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for the Electronic Service Industry

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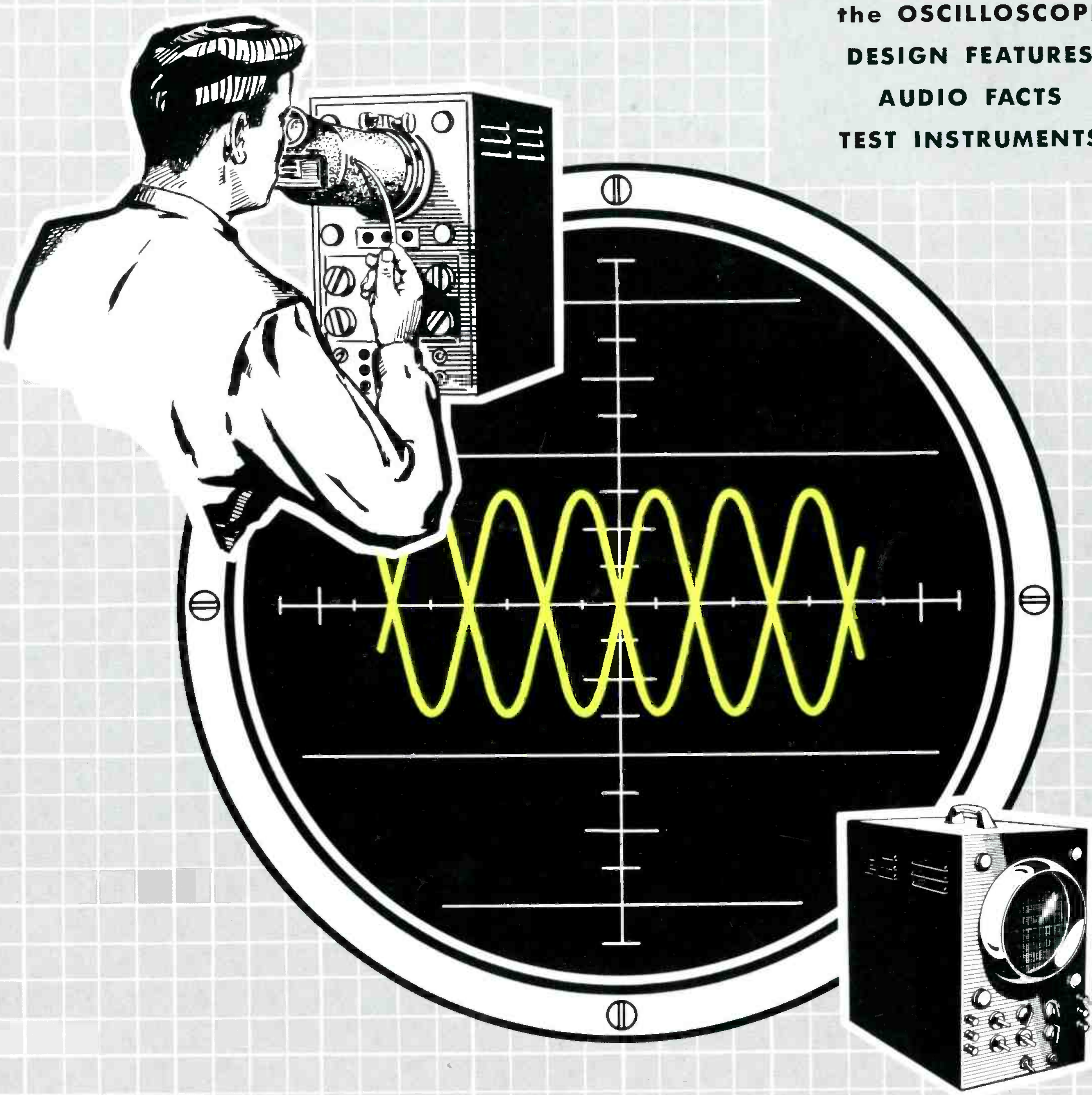

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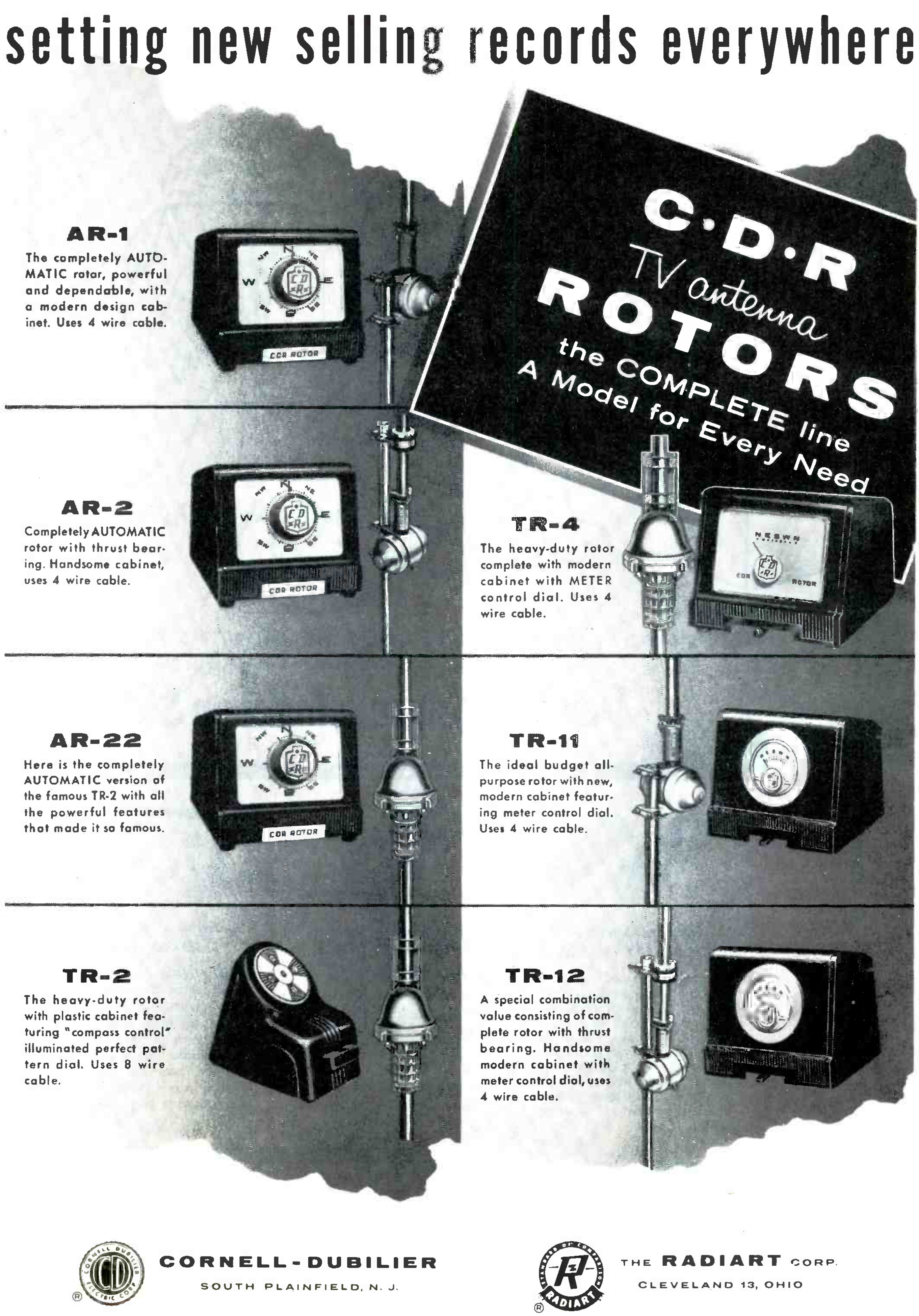
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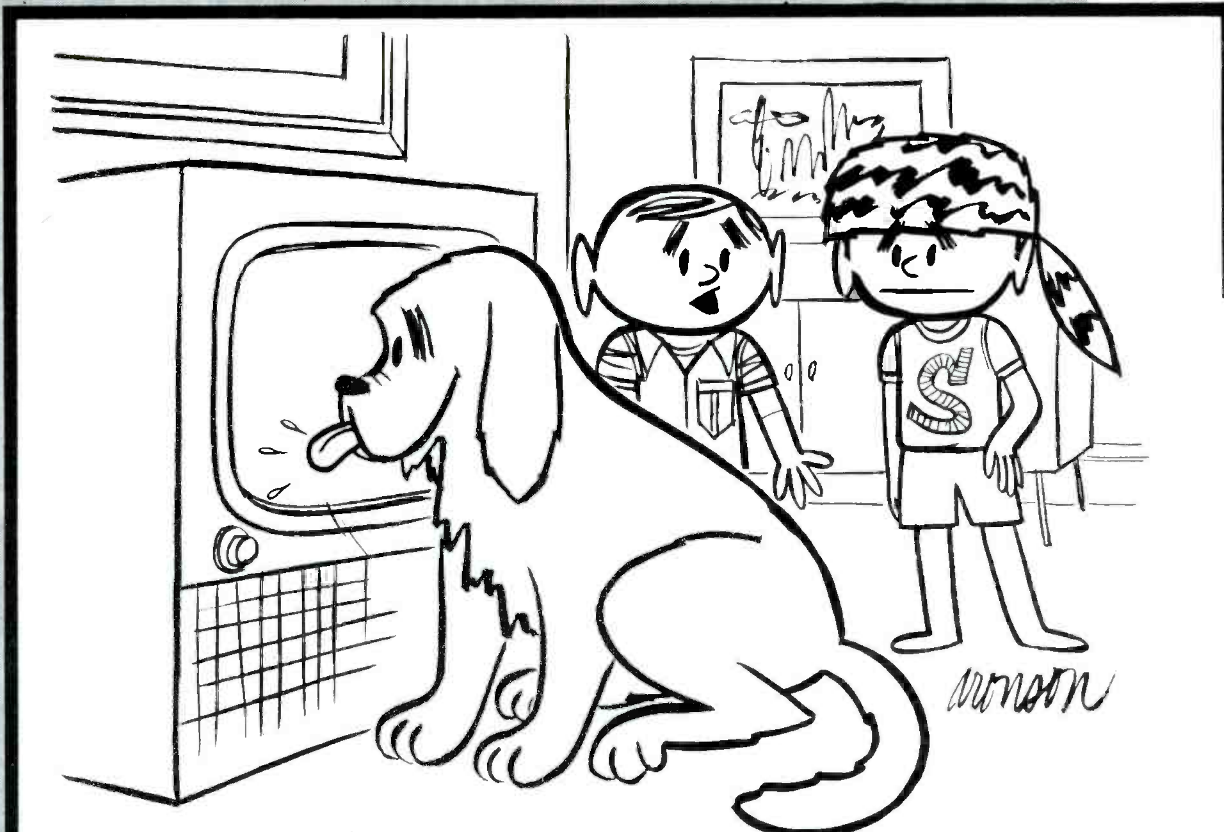

