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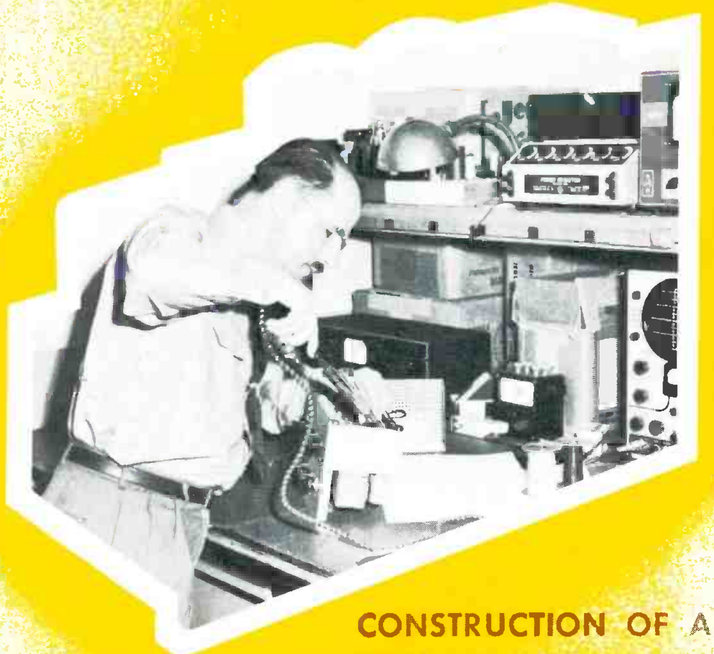

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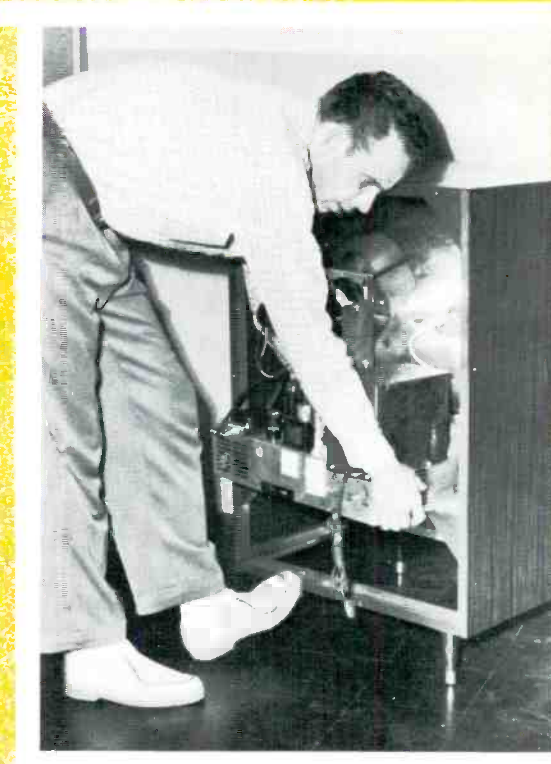
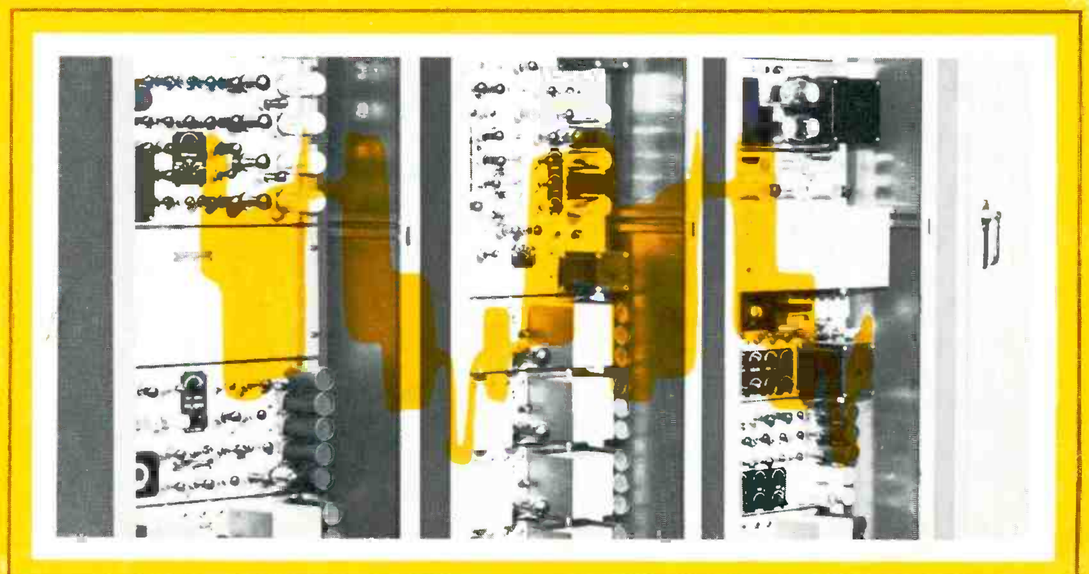
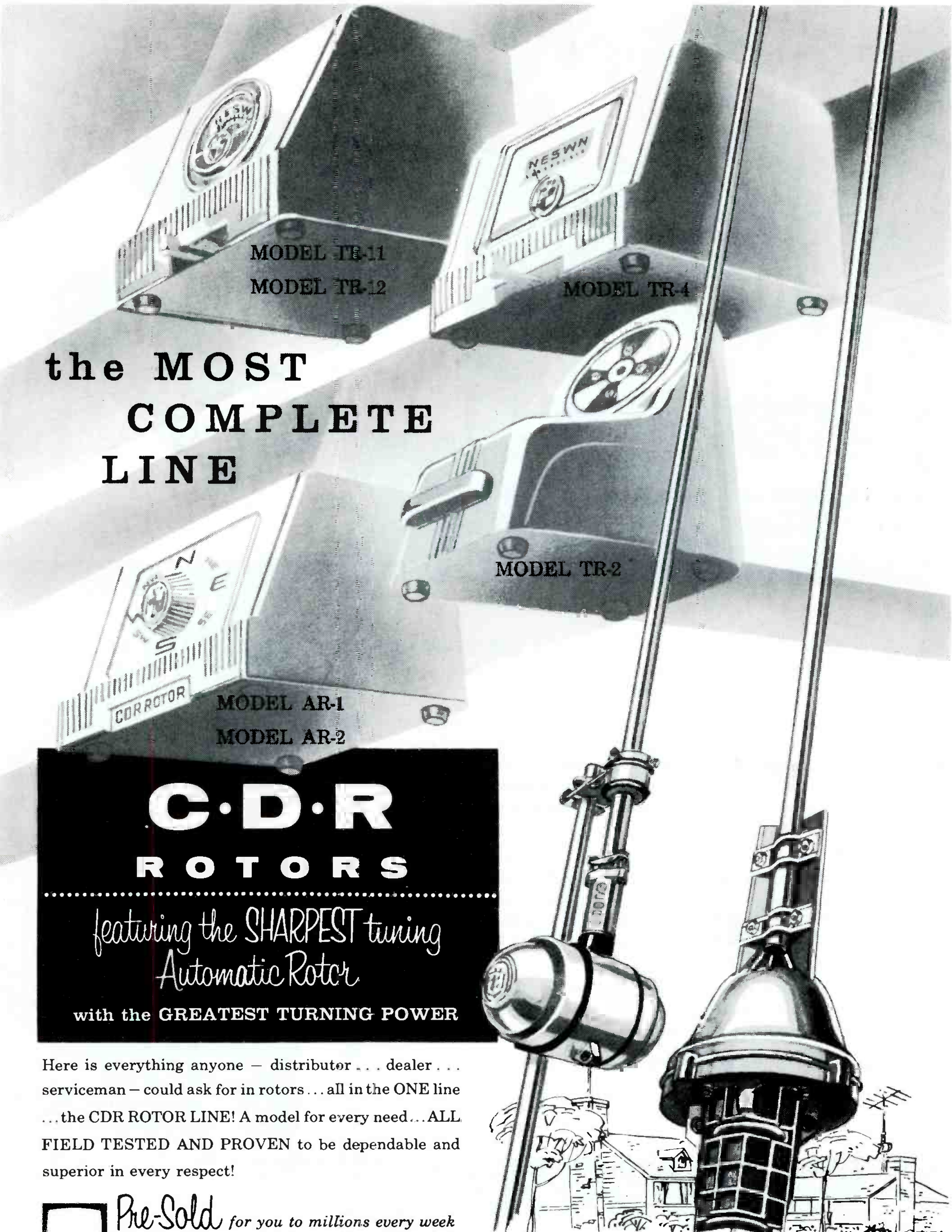


COLOR TV TRAINING SERIES PART VIII





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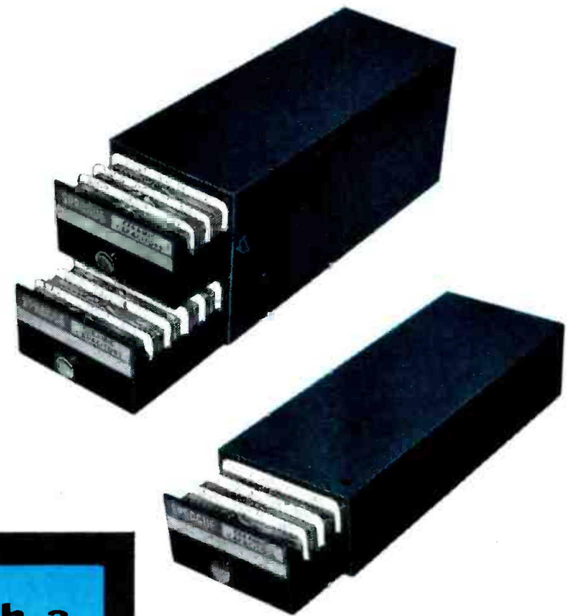

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5	5GA-Q39	5	5GA-T68
5	5GA-Q47	10	5GA-D1
5	5GA-Q5	5	5GA-D15
5	5GA-Q68	5	5GA-D2
5	5GA-Q82	5	5GA-D33
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for the Electronic Service Industry

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SUBJECT REFERENCE

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Shop Talk

MILTON S. KIVER

President, Television Communications Institute

MEASUREMENTS OF RECEIVER PERFORMANCE

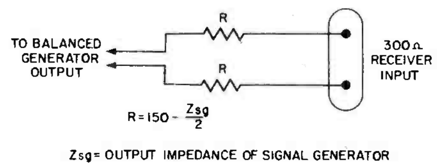
Service technicians are called upon from time to time to express their opinions concerning various features of television receivers. For example, the following are some of the questions asked. Is one make of set more sensitive than another? Is one type of AGC system more effective in its action than another? Is one set less prone to interference than other sets? Most of the time, whatever knowledge service technicians may have concerning receiver performance may simply be based upon observation of one or more sets in operation; and no serious attempts have usually been made to verify the opinions stated.

Occasionally, more precise information is desired. It is not particularly difficult to get this data if a signal generator with a calibrated output level is available. Generators of this type, such as the Hickok Model 292X in Fig. 1, have a meter which indicates the exact signal level within a range which is usually from zero to 100,000 microvolts. With a known input signal and with a VTVM or oscilloscope at the other end of the receiver, many important characteristics can be accurately measured.

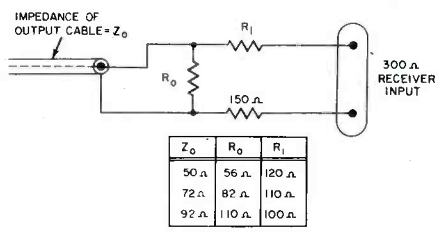
Fig. 1. A Crystal-Controlled AM Generator. (Sample Courtesy of Hickok Electrical Instrument Company.)

Sensitivity

Let us consider, for example, over-all receiver sensitivity. To make this measurement, you would proceed as follows. Connect the AM signal generator to the antenna input terminals, making certain that the generator impedance is matched to that of the receiver. If the generator output is balanced but its impedance is less than 300 ohms, the network



(A) With Balanced Generator Output.



(B) With Unbalanced Generator Output.

Fig. 2. Circuits for Matching Output Impedance of Signal Generator to Input Impedance of Receiver.

shown in Fig. 2A should be employed. On the other hand, if the generator has an unbalanced output, then the arrangement shown in Fig. 2B should be employed.

For the next step, an oscilloscope is connected between the grid or cathode of the picture tube and the receiver ground. The choice of grid or cathode depends upon which element receives the video signal.

The receiver is operated at maximum gain for this test; consequently, the contrast control is turned fully clockwise. In addition, the AGC line is shorted to ground. (If the receiver develops a low negative bias of 0.5 volt or so with no input signal, then apply a DC bias of the same value to the AGC line instead of grounding it.)

Next, tune the signal generator to the mid-frequency of the channel being checked, and adjust the unit for 30-per-cent modulation. Then rotate the fine-tuning knob on the receiver for maximum indication on the screen of the oscilloscope. The number of microvolts of generator output needed to produce a pattern having a peak-to-peak amplitude of 20 volts on the scope will be a measure of receiver sensitivity. The more sensitive the receiver, the less signal the generator will have to supply in order to produce the 20-volt signal at the picture tube. The value of 20 volts peak to peak at the picture tube is the standard established by the Institute of Radio Engineers.

In the VHF bands, it will be found that the highest receiver sensitivity will exist on channel 2 and the lowest on channel 13. Furthermore, the sensitivity on the UHF channels will be considerably poorer than on any of the VHF channels. Most of us know this; but with the sensitivity test, we can determine exactly how much difference exists between reception of different channels by the same receiver and between reception of any given channels by different receivers.

Image-Rejection Ratio

The image-rejection ratio is another receiver characteristic that can be determined by using the same setup of instruments used to check sensitivity. This is the ratio between receiver sensitivity to a normal signal and its sensitivity to a signal at the image frequency. For example, if the intermediate frequency representing the video carrier is 45.75 megacycles, the frequency of the local oscillator will be this far above that of the video carrier in the normal signal. See Fig. 3. The image frequency would then be 45.75 megacycles above the oscillator frequency. For

* * Please turn to page 65 * *

COLOR TV TRAINING SERIES

PART XIII ALIGNING THE COLOR RECEIVER

by C. P. Oliphant and Verne M. Ray

In Part XII of this Color TV Training Series, the discussion of the setup procedures for the color picture tube was concluded. A discussion will now be given concerning the alignment of the circuits in the color receiver.

In comparing the alignment procedure for a color receiver with that for a monochrome receiver, it can be said that aligning a color receiver is more difficult. The main reason for this is that the color receiver contains a larger number of stages than does the monochrome receiver. In order to reproduce colors faithfully, the alignment of the circuits of a color receiver must be very precise. Care must be taken in order to get the best possible responses from the circuits. For instance, the video IF section must have a bandwidth of nearly 4.5 megacycles in order to pass the 3.58-mc color subcarrier and its upper sidebands. The circuits must first be designed for this bandwidth; and second, they must be properly aligned. For best results, the response of the video IF section should be flat throughout the range of 4.5 megacycles.

The sections that need to be aligned in a color receiver are the RF, IF, sound, bandpass-amplifier, color-sync, matrix, and convergence sections. The RF, IF, and sound sections have their counterparts in the monochrome receiver; therefore, the alignment procedures for these sections in both the monochrome and color receivers are very similar. The bandpass-amplifier, color-sync, matrix, and convergence sections in the color receiver are those which do not have counterparts in the monochrome receiver.

This discussion about the alignment of the circuits in color receivers will first cover those circuits that pertain to color only. The color circuits will be presented in the following order: bandpass amplifier, color synchronization, matrix, and convergence. During the discussion about a particular section, it will be assumed that all the other sections of the receiver are functioning normally and that all the components in the section under discussion are in good condition.

A Color Plate is included for the purpose of showing the way the bar patterns should appear and the various ways they actually appear as a result of misalignment in the various sections of the receiver. The signals from the Hickok Model 655XC color-bar generator were employed while the photographs appearing in the Color Plate were being taken. Figs. C-1 and C-2 give the appearance of the bar patterns when operation of the receiver is normal and should therefore be used as standards for comparison with the other photographs which show symptoms of misalignment. Fig. C-1 shows a normal color-bar pattern, and Fig. C-2 shows a normal Q and I pattern.

Before entering into the discussion about the alignment of the circuits in a color receiver, let us consider the test instruments needed for color-television work.

TEST INSTRUMENTS

Practically all of the equipment now used when working with monochrome receivers is also needed when working with color receivers. Most of these instruments can be used without modification and in the same applications for which they were originally designed; however, some will have to have additional features before they will meet the requirements for color-television service work. In addition, new equipment will also have to be acquired. It was necessary to develop new instruments which had to be specifically designed for use in color-television service work and which are not useful in the adjustment or service of monochrome receivers.

Oscilloscope

The oscilloscope is a very useful instrument in television work. In order for this instrument to be satisfactory for observing the video signals associated with color television, it must have a wide bandpass characteristic because color television utilizes a wider band of video frequencies than is common in monochrome television. Since the frequencies contained in a composite color signal vary from a few cycles to nearly 4.5 megacycles per second, the response of the oscilloscope circuits should be fairly flat over this range of frequencies. Many of the oscilloscopes which were designed for use in connection with monochrome television also fulfill the requirements needed to observe the composite color signal or any portion of this signal, such as the color burst which has a frequency of 3.58 megacycles.

For viewing response curves in color receivers, oscilloscopes with narrow bandpass characteristics can be used just as they are for this purpose in monochrome receivers. This is true because the signal which is applied to the oscilloscope during the viewing of conventional response curves is comprised for the most part of low-frequency components.

Sweep Generator

The sweep generator is another test instrument which is used in connection with the servicing of monochrome television receivers. Its most useful application is during alignment of the tuner and video IF stages. To be more useful in color-television service work, a sweep generator should incorporate a video range which sweeps down to 50 kilocycles or below. This video range is necessary so that the frequency response of such circuits as the video amplifier, the bandpass amplifier, the I and Q circuits (or the R - Y and B - Y circuits), and the matrix circuits can be checked.

When the response curves of these circuits are checked, frequency markers from .5 to 4.5 megacycles are very helpful. At the present time, the marker frequencies supplied by most marker generators and those incorporated in sweep generators may not be within this range; but this presents no problem, since an RF signal generator will provide frequencies in the video range. The signal from such a generator can be injected and the generator can be tuned so that a marker will appear at practically any point on the video response curve.

High-Voltage Probe

Another instrument which is necessary in color-television service work is the high-voltage probe. Since the ultor voltage in a color receiver is regulated at a specific value, proper operation of the high-voltage circuit is most easily determined by an actual voltage measurement. The ultor voltage in many color receivers may exceed 30 kilovolts when unregulated; therefore, a high-voltage probe which will withstand this potential and which incorporates an ample safety factor is recommended. The use of a high-voltage probe was covered in the discussion of the setup procedure for the color picture tube. This discussion appeared in Parts XI and XII in the April and May issues of the PF REPORTER.

White-Dot and Color-Bar Generators

Oscilloscopes, sweep generators, and high-voltage probes are pieces of equipment that should be familiar to the service technician who has worked with monochrome receivers. The development of color television has brought about the need for two new types of test instruments. These are the white-dot generator and the color-bar generator.

Actually, the use of a dot generator is not new in television servicing; but the patterns which have been used in servicing monochrome receivers have consisted of black dots on white fields. Patterns consisting of white dots on dark fields are preferred for servicing color receivers because these patterns can be used not only for linearity adjustments but also for convergence adjustments. The use of a white-dot pattern was described in the discussions on convergence adjustments in Parts XI and XII of this Color TV Training Series in the April and May issues of the PF REPORTER.

A color-bar generator is very useful in checking the performance of the circuits in a color receiver. As the name implies, the color-bar generator develops a signal from which bars of various colors can be reproduced on the viewing screen of the picture tube. Most generators incorporate a function switch so that the bar patterns can be changed. One position of the switch may cause a combination of primary and secondary colors to be produced on the screen. Other positions may produce individual colors which correspond to I, Q, R - Y, and B - Y. The subcarrier oscillator in the color-bar generator is usually crystal controlled; consequently, this instrument is a reliable standard for checking the performance of the color circuits of a receiver.

BANDPASS AMPLIFIER

The bandpass amplifier is the first stage in the chrominance channel of a color receiver. This stage extracts the chrominance signal from the composite color signal and passes it on to the demodulator section. The signal at the input of the bandpass-amplifier section consists of the chrominance and luminance signals, the sync and blanking pulses, and the color burst. At the output of the bandpass amplifier, only the chrominance signal appears. This means that the luminance signal has been blocked and that the sync and blanking pulses and the color burst have been keyed out. The chrominance signal, which consists of the subcarrier at 3.58 megacycles and of the sidebands that extend to 2.1 and 4.2 megacycles, is allowed to pass.

The bandpass-amplifier circuit shown in Fig. 11-1 is employed in the RCA Victor Models CT-100 and 21-CT-55 color receivers. This circuit was discussed in Part VI of the Color TV Training Series in the November issue of the PF REPORTER, and it will be referred to later in the discussion concerning the alignment of the bandpass-amplifier section.

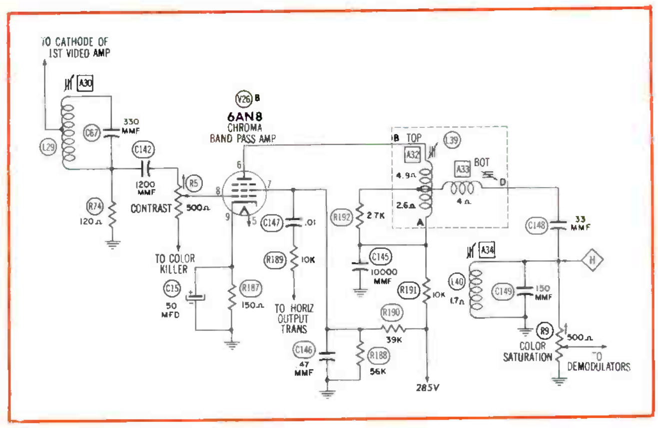


Fig. 11-1. Bandpass-Amplifier Circuit in RCA Victor Model CT-100 Color Receiver.

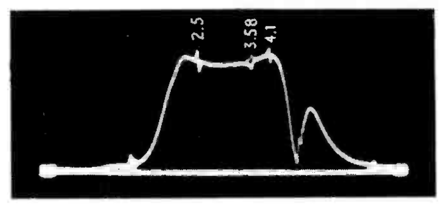
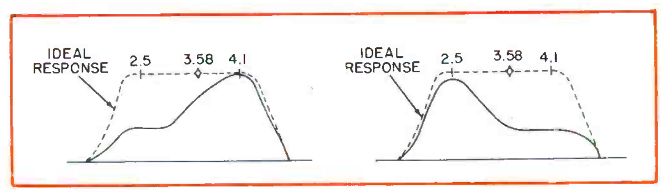


Fig. 11-2. Normal Response Curve of the Bandpass-Amplifier Circuit of Fig. 11-1.



(A) Showing Greater Attenuation at the Sideband Frequencies Far From the Subcarrier Frequency.

(B) Showing Greater Attenuation at the Sideband Frequencies Near the Subcarrier Frequency.

Fig. 11-3. Response Curves Which Are Abnormal Because of a Misadjusted Bandpass Filter.

The bandpass amplifier is similar to a conventional video amplifier, but it has components which are tunable so that the circuit can be aligned to provide the proper passband for the chrominance signal. The tunable components are contained in the bandpass filter and are designated as L39 and L40 in Fig. 11-1.

When the bandpass filter is properly aligned, all of the color signals will pass through the circuit to the color demodulators. Misalignment may cause a change in the saturation of the colors, and loss of color detail may also be present. Fig. 11-2 shows the normal response curve of the bandpass-amplifier section in Fig. 11-1.

The drawings in Fig. 11-3 illustrate abnormal response curves which may be obtained when L39 and L40 of the bandpass filter are misadjusted. Each curve in these drawings is sloped at the top instead of being flat which is the ideal response, and each is low in amplitude almost over the entire curve. With a response such as that shown

REFERENCE PATTERNS FOR ALIGNMENT PROCEDURE

COLOR TV TRAINING SERIES

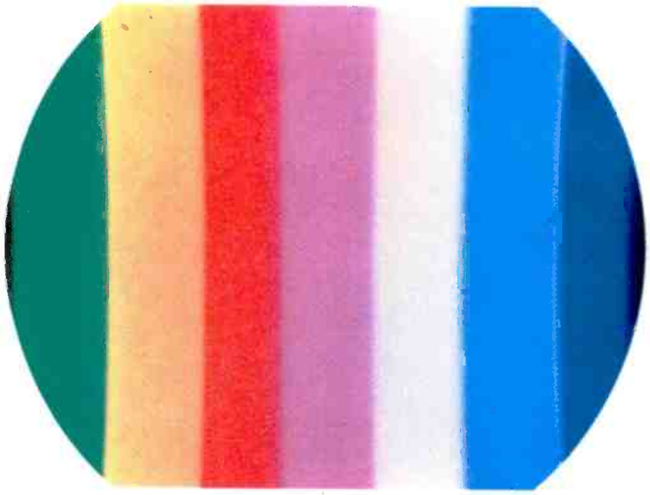


Fig. C-1. Normal Color-Bar Pattern.

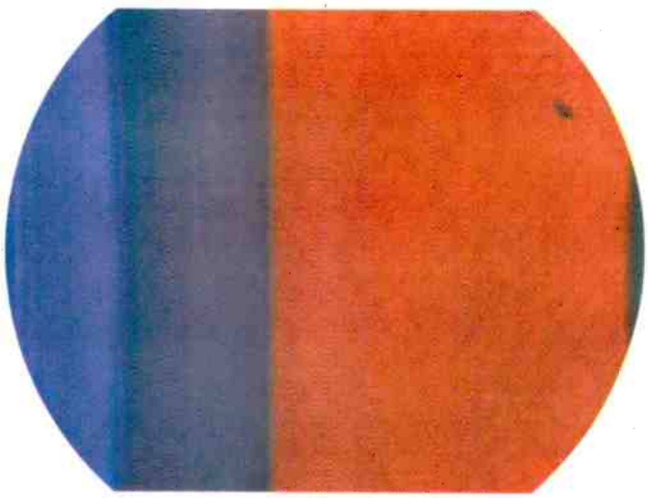


Fig. C-2. Normal Q and I Pattern.

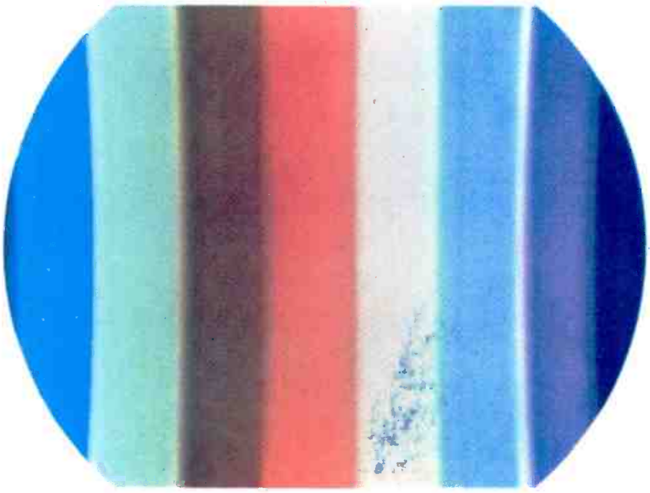


Fig. C-3. Color-Bar Pattern Resulting From Misadjustment of the Burst-Amplifier Transformer.

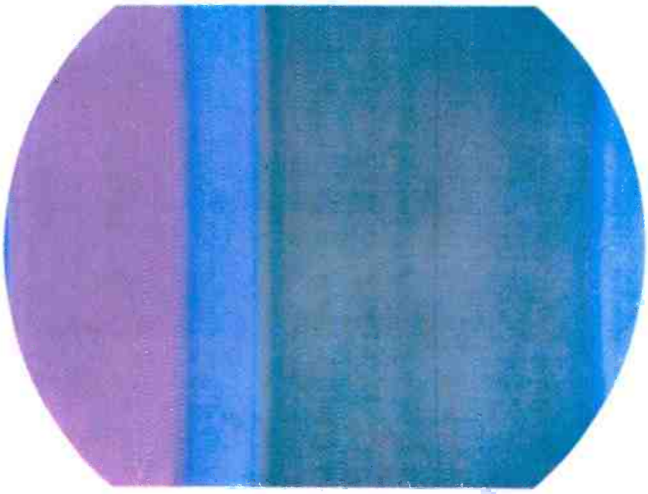


Fig. C-4. Q and I Pattern Resulting From Misadjustment of the Burst-Amplifier Transformer.

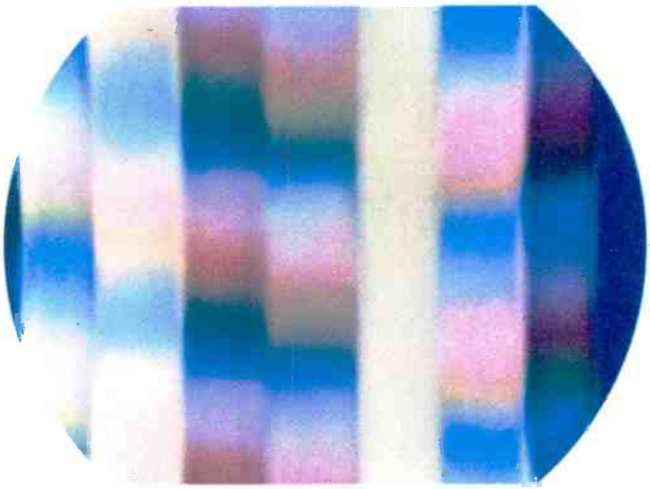


Fig. C-5. Loss of Color Synchronization Resulting From Misadjustment of the Coil in the Plate Circuit of the Reactance Tube.

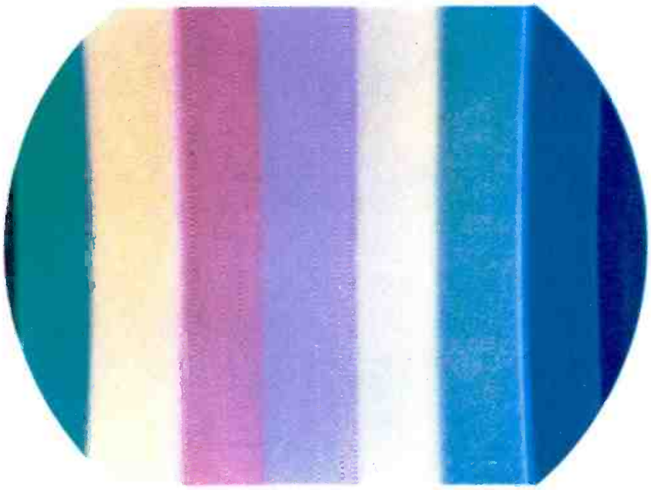


Fig. C-6. Color-Bar Pattern Resulting From Misadjustment of Quadrature Transformer. Phase Difference of CW Reference Signals Is Less Than 90 Degrees.

REFERENCE PATTERNS FOR ALIGNMENT PROCEDURE

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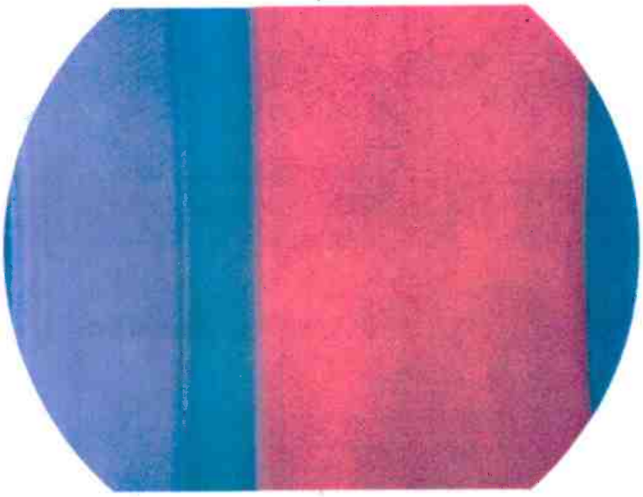


Fig. C-7. Q and I Pattern Resulting From Misadjustment of Quadrature Transformer. Phase Difference of CW Reference Signals Is Less Than 90 Degrees.

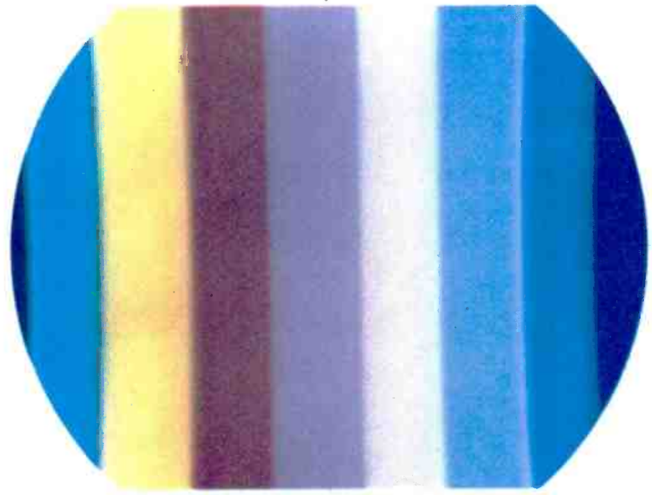


Fig. C-8. Color-Bar Pattern Resulting From Misadjustment of Quadrature Transformer. Phase Difference of CW Reference Signals Is More Than 90 Degrees.

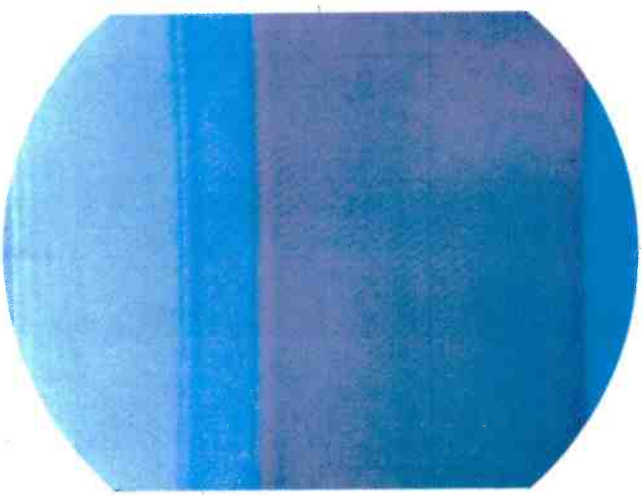


Fig. C-9. Q and I Pattern Resulting From Misadjustment of Quadrature Transformer. Phase Difference of CW Reference Signals Is More Than 90 Degrees.

