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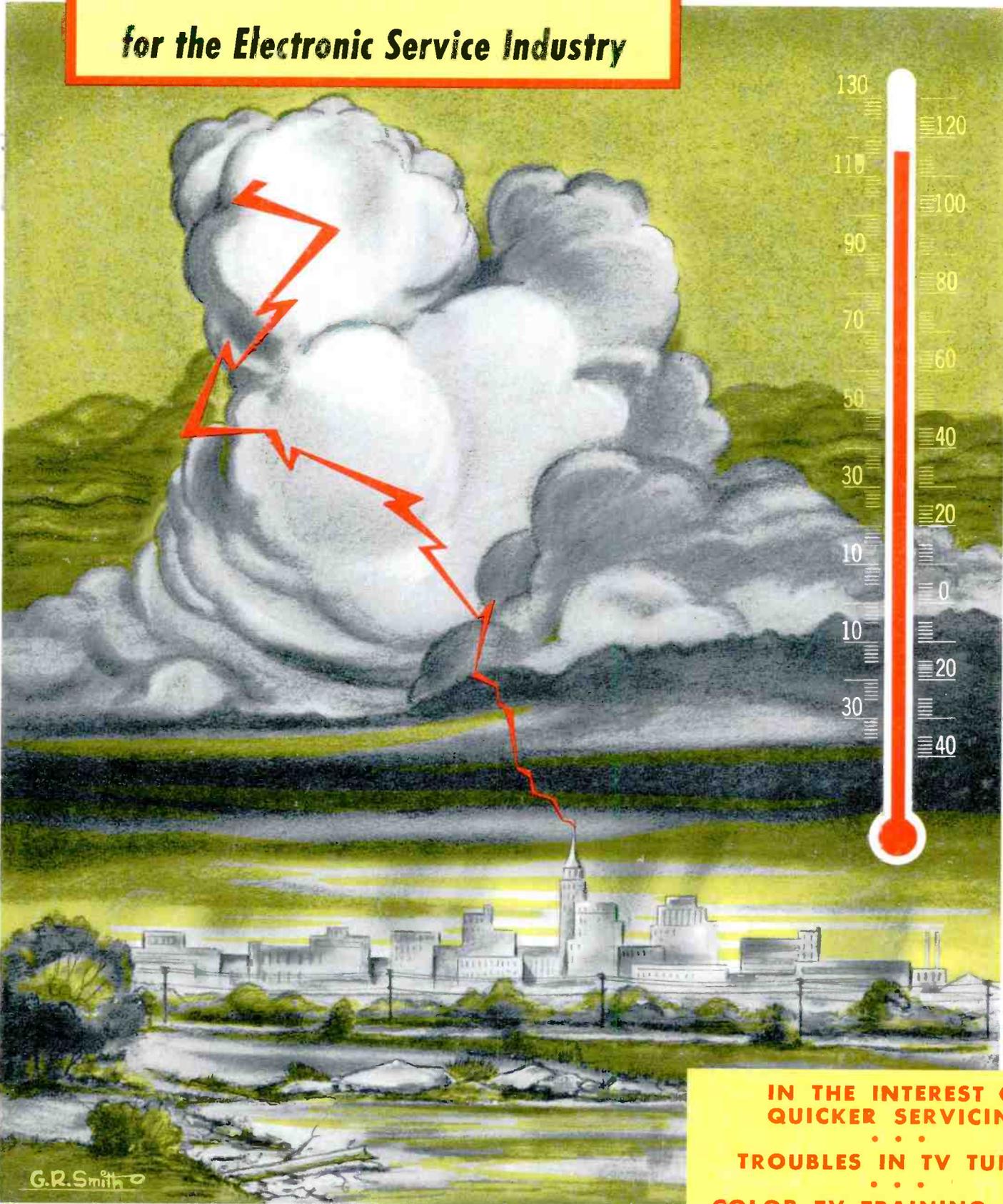
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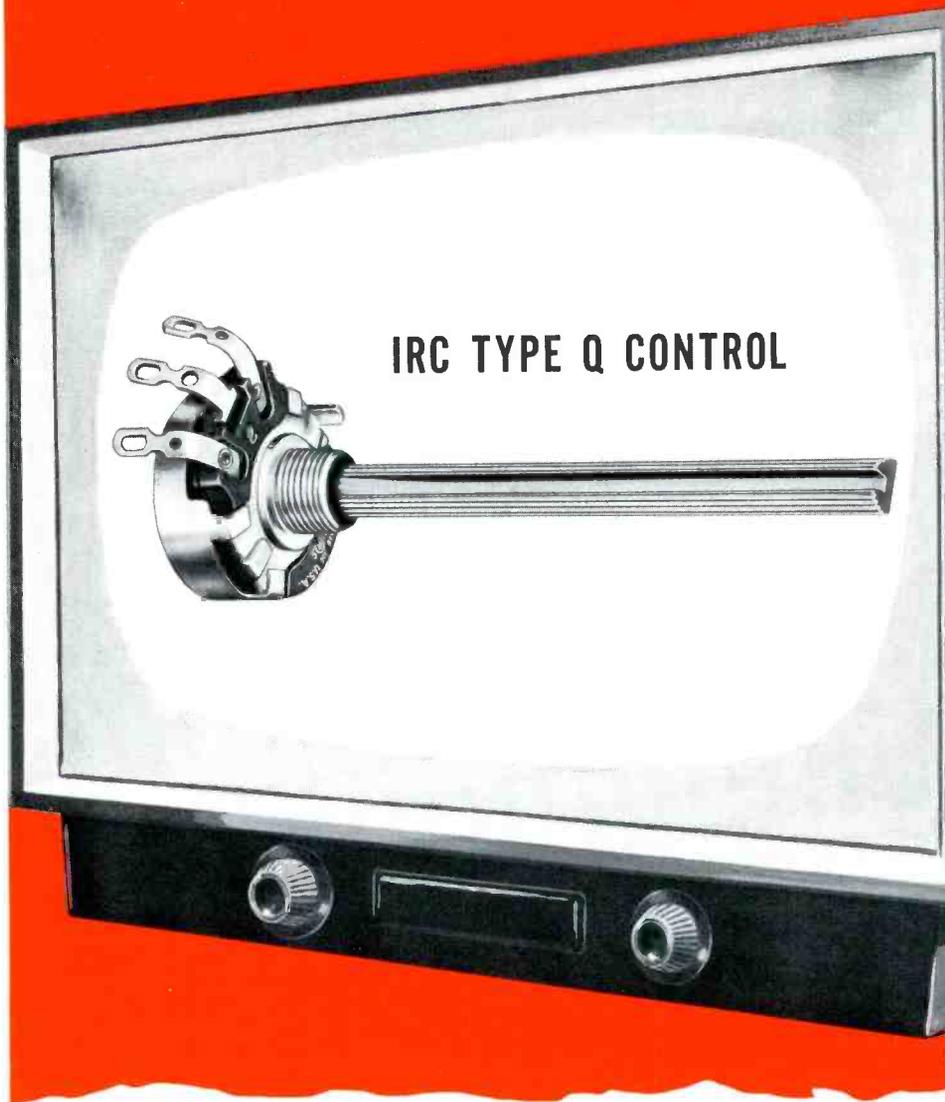
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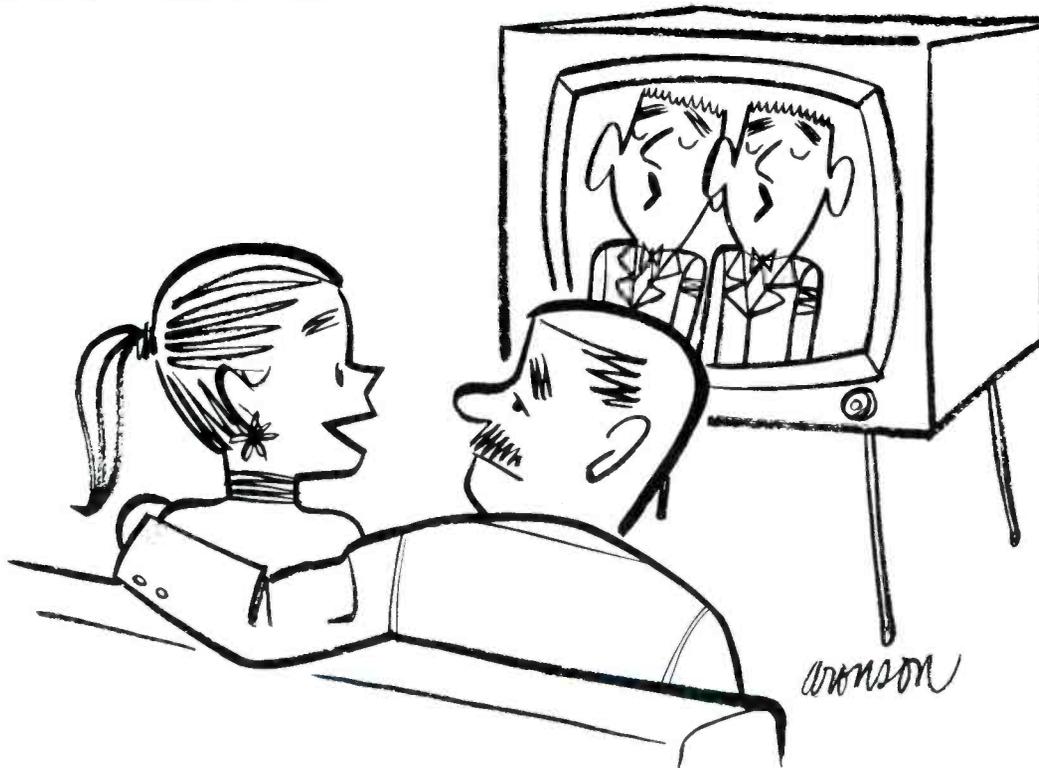
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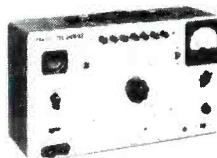
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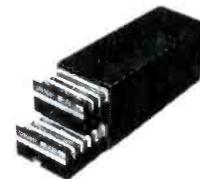
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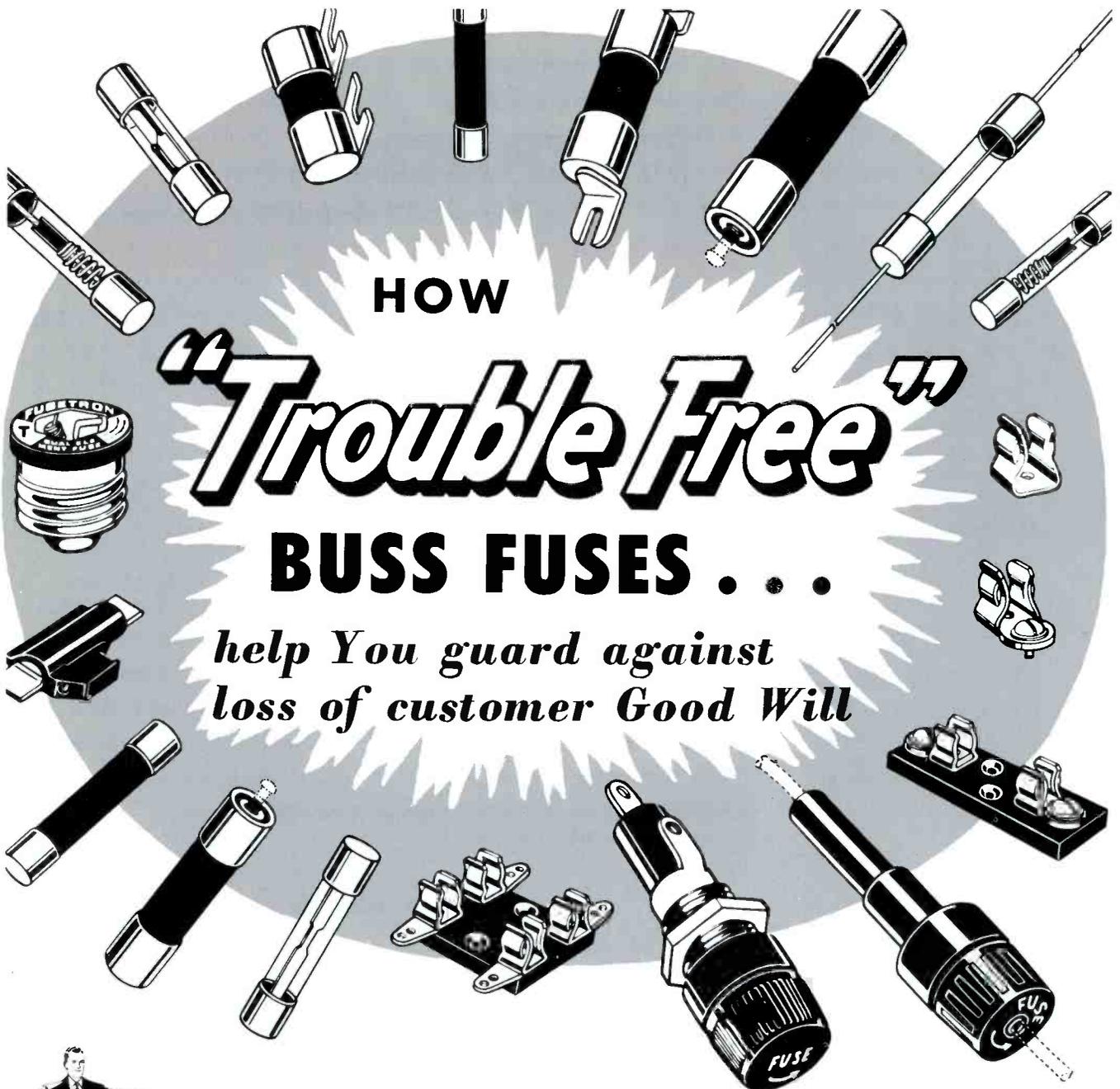
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ShopTalk

MILTON S. KIVER

President, Television Communications Institute

SOME SPECIFICATIONS FOR FM TUNERS

When one starts giving serious thought to the installation of a high-fidelity system, the question of a suitable FM tuner eventually enters the picture. Should the tuner be straight FM, or is it more desirable to have an AM-FM combination? Furthermore, how does one judge the quality of an FM tuner?

These are some very pertinent questions, since quality is inevitably tied in with economics and since very few customers are fortunate enough to have an unlimited amount of money to spend. To establish some criteria by which to judge the quality of an FM tuner, let us examine some aspects of FM receivers and FM reception.

FM receivers operate on frequencies between 88 and 108 megacycles. This is just slightly higher than the low VHF television band; and since we do not generally run into any difficulties receiving these VHF television stations, we should not expect any trouble with FM stations. It has been found by the author that most local FM stations are easily received with only an inside antenna; whereas, an outside antenna will bring in distant stations which may be as much as two hundred miles away. Thus, for a good many installations, the matter of receiver sensitivity is not a critical one; and there is no good reason for the customer to pay extra to obtain 3-microvolt sensitivity when 10-microvolt sensitivity will do as well. Because manufacturers stress sensitivity (which is understandable), most purchasers seem to place a similar emphasis on this characteristic. Extra sensitivity does not do any good unless it is used, so why pay an additional amount for it?

It is well to remember that a good outside FM antenna will frequently do more for reception than

increased sensitivity (for which the customer would have to pay considerably more). In many instances, the regular TV antenna will be adequate if the input twin-lead of the FM receiver is placed against the TV antenna lead-in. Connection between the two lead-in wires may not be required. Simply taping two or three feet of one lead-in against the other will frequently suffice. If a connection is required, a two-set coupler is recommended.

Quieting

In recent years, FM set manufacturers have changed from quoting receiver sensitivity as such to stating the input signal required to achieve quieting of a specific value, usually given in decibels. Thus, one manufacturer might claim that his receiver is capable of achieving a 30-db quieting with a 5-microvolt input level.

This method of designating receiver sensitivity serves to indicate the relative freedom of a receiver from objectionable internal noise during pauses in modulation when receiver noise is least likely to be masked by the modulation of the broadcast. Internal noise in a receiver consists largely of the noise which is generated in the RF amplifier and in the mixer. RF stages of the cascode type are known for their low noise, and so are triode mixers. In a tube, the greater the number of elements which have positive voltage applied, the more noise the tube will generate; and this is the reason triodes are quieter than pentodes.

For those readers who may wonder how the quieting figure is obtained, here is the procedure recommended by the IRE. An FM signal generator is connected to the receiver, and the output level is set initially for about .001 volt (1,000 microvolts). The generator is adjusted for a deviation of 30 per cent of 75 kilocycles. This would be about 22.5 kilocycles,

and the frequency will change back and forth at a rate of 60 cycles per second. At the output of a receiver tuned to this signal, the 60-cycle note would be heard. The volume control of the receiver is adjusted to some convenient level which is well below the audio-overloading point.

The modulation switch is turned off and on alternately while the signal output of the generator is reduced gradually until a point is reached at which there is a 30-db voltage difference (a voltage ratio of 31.62) in receiver output between the times when the signal is modulated and unmodulated. This value of input signal is the quieting figure. Obviously, the smaller the input signal for a specified quieting figure, the more desirable the receiver (all other things being equal). This means that 5 microvolts for 30-db quieting is better than 10 microvolts for 30-db quieting, or it is even better than 5 microvolts for 20-db quieting. Note again that if the signal level at a particular location is high, very little tangible value is gained by having a receiver with an extremely low quieting figure because there will always be enough signal coming in, modulated or unmodulated, to override the noise developed by the set.

While the quieting figure is a valuable indication of the ability of a set to override internal noise, it does not directly indicate how well the receiver will be able to combat noise which is received with the signal. The ability of a receiver to combat external noise is determined by the ratio of the signal level to the noise level and also by the nature of the noise. Most of the external noise which is objectionable is staccato. This is in contrast to internal receiver noise which is random in nature and more evenly distributed throughout the receiver bandpass.

* * Please turn to page 55 * *



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COLOR TV

TRAINING SERIES

PART XIV TROUBLE SHOOTING

by C. P. Oliphant and Verne M. Ray

In Part XIII of this Color TV Training Series, alignment of the circuits in a color receiver was discussed. In this issue, we will begin the discussion of trouble shooting the color receiver.

The trouble-shooting procedure for a color receiver does not differ greatly from that followed when trouble shooting a monochrome receiver. First, the picture on the screen is analyzed so that a diagnosis of what is lacking in the picture can be made. Then, it is decided in what sections of the receiver the cause of the trouble is most likely to be located. After this decision has been made, the cause of the trouble can be found more rapidly. It is very important to analyze thoroughly the picture produced by a color receiver before starting the trouble-shooting procedure. Because of the greater number of sections in a color receiver, much time can be wasted if the picture is analyzed incorrectly.

After it has been decided in what section or sections the cause of the trouble is located, these sections are checked by first looking for a bad tube and then by tracing the signal through the sections until the stage that contains the trouble is located. This is the procedure that will be followed in the discussion on trouble shooting.

It will be assumed that a color-bar generator is available. When trying to find a trouble in a color receiver, it is necessary to have a color signal — either a transmitted signal or one from a color-bar generator. Since color broadcasts are not transmitted at all times, it is necessary to have a color-bar generator to test all sections of the color receiver.

Troubles which occur in a color receiver fall into two main categories, monochrome and color. Monochrome troubles are those which cause improper reproduction of a black-and-white picture. The troubles that affect monochrome operation will also cause improper reproduction of a color picture. The category of color troubles can be broken down into conditions of no color, wrong colors, and loss of color synchronization. The condition of no color covers all troubles which cause the complete loss of color in the reproduced picture. In the case of wrong colors, the receiver is producing colors; but they are of the incorrect hue, saturation, or brightness. Loss of color synchronization is signified by the fact that the colors are present; but horizontal or diagonal stripes of variegated colors, either stationary or in motion, appear on the screen.

The discussion that concerns trouble shooting will contain first a section on checking monochrome operation of the color receiver; then the color troubles will be covered in the order of no color, wrong colors, and loss of color synchronization. This current issue will contain only the discussion about monochrome operation and the condition of no color. Subsequent issues will contain discussions about wrong colors and loss of color synchronization.

CHECKING MONOCHROME OPERATION

The first thing to do when beginning the trouble-shooting procedure for a color receiver is to tune in a transmitted monochrome signal and to check the operation of the receiver. If the results are good for monochrome, it is known that all the circuits which have to do with the reproduction of a monochrome picture are functioning properly. This means that the luminance signal is arriving at the picture tube correctly. If there is anything wrong with the monochrome picture, the color picture would also not be correct because the luminance signal is combined with the color signals; therefore, any monochrome troubles that are present must be eliminated before the operation of the receiver on a color signal is considered.

Servicing the monochrome section of the color receiver is the same as it is for a conventional monochrome receiver. The sections which are of concern are those through which the luminance signal passes. These sections are the RF, IF, and video detector stages, and the luminance channel. The luminance channel in most color receivers consists of two stages of video amplification, and both the luminance and chrominance signals pass through the first stage. At the output of the luminance channel, the luminance signal is applied either to a matrix section or directly to the picture tube.

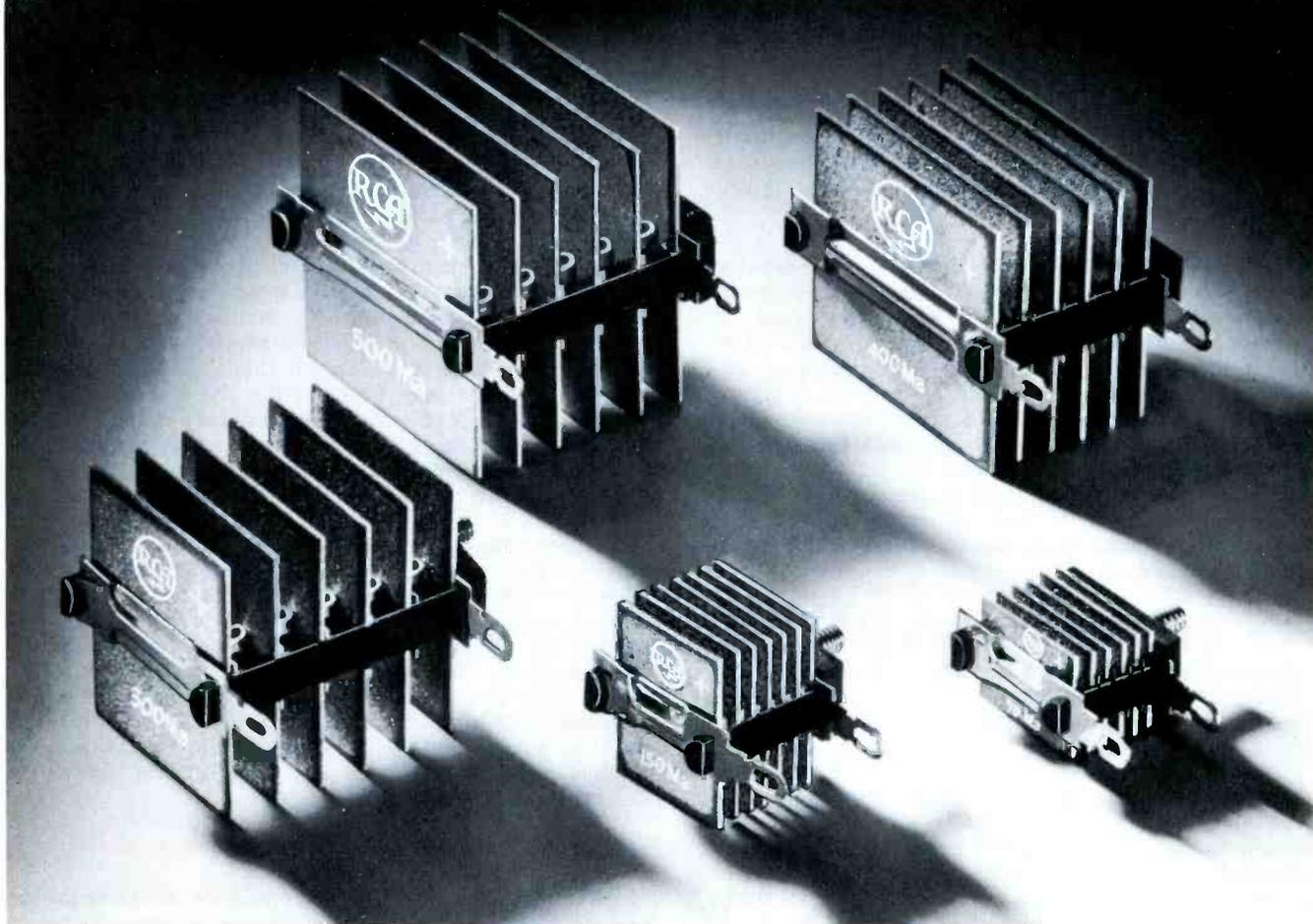
Loss of Monochrome Picture

If the receiver does not produce a monochrome picture when receiving a monochrome signal, the cause of the trouble can be located somewhere between the input of the receiver and the output of the luminance channel if the same procedure that is used when trouble shooting for loss of the picture in a monochrome receiver is followed. Since a color receiver is under consideration, the color-bar generator can be used to advantage in isolating the stage or stages in which the cause of the trouble exists.

Connect the RF output of the color-bar generator to the antenna terminals of the receiver. If color appears on the screen, it can be assumed that the stages up to the point where the chrominance signal is separated from the composite video signal are operating properly. This means that the cause of the trouble is somewhere between the stage in which the chrominance take-off point is located and the output of the luminance channel. The color bars on the screen would be representative of chrominance minus luminance since there is no output from the luminance channel.

If the receiver contains a luminance channel similar to that shown in Fig. 12-1, it would be necessary to substitute only one tube, the second video amplifier. If replacement of the tube does not eliminate the trouble, the circuit between the output of the first video amplifier and the output of the luminance channel should be checked. By using an oscilloscope and by checking the signal at the

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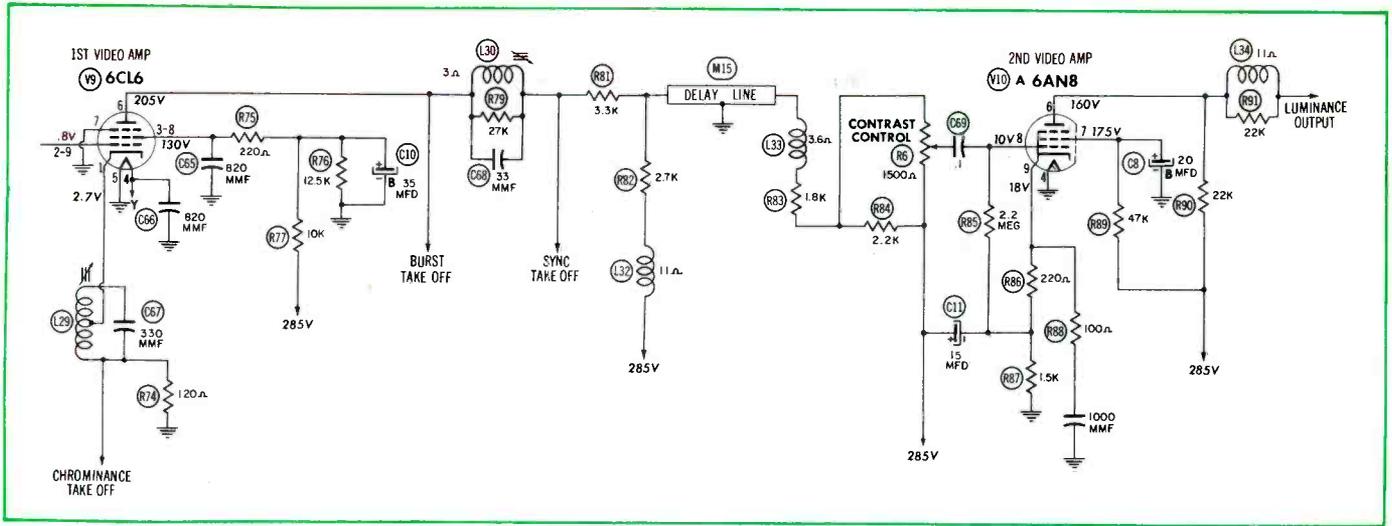


Fig. 12-1. Luminance Channel in the RCA Victor Model CT-100 Color Receiver.

input and output of the second video amplifier, it can be determined just where the trouble is located. Then through voltage and resistance checks, the component that has failed can be located.

If color does not appear when the RF output of the color-bar generator is connected to the input of the receiver, the cause of the trouble is located between the input of the receiver and the point where the chrominance signal is separated from the composite video signal. By following the conventional methods of trouble shooting, the defective tube or component can be found.

It can be seen from the foregoing that the color-bar generator can be very useful even when trying to find the cause for the loss of the monochrome picture. Time can be saved if it is known that the color signal is able to pass through the circuits that are also common to the luminance signal.

Improper Gray Scale

Certain troubles can develop in a color receiver, and they will affect the ability of the receiver to reproduce

proper values of gray. A trouble of this type is indicated if a monochrome signal is reproduced in values of a particular color instead of values of gray. In some cases, the image may be reproduced in values of a primary color; and in other cases, the image may be reproduced in values of a complementary color.

If a color receiver is unable to reproduce values of gray, either the circuits which control the voltages applied to the elements of the picture tube are not adjusted correctly; or there is a defective tube or component part in one of these circuits; or one of the guns in the picture tube is defective. Assuming that an attempt to adjust the gray scale is of no avail, let us examine some typical circuits and determine the possible causes for the reproduction of color instead of grays.

Fig. 12-2 shows the matrix section and the circuits associated with the picture tube in the Motorola Model 19CT1. The luminance signal is applied to the cathodes, and the color-difference signals are applied to the control

* * Please turn to page 29 * *

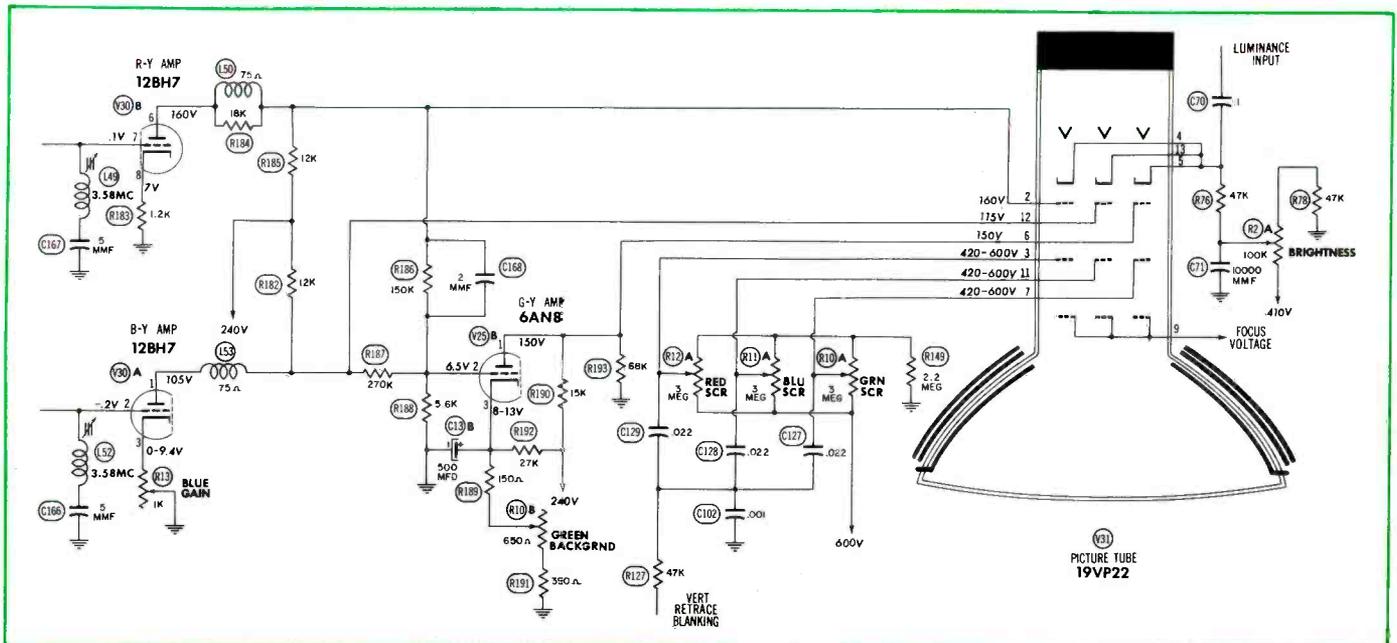


Fig. 12-2. Matrix Section and Circuits Associated With the Picture Tube in the Motorola Model 19CT1 Color Receiver.