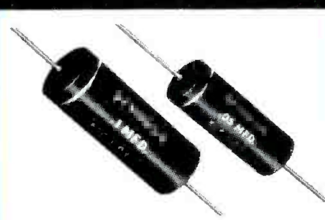

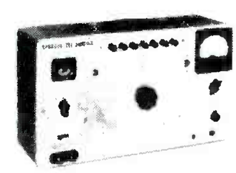

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ABOUT THE COVER

The service technician must understand the inner workings of his oscilloscope in order to properly interpret the waveform he obtains, and, thereby, use this versatile piece of test equipment to best advantage. See Part I of the article "Know Your Oscilloscope," by Paul C. Smith, starting on Page 10. Cover illustration by *Glenn R. Smith.*

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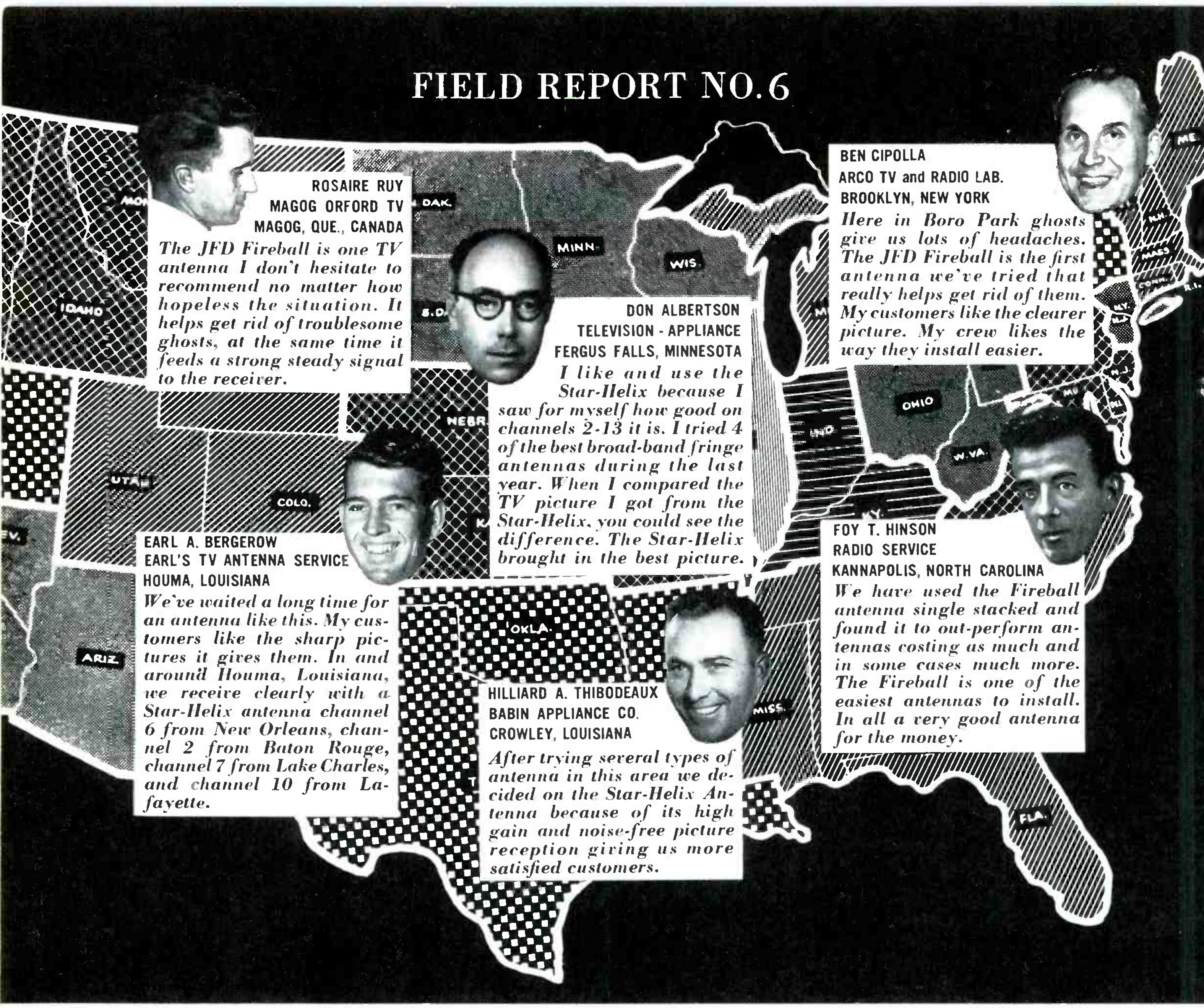

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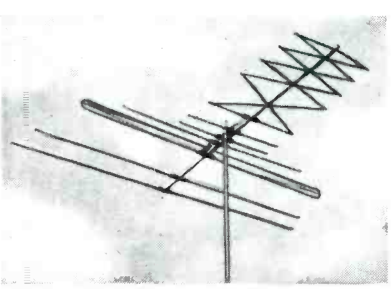

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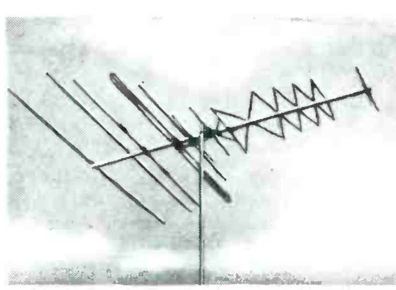

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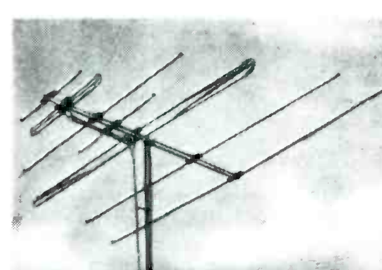

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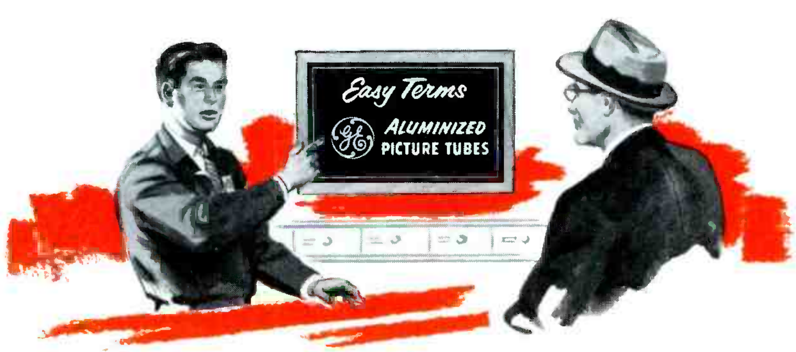