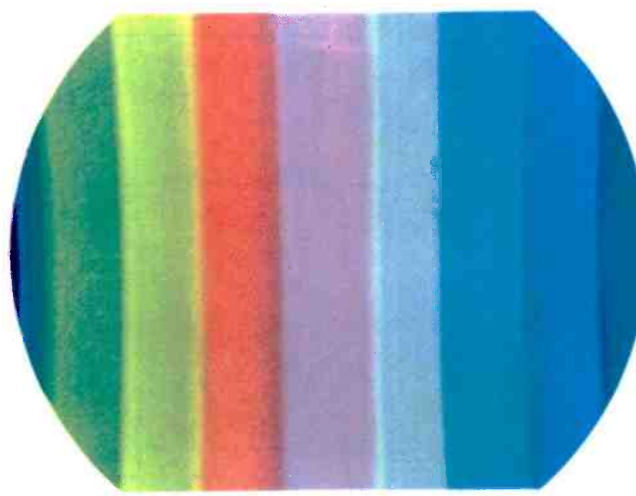


Fig. C-10. Color-Bar Pattern Resulting From Misadjustment of Video IF Coil L20.

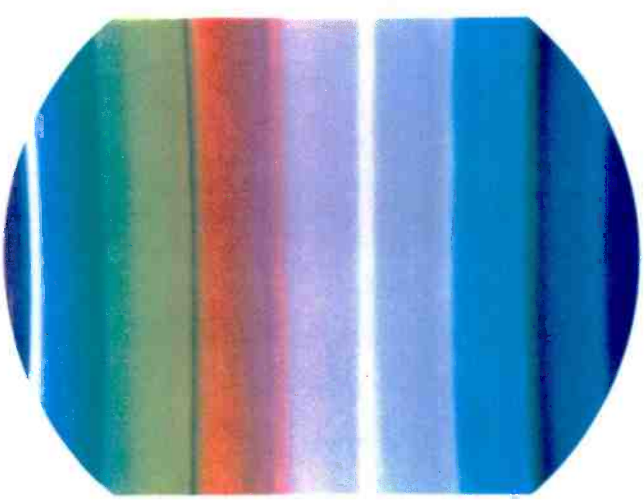


Fig. C-11. Color-Bar Pattern Resulting From Misadjustment of Video IF Coil L21.

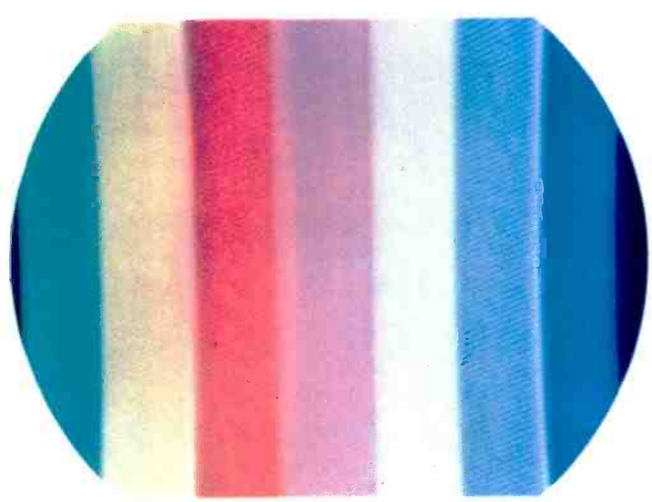


Fig. C-12. Color-Bar Pattern Showing 920-Kc Beat.

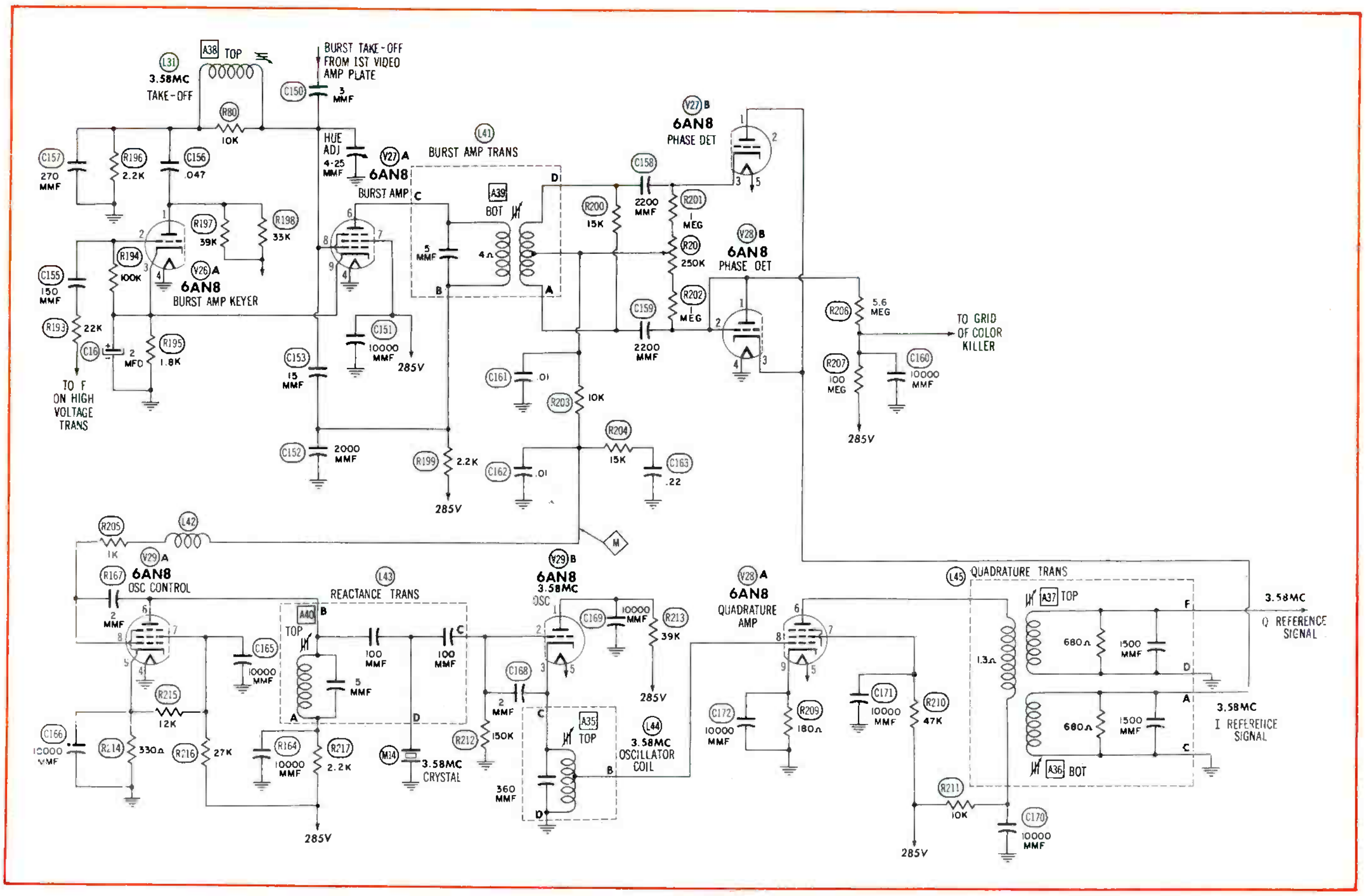


Fig. 11-4. Color-Sync Circuit in RCA Victor Model CT-100 Color Receiver.

in Fig. 11-3A, sideband frequencies which are the farthest from the subcarrier frequency are greatly attenuated. Color detail in small areas is conveyed by these frequencies. Since the frequencies are being greatly attenuated by the bandpass filter, color detail will suffer. With a response like that shown in Fig. 11-3B, the sideband frequencies near the subcarrier frequency are being attenuated. Blocks of color such as the color of the sky or grass in an outdoor scene are conveyed by these frequencies. If these frequencies are greatly attenuated by the bandpass filter, these blocks of color will undergo desaturation.

If loss of color detail is suspected of being caused by the bandpass-amplifier section, the response of this circuit should be checked. The response curve is obtained by applying a sweep signal with a center frequency of 3 megacycles to the control grid of the first video amplifier and by connecting the leads of the vertical amplifier of an oscilloscope to the input of the demodulators. Provided that all of the components in the bandpass-amplifier circuit are functioning properly, the flat response shown in Fig. 11-2 can be obtained by tuning L39 and L40.

COLOR-SYNC SECTION

The color-sync section has the duty of supplying to the color demodulators two CW signals which are used as reference signals during the demodulation of the chrominance signal. These reference signals must be in proper phase relationship with each other and with the color burst in the incoming signal so that the correct colors will be reproduced.

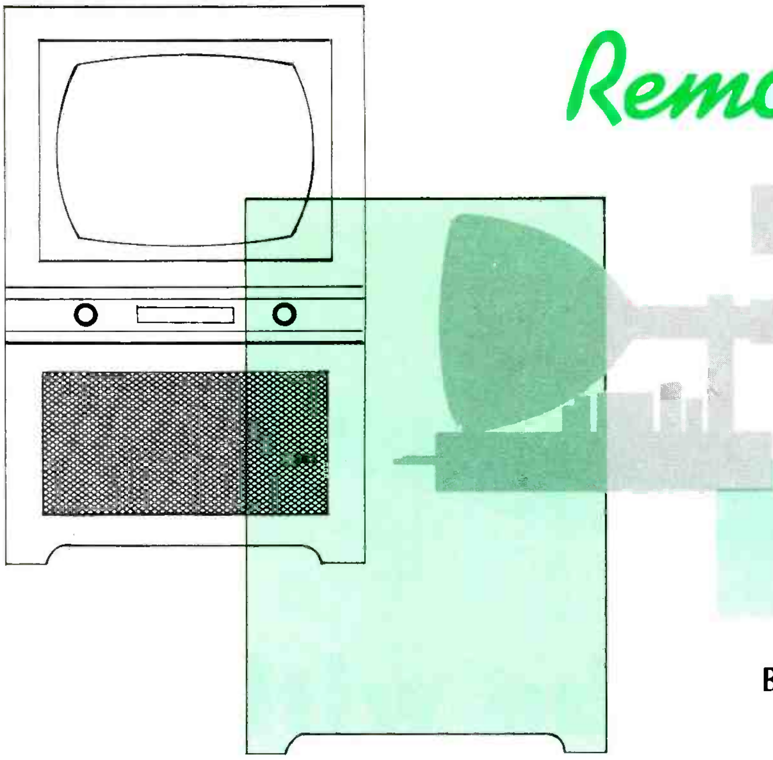
The color-sync section generates a CW signal which is compared in phase and frequency with the color burst that is contained in the composite color signal. The locally generated CW signal is correct when it has a certain phase relationship with and the same frequency as the color burst. One of the purposes in aligning the color-sync section is to make sure that this phase and frequency relationship is established. In addition, the locally generated CW signal undergoes a specific phase shift before it is fed to the color demodulators; therefore, the second purpose in aligning the color-sync section is to obtain this exact amount of phase shift.

The circuit shown in Fig. 11-4 is the color-sync section employed in the RCA Victor Models CT-100 and 21-CT-55 color receivers. The operational theory of this circuit was discussed in Part VI of the Color TV Training Series in the November 1954 issue of the PF REPORTER.

The hue control can be used as a means of checking the operation of the color-sync section. Through the use of this control, it can be determined whether the operation of this circuit is normal. When the correct color bars are obtained, the hue control should be approximately at midrange position. Then when the control is rotated in one direction, the bars should change color in a definite pattern. For instance, the magenta bar should change to a red color when the hue control is rotated in one direction and should change to a blue color when the hue control is rotated in the opposite direction. If the correct color bars cannot be obtained when the hue control is rotated throughout its range, the alignment of the color-sync circuit may not be correct.

The color-phase diagram is very useful when analyzing color-bar patterns on the screen of a color receiver. This diagram is shown in Fig. 11-5 and will be referred to from time to time during this discussion.

* * Please turn to page 31 * *



Removing the TV CHASSIS

Customary Methods for All Receivers and Special Procedures for Certain Makes

BY CALVIN C. YOUNG, JR.

The task of removing a television chassis from its cabinet is very familiar to most service technicians; however, the following material is being presented in order to acquaint the reader specifically with some of the things to heed when removing chassis from particular makes and models of receivers. In addition, a general coverage of the subject is presented for the benefit of the less experienced technician.

Normally, the decision to remove a chassis is reached after the service technician has checked the controls and has substituted tubes in the receiver section which is at fault. The customer is notified that the receiver requires shop service in order to be restored to its proper operation; and upon his authorization, the procedure to remove the chassis can be started.

Removal of Back Cover

Usually, the back cover of the receiver will have been removed by the technician before substituting tubes; however, the antenna lead between the back cover and the tuner may still be connected to the back cover. This line is sometimes connected permanently to the tuner, and provisions are made so that it may be disconnected from the back cover as it is in some of the Philco and RCA Victor models. There are certain Sylvania models, however, in which this lead should be disconnected at the tuner instead of at the back cover. After the back cover of the receiver has been removed, the control knobs which would interfere with chassis removal should be taken off.

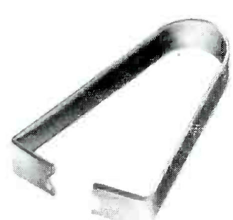


Fig. 1. Knob Puller Made by General Cement Mfg. Co.

Removal of Control Knobs

Some television receivers employ knobs which may simply be grasped firmly and pulled off; others use various methods for securing the knobs so that they cannot be so easily removed in this manner. There are available commercial pullers which are very valuable in removing knobs that have retaining clips or that fit tight and are hard to pull off. Such a knob puller is shown in Fig. 1. A rag or cord can be used when a commercial knob puller is not available. Fig. 2 shows a handkerchief being used for removing a knob. Prying off a knob with a screwdriver is not a good practice; there is too much danger of breaking the knob or damaging the cabinet of the receiver.

There are some cases, such as in early Magnavox models and in certain Stromberg-Carlson sets, in which the channel-selector knob is secured with a small Allen setscrew. When a receiver such as this is encountered, it is impossible to remove the chassis if the proper Allen wrench is not available; therefore, carry a set of these wrenches in the tool kit.

Some Philco and Arvin receivers employ a retaining clip on the channel-selector shaft. After the channel-selector knob is removed, the retaining clip must be removed before any attempt to remove the fine-tuning knob is made; otherwise, the fine-tuning knob may be broken. These clips are very springy, and care should be taken to guard against possible loss of one of them during removal.

Disconnect Cables

After the knobs are removed, the various cables should be disconnected. If the antenna lead was not disconnected when the back was removed, as would be the case if the antenna terminal strip were fastened to the cabinet, it should be disconnected and secured in such a manner

* * Please turn to page 74 * *

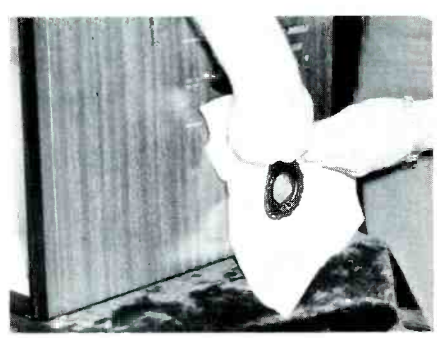


Fig. 2. Removing a Knob With a Handkerchief.

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Notes On
TEST EQUIPMENT

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

by Paul C. Smith

TESTERS FOR FLYBACK TRANSFORMERS AND YOKES

The November-December 1951 issue of the PF INDEX (now the PF REPORTER) and the April 1955 issue of the PF REPORTER each contained an article on checking horizontal-output transformers. The method described in these articles required the use of an AC voltmeter of the VTVM type and an audio oscillator having a range extending up to at least 100 kilocycles. With this method, the presence of shorted turns in a horizontal-output transformer can be detected by measuring the resonant frequency of the transformer. One or more shorted turns result in an abnormal increase in this frequency.

A number of testers for flyback transformers and yokes have appeared on the market. Some are based upon the principle just described, and others operate somewhat on the principle of the Q-meter or the grid-dip meter. In Fig. 1, both designs are represented in the group of testers for flyback transformers and yokes.

The transformer testers shown are designed to provide a positive check on the condition of flyback transformers and yokes. Some testers are designed so that they can be used to make continuity checks, although such checks are usually performed with an ohmmeter. This function is incorporated in these testers so that a complete check can be performed without resorting to the use of two separate instruments.

The designers of those testers that operate upon the principle of measuring the resonant frequency of the flyback transformer or of the horizontal-deflection system have taken into account the fact that all such systems have a natural resonant frequency within a certain range. The presence of shorted turns increases this resonant frequency.

Tester Employing Principle of Resonant Frequency

The Seco Model FB-4 flyback interval and inductance checker pictured in Fig. 1 uses the resonant-frequency principle for checking horizontal-deflection systems and for checking the inductances of yokes and flyback transformers. This instrument has a self-contained AC power supply, a multivibrator stage, a cathode-follower stage, and a 6E5 electron-eye indicator.

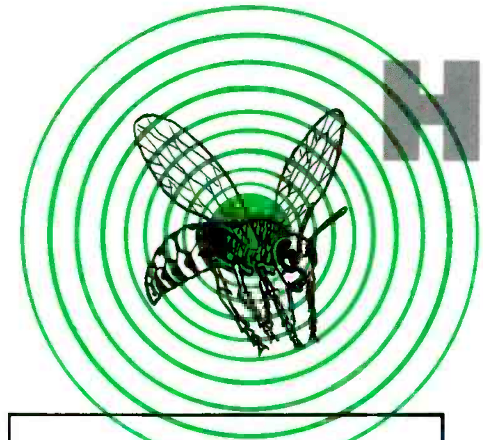
The frequency of the multivibrator can be adjusted by a front-panel control. This control is calibrated on the front panel with three different sectors which represent the normal resonant-frequency ranges for flyback transformers, horizontal-deflection assemblies, or yokes. Normal resonant frequency of the entire horizontal-deflection assembly should be reached when the front-panel control is in the FB-OK (flyback OK) sector. This assembly includes the flyback transformer, the yoke, the width coil, and all components associated with the horizontal-deflection system rather than just the flyback transformer alone.

The sector used for checking the flyback transformer alone covers a range from approximately 20 to 48 kilocycles, the sector for checking the horizontal-deflection system covers from 48 to 68 kilocycles, and the sector for checking the yoke covers

* * Please turn to page 61 * *

(A) Seco Model FB-4. (B) EICO Model 944. (C) Radio City Products Model 123.

Fig. 1. Representative Group of Testers for Flyback Transformers and Yokes.



HUM TROUBLES in AC-DC RADIOS

COMMON CAUSES AND CURES

by William E. Burke

The servicing of an AC-DC radio when it develops an excessive amount of 60-cycle hum can become quite lengthy and involved, because the troubles which can produce hum can be many and varied. If the technician becomes familiar with the most common troubles, he can reduce greatly the time required for servicing receivers which do have too much 60-cycle hum. Presented here are some of the major causes of such troubles and some of the methods for removing them.

The servicing procedure should be started by determining the type of hum which is present. Hum of the 60-cycle variety can be divided into two types or categories — tunable and nontunable. The term "tunable hum" indicates one which varies in volume or in tone as a station signal is tuned in and out. Nontunable hum does not vary with a variation in tuning.

Tunable Hum

When tunable hum exists in a receiver, it indicates that either the RF or IF signal is being modulated by the 60-cycle hum. The first step toward eliminating this trouble should be to determine whether the hum originates in the receiver or whether the signal is being modulated by the hum at a point which is external to the receiver. Another receiver which is known to be in good operating condition can be used for this check. If the hum is also found on the second receiver, the hum is from an external source; and your efforts should be directed toward removing the source of interference.

If the foregoing test proves that the receiver in question is faulty, the next step would be to check by substitution the RF, converter, and IF tubes. This can usually be done without removing the chassis from the cabinet and may save some time if the hum is being caused by a faulty tube or tubes.

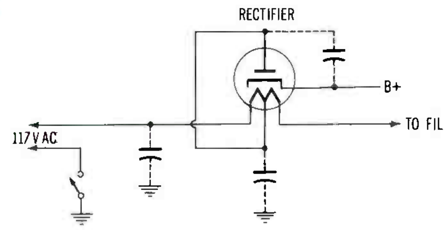


Fig. 1. Alternate Locations of Line-Filter Capacitor in Half-Wave Rectifier Circuit.

Further steps in the elimination of the hum will require the removal of the chassis from the cabinet, since the components and wiring on the underside of the chassis will be involved.

One frequent cause of tunable hum is a defect in the capacitor which serves as a filter in the AC power line to the receiver. This capacitor may suffer a loss in value or become open. Check it by bridging it with a good capacitor. Fig. 1 shows the three positions in which this capacitor is usually found.

There is always the possibility that some 60-cycle voltage can be introduced into the AVC line, and it will appear audibly as tunable hum. In some receivers, the frame of the tuning capacitor is connected to the AVC line and is insulated from the chassis by rubber grommets. See Fig. 2. The AVC line can become shorted to the chassis if the grommets deteriorate and allow the capacitor to touch the chassis. Since the chassis is connected to the AC line through the isolation capacitor and resistor, hum will sometimes appear on the AVC line.

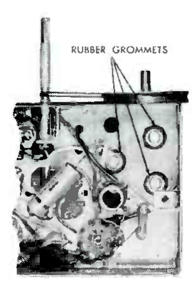


Fig. 2. Partial Underchassis View of Typical AC-DC Radio With Rubber Grommets Which Insulate Tuning Capacitor From Chassis.

Nontunable Hum

If the trouble is diagnosed as nontunable hum, several remedial steps can be taken before the chassis is removed from the cabinet. Check to make sure that the polarity of the AC plug does not have too great an effect upon the hum level. Some receivers will exhibit hum when the AC plug is connected to the AC line in such a way that the high side of the line is connected to the B- line in the receiver. When the plug is reversed, the hum will disappear, or at least it will decrease in strength. When servicing a receiver, always insert the plug so that the hum is at a minimum. In this way, some confusion will be avoided.

Substitute tubes in the following order: the audio output tube, rectifier, IF, detector and audio, converter, and RF (if it is used). This order is important because it takes into account the facts that some tubes are more prone to failure than others and that some tubes have more AC voltage applied than do others. The filament string of a typical AC-DC receiver will appear somewhat as shown in Fig. 3. Note that the output tube is near the high end of the string. A heater-to-cathode short in this tube will apply a high AC voltage to the cathode circuit and hence will give rise to considerable hum from the speaker.

Glass tubes used in the audio and IF stages can introduce hum into a receiver if shields which are normally used are missing. If the hum level increases when a hand is held near or around the bulb of one of these tubes, the original hum might be originating in that tube. Install a tube shield or substitute a new metal tube, and then test the receiver.

* * Please turn to page 59 * *

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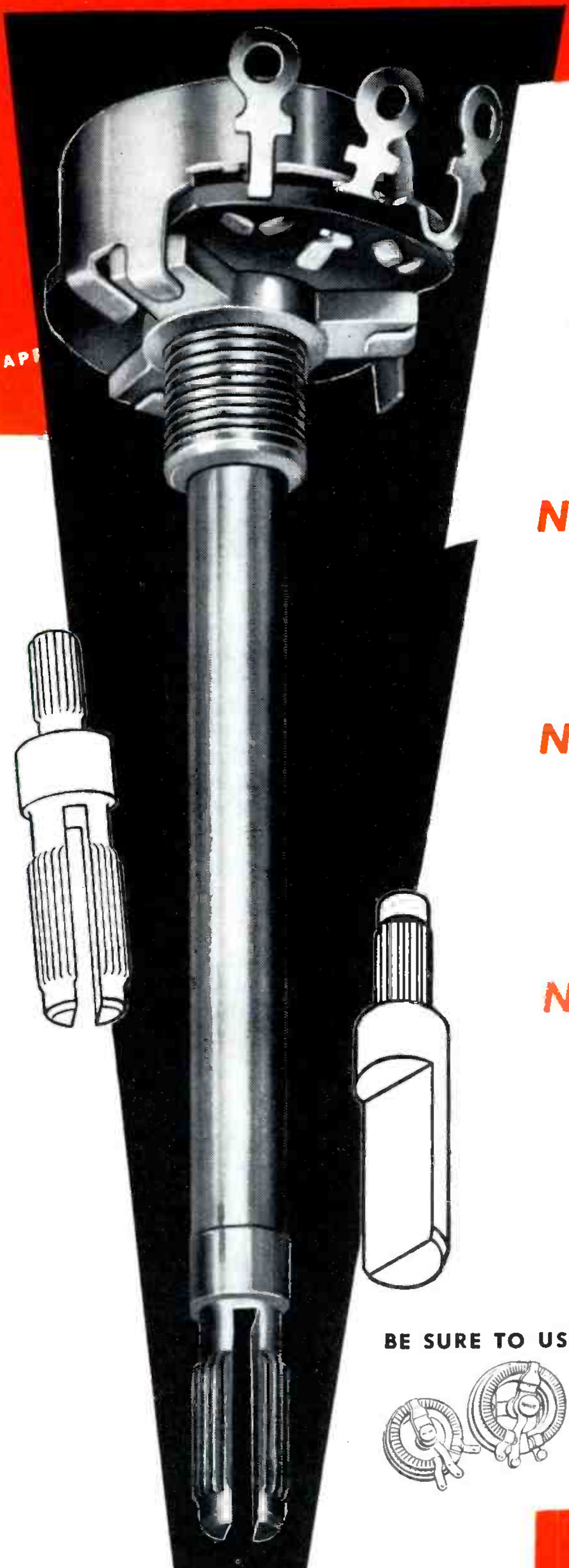

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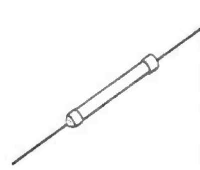

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Examining DESIGN *Features*

by LESLIE D. DEANE

NOISE-INVERTER CIRCUIT IN SYLVANIA CHASSIS 1-522-2

The Sylvania Chassis 1-522-2 incorporates an interesting circuit in the sync section. This circuit appears physically as a duo-triode 12AU7 tube located close to the high-voltage cage and is referred to as a noise-inverter stage.

Noise pulses of high amplitude often occur in the composite video signal because of outside interference. If these undesired pulses are allowed to pass through the sync separator, they can cause erratic operation of both the horizontal and vertical oscillators. In order to overcome this condition, the manufacturer of this particular chassis has incorporated a noise-inverter circuit which acts upon the signal between the sync amplifier and sync separator. A schematic diagram of this circuit is shown in Fig. 1.

The operation of the noise-inverter circuit is accurately described by the title, for it utilizes the principle of signal inversion. A composite video signal is introduced into the sync section through a series resistor R84. The signal voltage is sampled at this point of input and is then applied to one triode section V15B in the 12AU7 tube. If noise pulses of excessive amplitude are present in this signal, they are inverted in polarity and are fed back to a point in the original signal path where they cancel the incoming noise.

In conjunction with this stage, it is necessary to control the action of the inverter so that it cancels only the noise pulses and does not affect the normal sync pulses. One way to accomplish this is to vary the grid bias on the inverter V15B in accordance with any variation in signal strength. In order for the action to take place, use is made of the triode section V15A which is keyed by a positive pulse from the horizontal-output transformer.

The noise inverter V15B obtains its cathode potential from a voltage-divider network in the cathode circuit of the horizontal-output tube. A parabolic waveform may be observed at the cathode of V15B by use of an oscilloscope. The fluctuating voltage represented by this parabolic waveform varies at the rate of the horizontal frequency, and its most positive value occurs during the sync-pulse interval. When a positive sync pulse is fed to the grid of the inverter, the tube would normally conduct; but the voltage applied to the cathode becomes positive at this time and tends to hold the tube at cutoff. During the period between sync pulses, the cathode voltage of the inverter swings in a negative direction. This action will cause the tube to become more sensitive to grid excitation; therefore, any noise pulse impressed on the grid during this period will cause the inverter to conduct.

A positive signal containing sync pulses and video is coupled from the sync amplifier to the plate of the keyer V15A through capacitor C73. A positive-going pulse supplied from a winding on the horizontal-output transformer is fed to the grid. This pulse is generated by the retrace currents, and it occurs only at sync-pulse time. These voltages at the plate and grid will drive V15A into conduction only during the sync-pulse interval.

When the tube conducts, capacitor C73 will charge to a value determined by the amplitude of the applied sync signal. The capacitor discharges through resistor R81 which develops a bias for the inverter grid. The bias thus produced is sufficient to place the tips of the incoming sync pulses on the same level with the cutoff voltage of the inverter, regardless of variations in signal strength. Since the inverter is not conducting during the sync interval, the sync pulses from the sync amplifier are coupled to the sync separator through resistor R84 and capacitor C75 in a conventional manner.

Noise peaks which have excessively high amplitude and which occur between sync pulses will be coupled to the inverter grid. The coupling capacitor C73 offers a lower impedance than the resistor R84 at the relatively high noise frequencies. The inverter triode amplifies and inverts any positive noise pulse, and the resulting negative pulse at the plate of the inverter cancels the original positive noise pulse which has been coupled to the plate through resistor

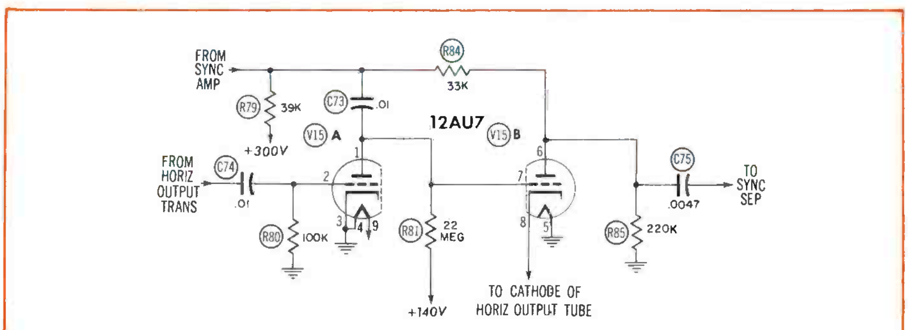

Fig. 1. Noise-Inverter Circuit in Sylvania Chassis 1-522-2.

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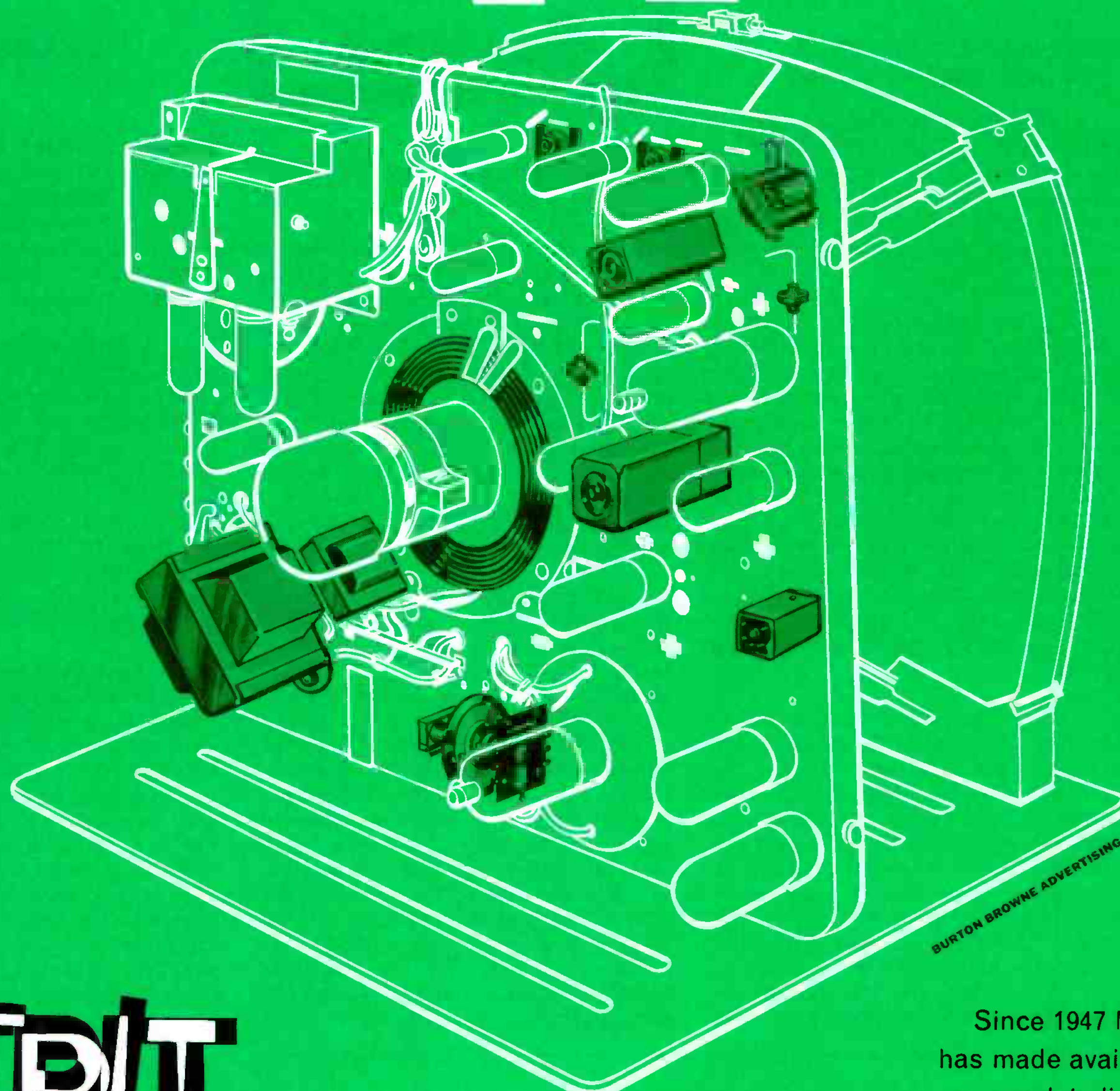

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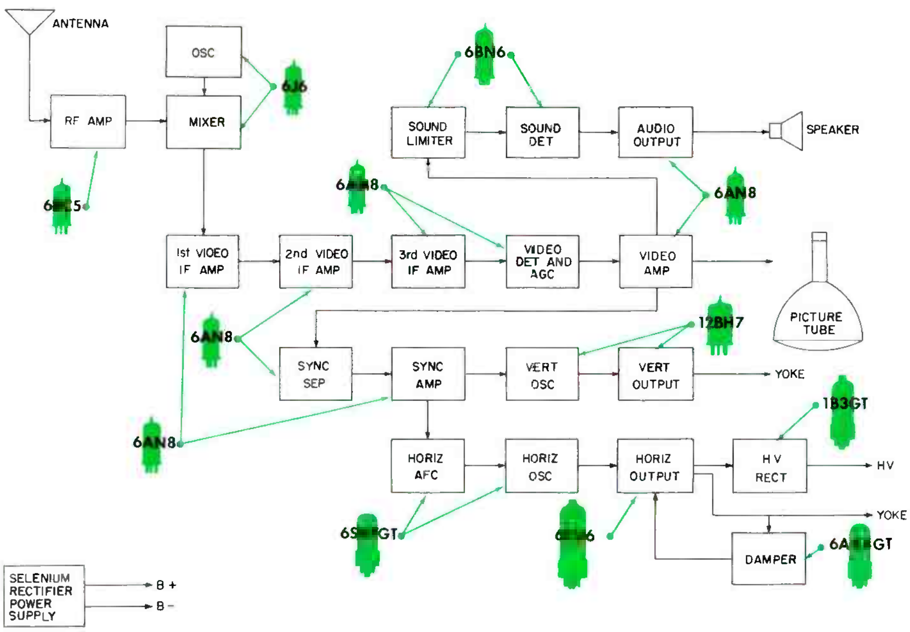

Fig. 2. Block Diagram Showing Distribution of Dual-Purpose Tubes in Olympic Model 14TD52 Television Receiver.