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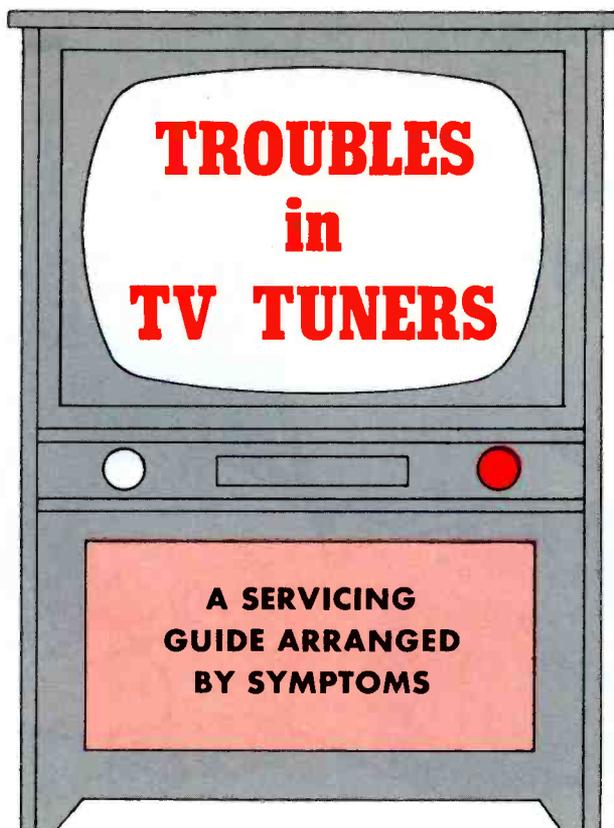
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by **LESLIE D. DEANE** and **CALVIN C. YOUNG JR.**

There are many troubles which can give the service technician a considerable amount of difficulty when they are in the tuner. Through a series of experiments in our laboratories, many of these troubles have been reproduced and information has been obtained which should help the service technician to find and eliminate them.

Troubles in television tuners are usually associated with the following symptoms in the picture, in the sound, or in both.

1. Raster, no sound, no picture, and no snow.
2. Humbars in the picture, sound distorted, and synchronization poor.
3. Intermittent condition in picture and sound.
4. Snowy raster, no sound, and no picture.
5. Sound and picture not obtained at the same tuning point.
6. Loss of synchronization.
7. Snowy picture and weak sound.
8. Negative picture and loss of synchronization.
9. Picture pulling.

10. Ghosts or ringing in picture.

11. Smeared picture.

Each of the foregoing common symptoms will be dealt with individually; and whenever possible, these will be illustrated with picture-tube displays showing the symptoms present. As a basis for reference, a normal test pattern is shown in Fig. 1.

GENERAL DISCUSSION

Tuners are usually classified according to the methods which are used for selecting channels and according to the types of RF stages employed. For selecting channels, some tuners use a turret, some use a switch, and others use a continuous-tuning arrangement. Widely used

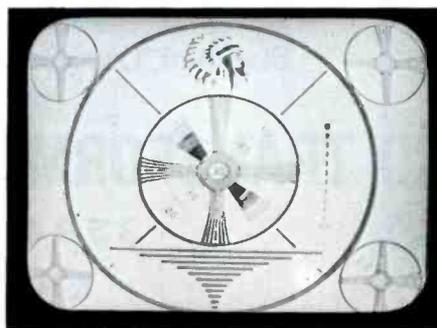


Fig. 1. Normal Test Pattern.

types of RF stages are the cascode and the pentode. For reference, the schematic diagram of a turret type of tuner which has a cascode type of RF stage is shown in Fig. 2; and the schematic diagram of a switch type of tuner which utilizes a pentode type of RF stage is shown in Fig. 3.

Electrically, the major difference between the turret and the switch type of tuner is that the turret tuner uses a separate set of coils for each channel to be received, but the switch type of tuner employs series-connected inductors which are mounted on wafer switches. On the highest channel (No. 13), minimum amounts of inductance are switched into the RF and oscillator circuits. On lower channels, additional coils are added in series. One coil for each successive channel is added as the channel selector is moved from channel 13 to channel 2.

A logical way to start a procedure to find any trouble in a receiver is to choose the section or sections in which the trouble is probably located and to check the tubes in these sections. They should be checked by substitution or with a tube tester of high quality. If the tubes are checked by substitution, then be sure that they are kept in the correct order so that they can be returned to their original sockets. This will guard against receiver misalignment caused by interchanged tubes.

When substituting tubes, use only those of known good quality; and keep in mind that after such substitution in the tuner the local oscillator may require realignment.

Any tuner alignment that might be deemed necessary should be performed according to the alignment instructions. NOTE: During a servicing operation other than alignment, avoid pushing or otherwise unnecessarily changing the physical location of any tuner component because such rearranging could make it necessary to realign the tuner.

In the process of isolating a trouble to the tuner, checks can be made at the points where the AGC, B+, and filament voltages enter the tuner. Most tuners in the field today employ terminal strips mounted on the rear or side of the tuner housing, and these strips serve as connecting points for the supply voltages from the main chassis. In a few of the new designs, these connecting points are at feed-through capacitors located on top of the tuner. It can be seen in the photographs of Fig. 4 that the points are easily accessible; therefore, checking the AGC, B+, and filament voltages is not difficult.

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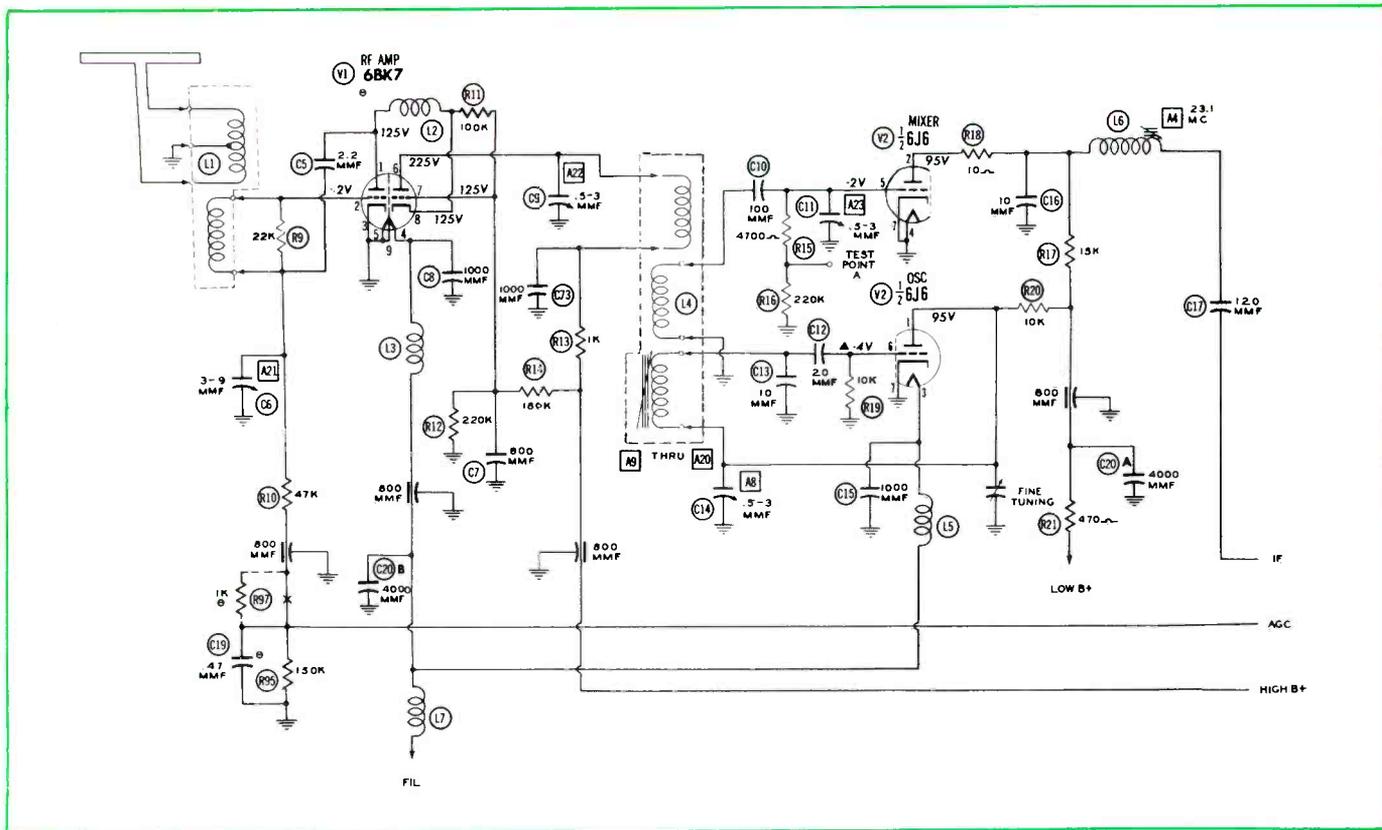


Fig. 2. Schematic Diagram of a Turret Type of Tuner With a Cascode RF Stage.

Since some of the over-all gain of a receiver is obtained in the tuner, nothing should be allowed to reduce the gain of a tuner when it is being serviced — particularly if the set is used in a fringe area. For instance, if the B+ voltage should be 10 per cent below normal, there could be a 30-per-cent decrease in the gain of the tuner. Such a loss might not show up in reception in local areas, but it could make the difference in fringe areas between a usable picture and no picture.

All tuners employ some type of electrical contacts which are usually silver plated. These can become tarnished or dirty and therefore could cause a varying degree of resistance between the contact surfaces. In cleaning tuner contacts, always use a cleaning solution which is especially made for that purpose. A cleaner that also lubricates the contacts is the best. If a cleaner which does not contain a lubricant is used, then a material such as Lubriplate should be applied after the cleaning process in order to prevent corrosion from forming and causing poor operation. A visual inspection of the tuner contacts under a strong light should help to reveal corroded or damaged contacts.

In the switch type of tuner, the individual wafers are separated by insulating spacers; and long screws hold the entire assembly in position. A unit of this design is shown in the

photograph of Fig. 5. All mounting screws and nuts should be tight in order to ensure good ground connections and proper operation of the switch.

Poor contact can also result from a shaft or drum that is loose or out of line. The shaft or drum assembly should be checked for any wobble or extra free play.

Another part which might be inspected is the detent mechanism which provides the mechanical lock for each channel position. The detent plate and roller of the turret type of tuner is indicated in Fig. 6, and the detent mechanism used in a switch type of tuner can be seen in Fig. 5. If the detent mechanism is not locking securely in each position, erratic operation of the tuner may occur. In correcting some of the mechanical troubles, it may become necessary to replace a complete assembly.

Common Symptoms

1. Raster, No Sound, No Picture, and No Snow.

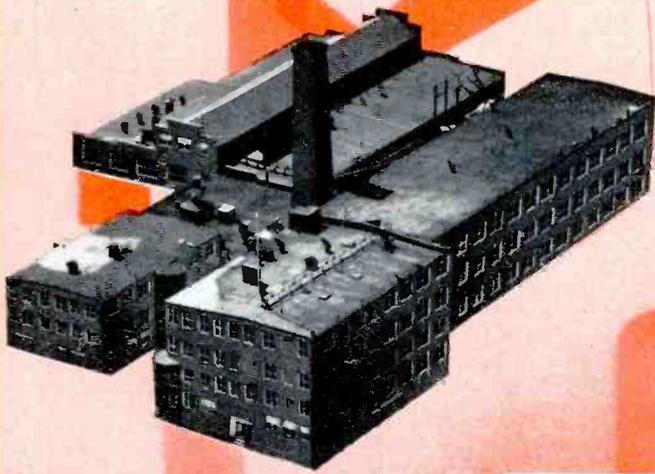
A condition in which the raster is present but in which there is no sound, no picture, and no snow can exist only when there is no signal reaching either the picture tube or the audio-output stage. The illustration in Fig. 7 is a photograph of the screen of a picture tube under such a condition.

To isolate the trouble, connect an amplitude-modulated signal (with a frequency which is approximately the same as the intermediate frequency) to the mixer-grid test point on the tuner (point A in Figs. 2 and 3). The appearance of one or more black bars on the face of the picture tube would show that the trouble is probably in the tuner. Varying the output of the signal generator should cause the indication on the face of the picture tube to change from a very weak pattern to one with high contrast. NOTE: It may be necessary to clamp the AGC line at a negative 3-volt level in order to make this check.

Possible causes for the symptom of a raster, no sound, no picture, and no snow are as follows:

- a. Defective oscillator - mixer tube.
- b. Defective RF amplifier tube.
- c. Open plate-load resistor in the oscillator or mixer stage.
- d. Failure of the feedback capacitor in the oscillator stage. (See C12 in Fig. 2 or C20 in Fig. 3.)
- e. Open decoupling resistor.
- f. Dirty or faulty contacts.
- g. Cold solder joint.

* * Please turn to page 39 * *



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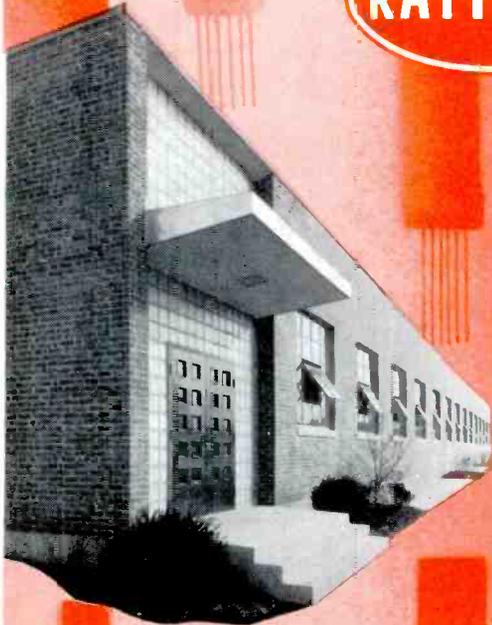
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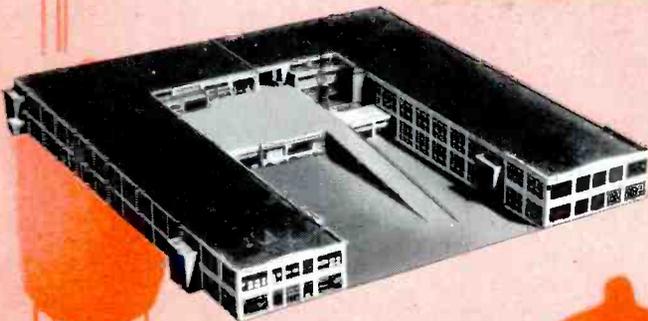
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RAYTHEON developed and was first to mass-produce the octal button stem receiving tube — today's most imitated construction for premium TV performance. Raytheon was first to make millions of these tubes as far back as 1946. These tubes featured a planar button stem and 8 straight leads (8-pillar) which go directly into a standard octal base. Raytheon's Patent Numbers 2310237, 2321600 and 2340879 apply to this invention.



Raytheon's Research Center Waltham, Mass.



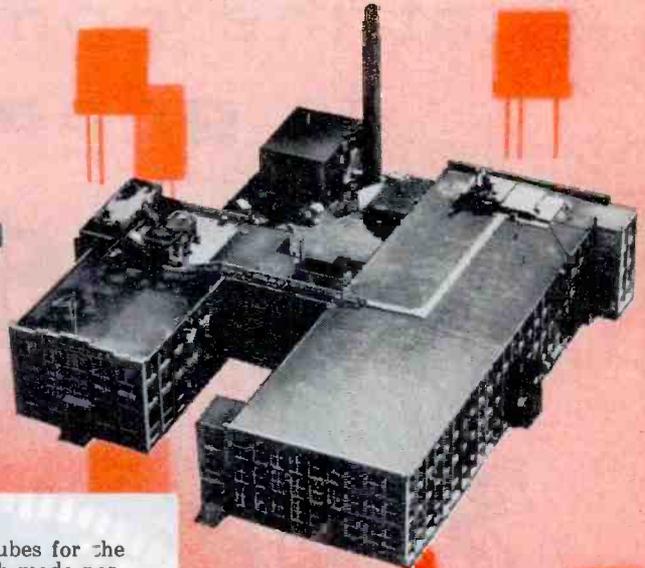
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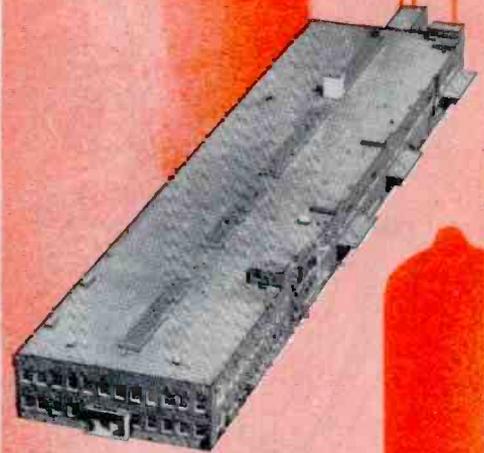
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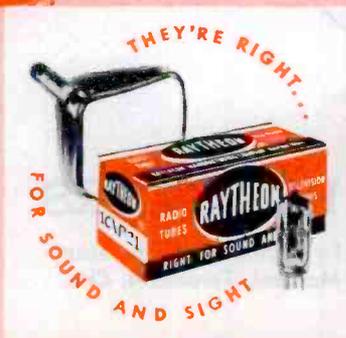
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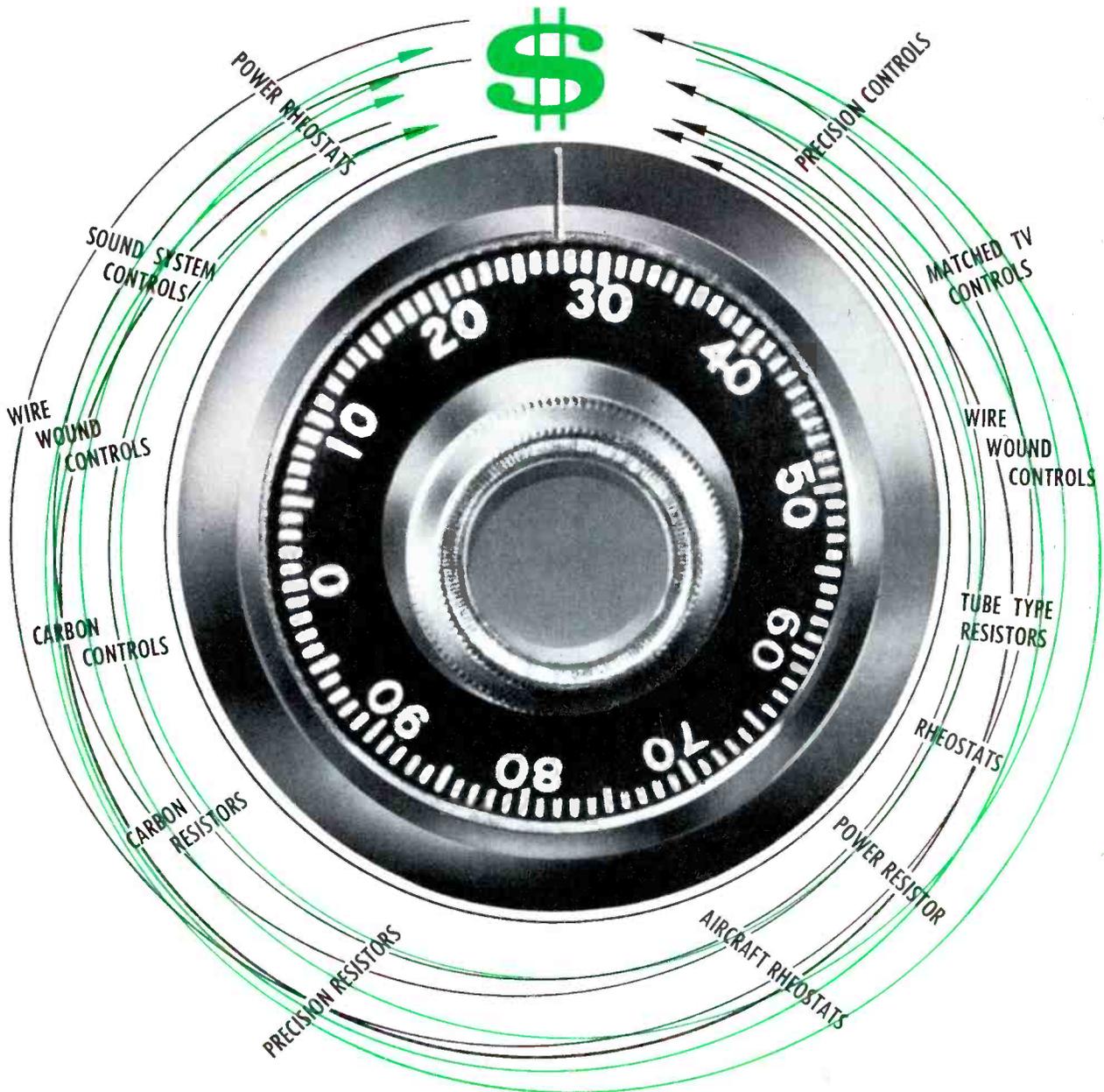
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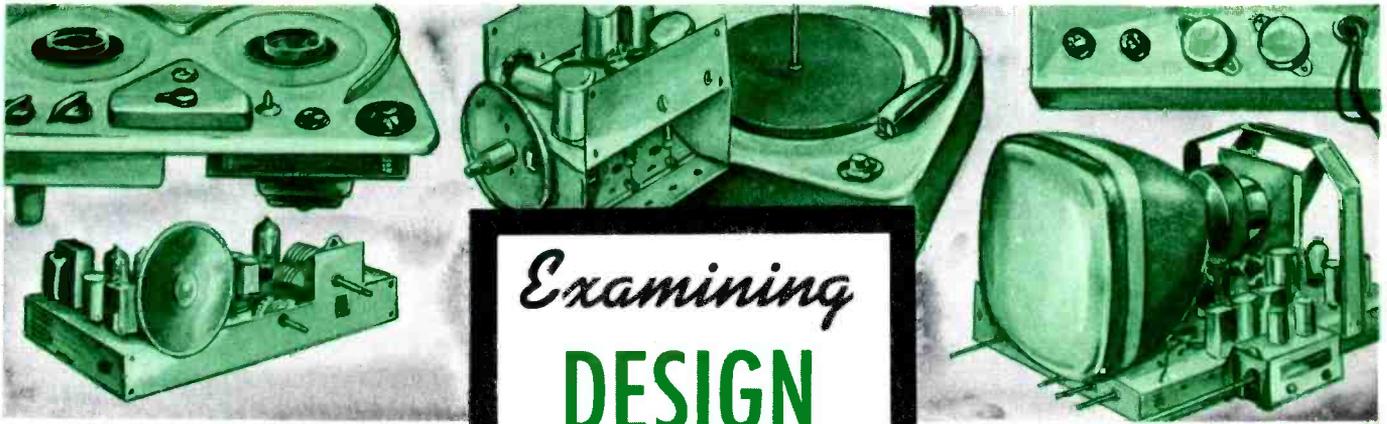
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ZENITH TV TUNER S22452

Recent Zenith television receivers have incorporated a new switch type of tuner. This tuner departs from the conventional large turret type of unit which has been associated with this manufacturer in the past.

The particular tuner under examination was found employed in the Zenith Chassis 16T20. This chassis incorporates a series filament string and utilizes selenium rectifiers to supply the low voltage. The tuner, part number S22452, is a 12-position VHF unit that is designed for series-heater operation. A photograph of this tuner is shown in Fig. 1.

A medium-mu twin triode 5BK7A is employed as an RF amplifier, and a triode-pentode 5U8 serves as both an oscillator and a mixer. These tubes have the relatively new 600-milliamperere heater in which the thermal characteristic of the filaments is controlled in order to minimize any voltage surge during the warm-up period.

The RF amplifier and converter tubes are completely shielded. In addition, a retaining spring is con-

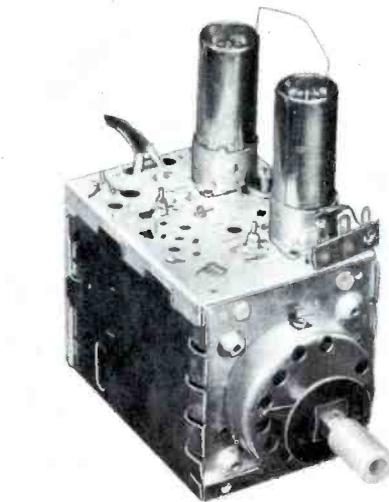


Fig. 1. Zenith S22452 Switch Type Tuner.

nected to both tube shields and is anchored to the tuner housing. This retainer prevents the tube shields from falling off and causing a possible short between the chassis and the metal cabinet. This precaution

is taken because one side of the 117-volt AC line is connected to the chassis. The retainer spring is pointed out in Fig. 2.

Channel selection, in this type of tuner, is achieved by adding the proper amount of inductance and distributed capacitance to each tuned circuit. The inductances consist of small coils of wire connected to a number of wafer-switch terminals. The wafer sections employed in this tuner can be seen in Fig. 2. Each wafer section contains both a front and a rear switch assembly and the associated terminals. The coils on each of the antenna, mixer, and oscillator wafers form continuous series inductances. The individual coils on each wafer are shorted or inserted into the circuit by the switching action, depending on whether a higher or lower frequency channel is desired. The fine-tuning control provides a means of varying the frequency of the oscillator in order to compensate for any frequency deviation resulting from circuit changes.

Fine-tuning is accomplished by moving a dielectric disc over two plates which are connected in the oscillator grid and plate circuits. The dielectric disc is eccentric with respect to the fine-tuning shaft, and it is constructed to permit continuous rotation of the fine-tuning shaft.

In order to eliminate feedback, a ground shield is located between the wafer-switch sections of the RF grid and RF plate. The tuner is also shielded on three sides by a removable cover. In order to remove this for servicing, channel-selector and fine-tuning shafts must be disengaged from the tuner and three self-tapping screws must be removed from the mounting bracket. Another feature

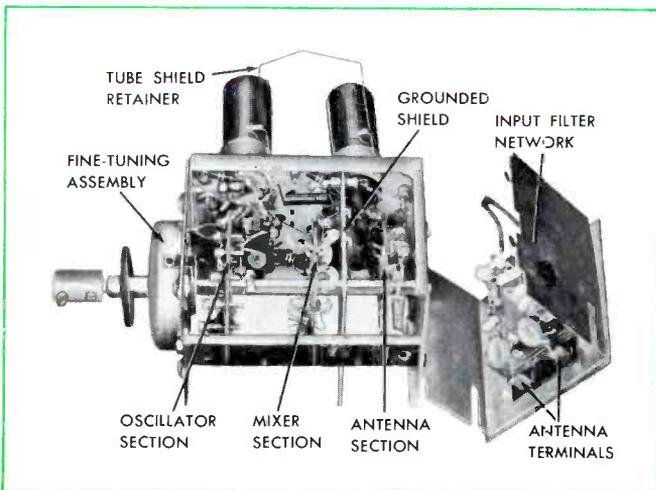


Fig. 2. VHF Tuner With Cover Removed.

* * Please turn to page 66 * *

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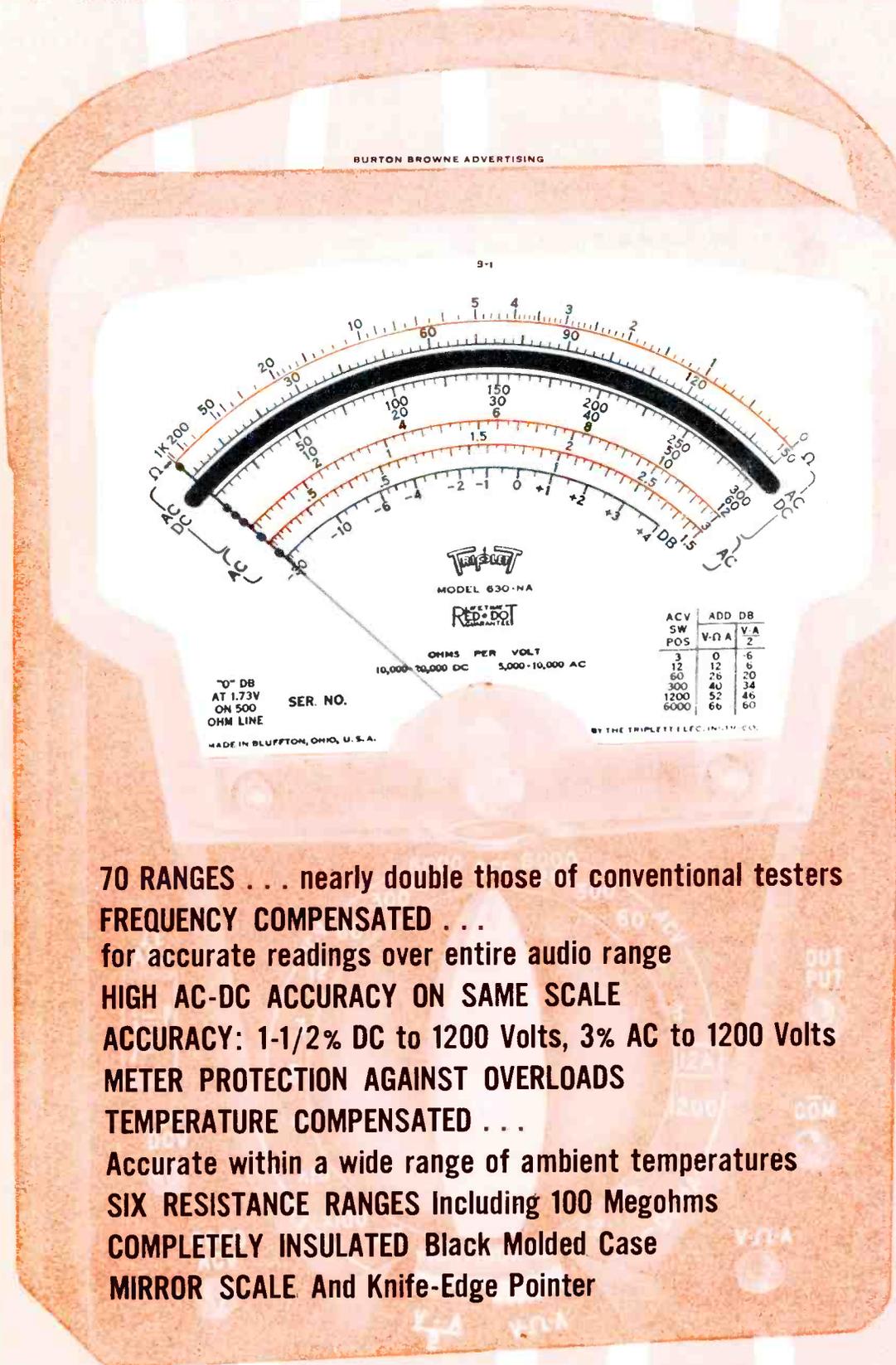
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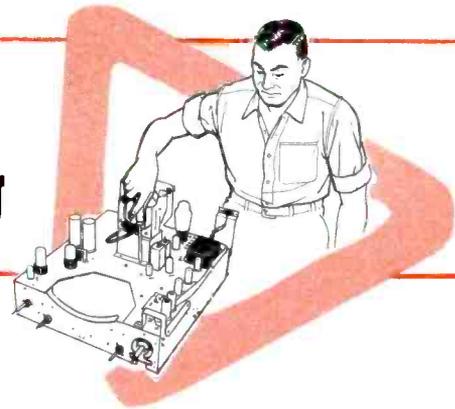
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SUMMER SERVICE PROBLEMS

There is a tendency for power-amplifier tubes, rectifier tubes, and certain other portions of a television receiver to give more trouble during the summer months because of two factors: (1) the increased heat and (2) the humidity in some areas.

Excessive heat greatly increases the rate of failure of rectifier and power-amplifier tubes as well as other components. Excessive humidity will contribute greatly to arcing and corona discharge, either of which can cause premature failure of the components in the high-voltage and horizontal-output sections.

Ventilation

Proper ventilation can do much toward removing excessive heat that may be present in extremely hot weather. To aid in obtaining proper ventilation, the television receiver should be set out from the wall at least six inches. If possible, the receiver should not be placed in a corner where the flow of air might be poor.

A sample layout that shows the set located for proper ventilation is shown in Fig. 1. It was not placed directly in front of the window be-

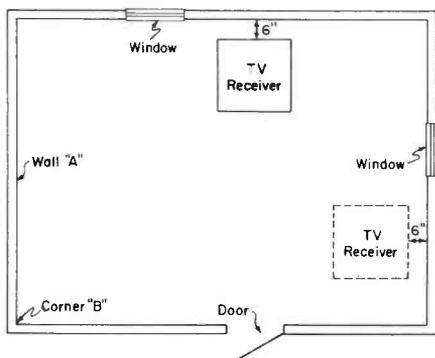


Fig. 1. Receiver Positions for Proper Ventilation.

cause direct sunlight can generate a considerable amount of heat. Notice also that the receiver is placed six inches away from the wall. The receiver should not be located along wall A nor in corner B because the ventilation at those points might be somewhat restricted. Another possible location where good ventilation is present is illustrated by the dotted square in Fig. 1. This is also six inches away from the wall.

If it is necessary or should be desired to locate a receiver in a place where the natural ventilation or air circulation is poor, then a small fan could be used to produce a circulation of air around the receiver in the selected site. Care must be exercised in the selection and use of a fan, because some fans may generate motor noise which would show up as streaks in the picture.

Remove Dust

During the winter months when the average temperature inside the house may range from 72 to 75 degrees, the accumulation of dust on the rectifier and power-amplifier tubes may be of little consequence. During the summer months, however, when the temperature may range up into the 90's or 100's, this dust accumulation may cause the rectifier or power-amplifier tubes to become overheated and thus fail. This happens because a covering of dust can reduce the heat-radiating efficiency of a tube envelope.