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Critical Components in the Sync-Separator and Sweep Circuits

In the sync-separator stages of a television receiver, the sync pulses are divorced from the rest of the video signal. In nearly all sync-separator stages, this action is accomplished by using a low plate voltage in combination with some form of grid-leak bias. The time constant of the grid circuit is also important in this section. To illustrate, a typical sync-separator section is shown in Fig. 1. The composite

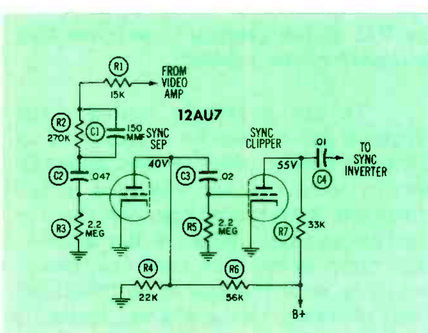


Fig. 1. Typical Sync Separator and Clipper.

video signal from the plate circuit of the video amplifier is coupled to the sync-separator grid through R1, R2, C1, and C2. Isolation resistor R1 prevents the separator from excessively loading the plate circuit of the video amplifier. Low-frequency noise pulses are rejected by R2 and C1. Cutoff bias developed by grid-leak action permits current flow only during the highest positive peaks (sync pulses) of the composite video signal. Sync-separator plate voltage is reduced for improved separator action by a voltage divider composed of R4 and R6.

Grid-leak bias is also used in the sync-clipper stage which follows the sync-separator stage. The negative peaks of the sync and noise pulses drive the tube to cutoff, and the desired clipping or amplitude-limiting action results.

Both the low plate voltages (40 and 55 volts, respectively) and the grid-leak bias work together toward the common goal of sync separation and each will have an influence over the final result. For example, if the plate voltage is too high, more of the video signal will get through and interfere with the synchronization of either the vertical or horizontal stages or both. Too low a voltage will reduce the amplitude of the sync pulses that do get through, and operation of the hold controls may become critical.

In the grid-leak section of this network, reduction of the time constant will have a beneficial effect in combatting the effects of noise; but the over-all amplitude of the output sync pulses will be reduced. On the other hand, if we increase the time constant of the circuit, we reduce the ability of this network to prevent noise pulses from getting through. It will also be found that with long-time-constant networks, the amplitude of the horizontal sync pulses immediately following a vertical sync pulse will tend to be lower in amplitude than will the horizontal sync pulses that occur in the middle of the picture. The reason for this stems from the fact that the grid-leak capacitor charges to a higher negative voltage during the vertical sync pulses than it does during the horizontal sync pulses. Hence, immediately following the vertical sync pulses, we find a greater negative voltage on the grid of the sync-separator tube (or tubes); and the horizontal sync pulses that follow produce output pulses of lower amplitudes. Gradually, of course, this larger bias decreases; and after a number of lines, it returns to a level which is more representative of the amplitude of the horizontal sync pulses.

The effect of the foregoing action may cause bending of the vertical lines at the top of the picture. This section of the image is particularly vulnerable to variations in the amplitude of the horizontal sync pulses because, within this region, synchronization of the horizontal oscillator passes from the serrations (or breaks) in the vertical sync and equalizing pulses back to the horizontal sync pulses themselves; and

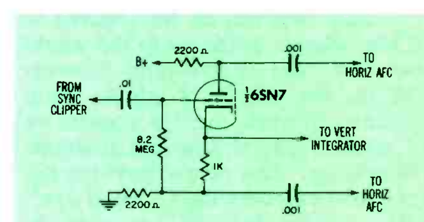


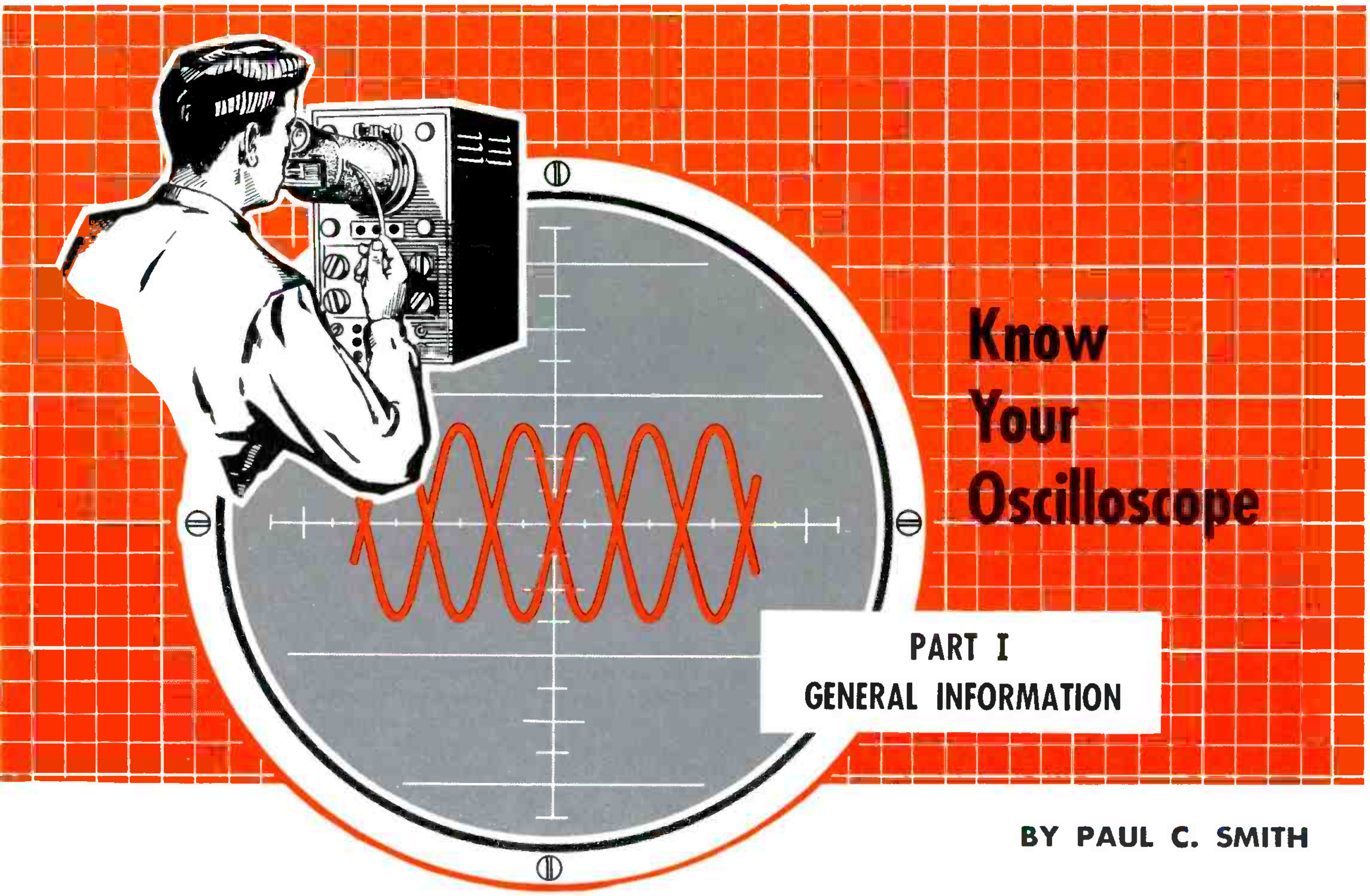
Fig. 2. Typical Sync Inverter.

if the latter do not possess sufficient amplitude, the horizontal oscillator may tend to alter its frequency. The shift in line structure, which is a result of this pulling away of the horizontal-oscillator frequency, produces the aforementioned bending.

In many receivers, the sync-separator section is followed by a stage known as a sync inverter. See Fig. 2. The important consideration in this circuit is to make certain that balanced output signals are produced. This, in turn, requires that the load resistances from which each of the sync pulses are taken are within 5 per cent of each other and preferably closer than that.

In the vertical-deflection system, the major critical components are the charge and discharge circuit,

* * Please turn to page 88 * *



Know Your Oscilloscope

PART I GENERAL INFORMATION

BY PAUL C. SMITH

Man depends on his senses to tell him what is going on in the world about him, and he probably depends most on his sense of sight. This accounts, in part, for the popularity and usefulness of the oscilloscope in servicing. The scope provides the service technician with a "third eye" which enables him to see what is happening in the many electronic circuits with which he works.

When the oscilloscope is properly connected and adjusted, it will give the technician a visible indication of the amplitude, frequency, phase, and waveform of the signal at any particular point in a circuit. An instrument that provides as much information as this is a very powerful tool, indeed. There is probably no phase of electronics where it has not proved useful for designing, testing, or servicing.

