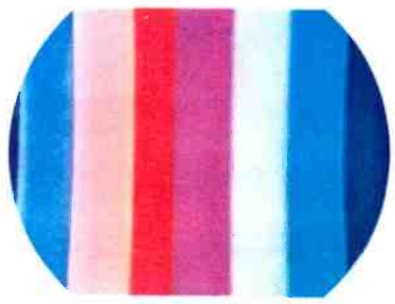

Fig. 10. Pattern Produced As a Result of the Failure of the Q-Demodulator Section.

bandpass amplifier. If such should be the case, check the operation of the color-sync section, as outlined under "Loss of Color Sync."

Color demodulation should take place if both the chrominance signal (Fig. 8) and the CW signal (Fig. 9) are present at the demodulators. If either is absent, locate the defective stage by signal tracing backward through the circuits. After the defective stage is located, voltage and resistance measurements will usually identify the defective component.

WRONG COLOR

Defects associated with wrong color can be classified into two main categories. They are: (1) complete or partial loss of one of the color-difference signals, and (2) a phase error either in the chrominance signal that is applied to the demodulators or in the CW reference signals that are applied to the demodulators.

The fact that there is any color produced indicates that the CW reference oscillator is operating and that the reference and chrominance signals are being fed to at least one of the demodulators. The first step is to determine whether or not both demodulator circuits are working. This can be done by noting the effects on the pattern as the hue control is rotated. In a normally operating receiver, the colors on the screen will vary through a wide range of colors as the hue control is varied. If only one of the color difference signals is present, each of the color bars will remain predominantly at one of two hues.

If the receiver demodulates on the I and Q axes, and if the Q signal is being lost, all the colored bars will appear predominantly an orange or a cyan color. Fig. 10 illustrates the appearance of the pattern produced in a receiver in which the Q-demodulator section has failed. Note that all of the colored bars are either orange or cyan. If the I signal is being lost, the colored bars will appear predominantly green or magenta. Fig. 11 illustrates a pattern that is produced under

these conditions. Not
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and magenta bars will
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If the receiver d
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Checking Demodu

Defects associated
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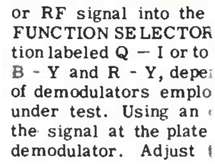

Fig. 12. Signal at Plate o
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Fig. 13. Signal at Plate o
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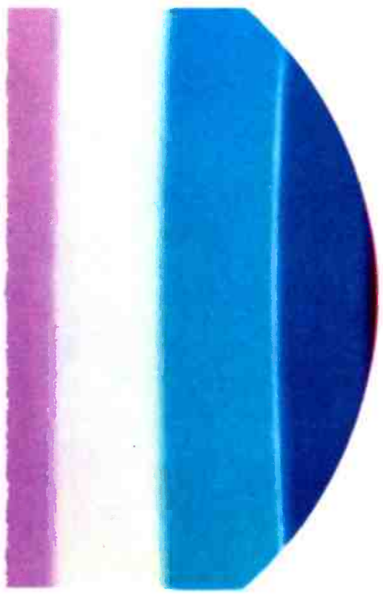
COLORBLOCK
hart No. 6

5XC COLOR-BAR GENERATOR



by the Color-Bar Signal.

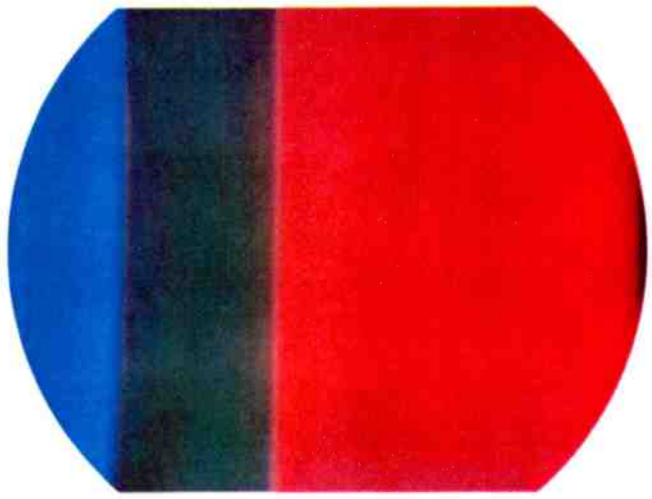


Fig. 4. Pattern Produced by the B-Y and R-Y Signal.