In making a service call during the late spring or early summer, wiping the envelopes of the rectifier and power-amplifier tubes may help to reduce failure caused by the accumulation of dust. This procedure would only take a very few seconds to perform.

Humidity

In some parts of the country, the humidity is high during the summer;

and if certain precautions are not taken, trouble may be experienced in the high-voltage sections of television receivers. Under some conditions, humidity may be a factor even in the winter.

Dust is also a factor where humidity is high, because dust may collect moisture and thus cause trouble. This is especially true in high-voltage sections of the receiver.

To help reduce the effect of high humidity on the high-voltage section, remove the chassis from the cabinet; then remove the cage and cover assembly. After this has been done, clean all of the dust from the components and tubes in this section. Remove all of the tubes from the high-voltage area, and then spray the transformer with a spray of acrylic plastic. Be careful not to get any of the spray into the pin contacts of the tube sockets. Then replace the tubes and give the receiver an operational check.

The illustration in Fig. 2 shows a chassis of a television receiver with the high-voltage cage and cover removed and with the tubes removed in preparation for spraying the transformer and rectifier assembly with plastic spray.

* * Please turn to page 58 * *



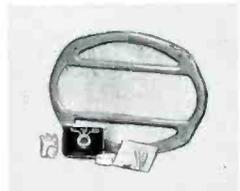
Fig. 2. High-Voltage Area Ready to Be Sprayed With Acrylic Plastic.



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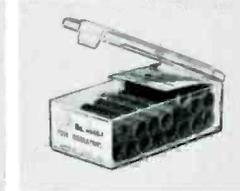
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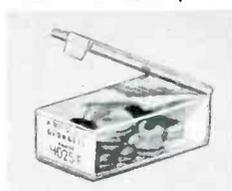
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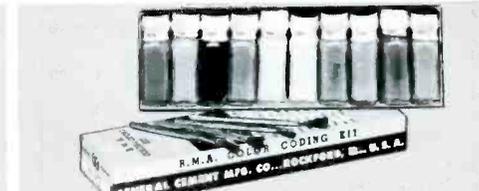
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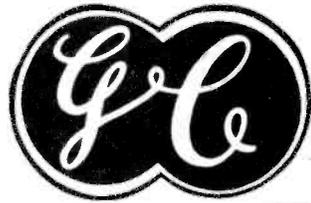


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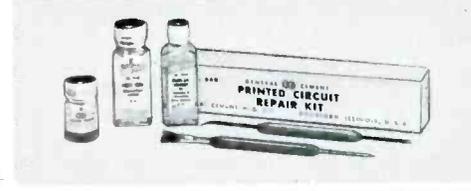
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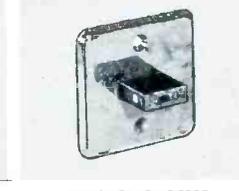
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Answering questions is part of the service technician's job. Answering them courteously and intelligently plays an important part in maintaining good customer relations. It builds up the customer's confidence in the technician's ability.

The modern technician never loses sight of the fact that time is money. Answering questions can use up valuable time; therefore, conversations should be kept short. The service technician cannot afford to engage in lengthy discussions while he is on the job.

The subject of color television represents a big question mark to the general public. Practically every service technician has been questioned about this medium of entertainment. It is good business to answer to the best of his ability; however, it is not a good idea to overwhelm the customer with a conglomeration of technical terms particularly when the right answer is not known. A good reply when you do not have an answer is, "I don't know the answer to that, but I do know" Then proceed to discuss briefly something which you do know, if it is closely related to the question.

A technician who is well-informed makes a good impression on the customer with whom he deals. With this thought in mind, it is felt that an article concerning questions and answers about color television might be helpful. In this respect, the most logical questions which a customer may ask a service technician or a service dealer were chosen. Following each question, there is a discussion of the facts involved; and at the end of each discussion, there is a suggested answer which is short and appropriate.

QUESTION

I've been thinking of buying a new TV receiver. Do you think I should wait and buy a color set after prices come down?

The entertainment value of television in general has increased because programs have improved and because more programs in black and white are available over an increased number of channels. Prices of monochrome receivers are lower than ever before. Anyone wanting a new receiver at this time does not therefore need to feel that the monochrome receiver will shortly be out of date because of color television. As a

matter of fact, by not buying a new monochrome receiver, a customer may be depriving himself and his family of excellent entertainment while he is waiting for color receivers to be more plentiful and less expensive.

SUGGESTED ANSWER. It will probably be some time before inexpensive color receivers are available. The entertainment value of television has increased because of improved programs and additional channels, and prices are lower than ever; consequently, a TV set is a better buy now than it has ever been. Your old receiver can be used in another room or traded in on a new receiver. Any set you buy now can be traded in later on a new color set.

QUESTION

Why are color receivers so expensive?

There are two major factors which enter into the selling price of a product. One is the cost of material, and the other is the cost of labor. The color receiver uses about twice as many component parts as a monochrome receiver, and the cost of assembling a color receiver is considerably more than that of assembling a monochrome receiver. In addition, the cost of some of the components used in a color receiver is relatively high. At this writing, the retail price of one particular make of color picture tube is \$265. When the facts are considered, it is easy to see why color receivers might cost as much as a thousand dollars or more.

SUGGESTED ANSWER. Compared to a black-and-white receiver, a color receiver contains about twice as many component parts and requires considerably more assembly time. These two factors plus the extra cost of such items as the picture tube make it necessary to price a color receiver much higher than a black-and-white set.

QUESTION

When will the prices of color receivers come down below the \$500 level?

Color television is a comparatively new development. Up to this



QUESTIONS and ANSWERS ABOUT Color TV

Items of Interest
to Your Customers

BY VERNE M. RAY

past year, television engineers have concentrated on developing a practical color system. Since the compatible color TV system has only recently been developed, the manufacturers of receivers and component parts have not yet had time to take full advantage of mass-production methods. In order to cut costs, such methods must be utilized in the production of intricate component parts such as the color picture tube as well as in the process of assembling the receivers.

A reduction in the number of components used and the simplification of circuit designs will also play an important part in reducing the prices of color receivers. Although progress along these lines is expected to be fairly rapid, it will probably be some time before prices of color receivers will be as low as or close to the prices of monochrome receivers.

SUGGESTED ANSWER. Receiver manufacturers are working hard to find ways of cutting the production costs of color receivers. Although progress has already been made in this direction, according to forecasters it is doubtful whether

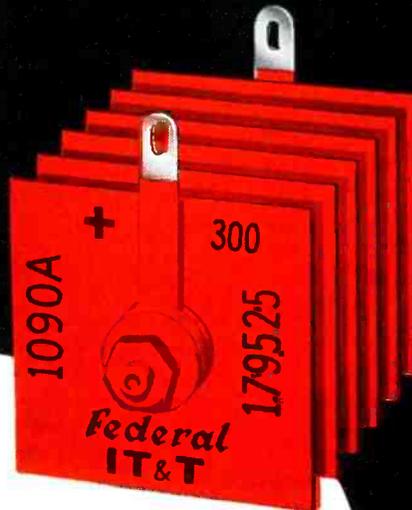
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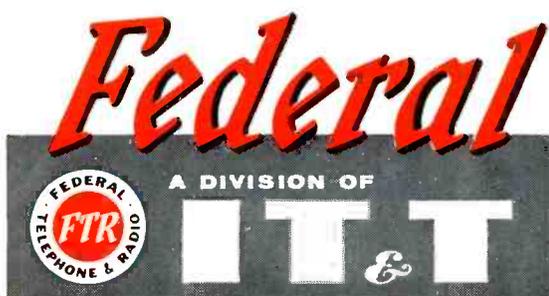


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Volume and level indicators are familiar items to many who have operated any kind of audio equipment. At least, most everyone has become acquainted with the meters and the cathode-ray eye tubes used as tuning indicators on the more elaborate radio receivers.

The increasing popularity of magnetic tape recorders has caused more people to become aware of several types of volume or level indicators. Every tape recorder including the least expensive model employs some form of volume or level indicator such as a neon lamp, a cathode-ray eye tube, or a meter.

STANDARDIZATION OF METERS

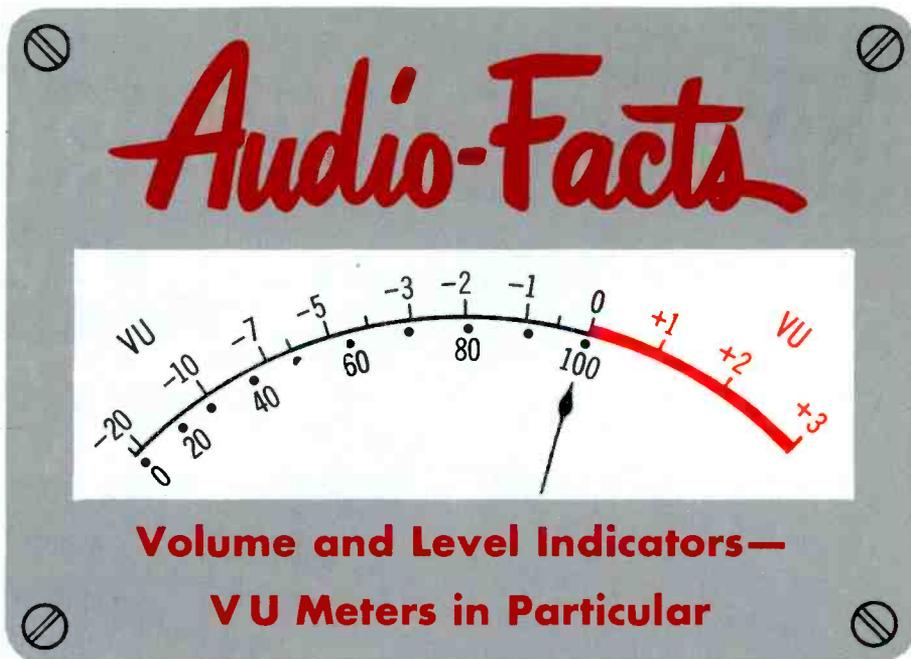
Most users recognize the importance of the recording-level indicator while operating any type of recording equipment. If the level of the signal fed to the record head of a tape recorder is too low, the signal may not be recorded at all or at least will be noisy when played back. If the level of the signal is too high, distortion may result.

Volume indicators are a necessity in communication, broadcast, and recording work in order to maintain at the correct level the audio signal obtained from many program sources. For instance, their importance is evident in radio broadcasting where the signal may be fed to a widely scattered network of two or three hundred stations. The signal must be fed at the correct level from the originating station and must be measured at many points in the network so that the signal can be maintained at the correct level throughout the system.

In fact, the need for a suitable standard of measurement and an appropriate instrument with which to do the measuring was so urgent and important that the Bell Telephone Laboratories, Columbia Broadcasting System, and the National Broadcasting Company combined their efforts to develop the VU meter. The VU (volume unit) meter was adopted by the electronics industry and now is used so universally that it is one of the most familiar items seen around studios and communication equipment when voice or music is handled.

REPRESENTATIVE TYPES OF VU METERS

Some typical VU meters are shown in the illustrations. Fig. 1 shows a Simpson 4-inch Model 142 VU meter. This meter is representative of the style used on most studio



equipment. A Triplet 3-inch Model 327-T VU meter is shown in Fig. 2. VU meters of this size and style are used on many pieces of portable equipment. Fig. 3 shows the VU meter mounted in the perforated metal front panel of the Ampex Model 600 magnetic tape recorder. All of these three meters are illuminated. Most meter manufacturers supply any of the standard models of VU meters.

Many audio enthusiasts are now becoming acquainted with VU meters because these meters are used on all professional and many semiprofessional types of tape recorders. While the user can have a fairly good understanding of how and why an eye tube or neon lamp operates, the real value and purpose of the VU meter may still be vague and not understood.

CHARACTERISTICS OF SIGNAL TO BE MEASURED

Before going into details concerning the use, construction, and specifications of the VU meter, we will discuss some of the characteristics of an audio signal and the problems encountered when an attempt is made to measure volume.

Because of the alternating nature of an audio signal, it is measured with AC type instruments, although the procedure is complicated by certain characteristics of the signal.

Pure sine-wave AC of constant amplitude and frequency can be measured, and the results can be expressed in any of three related values — average value, rms (or

by **ROBERT B. DUNHAM**

effective) value, or peak value. Complex, nonsinusoidal, periodic AC (not pure sine-wave AC but composed of many different frequencies and flowing in a more or less consistent pattern of bursts or pulses) can also be measured; and the results can be expressed in the same three values.

The audio signal usually has similar characteristics in that it is complex and nonsinusoidal, but it differs in that it is nonperiodic. A consistent and practical measure of the signal is difficult to obtain because of the irregular variation of the signal in respect to time.

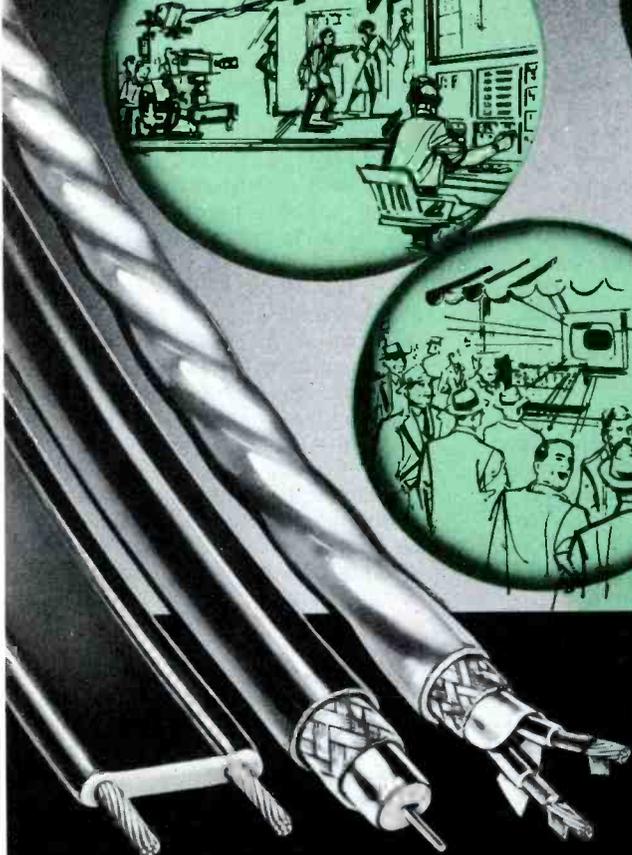
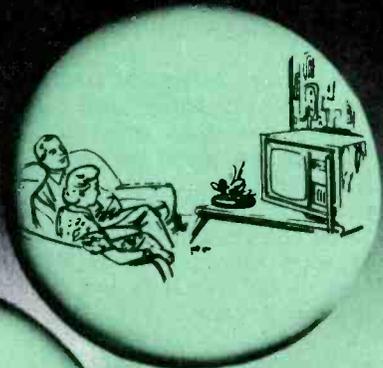
If a signal (for instance, music played back from a record) is observed on an oscilloscope, the amplitude and frequency of the ever-changing complex waveforms fluctuate over wide limits. When watching the continually changing waveforms, the observer can realize very readily that the average rms or peak value at any one particular instant cannot be selected as being representative of the signal level at all times.

MEASUREMENT OF VOLUME

A fourth electrical quantity or value, known as "volume" has been adopted to fulfill the need for a practical measure of audio signals in communication and recording work. Volume is suitable because it takes into consideration the dynamic range of the signal over a period of time. Volume has been standardized by

* * Please turn to page 70 * *

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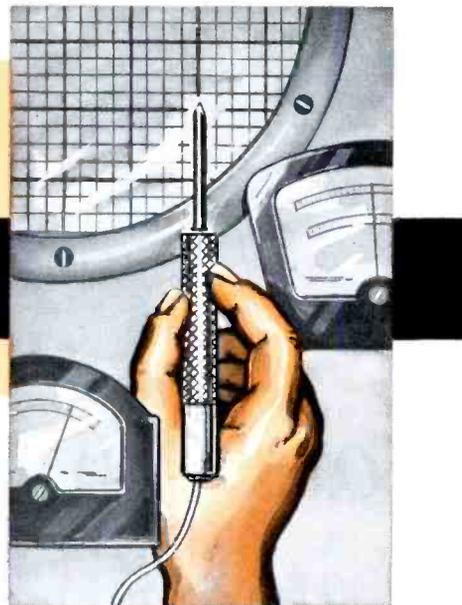
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3-8

Notes On

TEST EQUIPMENT

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



by Paul C. Smith



Fig. 1. Simpson Model 406 Chromatic Amplifier and Simpson Chromatic Probe.

SIMPSON MODEL 406 CHROMATIC AMPLIFIER AND CHROMATIC PROBE

The Simpson Model 406 chromatic amplifier and the Simpson chromatic probe are shown in Fig. 1. These units are mentioned together in this article, but that does not necessarily imply that they must always be associated with each other in use. Each has its own individual purpose and is a separate unit. The technician will find, however, that in many applications it will be convenient to use the two units together.

Chromatic Amplifier

The Model 406 chromatic amplifier is designed to provide amplification of video frequencies wherever such amplification would be useful in servicing color or monochrome TV receivers. A voltage amplification of 30 times is claimed over a band of 4 megacycles, with the output flat

within ± 0.5 decibel from 8 kilocycles to 4 megacycles.

In addition to its function as an amplifier of the frequencies just mentioned, the Model 406 chromatic amplifier also serves as a filter to attenuate frequencies above 4.5 megacycles. This feature is useful when the amplifier is used with a sweep generator having an output signal that might contain beat frequencies outside the desired range.

No attenuators are supplied on the chromatic amplifier because of the fact that this amplifier will be used with low-gain circuits in which the danger of overloading is not great. Any attenuation which may be necessary can usually be obtained from the attenuators on the signal source.

The input impedance of the chromatic amplifier is high, and the output impedance is approximately 2,200 ohms. These impedances must be kept in mind when the technician connects the amplifier to circuits being tested. If the input is connected to a point at which the impedance is high, the use of a shielded input cable may introduce enough shunt capacitance to bypass some of the higher frequencies. The response curve obtained under such conditions will not be a true indication of the actual circuit response. The remedy is to use a pair of open test leads, but this introduces another factor -- the possibility that an interfering signal may be picked up. This point will be illustrated a little later in the article.

Chromatic Probe

The Simpson chromatic probe is designed to enable the technician

to obtain a video sweep signal from his present Simpson Model 480 Genescope or Model 479 FM and TV generator. Basically, the chromatic probe is a crystal-diode modulator in which two signal frequencies may be heterodyned and from which the resulting difference frequency may be obtained as an output signal. If one of the two applied signals is an FM signal and the other is an unmodulated RF signal, the output will be another sweep signal of a frequency dependent upon the applied frequencies.

For example, when the FM and RF generator dials are both set to the same frequency -- let us say, 60 megacycles or any other frequency within the range of both generators -- a new FM signal will be obtained at the output of the probe. The difference frequency between the two signals when both are at 60 megacycles will be zero, and the difference frequency will vary on both sides of zero as the modulated input signal varies. The sweep width of the new FM signal will be the same as that of the modulated input signal.

Output Signal from the Chromatic Probe and Amplifier

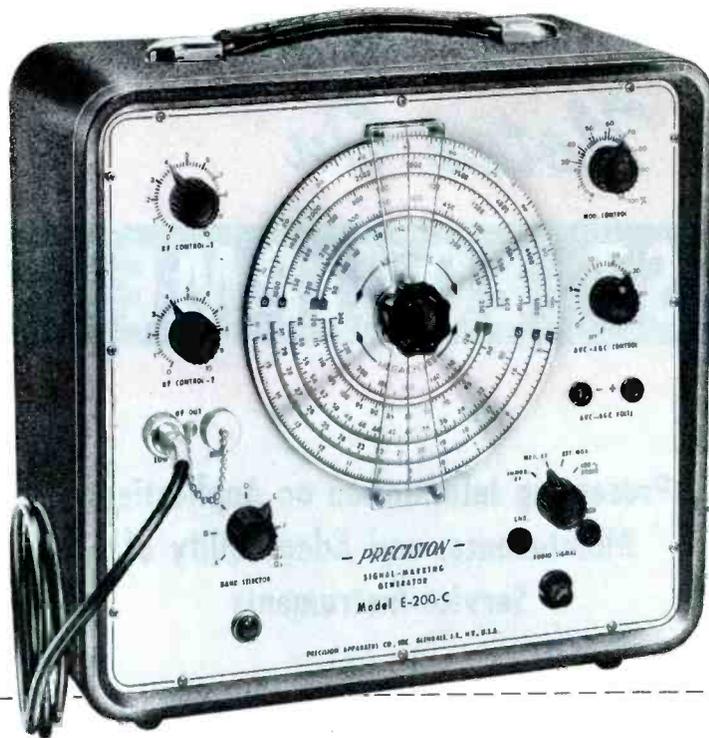
The video sweep signal obtained from the probe is centered about zero frequency but will not actually go as low as zero because of the tendency of two associated oscillators to lock together as they approach the same frequency. The output of the chromatic probe and amplifier, as viewed with an oscilloscope, is shown in

* * Please turn to page 51 * *

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Dollar and Sense Servicing

by *John Markus*

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

FORECASTS. Prosperity will continue to rise, income will reach new highs, jobs will be plentiful, and profits will be up in every field except farming, according to the confidential business-newsletter services and reports to which many firms subscribe. The Twentieth Century Fund predicts for 1960 an average family income of \$6,000 for a 37.5-hour work week, as compared to the 1954 report by the Bureau of Labor Statistics with figures of \$5,330 for a 40.7-hour week in manufacturing.

These figures take into account the increasing trend toward two persons working in a family; hence, they do not show individual income. In addition, the average work-week figure for servicing trades is considerably higher than the average for all types of work.

Nevertheless, the figures do mean that business should continue to be good for the next four years, barring any sudden and unforeseen change in the international situation. Therefore, take a good vacation this year so that you'll be in healthy physical and mental shape to make the most of the prosperous months to come. Be thankful that your business does have a summer slump during which you can get away for even a full month of vacation at a cost (in loss of income) that can be made up in just a few evenings of extra work during the winter peak of business.



PRINTED CIRCUITS. We are in an interesting period of evolution in printed circuitry these days. Wiring painted and fired on ceramic was about the first to find commercial use in hearing aids and combination RC plates as well as in military gear. These never did become widely used in radio and TV chassis chiefly because of high cost.

Right now, etched wiring predominates; but the value of the copper that goes down the drain after being removed by the etching process is one drawback. Some estimate this as being about \$75,000 worth of copper a year, with no economical process yet available for salvaging it. In addition, many etched-wiring boards have to go through a plating operation to get copper inside the punched or drilled holes so that solder will creep into the holes and give better joints.

The dark horse coming up fast is plated wiring, which Motorola has been advocating and using for some time. Now General Electric follows suit by announcing curtailment of their etched-wiring boards and a step up in the production of their "Thru-Con" boards. The latter have the copper wiring pattern plated right on the board as well as through the holes, and the number of steps involved in producing the mechanized wiring is thereby reduced.

Briefly, plated wiring is done by punching the required holes in a sheet of plain, unclad phenolic board and then by dipping the board in graphite solution or by using some similar process for applying a conductive coating. An insulating ink is applied to areas where copper is not wanted. Copper is then plated onto the board to form the wiring and the through connections in the punched holes. This process anchors the plated wiring firmly to each hole and minimizes the risk of loosened wiring when soldering is performed. Techniques for still further improving the plating operation and cutting its costs are under investigation and are about a year away from use in production.

Figures on total industry production of wiring boards are not available; but in the table-model radio field, it is very likely that the majority of sets made this year will have them. General Electric, for one, expects to turn out this year a million radios using printed-wiring boards.

HUMLESS CAR RADIO. Trade talk has it that a transistorized auto radio is now ready for production in a Philcoplant and that it will be marketed as special equipment in Chrysler cars this fall at around \$150. There'll be 11 transistors operating directly from the automobile storage battery. Absence of a vibrator means no hum, and absence of tubes means instant starting. Another publicity item that is expected to be featured is a low battery drain of only about a tenth that of an ordinary car radio. Technically, this is rather meaningless because modern automobile batteries and generators are designed to handle a radio. The saving in current thus won't even be noticed.

RCA has also announced a transistorized car radio using nine transistors, but there's no word yet as to adoption by a car manufacturer.



ACCESSIBILITY. During a discussion of TV servicing problems at a conference called by the governor of New York, Ithaca service technician Ben DeYoung heartily agreed with a previous speaker that it sometimes took \$20 worth of labor to replace a 20-cent part. "Some manufacturers have a long way to go," explained DeYoung. "Even if you find the trouble in five minutes, I dare any design engineer to get at it in four hours."

Fortunately, most of the larger manufacturers recognize the importance of the goodwill of the servicing industry and avoid stacking more than two or three parts, one atop the other. Etched-wiring panels designed for automatic assembling are still better, because so far no insertion head that will put in one part on top of another has been built; all parts have to go down against the panel.

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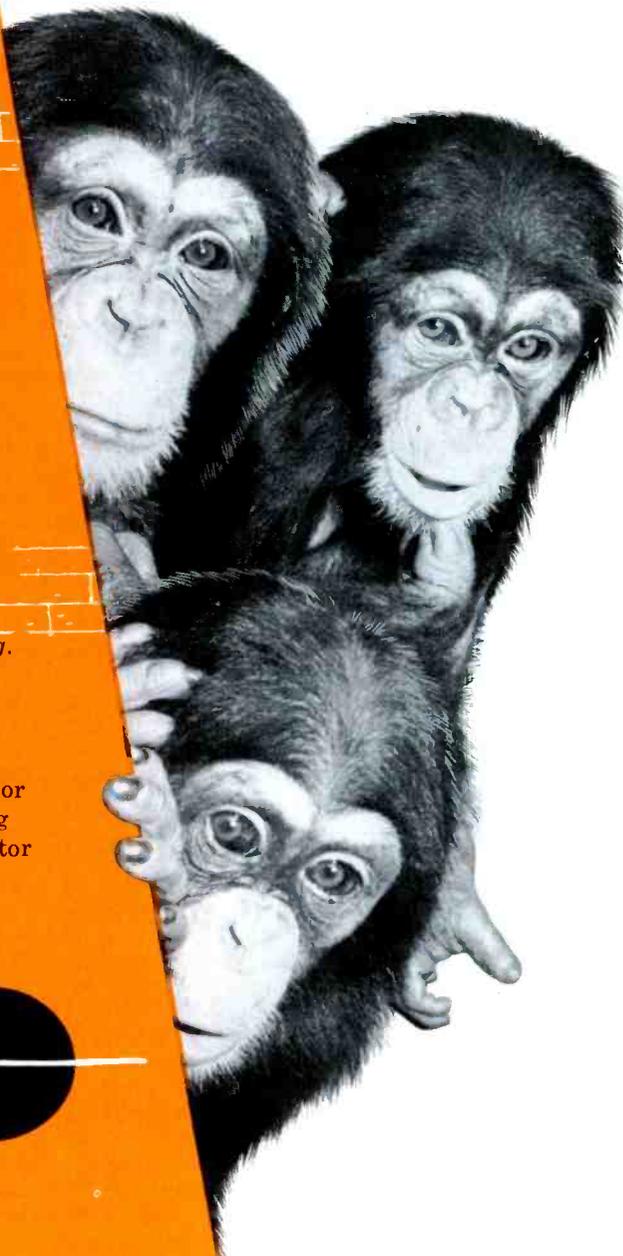
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Color TV Training Series

(Continued from page 9)

grids of the picture tube. Note that the plates of the color-difference amplifiers are DC coupled to the control grids of the picture tube. A change in the conduction of one of these amplifiers will change the voltage on the grid of the associated electron gun, and the reproduction of the gray scale will be affected.

The first step toward correcting such a trouble is to check the amplifier tube associated with the deficient or predominant color. If replacing this tube does not cause a considerable change in the image, the voltages on the cathode, control grid, and screen grid of the associated electron gun should be measured. One method of measuring these voltages is to insert a needle-point probe into the socket of the picture tube. As shown in Fig. 12-3, the probe is inserted alongside the insulation of the conductor so that it makes contact with the metal clip in the socket.

If the voltage on one of the elements of the gun is not within tolerance, the associated circuit should be checked for a defect. It is also possible for a defective gun to cause the voltages at the elements to be incorrect.

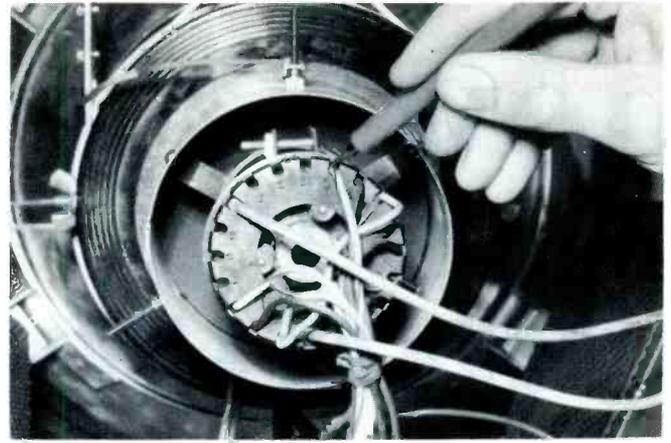


Fig. 12-3. A Needle-Point Probe Inserted at the Picture-Tube Socket to Measure Voltage.

These voltages may be measured after the socket has been removed from the tube base. If the voltages then appear to be normal, the associated gun may be defective. Caution should be observed when measuring voltages at the socket after it has been removed from the tube base because some of the voltages are very high.

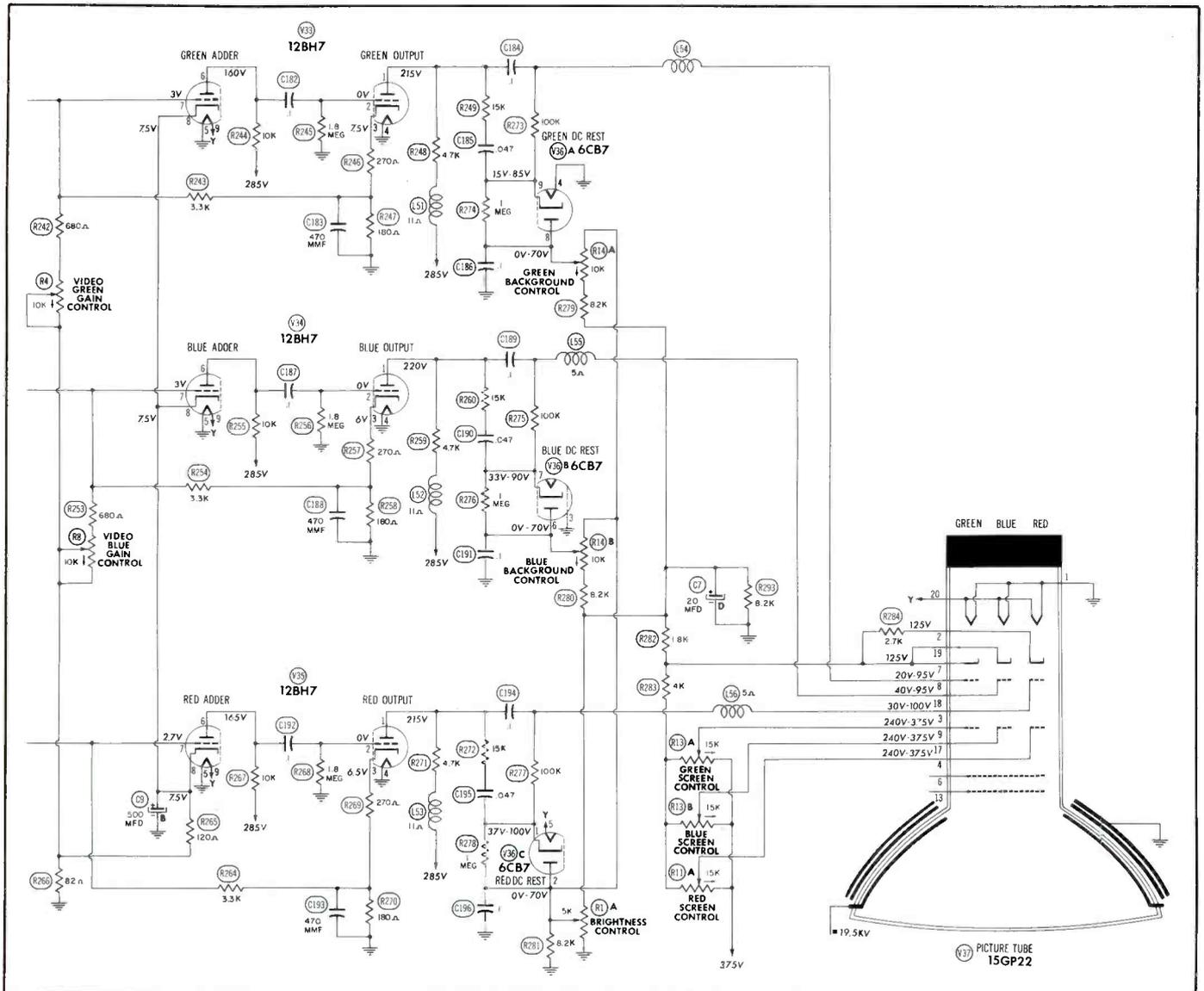


Fig. 12-4. Matrix Section and Circuits Associated With the Picture Tube in the RCA Victor Model CT-100 Color Receiver.