R84. The negative pulse is of greater amplitude than the original positive noise pulse because the original pulse has been attenuated by R84, and at the same time the negative pulse has been amplified; therefore, any noise pulse will appear with a negative polarity on the grid of the sync separator. This negative-going pulse will not affect the operation of the sync circuits.

The type of noise-inverter circuit just described greatly stabilizes the operation of the sync circuits in areas where the signal-to-noise ratio is poor; however, it has been noticed that in some very strong signal areas, a horizontal wiggle or vertical flop-over may be encountered.

Sync trouble of this nature may be caused by a weak or defective keyer section in the 12AU7 tube. For instance, if the keyer V15A is inoperative, the inverter section will be free to amplify and invert all sync signals present on its grid. The amplified and inverted sync pulses will override the original positive sync pulses, and negative-going sync pulses will be applied to the sync separator. The vertical and horizontal oscillator circuits will be very erratic in their operation since they require positive sync pulses for stable operation.

If a new 12AU7 tube does not correct the unstable synchronization in areas where there are strong signals, try removing the tube entirely. Removal of this tube is not given unqualified recommendation by the author nor by the manufacturer, although it has been found to help in severe cases.

OLYMPIC MODEL 14TD52 WITH CHASSIS AD

One of the features that becomes apparent upon first examination of the Olympic Model 14TD52 is its small size and light weight. The receiver is not of a style that could be hung on the wall, but its design is a step in that direction. The manufacturer has developed a chassis that utilizes only 12 tubes in addition to a standard picture tube. The total number of operational stages has not been reduced; but in order to achieve such a compact electrical design, dual-purpose tubes are employed almost exclusively. A block diagram of the complete television receiver is shown in Fig. 2. This figure also presents a pictorial illustration of the dual-purpose tubes and their applications.

In Fig. 3, it may be noticed that there are no operating controls on the front of the cabinet; however, the conventional controls are accessible on the side of the cabinet. The protective glass is removable from the front of the cabinet to facilitate cleaning of the picture-tube face. The operating controls which are located on the side of the cabinet are: the vertical-hold control, horizontal-hold control, brightness control, contrast control, volume control and on-off switch, channel-selector switch, and the fine-tuning control. All of those just mentioned, except the channel-selector switch and the fine-tuning control, are mounted on a separate strip which is isolated from

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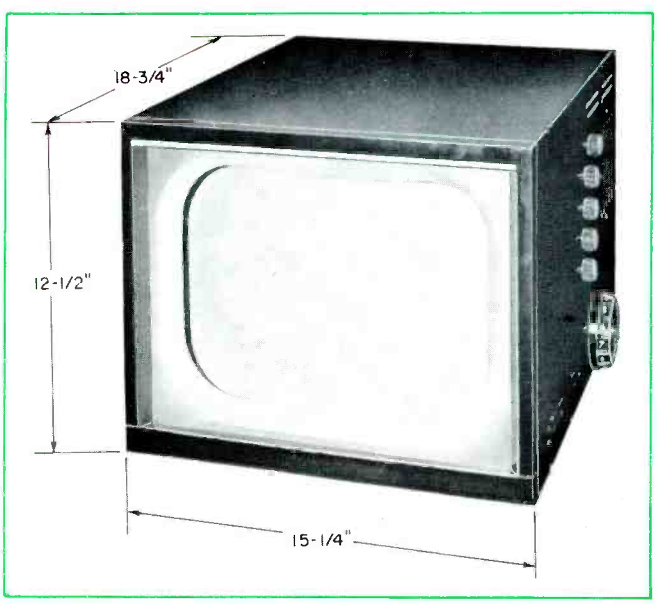

Fig. 3. Olympic Model 14TD52 Television Receiver.

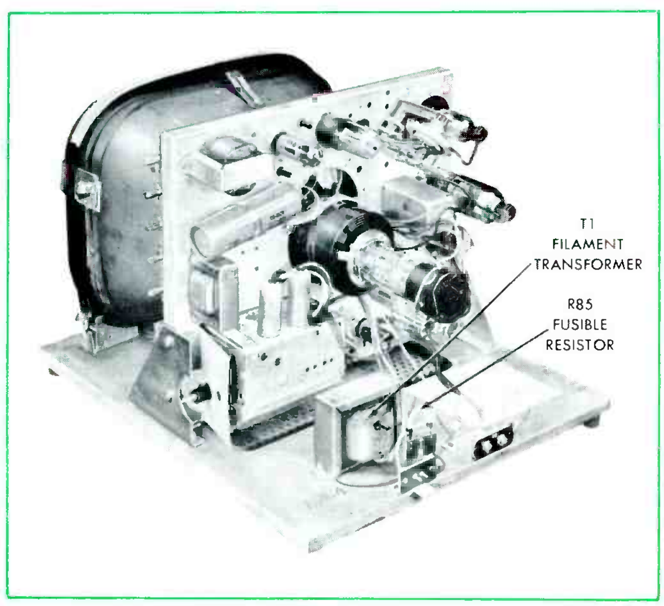

Fig. 4. Olympic Chassis AD.

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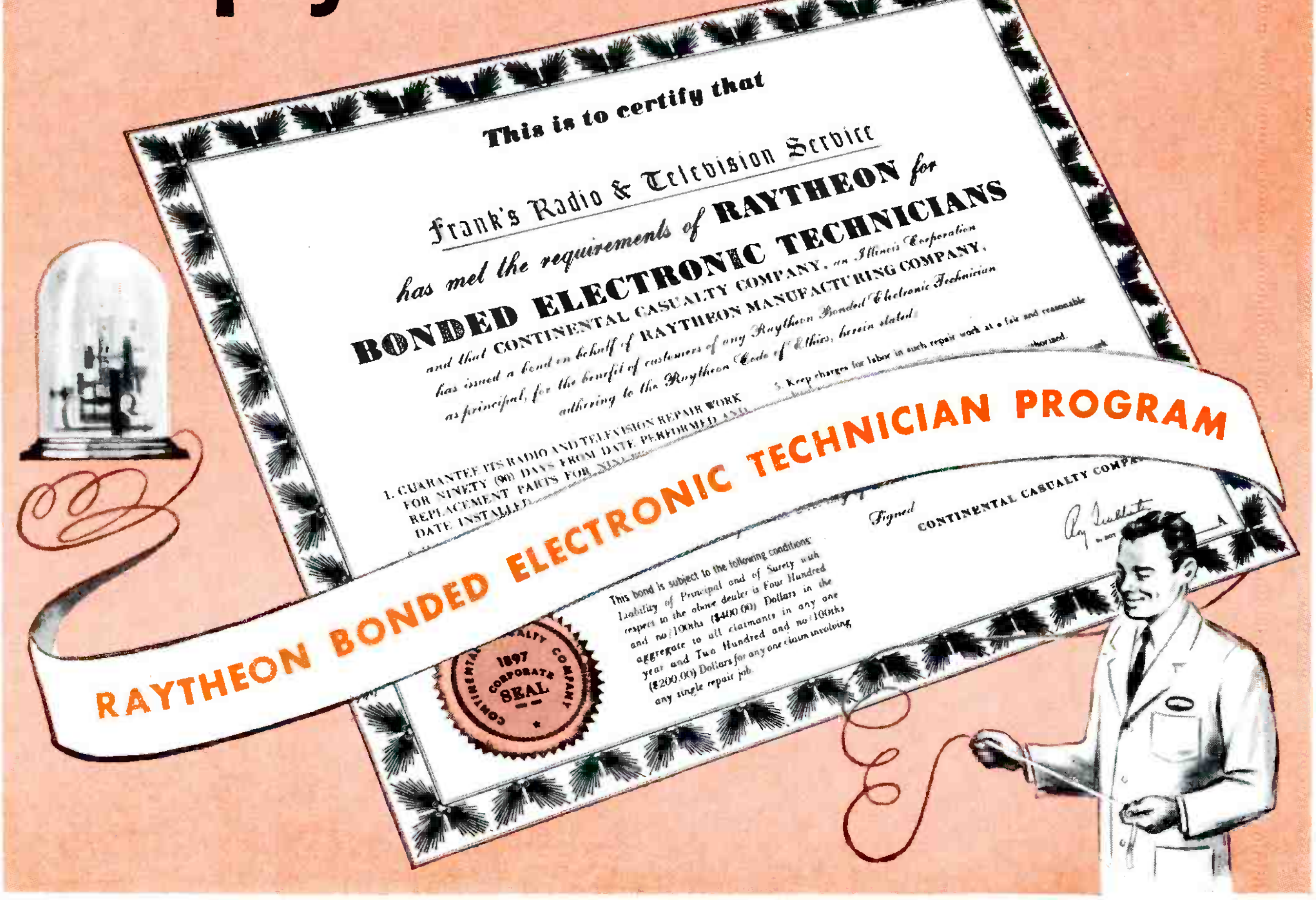

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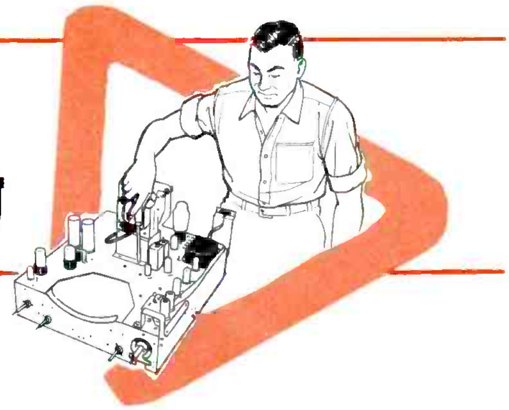


by **Henry A. Carter** *and* **Calvin C. Young, Jr.**

IN THE SHOP

Frequency Drift in AM Radios

Frequency drift in AM radios has always created a somewhat difficult service problem. The prevalence of this problem seems to have lessened to some degree in more recent years. This could be a result of several factors such as better tube designs, better tube materials, and better materials used in other components. Nevertheless, the problem still exists to some extent.

Many technicians have probably worked on radios that have had frequency drift. Often, the trouble can be cured by the simple replacement of a tube. Occasionally, tube substitution is not a remedy and other service procedures are needed.

Before we go further, let us clear up one important point. A detuning effect in an AM radio may not always be caused by a drift in the frequency of the local oscillator, although the oscillator is the most common offender. Sometimes a detuning effect may be produced by a shift in the frequency response of an IF stage. For example, the electrical characteristics of an IF transformer may change under the influence of heat; and the resonant frequency of the transformer may vary as a result.

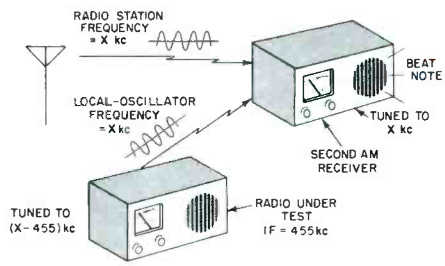


Fig. 1. Setup for Checking Oscillator Drift by Means of Second AM Receiver.

When confronted with a gradual frequency drift, the technician can save time by employing the following test to isolate the source of trouble to either the oscillator stage or the IF stages. A second AM radio is used in this test, and the method can be deduced from a study of the drawing in Fig. 1.

The two radios are placed side by side. The second AM radio is tuned to a station which is operating at a certain frequency, let us say at X kilocycles. It is preferable to select a station near the high frequency end of the broadcast band. Tune the radio under test to a frequency which is less than X kilocycles by an amount equal to the intermediate frequency in this same radio. When this is done, the local oscillator in the defective radio should be operating at a frequency of X kilocycles, because most local oscillators operate at frequencies above that of the incoming signal. The signal from the local oscillator in the defective radio will radiate and will be picked up by the second radio. There, it will mix with the signal from the radio station, and a beat note will be heard from the second radio. Tune the radio under test until a condition of zero beat is obtained. If a beat note reoccurs and increases in frequency after continued operation of both radios, a drift in the frequency of the local oscillator in the defective radio is positively indicated.

It is true that a slight drift may be considered normal; but if the drift is such that the beat note attains a frequency of four or five kilocycles after ten or fifteen minutes of operation, trouble is present in the oscillator. If the beat note from the second radio remains close to a condition of zero beat during this test, the IF stages in the defective radio should be suspected as being responsible for the detuning effect.

It is not necessary to disassemble the defective radio in order to make this test; however, if the chassis is already out of the cabinet, a hair dryer may be used to accelerate the heating in order to shorten the time needed for the radio to reach full operating temperature. Fig. 2 shows the hair dryer being used for this purpose. A heat lamp may be used in place of the hair dryer; but the advantage of using a dryer is that a warm stream of air can be directed at a particular component such as an oscillator coil.

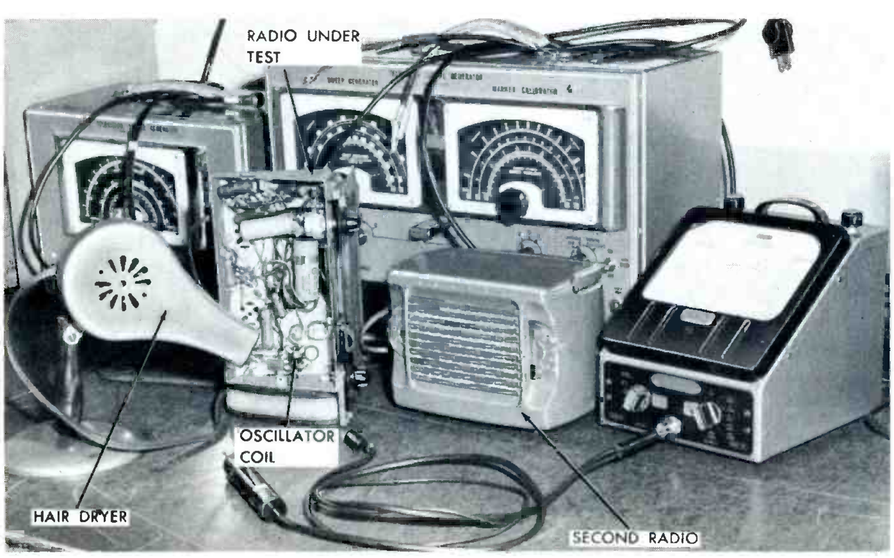


Fig. 2. Hair Dryer Being Used to Accelerate the Warm-up Time.

* * Please turn to page 69 * *

Audio-Facts

CONSTRUCTION DETAILS ABOUT A PREAMPLIFIER OF IMPROVED DESIGN

by ROBERT B. DUNHAM

The preamplifier and control unit described in the "Audio Facts" column in the July-August 1952 issue of the PF INDEX and the original unit from which it was developed have been in constant use in our laboratory since they were constructed. They have given very consistent and satisfactory service with many different audio systems under widely differing conditions. In fact, we gain more respect for these useful pieces of equipment the more we use them in our increasing audio activities.

Three years are a long time in these days of rapid development in high quality audio systems; therefore, in order to keep up with progress, some changes and improvements have been made in both units. Taking a cue from the number of inquiries and comments which we continue to receive concerning the preamplifier and control unit, we feel that it would be worth while to supply some information about these improvements and some detailed data for those who would like to construct a unit.

A view of the preamplifier and control unit fitted with a perforated metal cover can be seen in the heading of this article. The general construction and features of the unit can be seen in Figs. 1 and 2. Enough switches, controls, and inputs are provided to permit flexibility of operation; but not enough are provided to complicate the situation and make operation difficult rather than convenient.

The circuit of the complete unit, shown in Fig. 3, is made up of individual circuits that are mostly conventional and familiar. These individual circuits are effective and are worthy of some discussion before construction details are discussed.

Circuit Description

Any one of the three inputs can be switched into the circuit by the channel-selector switch. Input No. 1 is for use with magnetic phono pickups. Inputs No. 2 and No. 3 have the same characteristics. They are uncompensated and are intended for use with high-output devices such as tuners, TV receivers, crystal phono pickups, and tape recorders.

Input No. 1 connects directly to the grid (pin No. 7) of V1 which is a

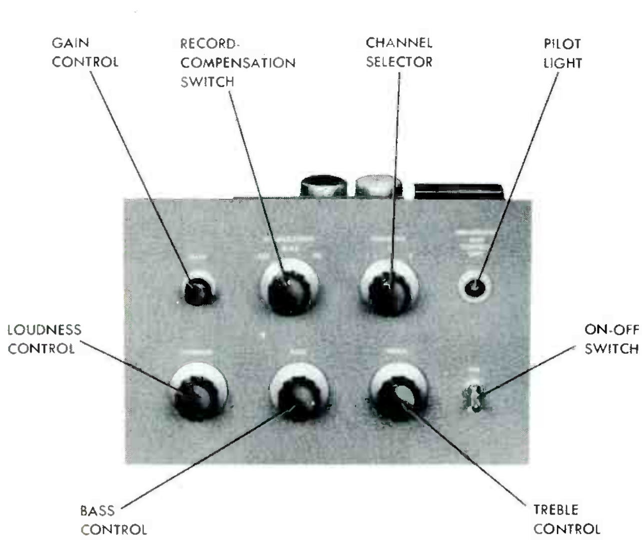


Fig. 1. Front View of Preamplifier and Control Unit.

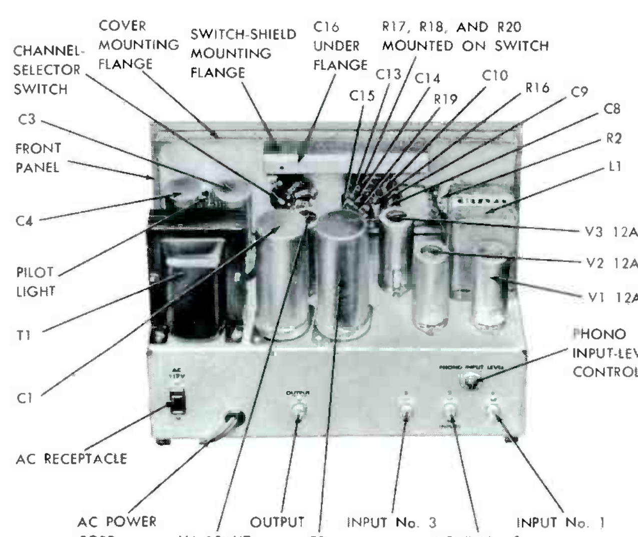


Fig. 2. Rear View of Preamplifier and Control Unit.

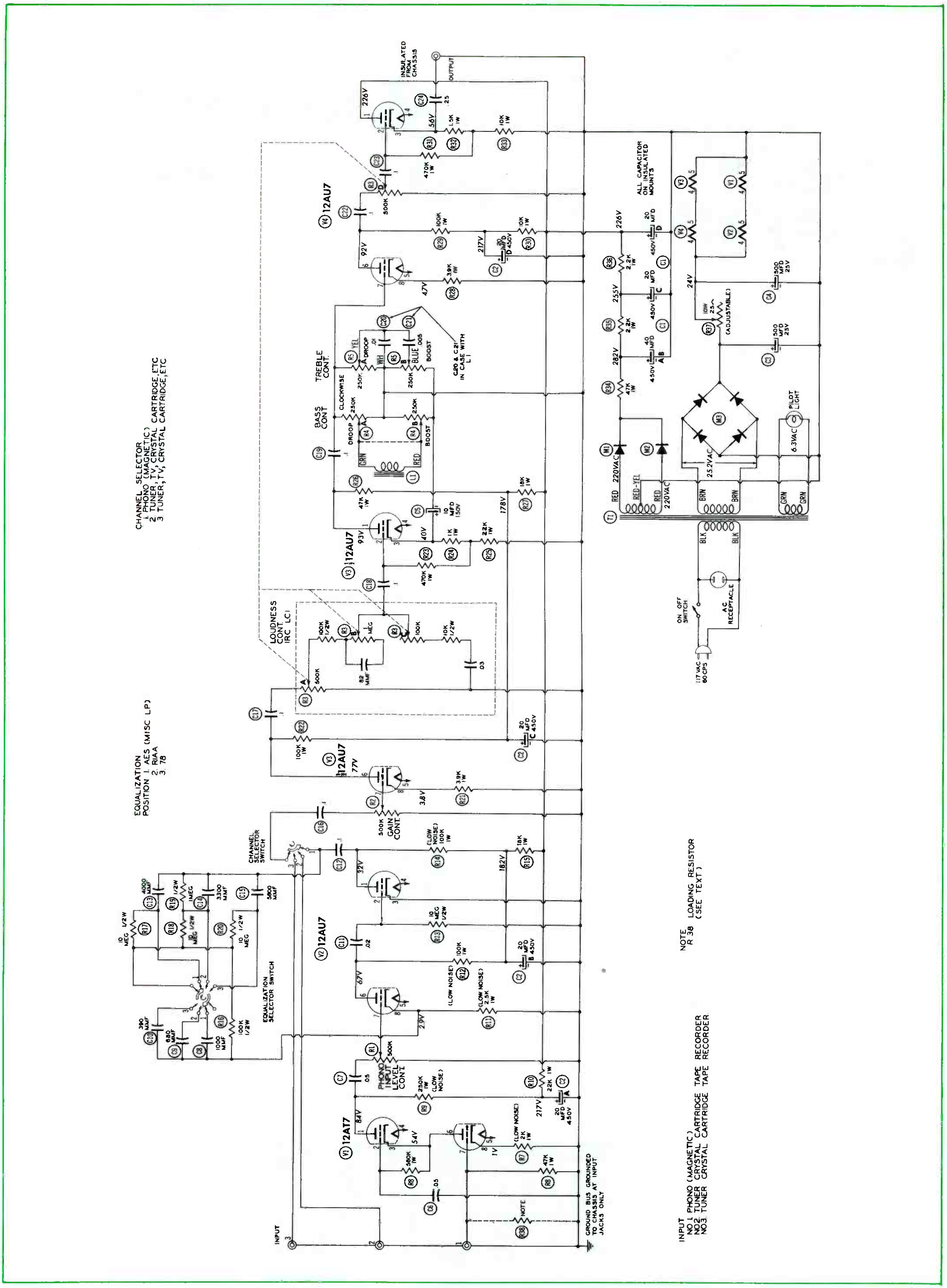
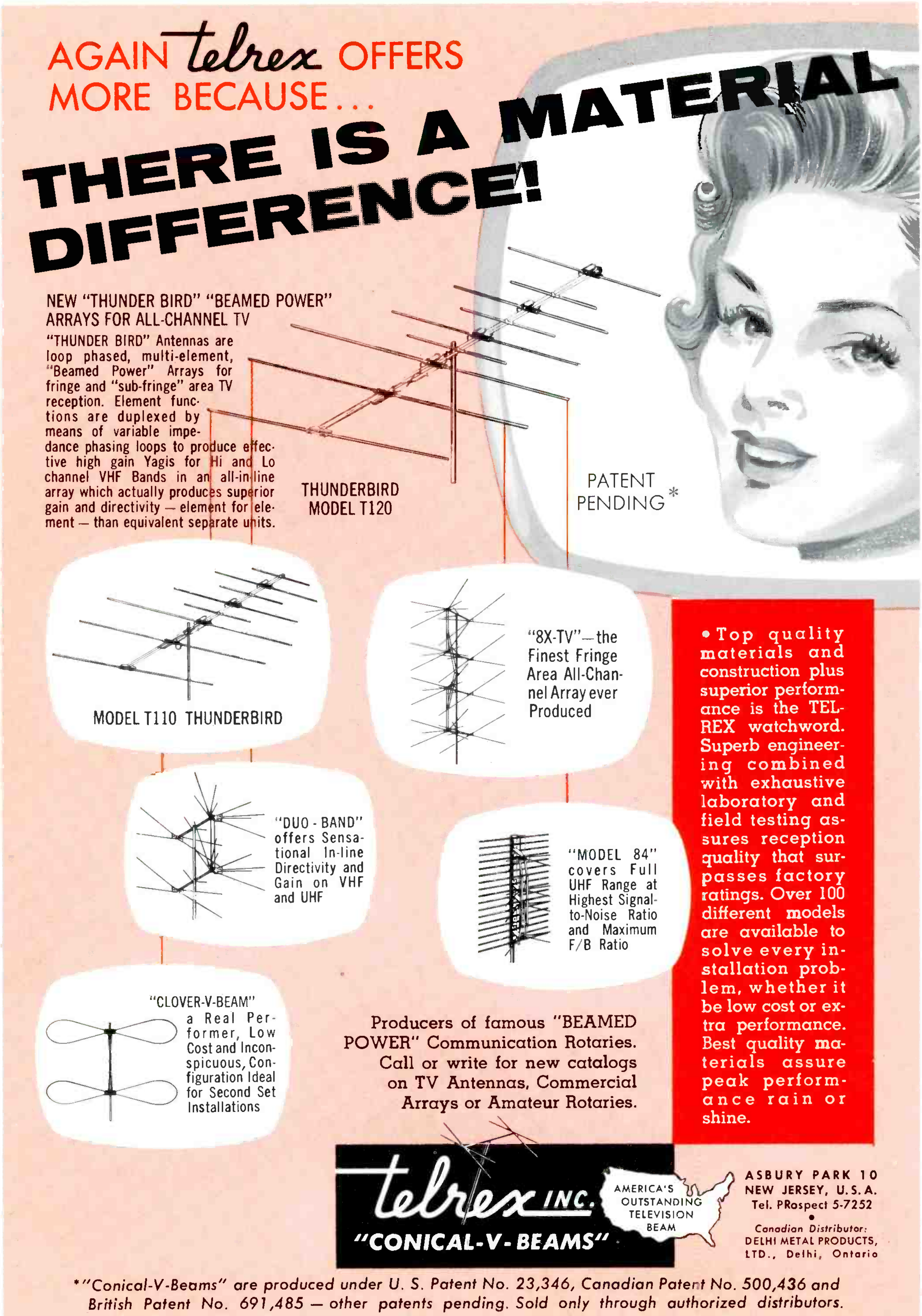


Fig. 3. Schematic Diagram of Preamplifier and Control Unit.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12AT7 tube operating as a cascode amplifier. The cascode circuit is used because of its high gain, low noise, very high input impedance, and low input capacitance. These characteristics make it a logical input circuit for magnetic pickups because these normally have very low signal outputs and low output impedances. This application of the cascode circuit was discussed in more detail in "Audio Facts" in the April 1955 issue of the PF REPORTER.

R38 (which is shown by dotted lines in Fig. 3) is a loading resistor that is not needed in most cases but can be used if the high-frequency response of the pickup is excessive and if it must be rolled off. The resistance value of R38 can be the value recommended by the manufacturer of the magnetic cartridge being used. One of the best methods is to try different values until the best balance in response is obtained. For instance, it was found that a 27K-ohm, 1-watt resistor R38 reduced the high-frequency response by the correct amount when a General Electric RPX-050 cartridge was used. R38 was not used at all with a Fairchild Model 220 cartridge. R38 can be installed either inside the chassis or in some convenient location on or close to the cartridge.

The phono input-level control R1 can be adjusted to provide a satisfactory operating level for any of the usual magnetic cartridges. Compensation for the characteristics of magnetic pickups and for record-playback curves is accomplished by the adjustable feed-back circuit which feeds back from the plate (pin No. 1) of V2 through C12 to the cathode (pin No. 8) of V2. Appropriate capacitors and resistors are switched into the feed-back circuit by the equalization-selector switch to provide bass boost and high-frequency roll-off according to three different playback curves.

Position No. 1, labeled AES (Audio Engineering Society), provides equalization based on a modification of the older AES curve and is suitable for use with many of the older microgroove recordings. Position No. 2 follows the RIAA (Record Industry Association of America) curve, now considered the standard playback curve. This position is suitable for most recent microgroove recordings. Incidentally, the new AES, orthophonic, and NARTB (National Association of Radio and Television Broadcasters) curves are identical and are the same as the RIAA curve. Position No. 3 is a compromise and is intended to be used in playing 78-rpm records.

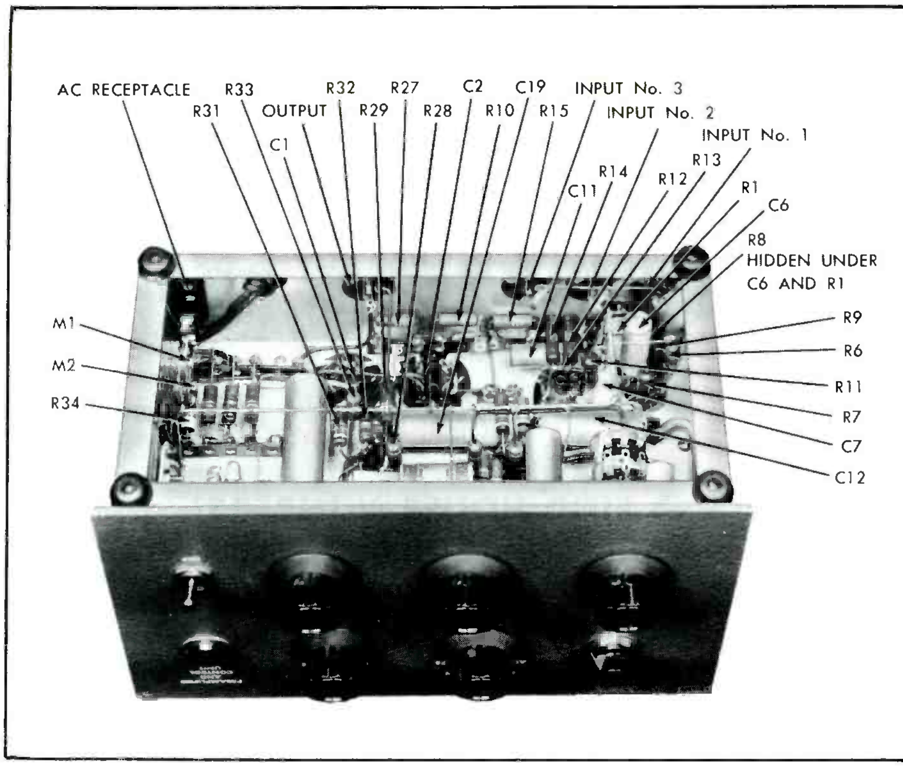

Fig. 4. Bottom View From Panel Side.

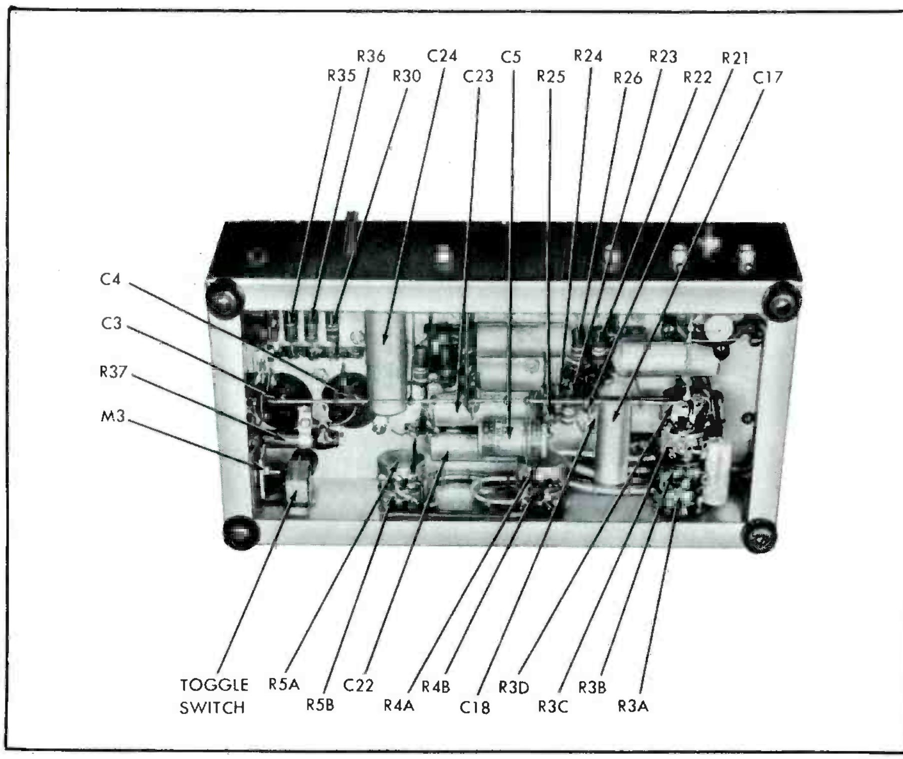

Fig. 5. Bottom View Showing Parts Located in Front Part of Chassis.

Any of these playback curves can be modified for best results by adjusting the treble and bass controls. It must be remembered that it is difficult to follow any particular recording curve when a recording is made and that conditions also make it difficult to play back a record according to a certain curve. Consequently, tone controls are useful for touching up the playback response in order to obtain the desired results.

The gain control R2, which operates on all input channels, is mounted on the front panel in a position convenient for setting the level of the signal fed to the loudness con-

* * Please turn to page 50 * *

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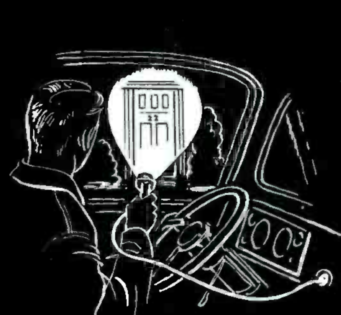

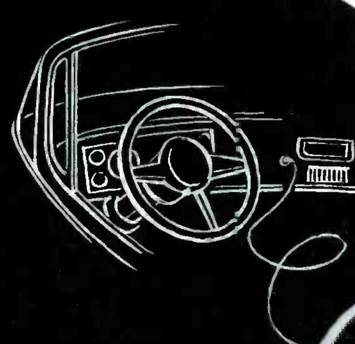

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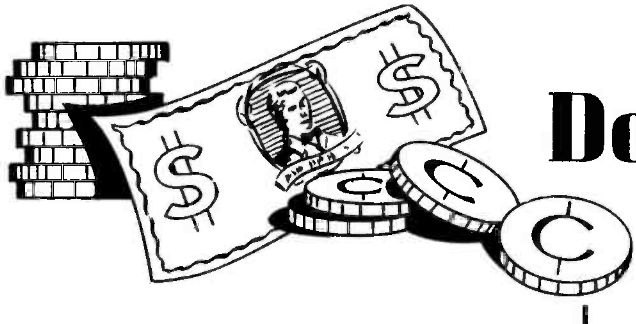

Dollar and Sense Servicing

by John Markus

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

MOOD MUSIC. For a "pick-me-up" on those mornings when you feel like biting somebody's head off, slip some of the following records (if you are fortunate enough to have them) on the phonograph while you're shaving, showering, and dressing:

Stars and Stripes Forever — Decca 2132-A

Grand March from Aida — Victor 11885-A

Humoresque — Victor 1170-B

Golden Age Ballet Suite-Polka — Victor 11-8239-B

Blue Danube Waltz — Victor 16658-A

Golliwog's Cake Walk — Victrola 7148-A

For the end of the day, if you're restless, jittery, all keyed up after a tough struggle with circuits and customers, pick your musical prescription from one of these relaxing, nostalgic, sentimental, and soothing selections:

Rhapsody in Blue — Victor 13835-B

Liebestraum No. 3 — Victor 11-8851-B

Lullaby (Brahms) — Victor 20174-A

Waltz of the Flowers — Columbia MM-395

For more musical prescriptions, particularly classical, see the article, "Music Can Make Your Mood," in the April 1955 issue of Tape Recording. It reports the research of Dr. A. Capurso, Director of Music at Syracuse University, on music therapy and gives his tested selections in four categories: (1) stimulating, (2) relaxing, (3) prayerful, and (4) sad. Listen before you buy, however; some selections may revive memories in an individual and cancel out the intended effect. When you get the pieces that make you feel on top of the world, put them on tape and let them chase away the grouches. The resulting increased efficiency of your work all through the day will pay for the records many times over and make your job a lot more pleasant.