The oscilloscope is really a voltmeter, but it is a voltmeter with special properties. The voltage applied to its terminals determines the position of the electron beam in the cathode-ray tube. The electron beam produces a spot of light wherever it strikes the fluorescent surface of the tube. As the beam moves across the face of the tube in response to the voltages on the deflection plates, the spot of light moves also; and if the movement is fast enough, the spot takes on the appearance of a continuous trace or line of light.

This blending of successive positions of the spot into an apparently continuous trace is due to two factors: (1) the persistence of the phosphor of the tube and (2) the persistence of vision, that property of the human eye which causes it to see any object or spot of light at its original position for a fraction of a second after it has moved to a new position. The persistence of a phosphor is the property of a phosphor which causes it to continue to glow for a short time after the electron beam has been removed from that spot. In general-purpose oscilloscopes, the blending of the spot into a line is due almost entirely to the persistence of vision. In special-purpose oscilloscopes, a tube with a phosphor of long persistence may be used so that some electrical phenomena of short duration and of a nonrepeating nature can be viewed.

The phosphor most commonly used in oscilloscopes is the P1 which is rated as having medium persistence. The P5 is a phosphor of very short persistence, and the P7 is one of very long persistence. Other phosphors are the P4 which is commonly found in TV picture tubes and the P11 which gives a blue trace that is easily photographed.

To use a simple analogy, the electron beam can be considered as a kind of pencil which writes upon the screen of the cathode-ray tube in accordance with the voltage on the deflection plates. When a horizontal-deflection system is used (and practically no oscilloscope is built without one), the trace on the screen is really a graph. The use of graphs is so commonplace nowadays that there is hardly a person who has not seen one. Some examples are the temperature graphs and electrocardiographs used by hospital personnel or the sales graphs which a business office may use to show the trends of its sales.

The reader has probably been called upon to draw graphs at some time in his school career and will remember that they deal with two sets of data, the values of one set varying in some direct relationship to the values of the other set. One set of values is plotted on the graph paper along the horizontal or X-axis, and the other set is plotted along the vertical or Y-axis. The points located in this manner are then connected to form a continuous graph. The action of the oscilloscope in tracing a response curve is so similar to this that some oscilloscopes even have

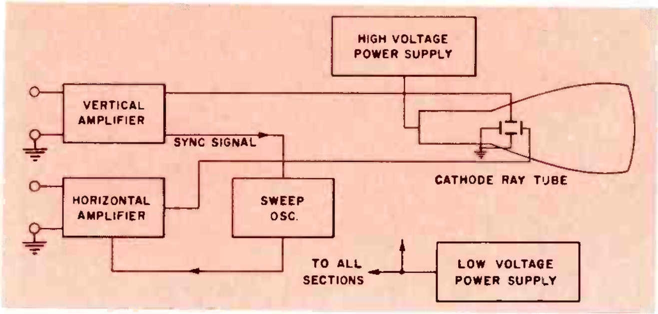


Fig. 1. Simplified Block Diagram of General-Purpose Oscilloscope.

inputs which are marked "X-amplifier" and "Y-amplifier."

We have made this comparison because we believe it is a good point to remember. When confusing indications are seen on the oscilloscope screen, it may help if the operator stops to think that the oscilloscope is plotting time in a horizontal direction and voltage in a vertical direction to produce a graphical account of the operating conditions of the circuit. Usually it is not necessary to know exactly how much time is represented by the horizontal travel of the trace, so long as the beam is uniform in its rate of travel; but if necessary, there are methods of determining this time very accurately and for very short intervals.

Before proceeding to a discussion of the oscilloscope section by section, there is a very important characteristic of all oscilloscopes that should be mentioned — the speed of reaction of the electron beam to any applied voltage. The beam possesses very little inertia. For all practical purposes, the beam can be said to have no inertia at all; consequently, it responds almost instantaneously to the impulse of the deflection voltages. This is the property that enables the trace to follow every variation of the applied signal, no matter how suddenly the signal may change in direction or amplitude. If there is a limitation such as a case in which the oscilloscope does not respond faithfully to the applied signal, this limitation will usually be caused by the associated circuits of the oscilloscope.

Another important characteristic of the oscilloscope is its high input impedance. This is a desirable characteristic with any instrument, and it means that the instrument will have a minimum loading or disturbing effect upon any circuit to which the instrument may be connected. The input impedance of the vertical amplifier in a conventional oscilloscope may have any value from 1 to 5 megohms shunted by 25 to 50 micromicrofarads. If connection is made directly to the deflection plates, the impedance may be as high as 10 megohms shunted by 15 micromicrofarads. The input impedance at the vertical amplifier can be increased by the use of high-impedance probes.

Fig. 2. Modern 5-Inch Cathode-Ray Tube.

A block diagram of a general-purpose oscilloscope is shown in Fig. 1. This is a greatly simplified diagram in which several features have been combined in each block. The focus, intensity, and positioning circuits are not shown but have been considered to be part of the low-voltage power supply. The step and vernier attenuators are usually associated with the vertical and horizontal amplifiers. Provisions for triggering and synchronizing the sweep oscillator are considered to be part of the sweep oscillator.

An oscilloscope, which would consist of a cathode-ray tube and a power supply only could be made. Such an oscilloscope would be extremely limited in the number of ways it could be used. The signal input would have to be made directly to the deflection plates, and a comparatively strong signal would be necessary to deflect the electron beam a usable amount. After the addition of vertical and horizontal amplifiers and a horizontal-deflection system which will provide a time base, the oscilloscope may be used for an increased number of applications. The oscilloscope can be made to respond to very weak input signals, and general-purpose oscilloscopes sometimes have a vertical-deflection sensitivity of 15 millivolts rms or less per inch.

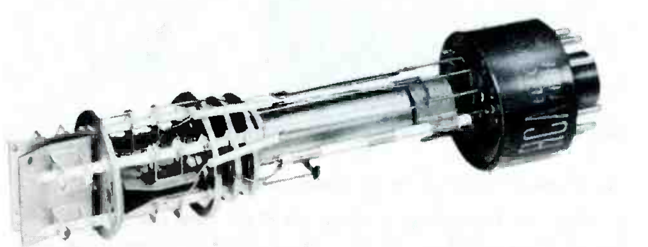


Fig. 3. Electron Gun of Cathode-Ray Tube.

The Cathode-Ray Tube

A modern 5-inch cathode-ray tube is shown in Fig. 2. Externally, the tube may be considered as being made up of four parts: the base, the neck, the bulb, and the face or screen. Inside the neck of the tube, a portion of the gun structure can be seen. Fig. 3 shows this gun structure after it has been removed from the tube. The gun contains all the electrodes for forming, shaping, and directing the electron beam which strikes the fluorescent screen of the tube.

Application of the proper voltages to the various electrodes of the gun results in the production of a beam that is brought to a focus in a small spot on the tube screen. Control of the intensity of the beam is maintained by means of the voltage on the control grid. The theory pertaining to the focusing action of the gun is probably of less interest to the service technician than the theory pertaining to the action of the deflection plates; consequently, more space will be devoted to the latter subject. This article will not deal with electromagnetic deflection systems, since they are used almost exclusively in television receivers rather than in oscilloscopes.

Fig. 4 is a perspective drawing which shows the manner in which the electron beam passes through the space between the deflection plates on its path to the screen. If all deflection plates are at the same electrical potential, the beam will pass along the axis of the deflection-plate assembly and will strike the center of the screen.

If one plate of a pair of deflection plates is made more positive or negative than the other, the electron beam will be attracted toward the positive plate and will be repelled from the negative plate. This is in accordance with the fundamental fact that unlike electron charges attract each other and like charges repel each other. The electron beam is

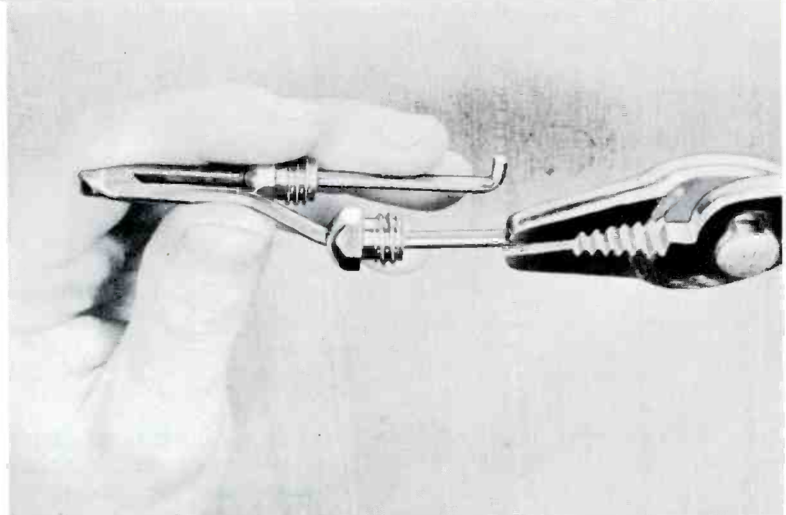
* * Please turn to page 81 * *

EXTENSION **TIP** *for SOLDER GUN*

by Calvin C. Young, Jr.