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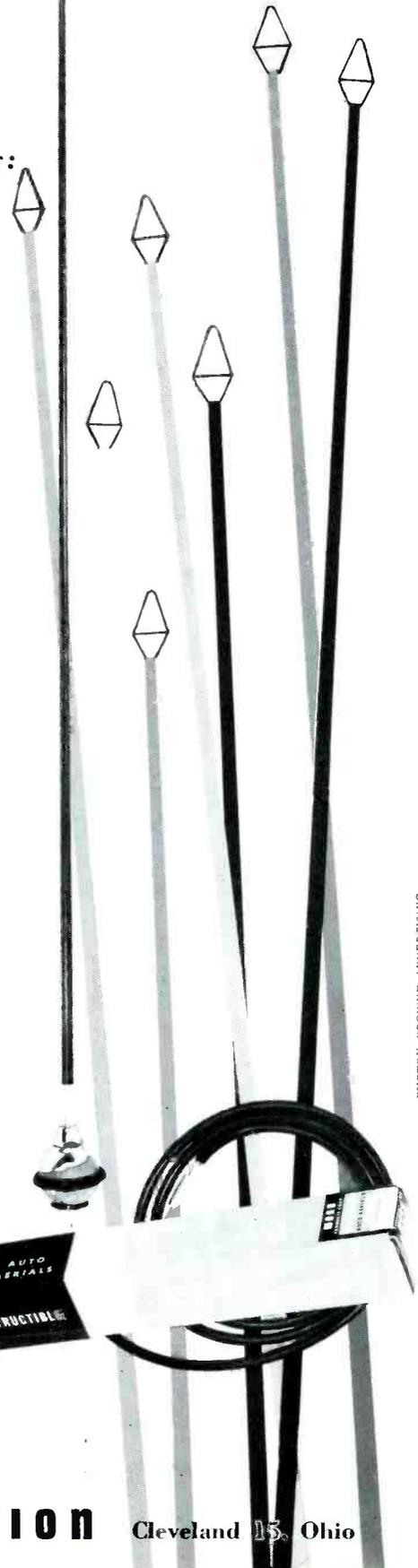
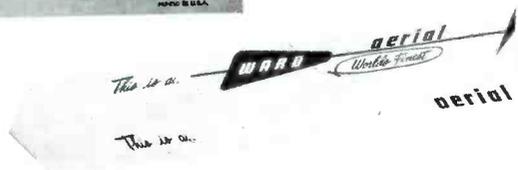
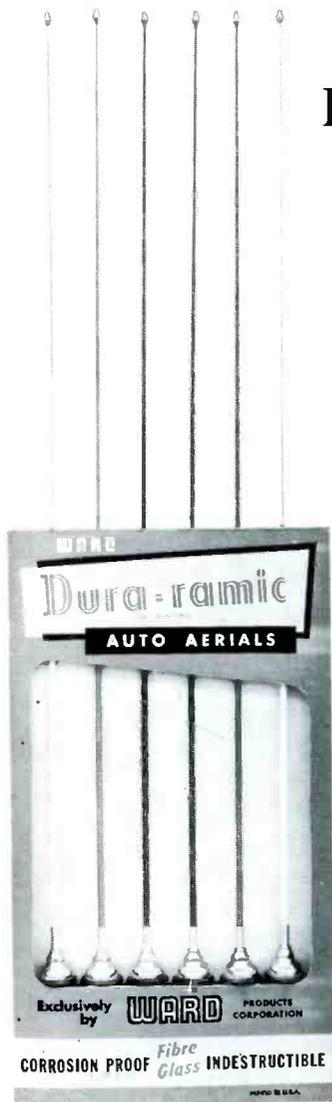
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The partial schematic diagram in Fig. 12-4 shows the matrix section and the circuits associated with the picture tube in the RCA Victor Model CT-100. The luminance signal in this receiver must pass through the three matrix channels to reach the picture tube. A faulty tube or component in one of these channels will affect the ability of the receiver to reproduce values of gray.

One method of determining whether or not the trouble is in the matrix section is to reduce the setting of the contrast control so that no video signals will modulate the picture tube. If a gray raster is obtained, then the trouble is confined to the matrix section. If not, the screen voltage to one of the guns is not correct, or one of the guns in the picture tube is defective. The screen voltages can be measured at the picture-tube socket; and if they are found to be incorrect, conventional servicing techniques can be employed.

If it has been determined that the trouble is in the matrix section, the tubes associated with the deficient or predominant color should be checked. These include the tube used in the adder and amplifier stages and the one used as the DC restorer. In the event that tube replacement does not remedy the trouble, the chassis should be removed and the defective stage isolated by using an oscilloscope to trace the signal through the suspected channel. When the defective stage is located, standard servicing procedures can be used to find the defective component.

COMPLETE LOSS OF COLOR

Testing With an RF Signal

When the complete loss of color is encountered, the color-bar generator can be used to determine in which section of the receiver the color is being lost. After the receiver has been checked for proper monochrome operation, connect the output terminals of the color-bar generator across the antenna terminals of the receiver. While the RF color signal is being applied to the receiver, the color-saturation control should be turned to its nearly maximum position and the fine-tuning control should be rotated throughout its range. The saturation control is adjusted to its nearly maximum position because, in some cases, the receiver might be producing color; but the

color might be of such a low amplitude that it would not appear on the screen unless the saturation control were turned up. In some color receivers, loss of color can also be caused by misadjustment of the hue control; therefore, this control should be rotated throughout its range.

If the receiver is in the home during this test and if the colors are correctly reproduced when the RF signal from the color-bar generator is being received, the loss of color may be caused by misadjustment of the color-saturation control, the hue control, or the fine-tuning control. There is also a possibility that the antenna may not be properly oriented or that one of the lead-in wires may be broken. It is possible to have these troubles present without seriously affecting monochrome operation. When a color signal is being received, however, the signal reaching the antenna terminals might be attenuated to such an extent that operation of the receiver would be affected.

Testing With a Video Signal

If color was not reproduced when the RF color signal was applied to the receiver, the video signal from the color-bar generator should be injected at the video input of the receiver. In most cases, the terminals of the generator can be connected to the input of the video section of the receiver without the need for removing the chassis from the cabinet. Shown in Fig. 12-5 are three possible connections which can be made.

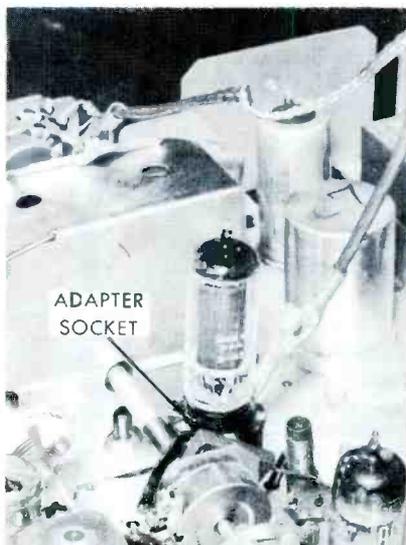
Fig. 12-5A shows the output lead of the generator clipped to the output terminal of the second-detector crystal. If the crystal is accessible on top of the chassis, this is the most convenient method to use.

A second method of connecting the output leads of the color-bar generator is by use of an adapter socket. Fig. 12-5B shows an adapter socket that has been inserted in the socket of the first video amplifier, after which the amplifier tube was inserted in the adapter. The clip lead of the generator has been connected to the terminal that connects to the control grid of the tube.

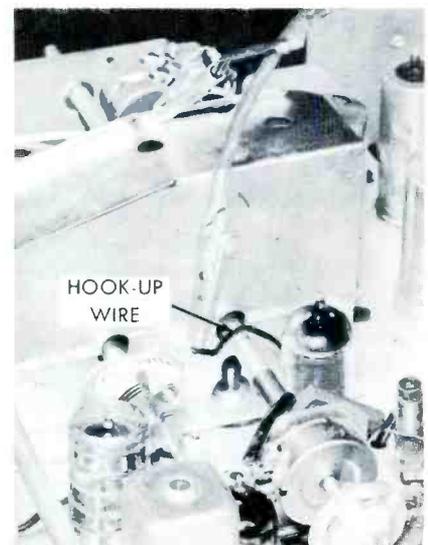
The third method is one that can be used if it is impossible to use either of the other two methods. Remove the first video amplifier tube and loop one end of a piece



(A) At Output Terminal of Second-Detector Crystal.



(B) At Adapter Socket.



(C) At Loose End of Hook-up Wire With Other End Looped Around the Pin of the Control Grid.

Fig. 12-5. Connections for the Injection of a Video Signal From a Color-Bar Generator.

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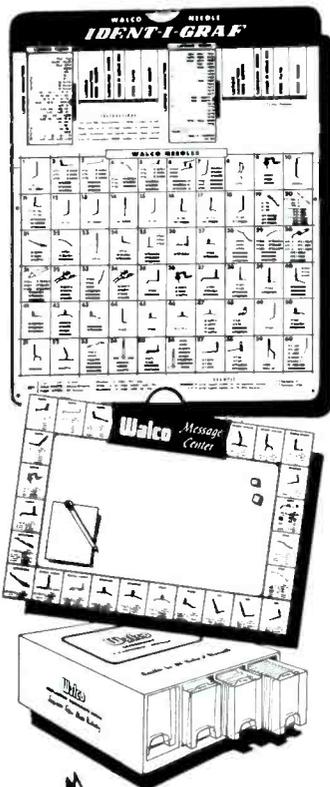
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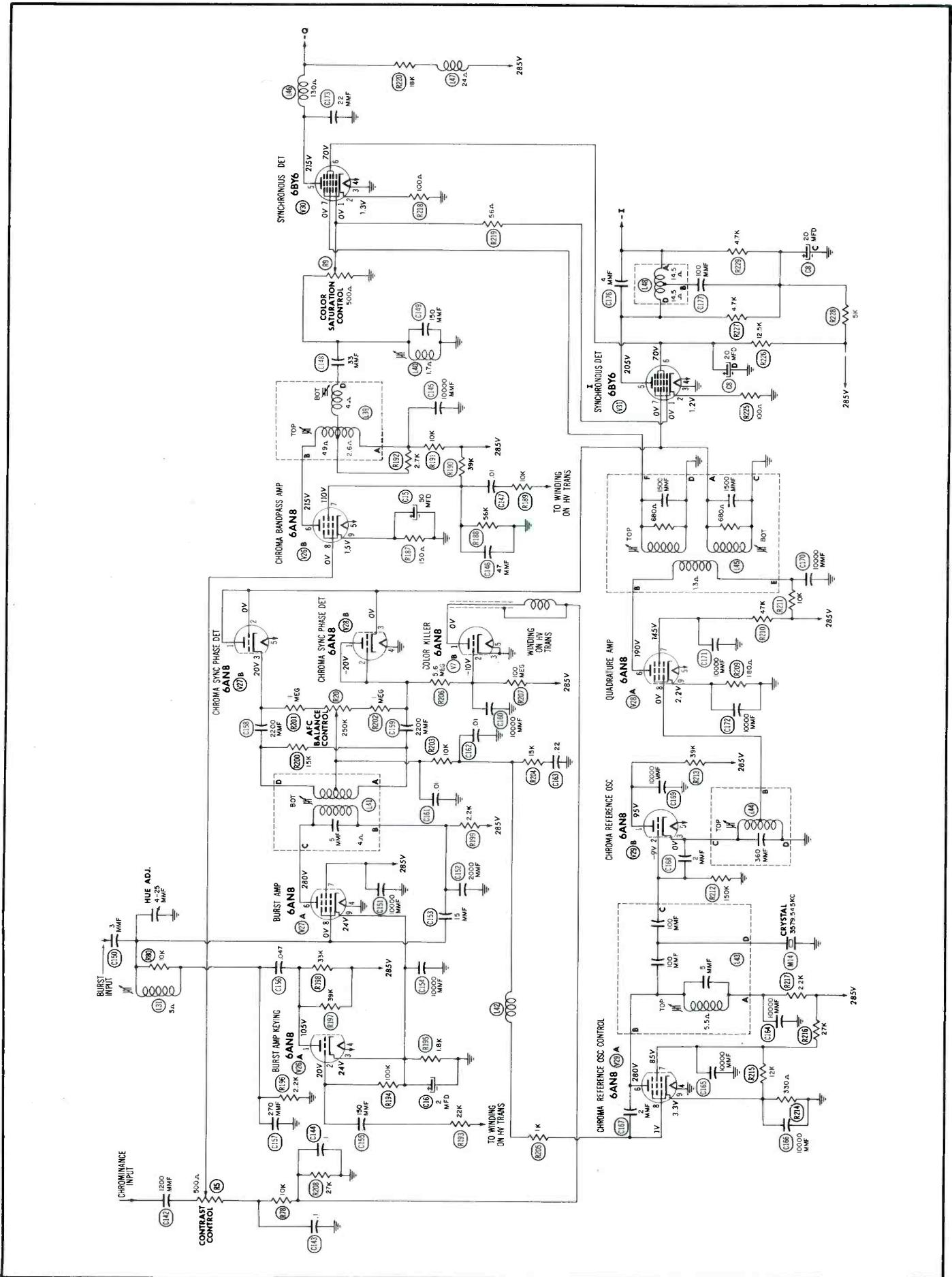
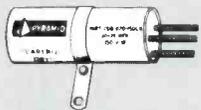


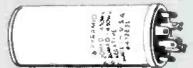
Fig. 12-6. Bandpass Amplifier, Color AFC, and Demodulator Circuits in the RCA Victor Model CT-100 Color Receiver.



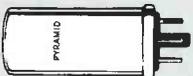
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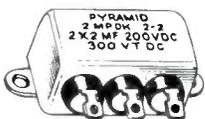
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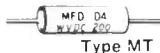
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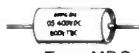
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of hookup wire around the pin of the control grid. Then replace the tube, being careful not to short the lead to any of the other pins or to the chassis. With the tube replaced, the lead of the generator can be connected to the loose end of the wire. This connection is shown in Fig. 12-5C.

Color Lost in the RF and IF Sections

By applying the video signal from the color-bar generator, it can be determined whether color is lost in the RF and IF sections or in the sections that follow the chrominance take-off point. If color does appear, the color circuits cannot be the cause of the trouble. Since color was not obtained when the RF signal was used but is obtained when the video signal is used, the color signal is not able to pass through the RF or IF sections. Whenever this is the case, the alignment of the RF and IF sections should be checked. The response of these sections must be broad and flat in order for the chrominance signal to pass. The response could be incorrect for color even though no serious effect might be noticed in the monochrome picture.

Color Lost in the Color Sections

Let us now consider the procedure to follow if color is not obtained when the video signal is applied to the video circuits. This indicates that the source of the trouble is not in the RF and IF sections but somewhere in the color circuits. The color circuits which are to be investigated are those shown in Fig. 12-6.

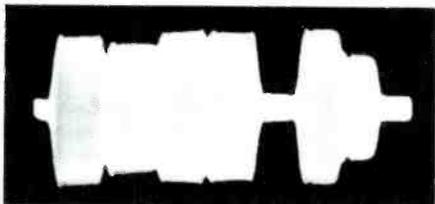


Fig. 12-7. Waveform of the Chrominance Signal at the Input of the Demodulators.

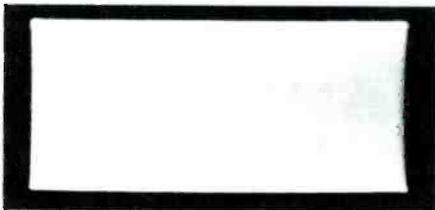


Fig. 12-8. Waveform of the Reference Signal at the Suppressor Grids of the Demodulators.

If the chassis is in the cabinet, the tubes to be replaced are in the bandpass-amplifier, the color AFC, and the color-killer circuits. It is not necessary to replace the color-demodulator tubes because both must be defective in order to cause a complete loss of color. There are nine stages in the color section of the receiver; but because of the use of dual-purpose tubes, it is necessary to make only five tube changes. The bandpass amplifier and the burst keyer are contained in one tube, the burst amplifier and one phase detector are in another tube, the reference oscillator and control are in one tube, and the quadrature amplifier and the other phase detector are in another tube. The color killer is also contained in a dual-purpose tube, and the other half of the tube is the fifth video IF.

If color is not restored after the tubes have been changed, the cause of the trouble is due to failure of a

component or components within the circuits under consideration. With the chassis removed and the video signal being applied to the receiver, the trouble-shooting procedure for the circuits is as follows.

In order for the color demodulators to operate properly, the chrominance signal must arrive at the input of these stages and the CW reference signals must be present at the suppressor grids. If either the chrominance signal or the reference signals are missing, no color will be reproduced. It seems, therefore, that the most logical place to start looking for the cause of the trouble is at the color-demodulator stages. With an oscilloscope, check for the presence of these signals. The chrominance signal should appear like the one shown in Fig. 12-7. The CW reference signals should appear like that shown in Fig. 12-8.

Chrominance and Reference Signals at Demodulators

If the chrominance signal and the CW reference signals are found to be present when using an oscilloscope, the trouble must be in the demodulator stages. The complete loss of color can be attributed to the demodulator circuits only if both tubes should go bad at the same time, which is very unlikely, or if there is a circuit which is common to both demodulators. In the circuit of Fig. 12-6, this could be possible because the screen of each demodulator is tied to a common circuit. If the screen resistor were to open, the screen voltage would be removed; and both demodulators would consequently be inoperative. As a result, there would be no output from the color channels.

Reference Signals Present but Chrominance Signal Absent

Let us consider a receiver in which the reference signals are present at the color demodulators but in which the chrominance signal is absent. This indicates that something is preventing the chrominance signal from passing through the bandpass-amplifier circuit. To locate the point where the signal is lost, trace back through the bandpass-amplifier circuit with the oscilloscope until the signal is found. When the signal is found, the cause of the trouble would then exist somewhere in the circuit between the point where the chrominance signal is present and the input of the demodulators. If the signal is found to be present on the input grid of the bandpass amplifier but not at the plate, the loss of the signal could be caused by a drop in plate or screen voltage or it could be caused by the fact that the stage is held at cutoff by the action of the color killer (if one is employed). A voltage check could be used to determine quickly which was the case. If the control grid has a negative potential, attention is then directed to finding the reason why the color killer is biasing the bandpass amplifier to cutoff.

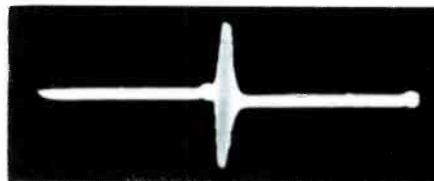


Fig. 12-9. Waveform of the Burst Signal.

The color killer is normally held at cutoff by a negative potential which is applied to its grid. This potential is developed by the phase detectors and is always present as long as there is a burst signal. When the burst is absent at the phase detectors, the color killer is allowed to conduct and to bias the bandpass amplifier to cutoff.

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15. Blank pin or locating key on each tube is shown on placement chart.
16. Tube charts include fuse location for quick service reference.

TUBE FAILURE CHECK CHARTS

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

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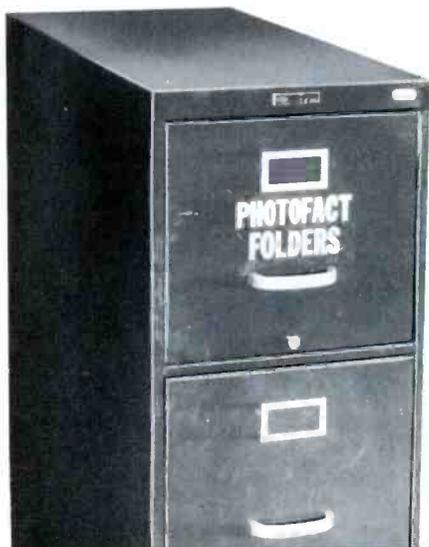
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To determine if the burst signal is arriving at the phase detectors, check for the presence of the signal by using an oscilloscope. The burst signal at the phase detectors should appear as shown in Fig. 12-9. If the burst signal is present, check the circuit of the color killer. In the circuit of Fig. 12-6, the grid of the color killer would go to zero potential if capacitor C160 were to become shorted. The color killer would therefore conduct, and the loss of color would result.

If the burst signal is not present, go back and check through the burst-amplifier circuit with the oscilloscope. The burst signal should appear at the plate of the burst amplifier. The signal at the input of the burst amplifier should be the composite color signal which would appear like that shown in Fig. 12-10. If this signal is present at the input but the burst is not present at the output, check the circuit associated with the burst amplifier.

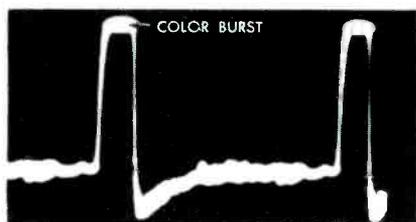


Fig. 12-10. Waveform of the Signal at the Grid of the Burst Amplifier.

The burst amplifier is caused to conduct during horizontal-retrace time either by a pulse from a burst-keyer stage, such as that shown in Fig. 12-6, or by a pulse that is taken from a winding on the horizontal-output transformer. Since the burst signal is transmitted during horizontal-retrace time, only the burst signal would be amplified by the burst amplifier. If the keying pulse is lost, the burst amplifier in either type of circuit would be in a nonconducting state at all times; consequently, no burst signal would appear at the output. The waveform in Fig. 12-11 shows the appearance of the keying pulse.

When a circuit such as that shown in Fig. 12-6 is employed, the loss of the chrominance signal can be from various causes. It can be lost in the bandpass-amplifier circuit, anywhere between the chrominance take-off point and the input of the demodulators. The bandpass amplifier could be biased to cutoff by the color killer because of the loss of the burst signal. The burst signal can be lost

anywhere between the burst take-off point and the input of the phase detectors. The burst will not reach the phase detectors if the keying pulse to the burst amplifier is missing. If a color killer is not employed to disable the bandpass amplifier during the absence of a burst signal, it would only be necessary to check for the loss of the chrominance signal in the bandpass-amplifier circuit.

Chrominance Signal Present but Reference Signals Absent

If it is found that the chrominance signal is present but both reference signals are absent when the signals at the color demodulators are checked, the bandpass-amplifier circuit is to be disregarded and attention is to be directed to the color-sync circuit. In order to have complete loss of color, the reference signal on the suppressor grid of each demodulator must be absent. If one

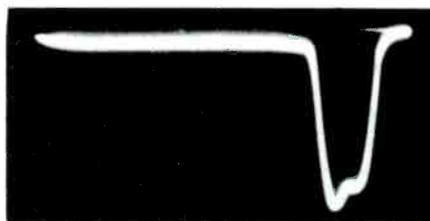


Fig. 12-11. Waveform of the Keying Pulse at the Burst Amplifier.

reference signal is present, colors would be reproduced but they would be incorrect. The reference signal that should be present at the demodulators is shown in Fig. 12-8.

The portion of the color-sync circuit in which the cause of the trouble is located is shown in Fig. 12-12. This circuit consists of the 3.58-mc oscillator and the quadrature amplifier. There are two possible reasons why the reference signals are missing at the demodulators. Either the reference signal is not being generated by the oscillator, or the signal is being lost between the oscillator and the output of the quadrature amplifier. By checking the signal with an oscilloscope at the grid of the quadrature amplifier, it can be determined whether to look for the trouble in the oscillator circuit or in the quadrature-amplifier circuit. If the signal is present at the grid of the quadrature amplifier, the signal is being lost in the quadrature-amplifier circuit. Voltage and resistance checks would determine the component that has failed.

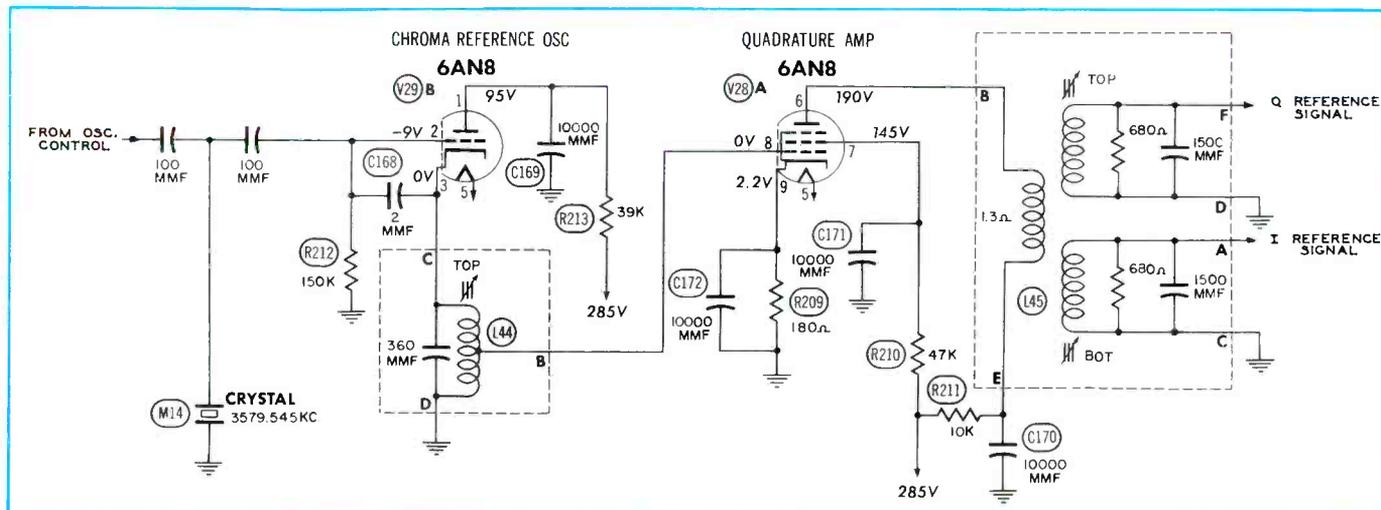
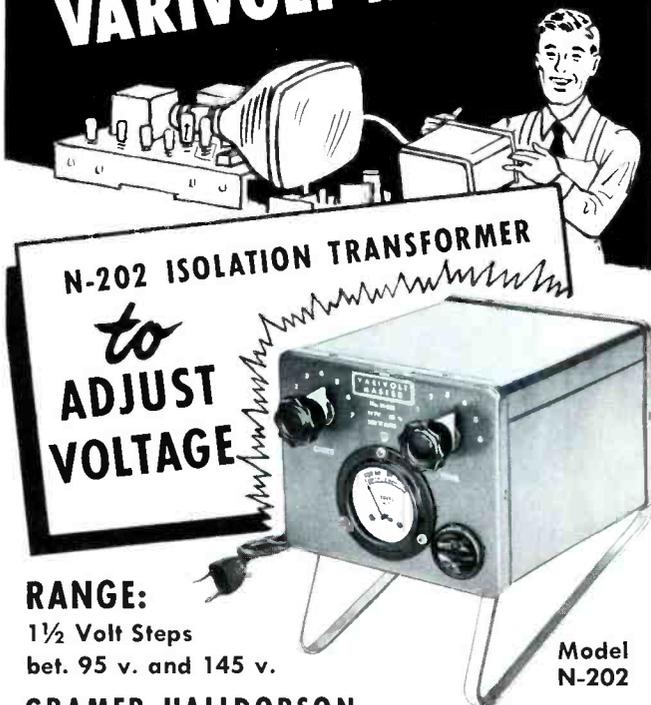


Fig. 12-12. Circuit of the 3.58-Mc Oscillator and Quadrature Amplifier in the RCA Victor Model CT-100 Color Receiver.

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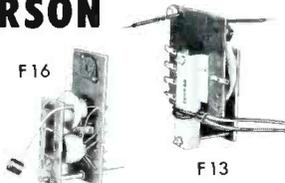
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If the signal is missing at the grid of the quadrature amplifier, the cause of the trouble is located in the oscillator circuit. Loss of the output signal of the oscillator can result from detuning of the 3.58-mc output coil located in the cathode circuit or from a bad crystal in the grid circuit. With either a detuned tank circuit in the cathode or a bad crystal, the plate voltage of the oscillator drops to almost half the value it should be. Substitution is the best way to check for a faulty crystal. Voltage and resistance checks should then be used to determine which other component had failed.

Let us summarize the steps of the trouble-shooting procedure for the condition of complete loss of color. If a good monochrome picture can be produced by the color receiver, apply an RF signal from a color-bar generator to the input of the receiver. If color appears on the screen after the controls have been properly adjusted, check for an improperly oriented antenna or a broken lead-in wire.

If color is not produced when the RF signal is being used, apply the video signal at the input of the video section. The results obtained will determine whether the trouble is before or after the video input. If color appears, the trouble is located in the RF or IF section. The alignment of these sections should be checked.

If color does not appear when using the video signal, the trouble is in one of the color circuits somewhere between the point where the chrominance signal is separated from the composite color signal and the output of the demodulators. If the chassis is in the cabinet, check by substitution of the tubes in the bandpass-amplifier, AFC, and color-killer circuits.

If the chassis is removed from the cabinet, check the signals at the demodulators with an oscilloscope. When both the chrominance and reference signals are present, the trouble is in a circuit that is common to both demodulators.

If the chrominance signal is absent but the reference signals are present, check back through the bandpass-amplifier circuit for the place where the signal is lost. If a color killer is employed and it is biasing the bandpass amplifier to cutoff, check the color-killer circuit or check for the absence of the burst signal. The burst signal can be lost anywhere between the burst take-off point and the phase detectors. If the correct signal is present on the grid of the burst amplifier but the burst is not present at the plate, check for the loss of the keying pulse from the horizontal-output transformer.

If it is found that the chrominance signal is present but the reference signals are absent when checking the signals at the demodulators, check the 3.58-mc oscillator and the quadrature-amplifier circuits for the point where the reference signal is being lost.

This concludes the trouble-shooting procedure for the condition of complete loss of color. In the next issue, we will discuss a trouble-shooting procedure for the condition when wrong colors are reproduced by the color receiver.

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

Troubles in TV Tuners

(Continued from page 13)

A plate-load resistor could be caused to fail by an internal short in the associated tube. A faulty decoupling capacitor could cause the decoupling resistor to fail. In replacing either the plate-load resistor or the decoupling resistor, it would be a good policy to replace the associated tube and also to check the decoupling capacitor.

If the feedback capacitor must be replaced, be careful that the lead length is kept the same as that for the original; and be sure to get an exact replacement in size, value, tolerance, and temperature coefficient. NOTE: All of these properties are equally important.

Some of the older types of continuous tuners that employ a high-low band-switch arrangement have the habit of failing to oscillate on the high band. This is usually caused

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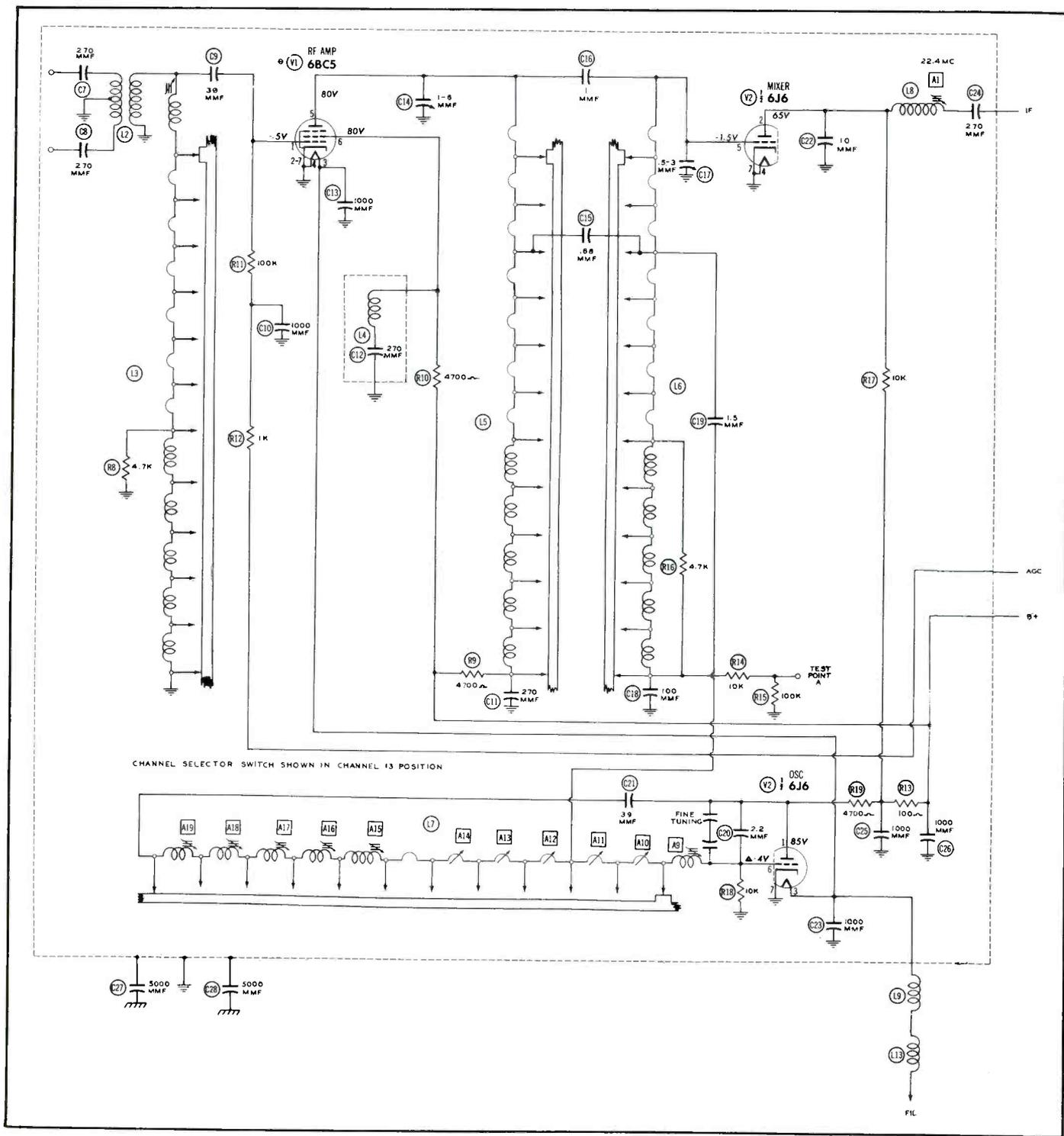


Fig. 3. Schematic Diagram of a Switch Type of Tuner With a Pentode RF Stage.