ANTICIPATION. "My wife gave me heck at breakfast. I can hardly wait to get down to the shop and take it out on the first customer," said one shop owner to a friend as they headed for Main Street together one morning, according to a recent cartoon.

With that sort of a start, along about five o'clock that same shop owner will probably be thinking, "Business sure was lousy today — can hardly wait to get home and take it out on the family at dinner." And that's why family life just has to be kept separate from business if both are to succeed.

LOSS PREVENTION. To give your service bench a real treat on its birthday, get it one of those heavy metal Scotch-tape dispensers that take rolls of tape 3/4 inch wide. Once you've had it for a week, you'll wonder how you got along without it — for sticking loose nuts, bolts, and knobs to a chassis; for attaching cards to a chassis; and for a hundred other simple jobs. Just preventing the loss of one unreplaceable bit of hardware justifies the outlay. Most stationery stores have them. They are priced around $3, and a roll of tape comes to about $1.20.

LEVELING OUT TV. Whenever production of TV sets gets too far ahead of sales, there is much moaning at the factory and much dumping in the stores, with everybody unhappy and losing money except the customer who gets a price break. When production gets caught napping and lags behind the demand, everybody is unhappy again — the customer is included this time, because he can't get the set he wants when he wants it.

To have a try at leveling out TV production, a survey company has been hired by RETMA to send out interviewers to selected retail stores once a month. These men come back with figures on actual inventory count and sales for radio and TV by type of set. By the 25th of the month, manufacturers who belong to this industry-wide association receive a 50-page booklet with detailed statistics on what moved and what didn't the prior month. The complex process of revising factory production schedules can thus get underway at least two months sooner than it did before, with a minimum of waste and confusion.

INTERFERENCE. In Canada, the law prohibits use of any apparatus which causes interference with the reception of a good radio signal (over 500 microvolts per meter), provided that the interference can be stopped by the manufacturer of the apparatus at a cost under $50. When a complaint is received, the government sends one of its 50 mobile units to investigate and recommend suppression techniques. Of the 12,000 complaints received yearly, there are very few cases in which the interference cannot be eliminated economically. The manufacturer bears most or all of the cost of eliminating the trouble, and dealers maintain a stock of suppression kits.

* * Please turn to page 46 * *


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Color TV Training Series

(Continued from page 11)

Misalignment of the color-sync section is characterized by a number of indications in the reproduced picture. Such troubles as wrong colors, colors out of synchronization (a barber-pole effect), and no color can result from improper alignment of this section of the receiver. The photographs in Figs. C-3 and C-4 of the Color Plate show the appearance on the screen when wrong colors are being reproduced as a result of misalignment of a portion of the color-sync circuit. To reproduce this effect, the burst-amplifier transformer L41 was misadjusted.

Notice by comparing the photograph of Fig. C-3 of the Color Plate with the normal bar pattern of Fig. C-1 that a definite pattern of colors has resulted. The sequence of color bars in Fig. C-3 is cyan, green, brown, red, blue, and violet instead of green, yellow, red, magenta, cyan, and blue, as shown in the normal pattern of Fig. C-1. It should be remembered that the relative luminance levels of the color bars remain the same as they are in a normal bar pattern — namely, 0.59 for green, 0.89 for yellow, 0.30 for red, 0.41 for magenta, 0.70 for cyan, and 0.11 for blue. As shown in Fig. C-3, the color of a bar can change but the luminance level does not. The technician should be mindful of this condition when analyzing a color-bar pattern. For instance, the third bar of Fig. C-3 has changed from red to brown. Actually, this bar is yellow, but it is at a low level of luminance which causes it to appear brown. The luminance level of the third bar is 30 per cent; but if the luminance level were 89 per cent, a yellow bar would be present instead of a brown bar.

Let us look at the fourth bar to analyze the condition shown in Fig. C-3 of the Color Plate and to see what has happened. In the normal bar pattern, this bar is magenta; but in Fig. C-3, it is red. Referring to the color-phase diagram of Fig. 11-5, we can see that the vector representing magenta is spaced 119.9 degrees from the reference vector and that the vector representing red is spaced 76.5 degrees from the reference vector. If the phase difference between the color vector and the reference vector were decreased, the reproduced color would change from magenta to red. This condition is indicated by the bar pattern in Fig. C-3 of the Color Plate. Because of the decreased phase difference, the receiver interprets the chrominance signal as being representative of red.

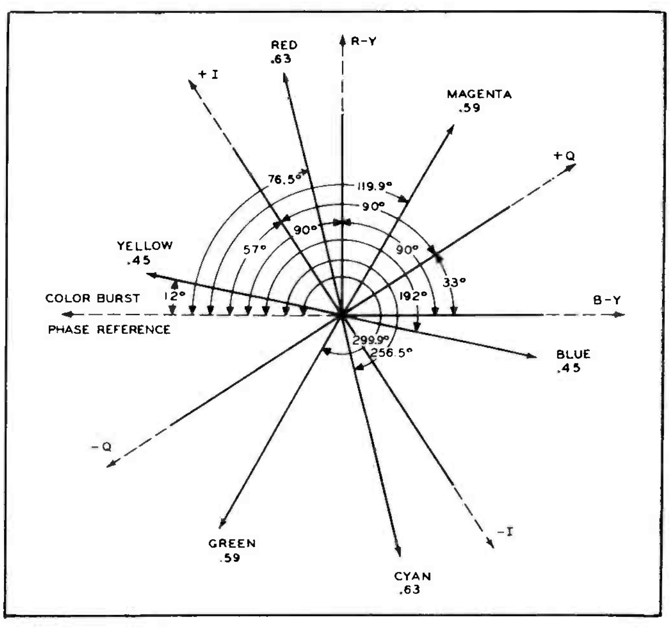

Fig. 11-5. Color-Phase Diagram.

In Fig. C-3 of the Color Plate, the last bar which is normally blue has become a violet color. This result can be explained in the same manner. With a reduction in the phase difference between the chrominance vector and the reference vector, the receiver erroneously interprets the blue signal as being representative of a color which is near magenta. The wrong colors of the other bars are also caused by a reduction in the phase differences between the chrominance vectors and the reference vector.

The change in color of the Q and I bars can be noticed by comparing the photograph of Fig. C-4 with that of Fig. C-2 of the Color Plate.

Loss of color synchronization will produce the effect shown in Fig. C-5 of the Color Plate. This trouble is characterized by horizontal bands of color moving diagonally and vertically. This indicates that the 3.58-mc oscillator is operating at the wrong frequency. When the horizontal bars are few in number, it signifies that the oscillator is operating at a frequency that is only slightly off. As the diagonal bars increase in number, the frequency of the oscillator is farther from 3.58 megacycles. This condition can be caused by the misadjustment of a variable component in the color-sync section. To obtain the results shown in Fig. C-5, the reactance coil L43 was detuned.

As was mentioned previously, a condition in which there is no color may be caused by misalignment of the color-sync section. For instance, if the 3.58-mc oscillator coil L44 were badly detuned, loss of color would result. With L44 badly detuned, there would be no output signal from the 3.58-mc oscillator; therefore, the color demodulators would not receive the CW reference signals which they require in order to detect the color-difference signals.

All of the abnormal conditions just discussed can also be caused by failure of components in the color-sync circuit. If any of these troubles occur and if it has been determined that component failure is not present, the alignment of the circuit is necessary.

A VTVM and a color signal from a color-bar generator or from a station telecasting in color are employed throughout the alignment procedure associated with the color-sync section. The color signal is fed to the antenna terminals, and the VTVM is connected across the output of the CW reference oscillator. First, the 3.58-mc oscillator coil L44 is tuned to produce a reading of five volts peak to peak on the VTVM. When this is done, the output of the oscillator will have sufficient amplitude.

Next, the quadrature transformer L45 is adjusted so that there is maximum transfer of energy from the quadrature amplifier to the color demodulators. The nature of the transformer and its associated circuit is such that a certain phase difference exists between the CW signal fed to one demodulator and that fed to the other demodulator after the quadrature transformer is adjusted. In the case of the circuit in Fig. 11-4, this phase difference is 90 degrees.

There are two adjustment points in the quadrature transformer. They are labeled A36 and A37. Before making the adjustments at these points, the color burst is removed from the color-sync circuit by shorting the grid of the burst amplifier V27A to the chassis. The VTVM is connected from the plate of the phase detector V28B to the chassis; then, adjustments are made at A36 for a

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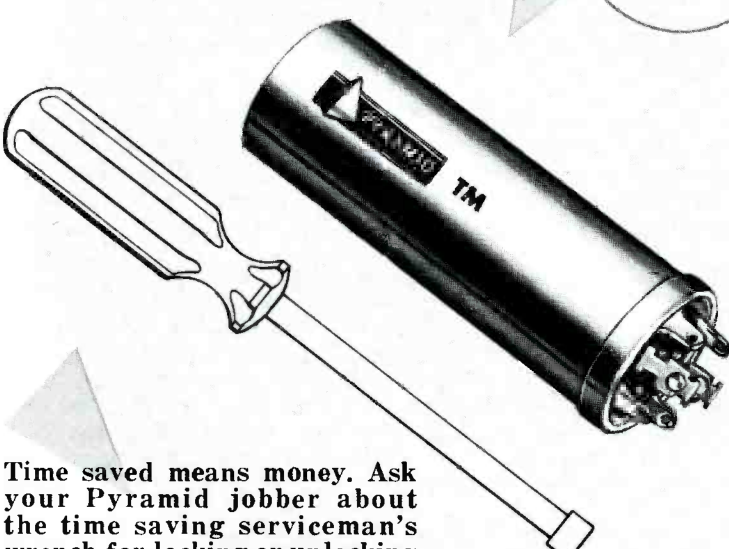

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maximum DC voltage indication on the VTVM and at A37 for a minimum indication. Reference to the schematic diagram in Fig. 11-4 will show that the phase detector V28B acts as a simple detecting device during this test. In other words, a DC voltage that is proportional to the amount of 3.58-mc signal present in one secondary of the quadrature transformer is developed across the VTVM because of the action of the phase detector.

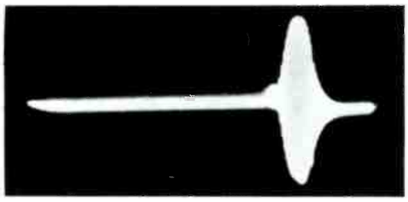


Fig. 11-6. Waveform of Burst Signal at Phase Detector in Fig. 11-4.

Adjustments at the next two points, A38 and A39, are performed in order that the color burst will be at the correct phase and amplitude when it arrives at the phase detectors. For these adjustments, the short between the grid of the burst amplifier V27A and ground is removed but the VTVM is left connected to the plate of the phase detector V28B. The hue control should be set at its mid-range position. Then, adjustment is made at A38 and A39 for maximum deflection on the VTVM. The VTVM in this case indicates a DC voltage that is proportional to the amplitude of the color-burst signal in the phase-detector circuit. As a further check, the color burst can be viewed on an oscilloscope by connecting the oscilloscope between the plate of the phase detector V28B and ground. The color burst should appear as shown in Fig. 11-6.

The next step is to make sure that the oscillator is operating at the correct frequency. This is done by adjusting the coil L43 in the plate circuit of the oscillator-control tube V29A. First, the input signal to the control tube is shorted to the chassis at point M. The VTVM is still connected to the plate of the phase detector V28B. Then, L43 is adjusted so that a zero beat between the color burst and the CW reference signal occurs in the phase-detector circuit. This zero beat will be indicated by a slow oscillatory swing of the VTVM pointer. The beat can also be detected on the picture-tube screen — the colors on the screen will change slowly rather than rapidly when the condition of zero beat is present.

With the oscillator operating at the correct frequency, the next adjustment is to balance the phase-detector circuit. This is done by adjusting the AFC balance control R20 so that the proper grid voltage will be applied to the oscillator-control tube V29A. This tube performs most efficiently when its grid voltage under normal conditions is slightly positive. To adjust the balance control, connect the VTVM between point M and ground. Shunt the 3.58-mc crystal with a 15-mmfd capacitor so that the oscillator frequency will be lower than normal. Then, adjust the balance control R20 until the VTVM reads zero volts. Remove the 15-mmfd capacitor. The oscillator will speed up, and the phase detector will interpret the frequency change as an advance in phase. A positive correction voltage will be developed and applied to the oscillator-control tube, and the oscillator signal will be maintained in a fixed phase relationship with the color burst.

The adjustment of the AFC balance control completes the alignment of the color-sync section of the color receiver. The CW reference signals should have the same frequency as the color burst and should also have fixed phase relationships with the color burst.

MATRIX

At the output of the I channel, there must appear a demodulated signal that is representative of only the I portion of the chrominance signal. The output of the Q channel must be a demodulated signal that is representative of only the Q portion of the chrominance signal. The signals at the outputs of the I and Q channels must also have the correct amplitudes. If the foregoing were not true, incorrect signals representative of red, green, and blue would be formed when the incorrect I and Q signals are combined with the luminance signal. The color signals will be correct when they arrive at the matrix if the necessary matrix adjustments are properly made.

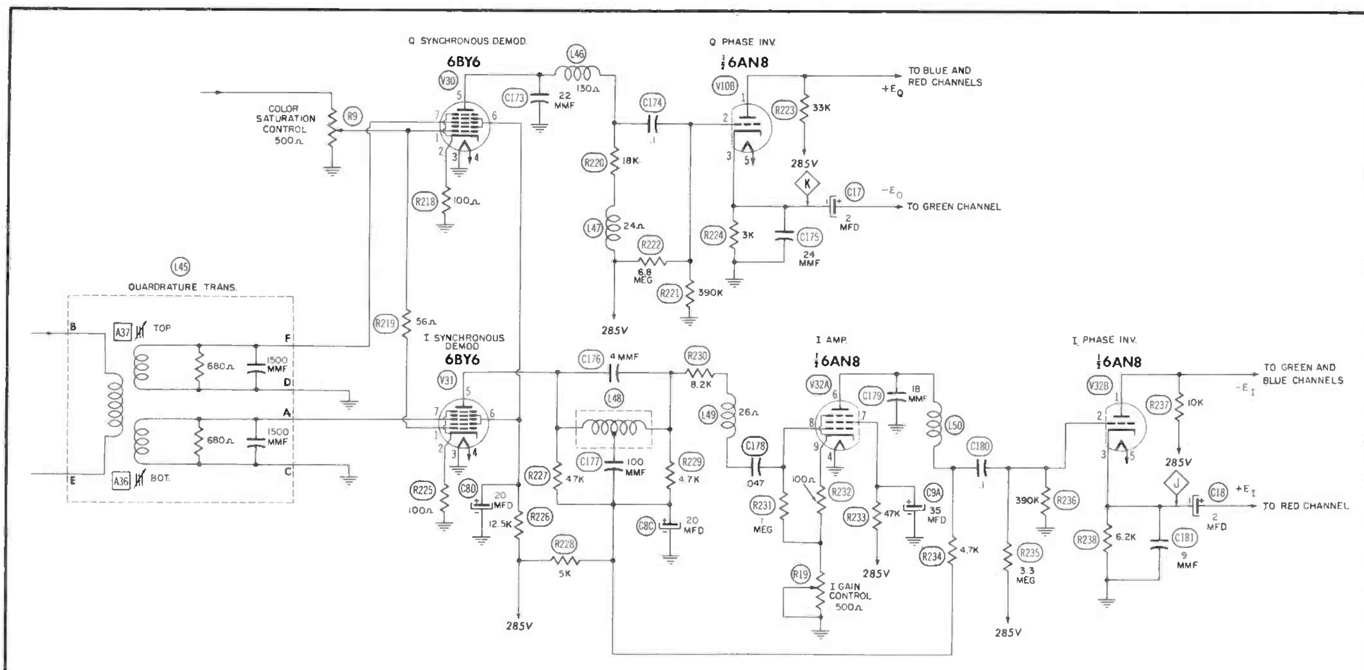
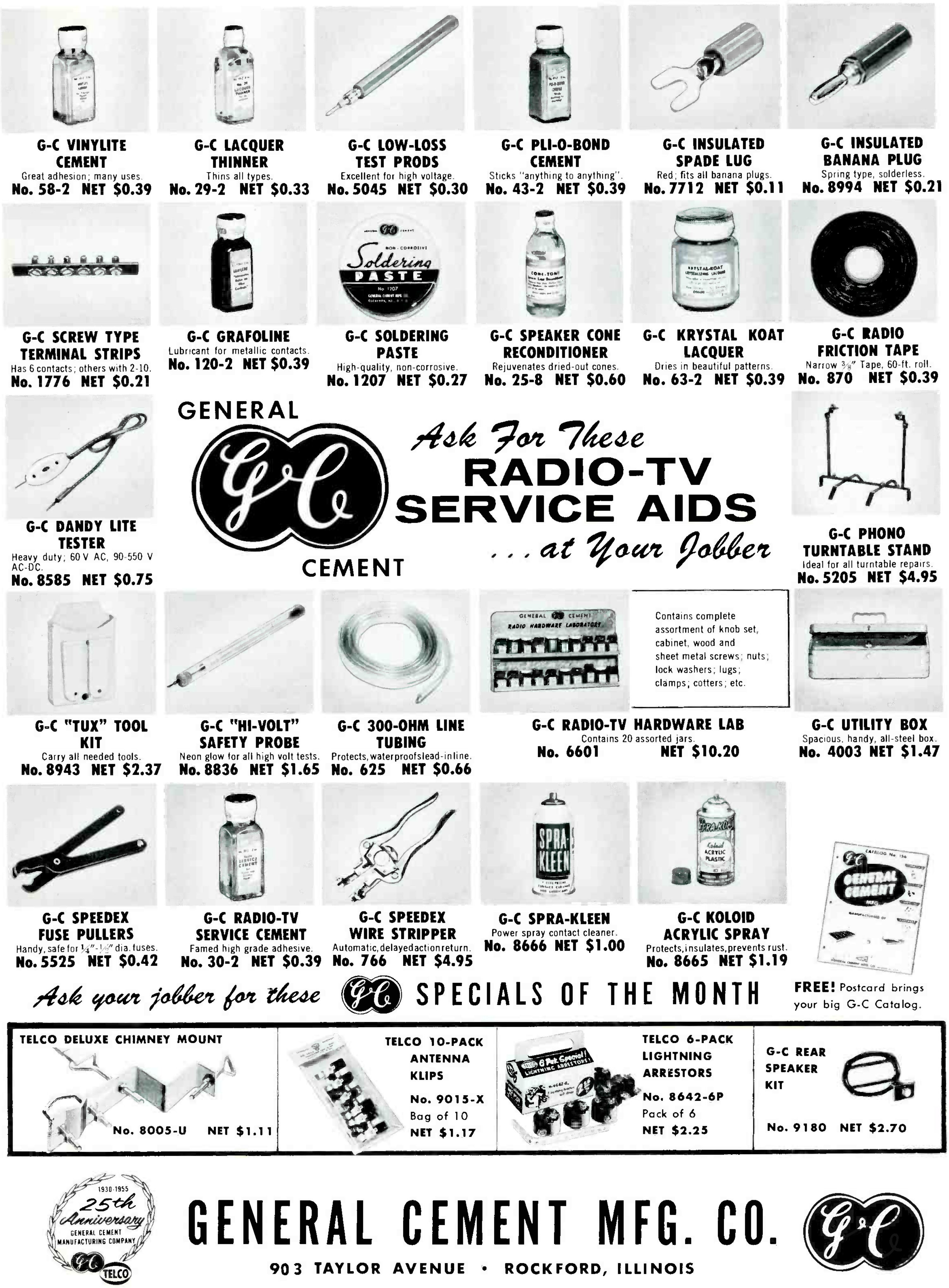


Fig. 11-7. The Circuitry of the I and Q Channels in the RCA Victor Model CT-100 Color Receiver.



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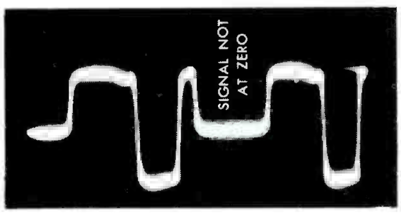
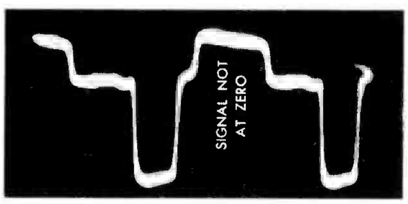
The adjustment points for obtaining proper matrixing are contained in the I and Q channels. The circuitry for the I and Q channels employed in the RCA Victor Model CT-100 color receiver is shown in Fig. 11-7. The quadrature transformer L45 is shown with this circuit because it will be referred to during the following discussion.

Let us investigate what would happen if an I portion of the chrominance signal were allowed to pass through the Q channel. First of all, assume that a chrominance signal that represents a Q bar and an I bar is fed to the input of the chrominance channel. With normal operation of the demodulators, the waveform at the output of the Q channel should appear as shown in Fig. 11-8A. This waveform was taken at the cathode of the Q phase inverter V10B. Notice that a negative voltage is developed during the transmission of the Q bar but that zero voltage is present during the transmission of the I bar. This is as it should be.

(A) With Proper Cancellation During Transmission of an I Bar.



(B) With Improper Cancellation During Transmission of an I Bar.

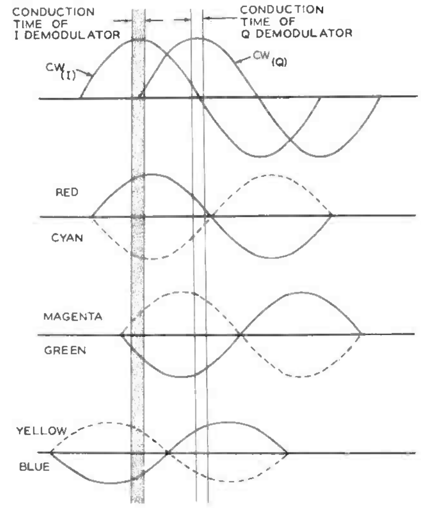


(C) With Improper Cancellation During Transmission of an I Bar.

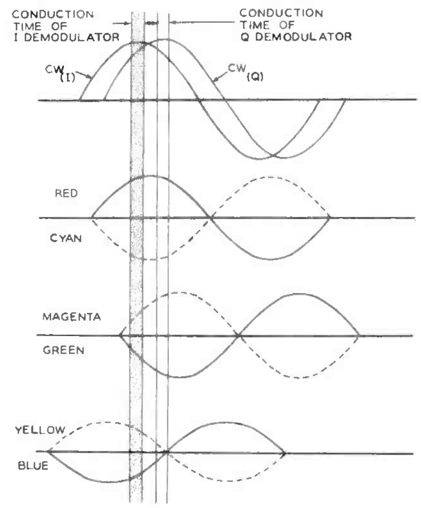
Fig. 11-8. Waveforms of Signals at the Cathode of the Q Phase Inverter.

If the Q demodulator were operating improperly, however, the signal at the cathode of the Q phase inverter could appear as shown in Figs. 11-8B or 11-8C. Fig. 11-8B indicates that there is negative voltage present during the time that the I bar is being transmitted. This means that the Q demodulator has erroneously interpreted an I portion of the chrominance signal as being a Q portion. Fig. 11-8C indicates that there is positive voltage present during the time that the I bar is being transmitted. Again, this shows that the demodulation in the Q channel is in error.

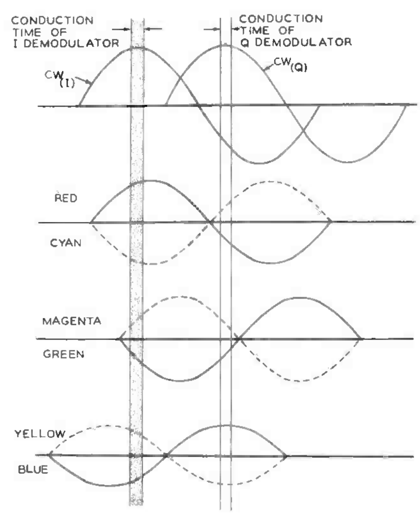
In the formation of the color picture signal, the I and Q portions of the chrominance signal are spaced 90 degrees apart in phase. In order that these portions may be demodulated separately, the CW reference signals which determine the sampling times of the demodulators must also have a phase difference of 90 degrees. Then, if a chrominance signal that represents only an I signal were to arrive at the input of the demodulators, it would be passing through zero during the sampling time of the Q demodulator. This would result in no output from the



(A) With Sampling Times Which Are Correct Because CW Reference Signals Are 90 Degrees Apart.

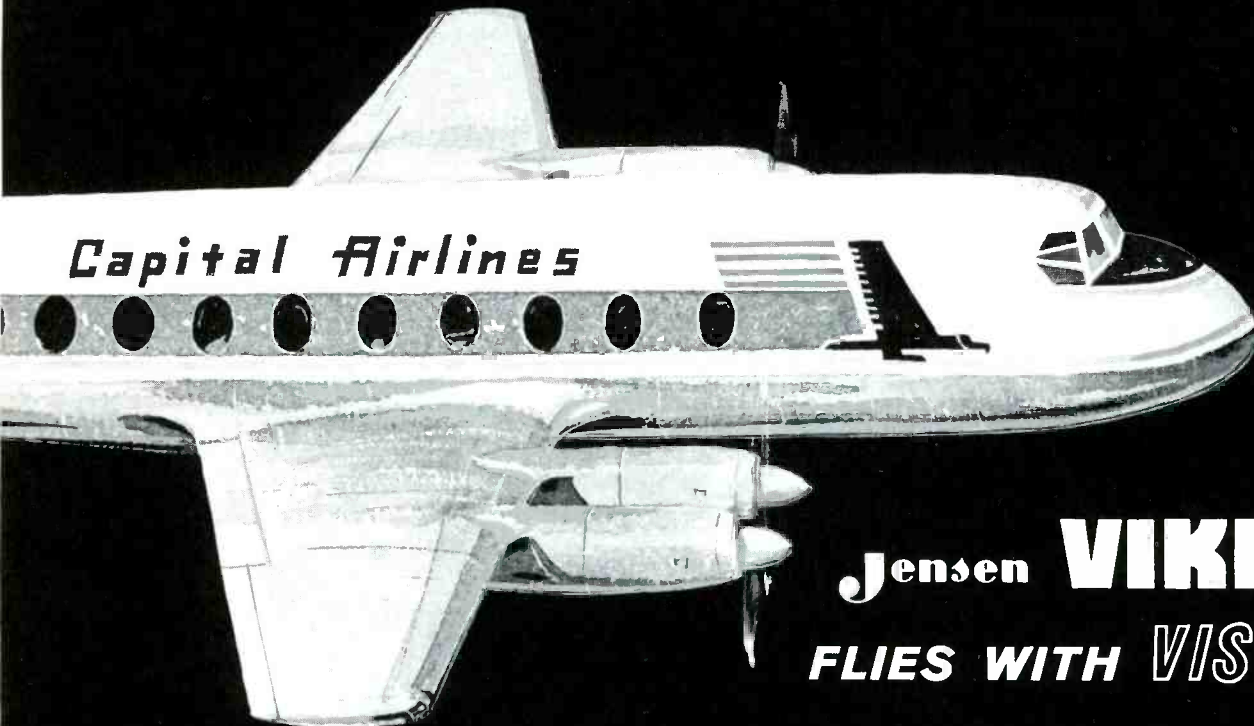


(B) With Sampling Times Which Are Incorrect Because CW Reference Signals Are Less Than 90 Degrees Apart.



(C) With Sampling Times Which Are Incorrect Because CW Reference Signals Are More Than 90 Degrees Apart.

Fig. 11-9. Waveforms of Chrominance and CW Reference Signals at Input of Demodulators. Sampling Times of Each Demodulator Are Indicated.



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Q demodulator. If the CW reference signals were either less than or more than 90 degrees apart, however, this same chrominance signal would not be passing through zero during the sampling time of the Q demodulator; therefore, the chrominance signal would be misinterpreted by the Q demodulator as having a Q portion.

When a color-bar pattern is being received, the bars will not have the correct hues if the Q demodulator samples the chrominance signal at the wrong time. The I portion in the chrominance signal will develop voltages in the Q channel, and the amplitude of the demodulated Q signal will not be correct.

The reader will recall that the three signals which drive the three guns in the color picture tube are reproduced in the receiver by combining specific proportions of the outputs from the I and Q channels with specific proportions of the luminance signal. During the transmission of a red bar, for example, the voltages which arrive at the matrix from the I, Q, and Y channels are such that the proportions available for the green gun add to zero. The proportions for the blue gun also add to zero. The proportions available to the red gun, however, combine to produce a voltage which drives this gun to conduction; and a red bar is produced on the screen.

If the voltage from the Q channel is either decreased or increased, the bar which is supposed to be red will not be a true red but will be closer to either a yellow or a magenta. This is caused by the fact that the proportions available to either the blue or green guns no longer add to zero; hence, one or both of these guns conduct, and the hue of the bar changes.

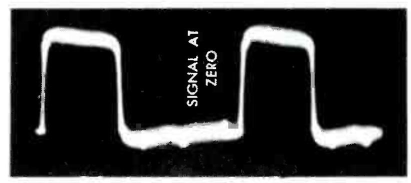
The illustrations in Figs. 11-9A to 9C show the waveforms of various chrominance signals, and the conduction times of the I and Q demodulators are indicated with respect to these waveforms. The waveforms of the CW reference signals are also shown in these figures. In Fig. 11-9A, the CW reference signals have a phase difference of 90 degrees. In this case, the chrominance signals are sampled at the correct phase. In Fig. 11-9B, the phase of the Q reference signal is changed so that there is less than 90 degrees of phase difference between it and the I reference signal. In Fig. 11-9C, there is more than 90 degrees of phase difference between the two CW reference signals. The sampling process of the I and Q demodulators can be understood from these illustrations.

The color-phase diagram of Fig. 11-5 can be very helpful in predicting what happens to each color when the CW reference signals are changed in their phase relationship to each other. When the Q reference signal is less than 90 degrees from the I reference signal, the Q vector is effectively rotated in a clockwise direction. The color vectors rotate in the same direction; therefore, the green bar would change toward a yellow color, the cyan bar toward a green, the blue bar toward a cyan, the magenta bar toward a blue, the red bar toward a magenta, and the yellow bar toward a red.

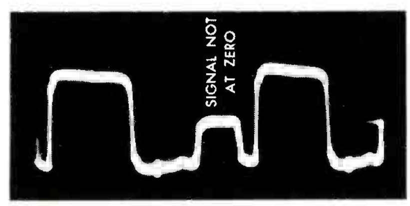
When the Q reference signal is more than 90 degrees from the I reference signal, the Q vector is effectively rotated in a counterclockwise direction. This causes the vectors which are representative of the primary and secondary colors to be rotated also in a counterclockwise direction. Under this condition, the green bar would change toward a cyan color, the cyan bar toward a blue, the blue bar toward a magenta, the magenta bar toward a red, the red bar toward a yellow, and the yellow bar toward a green. The amount of change in the color of each bar depends upon how far the Q reference signal is rotated in a clockwise direction.

Included on the Color Plate are color patterns which show the results obtained when the Q reference signal is less than 90 degrees from the I reference signal and when it is more than 90 degrees from the I reference signal. Fig. C-6 of the Color Plate shows the color-bar pattern which results when the Q reference signal is less than 90 degrees from the I reference signal. Fig. C-7 of the Color Plate shows the Q and I pattern for the same condition as that in Fig. C-6. Fig. C-8 of the Color Plate shows the color-bar pattern which results when the Q reference signal is more than 90 degrees from the I reference signal. The Q and I pattern for the same condition is shown in Fig. C-9 of the Color Plate. The change in phase of the Q reference signal was obtained by misadjusting the top slug of the quadrature transformer L45 which is shown in Fig. 11-7.

One method of making the necessary matrix adjustments in the circuit of Fig. 11-7 is through the use of a color-bar generator and an oscilloscope. The oscilloscope is connected to point J which is located at the cathode of the I phase inverter. With an I and Q signal from a color-bar generator applied to the receiver, the hue control is adjusted until there is zero output from the I channel during the scanning time of the Q bar. The waveform on the oscilloscope should appear as shown in Fig. 11-10A. If it appears as shown in Fig. 11-10B, the setting of the hue control is incorrect.

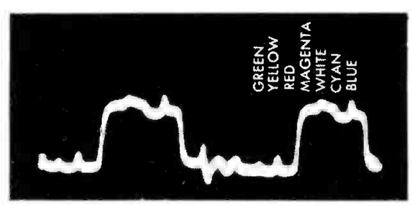


(A) With Proper Cancellation During Transmission of a Q Bar.

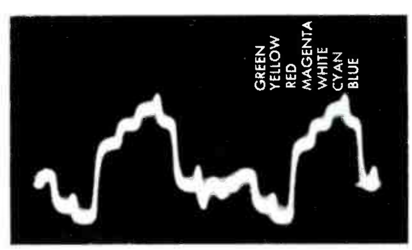


(B) With Improper Cancellation During Transmission of a Q Bar.

Fig. 11-10. Waveforms of Signals at Cathode of I Phase Inverter.