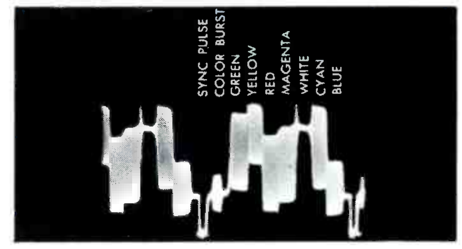


Fig. 5. Composite Video Waveform of Color-Bar Signal.

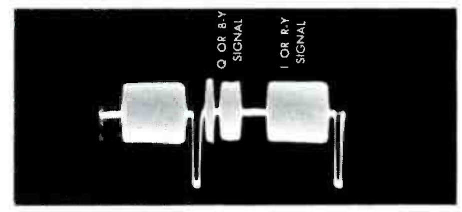


Fig. 6. Composite Video Waveform of Q and I or B-Y and R-Y Signal.

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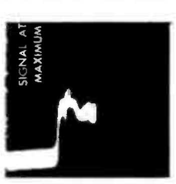

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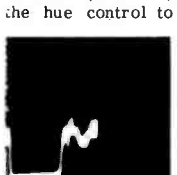

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tion of the Q Signal.

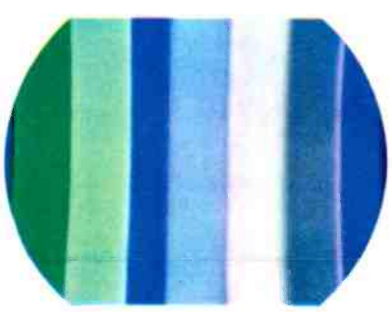


Fig. 11. Pattern Produced As a result of the Failure of the I-Demodulator Section.

obtain a zero signal during the scan time of the Q (or B - Y) bar. Fig. 12 illustrates the pattern that will be obtained under these conditions. Fig. 13 illustrates a pattern that will be obtained at an incorrect setting of the hue control. As the hue control is rotated on either side of the correct setting, the polarity of the signal during the scan time of the Q (or B - Y) bar will go alternately positive and negative.

With the hue control set so that the I (or R - Y) signal is at zero during the scan time of the Q (or B - Y) bar, connect

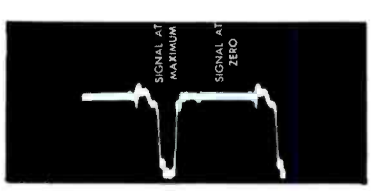


Fig. 14. Signal at Plate of Q-Demodulator Illustrating Proper Cancellation of the I Signal.

the scope to the plate of the Q (or B - Y) demodulator. Without readjusting the hue control, check to see that there is zero signal during the scan time of the I (or R - Y) bar. Fig. 14 illustrates such a condition. An incorrect condition is shown in Fig. 15.

If the signal is not zero during the scan time of the I (or R - Y) bar, the setting of the quadrature adjustment must be changed. (In some receivers, the order of checking the signals at the plates of the demodulators may be reversed. Consult the receiver service data to determine the proper order.)

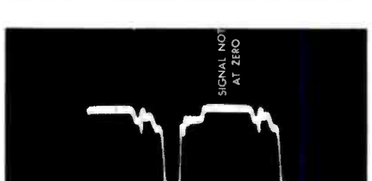


Fig. 15. Signal at Plate of the I-Demodulator Illustrating Improper Cancellation of the I Signal.

Refer to Fig. 2, and note that the Q signal appears at the left whereas the I signal is at the right. Note also that the I bar is much wider than the Q bar. This difference in width can also be seen in Fig. 6. The R - Y and B - Y signals are positioned in the same manner as the I and Q signals. To aid further in identifying the signals properly, the I or R - Y and Q or B - Y signals can be turned off individually by means of the switches on the panel of the generator. When checking for cancellation of one of the signals, turn off that signal and note any change in the pattern. If a change is noted, complete cancellation is not being obtained.

After making the quadrature adjustment, set the hue control to its proper position by adjusting it for cancellation of the unwanted signal at the plate of one of the demodulators. Turn the FUNCTION SELECTOR switch to the COLOR BAR PATTERN position. Adjust the contrast, brightness, hue, and saturation controls to obtain a pattern approximating that of Fig. 3. If the colors obtained are not satisfactory, check the operation and alignment of the matrix in the manner specified in the receiver service data.

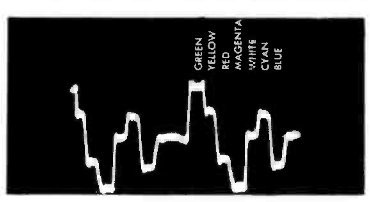


Fig. 16. A Minus Q Signal.