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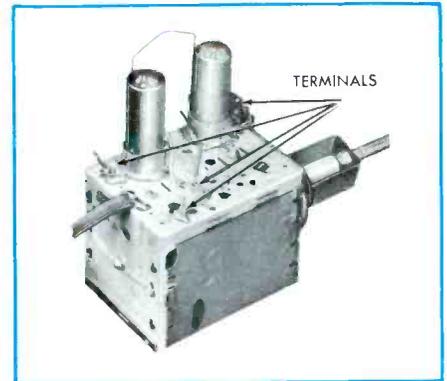
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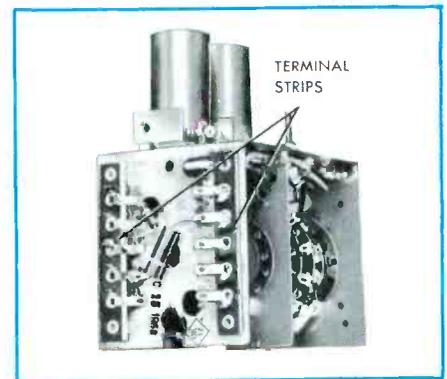
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tubes of the tuner, IF, and video stages with an eraser on a pencil or a tube tapper such as that shown in Fig. 10.

A check of the B+ and AGC lines in the tuner should reveal any 120-cycle signal which might be entering the tuner. If no 120-cycle signal is



(A) Terminals on Top of Tuner.



(B) Terminal Strips on Rear of Tuner.

Fig. 4. TV Tuners Showing Terminals for Connections to Main Chassis.

located at these points, then it can be assumed that the undesired modulation is not taking place in the tuner.

3. Intermittent Condition in Picture and Sound.

Intermittent operation is without a doubt the most dreaded problem of the servicing business. When there is an intermittent condition present in a tuner, the repair work may be even more difficult than in other parts of the receiver. This is caused by the inaccessibility of the components and the difficulty in making a visual inspection of the entire tuner. This condition is not so bad in the turret type of tuner as it is in the switch type because all unused turret strips can be removed, and the components and circuitry of the tuner are therefore available for testing. A turret tuner with most of the strips removed is shown in Fig. 6.

If it is the oscillator stage which is operating intermittently,

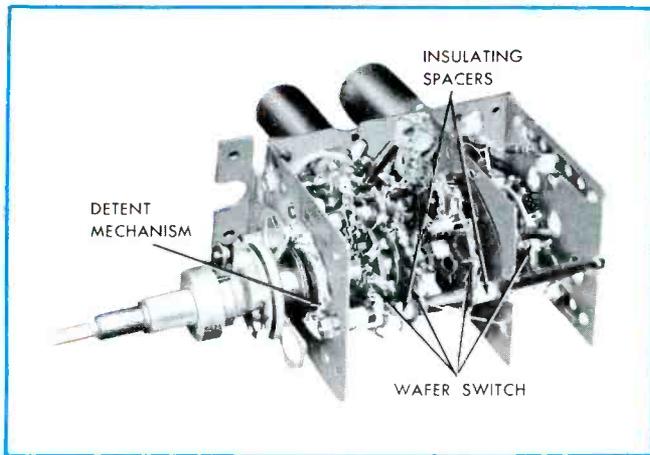


Fig. 5. Interior of Switch Type of Tuner.

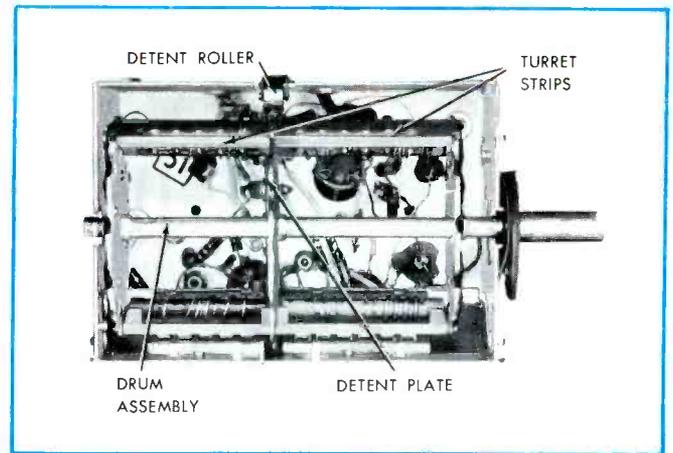


Fig. 6. Turret Type of Tuner with Strips Removed for Servicing.

this can definitely be discovered by checking the injection voltage of the oscillator at the mixer-grid test point A with a VTVM. A fluctuation of voltage at this point would indicate that the intermittent condition is in the oscillator stage.

Possible causes of an intermittent condition in the picture and sound are:

- a. Intermittent condition within the RF or mixer-oscillator tube.
- b. Dirty contacts.
- c. Cold solder joint.
- d. Defective component in either the RF, mixer, or oscillator circuits.
- e. Defective component in feedback network of oscillator.

The major problem in servicing a receiver which has an intermittent condition is the time which must be spent to locate the actual stage causing the trouble. There is on the market an instrument which can make the job of locating the intermittent stage much easier. This unit, the Authorized Model 202 intermittent recorder, was described and its operation and application were explained in an article in the

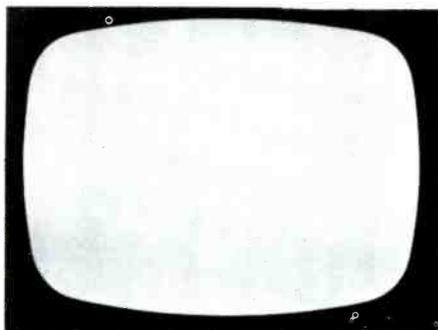


Fig. 7. Raster, No Sound, No Picture, and No Snow.

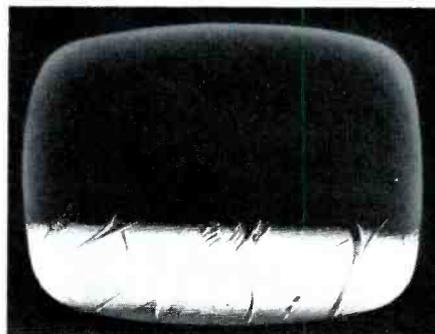


Fig. 8. Picture with 60-Cycle Hum.

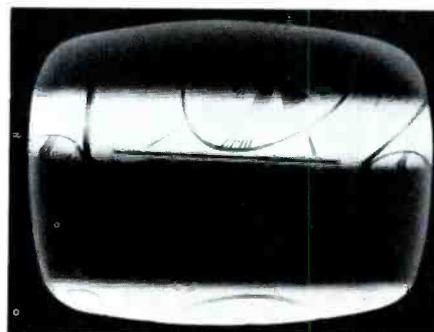


Fig. 9. Picture with 120-Cycle Hum.

February 1954 issue of the PF REPORTER.

A tube tapper or the eraser on a pencil can be used effectively when checking tubes for an intermittent condition.

4. Snowy Raster, No Sound, and No Picture.

The photograph in Fig. 11 illustrates a snowy raster. In order to find out if this trouble is within the tuner, apply an amplitude-modulated signal to the mixer-grid test point A. Observe the face of the picture tube for black bars. If the bars are present without snow, then the trouble is probably in the RF amplifier stage, mixer stage, or in the connections to the antenna.

Possible causes of a snowy raster, no sound, and no picture are:

- a. A faulty RF or mixer tube.
- b. Failure of the plate-load resistor in the RF amplifier stage.
- c. Dirty or burnt contacts in the RF or mixer stage.
- d. Failure of the plate-load or screen-load resistor in the mixer stage.
- e. An open antenna transformer.

A check of the voltages applied to the RF amplifier and mixer stages can help to locate a faulty plate-load, screen-load, or decoupling resistor. The use of a test adapter, such as the one shown in Fig. 12, makes it possible to check the voltages without removal of the tuner covers. (NOTE: The use of such an adapter in the converter socket may disable the local oscillator on some channels and produce erroneous readings.) There are also receivers in which the voltages applied to the tuner tubes can be checked without removing the chassis from the cabinet.

In weak-signal areas, the cause of a snowy raster with loss of picture and sound may be somewhat more difficult to locate and to remedy because failure in any one of the tuner, video IF, AGC, or video-detector stages could produce these symptoms.

If a snowy raster with loss of picture and sound is encountered during a home service call, it is also very essential to make sure that a



Fig. 10. Tube Tapper.

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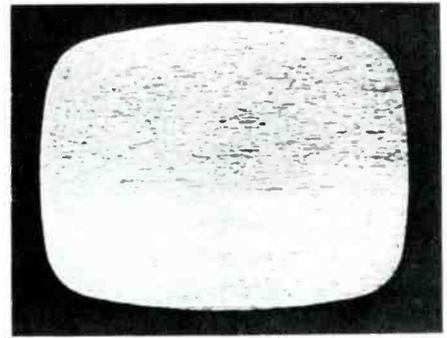


Fig. 11. Snowy Raster, No Sound, and No Picture.

signal of normal proportions is being delivered at the end of the antenna lead-in wire. The signal level may best be checked with a test receiver or a field-strength meter.

An open antenna coil or burnt contacts on turret strips are usually good indications that lightning has struck the antenna. A lightning arrester that is properly installed should prevent this type of damage.

5. Sound and Picture Not Obtained at the Same Tuning Point.

Sometimes the sound and picture may not be obtained at the same tuning point. In an intercarrier receiver, this is a symptom which is usually found when tuners of the continuous-tuning type are used. Fig. 13 shows a bandpass curve of a tuner in which the point of tuning for best sound will also produce the best picture. Fig. 14 shows a curve that would be indicative of a tuner with a narrow bandpass. Adjustment for either the best picture or the best sound will cause degradation of the other. Fig. 15 shows the response curve after the tuning has been adjusted to place the sound carrier at the point of maximum gain. Notice that the video marker is very low on the curve. This condition would cause a poor picture.

In the continuous type of tuner, the problem of maintaining for each channel the required bandpass and of simultaneously producing the desired gain and selectivity is somewhat



Fig. 12. Test Adapters for Tube Sockets.

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different than that encountered in the turret tuner. The reason is that in a continuous tuner a single set of tuned circuits is used to tune several or all channels. The turret type of tuner uses a different tuned network for each channel.

In split-sound receivers regardless of the type of tuner employed, excessive drift of the oscillator will cause the sound to fade out even though the picture may remain on the screen. Retuning is required in order to bring in the sound and picture together.

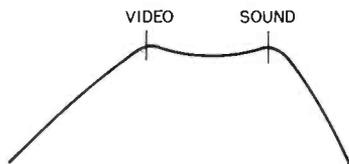


Fig. 13. Curve Showing Normal RF Bandpass.

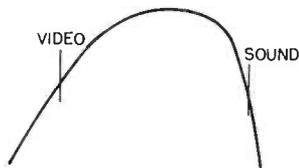


Fig. 14. Curve Showing Narrow RF Bandpass.

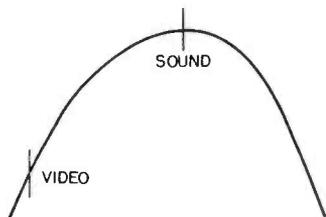


Fig. 15. Curve Showing Narrow RF Bandpass After Tuning Continuous Tuner for Best Sound.

Possible causes for not obtaining sound and picture at the same tuning point are:

- a. Defective RF amplifier tube.
- b. Improper alignment of the tuner.
- c. Defective oscillator-mixer tube.
- d. Excessive drift in oscillator circuit of split-sound receiver.

If a condition of narrow response makes it necessary to realign a tuner of the continuous type, then the most important thing to remember is that the required bandpass must be maintained for each channel to be received. The gain should be kept as

high as possible in keeping with the correct bandpass.

In the intercarrier system, a drift of a few kilocycles would not be too noticeable because the sound and picture are always 4.5 megacycles apart. A drift of even 50 kilocycles when compared to a bandpass of 3.5 to 4 megacycles is very small. In the split-sound system, however, a drift of 50 kilocycles would cause the complete loss of sound; and a drift of any smaller amount could cause severe distortion of the sound.

The local-oscillator tube is the cause of the trouble in most of the cases of severe drift, and its replacement will usually eliminate this trouble. Remember that it is normal to experience noticeable drift during the first 5 to 10 minutes of receiver operation. Another possible source of drift is the feedback capacitor in the local-oscillator stage. This capacitor is designated in Fig. 16. The 10-mmfd capacitor shown in the same figure may also cause drift troubles.

6. Loss of Synchronization.

Although loss of synchronization is usually caused by failure in the video or sync stages, there will occasionally be instances in which the cause of this symptom may be traced back to the tuner. A photograph of a picture tube with a condition caused by loss of synchronization is shown in Fig. 17. Usually this symptom will appear as loss of vertical synchronization with critical horizontal synchronization.

Possible causes of loss of synchronization are:

- a. Heater-to-cathode leakage in the RF amplifier tube or in the mixer-oscillator tube.
- b. Improper AGC voltage to the tuner.
- c. Pickup of external interfering signals.
- d. Improper plate or screen voltage applied to the RF amplifier or mixer stage.
- e. Shorted neutralization capacitor (C5 in Fig. 2) in a cascode RF amplifier stage.

The indications when the trouble is caused by heater-to-cathode leakage may be as follows: the vertical oscillator will fail to lock in and will cause the picture to roll, and the unstable horizontal synchronization will cause the picture to bend or wave at the top like a flag. Hum modulation may or may not be ap-

parent on the picture. When the trouble is caused by improper AGC action, the picture will probably be unstable; and this condition will probably be accompanied by a buzz in the sound.

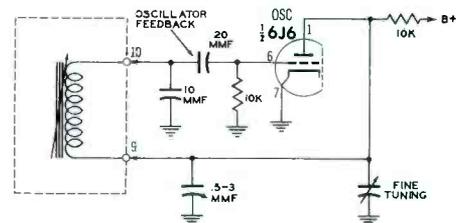


Fig. 16. Partial Schematic Diagram of Typical Oscillator Circuit in Tuner.

Pickup of an external interfering signal would probably result in erratic triggering of the vertical oscillator, and the picture would therefore roll a frame or two at intervals. This pickup of external signals will usually be caused by

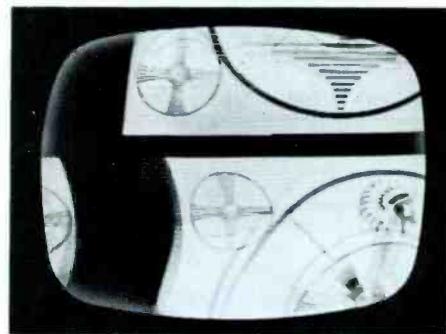


Fig. 17. Loss of Synchronization.

improper shielding of the tuner, or the signals may be picked up on the antenna.

7. Snowy Picture and Weak Sound.

The symptom of Fig. 18 represents a weak video signal containing snow, and this snow may or may not be accompanied by noise in the audio output. A washed-out picture of this kind with a large amount of snow usually indicates that the trouble lies somewhere ahead of the mixer stage.

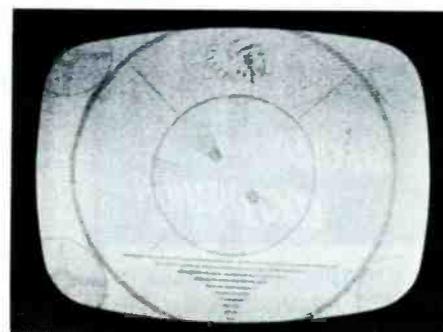


Fig. 18. Snowy Picture and Weak Sound.

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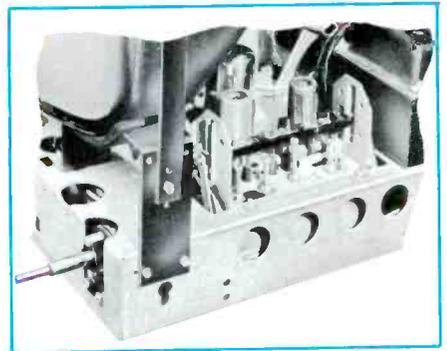


Fig. 19. TV Tuner Which Employs a High-Low Band Switch.

On the other hand, a weak picture with a very slight amount of snow will indicate trouble occurring after the mixer stage. This method of isolating the trouble is not always conclusive, but it may be helpful in many cases.

One of the first checks that should be made when a trouble of this type is encountered is to determine whether the snow is present on the picture tube when operating on all channels. If the snow shows up on the tube when operating on one channel only, this might indicate a mechanical disorder of some sort. Dirty contacts or cold solder joints can often render a circuit inoperative or can lower the signal strength considerably.

Some tuners employ two RF amplifiers and two converter tubes, one combination for the high channels and one for the low channels. If the undesired condition existed only on the low channels and not on the high ones, the fault would be isolated to the components used for tuning the low channels or to the switch contacts.

In Fig. 19, there is another type of tuner which employs a high-low band switch. It is relatively common for pictures on the high-frequency channels to become snowy while pictures on the low-frequency channels are reproduced normally with this type of tuner. The tuner uses a two-position sliding switch that is susceptible to dirt and corrosion

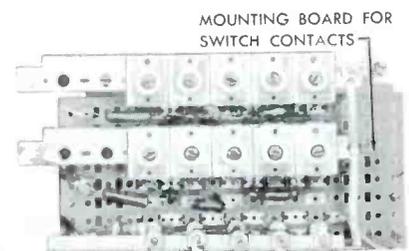


Fig. 20. Bottom View of TV Tuner Which Employs Push Buttons.

which may cause poor contact in the high-band position only.

The tuner unit pictured in Fig. 20 is of the push-button type and utilizes a large, rectangular mounting board for the switch contacts. The heat which is normally generated in a receiver is capable of warping the board and causing the switch contacts to meet improperly.

In general, there are not many tuner components that fail; however, a leaky capacitor or a gassy tube can cause decoupling resistors to increase in value or to open. A loss or decrease of plate voltage can produce a snowy picture and noise in the audio. Trouble of this nature can be traced by checking the plate voltages of the tubes involved.

Possible causes of a snowy picture with weak sound are:

- a. Dead, weak, or gassy tubes in the tuner.
- b. Misadjustment of an AGC control or switch.
- c. Poor antenna connections.
- d. Dirty switch contacts in the RF or mixer sections.
- e. Decoupling resistors which are too high in value or open in the RF amplifier circuit. (See R13 in Fig. 2 or R9 in Fig. 3.)
- f. Capacitors leaky or shorted. (See C5 or C73 in Fig. 2 or C11 in Fig. 3.)
- g. Poor connections caused by cold solder joints or mechanical defects in the RF or mixer stages.
- h. Failure of components in the AGC network of the RF amplifier.
- i. Open antenna transformer.
- j. Open coupling capacitor in the output circuit of the tuner.
- k. Input components or contacts damaged by lightning.

The most common cause of a snowy picture is a weak or dead RF amplifier tube or a weak or gassy mixer tube. The tubes used in cascade RF circuits sometimes become noisy or microphonic. The noise generated by an RF tube will be amplified by the video IF stages and will usually show up in both the picture and the sound. Another cause that should not be overlooked is a faulty antenna connection. This trouble often results in an intermittent condition; and many times, the source

of the trouble can be located by moving separately the antenna and portions of the lead-in wire while observing the effects on the screen.

If the AGC voltage supplied to the tuner is too high in value, it may lower the amplification of the stage to such a degree that a snowy picture will result. A large majority of receivers employ a sensitivity or AGC control in the form of a potentiometer or a multiple-position switch. In some areas, the setting of this control or switch may be critical on one or more channels.

It has been found in the field that when lightning strikes an outside antenna installation or strikes close to it, the tuner input system may become damaged. The RF contacts in a turret type of tuner will often burn or an antenna matching transformer may open because of a sudden surge of voltage. This condition will usually produce a snowy picture from only one channel or an intermittent trouble when the receiver operates on any channel.

8. Negative Picture and Loss of Synchronization.

A negative picture with loss of synchronization is a common trouble symptom encountered in TV servicing. The photograph shown in Fig. 21 illustrates a negative picture. The tuner, as a rule, is not often responsible for such a symptom; but its ability to produce this effect should not be ignored. The loss of synchronization which often accompanies a negative picture is a result of the reversal in polarity of the sync pulses which appear at the input of the sync section.

In the process of isolating the trouble which is causing a negative picture, the service technician can sometimes be misled. For instance, in checking the signal through the IF section, it may sometimes appear as if the second or third video IF stage is being overloaded. At this point, the technician suspects that the

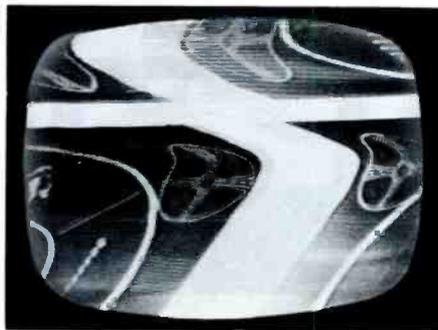


Fig. 21. Negative Picture and Loss of Synchronization.

IF stage involved is not operating properly. Many times, however, this condition actually originates in the tuner where the RF signal has undergone excessive gain; and with the additional amplification provided by a video IF stage, the signal overdrives one of the stages that follow, and a negative picture with poor sync stability will result.

Possible causes of a negative picture and loss of synchronization are:

- a. Defective RF or converter tubes.
- b. Misadjustment of the AGC control or switch in strong signal areas.
- c. Faulty components in the grid or cathode circuits of the RF or mixer tubes.
- d. Voltage-divider resistors too high in value in the B+ line in the tuner. (See R21 of Fig. 2 or R13 and R17 of Fig. 3.)
- e. Feed-through capacitor leaky in the B+ line. (See Fig. 2.)
- f. Defective components. (See C19, C6, R95, or R10 in Fig. 2; or C10, R11, or R12 in Fig. 3.)
- g. Dirty switch contacts or cold solder joints.

If an improper bias voltage is discovered at the RF amplifier tube, the AGC voltage normally supplied to the grid circuit should be carefully checked. It is also possible that the AGC lead to the grid circuit of the RF stage may short to the chassis and cause this stage to become overloaded.

A low B+ voltage to the tuner has been known to produce a negative picture; however, the voltage in most cases must drop a considerable amount without cutting off the local oscillator in order for this symptom to occur. The feed-through capacitors employed in the B+ circuit of some tuners can become shorted or leaky usually because of physical damage of some sort. A visual inspection or a resistance measurement will help to locate a defect of this nature.

The tuner tubes should never be forgotten as a possible source of trouble because grid emission or gassiness in one of them is capable of producing a negative picture.

9. Picture Pulling.

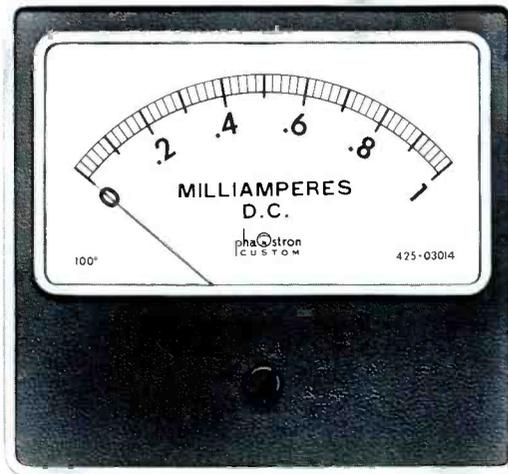
The distorted test pattern in Fig. 22 represents picture pulling or

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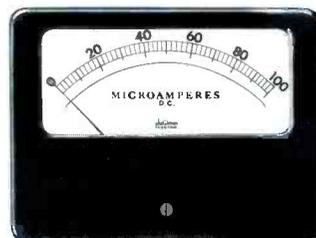
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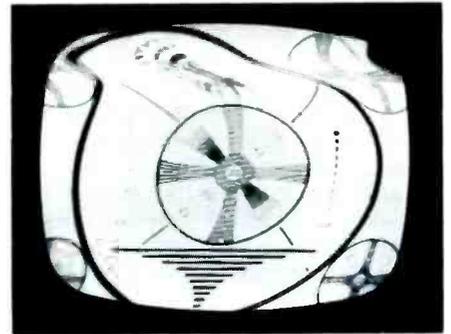


Fig. 22. Picture Pulling.

horizontal bending that can result from troubles in the television tuner. Picture pulling, as it is referred to in this discussion, is caused by troubles in the tuner, IF, or video circuits. It is rather difficult to isolate a trouble of this nature to the tuner because the same effect can be caused by faults in the video IF or video amplifier sections.

One of the first steps in tracing the cause of picture pulling should be a check of the raster with no signal applied. If the raster shows no indications of bending, then a local signal which will produce the pulling condition should be tuned in. Turn down the contrast control, and watch the picture. If the pulling is eliminated, the fault may be in the video circuit or in the sync circuit. If the contrast control has little effect upon the pulling and if the vertical synchronization is somewhat unstable, the low-frequency response of the set should be checked. This check may be done quickly by turning up the brightness control and by adjusting the vertical-hold control until the vertical-blanking signal appears on the screen. See Fig. 23. Observe the vertical sync pulse. If it is not darker than the darkest portion of the picture, either the sync-pulse level is too low because of poor low-frequency response or the sync pulses are being compressed by a limiting action somewhere in the video circuit.

A frequent cause of picture pulling is heater-to-cathode leakage

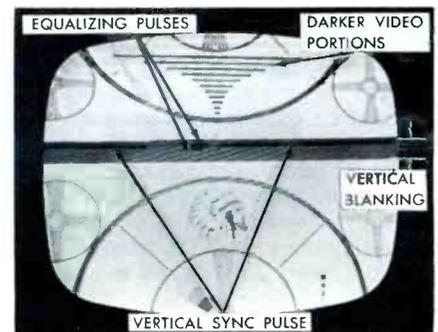


Fig. 23. Normal Vertical-Blanking Bar Obtained by Adjusting Vertical-Hold Control.

in the RF or IF tubes. As an aid in isolating the trouble of leakage which causes picture pulling, the presence of a 60-cycle hum bar usually indicates that the defective tube is in the RF, IF, or video stages; however, if only one tube has a slight amount of leakage, this hum bar may be almost imperceptible.

Possible causes of picture pulling are:

- a. Defective tuner tubes.
- b. Too strong a signal applied to the tuner.
- c. Misalignment causing poor low-frequency response.
- d. Interference reaching the tuner because of improper shielding.
- e. Mismatched antenna system.
- f. Component failure in the grid circuit of the RF or mixer tube.
- g. Poor alignment due to improper component placement or improper lead dress.

When a tube develops heater-to-cathode leakage, the coupling that exists between the tube elements will introduce a 60-cycle hum from the filament supply into the composite video signal. This 60-cycle hum is capable of modulating any signal passing through the tube; and if it is strong enough, the modulation will appear as a dark bar across the picture.

In cases of picture pulling caused by heater-to-cathode leakage, more than one tube may be defective. Substitution of every defective tube will be required in order to eliminate the pulling condition completely.

A pulling or waving at the top of the picture may be derived from overloading in the RF or IF stages. When the AGC voltage is too low, the bias is lowered on the RF and IF tubes and excessive gain will result. The strong signal thus produced will be limited at the video amplifier, and the sync pulses may be compressed. If the AGC voltage is satisfactory, a check of the voltages on the grids of the RF and IF tubes may indicate that one is leaky or gassy and is developing a positive voltage on its grid.

If the low-frequency response of the receiver is the suspected trouble, alignment of the tuner should be made in order to ensure that the frequency of the picture carrier will appear at the correct position on the response curve. A typical RF band-

pass is illustrated in Fig. 13. Many times, the only way to eliminate a condition of poor response is to perform a complete RF and IF alignment.

It may be well to keep in mind that picture pulling can also result from application of too strong a signal to the tuner. In areas of very high signal strength, it may be necessary to insert an attenuator pad in series with the antenna lead-in in order to reduce the input signal to a normal operating level. Certain problems of stray pickup which may cause picture distortion can often be solved by improving the tuner shielding or by locating and eliminating the source of radiation. It is also possible that the antenna and the transmission line may produce a freak condition in which the direct and reflected signals result in a distortion resembling picture pulling. A trouble of this nature only shows up in the home and not when the set is taken to the shop; therefore, a thorough check should be made of the antenna system before removing the set from the home.

10. Ghosts or Ringing in Picture.

In order to analyze the different faults which can cause ghosts or ringing, we will first distinguish between the two. Let us refer to any condition which is external to the receiver and which produces a symptom similar to the one shown in Fig. 24 as a ghost, and let us refer to a similar symp-

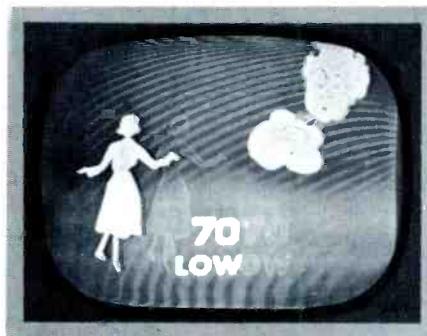


Fig. 24. Ghosts in Picture.

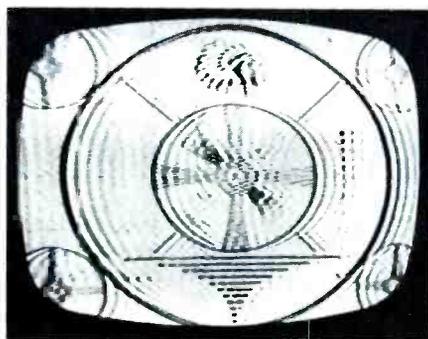


Fig. 25. Ringing in Picture.

tom caused by a condition within the receiver as ringing. The pattern in Fig. 25 indicates a ringing condition caused by misalignment of the tuner. When some trouble in the receiver produces a ringing condition, the displaced images will normally appear equally spaced and progressively weaker the farther they are displaced.

These images can also be affected by adjustment of the fine-tuning control. If this control is turned, the images produced by ringing may change from black to white or vice versa and they may increase or decrease in number.

Ghosts resulting from any external source (including the antenna system) will not be altered by adjustment of the fine-tuning control. Ghosts are more frequently encountered in areas where the signals reflected from tall buildings, mountains, or towers reach the receiver at a slightly later time than the signal which comes directly from the station.

In many cases, ghosts can be eliminated by orienting the antenna or by installing an antenna system which is highly directional. When a receiver that has trouble with ghosts is being serviced, the antenna and lead-in system should be checked for poor connections. At the tuner input, a mismatch caused by a defective input-filter component or by an open antenna transformer is capable of producing ghosts or ringing.

One complaint that is often heard from customers is that when anyone goes near the set, the ghosts get worse or disappear. This condition actually indicates that the antenna system is not supplying a signal strong enough to overcome the signal being picked up by the tuner. A close examination of the antenna, transmission line, or RF input circuit will probably reveal the cause.

Possible causes of ghosts or ringing are:

- a. Defective tuner tubes.
- b. Improper orientation of the antenna.
- c. Poor connections in the antenna system.
- d. Misalignment.
- e. Improper placement of the leads or components in the tuner.
- f. Open antenna-matching transformer. (See L2 in Fig. 3.)

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g. Improper shielding of the tuner.

h. Defective input-filter component.

i. Defective filament-bypass capacitor. (See C8 or C15 in Fig. 2 and C13 or C23 in Fig. 3.)

j. Faulty components or contacts in the grid circuit of the mixer stage. (See C10 or R16 of Fig. 2; also C16, C19, C18, R14, or R15 of Fig. 3.)

Ringling in the picture may be caused by a defective tube. Poor neutralization of a cascode RF stage or regeneration in the IF stages will produce oscillations which often appear in the picture as ringling.

Faulty components in the tuner may cause a loss of coupling between the RF amplifier and the mixer, and ringling may occur. Parasitic oscillations due to improper placement of leads or components can also cause ringling.

Shielding and isolation of the tuner are involved in eliminating ghosts and ringling; however, most manufacturers have originally designed their units with this in mind. As a last resort in correcting a problem of ringling, the receiver alignment should be checked. Poor frequency and phase response in the RF or IF stages can produce ringling.