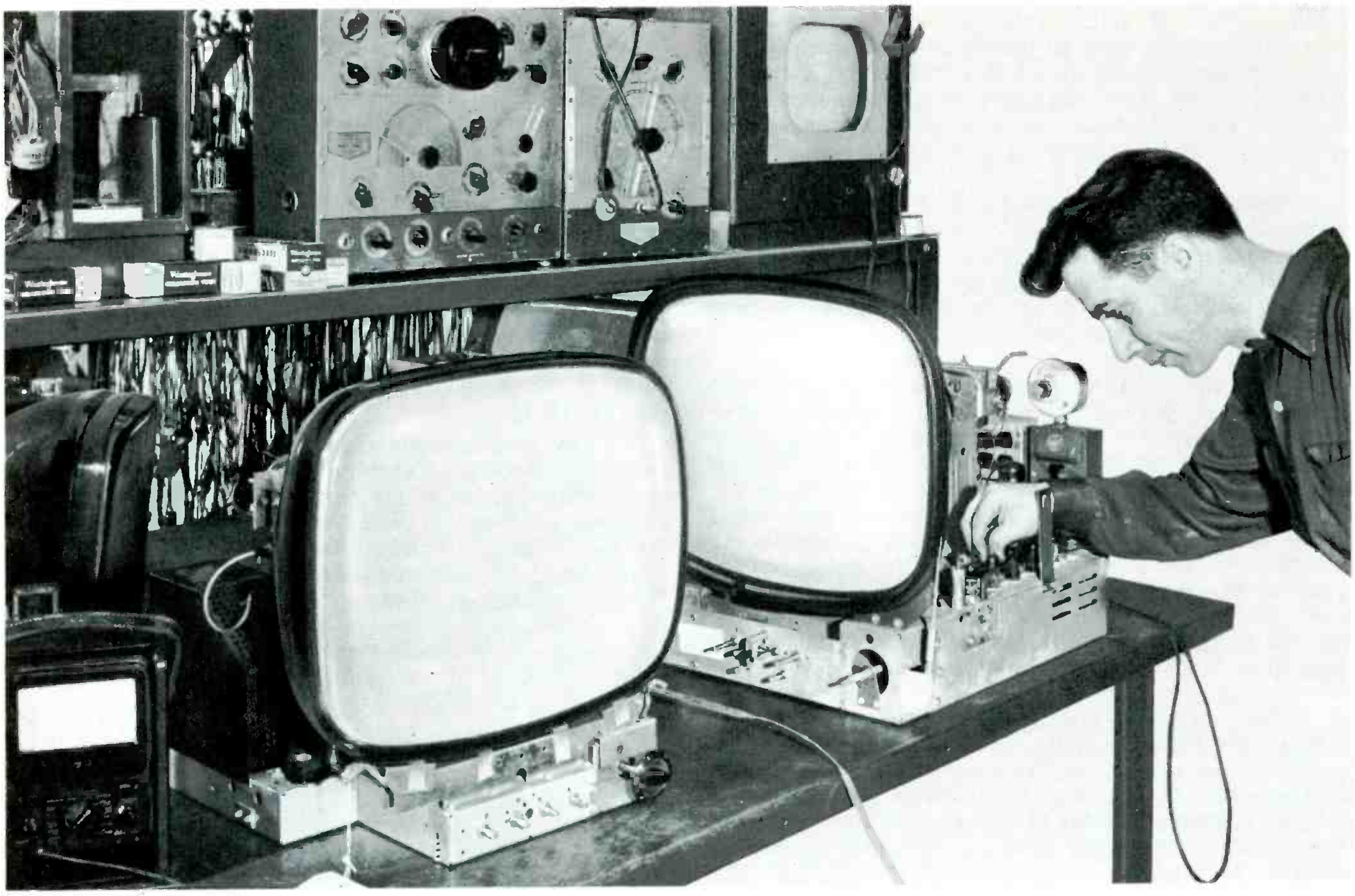


(A) Correct Signal.



(B) Incorrect Signal.

Fig. 11-11. Waveforms of Signals at the Grid of the Blue Gun.



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After the hue control is correctly adjusted, the oscilloscope lead is moved to point K which is at the cathode of the Q phase inverter. At alignment point A37 of the quadrature transformer, adjustment is made until there is zero output from the Q channel during the scanning time of the I bar. The waveform appearing on the oscilloscope should be the same as that which was shown in Fig. 11-8A. If the pattern is like either of those shown in Figs. 11-8B or 11-8C, the adjustment of the quadrature transformer is incorrect.

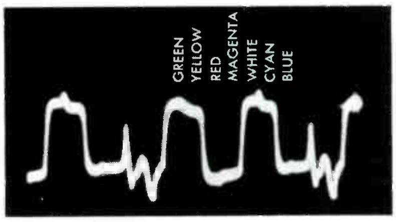

Fig. 11-12. Waveform of Correct Signal at Grid of Green Gun.

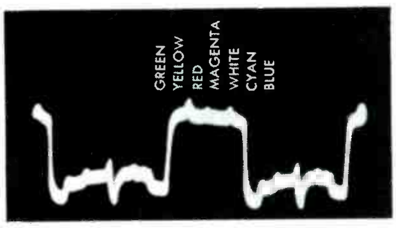

Fig. 11-13. Waveform of Correct Signal at Grid of Red Gun.

With the lead of the oscilloscope connected to the grid of the blue gun of the picture tube and with a color-bar signal applied to the input of the receiver, the next step in aligning the matrix is to balance the gains of the I and Q channels. The waveform at the grid of the blue gun should show maximum and equal amplitudes for the magenta, white, cyan, and blue bars. The amplitudes for the green, yellow, and red bars should be zero. The saturation control is adjusted for maximum cancellation of the green and yellow bars, and the I gain control is adjusted for maximum cancellation of the red bar. These two adjustments are made alternately until the best possible cancellation is achieved. The waveform in Fig. 11-11A shows the correct signal at the grid of the blue gun. If the signal appears like the one shown in Fig. 11-11B, the adjustments of the saturation and I gain controls are incorrect.

After the correct signal at the grid of the blue gun is attained, the signals at the grids of the green and red guns should be checked. The waveform at the grid of the green gun should show maximum cancellation of the red, magenta, and blue bars with maximum and equal amplitudes for the green, yellow, white, and cyan bars. The waveform at the grid of the green gun should appear like that shown in Fig. 11-12.

The waveform at the grid of the red gun should be like that of Fig. 11-13. There should be maximum cancellation of the green, blue, and cyan bars and maximum and equal amplitudes for the yellow, red, magenta, and white bars.

After the quadrature and gain adjustments have been made, the I and Q signals arriving at the matrix should be correct. When these signals are combined with the luminance signal, the blue gun should receive a signal that contains only blue information; the red gun should receive a signal that contains only red information; and the green gun should receive a signal that contains only green information.

DYNAMIC-CONVERGENCE CIRCUIT

In those receivers in which convergence of the electron beams is obtained electrostatically, the circuits which supply the convergence voltages must be aligned. This is a very simple procedure involving only the use of an oscilloscope. Convergence voltages having sufficient amplitude and proper phase will be supplied to the convergence element of the picture tube if the convergence circuit is properly aligned. This alignment procedure should not be confused with the setup procedure used to obtain the final beam convergence.

In receivers which employ electromagnetic convergence, the adjustments needed to obtain dynamic conver-

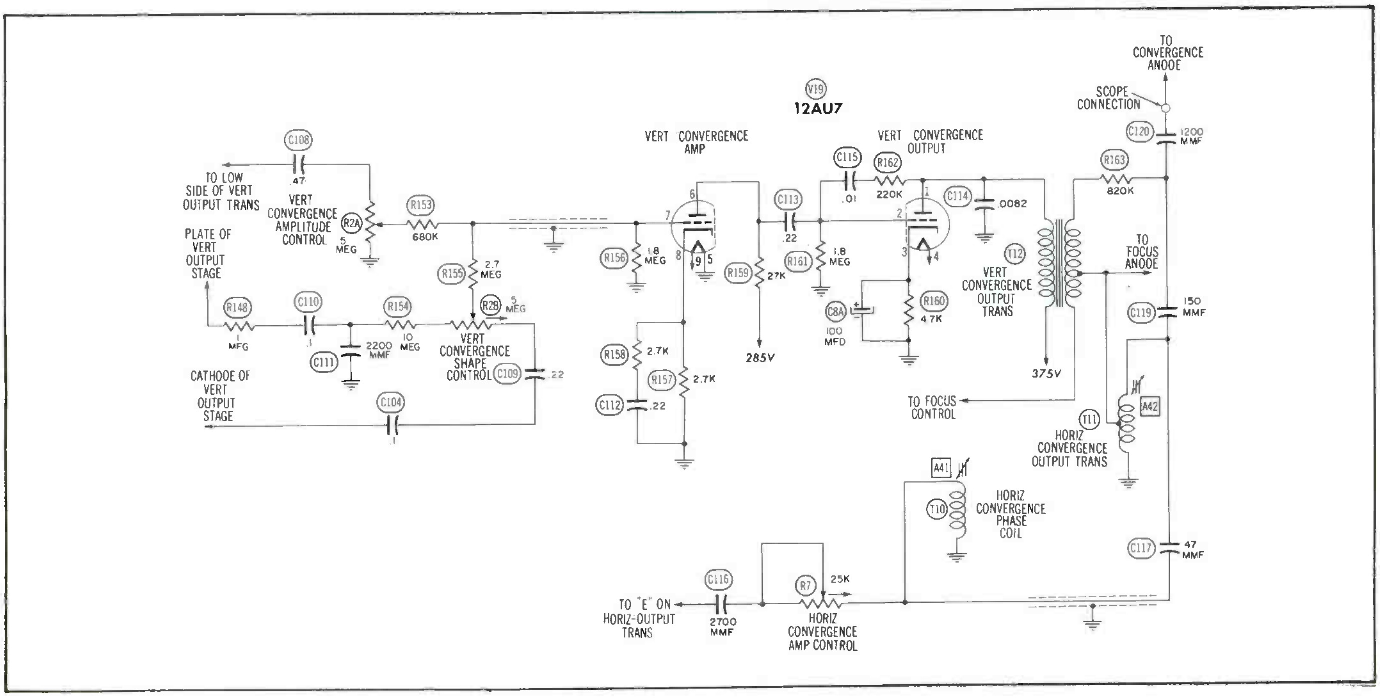

Fig. 11-14. Dynamic-Convergence Circuit in RCA Victor Model CT-100 Color Receiver.

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gence are made during the setup procedure for the picture tube. These adjustments were discussed in detail in Part XII of the Color TV Training Series in the May 1955 issue of the PF REPORTER.

The circuit of Fig. 11-14 is typical of the convergence circuits used in receivers which employ the electrostatic method to converge the electron beams. The adjustments at points labeled A41 and A42 are the ones specifically made during the alignment procedure. These adjustments are performed while observing on an oscilloscope the voltage waveform present at the convergence element of the picture tube. The convergence voltage can be coupled to the oscilloscope by clipping the vertical-input lead of the oscilloscope to the insulation of the conductor which connects to the convergence electrode of the picture tube.

Since only the horizontal-convergence voltage is affected while the convergence circuits in this receiver are being aligned, the dynamic voltage at the vertical frequency is not desired at the input of the oscilloscope. The vertical-amplitude control R2A should be turned fully counterclockwise, and the vertical-shape control R2B should be turned to the center of its range. By setting these controls as stated, no vertical-convergence voltage will be applied to the convergence element.

The horizontal-amplitude control R7 should be turned fully clockwise; then at point A41, adjustment of the horizontal-phase coil T10 may be made to obtain maximum amplitude of the horizontal sine wave that is applied to the convergence element.

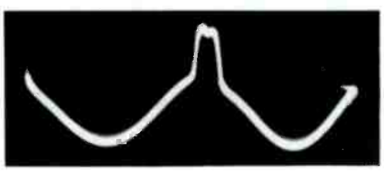


Fig. 11-15. Waveform of Signal at Convergence Electrode of Picture Tube.

Before making the adjustment at the point designated as A42, the horizontal-amplitude control R7 should be turned fully counterclockwise. Then, the core of T11 is adjusted so that the horizontal sync pulse will appear on top of the sine wave. This condition is shown by the waveform in Fig. 11-15. The horizontal-amplitude control R7 should again be turned to the maximum clockwise position. The sync pulse may be moved from the top of the sine wave by this adjustment. If it is moved, it may again be placed on top of the sine wave by adjustment of the horizontal-phase coil T10. If the sync pulse remains on top of the sine wave when the horizontal-amplitude control is turned counterclockwise, the alignment of the convergence circuit is correct.

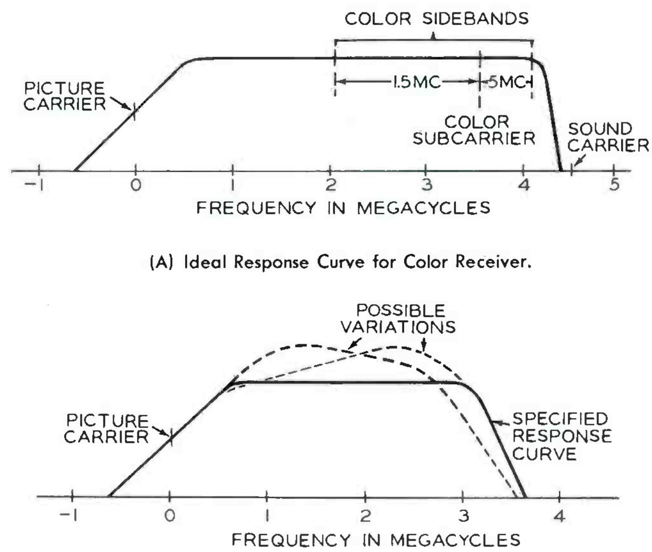
RF AND IF SECTIONS

The function of the RF and IF sections in a color receiver is essentially the same as it is in a monochrome receiver. These sections must provide amplification to a band of frequencies from .75 megacycles below the frequency of the picture carrier to around 4.2 megacycles above the frequency of the picture carrier. This range of frequencies covers all of the sideband frequencies that are contained in the color picture signal and is considerably wider than the range required in a monochrome receiver.

An ideal RF and IF response curve for a color receiver is shown in Fig. 11-16A. This curve shows that the frequencies of the upper sidebands of the color subcarrier extend into the region of 4.2 megacycles; consequently, a flat response up to this gerion is needed. In actual practice, the response curve may not be quite so flat as the ideal curve; however, it should be as near to the ideal curve as possible so that equal amplification of all the frequencies will be attained. Notice that the slope of the curve in the region of the sound carrier is very steep. It must be steep because the upper limit of the sideband frequencies of the subcarrier are only .4 megacycles away from the frequency of the sound carrier.

By comparing the RF and IF response curve in Fig. 11-16A to that shown in Fig. 11-16B, it can be seen that there is quite a difference. The curve shown in Fig. 11-16B represents the RF and IF response curve of a typical present-day monochrome receiver. The bandpass usually specified by most manufacturers of monochrome receivers is around 3.25 megacycles. If the RF and IF response curve of a color receiver should begin to taper off at 3.25 megacycles, complete loss of color would result because the color subcarrier is located at 3.58 megacycles above the picture carrier.

The dotted curves in Fig. 11-16B show possible variations in the RF and IF response curve for a monochrome receiver. In one case, the high frequencies would be attenuated and the low frequencies would be overamplified. In the other case, the low frequencies would be attenuated and the high frequencies would be overamplified. In either case, if a monochrome receiver has such a response, it is possible that very little effect in the reproduced picture would be noticed. In a color receiver,



(A) Ideal Response Curve for Color Receiver.

(B) Response Curve for Monochrome Receiver.

Fig. 11-16. RF and IF Response Curves for Color and Monochrome Receivers.

the effect of a sloping response curve would be noticed more readily because of the unequal amplification of the color signals.

The response of the RF tuner in a color receiver should be as flat as possible with a minimum amount of tilt and sag. An ideal response curve of a tuner used in a color receiver is shown in Fig. 11-17. A tilt or sag in the response of a tuner used in a monochrome receiver can be compensated for during the alignment of the IF section, but it is not advisable in a color receiver because a uniform response of all the color frequencies would not be attained.

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The alignment of the RF and IF sections in a color receiver is more complicated than it is for a monochrome receiver because there are more stages being employed and because there is the additional requirement of a flatter and wider bandpass. The alignment procedure for the color receiver should be followed step by step as outlined in the service literature.

The video IF and detector circuits employed in the RCA Victor Model CT-100 color receiver are shown in Fig. 11-18. The waveform shown in Fig. 11-19 represents the over-all response curve of the video IF section in Fig. 11-18. This curve shows the location of the frequencies that are passed by the IF section. The picture carrier is located at 45.75 megacycles and is placed at the 50-per-cent point on the slope of the curve. The color subcarrier is placed at 42.17 megacycles.

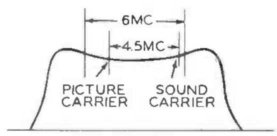


Fig. 11-17. Ideal Frequency Response Curve of Tuner Used in Color Receiver.

Figs. C-10 and C-11 of the Color Plate show the color-bar patterns obtained when the video IF section in a color receiver is improperly aligned. Compare these patterns with the normal pattern shown in Fig. C-1 of the Color Plate. The picture degradation in Fig. C-10 is not too serious — by many viewers, the picture would probably be regarded as being normal. Nevertheless, L20 was detuned at adjustment point A19 to obtain this photograph. Notice the slight ringing in the picture, particularly in the magenta bar.

There are more apparent defects in Fig. C-11. There is a large amount of ringing in the picture, and the color bars are of the wrong hues. The poor picture was caused by only slightly detuning L21 at adjustment point A10; and therefore if the alignment of the IF section is not absolutely correct, unsatisfactory results may be obtained.

The sound carrier is greatly attenuated by adjustments at A15, A7, and the sound-reject control R22 in order to reduce the 920-kc beat that is present between the sound carrier and the color subcarrier. If the sound carrier is not sufficiently attenuated, an interference pattern will be present on the screen. This beat pattern is very noticeable in Fig. C-12 of the Color Plate.

SOUND IF SECTION

The sound IF section of a color receiver is not necessarily different than that used in a monochrome receiver. One example is the sound IF section used in the RCA Victor Model CT-100 color receiver. This circuit is shown in Fig. 11-20. Although a separate detector circuit is used, the sound section in this receiver is fundamentally the same as those used in many monochrome receivers.

As might be expected, a conventional procedure is followed when aligning this section. Adjustments are made at points A1 through A4 so that the IF transformers will be resonant at 4.5 megacycles. The transformer secondary at A5 should be tuned so that the DC voltage measured across C82 will be zero at the same time that a 4.5-mc signal is applied between point C of L35 and ground.

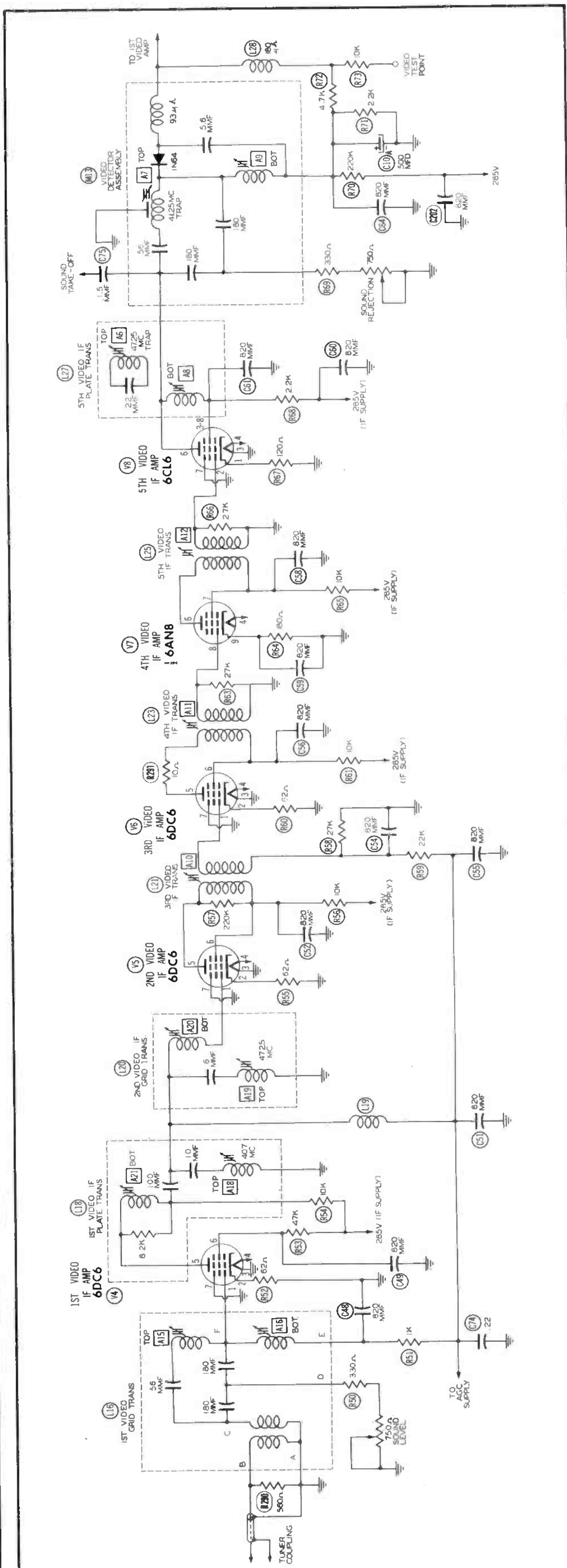


Fig. 11-18. Video IF and Detector Circuits in RCA Victor Model CT-100 Color Receiver.

The indications of poor alignment in the sound section are the same for color receivers as they are for monochrome receivers. For instance, a 60 cycle buzz might indicate that the secondary of the ratio-detector

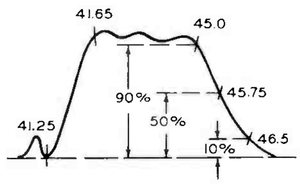


Fig. 11-19. Response Curve for Video IF Section of Color Receiver.

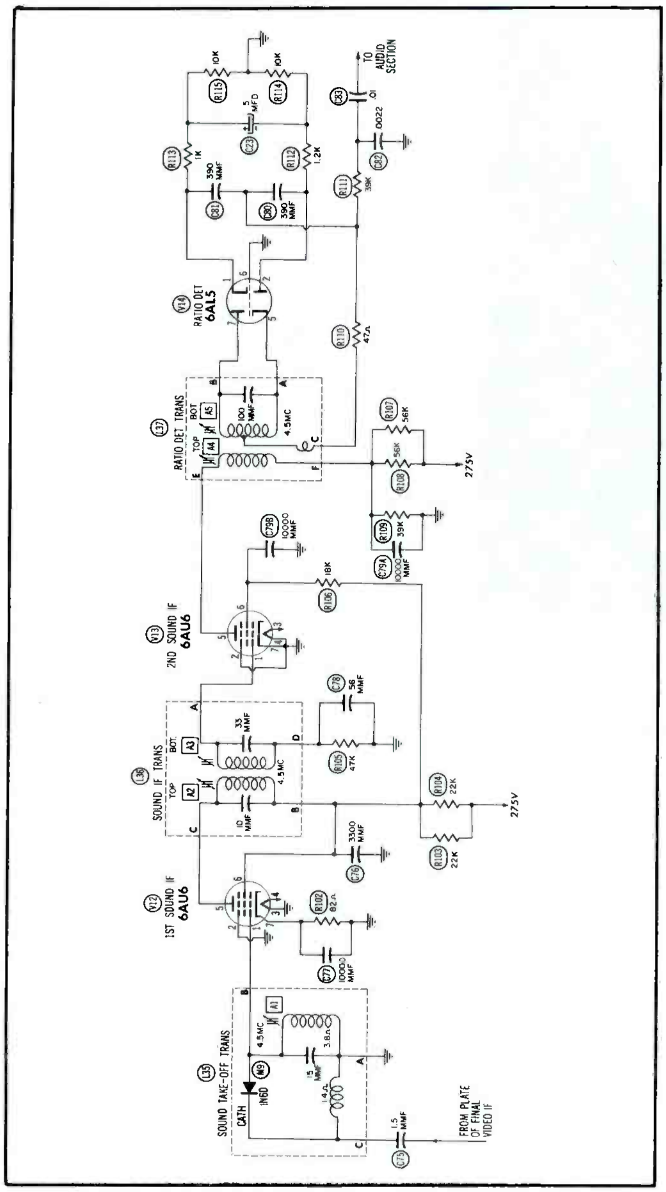


Fig. 11-20. Sound IF and Detector Circuits in RCA Victor Model CT-100 Color Receiver.

transformer is detuned. If one of the IF transformers were detuned, the sound signal would be weaker than normal.

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

C. P. OLIPHANT and VERNE M. RAY

Dollar and Sense Servicing

(Continued from page 29)

ANTENNA INSURANCE. Hurricanes of 1954 caused so much damage to TV masts that separate policies will be required in New York state for antenna coverage on new or renewal insurance. Cost will be $5 for each $100 in protection for antennas. The new ruling of the State Superintendent of Insurance does not affect current comprehensive fire and windstorm policies, which still cover antennas.

Unofficially it was estimated that the big blows cost insurance companies in the state at least $20 million in antenna damage claims last year. It is presumed that this all went to the service technicians who made the repairs. Or did it?

APPROVAL. Once again, the public has indicated its satisfaction with the quality, speed, and cost of TV service. The 1954 nationwide survey by Elmo Roper for RCA Service Co., showed that 90 per cent of the 5,000 sampled families fully approved of the quality of technicians who fixed their sets. Of the remainder, 6 per cent didn't know and only 4 per cent were dissatisfied. Unfortunately, it's this 4 per cent that make the most noise; and unfortunately, their complaints are justified in some cases.

Even though the average price per call was up 11 per cent over 1954, 87 per cent of the sampled families were satisfied with the prices charged. As to speed, 79 per cent got service within 3 days of their call and were satisfied with this.

DISSATISFACTION. Definition: That which people spread much farther than their satisfaction — and with a lot more impact on your pocketbook. On a long-term basis then, you'll make a lot more by taking your licking on one service job just to keep some grouch on your side than by sticking to your rights and letting him get out to broadcast lies about you. But take his name off your mail promotion list, and discreetly discourage his future business because you're human and can stand just so many of these chronic complainers.

TRANSISTOR SWAPPING. Because transistor characteristics are as unpredictable as women these days, users of the new components often play a swapping game with each other. They order perhaps five times as many transistors as they need, pick out the ones that work in their particular circuit, then swap the rest with another manufacturer who may need exactly what they don't.

The same game is played with tubes every now and then, even though it is discouraged by everyone because of the difficulty of getting selected replacement tubes for those critical circuits.

Remember the early days of TV when you didn't dare swap similar tubes for fear they had been carefully selected for their respective sockets? Today, this is no longer a worry, because no manufacturer can afford to fool around with picking out special tubes if he has to build a 21-inch set to sell for under $150.

SABOTAGE. During negotiations for a new contract between a TV station and its technicians' union, things got a bit out of hand one night and the station went off the air for quite some time. Investigation revealed that more than 100 fuses had been replaced by dummies, equipment and instruction books had been hidden, tiny pieces of wire had been put into sync generators in obscure spots, good tubes had been replaced by defective ones, scores of audio circuits had been disabled, and the film-projector optical systems had been thrown out of alignment. Top engineers had to be flown in to fix the trouble.

What a trouble-shooting party that must have been! And what a party there'll be in court if the saboteurs are fully prosecuted; penalities for such acts are rather stiff, amounting to 1 year of imprisonment and/or a $10,000 fine since the station operates under government license.

NICKNAME. An ear-splitting sound generator is used at the Armour Research Foundation to test performance of tubes and parts at the high sound intensities encountered in jet-engine aircraft. The technicians who have to work near the thing call it "Screaming Meemie."

SECRET RECORDER. Actually on the market now is a leather briefcase that opens conventionally on one side for removal of papers without revealing the magnetic tape recorder concealed within it. A zipper panel on the other side provides access to the hidden recorder for loading and unloading tape and making preliminary adjustments, after which the combination slide lock and switch of the briefcase provides secret starting and stopping of the recorder. A hidden microphone in one end of the briefcase picks up conversations up to 100 feet away, according to specifications of the manufacturer — Amplifier Corp. of America, 398 Broadway, New York 13, N. Y.

A $2.30 set of amplifier batteries is rated to last 100 hours, and a $2.70 set of mercury type motor batteries is good for 12 to 24 hours. Frequency response is 100 to 3,000 cps, strictly for spy stuff, newspaper reporting, criminal confessions, and other investigative work. With the new long-play tape and twin-track recording, playing time is 3 hours per 5-inch reel at a recording speed of 1 7/8 inches per second.

This firm also has other completely portable models in conventional housings and with various higher tape speeds for high-fidelity work, as required by newscasters for on-the-spot interviews. These come with either battery or spring-powered motors.

Broadcast Equipment Specialities Corp., P. O. Box 149, Beacon, N. Y., is another firm selling spring-powered portable tape recorders complete with schematics and servicing instructions. In general, you can figure on $300 to $350 net price for a good portable tape recorder.

Companies that provide complete diagrams and servicing instructions with specialized electronic equipment deserve commendation. Their customers benefit because they can then get speedy repairs practically anywhere in the world, and service technicians benefit because they can then handle these extra-income jobs efficiently.

AUTO RADIO. Two out of three cars on the highway today have radios, according to the Automobile Manufacturers Association. In 1954, auto-radio sales shot over 5 million and comprised 38.7 per cent of total radio production.

FUTURE. Service technicians thinking of going into defense work in the electronics field will be cheered by the ten-year predictions of Sylvania's Frank Mansfield. He estimates an almost linear rise in defense expenditures in electronics from an estimated $2.46 billion for 1955 to an estimated $4.05 billion for 1964. This is encouraging assurance of job security, though of course individual firms will have their ups and downs in accordance with their success or failure in landing the government contracts.

CHARGES. Typical TV service charges are $7.50 for replacing a 21-inch picture tube, $8.25 to $9 for 24 to 27 inchers, $8 to $10 for changing a power transformer, as estimated by Motorola's service manager Russ Hanson in NARDA News. He figures $10.50 for the all-round average COD charge for a TV call, including parts; and he thinks that 80 to 90 per cent of the calls are now being completed in the home.

HIRING. Confirming our belief that it's better to get along without than to hire the wrong man, the American Management Association just announced that the average cost of a mistake in hiring a salesman is over $6,000. This includes the cost of his training, his salary, the value of the business he didn't get, and the value of the customers he lost permanently through his blunders.

HEAT SEEKERS. Guided missiles depend upon a variety of different principles for guidance to their targets, but the one that intrigues us most is the heat seeker. In the nose of this missile is a souped-up modern version of the old bolometer, which gives out a voltage in proportion to the amount of heat reaching it. The missile has to be launched from behind a target jet plane to pick up its heat. Once such a missile homes on the heat source, it goes right up the tail pipe of the enemy plane, they say. Sure must be embarrassing to the enemy!

JOHN MARKUS

Audio Facts

(Continued from page 27)

trol. Some experimenting will reveal that the loudness control will produce the most pleasing balance between highs and lows when it is operated over a certain portion of its rotation. The gain control R2 is set to the position which permits the loudness control to operate within the correct range.

R3 is a standard IRC Type LC1 loudness control which has proved to be very satisfactory in maintaining balanced treble and bass response as the loudness level is varied. This control can be purchased as a complete assembled unit or can be made up from standard components.

The front section R3A of the loudness control is a 500K-ohm control (IRC stock No. Q11-133), the second section R3B is a 1-megohm multisection (IRC stock No. M13-137), and the third section R3C is a 100K-ohm multisection (IRC stock No. M13-128). A 10K-ohm half-watt resistor, a 100K-ohm half-watt resistor, an 82-mmfd ceramic capacitor, and a .03-mfd tubular capacitor are connected to the control as shown in the schematic diagram of Fig. 3.

In this preamplifier and control unit, a fourth section R3D which is a 500K-ohm multisection (IRC stock No. M11-133) is added to the loudness control and operates in the input of the output stage to reduce noise. The noise reduction which results from the action of this control is very pronounced, especially during the absence of a signal.

A Stancor C-2332-1 tone-control unit L1 and two dual 250K-ohm controls are used in a nonresonant LCR variable equalizer circuit. The insertion loss with this type of tone control circuit is not so high as the loss experienced with a circuit employing only capacitors and resistors. We have found this circuit to be one of the most stable ever used. In addition, it provides a wide range of bass and treble boost or droop.

With the dual bass control R4 in its maximum counterclockwise position, bass is attenuated because of the high resistance in the cathode circuit of the second section of V3 and because of the shunting of the low frequencies through L1 to ground in the grid circuit of the first section of V4.

When the bass control R4 is in the maximum clockwise position, the bass receives maximum boost because of the fact that the low reactance of L1 to low frequencies reduces

PARTS LIST

Tubes

V1	12AT7
V2	12AU7
V3	12AU7
V4	12AU7

Capacitors

	CAPACITANCE (mfd)	VOLTAGE (volts)	MALLORY	PYRAMID	SANGAMO	ERIE	CENTRALAB
C1A	20	450					
C1B	20	450					
C1C	20	450	FP444	TM-Q20-450	Q-040		
C1D	20	450					
C2A	20	450					
C2B	20	450	FP444	TM-Q20-450	Q-040		
C2C	20	450					
C2D	20	450					
C3	500	25	WP057	TM-500-25	S-040		
C4	500	25	WP057	TM-500-25	S-040		
C5	10	150	TC42	TD-10-150	MT-1512		
C6	.05	600	PT-615	IMP6-S5	330615		
C7	.05	600	PT-615	IMP6-S5	330615		
C8	1000	500	UC-521			GP2L-102	D6-102
C9	680	500	UC-5368			GP2K-681	D6-681
C10	390	500	UC-5339			GP2K-391	D6-391
C11	.02	600	PT-612	IMP6-S2	330612		
C12	.1	600	PT-601	IMP6-P1	330601		
C13	4000	500	UC-5240			GP2-333-402	D6-402
C14	3300	500	UC-5233			GP2-333-332	D6-332
C15	5600	500	UC-525			GP3-333-562	D6-562
C16	.1	600	PT-601	IMP6-P1	330601		
C17	.1	600	PT-601	IMP6-P1	330601		
C18	.1	600	PT-601	IMP6-P1	330601		
C19	.1	600	PT-601	IMP6-P1	330601		
C20	.01	in case with L1					
C21	.005	in case with L1					
C22	.1	600	PT-601	IMP6-P1	330601		
C23	.1	600	PT-601	IMP6-P1	330601		
C24	.25	600	PT-6025	IMP6-P25	3306025		

Controls

	RESISTANCE (ohms)	IRC	CLAROSTAT	CENTRALAB	MALLORY
R1	500K	Q13-133	A47-500K-Z FKS-1/4 (shaft)	B60	U48
R2	500K	Q13-133	A47-500K-Z RS-2 (shaft)	B60	U48
R3		LC1			
R3A	500K	Q11-133			
R3B	1 meg	M13-137			
R3C	100K	M13-128			
R3D	500K	M11-133			
R4A	250K	Q13-130	DC-8-Z	BB-103	UF254A DS36 (shaft)
R4B	250K	M13-130			UR254A
R5A	250K	Q13-130	DC-8-Z	BB-103	UF254A DS36 (shaft)
R5B	250K	M13-130			UR254A

Resistors

	RESISTANCE (ohms)	WATTAGE RATING (watts)	IRC
R6	47K	1	BTA 47K
R7	2000	1	DCF 2000
R8	560K	1	BTA 560K
R9	250K	1	DCF 250K
R10	22K	1	BTA 22K
R11	2500	1	DCF 2500
R12	100K	1	DCF 100K
R13	10 meg	1/2	BTS 10 meg
R14	100K	1	DCF 100K
R15	18K	1	BTA 18K
R16	100K	1	BTA 100K
R17	10 meg	1/2	BTS 10 meg
R18	10 meg	1/2	BTS 10 meg
R19	1 meg	1/2	BTS 1 meg
R20	10 meg	1/2	BTS 10 meg
R21	3900	1	BTA 3900
R22	100K	1	BTA 100K
R23	470K	1	BTA 470K
R24	1000	1	BTA 1000

	RESISTANCE (ohms)	WATTAGE RATING (watts)	IRC
R25	22K	1	BTA 22K
R26	47K	1	BTA 47K
R27	18K	1	BTA 18K
R28	3900	1	BTA3900
R29	100K	1	BTA100K
R30	10K	1	BTA 10K
R31	470K	1	BTA 470K
R32	1500	1	BTA 1500
R33	10K	1	BTA 10K
R34	47	1	BW1-47 Wire wound
R35	2200	1	BTA 2200
R36	2200	1	BTA 2200
R37	25	10	1 3/4 AA-25 Adjustable wire wound
R38	Chosen by trial if required to roll off high-frequency response (see text)		

Selenium Rectifiers

	RADIO RECEPTOR	FEDERAL	MALLORY	SARKES TARZIAN	INTERNATIONAL
M1	(1) 16Y1 or (2) 8Y1	(2) 1159	(2) 8S20	(2) 35	(2) CR20
M2	(1) 16Y1 or (2) 8Y1	(2) 1159	(2) 8S20	(2) 35	(2) CR20
M3	P1B1S1C	1016		304B	JD507G

Power Transformer

	STANCOR	PRIMARY	SECONDARY 1	SECONDARY 2	SECONDARY 3
T1	PC8417	117V AC	440V AC @ 50 ma DC	25.2V AC @ .5A	6.3V AC @ .6A

Tone Control Unit

L1	Stancor	C-2332-1

Miscellaneous

QUANTITY	
1	2-pole, 3-position switch (Centralab –1473; Mallory – 1215L)
1	Single-pole, 3-position switch (Centralab –1461; Mallory – 1211L)
1	Single-pole, single-throw toggle switch
1	Pilot-light assembly
1	AC receptacle
4	9-pin noval tube socket
4	Phono jacks
1	AC power cord
1	Aluminum chassis, 5 by 10 by 3 inches
	Panel, terminal strips, miscellaneous hardware, etc.

the degeneration of low frequencies in the cathode circuit of the second section of V3. Furthermore, there is no loss of low frequencies in the grid circuit of the first section of V4 since L1 is, in effect, removed from the grid current.