Soldering in places which are difficult to reach with a solder gun that has a standard tip can be facilitated through the use of an extension tip. The following article illustrates the steps necessary in making and using an extension-tip assembly. The parts required for this assembly are: an additional standard tip, a set of locking nuts, and a short length of No. 12 copper wire.

NOTE: Only a heavy-duty solder gun rated at 250 watts or more should be used with the extension-tip assembly. This is due to the fact that a light-duty gun could not heat the soldering end of this assembly to the melting point of solder during the duty cycle of the gun.

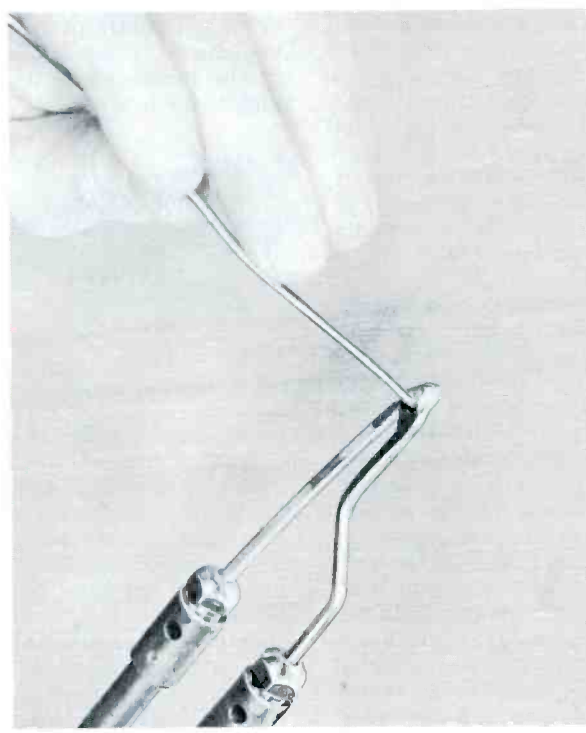


1. Bending Insertion Ends of New Standard Tip.

The locking nuts are properly installed on a new standard tip, and each insertion end of this tip is bent at a point approximately 3/16 inch from the end so that it will fit properly into the solder gun.

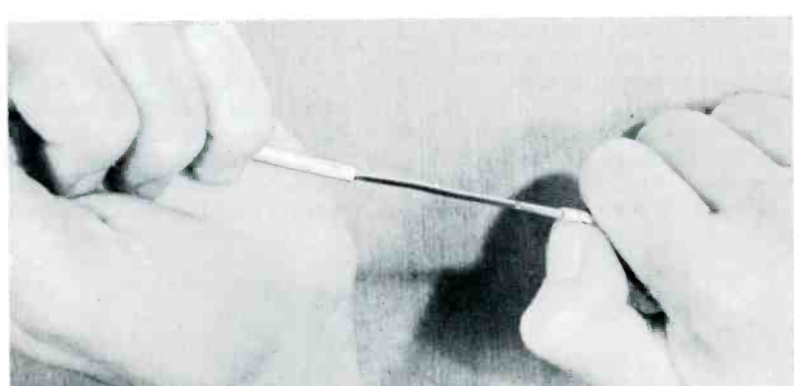
2. Tinning New Standard Tip.

After the new standard tip is installed in the gun, the soldering end should be tinned generously before it becomes heated to a high temperature. The tinning temperature should be no higher than the melting point of solder.



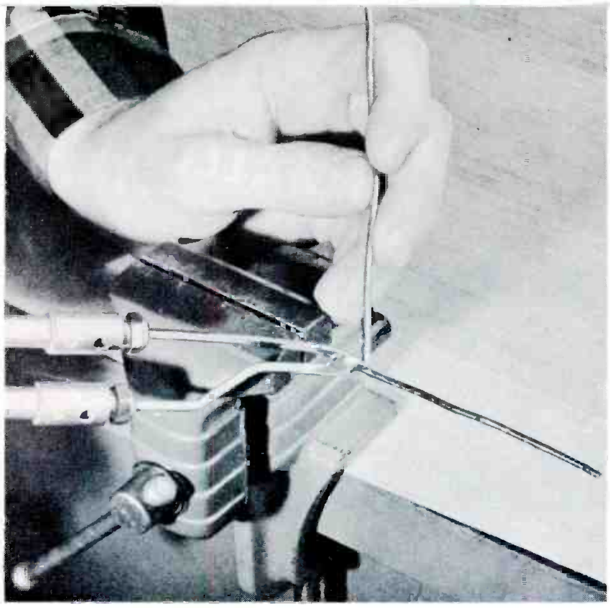
3. Wiping Off Excess Solder.

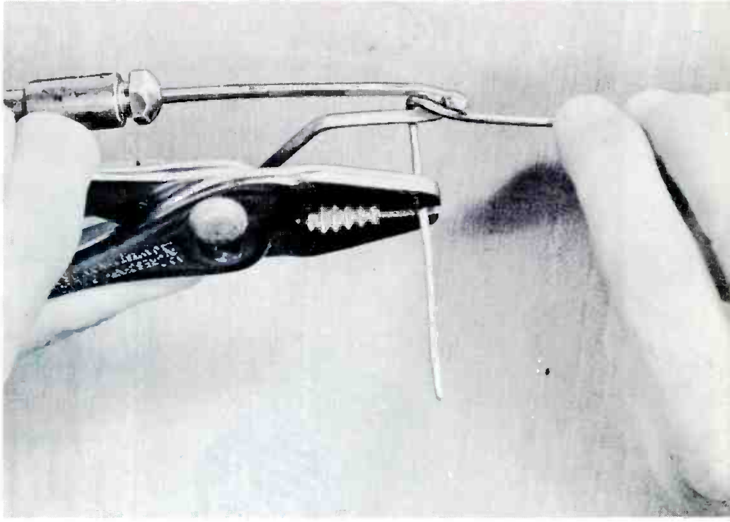
After the soldering end has been thoroughly tinned, all excess solder should be wiped off with a heavy rag that has been folded several times.



4. Preparing Wire for Extension Tip.

The copper wire needed for the extension tip can be of the type normally used in wiring houses. No. 12 is a good size. Cut off a piece about six inches long, and remove the insulation.



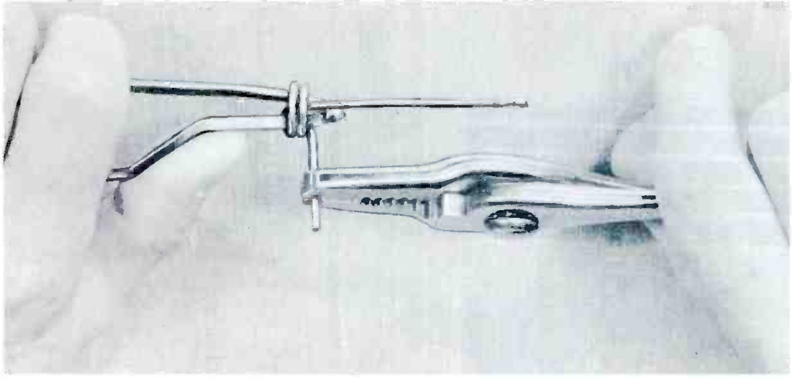


5. Tinning the Wire.

About half the length of the wire should be tinned so that good heat transfer between the new standard tip and the extension tip will take place. During tinning, the end of the wire may be clamped in a vise if a second person is not available to hold the wire.

6. Attaching the Extension Tip.

The wire for the extension tip is bent approximately at its mid-point and is passed through the new standard tip for the solder gun. A pair of pliers should be used for wrapping the tinned half of the wire around the end of the new standard tip.