11. Smeared Picture.

The symptom pictured in Fig. 26 is a smearing effect usually caused by improper alignment. It may be noticed in the pattern that the blacks are smeared at the trailing edges and that a very slight bending appears near the top of the raster. In some cases, the indication may change to trailing whites. These conditions indicate a poor frequency response.

If a weak RF response is encountered, it may be well to remember that the poor response might be a result of a faulty tuner component or an insufficient amount of B+

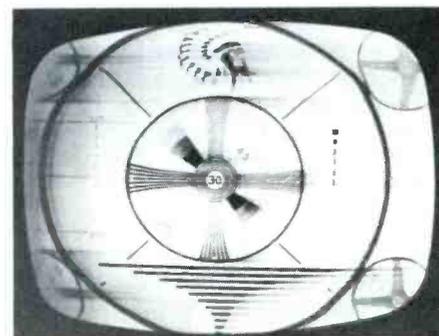


Fig. 26. Smeared Picture.

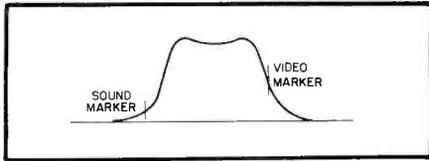


Fig. 27. Curve Showing Normal Video IF Response.

supply voltage. Voltage and resistance checks are recommended before the RF alignment is attempted.

A typical RF response curve is illustrated in Fig. 13. In most television tuners, the RF bandwidth is more than adequate; and it will tend to increase on the higher channels. The video IF alignment will usually have more effect on correcting the over-all frequency response than alignment of the RF stage.

A black smearing of the vertical wedge in a test pattern is one of the symptoms indicating the presence of regeneration which is most evident during reception of weak signals when the video IF gain is maximum.

Possible causes of a smeared picture are:

- a. Defective tuner tubes.
- b. Misalignment.

c. Improper placement of components or leads in the RF or IF stages.

d. Decoupling resistors too high in value. (See R13 of Fig. 2 or R9 of Fig. 3.)

e. Capacitors may be leaky. (See C5, C73, or the feed-through capacitor in Fig. 2; or C11 in Fig. 3.)

f. Open or high-resistance contacts in mixer section.

In connection with alignment many receivers employ adjacent-channel sound traps which if improperly tuned may result in a poor picture that resembles one with smearing. The adjustment of these traps should definitely be included in the alignment procedure.

If sharp high peaks and a general instability are observed while the frequency response is being checked, these symptoms can be caused by regeneration. They may result from improper arrangement of the test equipment, which arrangement must be very exact, or from feedback occurring in the RF or IF circuits. A normal video IF response curve is shown in Fig. 27. One containing a noticeable amount of regeneration is illustrated in the drawing of Fig. 28.

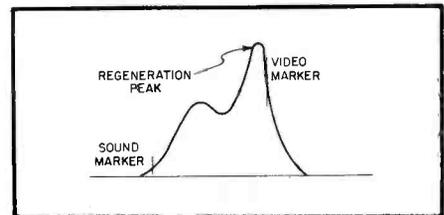


Fig. 28. Curve Showing Regeneration in Video IF Response.

Tubes seem to be the chief troublemakers in a large number of tuner troubles, and they can also cause a smeared picture. A gassy tube in the tuner usually causes improper bias and may produce a washed-out or smeared picture. In some cases of trouble with a gassy tube in the tuner, the contrast control will appear to have little effect on the picture quality.

In concluding this article concerning the diagnosis of troubles in TV tuners, we should state that the high quality of present-day tuners makes the troubles that are attributable to them a relatively small percentage of all the troubles which occur in TV receivers. The foregoing material is intended to be used as a guide for locating those troubles which do occur in tuners.

LESLIE D. DEANE

and **CALVIN C. YOUNG, JR.**

Dollar and Sense Servicing

(Continued from page 27)

TELEPHONING. According to Look magazine, the average man spends 365 days of his life on the telephone. If this is true, the average service technician running his own business comes close to doubling that figure. It's quite revealing to sum up the other ways in which you use up your lifetime. For a starter, here are some more: sleeping — 20 years, shaving and dressing — 5 years, recreation — 16 years, just plain waiting — 3 years.



MESS CALL. Father is stretched out in his easy chair pulled up in front of the TV set. Son, probably 8, is perched on a hassock halfway closer to set. Wife is leaning against the door frame and swinging the line cord and plug of the TV set in her hand as she announces, "The restaurant closes in five minutes."

Cartoonist Al Kaufman sure must have been thinking of dinnertime at our home when he drew up that one for Electrical Merchandising.

CLOCK TV. In the 1956 TV lines, look for clocks below the screens. These are for turning on the set at a given time so that a desired program will not be missed. Some sets will use Sessions clocks which can be set 24 hours ahead; whereas, others will use the 12-hour Telechrons. The added feature will probably boost the retail cost of the set \$15 to \$20. Olympic Radio briefly promoted clock-timed TV in 1952 then dropped it; but clock radios have been with us for 9 years, according to TV Digest.



AT LAST. Tedious copying of Morse code signals letter by letter has been made obsolete by a new all-electronic code converter developed at C. G. S. Laboratories, Inc. It takes code at any speed from 10 to 600 words per minute and converts it into a printed message on a standard Teletype printer. The converter first recognizes each code signal with the aid of an electronic memory and then converts the signals into the entirely different system of code pulses required to operate the Teletype machine.

Along much the same lines, the work of reading printed letters and numerals has been taken over by another new electronic machine called an analyzing reader. It's made by Intelligent Machines Research Corp., of Arlington, Va., and will see its first use in reading ten-digit account numbers from Charge-Card sales invoices coming in from gas stations. These numbers, printed on standardized IBM punched cards by simple devices alongside gas pumps at stations, are scanned vertically by the machine as the cards go through at the rate of 450 per minute. A phototube in the scanning system feeds the resulting pulses into an electronic-memory section for recognition, and this in turn actuates the correct IBM punch for punching that number into the card.

Here is an example of electronic reading. When scanning the capital letter E vertically, the three horizontal lines of the E would produce three short pulse patterns for many scans and the vertical line would give a single long pulse for at least one scan. The memory settings for recognizing this E would be "long vertical line left side" and "three horizontal lines" and "nothing to the right of three horizontal lines."

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SURPLUS. Idle military electronic equipment either becomes obsolete or unreliable in just a few years of storage, even under the best of conditions. Capacitors are particularly troublesome as they grow old. A point is reached where it no longer becomes profitable to repair old equipment, as every service technician knows. Recognizing this, steps are under way for disposal of obsolete stock in Armed Forces warehouses because it is today worthless for military use even though it may never have seen action. Such disposal would clear valuable warehouse space for storage of new equipment or for reduction of storage costs.

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COOKING. General Electric announces it'll invade the electronic-oven field next year with a built-in model intended for private homes. Magnetron-produced high-frequency radio waves will do the cooking in a fraction of the time required by conventional gas or electric ovens. A special added feature will cause the food to brown on the outside so that it will look good, as well. It'll be a luxury item costwise, however; so don't expect to get any oven-repair business for some years yet.

JOHN MARKUS

Notes on Test Equipment

(Continued from page 25)

Fig. 2. The two input signals were obtained from a Simpson Model 480 Genescope. The level of the signal was increased by the chromatic amplifier, and a Simpson peak-to-peak demodulator probe was used to detect the signal before it was applied to the oscilloscope.

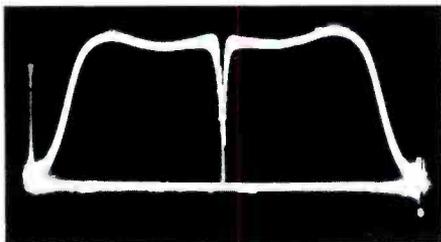


Fig. 2. Response Curve Representing the Output Obtained From Simpson Chromatic Amplifier and Probe When These Are Used With a Simpson Model 480 Genescope.

The abrupt dip in the center of the response curve of Fig. 2 represents the zero-beat point at which the two oscillators (the FM and RF oscillators) are locked together in frequency. On either side of this point, the curve represents a sweep output. There is a rise in amplitude toward the ends of the curve and a sharp fall in amplitude beyond the 4.5-mc points (not marked on the curve in this example).

It should be understood that the limiting factor in the 4.5-mc bandwidth which is obtained is the filter action of the chromatic amplifier. The width of the sweep signal developed in the chromatic probe depends on the width of the FM sweep signal which is applied to the probe, and it can be much wider than 4.5 megacycles.

Marking the Response Curve

The reader may wonder how the technician will mark the response curve to identify different points, since he will use both sweep and marker signals to develop the video sweep. This point was covered briefly in a previous article in the May 1955 issue of the PF REPORTER. Of course, it is possible to introduce another marker signal at some point in the circuit; but this may prove difficult, and the technician may not have an extra marker generator. The principle of marking by shifting the response curve on the oscilloscope may be used.

With this method, the technician first adjusts the horizontal-centering control of the oscilloscope and the

generator frequency so that the zero-beat point of the response curve will occur at the center line of the oscilloscope screen. Then, after noting the dial settings of the generators, he shifts the setting of one of the tuning controls until the desired point of the response curve occurs at the center line of the oscilloscope. The difference between the old and the new dial setting will be the amount by which the curve has been shifted, and it will also be the frequency of the point marked by the center line.

Another point which might be made at this time is that the technician will probably not wish to view a double response like that of Fig. 2 at all times. If not, he can move one of the halves of the response curve off the side of the oscilloscope screen by readjusting the tuning controls of one of the generators.

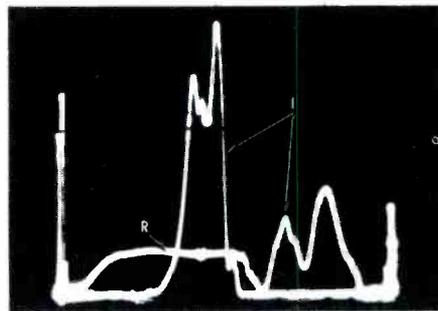


Fig. 3. Response Curve Showing Interference Pickup Caused by the Use of Long Unshielded Leads to the Chromatic Amplifier.

It was stated previously that there is some possibility of pickup of interfering signals if the input leads to the chromatic amplifier are unshielded. The illustration shown in Fig. 3 was taken under extremely bad conditions of interference. The output signals from a Simpson Model 480 Genescope were applied through the bandpass circuits of a color receiver to the chromatic amplifier and from there to the Simpson peak-to-peak high-frequency probe. The detected signal was then displayed on the oscilloscope. The connections between the receiver circuits and the chromatic amplifier were made with unshielded leads about 12 inches long.

The response curve of the bandpass circuit is the low, flat curve marked "R" in the figure. The large, irregular peaks marked "I" were caused by a large fluorescent lamp mounted directly above the color receiver. When this lamp was turned off, the interference disappeared.

If used with suitable FM and RF signals, the chromatic probe and chromatic amplifier will provide the technician with a video sweep signal with which he can check video circuits

and the bandpass and chrominance circuits in color TV receivers. In a typical color receiver, the bandpass response lies between the approximate values of 2.1 and 4.2 megacycles, the I-channel response is considered to extend from 0 to 1.5-megacycles, and the Q-channel response is considered to extend from 0 to 500 kilocycles. It can therefore be seen that the band of frequencies passed by the chromatic amplifier is adequate for checks and adjustments of these circuits.

The chromatic probe is fitted with a connector to match the output connector on the Simpson Model 480 Genescope or the Simpson Model 479 FM-TV generator. There seems to be no reason why the probe cannot be used with other FM and marker generators, provided that some means is found to adapt the connectors and apply both signals to the probe.

TRIPLETT MODEL 630-NA VOLT-OHM-MIL-AMMETER

The new Triplett Model 630-NA volt-ohm-mil-ammeter is shown in Fig. 4. This meter has several features of special interest; among these are the large number of ranges offered and a meter circuit which protects the meter movement against heavy overloads. According to the manufacturer, overloads of 1,000 times the rated current have been applied to the movement without damage. The rectifier unit has been shielded to permit the use of the instrument in strong RF fields such as those that may be encountered near transmitters, induction heaters, and similar equipment.

The 70 ranges provided by the instrument are as follows: 0 to 120 and 240 DC millivolts; 0 to .3, .6, 1.5, 3, 6, 12, 30, 60, 150, 300, 600, 1200,



Fig. 4. Triplett Model 630-NA Volt-Ohm-Mil-Ammeter.

3000, and 6000 DC volts; 0 to 1.5, 3, 6, 12, 30, 60, 150, 300, 600, 1200, 3000, 6000 AC volts; 0 to .06, 0.12, .6, 1.2, 6, 12, 60, 120, 600, and 1200 milliamperes; 0 to 6 and 12 amperes; 0 to 1000, 10,000, and 100,000 ohms; 0 to 1, 10, and 100 megohms; -36 to +70 decibels of output in 12 ranges; and output voltage in 12 AC ranges.

The dial calibration for this large number of ranges is simplified through the use of a slide switch. When this switch is in the right-hand position, all readings are of the value indicated on the scales; when the

switch is in the left-hand position, any voltage or amperage reading is one half of the value indicated on the scale. With this choice, one range may be selected so that practically any reading may be made to fall in the upper half of the scale where the accuracy is greatest.

Accuracy of the meter is stated to be 1 1/2 per cent for DC up to 1,200 volts and 3 per cent for AC up to 1,200 volts. Above 1,200 volts, the accuracy is 2 1/2 per cent for DC and 5 per cent for AC. AC ranges up to and including 300 volts are fre-

quency compensated for accurate reading of AC voltages ranging in frequency from 30 cycles per second to 20 kilocycles.

When the slide switch is in the right-hand position, the sensitivity of the instrument is 10,000 ohms per volt DC and 5,000 ohms per volt AC. With the switch in the left-hand position, the sensitivity is 20,000 ohms per volt DC and 10,000 ohms per volt AC.

The meter scale contains a mirror sector to eliminate reading errors due to parallax.

The meter is housed in a molded black case with an unbreakable window that is transparent.

The dimensions of the instrument are 3 11/32 by 5 1/2 by 7 1/2 inches. The weight is approximately 4 pounds.

TRIPLETT MODEL 3439 COLOR-BAR GENERATOR

The Triplett Electrical Instrument Co., Bluffton, Ohio, has announced a new Model 3439 color-bar generator. It is shown in Fig. 5. The generator is designed to provide a color-bar signal that is useful in checking the performance of a color TV receiver or in adjusting color-phasing and quadrature circuits. The signal provides a display of ten color bars, each accurately spaced at 30-degree phase intervals. Among these are bars corresponding to the colors of the R - Y, B - Y, G - Y, I, and Q axes.

The Model 3439 color-bar generator provides both RF and video signals. The RF output frequency on channel 3 is crystal controlled. Generators for channel 2 or channel 4 can be supplied on special order. The color-subcarrier and sound-carrier frequencies are also crystal controlled.

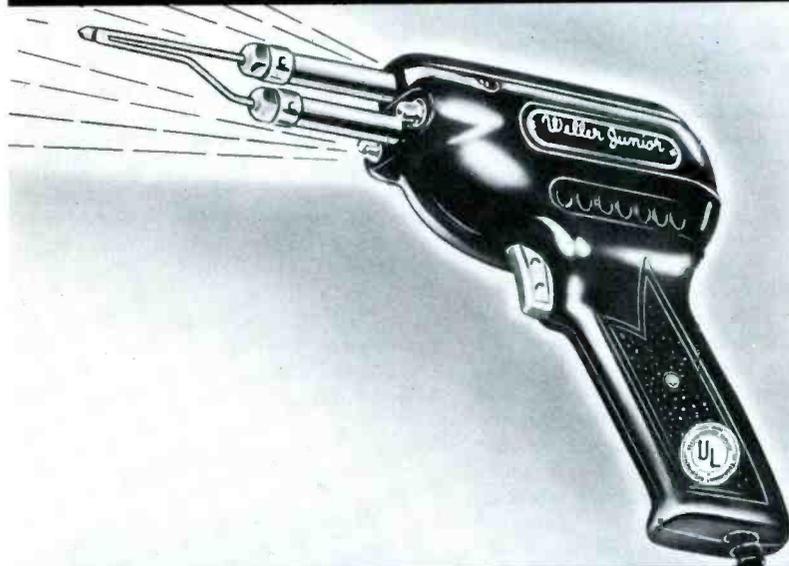
The RF output impedance is approximately 300 ohms at the end of



Fig. 5. Triplett Model 3439 Color-Bar Generator.

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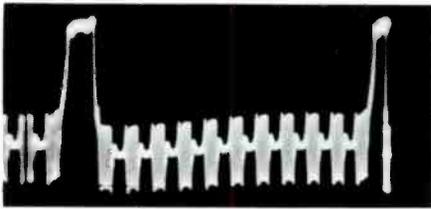


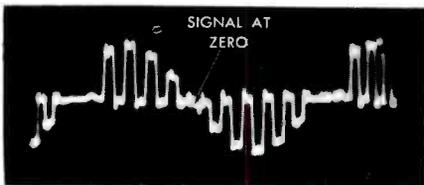
Fig. 6. Waveform of Color-Bar Signal Provided by the Triplet Model 3439 Generator.

the RF output cable. Two video outputs are provided: a low-impedance output of 75 ohms, and a high-impedance output of 5,000 ohms. Either negative or positive video may be selected by turning the VIDEO switch to the desired position.

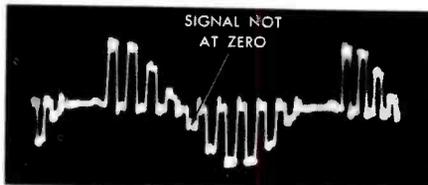
A built-in VTVM circuit provides for quick and easy checking of the sync-signal, subcarrier, and modulation amplitudes. Controls that can be reached by a screwdriver through the front panel are provided for adjustment of these amplitudes.

Brightness modulation of the color-bar signal can be obtained by pressing the MOD. button on the front panel. This provides a check for possible shift of hue in the bright areas of a picture.

The unmodulated sound carrier serves as a guide to precise tuning of the receiver being checked. It also is a means for checking the sound-rejection qualities of a receiver and the presence of beat interference between the color subcarrier and the sound carrier. The sound carrier can be removed by pressing the SOUND CAR. OFF button on the front panel. This provides a more positive indication in the foregoing tests.



(A) With Correct Adjustment of the Hue Phase Control.



(B) With Incorrect Adjustment of the Hue Phase Control.

Fig. 7. I-Channel Waveforms of the Color-Bar Signal From the Triplet Model 3439 Generator.

An oscilloscope display of the video signal provided by the Model 3439 color-bar generator is shown in Fig. 6. A wide-band oscilloscope was connected to the low-impedance output jack to obtain this display. The horizontal-hold control of the generator and the sweep system of the oscilloscope were adjusted to obtain the required number of bar signals. Note that a large pulse appears and is followed to the right by eleven signal bursts. The first of the eleven bursts serves the same purpose as the color burst of a composite color signal; that is, it is a phase reference to

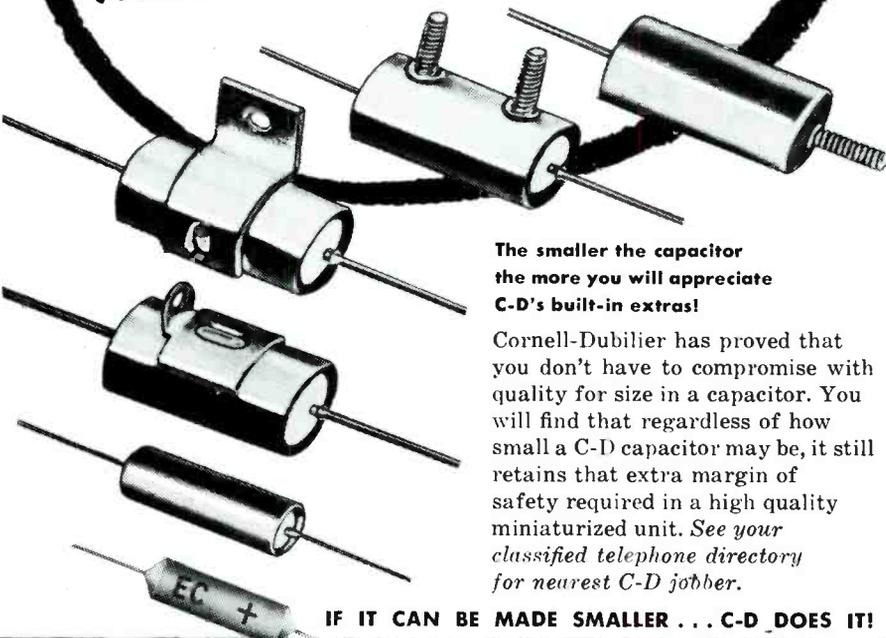
which the other signals may be compared. Each succeeding burst represents one of the ten color bars provided by the instrument, and the color of each bar depends upon the phase relationship between the bar signal and the reference signal.

The average phase shift from one bar to the next is 30 degrees when the horizontal-hold control of the generator is properly adjusted to provide 10 color bars. A reference to the PHOTOFAC T Colorblock Reference Chart No. 4 in the December 1954 issue of the PF REPORTER will show

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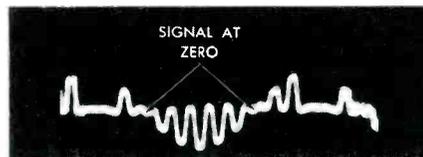
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that the R - Y and B - Y phases of 90 and 180 degrees will be represented exactly and that the I and Q signal phases will be represented very closely. The manner in which this type of signal can be used to check phase adjustments in a color receiver is illustrated in Figs. 7 and 8.

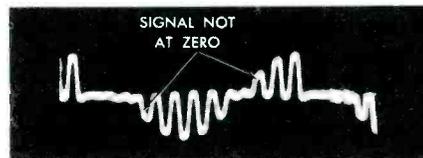
Figs. 7A and 7B were obtained, at the cathode of the I-phase-inverter stage of a color receiver. At this point, no Q-signal voltages should be developed; and this condition is indicated in Fig. 7A by zero output for

the fifth bar (the Q signal). Fig. 7B is the response indicating a misadjustment of the hue phase control. In this case, another bar other than the fifth (or Q bar) is on the zero axis.

Going to the Q channel, we should expect to find the I signals on the zero axis, as in Fig. 8A. In this example, bars No. 2 and No. 8 are at zero amplitude. With the hue phase control correctly set, a response such as that in Fig. 8B would indicate improper functioning of the quadrature circuits. In other words, the Q and I channels



(A) With Correct Operation of the Quadrature Circuits.



(B) With Incorrect Operation of the Quadrature Circuits.

Fig. 8. Q-Channel Waveforms of the Color-Bar Signal From the Triplet Model 3439 Generator.

would not be demodulating at a 90-degree phase relationship to each other.

The subcarrier modulation control is normally set in the fully clockwise position. If this control is turned fully counterclockwise, the color bars will be removed from the output signal but the signal will still produce a visible crosshatch pattern on a receiver; and this pattern can be used for linearity checks and adjustments.

The instrument is housed in a black case of baked-enamel suede finish. The panel is of aluminum, silver finished, with black and red etched markings.

The size of the instrument is 15 11/32 by 11 1/32 by 6 1/4 inches. The weight is approximately 16 pounds.

PAUL C. SMITH

(Advertisement)



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6AZ8	6.3 A128 AC345 16VY A129 AC67 34WZ	30 2JLQ 20 6PR	6.3	-	30 2JLQ 20 6PR
6CD6GA	6.3 124 AB369 15W	8 8JPS	6.3	356	8 8JPS
12BH7A	12.6 123 A45 35Z 127 A89 35Z	11 2LS 11 4NS	12.6	7	11 2LS 11 4NS
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Shop Talk

(Continued from page 5)

Impulse or staccato noise consists of short, sharp bursts of energy caused by agents, man-made or natural. A very familiar example of interference which is due to a man-made agent is the noise generated by automobile ignition systems or by arcing in electrical machines. Natural staccato noise comes from lightning flashes. Although the average value of these bursts is low, their peak value may exceed the signal and hence they may appear as sound at the loudspeaker. At best, all that can be done is to minimize the effects of these peaks. For this purpose, the limiter stage (or stages) can be very useful if the time constant is made short. More will be discussed about this in a moment.

FM Detection

FM receivers, with very few exceptions, use either a ratio detector or a discriminator. The ratio detector requires no limiters since it will not respond to amplitude variations in a strong or moderately strong signal. At low signal levels, however, distortion may arise because of nonlinearity of the diodes. Each diode section in the ratio-detector tube may pass considerably different amounts of current when the applied voltages in the two sections are equal but low in value. Another factor which will degrade the performance of this type of detector is misalignment. Unfortunately, misalignment is not an uncommon condition and undoubtedly occurs because the adjustment of a ratio detector is critical.

Thus, because the ratio detector does not require a limiter, it is suitable for low-priced FM receivers. The distortion at low signal levels prevents the ratio detector from being used in FM receivers of better quality. In the latter, the discriminator (with dual or cascaded limiters) is usually used.

Dual Limiters

Dual limiters are superior to a single limiter stage because of the more complete job that they do in suppressing AM interference. Of particular interest in this respect is the ability of a dual limiter to suppress staccato types of noise. The action of a grid network having a short time constant will minimize, if not eliminate altogether, the effects of these quick-acting impulses. A network having a long time constant cannot change its voltage level fast enough; and before it develops a suitable bias voltage for the limiter tube, the staccato pulse has passed through the

stage and has appeared at the discriminator where an audio voltage is developed and is heard in the loudspeaker.

The disadvantage of a grid network having a short time constant is that the low capacitance and the low shunt resistance in the grid circuit greatly damp the tuned circuit and consequently lower the effective value of the signal which reaches the grid. In order to develop a large signal voltage across a resonant circuit, a high impedance should be presented to the signal. Shunting a low resistance across the circuit reduces the total impedance. In addition, large input signals cause a sufficient flow of grid current in the input circuit to detune the resonant circuit. With longer time constants, better regulation of the signal is provided.

To obtain the advantages that short time constants offer in combating sharp impulses as well as to obtain the better regulation and higher gain of long time constants, two limiters are used. The gain of one limiter stage may not be much more than unity; whereas, two stages in cascade provide an over-all gain of 5 or 6 to 1. This enables the full limiting action to occur with lower input signals. When the ability to react more quickly to impulse noises is added, it can be seen that the advantages of dual limiters are considerable.

Networks with time constants of approximately 1 to 2 microseconds are common in at least one of the two limiter stages. Without question, dual limiters are a desirable feature of an FM receiver and should be included in the design, if possible.

Distortion

Another factor of importance in an FM receiver is its ability to convert the FM signal to an audio signal without distortion. This ability depends upon two factors: the extent of the linearity of the detector and the bandwidth of the RF and IF stages. Bandwidth is the less critical of these two items because more than adequate bandwidth is obtained at the frequencies used in the RF and IF sections without the need for any special loading resistors. Hence, even low-priced sets should be satisfactory in this respect.

The linearity of the detector depends upon the design of the original circuit plus its existing alignment condition. The alignment of the IF system is also important. If an FM receiver is believed to be well aligned, then a check of its ability to receive FM signals without distortion

can be readily performed. Turn on the set and tune in a signal, preferably music. With the volume control turned down, listen to the loud passages. If they come through without distortion, then the conversion from FM to audio is being made linearly. Distortion, on the other hand, indicates an inadequate bandwidth. (NOTE: The volume is turned down in this test to prevent distortion due to overloading in the audio-amplifier stages.)

Drift

Another important feature that should be carefully checked is the tendency of an FM receiver to drift, particularly after the receiver has had several minutes to warm up. The need to adjust a set periodically is very annoying and may become even more bothersome in time. Hence, it is advisable to pay close attention to drift when evaluating an FM receiver.

The foregoing features represent the most important ones that should be carefully considered about an FM receiver. Beyond this, there is what might be termed the secondary group of features which include AFC, a cathode-follower output, a phono preamplifier, tone controls, and a combination with an AM tuner. Obviously, the more extra features a unit has, the more it will cost; and the purchaser will have to decide for himself how much he can afford to spend. It may be, for example, that he already possesses some of these items in other equipment, in which case he would be paying extra for duplicate equipment. This frequently happens when the customer already has the phono amplifier and the AM tuner.

On the other hand, if the customer can use the extras that may come with a particular tuner, then it would be to his economic advantage to take them. The cost of one multipurpose device is seldom as much as the total cost of single-purpose devices which together provide the same functions. Furthermore, the multipurpose device requires less space, fewer interconnecting wires, and is frequently easier to operate than an installation composed of several pieces of equipment.

REVIEW

The transistor is rapidly approaching the point where it can no longer be ignored by the radio and television service technician. Already (at the time of this writing), there are two commercially available transistorized portable radios and

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for
example



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the certain knowledge that more are to come. Some receiver manufacturers have announced transistorized car radios that operate directly off the car battery and eliminate the vibrator and power-supply components. Consequently, there is a very good possibility that one of these days someone will walk into your shop; plunk down a transistor radio on your counter; and say, "Fix it."

It was with just such a situation in mind that Elbert Robberson wrote his article "Make Ready for Transistors" that appeared in the April 1955 issue of Radio & Television News Magazine, and it is for the same reason that this article is being reviewed here.

Radio & Television News Magazine is published monthly by the Ziff-Davis Publishing Company, 366 Madison Avenue, New York 17, N. Y. Subscription rates are \$4.00 per year for the United States, its possessions, and Canada. Single copies cost 35 cents.

One of the most noticeable features about transistors is their small size (about 1/10 the volume of a miniature tube). Furthermore, the exceptionally low voltages used in transistor circuits lead to a corresponding miniaturization of all the other associated components such as resistors, capacitors, and coils. The over-all result is a device which is usually so compact that soldering irons (or guns) and side cutters of conventional sizes cannot be safely employed. Hence, as a first step in adapting your shop for servicing transistorized equipment, you will need a set of small tools. In place of pliers, for example, two or three shapes and sizes of tweezers are suggested. For cutting, either grind off the excess metal from a pair of small side cutters or use a sturdy pair of slender scissors.

Another useful accessory is a large reading glass with a holding stand to leave the hands free. Soldering should be done with a light-duty iron (of 35 watts or less) or a soldering pencil with a fine tip. To avoid overheating some of the miniature components when soldering has to be done, it is suggested that a piece of aluminum or copper be held on the lead of the part being soldered in order that the heat may be dissipated.

Let us leave the subject of tools and consider the components in the transistor radio. Because of the low voltages used, the working voltages of capacitors are far below those of present-day capacitors. In a transistor radio, a coupling capacitor having a value of 3 microfarads, for



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example, may be rated at less than 10 volts. (Take another look at that rating, because it is really that low.) If you attempt to check such a unit with a conventional capacitor checker in which the applied voltage is generally much higher than 10 volts, you will probably ruin the capacitor.

(The reviewer had occasion recently to talk with one of the engineers of the Pyramid Electric Company, and this matter of checking low-voltage capacitors came up. The engineer indicated that work was being done on modification of their present capacitor checker and that information on this change would be released shortly. Undoubtedly, all other manufacturers of capacitor checkers are working on similar modifications of their existing instruments.)

In the meantime, the problem of checking a low-voltage capacitor remains; and the following tests using a VTVM may prove helpful. If a capacitor is suspected of being faulty, disconnect one lead from the circuit and make a resistance check of the capacitor. A good paper or mica capacitor will show a slight deflection on a high-resistance range ($R \times 1$ meg), and the reading will quickly return to full scale. The smaller the capacitance value of the capacitor, the smaller the needle deflection; and therefore, this test becomes inconclusive when the capacitance becomes too small.

An electrolytic capacitor may also be checked with an ohmmeter if the proper polarities are taken into account. In other words, the lead connected to the negative terminal of the battery which is located inside the meter should go to the negative side of the capacitor; and the other lead of the meter should go to the positive side of the capacitor. In some meters, the polarity of the voltage between the test leads is the reverse of that which would normally be expected; therefore, a second meter should be used to determine this polarity. The use of the second meter will also enable the technician to determine the amplitude of the test voltage from the first meter. This voltage should not exceed the rating of the capacitor to be tested. Since electrolytic capacitors will charge more slowly because of their high values, it is recommended that they be checked on the $R \times 10K$ range.

An open capacitor of any type will not give a meter deflection. A leaky capacitor will have a resistance value, and the meter indicator will not return to full scale when an ohmmeter measurement is taken.

Inductors and resistors offer no test problems since they can be checked in the usual manner by VOM's or VTVM's. But how about transistors? Like tubes, these go bad, although not at the same rate. Still, some method of checking is required. At the present time, there are no inexpensive transistor testers on the market. That leaves the service technician with two alternatives: either he can substitute another unit known or believed to be good, or he can build his own transistor tester.

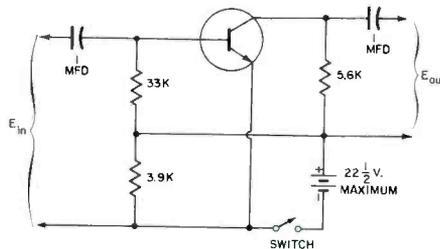


Fig. 1. Circuit for Testing Transistors Used in Amplifier Stages. Connections Are Shown for an n-p-n Type of Transistor.