With the dual treble control R5 in the maximum counterclockwise position, the high frequencies are given a maximum droop because of the shunting of the control section R5A by capacitors C20 and C21 and also because of the degeneration in the cathode circuit of the second section of V3.

Setting the treble control R5 to the maximum clockwise position results in maximum treble boost because of the shunting of control section R5B by capacitors C20 and C21. This shunting action reduces the degeneration of high frequencies in the cathode circuit of the second section of V3. In this position of the treble control, there is no capacitive shunting in the grid circuit of the first section of V4.

Any degree of boost or droop of the bass or treble between the extremes can be had by adjusting the appropriate control. This wide range is possible because of the dual action in the cathode circuit of the second section of V3 and because of the dual action in the grid circuit of the first section of V4. Such flexibility of control is very desirable when compensating for variations in program material and listening conditions.

The output stage (second section of V4) is a cathode follower and permits a long shielded cable to be used to connect the output of the unit to the input of a power amplifier without loss of high frequencies.

The power-supply section is similar to the supply discussed in detail in "Audio Facts" in the July 1954 issue of the PF REPORTER. Selenium rectifiers are used in conjunction with power transformer T1 to supply plate voltages and to furnish direct current to heat the tube filaments.

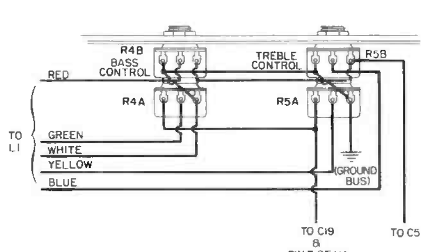


Fig. 6. Details for Correct Wiring of Bass and Treble Controls.

Two selenium rectifiers M1 and M2 are employed to supply the plate voltages. Rectifiers M1 and M2 are 16Y1 Seletron units each of which is rated at 260 volts AC input and 20 milliamperes DC output. Two 8Y1 Seletron units (each rated at 130 volts AC input and 20 milliamperes DC output) or two of any listed in the Parts List can be connected in series and used for M1 or for M2. These units will handle the input voltage of 220 volts AC from the power transformer. Sections A and B of the four-section capacitor C1 are connected in parallel to provide 40 microfarads for the input capacitor of the filter.

A bridge type of selenium rectifier M3 is used in the DC heater supply. The full-wave output of the rectifier is filtered by the network composed of C3, C4, and R37. R37 is adjusted so that 24 volts DC are applied to the tube heaters which are connected in series parallel, as shown in the schematic diagram. Anyone who has never used direct current to heat tubes in low-level stages will be surprised to find how effective this type of supply can be in keeping hum at minimum. The 6.3-volt AC secondary is used only to light the pilot light.

Layout and Construction

The general layout of parts can be seen in the two bottom views of the unit shown in Figs. 4 and 5. Two views are used in order to show as many helpful details in layout and wiring as possible. Fig. 6 is included to show the correct method of wiring the bass and treble controls.

A ground bus, which connects to the chassis at the input jacks only, reduces the possibility of ground loops and is convenient to use when wiring the unit. All electrical grounds are made in progressive order on the ground bus. Shielded wires, with the shields grounded only at one end, are run to the input jacks and to the switches on the front panel. All electroylic capacitors and the output jack are mounted on insulated mounts.

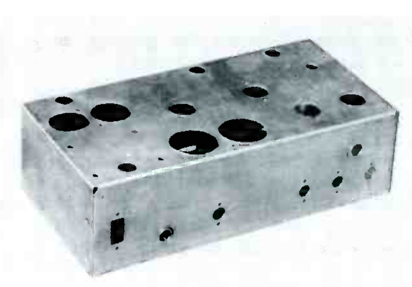


Fig. 7. Punched Chassis Before Parts Were Mounted.

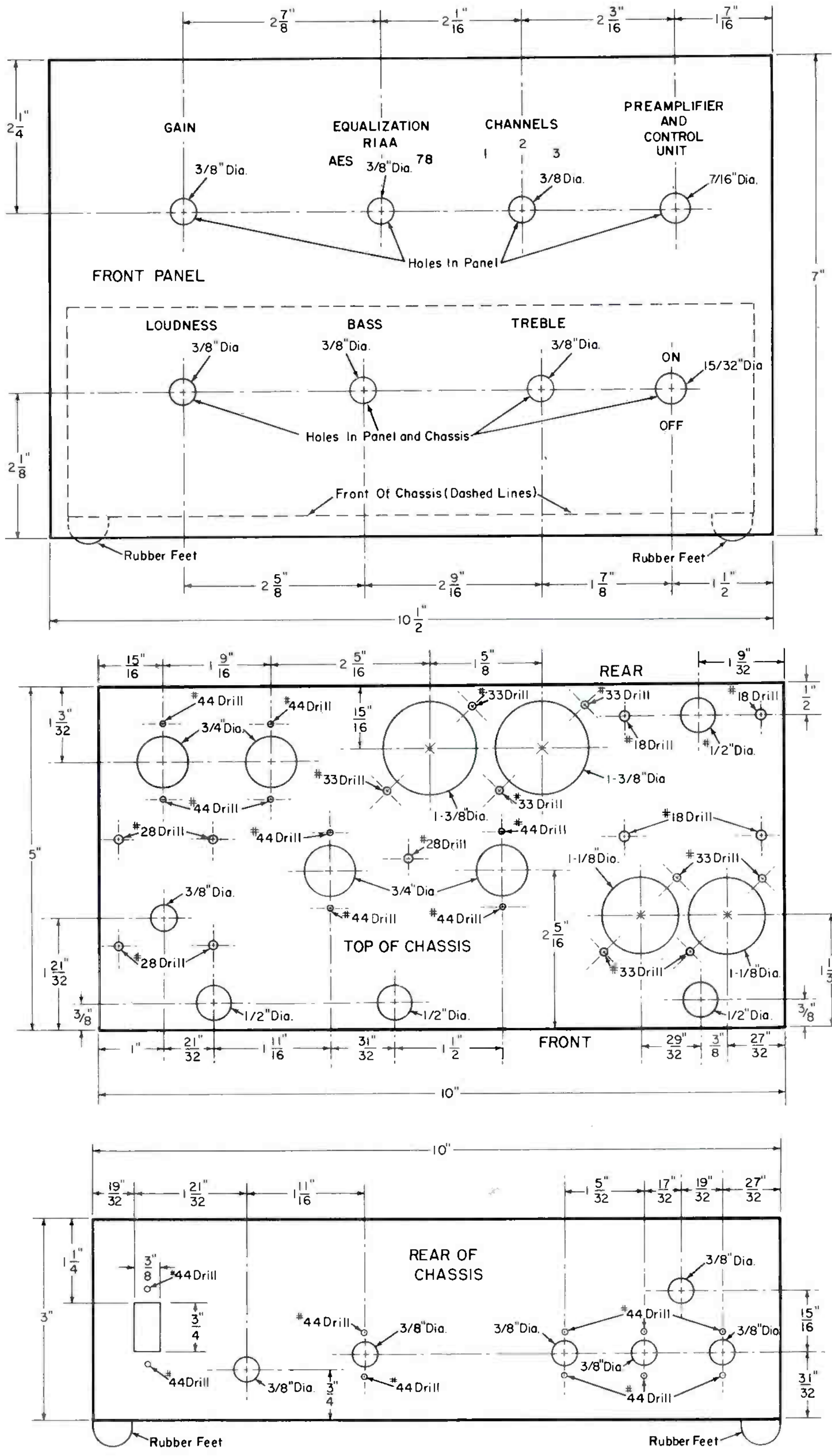


Fig. 8. Drawings Showing Locations of Holes in Chassis and Front Panel.

The phono-input circuit and preamplifier section are arranged in a small area located as far away as possible from the rest of the circuits. The layout and wiring arrangement has proved to be very satisfactory with no interaction of circuits or unwanted feedback being detected at any time.

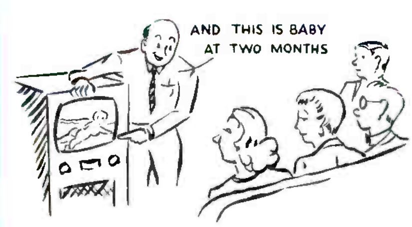
A photograph of the punched 5- by 10- by 3-inch aluminum chassis before any parts were installed is shown in Fig. 7. The locations of all large mounting holes are given in the drawings shown in Fig. 8. Since the locations of the small holes for the machine screws used to secure the parts to the chassis will depend upon the parts selected, no exact locations for these holes are indicated. Their general locations and the sizes of the drills with which they were drilled in this chassis are shown, however. Of course, the layout of parts can be changed to accommodate available components; but the arrangement shown has proved to be very satisfactory.

The front panel was cut from a standard 1/8-inch gray aluminum rack panel. It is secured to the chassis by the mounting nuts on the controls and on the ON-OFF switch. Decals made by the Tekni-Label Co., 732 S. Victory Blvd., Burbank, Cal., were applied to identify the controls and switches.

The cover, visible in the photograph in the heading of this article, was made from Reynolds perforated aluminum sheet. A sheet of paper can be folded, fitted to the unit, and used as a pattern to make a metal cover, if one is desired. A piece of sheet metal was cut and bent to serve as a mounting flange for the cover and for a small shield over the compensation and channel switches. Items such as the cover and switch shield should be tailored to fit the finished unit.

A parts list is included for those who wish to construct this useful piece of audio equipment.

ROBERT B. DUNHAM



VACATION. Excellent low-cost color program, which is used by Seattle's KING-TV, involves inviting people to bring in their own vacation color slides. Judicious screening of the slides beforehand by the station's picture editor invariably results in a few choice ones that have general interest. They are shown with commentary either by the photographer or the station's announcer.

What a thrill it must be to have your own pictures shown on TV with all the relatives looking in. Such a program could surely boost the sales of color film as well as stimulate color TV sales. When color TV breaks, local TV set dealers could well collaborate to sponsor such a program or split costs with the local photo-equipment shops.

MARKUS · · *Dollar and Sense Servicing*

Examining Design Features

(Continued from page 21)

the chassis. The channel-selector and fine-tuning shafts are also electrically insulated from the tuner. This is done to eliminate any shock hazard arising from the fact that one side of the AC line is connected to the chassis. For this reason also, an isolation transformer should be used before attempting any service or alignment of the chassis.

The chassis is vertically mounted and surrounds the neck of the picture tube. This arrangement eliminates the need for a large mounting bracket for the yoke. It also reduces the over-all space required for the complete unit. The chassis and picture tube are fastened to a plywood mounting board one-half inch thick. This board forms the bottom of the cabinet and permits easy removal of the entire assembly from the remaining part of the cabinet. The chassis and mounting board of this receiver are shown in Fig. 4. It can be seen from this figure that there will be easy access to all the tubes after removal of the rear cover because the chassis is mounted vertically. All the tubes except those in the tuner are mounted horizontally.

Tuner

The Olympic Chassis AD incorporates a turret type of RF tuner. This unit provides selection of all 12 of the present VHF channels. The antenna input to the tuner has a resistor-capacitor network in series with the signal path. A 470K-ohm resistor in each side of the 300-ohm transmission line serves as protection against a possibly fatal shock from the antenna terminals which would otherwise be connected through a low impedance to the chassis and to the AC line. Each 220-mfd capacitor connected in parallel with each 470K-ohm resistor is included to couple the incoming RF signal to the tuner.

The operation of this type of tuner is conventional. A 6BC5 pentode provides RF amplification, and a 6J6 dual-triode is used as an oscillator and mixer. These tubes are completely shielded, and there is a sufficient amount of decoupling to minimize radiation.

The gain of the RF amplifier is governed by the bias furnished by the AGC voltage which is fed back to this stage. The tuner also houses a tunable IF coil which is located in the plate circuit of the mixer. The tuned circuit associated with this coil and that associated with a coil in the grid circuit of the first video IF amplifier have a capacitor in common. This arrangement is known as common-impedance coupling and makes it possible to tune both coils for a broad frequency response.

Video IF

The Olympic Chassis AD features an intercarrier sound system and utilizes three stages of video IF amplification. The IF transformers are stagger tuned, and proper alignment of the IF circuits will produce a very satisfactory over-all response.

The first and second video IF stages employ the pentode sections of two 6AN8 tubes. A 6AN8 tube combines a pentode and a triode section into one envelope. The internal construction of this tube is designed so that coupling between the two sections is virtually nonexistent and so that the tube may be mounted in any position. The AGC voltage is applied to the grids of the first two IF stages through a voltage-dividing network.

The third and final IF stage utilizes the pentode section of a 6AM8 tube. The 6AM8 is another dual-purpose type of tube, and it houses both a pentode and a diode. The pentode section has a sharp-cutoff characteristic and provides adequate gain at intermediate frequencies.

Transformer coupling is used for all three stages of IF amplification. The IF transformers are unshielded single-tuned units which are mounted on the wiring side of the chassis.

Video Detector and Amplifier

The diode section of a 6AM8 tube is employed as a series type of video detector. A shield has been provided for this tube because this tube is also serving as the third video IF amplifier.

The signal voltage from the secondary of the third video IF transformer is impressed on the cathode of the detector. The plate is returned to ground through a 5600-ohm resistor, and the voltage developed across this diode load is capacitively coupled to the video amplifier. The AGC voltage is also derived from the output of the video detector and is filtered before application to the RF and IF circuits.

The video-amplifier stage consists of the pentode section of a 6AN8 tube. The design of this stage is relatively conventional except for the fact that the plate voltage is obtained from the boost voltage supplied by the damper tube. The composite video signal is then fed to the cathode circuit of a 14HP4 rectangular picture tube.

Sound

The sound section of this receiver employs only two tubes. A 6BN6 gated-beam pentode serves as a limiter and FM detector, and the triode portion of a 6AN8 is used as an audio output stage. The 4.5-mc sound signal is taken from the plate of the video amplifier and is developed across a tuned circuit connected to the limiter grid. This tuned circuit also acts as a 4.5-mc trap and therefore removes the sound from the video signal before that signal reaches the picture tube.

Buzz or hum encountered in the output of the 6BN6 and caused by improper biasing may be corrected by adjustment of the buzz control located in the cathode circuit. The plate load is sufficiently bypassed for intermediate frequencies, and the DC voltage appearing across this load is directly proportional to the original modulating signal. The audio voltage thus produced is then capacitively coupled to the volume control and in turn to the output stage. The audio-output transformer drives a five-inch speaker which is mounted on the side of the cabinet.

Synchronization

Dual-purpose tubes are again utilized in the synchronization circuits of this receiver. The triode sections of two 6AN8 tubes function as a sync separator and a sync amplifier, respectively. The purposes of these two sync stages are to separate the vertical and horizontal sync pulses from the composite video signal and to amplify them so that they are of an amplitude which is usable for controlling the sweep circuits. In the Olympic receiver being examined, the composite video signal is taken off at the output of the video amplifier and is fed to the grid circuit of the sync separator. The sync pulses, which are more positive than the picture content in the video signal, drive the grid of the 6AN8 sync separator. The tube is biased in such a manner that a clipping action takes place. The lower amplitude of the picture portion of the composite video signal is not sufficient to produce plate-current flow, and this portion will not appear in the output of this circuit. As a result of the clipping action, only sync pulses are passed.

The sync pulses from the output of the sync separator are coupled by an RC network to the sync amplifier. This stage amplifies and distributes the sync pulses to the vertical-sweep and horizontal-sweep circuits.

Vertical Sweep

The vertical-sweep system involves only one 12BH7 tube that serves as both an oscillator and an output amplifier. The 12BH7 is a miniature dual-triode tube frequently used in television receivers. In the Olympic model, the two triode sections function together as a multivibrator circuit. The sync pulses from the sync amplifier are fed to the first triode section through a conventional integrator network. The vertical-hold control is located in the grid circuit of the first section in order to control the frequency. A height control is incorporated in the plate circuit, and by adjusting this control the amplitude of the vertical saw-tooth voltage may be varied.

The remaining triode section of the 12BH7 is employed as a vertical-output stage. To obtain a linear output from this tube, a vertical-linearity control is connected in the cathode circuit. The output of this stage is then

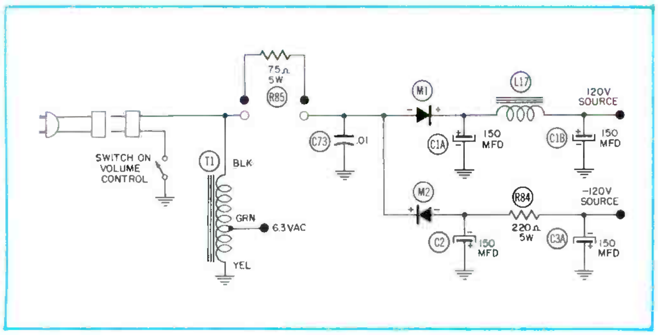


Fig. 5. Low-Voltage Power Supply in Olympic Chassis AD.

coupled to the yoke by means of a vertical-output transformer.

A negative pulse from the plate circuit of the first section of the 12BH7 is fed to the picture-tube grid in order to accomplish blanking during the vertical-retrace time.

Horizontal Sweep

The sync pulses from the sync amplifier are also fed to the control tube in the horizontal-sweep circuit. This AFC stage comprises one triode section of a 6SN7GT, and it is a part of the familiar Synchroguide circuit. The horizontal oscillator is essentially a blocking oscillator, and it is controlled by a variable grid bias which is supplied by the AFC tube. The transformer associated with the horizontal oscillator has two adjustable slugs which must be set for the correct frequency and phase. In addition, the horizontal-hold control provides a fine adjustment of the oscillator frequency. The horizontal-output system of this receiver employs a 6CU6 tube. This stage is designed to operate without a drive control or drive trimmer in the grid circuit, and the cathode is returned to a negative 120-volt supply. The flyback transformer furnishes coupling to the yoke and supplies a high voltage of approximately 14 kilovolts to the picture tube. A 1B3GT tube is used for high-voltage rectification, and a 6AX4GT tube serves as a damper. Protection for the horizontal-output circuit is supplied by a 3/8-ampere fuse placed between the damper plate and the B+ supply.

The horizontal-output stage is designed to operate without the use of a width or linearity control; therefore, most of the component values involved are relatively critical.

Power Supply

The low-voltage power supply of this receiver is shown in Fig. 5. It uses two selenium rectifiers, each one connected for half-wave rectification. M1 furnishes a positive 120 volts, and M2 supplies a negative 120 volts with respect to chassis ground. The outputs of the two rectifiers combine to produce an effect which is essentially the same as that of a conventional full-wave voltage doubler, provided that the load is connected between the points of positive and negative voltage. These selenium rectifiers are rated at 300 milliamperes, and the circuit is protected by the 7.5-ohm fusible resistor R85 which may be seen in the photograph of Fig. 3. In order to supply the filament voltage required for all the tubes, the 6.3-volt filament transformer T1 which is of the autotransformer type has been employed. This unit is located on the mounting board of the chassis and may also be seen in the photograph of Fig. 3.

LESLIE D. DEANE

Hum Troubles in AC-DC Radios

(Continued from page 17)

Most receivers are constructed in such a way that the socket for the dial light is mounted on a bracket which is fastened to the chassis. Occasionally, one of these sockets will develop a high-resistance leakage path to the bracket. This condition will cause hum troubles to appear in the receiver. To test for this condition, remove the socket from the bracket and position it so that it does not touch the chassis. If the hum has disappeared when the receiver is tested under this condition, the socket is faulty and should be replaced.

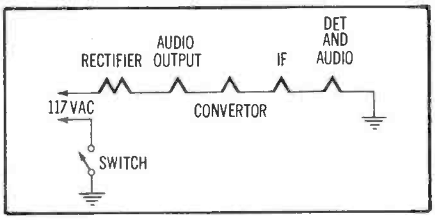


Fig. 3. Filament String in Typical AC-DC Radio.

Dial lights can cause hum troubles to appear when they develop an intermittently open condition. The opening and closing of the filament in the light is often at a 60-cycle rate.

If the nontunable hum persists after these initial checks, remove the chassis from the cabinet. Connect an external capacitor in parallel with the input filter capacitor. The value of the external capacitor does not have to be exact, but it should be approximately equal to the value of the filter capacitor in the set. A decrease in the hum level indicates that one or more sections of the filter capacitor have diminished in value and that the entire capacitor should be replaced. Since this trouble is by far the most common cause of nontunable hum in AC-DC receivers, the filter capacitor should always be the first thing tested after the chassis is taken out of the cabinet.

If the preceding test does not eliminate the trouble, measure the voltage from B- to each side of the filter resistor. If the readings are very close, the filter resistor may have decreased in value or the two positive leads of the filter capacitor may have shorted together inside the capacitor.

Disconnect one lead of the resistor, and measure the value of the resistor. Replace the resistor with a new one if its measured value differs from its rated value by more than 20 per cent. Measure the resistance between the two positive leads of the capacitor while the resistor is still disconnected. If the reading is zero or very low, replace the capacitor.

The average AC-DC receiver has a three-section electrolytic capacitor. Two of the sections are used as filters in the B+ circuit, and the third section is used as a bypass across the cathode resistor in the output stage. See Fig. 4. Occasionally, a high-resistance short will develop inside the capacitor between the positive lead of one of the filter sections and the positive lead of the cathode section. A trouble of this nature will couple a 60-cycle voltage into the audio amplifier.

If the short is of low resistance, an ohmmeter measurement between the leads of the capacitor will indicate that the capacitor is faulty. The ohmmeter will not give a definite indication of trouble if the short is of high resistance. In this case, the receiver should be tested after the lead between the capacitor and the cathode terminal has been disconnected. An absence of hum will indicate that the capacitor is faulty.

Whenever a fault develops in one section of a multisection electrolytic capacitor, the entire capacitor should be replaced. In the case just mentioned, some technicians might be tempted to clip the wire to the cathode section and to install a separate single-section capacitor from the cathode terminal to B-. If this is done, there is a hazard that leakage will develop between the two filter sections; then a free callback will be necessary to cure another case of hum in that receiver.

Some receivers of the type which have the B- line isolated from the chassis will produce hum if this line and the chassis are shorted together. There is no way of predicting which receivers will produce hum when B- is shorted to the chassis, but the possibility of this trouble should always be considered when servicing a receiver which has hum.

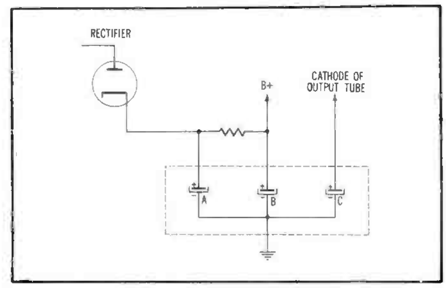


Fig. 4. Typical Connections of Three-Section Filter Capacitor.

In addition to producing tunable hum, the capacitor which filters the AC line can produce nontunable hum if this capacitor is connected from the high side of the AC line to the cathode of the rectifier and if it develops an internal short or a high value of leakage. If these conditions exist, 60-cycle voltage may enter the B+ line; and in most cases, the filter capacitor will be unable to remove all of the hum. In some extreme cases, the high AC voltage will cause the filter capacitor to fail completely.

The more obscure cases of hum will be due to such troubles as inter-element leakage within the rectifier tube, cold-solder joints, leakage between socket terminals, or an open circuit in the negative lead inside the filter capacitor. Be especially wary of those receivers in which spare terminals on the sockets of the rectifier tubes are used as tie points for components in audio circuits. The very small amount of hum voltage which might be coupled across the socket or through the rectifier tube will be amplified to a high volume by the time it emerges from the speaker.

WILLIAM E. BURKE

Notes on Test Equipment

(Continued from page 15)

from 68 to approximately 120 kilocycles. Resonant frequencies of most yokes and transformers fall somewhere within the prescribed ranges when these components are operating normally. The natural resonant frequency of the entire horizontal-deflection system is higher than that of the flyback transformer alone, as was pointed out in the two articles mentioned.

In practice, the Seco Model FB-4 tester is connected across the yoke or flyback circuit to be tested, the SELECTOR switch of the tester is turned to the position marked FLYBACK and TRANSF., or to YOKE, as desired; and the SENSITIVITY control is adjusted to the proper point, according to the instruction book accompanying the tester. Then the frequency control is rotated to the point at which the eye indicator opens widest, and the condition of the component under test is determined from the dial setting.

When the SELECTOR switch is turned to YOKE position, a 500-mmf capacitor in the instrument is connected in parallel with any yoke being tested. This is for the purpose of tuning the yoke so that its resonant frequency will be within the frequency limits indicated by the yoke sector. Any yoke winding having an inductance of 20 millihenrys or more may give an indication falling outside the yoke sector, but the danger of a misinterpretation of the test results under such a condition will be lessened if the rated yoke inductance is known.

The manual also offers the following suggestions in case the yoke inductance is not known. Two troubles which may be encountered in testing yokes are: (1) arc-over between horizontal and vertical coils or between the two horizontal coils themselves, and (2) shorts between adjacent turns or layers of turns. The first trouble will be manifested by a resistance between windings and can be checked with a high-resistance ohmmeter.

In checking for the second trouble, it is safe to assume that seldom will it be found that both halves of the horizontal winding in a yoke will go bad at the same time; therefore, if the windings are in normal condition, the same resonant-frequency indication will be obtained from the tester when each half is tested. A marked difference in indication between the two halves of the winding would indicate that one is defective.

NOTE: The capacitor which is often connected across one of the windings should be removed before this comparison test is made.

The check of the horizontal-deflection system can be made with the Seco Model FB-4 without the necessity of disconnecting any components. There must be no power applied to the receiver at the time.

If it is desired to test the flyback transformer alone, a number of preliminary operations should be performed. The manual recommends:

1. Remove the plate caps on the horizontal-output tube and the high-voltage rectifier.

2. Remove the high-voltage rectifier from its socket. (The filament of this tube is operated from a winding on the flyback transformer; and if this tube is in place, a closed circuit which loads the flyback transformer is formed.)

3. Unplug or disconnect the deflection-yoke assembly.

4. Unsolder one side of the width coil.

All four steps are taken to avoid loading the flyback transformer and thereby changing its natural resonant frequency.

Testers Employing Principle of Q-Meter and Grid-Dip Meter

The EICO Model 944 tester and the Radio City Products Model 123 tester for flyback transformers and yokes are shown in Fig. 1. They can be considered as examples of testers working on the principle of the Q-meter or of the grid-dip meter. Strictly speaking, there are certain similarities of operation among all three of the testers discussed, inasmuch as the Q of any circuit under test affects the readings on all three. The frequencies of the operating signals in the EICO Model 944 and in the Radio City Products Model 123 are further removed from the natural resonant frequency of any circuit being tested; therefore, the readings obtained when a component is being tested will be affected more by the Q of the component than by its resonant frequency.

The testing signals provided by these two instruments, the EICO and the Radio City Products models, are very similar. The first is a 600-cycle signal interrupted at a 60-

cycle rate, and the second is a signal of approximately 1500 cycles interrupted at a 60-cycle rate. The 60-cycle interruption causes a pulsed signal which is similar to the signal present under normal operating conditions in the flyback circuits. It is claimed that such a signal is more useful in showing up intermittent conditions than a steady, nonpulsed signal would be.

When a yoke or transformer is connected across the terminals of either of these two instruments, it is effectively coupled to the internal oscillator circuit. The output of this oscillator is indicated by a deflection of the pointer in the panel meter. A control is provided so that the pointer can be set to a calibration point on the dial before the component to be tested is connected. In the case of the EICO tester, two calibration points are used. One is for iron-core transformers, and the other is for air-core transformers.

A coil having shorted turns will load the oscillator and absorb power from the oscillator circuit. This causes the meter needle to drop to a lower scale sector marked either BAD or REPLACE, and thus a defective component is indicated.

Operating instructions for all three of these instruments specify that any damping networks should be removed from yoke windings before testing. The damping resistors found on the vertical windings of yokes are of comparatively low value, usually 500 to 600 ohms; and their presence across the windings would reduce the Q of the circuit to the point where a reading indicative of a defective component would be obtained on the testers.

The technician will find that a flyback tester such as any of those just described will reduce the amount of guess work or experimental substitution sometimes resorted to when trouble shooting horizontal-sweep circuits. Proper application methods will enable the operator to test other inductive components in a TV receiver; for example, the Seco manual lists the values of shunt capacitances necessary to adapt the Seco FB-4 tester for checking ringing coils, linearity coils, and width coils.

RECENT RELEASES

Precision Model 120 VOM

The Precision Model 120 volt-ohm-milliammeter (VOM) shown in Fig. 2 is a product of the Precision Apparatus Company, Inc., Glendale, L.I., New York. This meter provides forty-four AC and DC ranges as follows:

DC voltage ranges at 20,000 ohms per volt; 0 to 1.2, 3, 12, 60, 300, 600, 1200, 6000 volts.

Fig. 2. Precision Model 120 Volt-Ohm-Milliammeter.

AC voltage ranges at 5000 ohms per volt: 0 to 1.2, 3, 12, 60, 300, 600 1200, 6000 volts.

AC output ranges: same as the AC voltage ranges, but with blocking capacitor added.

DC current ranges: 0 to 60, 300 microamperes; 0 to 1.2, 12, 120, 600 milliamperes; and 0 to 12 amperes.

Resistance ranges: 0 to 200, 2000, 200,000 ohms; 0 to 2, 20 megohms.

Decibel ranges: -20 db to +77 db. Zero-db reference level is 1 milliwatt, 600 ohms.

A feature of special interest is the R x 1/10, or the lowest ohms range. This feature permits measurement of very small values of resistance. On this range, the first scale division indicates a resistance of only .025 ohm.

Jacks and plugs are of the banana type. The same COMMON jack is used for all measurements. A positive (+) jack is used for the positive lead for all ranges except the following: 12 AMPS, OUTPUT, 1200V AC, 1200V DC, 6000V AC, 6000V DC. These six ranges are served by the use of five additional jacks on the front panel. One jack is used both for 1200 volts AC and for 1200 volts DC. An AC-DC switch on the front panel may be set for the operator's choice of either AC or DC measurements.

One position of the range-selector switch is labeled TRANSIT and provides damping for protection of the meter movement when the meter is not in use or when it is being moved about. The ADJ OHMS knob is recessed into the front panel.

The 5 1/4-inch meter is mounted in a molded black phenolic case measuring 5 3/8 by 7 by 3 1/8 inches. Panel markings are deeply engraved for maximum legibility and long life.

Accessories available for the Model 120 are: (1) TV-2B, a 30-kilovolt safety probe; (2) LC-3, a leather instrument case; and (3) ST-1, a snap-on foldaway tilt-stand.

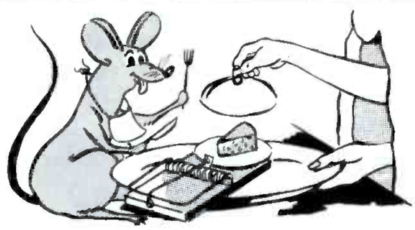
Precision Model 88 VTVM

Another product of the Precision Apparatus Company, Inc., is the Model 88 vacuum-tube voltmeter (VTVM) and electronic ohmmeter shown in Fig. 3. The instrument has the following voltage and resistance ranges.

Fig. 3. Precision Model 88 VTVM.

Zero-center DC voltage ranges at a constant 26 2/3-megohm input resistance: 0 to ±1.2, ±6, ±12, ±60, ±300, and ±1200 volts.

Left-hand zero DC voltage ranges (either positive or negative) at a constant 13 1/3-megohm input resistance: 0 to 1.2, 6, 12, 60, 300, and 1200 volts.



MOUSE CATCHING. Mice are clever in Kalamazoo. Even an epicure's assortment of Cheddar, Roquefort, Gruyere, Limburger, and bacon rind failed to lure their little noses under the spring. But one night the housewife in question noticed the marks of two tiny incisors on a scrap of shiny aluminum foil sticking to a piece of cheddar. Realizing then that the mice were rebelling at the lack of modern packaging on their bait, she wrapped each tempting morsel in bright clean Alcoa foil before putting it back on the trigger. That night the mice succumbed and met their doom.

Packaging and polish attract women, too. Spend a few extra minutes cleaning the glass and polishing the cabinet of each TV set you handle, and notice how much easier it is to get payment in full.

MARKUS · · *Dollar and Sense Servicing*

Rms AC voltage ranges: 0 to 1.2, 6, 12, 60, 300, 1200 volts. Input-impedance characteristics on rms AC ranges are:

RANGE (volts)	IMPEDANCE CHARACTERISTICS
up to 60	3 megohms, 90 mmf
300	1 megohm, 70 mmf
1200	4 megohms, 67 mmf

Peak-to-peak AC voltage ranges: 0 to 3.2, 16, 32, 160, 800, 3200 volts. Input-impedance characteristics on these ranges are:

RANGE (volts)	IMPEDANCE CHARACTERISTICS
up to 160	6 megohms, 90 mmf
800	1 megohm, 70 mmf
3200	4 megohms, 67 mmf

Resistance ranges: 0 to 1000, 10,000 ohms; 0 to 1, 100, and 1000 megohms.

High-frequency probe ranges: 0 to 1.2, 6, 12, 60, and 300 volts rms. These ranges require the use of the Model RF-10A high-frequency probe which is optional accessory equipment. Input capacity of this probe is stated to be approximately 5 micromicrofarads.

The eight-position function-selector switch is marked as follows: OFF, ZERO CENTER, OHMS, -DC, +DC, AC RMS, AC P-P, HF PROBE.

The ZERO ADJ and OHMS ADJ controls are recessed into the front panel.