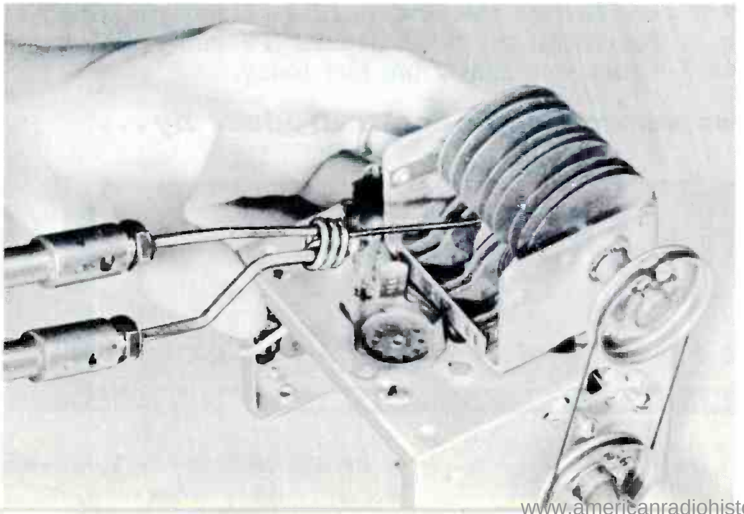


7. Wrapping the Wire.

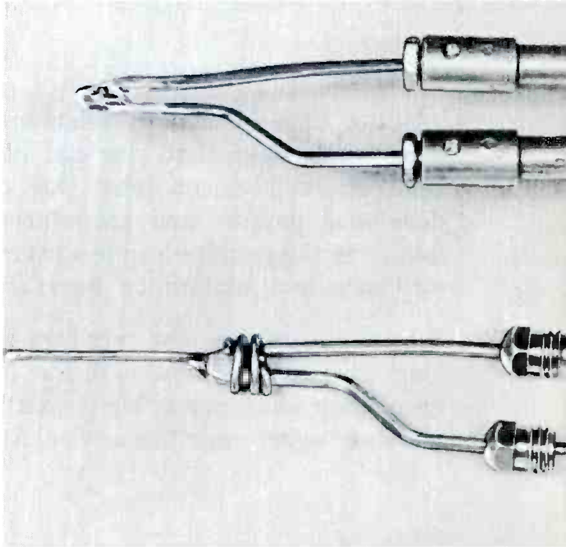
The wire should be wound tightly on the end of the new standard tip. The direction of the wrapping should be away from the solder gun so that the coils will encircle the tinned portion of this tip. After the wrapping operation, make sure of maximum heat transfer to the extension tip by applying liberal amounts of solder to the joint. Tin the extension tip at its end.

8. Example of Typical Application.

An extension-tip assembly can be very useful when the center contacts of the spiral inductors in a one-tube tuner must be soldered.

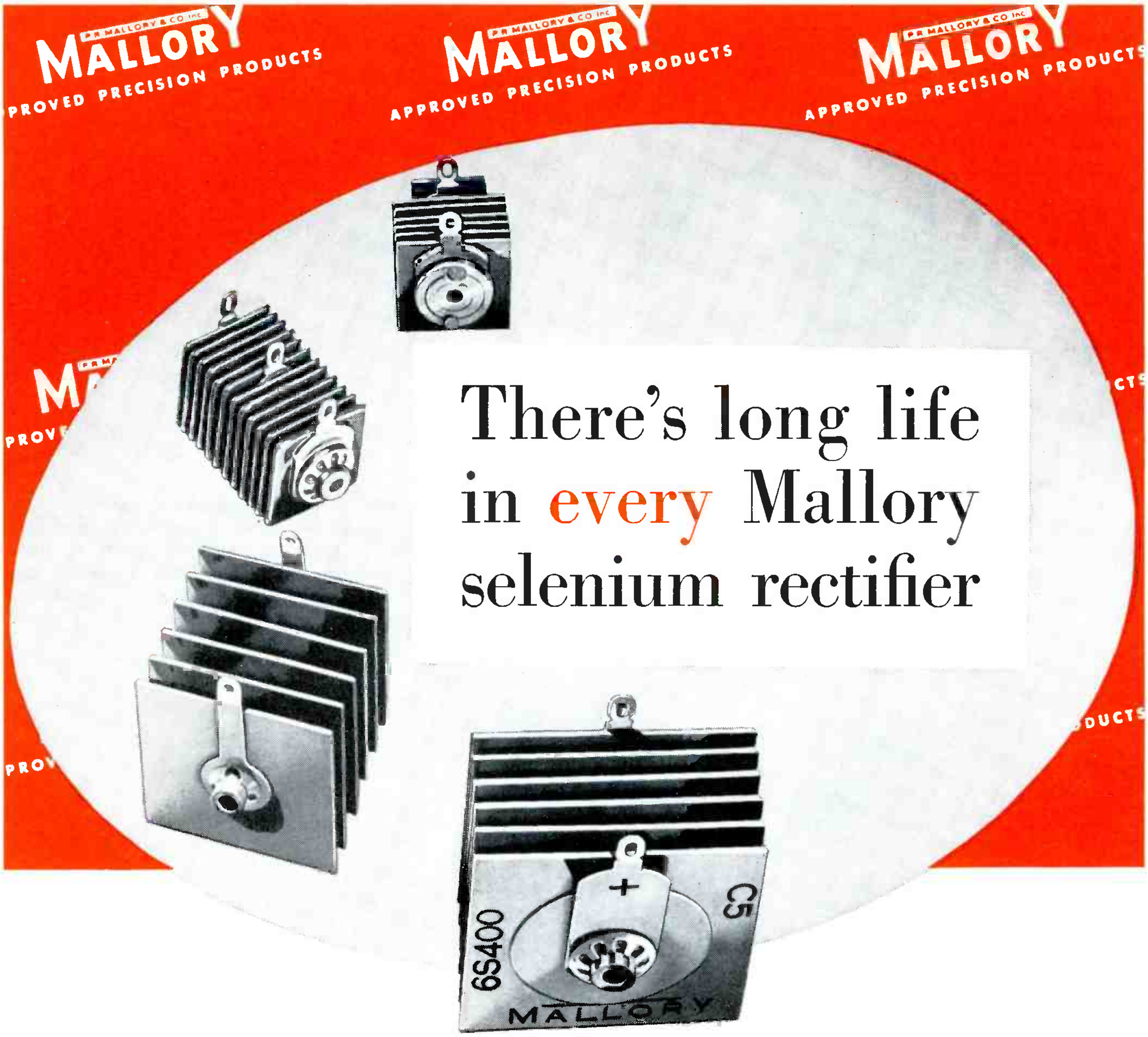


Photographs: Robert W. Reed



9. Two Interchangeable Tips.

An extension-tip assembly may be removed and retained for future use. Since the bent insertion ends of either tip would break off if they were straightened out for removal of the locking nuts, each tip should have its own set of locking nuts.



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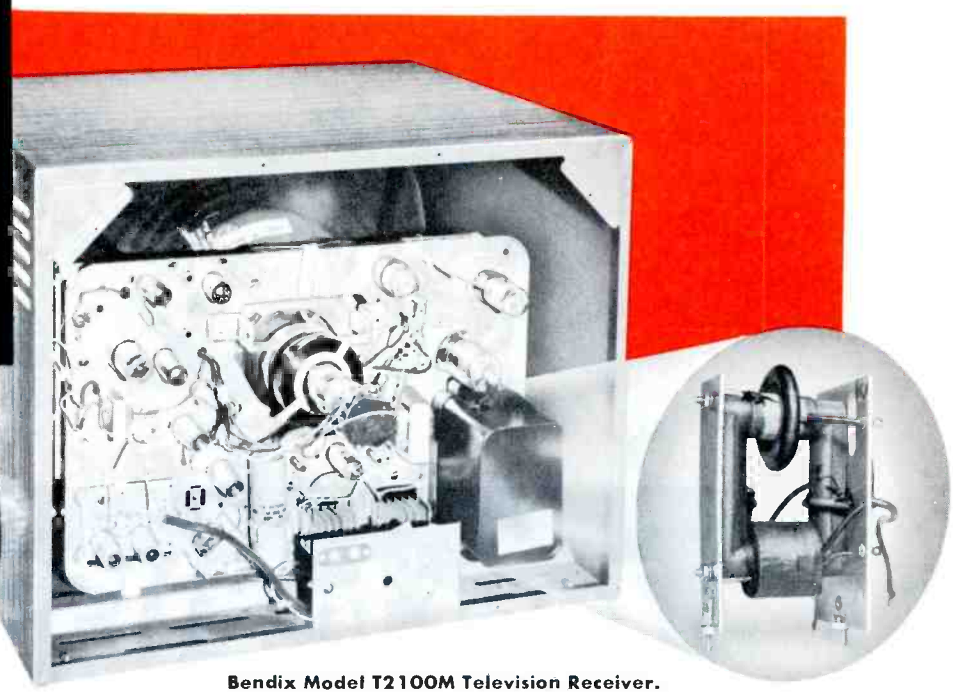
Examining DESIGN Features

by Leslie D. Deane



Bendix Model T2100M Television Receiver.

What's New in Flybacks?

Horizontal-output and high-voltage transformers employed in the latest television receivers continue to increase in efficiency and to change in design. Ever since the development of the 90-degree picture tube, the horizontal-output and high-voltage circuit has been called upon to produce more and more high-voltage and sweep output. This condition has brought about the need for an increased efficiency in the flyback transformer itself.