For the latter, Mr. Robberson suggests the circuit shown in Fig. 1. With a VTVM of the AC type, measure the signal voltage applied to the circuit and the signal voltage appearing at the output. An audio oscillator will serve as the signal source. The gain can then be taken from the chart in Fig. 2 and compared to the rated value or to that of transistors that are known to be good.

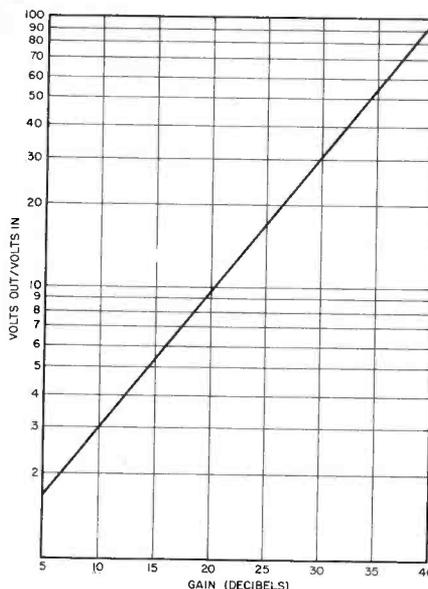


Fig. 2. Conversion Chart for Finding the Gain of a Transistor in an Amplifier After Measuring Input and Output Voltages.

There are certain precautions that must be carefully observed concerning transistors or you will end with a unit that is permanently

damaged. Never insert or remove transistors from a circuit after the voltages have been applied to the circuit. The resulting transients could easily ruin the transistor. Be especially watchful of the polarities of the voltages applied to the transistor collector. If the polarities are reversed, the transistor may be ruined. Furthermore, voltages of the same polarity are not applied to the collectors in all transistors. An n-p-n transistor, for example, has a positive voltage applied to its collector; for p-n-p transistors, the collector voltage should be negative. In this respect, the service technician has a lot to learn. He knows that in vacuum tubes the application of the reverse voltage to the plate does no damage — now he finds that in transistors, it does.

Another interesting characteristic of transistors is the fact that application of too high a voltage (even one of the correct polarity) can be just as destructive as the application of a lower voltage of reverse polarity. The admonition to go slow when working with transistors is not a meaningless warning.

Transistors are new, both in their mode of operation and in the ways in which they are used. To a certain extent, they can be compared to tubes; but to a far greater extent, they possess their own unique features and must be considered in the light of these. Undoubtedly, there will be a period of agonizing readjustment during which all of us will make blunders. These can be kept to a minimum if a sincere attempt is made to learn how transistors operate. Several articles on this subject have already appeared in the PF REPORTER.

Another thing that can be done to broaden your understanding of the operation of transistors is to purchase a transistor kit and to perform the indicated experiments. This will help you get experience and will provide first-hand information on transistor performance.

MILTON S. KIVER



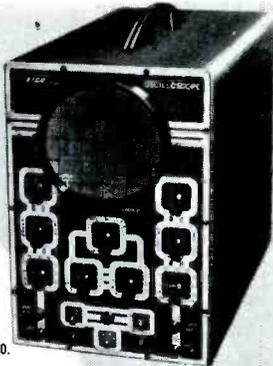
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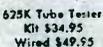
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In the Interest of Quicker Servicing

(Continued from page 19)

The anode connector of the picture tube is another place where moisture and dust often team up to cause arcing or corona discharge. This effect can be lessened by removing the dust from the area around the anode connector and by spraying with plastic. Several coats may be necessary.

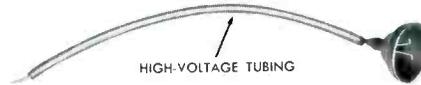


Fig. 3. High-Voltage Tubing on Anode Lead.

The high-voltage lead is also a point where arcing or corona discharge often starts. The installation of a piece of high-voltage tubing around this lead, as shown in Fig. 3, can lessen or eliminate this source of trouble. It is usually necessary to disconnect the lead at the socket of the high-voltage rectifier in order to install the tubing. If the technician does not wish to disconnect the lead, vinyl tape may be wrapped around it. This is often as effective as the use of tubing.

ANTENNA SERVICE IN THE SUMMER

During the summer, there may be some periods during which business is somewhat slack because of vacations and because families spend more time outdoors. These slack periods offer an excellent chance to sell and install outside antenna systems which may have become damaged during the winter months or which may just be suffering from old age.

The lightning arrestor, ground wire, lead-in wire, and standoff insulators are all parts which should be checked periodically and replaced if necessary. If the antenna lead-in wire has been in service for a period of two or more years, it is very possible that the wire will be in need of replacement because of wear and weathering effects on the dielectric.

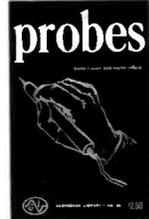
When the lead-in wire is replaced, it would also be a very good idea to change the standoff insulators because the dielectric of these units will also have suffered from the effects of the weather, and considerable attenuation of the received signal could result. The antenna, mounting hardware, mast, and guy wires should also be checked and

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should be replaced or repaired if necessary.

Special care should be exercised in checking the guy wires and the mounting hardware, because the ice and snow of the winter and the strong winds during the early part of spring could have weakened the system and made it more vulnerable to damage during the rain and electrical storms which usually occur during the summer and early fall.

ADDING CASTERS TO TV CABINETS

Although a great many of the console types of television receivers now being sold come equipped with casters, there were large numbers of consoles and consolettes sold without casters. The addition of casters to these units would make it possible for the housewife to move the receiver for cleaning purposes. This would also make it possible to change the location of the receiver without having to lift the entire unit and move it to a new location in the room.

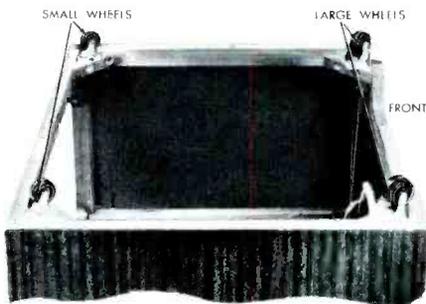


Fig. 4. Suggested Locations of Casters.

If the cabinet construction should permit, casters may be installed while in the home. The cabinets which are the easiest to equip with casters are those which have triangular blocks glued into each corner, as illustrated in Fig. 4. This type of cabinet usually does not require modification to make possible the installation of casters.

There are several types of standard caster assemblies which may be obtained at any hardware store. Samples of some of these units are shown in Fig. 5. Notice that there are two basic types: the ball type and the wheel type. In

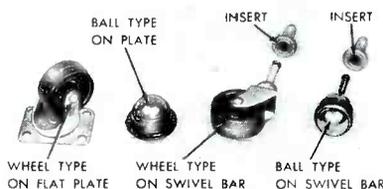


Fig. 5. Several Types of Standard Casters.



Fig. 6. Position of Cabinet While Casters Are Being Mounted.

each basic type, there are two styles: the flat-plate style and the shaft style.

The ball type of caster usually raises the height of the cabinet a slight amount. This type of caster should not be used on a wood floor because the balls could cause damage when the receiver is rolled across the floor. This type can be used satisfactorily on tile floors or where there is carpeting.

The author installed a set of the standard wheel type of casters on the receiver shown in Fig. 6. This receiver was turned upside down and was placed on a furniture pad for the installation work. A word of warning should be mentioned about this procedure — you should always be absolutely positive that all chassis bolts are securely fastened and that the picture tube is securely in place. A receiver in which the picture tube is held in place by an elastic band should not be turned upside down or placed on its side because such procedure could result in snapping off the neck of the picture tube if the elastic band has weakened from age.

In Fig. 4, it may be seen that the front pair of wheels are larger than the rear pair. This was necessary because the triangular wood blocks in the front were higher from the floor level than those in the rear. The difference in wheel sizes compensates for that difference.

The two triangular pieces at the rear and closest to the floor level could have been removed and new pieces could have been installed level with the triangular pieces in the front. This would have made it possible to use all four casters of the same size.

The plate style of wheel caster was used for this installation because it was easier to install. There may

be cases, however, when it will be desirable to install the shaft type.

If considerable modification of a cabinet is necessary before any of the standard types of casters can be installed, it may not be practical to use these casters. The Walsco Electronics Corporation makes a caster assembly known as the "TV Rolabout" which can be installed on a large variety of cabinets with a minimum of modification. This caster assembly is shown in Fig. 7. It is adjustable for different sizes of cabinets and raises them only enough to clear the floor. The assembly is available through local electronics distributors.

In the installation of any set of casters, be careful not to damage the cabinet. Care should also be exercised to guard against damage to the chassis or picture tube when turning the cabinet upside down to install the casters. If it is necessary to drill holes in the cabinet or to make any modifications that would produce

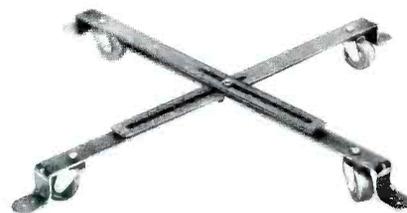


Fig. 7. "TV Rolabout" Made by Walsco Electronics Corporation.

sawdust, be careful that none of the sawdust is dropped into the mechanism of the receiver nor on the customer's rug.

IN THE SHOP

CONVERSION TO PLUG-IN SELENIUM RECTIFIERS

Service technicians in general have had two obstacles to face in replacing selenium rectifiers. One of these obstacles is that a soldering iron or gun must be used to replace these rectifiers, and the other is that the chassis has to be removed in most cases. These are also the reasons that most service technicians make the replacement of selenium rectifiers a bench job.

Changing selenium rectifiers would meet with much more approval from the technicians if they were as easy to replace as tubes are, in which case the technicians could then carry replacements in their tube caddies and thus eliminate unnecessary trips to the shop. This would mean a

savings to their customers and would promote good will.

Sarkes Tarzian, Inc., has introduced to the market a unit which may prove to be of help to the service technician in this matter. The unit is a small conversion chassis which will enable the technician to plug selenium rectifiers into a set in the same manner that tubes are inserted. This conversion chassis Model CC-1, together with a pair of typical selenium rectifiers, may be seen in the photograph of Fig. 8.

Fig. 9 shows the rectifiers after they have been plugged into the con-

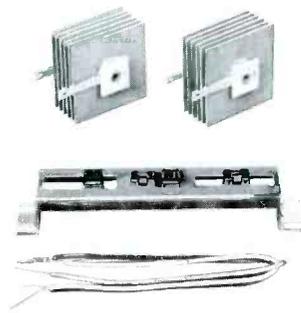


Fig. 8. A Pair of Selenium Rectifiers Together With Conversion Chassis Model CC-1 Made by Sarkes Tarzian, Inc.

version chassis. The only step necessary before the rectifiers can be plugged in is to twist the positive lug on each rectifier 90 degrees. Twisting the lug in this way ensures that the rectifier will always be in the correct polarity when it is inserted.

There are a couple of items that should be considered prior to the installation of this conversion chassis for plug-in rectifiers. One of these items is space. Many of the older sets have sufficient room somewhere on the chassis or in the cabinet beside the chassis. It is not necessary for the conversion chassis to be mounted on top of the main chassis, although that is generally the best location. Frequently, there is room between the side of the chassis and the side of the cabinet; and the conversion chassis can be mounted on the side panel of the main chassis.

Even the new vertical chassis have room for mounting the conversion unit. This is particularly true of those receivers in which the vertical chassis rest on wooden bases. The photographs in Figs. 10A and 10B show two chassis of this type, and the rectifier conversion units are shown in their possible mounting positions.

Fig. 10A shows the conversion unit mounted on the base directly be-

hind the vertical chassis and below the neck of the picture tube. There is a large space below the neck; therefore, there will be more than enough clearance. In Fig. 10B, there is no room behind the main chassis; therefore, the plug-in unit was moved around to the side where there is more than sufficient space, as can be seen in the photograph. There are a few vertical chassis on which it may be impossible to mount these conversion chassis because of insufficient space.

The next consideration when choosing a mounting position is heat. The selenium rectifiers should be placed as far away from heat sources as possible in order to lengthen their operating lives. In other words, they should be kept away from such places

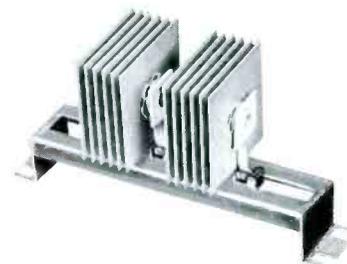


Fig. 9. View of Conversion Chassis With Rectifiers in Place.

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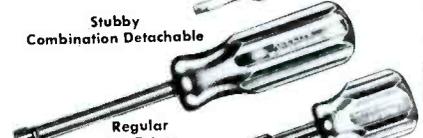
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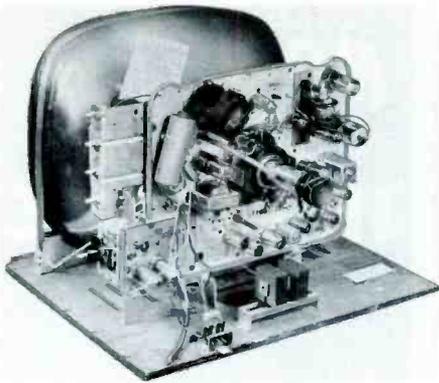



EXECUTIVE QUALITIES. A technician or engineer differs from a typical executive in five important ways, according to the discussions at a recent IRE technical-management session:

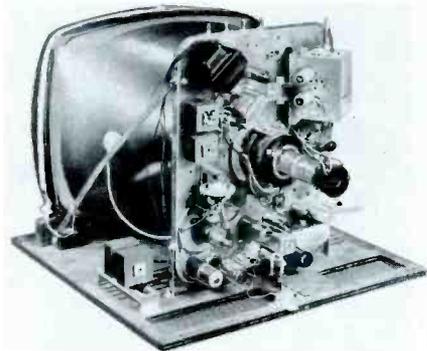
1. The executive is interested primarily in people, but the engineer is interested in technical equipment.
2. The executive is primarily proud of his practicality, but the engineer is primarily proud of what he knows.
3. The executive excels at expressing his thoughts and desires clearly, but the engineer has difficulty in getting his ideas across to others.
4. The executive can accept his own emotions and use them as drives to accomplish results with himself and others, but the engineer is more apt to be led astray by his own emotions.
5. The executive is active and extroverted but not particularly thoughtful, but the engineer is more thoughtful than active and is generally introverted.

To lump all these into one, an effective technical executive is able to organize and direct the work of others for greater productivity. Both types of men are essential; the important thing is that you should be in the right category of job so that your abilities will be used to best advantage.

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(A) On Mounting Base to Rear of Vertical Chassis.



(B) On Mounting Base to Side of Vertical Chassis.

Fig. 10. Suggested Locations for Rectifier Conversion Unit.

as those above the horizontal-, vertical-, and audio-output tubes; and they should also be kept away from any other components that ordinarily get very hot. If at all possible, they should be placed where the air will circulate around them. The selenium rectifiers themselves produce a certain amount of heat which has to be taken away by the surrounding air.

For the purpose of illustrating the procedure for installing one of the conversion units, a General Electric receiver of the console type and about four years old was chosen. It should be a good example to show the need for a plug-in rectifier system, because the position of the original rectifiers in the set was below the chassis

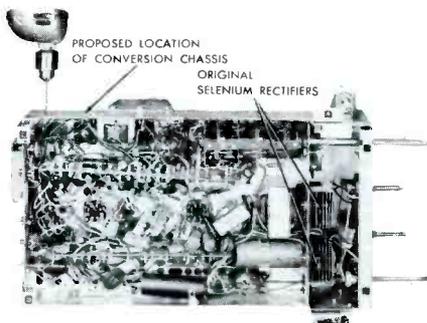


Fig. 11. Location of Original Rectifiers in General Electric TV Receiver and Holes Being Drilled at Proposed Location on Conversion Chassis.

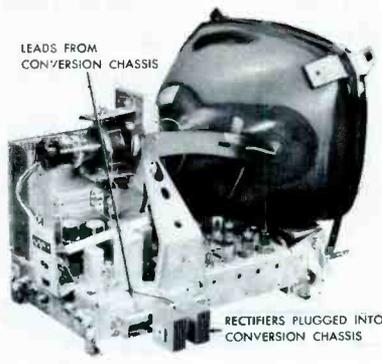


Fig. 12. Completed Installation for Plug-in Rectifiers.

and in a spot which made their replacement rather difficult.

The first step in converting this set for plug-in selenium rectifiers was to pick out the best location for the conversion unit. The right-hand side (when looking from the rear of the receiver chassis) was chosen because the horizontal- and vertical-output tubes were located on the left-hand side, and it was considered best to choose a location as far away from them as possible. There was plenty of space on the right side between the chassis and the cabinet. The space would allow the rectifiers to be plugged in easily and to operate at a cool temperature.

After choosing the location for the rectifiers, the next step was to use the conversion chassis as a template in order to mark the main chassis for drilling. A reasonably small-sized drill bit was used because the conversion unit was to be held by self-tapping screws. A careful check should always be made after self-tapping screws are used in order to guard against possible shorts caused by the screws if they should touch wires or terminals under the chassis. A photograph taken while the mounting holes were being drilled may be seen in Fig. 11.

The photograph shown in Fig. 12 shows the completed installation before the chassis was placed back in the cabinet. As can be seen in the photograph, a hole through which to run the wires was very convenient so that it was not necessary to drill a new hole. The connecting wires can be seen at the rear right-hand corner of the chassis.

CHECKING COUPLING CAPACITORS WITH A VTVM

Most technicians use either one of two ways to check a coupling capacitor. One way that is quite well known is to check the leakage resistance through the capacitor by using

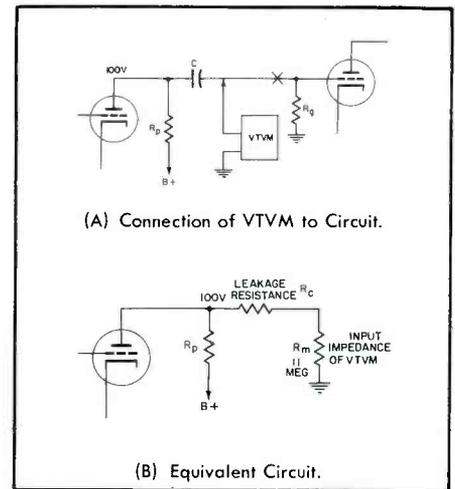


Fig. 13. Setup for Testing a Coupling Capacitor for Leakage Resistance.

a regular ohmmeter. The second method is to use a capacitance checker.

There is still another method which may not be so well known but which can be used to detect very high values of resistance in leaky capacitors. This method involves the use of a VTVM. The output side of the coupling capacitor to be tested should be disconnected from the circuit, and the VTVM is placed in series between the capacitor and ground. The schematic diagram for this hookup is shown in Fig. 13A, and the equivalent circuit is given in Fig. 13B. In the example shown, there are two known values: the plate voltage on the first tube is 100 volts, and the input impedance of the VTVM is 11 megohms.

Assume that the VTVM indicates 1 volt when the hookup is made. The current through the meter must therefore be:

$$\frac{1 \text{ volt}}{11 \text{ megohms}} = .091 \text{ microampere.}$$

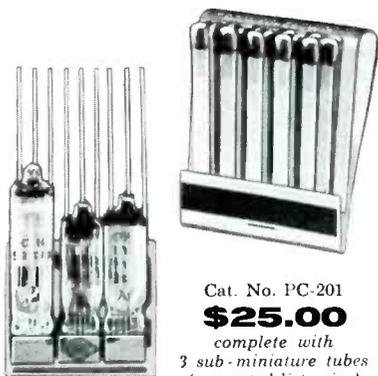
This current is also flowing through the capacitor. The leakage resistance R_C can be calculated:

$$R_C = \frac{100 \text{ volts} - 1 \text{ volt}}{.091 \text{ microampere}} = 1100 \text{ megohms (approx.)}$$

In most cases in which a leaky coupling capacitor is causing trouble, the leakage resistance will be much less than this; but this example does show how sensitive the VTVM can be when measuring leakage resistance in a coupling capacitor.

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Questions and Answers About Color TV

(Continued from page 21)

new-model large-screen color receivers will be designed to sell at a retail price below \$500 within the next two years.

QUESTION 4

Can my present receiver be modified for color?

Actually, it is possible to modify a monochrome receiver for color, but it would involve rebuilding the entire receiver. This would be very impractical, and the cost would be prohibitive. A few people may be disappointed with this answer, especially those who purchased receivers having a color-adaptor jack. Most such receivers were designed to be adapted to the mechanical color wheel which is not used in the new compatible color system that has been adopted.

If your customer has a receiver that was originally designed to be adapted to the mechanical color wheel, it is not a good idea to ridicule the set manufacturer nor the customer's choice of receiver. He will feel better if you remind him that he did not have to pay anything extra for that feature of his receiver and that he has also been enjoying the use of the receiver as much as any other he might have purchased.

SUGGESTED ANSWER. Yes, it is possible to modify your receiver for color; however, it would be almost the same as custom building a complete color receiver. The labor and parts would cost as much or more than the color receivers on the market. Some of the parts would be difficult to obtain, and your receiver would not be so well-built as those built at the factory.

QUESTION 5

Is color TV good?

This question may be asked by a person who has little or no conception of color television. It is easily answered if your local station transmits color programs and if your

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customers have the opportunity to see some of them. Almost all those who have seen the results are favorably impressed with color television. If your organization sells color receivers or if you know of a store that handles them, advise your customer to attend a demonstration and form his own opinion.

If your local station does not yet transmit programs in color and if you have not seen a program in color, there is not much you can say in answer to the question. Probably your best answer is that you have not yet had an opportunity to see color television in operation but that those who have seen it were impressed.

SUGGESTED ANSWER. Those who have seen color television seem favorably impressed, but you should really make arrangements to see it yourself.

QUESTION 6

Can color programs be telecast by our local station?

The stations in many major cities are already equipped to handle color telecasts. It is relatively inexpensive for a station to install the necessary equipment to relay a color program from the networks, but it is expensive to install the equipment necessary to originate a color program.

If your station receives network programs, then the chances are that they already have or are planning to obtain the equipment to retransmit composite color signals. As a matter of fact, a few of these stations have already installed the necessary equipment for originating their own color programs. Check with your local station (or stations) concerning their plans for color telecasting so that you can tell your customers just what the situation is. Any of the four answers which follow may be applicable to the situation in your particular community.

SUGGESTED ANSWERS.

1. Yes, our local station can relay network programs in color; and, in addition, it can originate its own color shows.

2. Yes, our local station can relay network programs in color.

3. No, our local station cannot transmit color programs until it in-

stalls the necessary equipment. Even though it now relays live color programs from the network, these programs are transmitted in black and white only.

4. No, our local station cannot transmit color programs until it obtains live network programs and until it installs the necessary equipment for relaying the color programs from the network in color.

QUESTION 7

Can color be telecast by UHF stations?

Television transmission at ultra-high frequencies has its own peculiar problems, but the transmission of color is no more of a problem to UHF stations than it is to VHF stations.

In areas where television coverage is carried by UHF stations only, it is natural for the layman to ask this question. If your local station transmits on a UHF channel and if the customer has the local station in mind when he asks this question, the various possible answers will be the same as those for the previous question.

If the intent behind the question is only to learn whether UHF signals can carry color as well as VHF signals, the following answer is suggested.

SUGGESTED ANSWER. Yes, color can be telecast by UHF stations as well as by VHF stations.

QUESTION 8

The quality of the picture received on my black-and-white receiver during a color program is very poor sometimes. Why is this so?

The color-television system was specifically designed to be compatible. This means that a color signal that is properly transmitted should produce on a black-and-white receiver the same results as those produced by a monochrome signal that is properly transmitted. If it is assumed that the receiver is in good working order, occasional poor picture quality must be attributed to transmission difficulties.

Since the transmission of color requires the use of additional equip-

ment and since this equipment must be very precise in its operation, it is somewhat more difficult to maintain perfection during color telecasts than during those in monochrome. Color transmission is still a new art; and although the system is considered to have been perfected, errors are bound to occur now and then. After all, transmission difficulties still occur during monochrome telecasts; so why should there not be difficulties during color telecasts?

SUGGESTED ANSWER. If a receiver performs satisfactorily during monochrome telecasts, poor picture quality during a color telecast is probably due to transmission difficulties. Additional equipment is required to transmit a color program. This fact makes it difficult to maintain perfection during every color transmission. As the art of transmitting color programs progresses, transmission problems will gradually be overcome.

QUESTION 9

When will more color TV programs be transmitted?

At the present time, facilities for producing color TV programs are limited. Expansion is going on, however; and more programs can be expected as soon as the specially equipped studios and other facilities become available.

During the first three months of this year, about 20 hours of color telecasts were presented by two of the major networks. This averages about six hours and forty minutes per month or a little more than an hour and a half a week. It is difficult to predict the amount of time that will be devoted to color during the summer months. It is rumored that several experimental color telecasts may be produced in preparation for the fall season. Next fall, there should be a marked increase in the time devoted to color programs. By then, one of the major networks plans to produce from four hours per week to an hour per day in compatible color.

SUGGESTED ANSWER. Starting next fall, there should be a definite increase in the number of color programs produced for network distribution.

QUESTION 10

How long will it be before all programs are transmitted in color?

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It is probable that a great many of the future shows on the major networks will be in color. Eventually, most stations will have the equipment necessary to relay color programs produced for network distribution because the cost of this equipment is relatively inexpensive; however, it may be a long time before every station goes to the expense of installing equipment to originate color programs.

This analysis leads us to believe that the major portion of the programs from the networks will eventually be presented in color, but the local programs will be produced mostly in black and white for some time. There may still be programs which it would be impractical to produce in color, and standard monochrome transmission may continue to be used partially.

SUGGESTED ANSWER. There may never come a time when all programs will be transmitted in color. A few types of shows are not given as much added appeal by the addition of color as others. It is probable, however, that in a few years many of the shows from the major networks will be in color.

QUESTION



Can I use my present antenna with a color receiver?

The first thought which is brought to mind by this question is the frequency response of the antenna. In this respect, many of the antennas designed for monochrome reception will provide satisfactory reception of composite color signals. This is particularly true of antennas which have been designed to provide good reception over a wide range of channels.

The major problems to consider for satisfactory reception of color telecasts are signal-to-noise ratio and multipath reception. If a customer is troubled by noise interference with his monochrome receiver, color reception on a color receiver would be even more annoying with the same interference. A change in the location and the type of antenna may improve reception. If the noise is severe, other methods may have to be employed to improve the signal-to-noise ratio.

In addition to causing "ghosts" and poor synchronization, multipath reception can affect the phase and amplitude of the chrominance portion

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of a composite color signal. This will cause changes in the hue and saturation of the colors in a scene. Multipath reception that has certain characteristics can affect the composite color signal to such an extent that a complete loss of color may result.

It is not wise to make a definite statement as to whether or not a particular antenna system will provide satisfactory reception of color telecasts until actual tests are made. The best check of any antenna system is to connect it to a color receiver known to be in good operating condition and to observe the reception of a color test signal or a color program from each of the stations in the area.

Service technicians do not carry color receivers around just to check every antenna system for good color reception. The customer should be advised that his existing antenna can be checked when he buys a color receiver. If reception does not prove to be satisfactory, then the antenna system would have to be replaced or reworked.

Color-receiver manufacturers are aware of the problems which might arise through the use of an existing antenna. In fact, one manufacturer is supplying with each of his color receivers an antenna which is suitable for color reception.

SUGGESTED ANSWER. Although good reception of black-and-white signals is a favorable sign, it is not a positive indication that the antenna system is suitable for color. In order to give a definite answer concerning the ability of an antenna system to provide satisfactory color reception, the antenna should be connected to a color receiver and checked during the transmission of a color signal. This can be done by the technician who installs your color receiver. He will be able to give advice as to whether or not your antenna system needs to be reworked or replaced.

QUESTION 12

How will service charges for work on a color receiver compare with those for a monochrome set?

It is reasonable to assume that labor charges for servicing color receivers will be higher than for monochrome sets, at least for the

next year or so. There are several good reasons for this assumption.

In the first place, a color receiver is more complex than a monochrome receiver in that it contains more circuits, has many more service adjustments, and must be more precise in its operation. All of these things add to the time a service technician must spend in servicing the receiver and will undoubtedly cause the price of such service to be higher.

Secondly, technicians who service color receivers will require special training. Whether the training is gained through formal education or through self training, a considerable investment of time and money is involved.

In the third place, the business of servicing color receivers requires special test equipment. Additional tubes and component parts used in color receivers will have to be stocked, and some of these are expensive. New equipment, tubes, and component parts represent an increase in capital investment. Since this increase can be attributed solely to servicing color receivers, the price of this service will be governed accordingly.

In time to come, servicing color receivers will represent a large portion of the TV service business. By that time, the receivers will be simpler, the technicians will have gained in experience, and the greater volume of color service work will reduce the charge for equipment depreciation per job. All of these things will reduce the individual service charges on color receivers.

SUGGESTED ANSWER. Under the present conditions, it is expected that labor charges for repairs on color receivers may be at least 50 per cent higher than the charges for black-and-white sets. These larger charges will be due principally to the time involved in repairing and adjusting a color receiver. In time, color receivers will be simplified, servicing time will be minimized, and labor charges will be reduced accordingly.

As for the replacement of parts, most of the components in a color receiver compare in price to those in a monochrome receiver. There are some items, such as the color picture tube, which are more expensive than their monochrome counterparts. Replacement of these parts will obviously result in increased charges.

QUESTION 13

How difficult is it to operate a color receiver?

With a little practice, the customer should have no more difficulty in adjusting a color receiver than he does a monochrome receiver. The only operating controls which are not found on a monochrome receiver are those which control the hue and saturation of the colors, and they can be adjusted for the most pleasing results to the viewer. Precision is not required in the setting of these controls. Probably the only other control with which the operator should be concerned is the fine-tuning control which requires a more precise setting for a color receiver because misadjustment can cause a complete loss of color.

SUGGESTED ANSWER. A color receiver is relatively simple to operate. There are only two operating controls in addition to those found on monochrome receivers, and their adjustments are not critical.

QUESTION 14

How much power is used by a color receiver?

The average color receiver uses about 450 watts of power. A monochrome receiver may use any amount from 200 to 375 watts, depending upon its size. These ratings may be compared with those of electric irons which may use as much as 1200 to 1500 watts. The cost of electric power is relatively inexpensive. Even at a comparatively high cost per kilowatt hour, it would only take about two cents per hour to operate the average color receiver and would usually cost less.

SUGGESTED ANSWER. A color receiver uses less than half the power used by the average electric iron or about twice that used by the average black-and-white receiver. The cost of the power needed to operate the average color receiver is only about one or two cents per hour.

VERNE M. RAY

Examining Design Features

(Continued from page 17)

that may be brought to attention is the manner in which the filament, AGC, and B+ supply points are connected at the top of the tuner. Each connecting point consists of a tubular ceramic feed-through capacitor which acts as a bypass and as a terminating point for the lead. The looker point B is situated on the top of the tuner at one end of a feed-through capacitor. These points may be used for

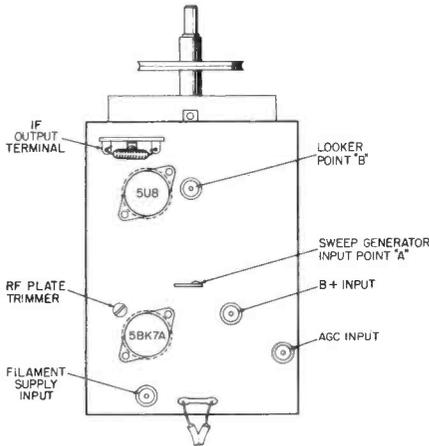


Fig. 3. Top View of Tuning Unit Showing Various Test Points.

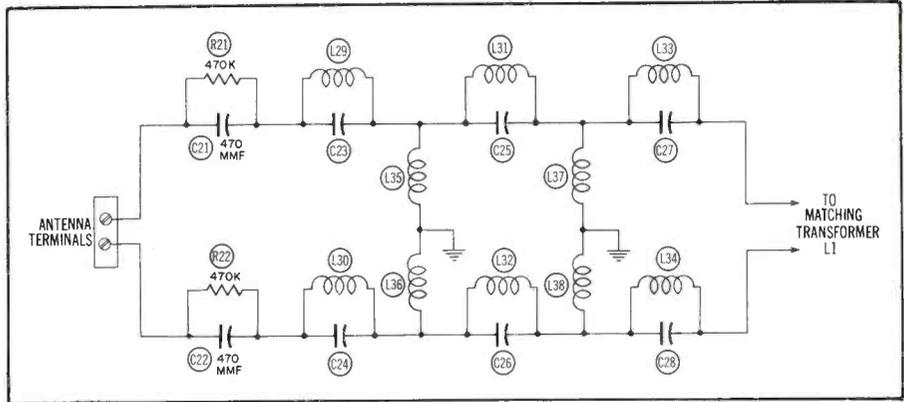


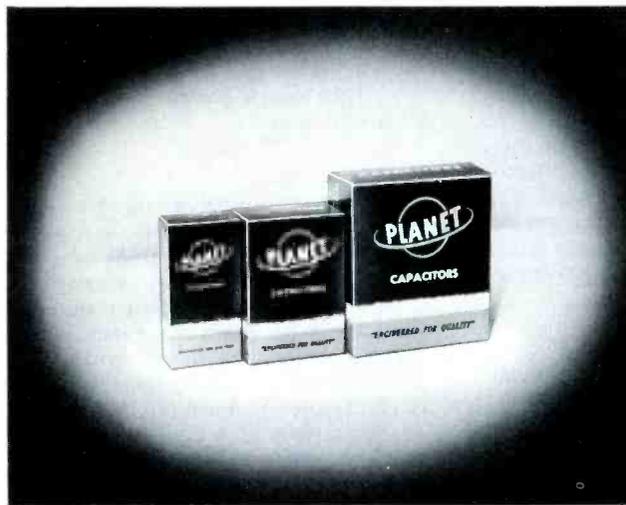
Fig. 4. Schematic Diagram of Tuner Input Circuit.

operational tests and are shown in Fig. 3.