A P-P (peak-to-peak) reset button provides for fast return of the pointer to zero position after a peak-to-peak voltage reading has been made.

The 5 1/4-inch meter is mounted in a molded black phenolic case measuring 5 3/8 by 7 by 3 1/2 inches. Panel markings are deeply engraved for maximum legibility and long life.

Accessories in addition to the Model RF-10A high-frequency probe already mentioned are a Model TV-8 60-kilovolt safety probe and a Model ST-1 snap-on foldaway tilt-stand.

PAUL C. SMITH

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	41	44
1X2	5	1
1X2A	4	5
c1X2B	-	-
c3A3	-	-
*3BC5	-	-
*3BN6	-	-
*3CB6	-	-
*5J6	-	-
c5U4G	47	49
*5U8	-	-
5V4G	7	-
5Y3GT	4	2
6AB4	3	2
6AC7	7	7
c#6AF4	3	3
6AG5	29	9
6AG7	2	2
6AH4GT	3	4
6AH6	7	9
6AK5	4	3
c6AL5	74	74
6AL7GT	5	-

	46-55 Models	52-55 Models
c6AM8	-	-
#6AN4	-	-
c6AN8	-	-
6AQ5	13	14
6AQ7GT	2	2
6AS5	2	2
c6AS6	-	-
6AT6	4	3
c6AU4GT	-	-
6AU5GT	4	4
c6AU6	127	118
6AV5GT	2	3
c6AV6	16	17
*6AW8	-	-
6AX4GT	10	9
6AX5GT	1	2
6BA6	13	10
6BC5	9	7
c6BC7	-	-
c6BD4	-	-
6BE6	6	7
6BG6G	12	6
6BH6	7	-
6BJ6	1	-

	46-55 Models	52-55 Models
c*6BJ7	-	-
6BK5	2	3
6BK7	3	5
6BK7A	2	2
6BL7GT	5	8
6BN6	4	4
*6BQ6GA	-	-
6BQ6GT	19	26
6BQ7	6	12
c6BQ7A	5	5
c6BY6	-	-
6BZ7	6	7
6C4	10	9
c6CB6	106	138
c6CD6G	9	10
6CF6	1	1
c6CL6	1	2
6CS6	1	1
*6CU6	-	-
c*6DC6	-	-
6J5	3	3
6J5GT	1	1
6J6	32	29
6K6GT	15	9
6S4	9	10
6SH7GT	1	-
6SL7GT	3	2
c6SN7GT	71	78
6SN7GTA	5	5
6SQ7	2	2
6SQ7GT	2	2

	46-55 Models	52-55 Models
#6T4	-	-
6T8	13	14
c6U8	8	10
6V3	2	3
6V6GT	20	19
6W4GT	27	29
6W6GT	6	11
6X5GT	1	1
6X8	5	7
6Y6G	3	1
7N7	2	-
c12AT7	14	13
c12AU7	45	32
12AV7	3	3
12AX4GT	2	4
12AX7	4	5
12AZ7	-	2
*12B4	-	-
c12BH7	9	13
12BY7	5	6
12BZ7	2	-
*12L6GT	-	-
12SN7GT	5	4
*12W6GT	-	-
19BG6G	3	-
*25BK5	-	-
25BQ6GT	3	4
*25CU6	-	-
25L6GT	5	5
25W4GT	1	1
5642	1	1

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

* New tubes recently introduced.

c Tubes used in color television receivers.

Shop Talk

(Continued from page 5)

a certain channel, let us say channel 3, the video carrier will be at 61.25 megacycles; the oscillator signal will be at 107 megacycles; and the image signal, if any, will be at 107 megacycles plus 45.75 megacycles, or 152.75 megacycles.

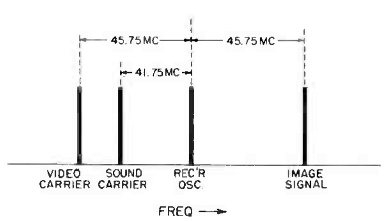


Fig. 3. Frequency Spectrum Showing Relationship Between the Desired Incoming Signal and an Image Signal.

The method of determining the image-rejection ratio is carried out as follows. The receiver is set to receive a signal on one of the VHF or UHF channels. The signal generator, on the other hand, is tuned to the image frequency for that channel. Generator output is increased until an indication is obtained from the receiver. The setting of the fine-tuning control on the receiver is not shifted from the position at which the control was set for reception of the normal signal. With the signal modulated, attempt to obtain at the picture tube an output signal with an amplitude of 20 volts peak to peak. Note how much input signal is required to produce this output. This amount of input signal divided by the amount of input signal at the channel frequency represents the image-rejection ratio.

If it is not possible to develop at the picture tube an amplitude of 20 volts peak to peak with an input signal at the image frequency, strive for a lower amplitude, let us say 5 or 10 volts peak to peak. Then determine how much input signal at the channel frequency is required to produce the same output; and from these two input signals, the desired ratio can be obtained.

IF Rejection Ratio

Another important gauge of the ability of a receiver to reject interference is the IF rejection ratio. This is the ratio between the normal receiver sensitivity and the sensitivity to a signal at the intermediate frequency. The procedure is carried out in the same manner as for the image-rejection ratio, except that the generator is tuned to the intermediate frequency which produces the greatest output in the receiver. Again, the generator should be set up to provide the standard output (20 volts peak to peak). If this value is not obtainable, the maximum output is recorded. Then, set the generator to the video-carrier frequency of the channel, and adjust the generator to produce the same output at the picture tube. The ratio between the two input signals (the IF input signal and the normal input signal) is the IF rejection ratio.

AGC Figure of Merit

The ability of the AGC system to maintain a constant output with different levels of input signal can be evaluated. The Hazeltine Laboratories employ what they call an "AGC figure of merit." The greater this figure of merit, the more efficient the AGC system. The figure is determined in the following way.

With an equipment setup similar to that for a sensitivity measurement, the receiver is adjusted for operation on a particular channel. The level of the input signal is set to .1 volt (100,000 microvolts), and the contrast control of the receiver is adjusted so that there will be no overloading of the video amplifier. It is usually sufficient to set the contrast control to about 40 per cent of its maximum setting. The level of output signal is recorded, and then the input signal is gradually reduced until the output signal falls to 31.5 per cent of its previous value. The AGC figure of merit is recorded as the decibel equivalent of the ratio between the original input signal (100,000 microvolts) and the input signal required to produce this output change. The more the input signal has to be reduced to obtain this change, the greater the AGC figure of merit, and the more efficient the AGC system.

It should be noted that with simple AGC systems, sine-wave modulation of the input signal is satisfactory; however, with keyed AGC systems, a pulse type of modulation is essential.

There are many other performance tests which may be made on receivers, but more elaborate equipment is required. For the tests described, only a VTVM or scope and a signal generator with a calibrated output level are needed.

SUMMARY OF HAZELTINE REPORT

Each year since 1950, the Hazeltine Research Laboratories have issued a report concerning American-made television receivers, as checked in their laboratories. Some of the results are shown in Table I.

Let us consider some of the results obtained for receivers made during 1953. The report shows that 67 per cent of the sets employed 21-inch picture tubes, 27.5 per cent used 17-inch tubes, and 5.5 per cent had 24-inch tubes. All receivers were intercarrier sets. Of these, 71 per cent had an intermediate frequency of 40 megacycles, and 29 per cent had an intermediate frequency of 20 megacycles. Furthermore, the trend toward fewer tubes was indicated by the fact that 67.5 per cent of the sets tested had three tubes in their IF stages; whereas, only 32.5 per cent had four tubes.

The average receiver sensitivity to a video signal is given in this report as 91 decibels for channels 2 through 6 and as 86 decibels for channels 7 through 13. To interpret these decibel values, it is first necessary to know that each decibel figure represents the ratio between 1 volt and the input voltage needed to produce 20 volts peak to peak at the picture tube. For example, over channels 2 through 6, the input signal had a level which was 91 decibels below 1 volt. The figure of 91 decibels represents a voltage ratio of approximately 35,000. If we change 1 volt into 1,000,000 microvolts and divide by 35,000, we see that the level of the input signal was 28 microvolts.

For channels 7 through 13, the signal level was 86 decibels below 1 volt. The figure of 86 decibels represents a voltage ratio of 20,000, and this latter ratio divided into 1,000,000 microvolts gives a result of 50 microvolts which was the input level needed on the higher VHF channels to produce 20 volts peak to peak at the picture tube. This system of using decibel values below 1 volt to designate signal levels may appear awkward at first; however, if the voltage ratios that correspond to 10-, 20-, 30-, and 40-db values and so on are calculated, there will appear a repetitive pattern which makes the system rather simple to use.

TABLE I

Comparisons Drawn by Hazeltine Research Laboratories From Sample Groups of American TV Receivers Made in 1953 and 1954

DESIGN FEATURES	1953 RECEIVERS IN GROUP SAMPLED		1954 RECEIVERS IN GROUP SAMPLED	
	(per cent)	(average)	(per cent)	(average)
17-inch tube	27.5		42.4	
21-inch tube	67.0		50.0	
24-inch tube	5.5		3.8	
27-inch tube			3.8	
20-mc IF	29.0		50.0	
40-mc IF	71.0		50.0	
3-tube IF system	67.5		96.2	
4-tube IF system	32.5		3.8	
VHF cascode RF stage	not given		61.5	
VHF pentode RF stage	not given		38.5	
IF bandwidth at 6 db down		3.45 mc		3.25 mc
AGC figure of merit		64 db		63 db
Total power consumption		198 watts		166 watts

The foregoing results are average figures for a group of typical receivers. Some sets were obviously better than the average; some were worse.

On the UHF channels, the same group of sets had sensitivities that ranged from 8 to 10 decibels lower than their VHF sensitivities. A figure of 8 decibels is equivalent to a voltage ratio of approximately 2.5, and a figure of 10 decibels corresponds to a voltage ratio of 3.2.

The following are some additional facts concerning the averages for these typical receivers that were investigated.

1. Image-rejection ratios for the lower VHF channels averaged about 55 decibels. In terms of voltage, this represents a ratio of 560, which means that an image signal would have to be 560 times stronger than the desired signal in order to produce the same voltage at the picture tube as the desired signal produces. On the higher VHF channels, the average image-rejection figure was about 48 decibels. Note that this corresponds to a voltage ratio of 250, and hence an image signal would have to be only 250 times stronger than the desired signal. This degradation of the image-rejection ratio when the frequency increases is characteristic of all television receivers. In the UHF band, the rejection ratio drops to 33 decibels at 500 megacycles; and at 850 megacycles, it is a mere 20 decibels. The latter decibel value corresponds to a voltage ratio of only 10 to 1, which is one of the reasons that UHF television is experiencing as much trouble as it is.

2. Representative IF rejection ratios did not decrease consistently with increase in channel frequency. They were:

Lower VHF channels	—	59 db
Upper VHF channels	—	63 db
In UHF band	—	41 db

3. The average IF bandwidth at 6 decibels (50 per cent down) was 3.45 megacycles.

4. The AGC figure of merit was greater than 64 decibels. This means that the input signal had to be decreased to about 1/1600 of its original value in order for the output of

the receiver to decrease to 31.5 per cent of the original output voltage. This efficiency in AGC action can be considered very good. For example, if we started with an input signal of 100,000 microvolts, then this signal could have been reduced to 60 microvolts in order for the output signal to drop 68.5 per cent.

It may be of interest to compare some average characteristics of 1953 and 1954 television receivers. This is done in part in Table I, and even a casual perusal reveals a number of interesting facts. For example, the proportion of sets with 17-inch picture tubes rose from 27.5 per cent in 1953 to 42.4 per cent in 1954. On the other hand, the number of 21-inch sets dropped almost the same amount. The trend toward larger screens, which was so noticeable in recent years, seems to have been halted for the present.

Another item of interest is the fact that 61.5 per cent of all VHF tuners in 1954 receivers were of the cascode variety and 38.5 per cent were of the pentode variety. Since the noise factor of cascode tuners is 2 to 3 decibels lower than that of comparable pentode tuners, one may wonder why cascode tuners were not used exclusively. The answer can be found in two facts. With many TV stations markedly increasing their effective radiated power, the need for low-noise tuners is not so great today as it was perhaps two or more years ago. Secondly, emphasis in recent months has been placed on lowering set cost, as all of us in the industry know. This has led to the development of the vertical chassis and to the increasing use of printed circuitry, since the latter can be fabricated automatically. It has also led to the favoring of pentode tuners because they can be produced more cheaply than cascode tuners.

Another indication of the economy trend is the increase in the number of sets using a 20-mc video IF system. In 1953, only 29.0 per cent of the sets that were checked utilized a 20-mc IF system; and 71.0 per cent had a 40-mc system. In 1954, the percentages stood at 50 per cent each. A 20-mc system is cheaper to build, and it will provide more gain (for the same number of stages) than a 40-mc system. Practically all 1954 receivers used a three-tube video IF system compared to only 67.5 per cent in 1953.

One would surmise from these figures that 1954 receivers were not so sensitive as 1953 sets, and this belief is substantiated by comparing the picture and sound sensitivities for the two years. On the average, 1954 sets were 1 to 2 decibels (10 to 20 per cent) less sensitive than their 1953 counterparts. (If the television industry stressed receiver sensitivity in sales campaigns as much as automobile manufacturers stress horsepower, we would have had some very interesting sales copy, indeed!)

To recover some of the lost gain caused by the preceding economies, over-all IF bandwidth dropped from 3.45 megacycles in 1953 to 3.25 megacycles in 1954. This helped, but it was not enough to recapture fully all of the lost sensitivity. Actually, the only persons who were noticeably affected by this cost cutting were those who lived in fringe areas. In most of the television areas throughout the country, the lowering of set characteristics could not be visibly detected by any one not professionally in the servicing or engineering end of the business. The resulting economy not only gave the public more set per dollar spent, but it also enabled the set manufacturers as a whole to have the second best TV year in their histories.

MILTON S. KIVER

In the Interest of Quicker Servicing

(Continued from page 23)

A defect in the oscillator coil is a common cause of drift of oscillator frequency. The reason for this seems to be that when some coils heat up, the windings on the coils may expand. This expansion causes a change in the distributed capacitance between windings. Although the change in capacitance may be only two or three micromicrofarads, it is enough to cause a change in oscillator frequency, particularly when the radio is tuned to some station at the high-frequency end of the broadcast band. The tuning capacitor of the oscillator is almost fully open at this time, and its capacitance may be approximately 20 micromicrofarads. The 2-mmfd change in distributed capacitance in the oscillator coil would represent a change of 10 per cent in the tuning capacitance of the oscillator. The change in frequency would be appreciable.

When the radio is tuned to a station at the low-frequency end of the broadcast band, the tuning capacitor of the oscillator may have a capacity of approximately 180 micromicrofarads or more. Under this condition, the 2-mmfd change in distributed capacitance represents only 1.1 per cent or less of the total capacitance. Hence, frequency drift may not be so noticeable when stations at the low-frequency end of the broadcast band are received.

The trimmer capacitor in the oscillator circuit should never have to be tightened excessively in order to obtain proper alignment. When such a capacitor is tightened to maximum, it becomes more susceptible to temperature changes and a drift problem can arise. Changes in temperature cause either expansion or contraction of the parts of a capacitor. When the spacing between the plates is very small, a very slight change in the amount of this spacing will produce an appreciable change in capacitance and a consequent frequency variation. The effect of a change in spacing is less when the spacing is greater; therefore, insert a small fixed capacitor in parallel with a trimmer capacitor that is too tight. This action will permit proper oscillator alignment to be obtained when the trimmer has been adjusted to a more open position.

The following is a discussion of two interesting servicing problems related to frequency drift.

Problem No. 1

The customer complained that he always had to retune the radio to a station several times during the first fifteen minutes after turning on the radio. When he first turned on the receiver, he tuned in the station; then during the time that the radio warmed up, the station signal would fade and have to be tuned in again. Incidentally, it so happened that all of the radio stations in this particular city were operating on frequencies above 900 kilocycles; and the drift was much more noticeable than it would have been if the station frequencies were below 900 kilocycles.

The technician suspected that the trouble was instability of the oscillator. Not being positive about this, he decided to try out the checking system that we have discussed. He obtained a second receiver to be used in the process, turned it on, and tuned in a station at a frequency of 1490 kilocycles. Next, he tuned the set under test to a frequency of 1035 kilocycles and obtained a zero beat in the second set. He then left the two receivers to operate for a short while. It was not long before the second set started to buzz. The buzz became a squeal and then a whistle and kept climbing in pitch until it could no longer be heard. As a result, the technician was sure that the trouble was in the oscillator.

The oscillator circuit of the defective radio consisted of only four components other than the tube, as may be seen in the partial schematic diagram in Fig. 3. These components were: the grid resistor R1, the oscillator coil L2, the oscillator tuning capacitor C3, and the trimmer capacitor C4.

The tuning capacitor was eliminated as a possible cause of the trouble because the value of such a

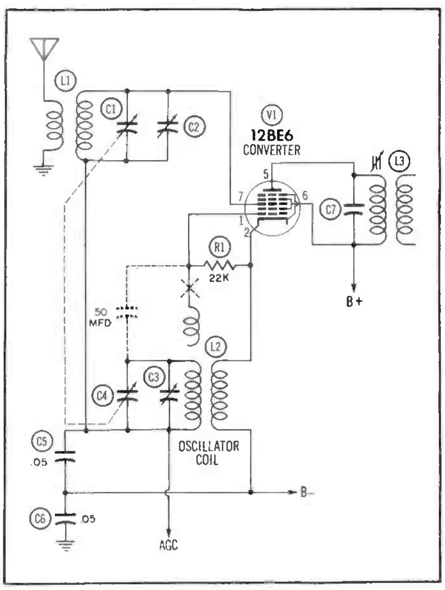


Fig. 3. Typical Converter Stage in AM Radio.

capacitor does not normally change as a result of the temperature variations in a radio. It also seemed that the resistor R1 would be an unlikely suspect because of the large amount of heat that is usually required to cause a resistor to change value. Consequently, the only components left to blame for the trouble were L2 and C4.

The chassis was removed from the cabinet and the air stream from a hair dryer was turned directly on the coil. The heat was switched on; and as a result, the station signal faded. The heat was next turned off, and cold air was permitted to blow on the coil. The station came back in as the coil cooled. This test indicated that the coil was the source of the trouble.

The service technician thought that the trouble might only be in the take-off or capacity winding of the coil. The connection of this winding can be seen in Fig. 3. The winding was disconnected, and a 50-mmfd mica capacitor was connected between the top of the secondary of the oscillator coil and the grid of the converter. This capacitor is shown connected by dotted lines in the diagram of Fig. 3. The hair dryer was again used, but the station signal still faded. The coil had to be replaced.

The replacement used was a universal oscillator coil with an adjustable core and a multiple-tapped secondary. This coil did not contain a take-off or capacity winding; therefore, the 50-mmfd mica capacitor that was used in the test was left in the circuit.

Because of the construction of the replacement coil and because of the fact that this coil contained a slug for varying the inductance, it could not be mounted in the same manner as the original coil. Instead, a hole had to be drilled in the end of the chassis where the antenna loop was mounted. This new mounting may be seen in the photograph of Fig. 4.

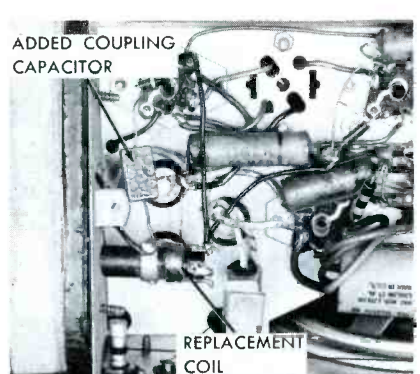


Fig. 4. Partial Bottom View of Radio Chassis Showing New Oscillator Coil and Coupling Capacitor.

The photograph of Fig. 5 shows the location of the tuning slug of the replacement coil after installation. The portion of the secondary used was selected through the printed information given with the replacement coil.

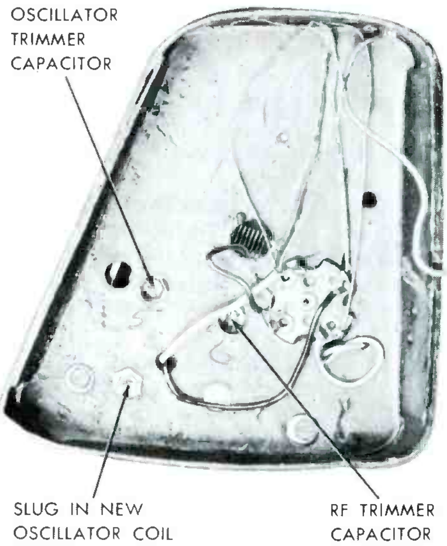


Fig. 5. Side View of Loop Antenna Showing Alignment Points.

The oscillator was aligned in the following manner. First, the IF alignment was checked in the usual way. Next, a signal generator was coupled through a capacitor to the loop antenna and was adjusted to give a modulated signal at 600 kilocycles. The receiver dial was turned to 600 kilocycles, and the slug of the oscillator coil was adjusted to obtain maximum output from the receiver. Then, the signal generator and the receiver were both set to a frequency of 1500 kilocycles, and trimmer capacitor C4 was adjusted for maximum output from the receiver. Another check of the adjustment at 600 kilocycles was made, and finally the RF trimmer capacitor C2 was set according to the standard alignment procedure.

Problem No. 2

The complaint concerning this set was the same as that for the radio discussed in Problem No. 1. When the radio was first turned on, a station was tuned in. Then after about ten minutes, the station would drift out of tune far enough that the sound would become distorted and carrier noise could be heard in the form of a hissing. This made it necessary to bring the station back in by adjusting the tuning control.

The first thought of the service technician was that there was oscillator trouble; however, when the radio was tested by using a second receiver, the output from this second receiver stayed close to a condition of zero beat. In other words, no oscillator drift was indicated. This meant that the oscillator was operating satisfactorily.

There was only one other possibility. The IF bandpass was probably shifting so that the peak response was at a frequency higher or lower than the rated intermediate frequency. This condition occurs very rarely, a fact which makes the trouble even more difficult to diagnose when it is encountered. Certainly, the IF amplifier tube could not cause this condition because it has very limited frequency-determining properties. The source of trouble had to be in the IF transformers. When the transformers were replaced, the detuning effect in the radio disappeared.

The symptom most commonly encountered when the resonant frequency of an IF transformer varies is a loss in selectivity. This loss is caused by the broadening of the overall IF response. The best method to check such a condition is to use a sweep generator, marker generator, and oscilloscope. If a broadening of the IF response occurs as the radio warms up, it will be detected on the oscilloscope.

IN THE HOME

Low-Voltage Rectifiers in Philco Model 50T1600 Code 122

A service technician recently made a call to service a Philco television receiver, Model 50T1600 Code 122. The receiver was an older model that used as low-voltage rectifiers three 5Y3GT tubes connected in parallel.

The customer's complaint was that the set had very weak sound and no picture. Close examination of the receiver showed that one of the 5Y3GT tubes glowed with a purplish light, a symptom which usually indicates tube failure due to excessive gas.

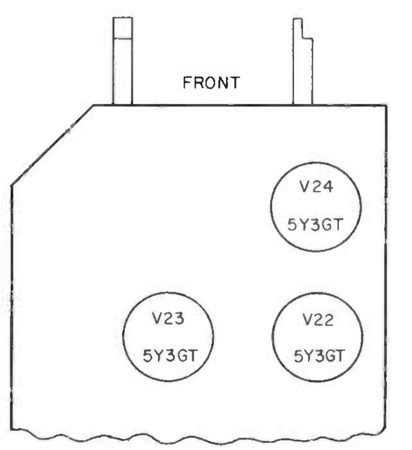


Fig. 6. Partial Tube Layout Showing Location of Three Low-Voltage Rectifiers.

Since the three rectifier tubes were connected in parallel, the technician felt that all three should be replaced in order to eliminate the danger of a weak tube causing a repeated failure; but investigation of the service kit revealed that there were only two 5Y3GT tubes in stock. Rather than take a chance on a combination of two new tubes and one old one, the technician decided to make an experiment.

If the drawing in Fig. 6 is consulted, the layout of the original three rectifier tubes will be found on the right front corner of the chassis. The electrical hookup of this system is shown in Fig. 7. The technician installed two 5U4G tubes in the sockets formerly occupied by V23 and V24. This was done to keep the larger 5U4G tubes from touching one another. Two 5U4G tubes draw the same heater current that three 5Y3GT tubes do; therefore, the drain on the power transformer was not altered and a satisfactory repair was achieved. Since the total DC current capacity of two 5U4G tubes exceeds the capacity of three 5Y3GT tubes, longer rectifier life can be expected; and the cost of two 5U4G tubes is about the same as that of three 5Y3GT tubes.

Replacement of 6SN7GT Vertical-Output Tube

A number of receivers use a single 6SN7GT tube as a vertical oscillator and vertical-output amplifier. In this application, the older type of 6SN7GT tube frequently fails for one reason or another. The new 6SN7GTA tube with its higher ratings and more rugged construction should prove to be far superior and should reduce the number of failures of tubes in this application.

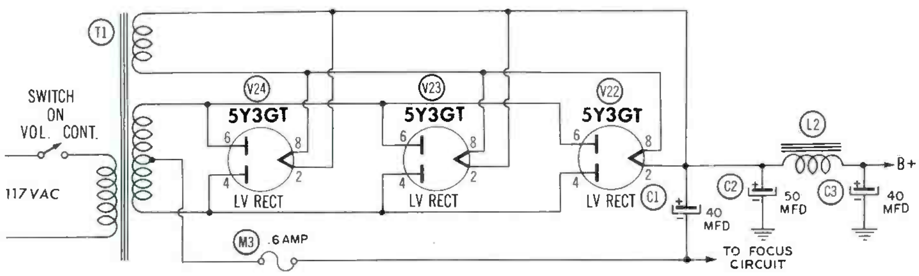


Fig. 7. Schematic Diagram of Low-Voltage Supply in Philco Model 50T1600 Code 122.

Isolation of Antenna Troubles

Flashing or streaks through the picture and certain other troubles are often caused by trouble in the antenna system. If the technician is not careful, a considerable amount of time can be wasted looking for the trouble in the television receiver.

A good procedure to follow, when there is a possibility that the antenna system is causing the trouble, is to check it first. In this way, the trouble can definitely be isolated.

Trouble in the antenna system may be caused by a loose or broken connection, by a broken wire in the lead-in, by the lead-in wire rubbing a metal gutter, or even by foliage from a tree brushing against the antenna or lead-in. The checking of each part of the antenna could require a considerable amount of time and, in fact, could require a two-man crew. Obviously, it is not usually possible on a service call to have the extra man.

In local reception areas, substitution of an indoor antenna of known good quality will show whether or not the original antenna is at fault.

NOTE: An indoor antenna which the customer just happens to have should not be used in this testing because it may also be faulty.

In suburban or fringe areas where the signal is too low to get dependable reception with an indoor antenna, the antenna system can be checked by use of a field-strength meter. Disconnect the lead-in from the receiver at a point indicated in Fig. 8, and connect the field-strength meter to the antenna lead-in wire. A fluctuating or very low reading would indicate possible trouble in the antenna system.

Another method of testing the antenna system is to use a test receiver (a small portable television receiver) to check the antenna system.

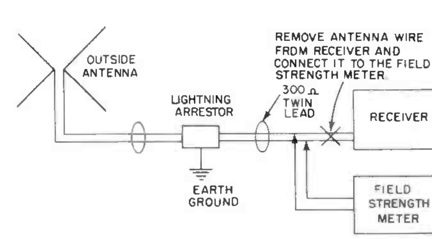


Fig. 8. Setup Used When Connecting Field-Strength Meter to Check Outside Antenna.

If the trouble does not show up in the test receiver, then the customer's receiver can be assumed to be at fault.

Other Uses for Field-Strength Meter

The field-strength meter can be used in orienting the antenna to pick up a maximum signal. This is especially important if no rotator is used. It is also important that the antenna be located at the right height, since the signal strength may vary greatly at different heights.

A battery-operated field-strength meter is very handy because it requires no AC power, and thus a long power cord is not needed. In fact, the technician could use a battery-operated unit on the roof; and this would make it possible for a single man to install and orient a small antenna system properly. In the more complex systems using high masts or towers and heavy antennas, two or more men would be required.

"Plus" Services

In making home service calls, the most important job the technician must perform is satisfying the customer. Anything and everything that the technician says or does as a "plus" service should be done with this in mind. There have been cases in which excellent technicians have repaired receivers perfectly and did not achieve customer satisfaction. In this type of case, the lack of customer satisfaction may have been caused by the failure of the technician to attend to some minor details.

Whether the service call is for a new customer or for a former one, the technician should always notice such small details as an inoperative pilot light or channel-indicator light, and he should replace all faulty units.

The light that illuminates the channel numbers is often the only pilot light employed; and when this unit is inoperative, it may be very difficult to see the different channel numbers. This replacement will cause the customer to remember the service rendered because each time he changes channels he will notice the new pilot light which makes it easier for him to see the channel numbers.

Another place where attention to detail is important is the face of the picture tube and the safety glass. These may be dirty especially if it has been some time since the receiver was last serviced. Whenever the picture-tube face and safety glass are visivly dirty, they should be cleaned. A discussion about cleaning the picture-tube face and safety glass was presented in the article "In the Interest of Quicker Servicing" in the December 1954 issue of the PF REPORTER.

The cabinet of the receiver is another place where small services will cause the technician to be remembered. Products that can be used to hide scratches are available at most local distributors of electronic parts. One such product is called a "Scratch Stik" and is made by the General Cement Mfg. Co. See Fig. 9. It is made in walnut, oak, and mahogany stains which match most of

Fig. 9. "Scratch Stik" Made by General Cement Mfg. Co.

the cabinet finishes that are in common usage. This unit consists of stain in a hard form on one end and an oil-impregnated felt dauber on the other end. Through the use of a "Scratch Stik," small scratches can be stained and filled in so that they are almost invisible. Should a small scratch be located so that it is visible from the front of the receiver, the customer would be very pleased to have it covered up.

There are repair kits available which will make it possible to fill in large scratches and to eliminate other cabinet faults when properly used. A technician should be thoroughly familiar and experienced with this type of equipment before attempting to make a repair on a customer's cabinet.

Always be careful to ask the customer what his specific complaint is and to remedy that trouble first. When this has been done, give the receiver a complete checkup to make sure that all controls operate properly and that no other troubles exist in the receiver.

In addition to generating good will, this procedure will also help sell service and replacement parts and may reduce call backs within the guarantee period.

HENRY A. CARTER and

CALVIN C. YOUNG, JR.

Removing the TV Chassis

(Continued from page 13)

that there will be no danger of snagging and thus breaking it. Fig. 3 illustrates an antenna lead that has been secured before removal of the chassis in order to avoid snagging.

The speaker leads are the next to be disconnected, if the speaker is not mounted on the chassis. If you are not familiar with the receiver and are not sure where these leads are to be disconnected, check at the speaker first. If the leads do not disconnect there, then trace them until the point is located. Disconnect and dress them in order to prevent difficulty when the chassis is removed.

On some combination sets, a single speaker is used for the radio, phonograph, and television sections; and in such cases, it is possible that there may be more than one set of leads connected to the speaker. Make sure that only the correct ones are disconnected.

After the speaker leads are disconnected, then disconnect all radio or phonograph cables that are connected to the TV chassis. Remember that not all of the cables may emerge from the back of the chassis where they would be in plain sight; therefore, you may have to look for them elsewhere. On some combination models, cables may run directly through the panel that separates the television and the radio or phonograph sections or down through the shelf on which the chassis rests; therefore, look for them there.

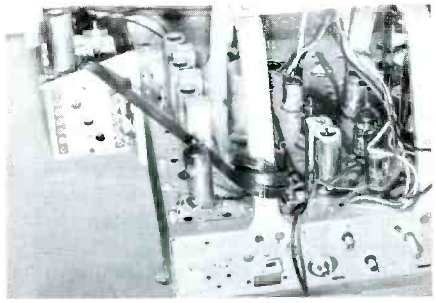


Fig. 3. Antenna Lead Secured to Prevent Snagging.

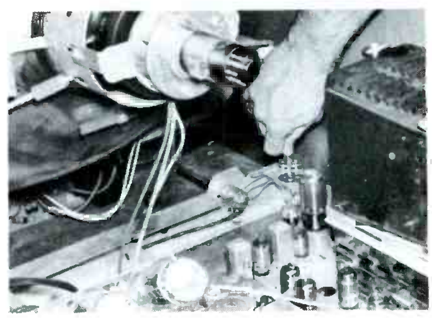


Fig. 4. Disconnecting the HaloLight Cable.

Many console television receivers have a phono socket and switch, and the customer may have an auxiliary unit plugged into this socket. Be sure that any such unit is unplugged and that the lead is properly dressed out of the way.

All accessories such as remote pilot lights, remote-control cables, the HaloLight in Sylvania receivers, and any others should be disconnected. Some of the RCA Victor console models have a small pilot light located at the bottom center of the cabinet; and unless a service technician is very careful or thoroughly familiar with these models, it is easy to overlook this light and thus damage the leads when the chassis is removed. In some Philco models, the pilot light that illuminates the channel numbers is secured to the cabinet and must be disconnected before the chassis is removed.

Many Sylvania models have the HaloLight feature. The cable for this assembly usually plugs into the front corner of the chassis, and the chassis must in most cases be pulled out slightly so that this cable can be reached. Remember to pull out the chassis only a very short distance because moving it too far while the cable is still connected could seriously damage the HaloLight assembly. See the illustration in Fig. 4 which shows the HaloLight cable being disconnected.

Special Problems with Cabinet-Mounted Picture Tubes

If the picture tube is cabinet mounted, then the leads of the yoke, of the picture-tube socket, and of the focus coil (if used) should be disconnected and dressed so that they will not snag when the chassis is removed.

Some receivers which have the picture tube mounted in the cabinet employ bonding straps between the chassis and the mounting brackets for the picture tube or even between the chassis and the band around the front of the tube. All of these bonding straps should be disconnected.

The type and nature of the trouble will determine whether or not the focus assembly or yoke or both should be removed and taken into the shop with the chassis. In all cases in which the nature of the trouble is such that these units are not involved, they should not be taken to the shop. This is true because a standard replacement yoke which most shops have on hand will be suitable to connect for most testing purposes. When the focus assembly and yoke are removed from the cabinet, they must be reinstalled and adjusted. This is a time-consuming job.

In the past, it has been considered necessary to take the picture tube into the shop for the correction of certain video and synchronization problems. As previously mentioned, the removal of the picture tube makes it necessary to reinstall and adjust units when the chassis is returned. In view of this, the TV-receiver check tube 5AXP4 that Sylvania has recently placed on the market is a very valuable accessory. This substitute picture tube was discussed in the January 1955 issue of the PF REPORTER. It is a universal type and will function with any size or type of television receiver that employs magnetic deflection, and it should therefore be a valuable asset.