The high voltage required to operate many of the 90-degree picture tubes is approximately 18,000 volts, but the smaller 70-degree tubes may require an average of only 14,000 volts. In addition, the majority of newly developed picture tubes utilize electrostatic focus which often requires a DC potential of approximately 500 volts on the focusing anode. Fortunately, the boost voltage that can now be obtained from a well-designed flyback circuit is sufficient for this purpose.

Fig. 1. Tube Socket for High-Voltage Rectifier Employed in Zenith Model X2220R Television Receiver.

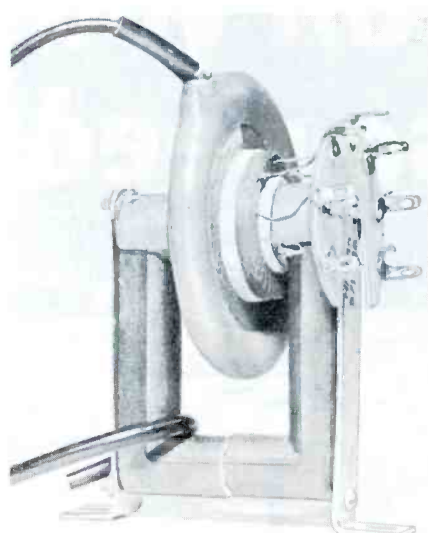


Fig. 2. Flyback Transformer Used in Setchell-Carlson Model P-61.

In their design of more efficient units, many manufacturers of flyback transformers have also found it necessary to improve the quality of insulation material used. This is a very important factor because poor quality material not only limits the operating voltages of the circuit but usually governs the life of the transformer. The tube socket of the high-voltage rectifier has always been constructed of an efficient insulating material to prevent arc-over and corona; however, many of the new receiver designs are now incorporating additional cuplike insulators which house the entire rectifier tube socket. An insulator of this type can be seen in the photograph of Fig. 1. The example shown is currently employed in the new Zenith television receivers.

There has been a definite trend toward the utilization of autoformer type windings in flyback transformers for the past two years. In general, autoformers are more efficient than transformers with isolated secondaries; and consequently, they are now being used in about 90 per cent of the newer designs. The compact design of the vertically mounted

* * Please turn to page 69 * *

Fig. 3. New Flyback Unit Currently Employed in the Sylvania Model 612MU Television Receiver.

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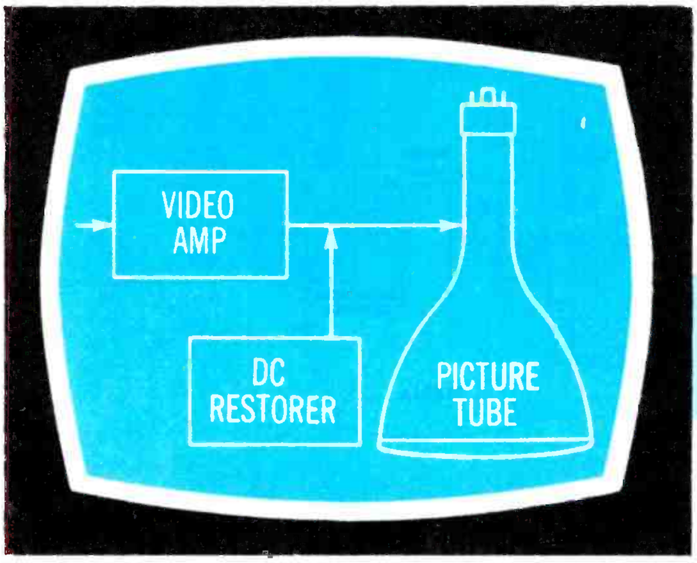

TROUBLES in VIDEO AMPLIFIERS, DC RESTORERS, and PICTURE TUBES

A Servicing Guide Arranged by Symptoms

by Leslie D. Deane and Calvin C. Young, Jr.

The stages in the video section of a TV receiver are the video amplifiers, DC restorer (if used), and the picture tube. A thorough understanding of the trouble symptoms which are usually associated with these stages is most helpful in locating and correcting troubles originating within the video section. Some of the more common of these symptoms are listed as follows:

1. Loss of picture, no snow.
2. Dim picture or lack of contrast.
3. Hum in picture.
4. Darkening of gray portions in picture.
5. A 4.5-mc beat in picture.
6. Negative picture.
7. Smeared picture.
8. Loss of picture detail.
9. Horizontal pulling in picture.
10. Ringing in picture.
11. Retrace lines visible.
12. No raster.
13. Loss of synchronization.
14. Intermittent picture.

Each of these common symptoms will be dealt with individually; and wherever possible, a photograph of the picture tube displaying the symptom will be shown. As a basis for reference, a normal test pattern is shown in Fig. 1.

GENERAL DISCUSSION

As a preliminary to the discussions about the individual trouble symptoms, this section will present a general procedure for isolating troubles to a certain stage or group of stages in the portion of the receiver under investigation. First, it is always a good practice to check all of the tubes in the suspected section or sections of the receiver. This check may be made by direct substitution of replacement tubes of known good quality or by the use of a high quality tube checker.

The second logical step is to clamp the AGC line to a DC level of approximately -3 volts. If the picture becomes normal when the AGC line is clamped, the trouble is in the AGC circuit. If the picture is not normal, check the waveform of the signal at the output of the video detector. The AGC line should remain clamped for this check. The polarity of the detector waveform will be determined by two factors: (1) the number of video-amplifier stages and (2) whether the grid or the cathode of the picture tube is driven.

As an illustration of this, the video sections of two different receivers are shown in the schematic diagrams of Figs. 2 and 3. In Fig. 2, two video amplifiers drive the grid of the picture tube; whereas in Fig. 3, only one video amplifier drives the cathode of the picture tube. These differences in the two designs account for the fact that the polarity of the signal across the video-detector load in one receiver is the same as that in the other receiver.

If the output waveform at the detector is satisfactory in the receiver being serviced, then it is known that the trouble is located in the video section. The grid signal of each amplifier should be checked for correct shape and amplitude by

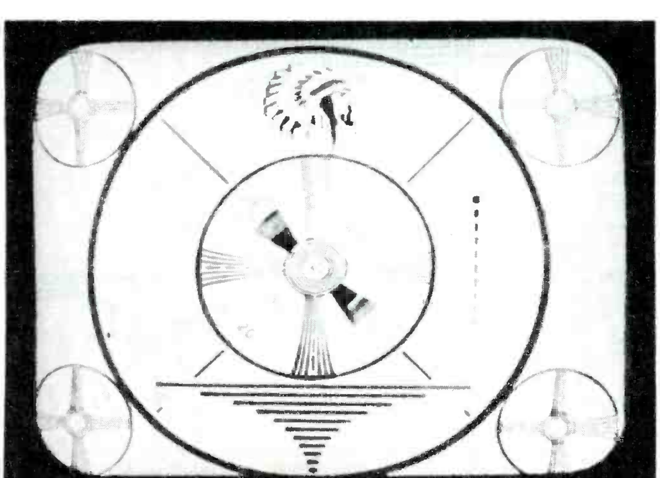

Fig. 1. Normal Test Pattern.

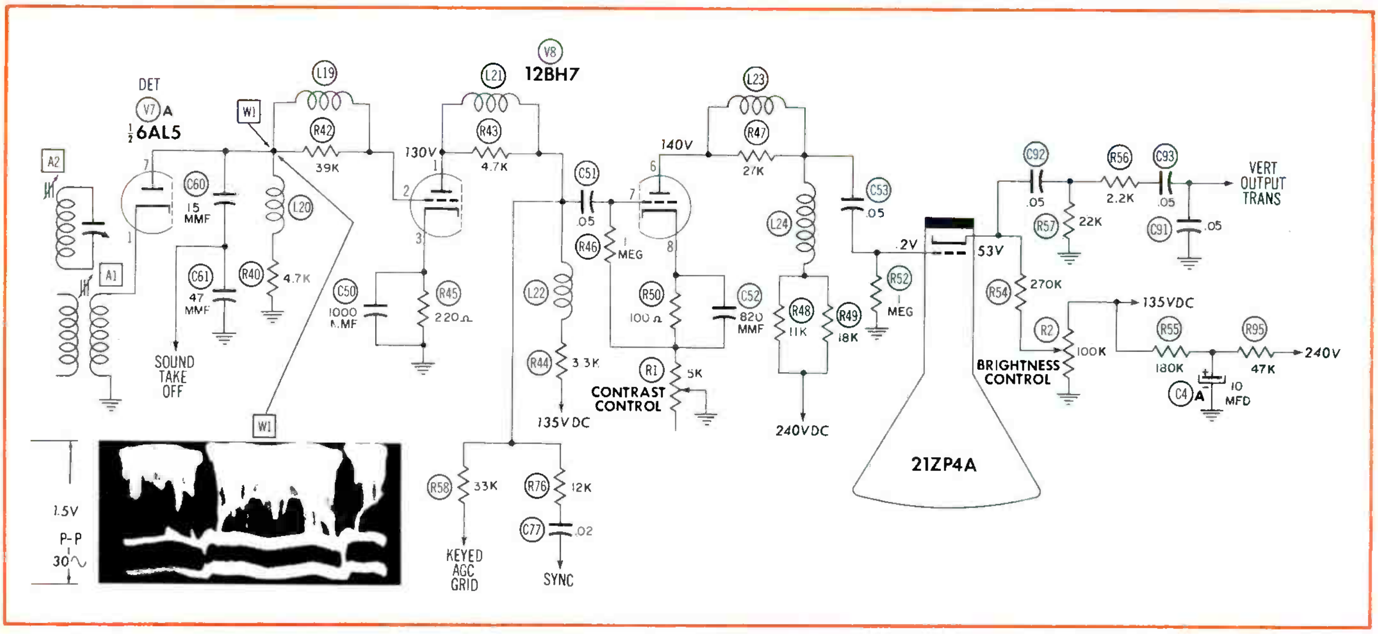

Fig. 2. Schematic Diagram of a Video Section Having Two Video Amplifiers.