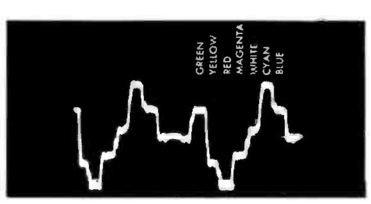


Fig. 17. A Minus I Signal.

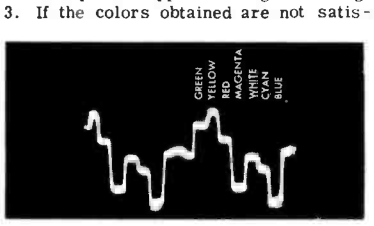


Fig. 18. A Minus B-Y Signal.

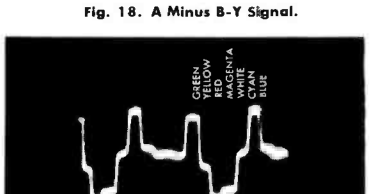


Fig. 19. A Minus R-Y Signal.

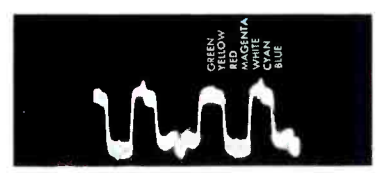


Fig. 20. Signal at Grid of Green Gun.

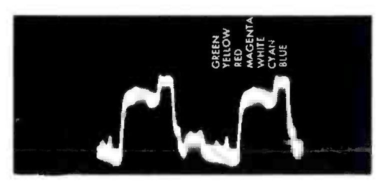


Fig. 21. Signal at Grid of Blue Gun.

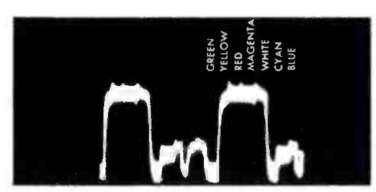


Fig. 22. Signal at Grid of Red Gun.

Figs. 16 through 19 illustrate color-difference signals that are obtained in some receivers when using the Hickok 655XC color-bar generator as a signal source. Fig. 16 shows a minus Q signal, Fig. 17 shows a minus I signal, Fig. 18 shows a minus B - Y signal, and Fig. 19 shows a minus R - Y signal. These waveforms can be referred to when checking demodulator operation, when adjusting the matrix, and when checking the operation of the color-difference amplifiers.

Figs. 20 through 22 illustrate the waveforms that are present on the grids of the color picture tube of a receiver in which matrixing is not performed in the picture tube itself. An analysis of the waveforms which are present on the grids of the picture-tube guns can be very helpful in locating causes for incorrect colors.

LOSS OF COLOR SYNC

If the reference oscillator of the receiver does not synchronize with the color-burst signal, color demodulation takes place at a random rate. Under these conditions, diagonal or horizontal stripes of variegated colors appear in the picture. These stripes may or may not move, depending upon the operating frequency of the reference oscillator. When loss of color sync is experienced, trouble in the burst amplifier or color-synchronizing stages should be suspected.

Because of the fact that some color is produced, two things are known: (1) the chrominance signal is being applied to the demodulators and (2) the CW reference oscillator is operating. The problem is to find out why the color burst does not synchronize the CW oscillator.

Fig. 23 illustrates the waveform present on the plate of a burst amplifier. The large spike is caused by the keying pulse obtained from the horizontal-output stage. Note the color burst positioned at

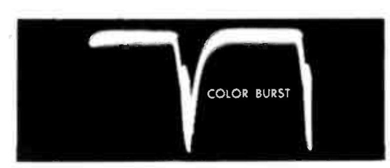


Fig. 23. Signal at Plate of Burst Amplifier.

the tip of the spike. If the color burst is not present, rotate the hold control and note whether the color burst appears. When checking some receivers or when using a scope which has only medium gain at 3.58 mc, it may be necessary to increase the vertical gain of the scope to maximum in order to see the color burst. Position the pattern so that the tip of the spike is visible, and then check to see if the color burst is visible.

If the color burst is present in the output of the burst amplifier, trace the signal to the color-synchronizing section. The type of synchronizing circuit used in the receiver being serviced will dictate the servicing procedure that should be used in the color-sync stages; but in the majority of receivers, voltage and resistance checks will disclose the defective component.