Some receivers may have filter chokes or audio output transformers mounted on the speaker frame. If they do have, the service technician must remove the speaker and take it to the shop for most repairs, unless some arrangement has been made at the shop to have a suitable substitute to use. A substitution unit for the speaker was described in the article entitled "A Universal Substitute Speaker" in the April 1954 issue of the PF INDEX. The use of such a unit would eliminate the need for removing any speakers unless one were suspected as being defective. Leaving speakers mounted eliminates the risk of damage in transit or even in the shop.

Removal of Chassis Bolts

There may be any number from four to almost a dozen bolts holding down the chassis. For the most part, these bolts have hexagonal heads; and the heads will usually be either 5/16, 3/8, or 1/2 inch in size. The bolts may be easily removed with a standard driver of the correct size. There are cases, however, when the bolts will have heads of the Phillips type and will require a Phillips screwdriver for removal. Using a driver of the proper size and type will guard against damaging the head of the bolt. A damaged head makes a bolt difficult to remove. In addition to this, there is always the risk that a screwdriver that is too small may be broken if used on bolts that are too large.

Fig. 5. Set of Socket Wrenches Made by Sylvania Electric Products Inc.

Some of the earlier Motorola combination models used a lowboy type of cabinet in which the chassis is very close to the bottom of the cabinet. In these models, a standard size of nut driver is too long to be used in removing the chassis bolts. These bolts may be removed by using either a short stubby nut driver or a socket wrench of the type shown in Fig. 5. The socket-wrench kit shown in this figure is a service kit which is available from many distributors, and similar kits are also sold by hardware stores. A kit such as this would have many other applications and should prove valuable when bolts or nuts are to be removed from places where a good grip on the handle of a nut driver is not possible or where a standard tool is too long to be used.

Balance the Chassis in Removal

After the bolts are all removed, the chassis may be slipped out of the

Fig. 6. Balancing a Chassis During Removal.

cabinet. If there are accessories connected at the front, do not forget to slip the chassis out a few inches and disconnect the cables before proceeding to remove it.

Many receivers have large heavy power transformers mounted in a rear corner or at one side of the chassis. When removing the chassis, the service technician should always grasp it in such a way that it will be balanced; otherwise, it might tip and the technician might drop it. Fig. 6 is an illustration of a chassis being balanced properly during removal. Note that one hand is placed near the power transformer and that the other hand is at the opposite corner under the face of the picture tube.

If it is necessary to set down the chassis after it is removed from the cabinet, a drop cloth or several pieces of newspaper should have been placed on the floor previously in order to prevent damaging the floor or soiling the rug.

Storage of Knobs and Hardware

After the chassis is removed, the knobs and all hardware except two screws should be placed in a container and set inside the cabinet where the chassis formerly rested. An example is shown in Fig. 7. The back cover should then be secured in place with the two screws. This procedure will ensure that all of the hardware and knobs will be available when the chassis is returned.

Special Cases

Some of the new table models with vertical chassis are treated somewhat differently than those with horizontal chassis. Instead of removing the chassis from the cabinet, the cabinet is removed from the rest of the receiver. Usually these table models are carried to the shop in their cabinets, and chassis removal is done at the shop.

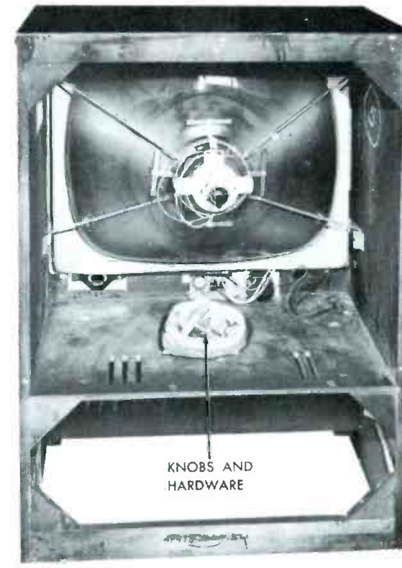


Fig. 7. Storage Place for Knobs and Hardware.

Some of the new Zenith table models have the cabinet constructed in three pieces: (1) the front or mask and safety glass; (2) a piece of metal that forms the top, bottom, and sides; and (3) the back cover. The first two of these pieces are shown in Fig. 8. To take one of these receivers apart,

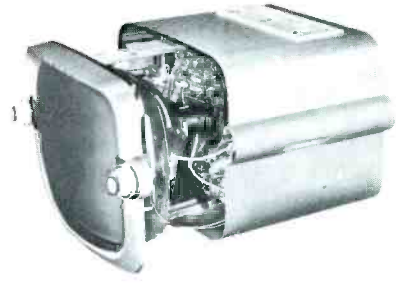


Fig. 8. Zenith Table-Model Receiver Partially Disassembled.

first remove the screws holding the back cover, then remove the four knobs that come through the top of the cabinet, and disconnect the speaker leads. Remove the remaining four screws that are in the back edge of the cabinet. The metal piece that forms the top, bottom, and two sides may then be pulled to the rear and removed. This leaves the chassis, the picture tube, and the front piece as one assembly.

To remove the cabinet from one of the Hallicrafters and the Crosley table models which have the vertical chassis, remove the back cover and the knobs. Disconnect the speaker leads, and remove the bolts from around the outer edge of the bottom of the cabinet. The cabinet

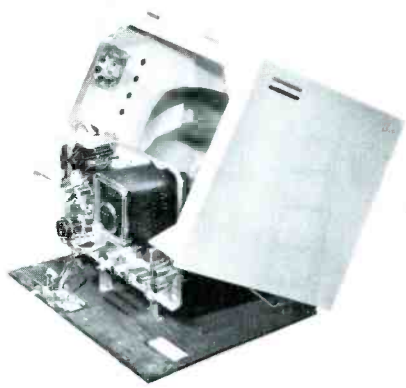


Fig. 9. Hallicrafters Table-Model Receiver Partially Disassembled.

can then be removed by pulling it up and toward the front. This is shown in Fig. 9. Removal of the cabinet leaves the chassis and picture tube mounted on the bottom board.

Returning the Chassis

After the chassis has been properly repaired in the shop, it must be taken back and reinstalled in the cabinet. Generally, it is impossible to carry both the repaired chassis and the tool kit into the customer's home in one trip; therefore, it is good practice to carry the tool kit into the home first and to perform certain preliminary tasks before carrying in the chassis. If the speaker was removed and taken to the shop, it could also be carried in with the tool kit and installed first, because it is often easier to install the speaker before installing the chassis. Refer to Fig. 10 for an illustration of the speaker being installed. Always position the speaker so that the wire terminals on the speaker are as near as possible to the hole which provides access to the chassis. This ensures that a maximum length of speaker cable is available for connection. Care should be exercised in order to guard against possible damage to the speaker cone when the speaker is being positioned on the hold-down studs.

In some table models, the speaker must be installed after the chassis is set in place because the chassis cannot be put into the cabinet when the speaker is in its normal position. A condition such as this should have been noted when the chassis was removed.

The cabinet should be set out away from the wall and turned so that the chassis can be readily installed. Remove the back cover, and take out the container of hardware. The hardware can be placed on the floor to one side of the cabinet where it will be readily available. Next, clean the safety glass and mask.

Prop open the entrance door of the house, or solicit the aid of the customer to hold it open. During warm weather, the chassis may then be taken into the house and immediately installed in the cabinet. This may be done because the tube face should have been cleaned in the shop and wiped off in the truck just prior to taking it into the house.

During cold weather, a problem of moisture condensation on the picture tube may be encountered when the tube is taken into a warm house. In a case such as this, the tube should be allowed to reach room temperature and then should be wiped dry before it is installed in the cabinet. A hair dryer provides a handy means of cutting short this warm-up time.

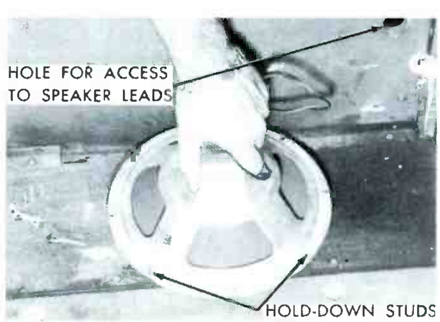


Fig. 10. Reinstalling a Speaker.

The chassis is carefully slipped forward into the cabinet. Remember to hook up any accessories that must be connected at the front of the chassis before pushing it to its normal position.

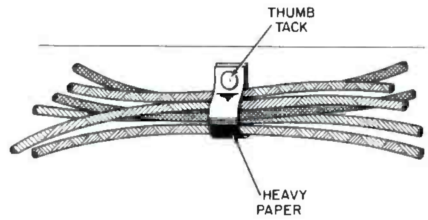


Fig. 11. Drawing Illustrating Means of Securing Cables to Cabinet.

When the chassis has been pushed forward to about its normal position, hook up the speaker, the phonograph, the radio, or any other cables. If any were originally secured to the side of the cabinet or were in clips on the chassis, they should again be secured in their former locations. In case these cables were fastened to the cabinet, a tack or wire staple will again be needed to attach them securely. Fig. 11 shows cables secured with a tack and heavy paper.

Connect the antenna lead from the tuner in its original position, connect the lead-in to the antenna terminals, and apply power to the receiver. Adjust the controls, and check for normal operation of the receiver.

Check to make sure that nothing hangs down in front of the face of the picture tube. Fig. 12 shows what happens when the dust seal that should close the crack around the face of the tube between the tube and the mask slips out of its normal position.

The chassis bolts and the knobs may next be installed. Make sure that all washers are in place on the chassis bolts. The bolts should be started carefully because the threads in the holes in the chassis can be easily stripped. Care should be taken to replace all retaining clips on the knobs in order to ensure proper operation and to guard against possible loss of the knobs.

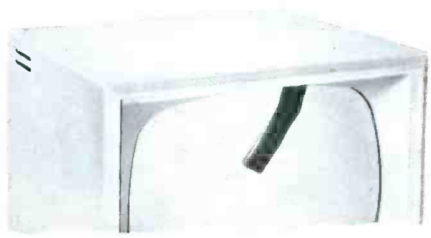


Fig. 12. Dust Seal Out of Place.

When the chassis bolts and the knobs have been replaced, apply the power and check the operation of the receiver again. If everything operates satisfactorily, remove the power cord and reinstall the back cover. Be careful not to disturb the setting of any of the rear controls, and also be careful not to bump the neck of the picture tube. If a focus adjustment shaft is provided, be sure that it is brought out through the hole provided for it. The same applies to the centering lever.

When the back has been replaced, connect the lead-in to the antenna terminals, and check the focusing and centering of the picture. If the levers for centering and focusing do not extend through the back cover, these adjustments should be taken care of before installing the back cover. With the back correctly replaced, locate the receiver in its original position or in a place specified by the customer; and the job is done.

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QUESTIONS ON PART XIII

Part XIII of the Color TV Training Series appears in this issue and should be studied prior to reading the following questions.

These questions are presented to give the reader an opportunity to test himself on the color-television material discussed in this part.

1. What new test equipment is needed for servicing color receivers?
2. How does the bandpass-amplifier section differ from a conventional video-amplifier section?
3. What effects would be noticed if the bandpass-amplifier section were misaligned?
4. What are the purposes of aligning the color-sync section?
5. What are the results which can be caused by misalignment of the color-sync section?
6. What effect will be noticed when loss of color synchronization is present?
7. What is the purpose of making the matrix adjustments?
8. If the Q demodulator interprets an I portion of the chrominance signal as being a Q portion, what effects would result?
9. If the Q reference signal is more than 90 degrees from the I reference signal, what would be the effect upon the vectors in the color-phase diagram?
10. What is the correct appearance of the waveform that is present at the grid of the blue gun during reception of a color bar pattern?
11. How does the response of the RF and IF sections of a color receiver differ from that of a monochrome receiver?
12. How could loss of color result from misalignment of the video IF section?

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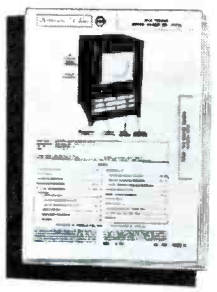

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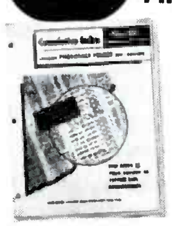

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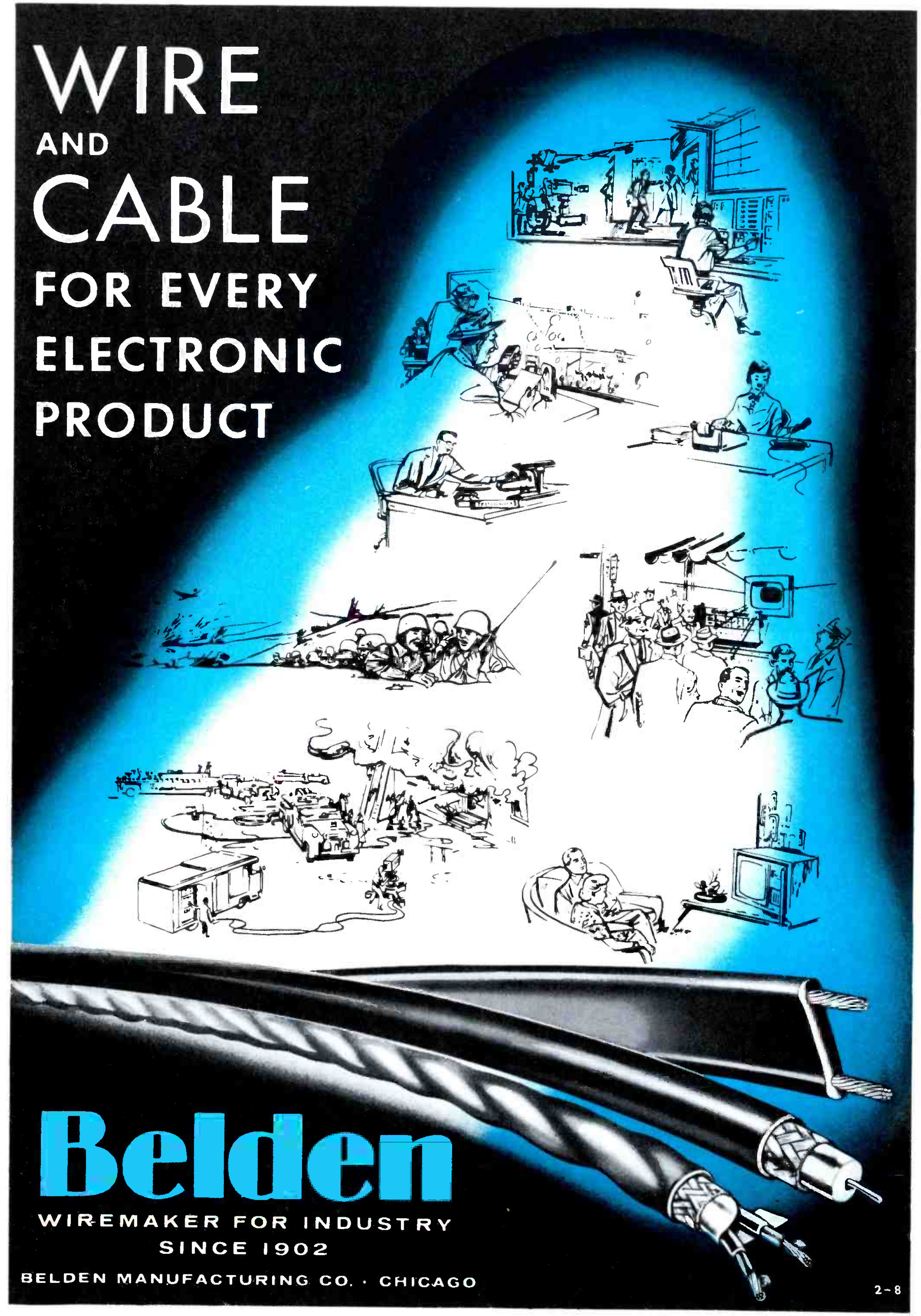

USING THE JACKSON MODELS 700

Fig. 1. The Jackson Model 700 Color-Bar Generator.

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

Fig. 3. Pattern Produced by the R-Y and B-Y Signal.

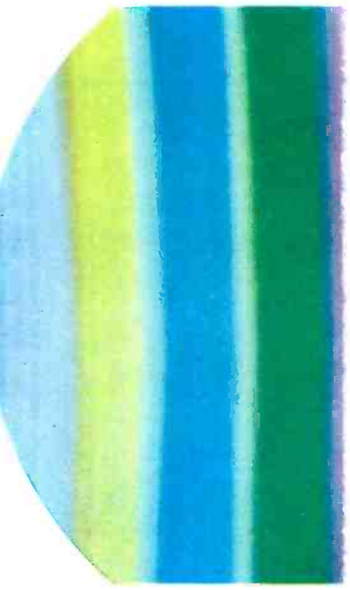

Fig. 4. Pattern Produ

GENERAL DESCRIPTION

The Jackson Model 700 color-bar generator is designed to provide a variety of color signals which can be used for adjusting and testing color receivers. The unit is housed in a cabinet designed for bench use. The cabinet, however, is equipped with a carrying handle which makes the generator adaptable for portable use. The front-panel controls are neatly arranged and clearly marked to facilitate the selection of the desired signals. Fig. 1 is a photograph of the Model 700.

The Jackson Model 712 is similar in appearance to the Model 700; however, it has an additional feature in that two signals which can be used for linearity and convergence adjustments are provided. The white-crosshatch signal can be used to adjust the sweep linearities of both monochrome and color receivers. The white-dot pattern can be used to make adjustments of the convergence in color receivers. A photograph of the Model 712 is shown in Fig. 7.

SIGNALS PROVIDED

There is a video signal of either polarity and an RF signal on channels 3, 4, or 5 available from either the Model 700 or the Model 712. Attenuators are provided to adjust the signal amplitudes for both outputs. The video signal is adjustable up to 2 volts across 90 ohms, and the RF signal is adjustable up to 100,000 microvolts across 300 ohms. A video-polarity switch is provided on the front panel so that either polarity of video signal can be obtained. The RF attenuator control has an OFF position which disables the RF portion of the generator while the video signal is being used.

The color-bar selector switch on the Model 700 has five positions. Position No. 1 is labeled MULTI, and in this position the generator produces a multibar pattern. The bars are in the following order: white, yellow, cyan, green, magenta, red, blue, and black. Fig. 4 illustrates the pattern which is viewed on a receiver that is operating normally when the switch is in position No. 1.

Position No. 2 of the color-bar selector is labeled COLOR DIFF. In this position, an I and Q signal like that seen in Fig. 2 can be obtained or an R - Y and B - Y signal like that shown in Fig. 3 can be obtained. In addition, each one of the bars can be obtained individually. This arrangement permits a positive check on the operation of the receiver without chance of error on the part of the operator in interpreting the bar pattern.

The third position of the color-bar selector produces a red bar like that shown in Fig. 28, the fourth position produces a green bar like that shown in Fig. 29, and the fifth position produces a blue bar like that shown in Fig. 30.

A sound carrier that is removed 4.5 megacycles from the video carrier can be obtained by turning the SOUND switch to the ON position. The presence of this carrier makes possible a check of the receiver to determine whether or not the sound traps are operating properly. Improper operation of the receiver will result in the production of a 920-kc beat pattern on the screen.

In order to make possible the selection either of the luminance or the chrominance signal, another switch is provided on the front panel. This switch is marked LUM. ONLY, LUM. AND CHROM., and CHROM. ONLY. The luminance signal is especially helpful when setting up the gray scale of a color receiver.

The Jackson Model 712 shown in Fig. 7 has a slightly different arrangement of the front-panel controls in order to provide the crosshatch and dot patterns. The color-bar selector is a 10-position switch and provides signals in the following order: multicolor bar, R - Y and B - Y, R - Y, B - Y, I and Q, I, Q, red bar, green bar, and blue bar. These signals are obtained when the switch for CROSSHATCH, DOT, AND COLOR BAR is in the COLOR-BAR position. By turning this switch to the DOT position, a white-dot pattern is obtained. With the switch in the CROSSHATCH position, a white-crosshatch signal is obtained. Any one of these signals is available as either a video signal of plus or minus polarity or as a modulated RF signal. The tuning dials on both the Models 700 and 712 are for the purpose of setting the RF output frequency. The carrier frequencies for channels 3, 4, and 5 are clearly marked on the dial in order to aid in tuning.

The multicolor-bar pattern generated by both the Models 700 and 712 conforms to the NTSC Standards with regard to luminance and chrominance amplitudes. All color-difference signals are produced at zero luminance and at a relative chrominance amplitude of .25. The red, green, and blue bars are produced at a luminance amplitude of .3 and at a relative chrominance amplitude of .5. These bars occupy approximately 60 per cent of the screen width.

On the rear panel of the Model 712, there are two jacks from which can be obtained the 3.58-mc subcarrier signal at burst phase and a horizontal-sync signal. The subcarrier signal can be used as a reference signal in testing color synchronizing circuits in color receivers. The horizontal-sync signal can be employed

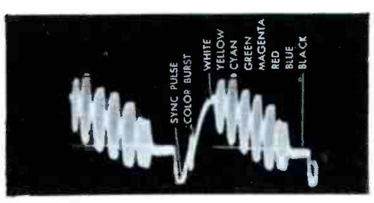

Fig. 8. Waveform Produced by the Multibar Signal.

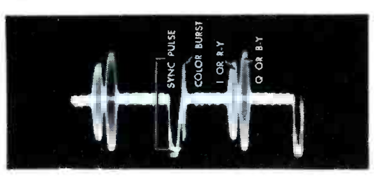

Fig. 9. Waveform Produced by the I and Q or the R-Y and B-Y Signal.

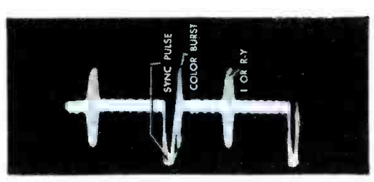

Fig. 10. Waveform Produced by the I or R-Y Signal.

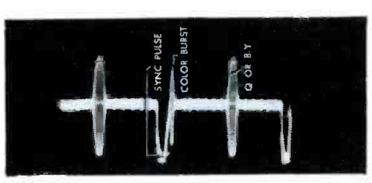

Fig. 11. Waveform Produced by the Q or B-Y Signal.

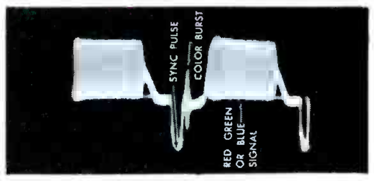

Fig. 12. Waveform Produced by the Signal Which Generates the Red, Green, or Blue Bar.

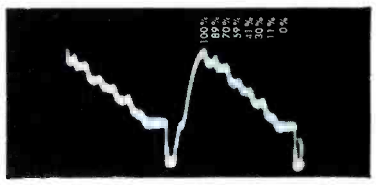

Fig. 13. Luminance Signal Only.

to synchronize the horizontal-sweep section of the oscilloscope, if desired.

Figs. 8 through 13 show the waveforms of the video signals which are available from either the Model 700 or 712. Fig. 8 shows the waveform for the video signal which is obtained in the multibar position. The sync pulse, sync burst, and various colors are identified. Fig. 9 illustrates the waveform that is obtained when an I and Q or an R - Y and B - Y signal is being produced. Fig. 10 illustrates the waveform that is obtained when an I or R - Y signal is being produced. Fig. 11 shows the waveform that is obtained when a Q or B - Y signal is being generated. Note that the individual bars shown in the waveforms of Figs. 10 and 11 are placed in the same relative positions as they were for the corresponding signals in the waveform shown in Fig. 9.

Fig. 12 shows the waveform that is produced by the signals for the red, green, or blue bar. On the oscilloscope, all of these appear the same because the only difference is in the phase of the chrominance signal. Fig. 13 shows the luminance portion of the multibar signal.

CHECKING RECEIVER OPERATION

Turn on the generator, and allow the 15-minute warm-up period. Connect the RF output of the generator to the antenna terminals of the receiver under test. Set the RF attenuator to maximum and the color-bar selector switch to the MULTI position. Set the switch to the LUM. AND CHROM. position. Turn the SOUND switch to the ON position, and set the HORIZ. SPEED control to the proper setting. Usually this control will not need to be adjusted, particularly after the generator has been given sufficient warm-up time. Set the RF tuning control to the desired channel. Set the channel selector of the receiver to the same channel, and adjust the fine-tuning control of the receiver to obtain color and to obtain a minimum 920-kc beat in the picture. After the fine-tuning control has been adjusted, the SOUND switch may be turned to the OFF position.

Adjust the brightness, contrast, saturation, and hue controls of the receiver in an attempt to produce the proper pattern illustrated in Fig. 4. If the receiver produces a satisfactory pattern, its operation can be considered normal.

If a satisfactory picture cannot be produced, 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 synchronization. After determining the proper category of 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 Jackson Model 700 or Model 712 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, inject 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 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 input of the signal at the demodulator stages. Fig. 14 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 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. 14) and the CW signal (Fig. 15) 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.

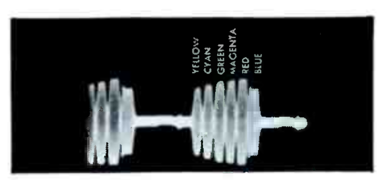

Fig. 14. Chrominance Signal at Input of Demodulators.

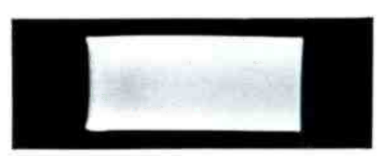

Fig. 15. CW Signal at Input of Demodulators.

Fig. 28. Pattern Produc

Fig. 29. Pattern Prod
Signal.

Fig. 30. Pattern Pro
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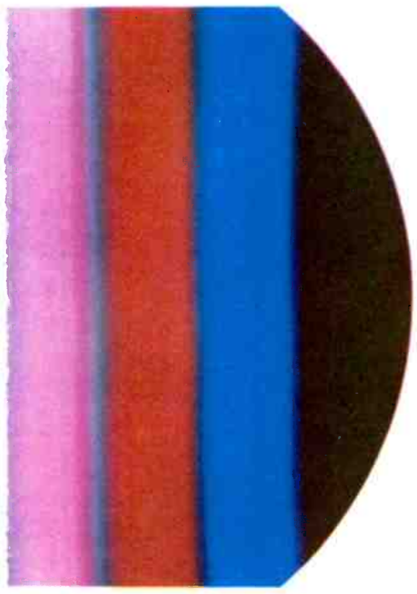
CK Reference Chart No. 7

AND 712 COLOR-BAR GENERATORS



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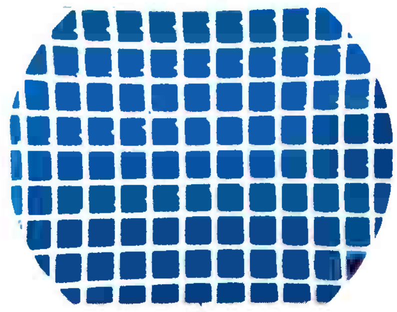


Fig. 5. Pattern Produced by the Crosshatch Signal.

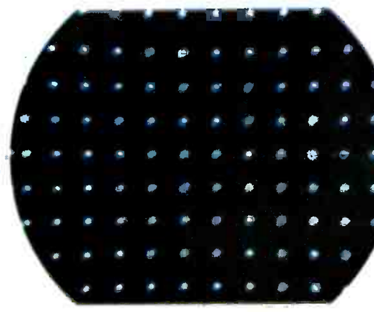
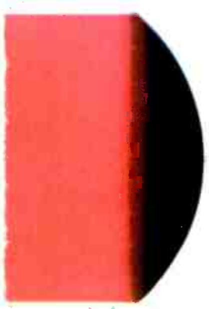


Fig. 6. Pattern Produced by the Dot Signal.

Fig. 7. The Jackson Model 712 Color Bar/Dot Generator.



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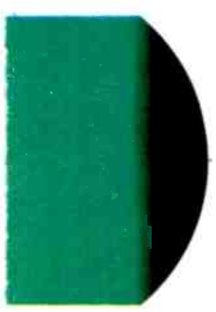

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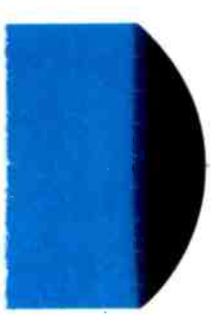

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all the color bars will appear predominantly an orange or a cyan color. If the I signal is being lost, the color bars will appear predominantly green or magenta. As the hue control is varied, the green and magenta bars will appear to vary in saturation and some of them may take on the opposite hue.

If the receiver demodulates on the R - Y and B - Y axes and if either of the demodulator sections fail, a condition similar to that described in the previous paragraph will exist. The only difference will be in the hues of the color produced. If the B - Y signal is lost, the bars will appear predominantly red or cyan. If the R - Y signal is lost, the bars will appear predominantly greenish yellow or blue. If desired, the switch can be set to the CHROM. ONLY position during the tests just outlined.

Another significant thing that will be noted when checking a receiver that has lost one of the color-difference signals is that some of the bars may lose all color at certain settings of the hue control. After it has been determined which signal is absent, a signal-tracing procedure should disclose the faulty stage.

Checking Demodulator Action

Defects associated with phase errors in the CW reference signal or the chrominance signal can be located through the use of the signals produced by the generator. If (after adjustment of the contrast, brightness, hue, and saturation controls) the receiver cannot produce a pattern such as that shown in Fig. 4, check the operation of the demodulators. Inject a signal into the receiver, and set the generator to provide a Q and I or B - Y and R - Y signal depending upon the type of demodulators used in the set. Using an oscilloscope, check the signal at the plate of the I (or R - Y) demodulator. Adjust the hue control to obtain a zero signal during the scanning time of the Q (or B - Y) bar. Fig. 16 illustrates the pattern that will be obtained under these conditions. Fig. 17 illustrates a pattern that will be obtained when there is 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 scanning time of the Q (or B - Y) bar will go alternately positive and negative.

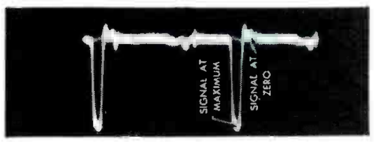

Fig. 16. Signal at Plate of I-Demodulator Illustrating Proper Cancellation of Q Signal.

Fig. 17. Signal at Plate of I-Demodulator Illustrating Improper Cancellation of Q Signal.

Fig. 18. Signal at Plate of Q-Demodulator Illustrating Proper Cancellation of I Signal.

Fig. 19. Signal at Plate of Q-Demodulator Illustrating Improper Cancellation of I Signal.

With the hue control set so that the I (or R - Y) signal is at zero during the scanning time of the Q (or B - Y) bar, connect 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 scanning time of the I (or R - Y) bar. Fig. 18 is a waveform illustrating such a condition. The result of an incorrect condition is shown in the waveform of Fig. 19.

If the signal is not zero during the scanning time of the I (or R - Y) bar, an adjustment of the quadrature transformer must be made. (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.)

Refer to Fig. 2, and note that the Q signal appears at the right and that the I signal appears at the left. The R - Y and B - Y signals are in the same relative positions as the I and Q signals, respectively. This can be seen in Fig. 3. To aid further

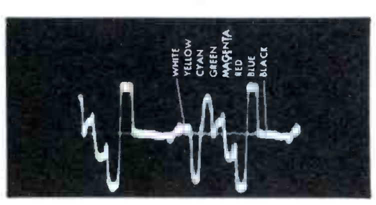

Fig. 20. A Minus I Signal.

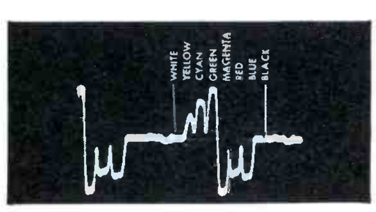

Fig. 21. A Minus Q Signal.

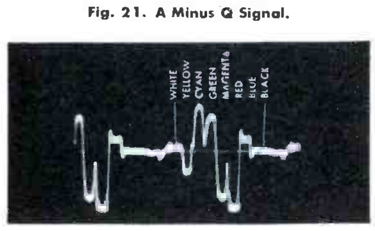

Fig. 22. A Minus R-Y Signal.

Fig. 23. A Minus B-Y Signal.

in identifying the signals properly, individual color bars can be obtained. 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. Set the color-bar selector switch to the MULTI position. Adjust the contrast, brightness, hue, and saturation controls to obtain a pattern approximating that of Fig. 4. If the colors obtained are not satisfactory, check the operation and alignment of the matrix in the manner specified in the receiver service data.

Figs. 20 through 23 illustrate color-difference signals that are obtained when using the Jackson Models 700 or 712 color-bar generators. Fig. 20 shows a minus I signal, Fig. 21 shows a minus Q signal, Fig. 22 shows a minus R - Y signal, and Fig. 23 shows a minus B - 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. 24 through 26 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.

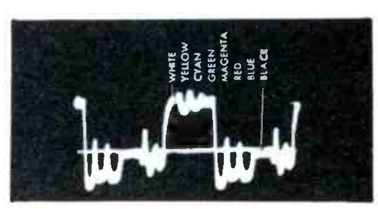

Fig. 24. Signal at Grid of Green Gun.

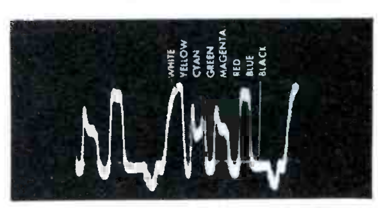

Fig. 25. Signal at Grid of Blue Gun.

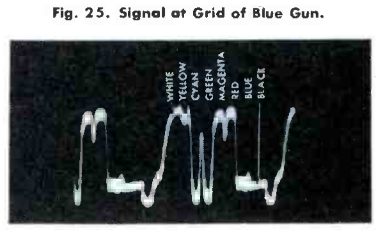

Fig. 26. Signal at Grid of Red Gun.

LOSS OF COLOR SYNCHRONIZATION

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 synchronization 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 color 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.

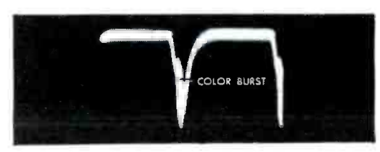

Fig. 27. Signal at Plate of Burst Amplifier.

Fig. 27 illustrates the waveform present on the plate of the burst amplifier. The large spike is caused by the keying pulse obtained from the horizontal-output stage. Note the color-burst position at the tip of the spike. If the color burst is not present, rotate the horizontal-hold control and note whether the color burst appears. When checking some receivers or when using an oscilloscope which has only medium gain at 3.58 megacycles, it may be necessary to increase the vertical gain of the oscilloscope 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.

SETTING CONVERGENCE

As previously stated, the Jackson Model 712 produces a white-crosshatch pattern and a white-dot pattern. These signals can be used to adjust the linearity of a receiver and to check and adjust the convergence amplifiers in the receiver. Fig. 5 illustrates the crosshatch pattern which is obtained, and Fig. 6 illustrates the dot pattern. Since the adjustment procedure for the convergence circuits varies with different receivers, the service data for the particular receiver being serviced should be consulted.

PHOTOFACT* COLORBLOCK

*TRADE MARK

Reference Chart No. 7

A COLORBLOCK Which Outlines the Uses of the Jackson Model 700 Color-Bar Generator and the Jackson Model 712 Color Bar/Dot Generator in Adjusting and Servicing Color Receivers.

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

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