The filter network which is employed in series with the antenna input lead to this tuner is schematically illustrated in Fig. 4. This unit is a small subassembly, and it snaps into position at the rear of the tuner, as can be seen in Fig. 2.

The network is designed to match a 300-ohm balanced-line input, and each side of the line consists of an isolation network and a three-section high-pass filter. The 470K-ohm resistors R21 and R22 isolate the antenna terminals from the input

circuit which utilizes the hot chassis as a ground return. Capacitors C22 and C21 are connected in parallel with the isolation resistors in order to permit coupling of the RF signal to the filter circuit. The filter components L29 to L34 and C23 to C28 are tuned circuits which resonate at slightly lower frequencies than those present in the television band. These elements offer little attenuation to the input signal at the television frequencies; however, they act as series traps to the frequencies commonly used in the IF stages of police-band receivers. The signal voltages at the higher television frequencies are readily developed across the induc-



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The advantages of the CapaciTester outlined above apply equally well to trouble-shooting conventional electronic equipment. The CapaciTester may also be used to detect leakage between transformer windings or between any two points where leakage may develop.

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When the tuner is receiving the higher channels 7 through 13, the coils of the lower channels are shorted by contacts on the switch to prevent them from producing parasitic oscillations that may cause interference. Coupling to the mixer stage from the coils of the mixer grid is accomplished by capacitor C12. The mixer wafer section operates in the same manner as the antenna switch by adding small inductances to the circuit as the bar on the schematic moves down. Adjustment of the coils that are mounted on the switch wafers of the antenna and mixer circuits are made by compression or expansion of the turns of wire or by bending of the high-channel loops closer to or farther away from the wafer form. This alignment is executed at the factory and should not ordinarily require attention in the field except in cases in which components are replaced with others having characteristics slightly different from those of the original components.

The mixer action in this tuner takes place in the pentode section of the 5U8 tube. The 100K-ohm resistor R15 serves as a grid load for both the RF and oscillator signals at this stage. The looker point B which is in the screen-grid circuit of the

mixer is a convenient test point for checking the RF response of each channel.

The test point A which is located at the grid of the mixer tube and is accessible at the top of the tuner is utilized when performing the video IF alignment. A sweep and marker generator operating in the 40 megacycle IF range is connected to this point; thus, an over-all IF response curve may be observed at the output of the video detector. Fig. 3 is a top-view drawing of the tuner and shows the location of point A.

The local oscillator takes the form of a modified Colpitts circuit employing the triode section of the 5U8. The output IF of this tuner is in the 40-megacycle range; therefore, the oscillator frequency when the tuner is set to a selected channel is 41.25 megacycles above the sound carrier or 45.75 megacycles above the picture carrier of that channel. Coarse tuning is accomplished by adding or subtracting small amounts of inductance to the tank circuit of the oscillator.

The oscillator switch operates in the same manner as the antenna and mixer sections. The individual channel coils consist of a few turns

of wire around a brass screw which is adjustable from the front end of the tuner. The fine-tuning control acts as a variable capacitor connected between the oscillator grid and plate and has a range capable of overcoming any variation in the interelectrode capacitance of the tube. The capacitor C14 also lessens the effect of a change in the interelectrode capacitance, and resistor R18 and capacitor C15 comprise the grid-leak network. Capacitor C13 couples the oscillator signal to the mixer stage, and the 12K-ohm 2-watt resistor R20

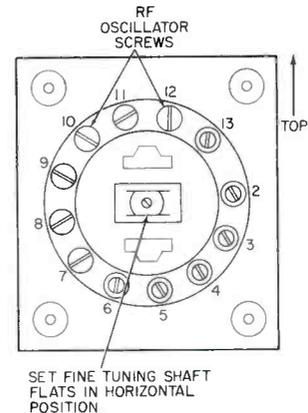
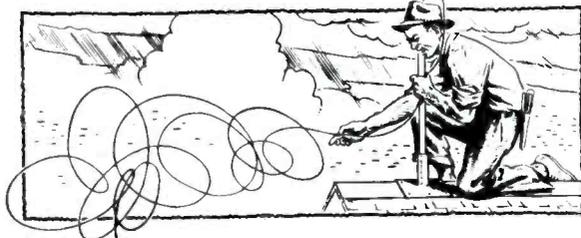


Fig. 6. Front View of Tuning Unit Illustrating RF Oscillator Adjustments.

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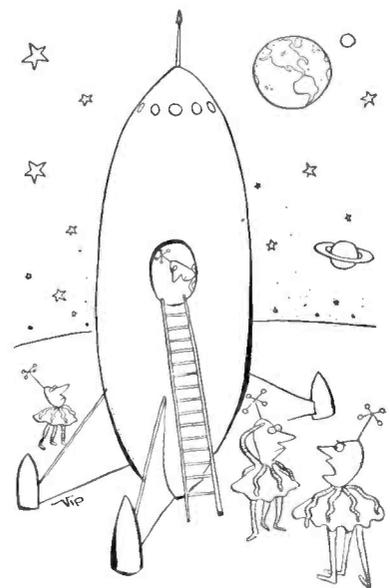
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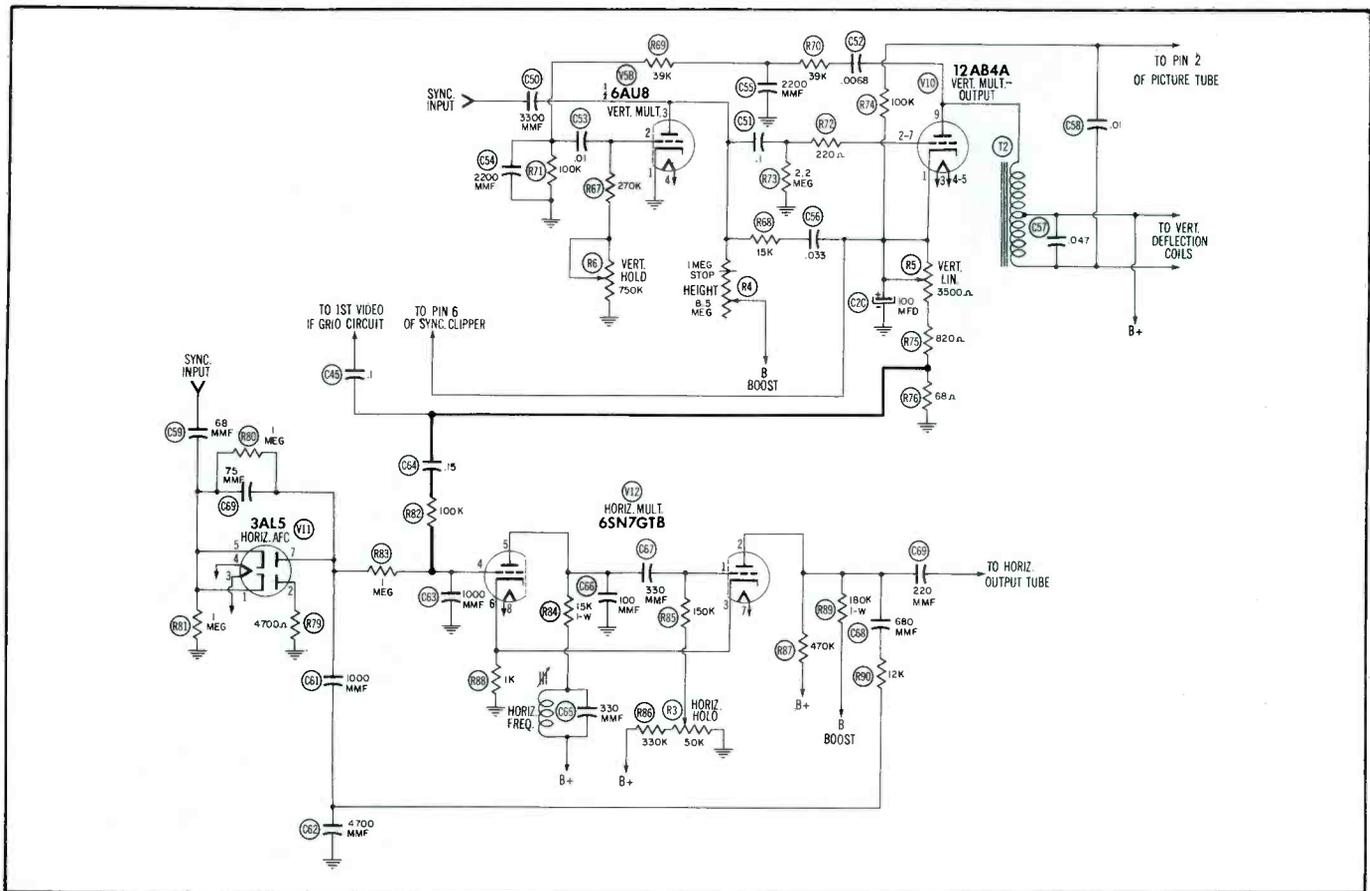


Fig. 7. Bend-Correcting Circuit Used in Zenith Chassis 16T20.

serves as a plate load. Resistor R19 shunts the channel-13 oscillator coil and thus reduces the output of the oscillator on that channel.

When adjusting the oscillator slugs, first set the fine-tuning control to the approximate center of its range (see Fig. 6). Adjust each channel slug (starting with the one for channel 13 and ending with the one for channel 2) by inserting an insulated alignment tool through the appropriate hole in the front of the tuner. Care should be taken not to move the fine-tuning shaft when switching channels.

In some areas, an interference from an adjacent channel may be encountered. In order to compensate for this, the manufacturer has incorporated a 39.75-megacycle trap which will attenuate the picture carrier in an adjacent channel. The trap is mounted on the main chassis near the tuner and has one side grounded and the other side connected to the IF output terminal on top of the tuner. The trap has been aligned at the factory but may require some adjustment in the field to obtain optimum rejection of interference from an adjacent channel.

Zenith receivers with UHF provisions use a 13-position switch type of tuner which is similar to the 12-

position unit except that, when the selector switch is in the UHF position, the mixer and RF tubes become part of the 45-megacycle IF strip.

PARABOLIC CORRECTION VOLTAGE USED IN ZENITH CHASSIS 16T20

A slight bending at the top of the picture in many television receivers has indicated for some time that there is room for design improvements in the horizontal-sync system. This bending is caused by interaction of the vertical- and horizontal-sync circuits; this produces phase modulation of the horizontal oscillator signal at the start of each vertical-scanning period. In some receivers, the modulation voltage may be coupled through the power supply. The Zenith Chassis 16T20 incorporates a means for preventing this type of distortion. A schematic diagram in Fig. 7 illustrates the bend-correcting components and their associated circuitry.

A small amount of out-of-phase voltage is fed from a network located in the cathode circuit of the vertical-output tube to the grid circuit of the horizontal multivibrator. This 60-cycle correction voltage has a parabolic waveform and is developed across the 68-ohm resistor R76 located at the grounded end of the

voltage divider in the cathode circuit of the vertical-output stage. The .15-mfd capacitor C64 and the 100K-ohm resistor R82 couple the parabolic voltage to the horizontal multivibrator and form what the manufacturer refers to as a stabilizing or anti-hunting circuit.

The parabolic voltage obtained in this manner cancels the effect of the parabolic voltage appearing in the B+ voltage applied to the plate of the horizontal multivibrator. The resistance value of R76 is critical, and any change in its value may tend to bend the picture either to the left or to the right.

A certain amount of this correction voltage is also coupled through C45 to the grid of the first video IF amplifier to compensate for the effect of the parabolic voltage in the B+ voltage supplied to the tuner and IF stages. Another portion of the parabolic voltage present at the vertical-output cathode is utilized in the sync-clipper stage. This voltage is tapped off at the cathode of the output tube and aids in the operation of the sync stage to reject noise pulses during the vertical-retrace period.

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Audio Facts

(Continued from page 23)

establishing reference levels, and volume indicators that have certain specified electrical and dynamic characteristics have been standardized so that accurate measurements of these levels can be made. This will be discussed in more detail when the specifications of the VU meter are given.

Various methods have been used to measure or indicate volume. Meters have been employed to read rms or peak values of power or voltage. Neon bulbs have been used to indicate signal amplitude by flashing when peaks reach predetermined levels approaching the overload region. Two or more have been used in arrangements in which additional lamps flash as higher signal levels are reached. An elaborate arrangement employing several lamps can give a fairly accurate indication of the signal level.

Cathode-ray eye tubes have been used as tuning indicators on radio receivers for many years and are now used as recording-level indicators on many tape recorders.

All of these indicators possess advantages and disadvantages. Some indicate peak values and others rms values or approximate values of rms voltage. For instance, eye tubes usually operate in conjunction with a filter network which determines how closely the indicator will follow the peak value of the instantaneous signal peaks.

Meter movements do not permit the pointers to move fast enough to follow the high-frequency variations in the signal. In fact, it takes a fraction of a second for the average meter to reach full-scale deflection; therefore, a meter cannot follow signals of frequencies higher than one or two cycles per second.

The oscilloscope is about the only instrument that does show actual peak-to-peak signal levels. Many other so-called peak-to-peak indicators cannot respond to the high frequencies encountered.

Actually in practice, it does not really matter whether the volume indicator shows peak or rms values as long as the maximum limits of the signal are indicated.

THE VU METER

The VU meter is valuable because of its ability to indicate a



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reference volume level. Reference volume is an arbitrary but important term which is often not thoroughly understood. It is the level of an audio signal which causes a correctly calibrated VU meter to indicate zero VU when the VU meter is used in the prescribed manner.

Reference volume must not be confused with the power level of a single-frequency sine wave which is used to calibrate the VU meter.

Calibration

The VU meter is designed so that its internal impedance is 3,900 ohms. An input impedance of 7,500 ohms is required to obtain correct readings when a VU meter is bridged across a 600-ohm line; therefore, a 3,600-ohm resistor must be externally connected in series with the meter.

The sensitivity of a VU meter is such that a reading of zero VU will be obtained when 1.228 volts rms (4 decibels above 1 milliwatt across 600 ohms) is applied to the meter with a 3,600-ohm resistor in series with its terminals.

In the calibration of a VU meter, a standard level of 4 decibels above 1 milliwatt across 600 ohms (or 4 dbm) is used. The unit dbm designates the number of decibels above or below a reference level of 1 milliwatt through 600 ohms when a sine-wave current of a single frequency is measured. The term dbm is used only with steady signals and cannot be used to measure audio signals that are varying rapidly. The usual audio signal which will develop sufficient power in a 600-ohm load to give a reading of zero VU will contain instantaneous peaks several times greater than 1 milliwatt; whereas, the average power is far below the 1-milliwatt reference level. It must be remembered that the volume unit (VU) is an arbitrary value and has no fixed value, as does the dbm.

Using the VU Meter

When the volume level of an audio signal is being read on a VU meter (in volume units), the meter is observed over a period of time which is long enough to include a sufficient number of signal peaks to permit the signal level to be adjusted to keep the readings within normal limits on the meter scale. This period of time will vary with program material. With voice, the peaks may be so consistent that signal limits can be established in a very short time, probably a matter of a few seconds. Musical program material may have to be observed for a much longer period of time because

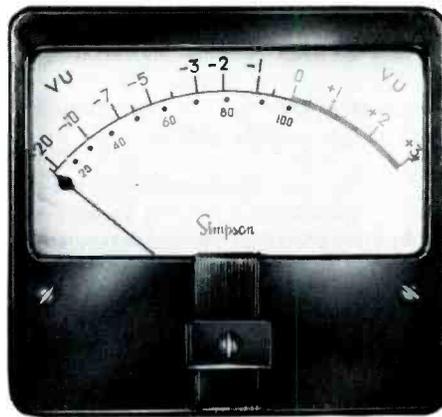


Fig. 1. Simpson 4-Inch Model 142 VU Meter. "A" Scale.

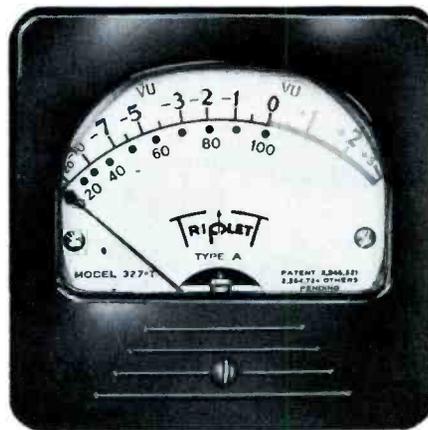


Fig. 2. Triplet 3-Inch Model 327-T VU Meter. "A" Scale.

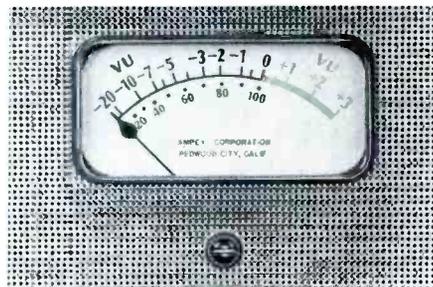


Fig. 3. VU Meter Used on Ampex Model 600 Magnetic Tape Recorder. Meter Is Mounted in Perforated Metal Front Panel of Recorder.

of the wide dynamic range encountered in musical selections in which the high-level peaks may occur only at long and irregular intervals.

As can be seen in Figs. 1, 2, and 3, the scale of the VU meter is calibrated in volume units and reads -20 to +3 VU from left to right. Below the line, the scale is marked in percentage of voltage with 100 per cent at the zero-VU point. The numbers and the scale on the left of zero VU are black. To the right, they are red. Normal volume level is at the zero-VU (100 per cent) point which

is located at about 71 per cent of full-scale deflection.

The meters illustrated use the "A" scale which is used on most recorders. The "B" scale, which has the percentage scale located above the line and the VU scale below, is also available. The "B" scale is used when percentage of modulation is of the greatest concern.

A DC-meter movement is used with a full-wave, copper-oxide rectifier. The full-wave circuit is used so that both sides of the signal will be rectified. Many audio signals do not have symmetrical waveforms; consequently, if only one half of the signal is utilized, as is done with a half-wave rectifier, a true reading will not be obtained.

The VU meter responds to an approximate rms value of the signal. The value varies to some extent depending upon the nature of the waveform and the harmonics present in the signal.

Specifications

All VU meters are built to certain specifications so that they will have the same electrical and dynamic characteristics and so that all pointers will move in unison if several meters are connected to the same signal source. The characteristics selected do not allow the pointer to move so fast that it might be difficult to follow with the eyes.

The sudden application to a VU meter of a 1,000-cps sine-wave signal, that has an amplitude sufficient to give a steady-state reading of zero VU, will move the pointer to 99 per cent of its final deflection in 0.3 second. The meter is designed with proper damping so that the pointer will overshoot at least 1 per cent but not more than 1.5 per cent when this signal is applied.

The frequency response between 35 and 10,000 cps is kept within 0.2 decibel of the response at 1,000 cps and within 0.5 decibel from 25 to 16,000 cps.

The meter is designed to tolerate, for a period of 0.5 second, signal peaks that are as much as ten times the amount required to obtain a deflection of zero VU. Continuous overloads of five times the amount of signal required to obtain a deflection of zero VU will not damage the meter nor its calibration.

Several features that aid in ease and accuracy of reading and thereby reduce eye strain have been included in the design of the VU

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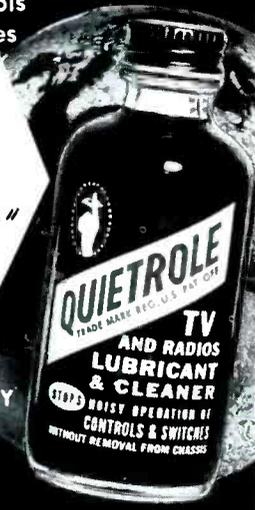
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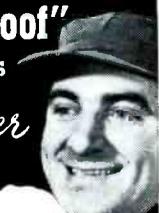
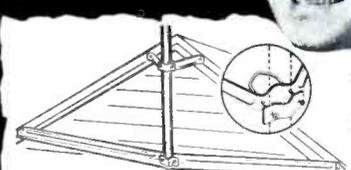
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meter. Besides controlling the dynamics and damping of the meter movement so that the eye can follow the pointer without fatigue, the color of the meter face has been standardized as a light orange-yellow.

Proper illumination is essential; therefore, most VU meters are supplied with illuminated dials, particularly for studio applications. The meters shown in Figs. 1, 2, and 3 are illuminated. In Fig. 4, the face of the 4-inch Simpson meter has been removed (made possible by the removal of the two screws which held it in place) to show the two dial lamps mounted in their brackets. A snap-in dial-lamp assembly plugs into the back of the 3-inch Triplett meter, as shown in Fig. 5. The dial of the meter is illuminated by the light that shines through the clear plastic piece (visible in Fig. 2) which encircles the upper half of the face opening.

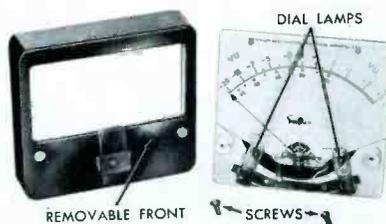


Fig. 4. Simpson 4-Inch Model 142 VU Meter With Front Removed to Show Access to Dial Lamps.



Fig. 5. Rear View of Triplett 3-Inch Model 327-T VU Meter Showing Method of Mounting Dial Lamp.

The dimensions of the meter scales have been standardized. For example, the scales of the meters shown in Figs. 2 and 3 are identical in length; but because of the smaller window in the 3-inch Triplett meter, the numbers at the ends of the scale have been compressed.

Most audio equipment and the transmission lines encountered in telephone and communication work have a characteristic impedance of 600 ohms. A VU meter can be bridged across other circuits besides those which have a 600-ohm impedance, but a correction factor must be used to obtain true readings.

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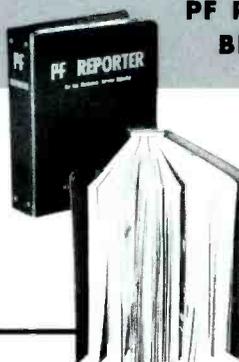
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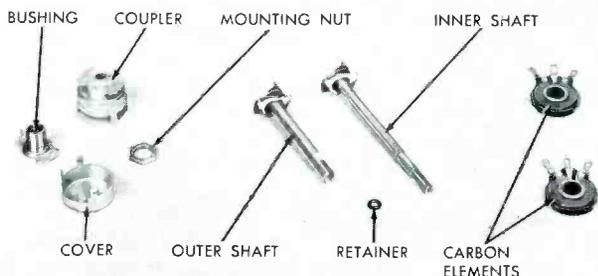


Fig. 5. Parts Required to Construct a Dual Control From IRC "Concentrikit."

International Resistance Company

A kit is made by the International Resistance Company (IRC) and is known as the "Concentrikit." A few of these kits together with a stock of various shafts, switches, and base elements enable the technician to make a wide variety of concentric dual controls.

Each base element is of molded construction and is complete with resistive element, terminals, and collector ring. There are two types of base elements available: (1) the type B with a carbon resistive element and (2) the type W with a wire-wound resistive element.

Each concentric dual control requires the use of one Concentrikit, two base elements, and two shafts. A switch can be added if desired.

The photograph in Fig. 5 shows typical parts required to assemble a Concentrikit dual control using two carbon elements. The components that come in a K-2 Concentrikit are grouped at the left-hand side of the photograph. They are known as the common parts for an IRC Type-Q Concentrikit dual control. For a dual control in which a wire-wound element is required for the panel section, a K-3 Concentrikit is used.

In the center of the picture, the outer and inner shafts and the retainer are shown. Shafts of various lengths and of various end constructions are available. The carbon elements are at the right-hand side of the photograph. There is no difference in the physical construction of the two elements; therefore, any carbon element made for these controls may be used either as a rear or a panel element.

The photographs in Figs. 6A through 6H show the controls at the various stages of assembly. First, the rear element is placed on the coupler with the carbon side up in the position shown in Fig. 6A. Next, the inner shaft is slipped into place through the hole in the element (see Fig. 6B). This entire unit is then turned over, and the retainer is slipped onto the inner shaft (see Fig. 6C). Using the thumb and forefinger, push the retainer down the shaft as far as possible. The outer shaft can be used as a tool for seating the retainer into the shaft groove. This is done by reversing the shaft (see Fig. 6D). Hold the coupler between the thumb and middle finger, and use the index finger to press the back end of the inner shaft in order to compress the contact spring. At the same time, push the retainer into place with the reversed outer shaft. After doing this, rotate the shaft to make sure that it operates smoothly.

Next, place the outer shaft over the inner shaft with the contact end next to the coupler (see Fig. 6E).

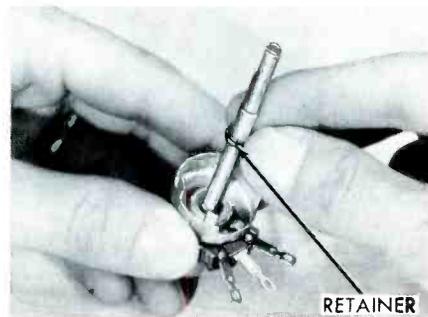


Fig. 6C. The Retainer Is Placed on the Inner Shaft.



Fig. 6D. The Outer Shaft Is Used to Seat the Retainer.

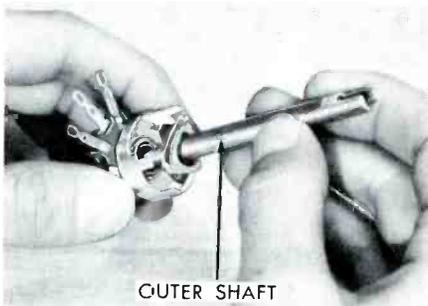


Fig. 6E. The Outer Shaft Is Placed Over the Inner Shaft.



Fig. 6F. The Panel Element Is Slipped Over the Outer Shaft.

Then, slide the panel element over the outer shaft with the carbon side down (see Fig. 6F). The next step is to slip the bushing over the outer shaft and to seat it properly (see

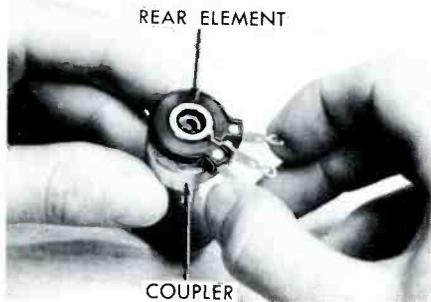


Fig. 6A. The Rear Element Is Placed on the Coupler.

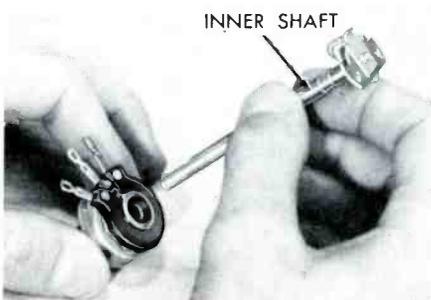


Fig. 6B. The Inner Shaft Is Inserted in the Rear Element.

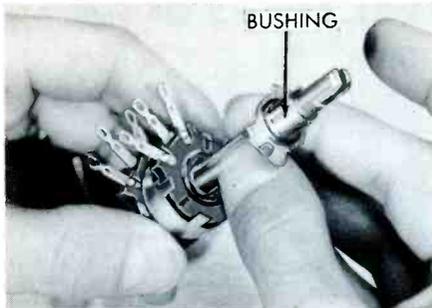


Fig. 6G. The Bushing Is Slipped Into Place Over the Outer Shaft.

Fig. 6G). The cover or switch (whichever is required) is then placed over the rear element. The final



Fig. 6H. The Completed Control.

step is to bend down all eight tabs which are on the panel and rear sections.

The completed unit is shown in Fig. 6H ready for mounting in place on the chassis. The unit can then be wired into the circuit.

Note that it was not necessary to cut the shafts because exact duplicate shafts were used. An IRC Universal Shaft Kit KS-2 is also available for use in assembling carbon concentric dual controls when exact duplicates are not available. The shafts in the KS-2 kit must be modified so that they will match the original shafts properly. The instructions for doing so are included in the Concentrikit package.

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COLOR TV TRAINING SERIES

QUESTIONS ON PART XIV

Part XIV of the Color TV Training Series, appearing in this issue, should be studied prior to reading the following questions.

The questions are presented to give the reader an opportunity to test himself on the color-television material in this issue.

1. What is the first thing that should be done when trouble shooting a color receiver?
2. Why is it necessary to obtain a good monochrome picture before checking color operation?
3. What are the possible causes if the monochrome picture is reproduced in values of cyan instead of values of gray?
4. When the video signal from a color-bar generator is applied at the video input of a receiver that will not produce color normally and color is reproduced, what are the sections of the receiver in which the cause of the trouble can be located?
5. If color is not reproduced when using a video signal, what are the sections of the receiver in which the trouble can be located?
6. Upon checking the signals at the input of the demodulators with an oscilloscope, it is found that both the chrominance and the reference signals are present. What could be causing the loss of color?
7. If the reference signals are present at the demodulators but the chrominance signal is absent, which circuit should be suspected first?
8. What happens when the burst signal is not present at the phase detectors?
9. If the chrominance signal is present at the demodulators but the reference signals are absent, which section of the receiver should be checked?

C.P.O. & V.M.R.

Howard W. Sams



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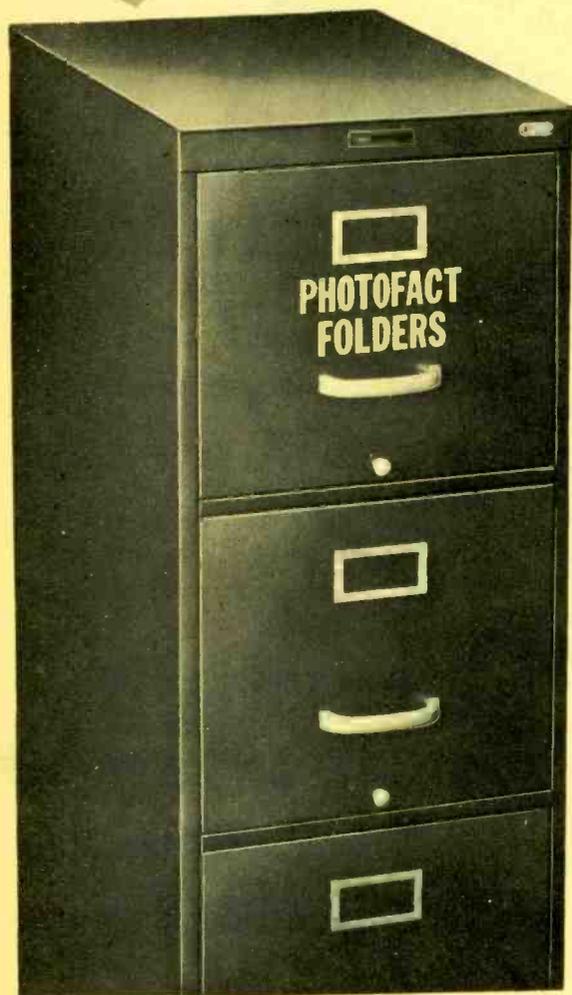
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HOW TO USE THIS INDEX

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

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

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

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

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CROSLY-Cont.

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Table listing David Bogen radio models and their corresponding set numbers, including models like R750, RC, and RP-1.

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Table listing David Bogen radio models and their corresponding set numbers, including models like AMB-1 TV Booster and AM901.

NOTE: PCB Denotes Production Change Bulletin. Production Change Bulletin Nos. 1 Through 63 Are All Contained in Set No. A-200. Production Change Bulletin Nos. 64 Through 104 Are All Contained in Set No. A-250. * Denotes Television Receiver.

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Table listing Emerson models and their specifications, including 669B, 671B, 671D, 671E, 672B, 673B, 674B, and various other EM series models.

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Table listing Emerson models and their specifications, including 734B, 736B, 737A, 738B, 740D, 741D, 742B, 743A, and various other EM series models.

NOTE: PCB Denotes Production Change Bulletin. Production Change Bulletin Nos. 1 Through 63 Are All Contained in Set No. A-200. Production Change Bulletin Nos. 64 Through 104 Are All Contained in Set No. A-250. Denotes Television Receiver.

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NOTE: PCB Denotes Production Change Bulletin. Production Change Bulletin Nos. 1 Through 63 Are All Contained in Set No. A-200. Production Change Bulletin Nos. 64 Through 104 Are All Contained in Set No. A-250. ● Denotes Television Receiver.

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