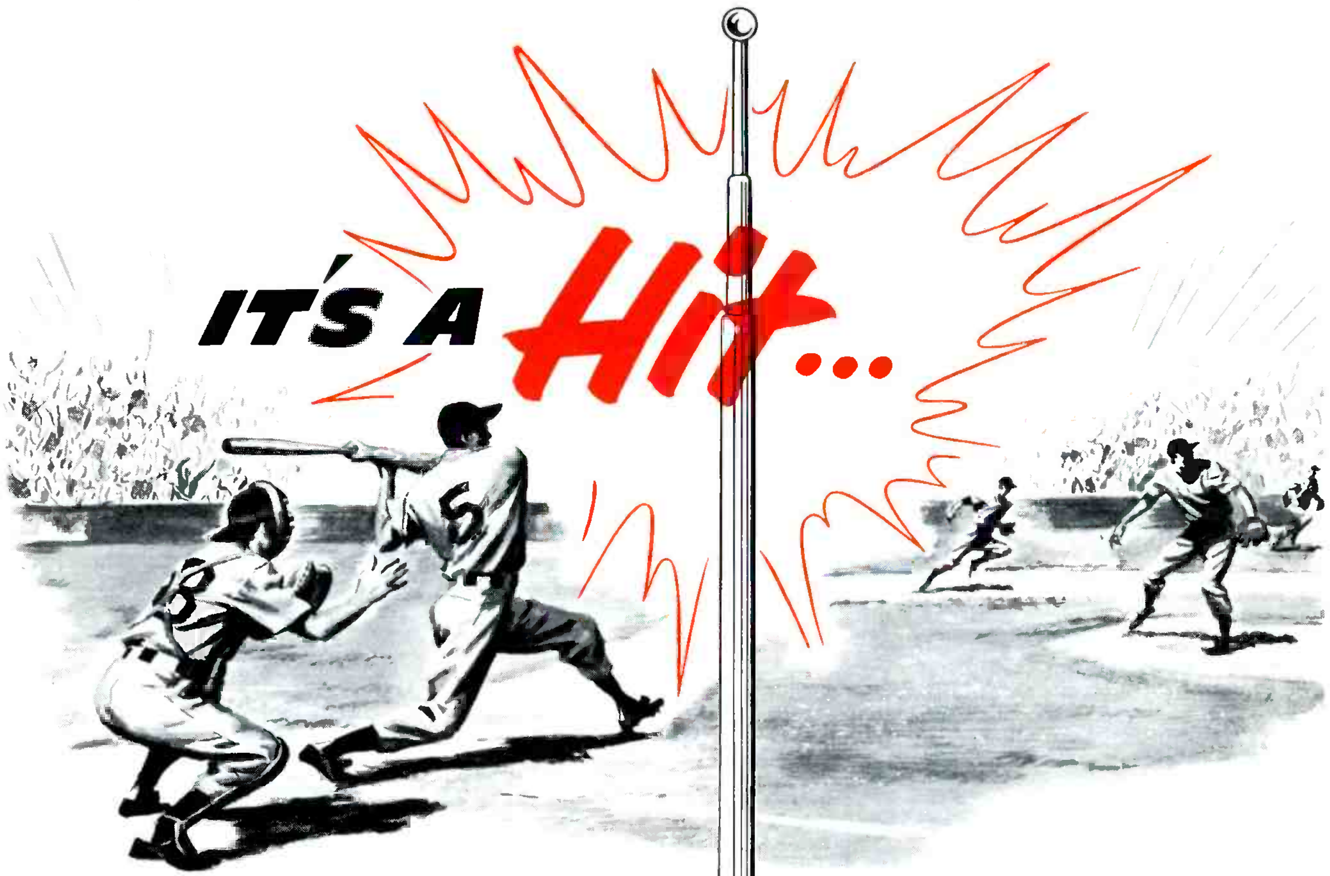
If the spike shown in Fig. 23 is not present when checking the signal at the plate of the burst amplifier, determine whether a keying pulse is being applied to the burst amplifier. If this pulse is absent, the color burst cannot be passed by the burst amplifier.

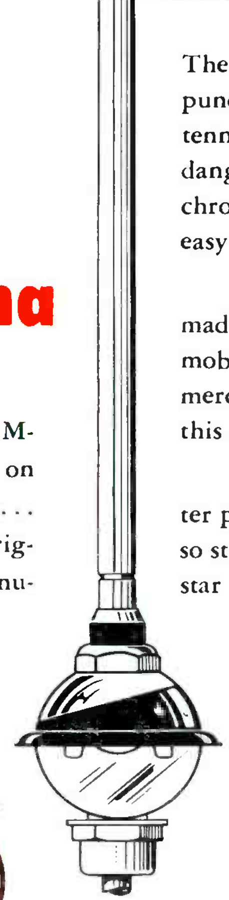
PHOTOFACT* COLORBLOCK
*TRADE MARK

Reference Chart No. 6

A COLORBLOCK Which Outlines the Uses of the Hickok Model 655XC Color-Bar Generator for Adjusting and Servicing Color Receivers.

Prepared by the Editorial Staff of the
PF REPORTER for the Electronic Service Industry—April, 1955





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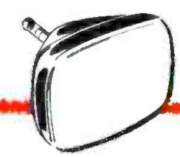

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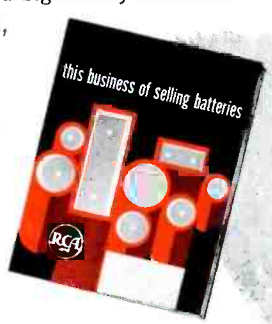

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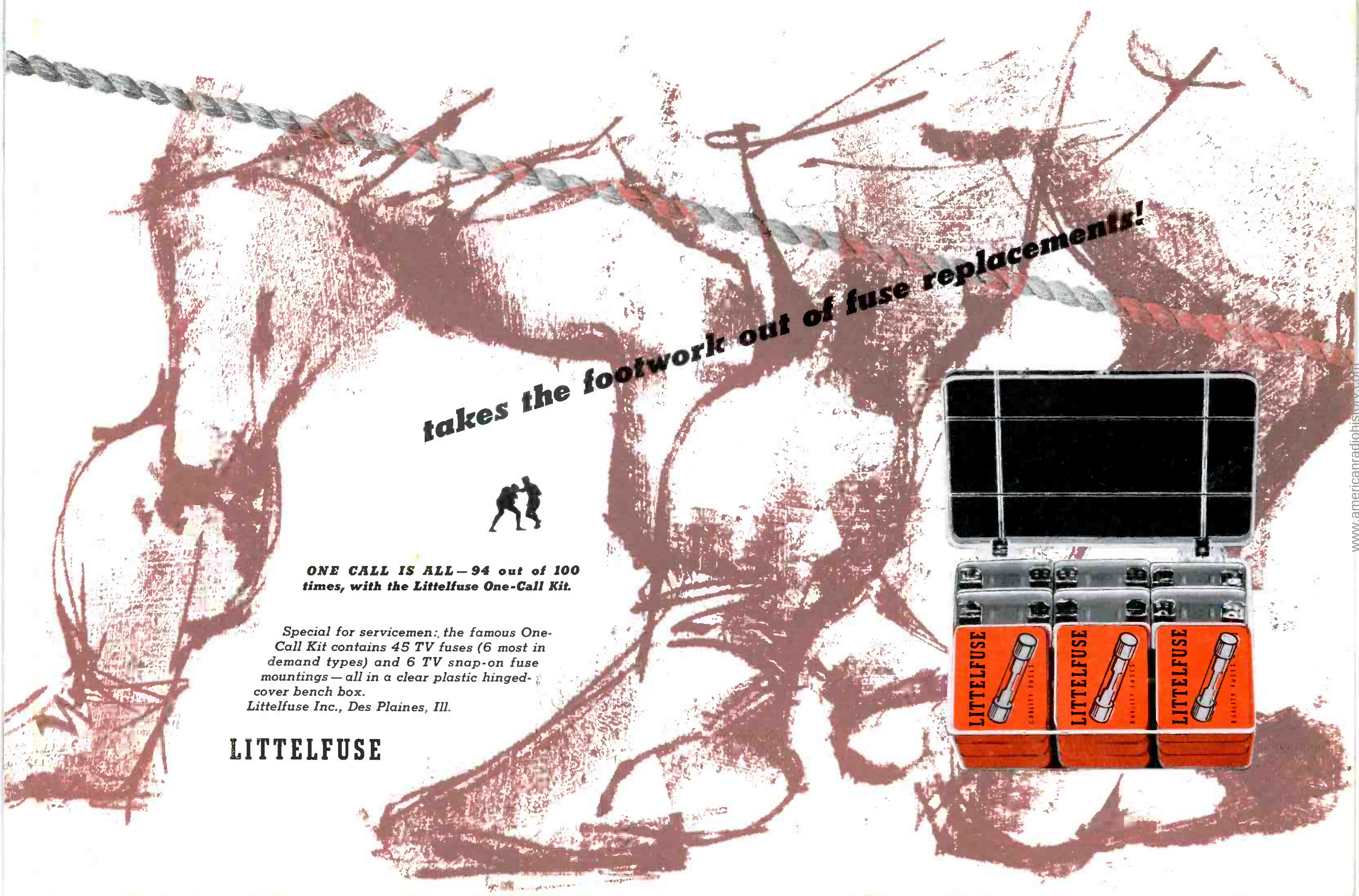
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