means of an oscilloscope. If a grid signal is distorted, make voltage and resistance measurements in the preceding stage; also check the grid circuit in which the loss or distortion of the signal is observed.

In sets that employ a keyed AGC system, it is important for the AGC line to be clamped at the proper level during the entire trouble-shooting procedure in order to counteract the effects which video troubles can have on the development of the AGC voltage. All voltage and resistance checks should be made with a high quality instrument that will not load the circuit under investigation.

In addition to the circuits shown in Figs. 2 and 3, a typical DC restorer is presented in Fig. 4. Components in these circuits will be referred to from time to time in the discussions which follow.

Common Symptoms

1. Loss of Picture, No Snow.

Loss of picture results in the blank raster shown in Fig. 5. Notice that there is no snow nor noise symptoms in the raster. This condition is usually caused by an interruption of the video signal, and so no signal at all reaches the driven element of the picture tube.

Possible causes of loss of picture and no snow are as follows:

a. Failure of either the video amplifier or the video-output tube.

b. Failure of picture tube.

c. Open contrast control.

d. Open coupling capacitor. (See C51 or C53 in Fig. 2.)

e. Open plate-load resistor. (See R42 or R43 in Fig. 3.)

f. Open peaking coil. (See L22 or L24 in Fig. 2 and L17 in Fig. 3.)

g. Open cathode resistor. (See R45 or R50 in Fig. 2.)

In the process of trying to isolate a trouble, it can often be advantageous to observe the effect on the raster while the contrast, bright-

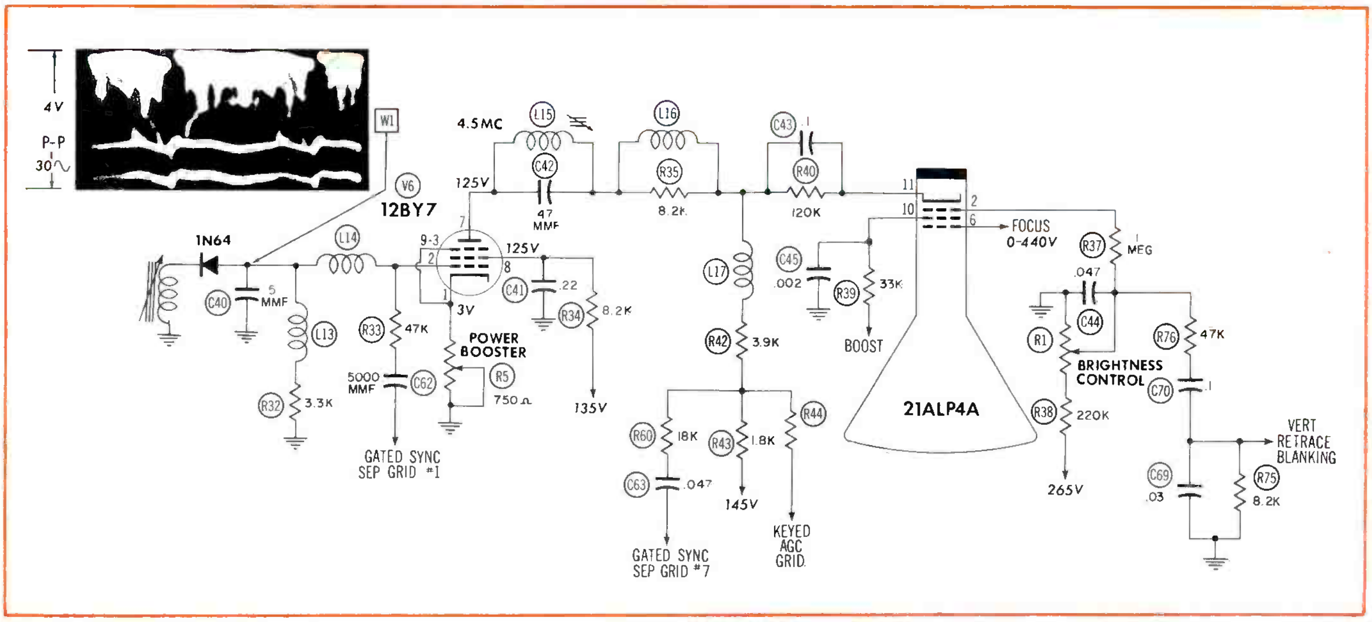

Fig. 3. Schematic Diagram of a Video Section Having One Video Amplifier.

ness, and AGC controls are being rotated through their ranges.

Complete failure of one of the tubes in the video section causes a complete loss of signal; and therefore, no signal will appear on the raster. Complete failure of a tube would probably be due to open elements, shorted elements, or total loss of emission from the cathode.

An open coupling capacitor in the video section would cause loss of the video signal; and usually, there would not be enough noise generated within the video section to show up as snow on the raster.

An open contrast control or cathode resistor has the same effect on the operation of an amplifier stage as an open cathode in the tube would have. When there is an open contrast control, the cathode voltage with respect to ground will be nearly the same as the plate voltage.

If a plate-load resistor or a series-peaking coil were open, there would be no B+ voltage applied to

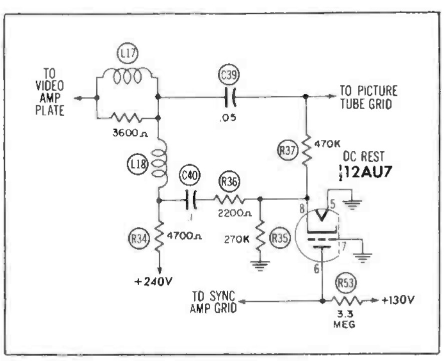

Fig. 4. Schematic Diagram of a DC Restorer Stage.

the plate of the stage. The stage would be inoperative, and no signal would reach the picture tube.

2. Dim Picture or Lack of Contrast.

A dim picture is caused by a weak signal being applied to the driven element of the picture tube. This symptom is illustrated in Fig. 6. Notice that there is also a lack of noise interference as well as an insufficient signal.

Possible causes of a dim picture or lack of contrast are:

a. Weak video-amplifier or video-output tube.

b. Defective picture tube.

c. Low plate or screen voltage on either the video-amplifier or the video-output tube.

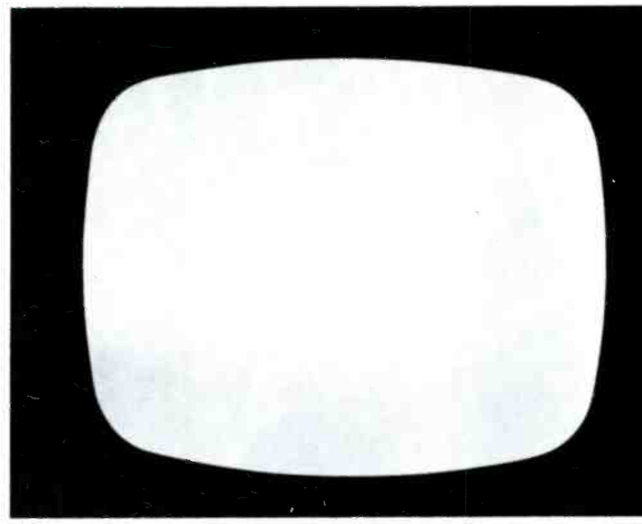

Fig. 5. Loss of Picture, No Snow.

d. Incorrect bias on either the video-amplifier or the video-output tube.

e. Incorrect bias on picture tube.

Weak tubes in the video section of a receiver can cause a picture of low contrast because weak tubes result in a reduction of gain. This means that a signal with a low peak-to-peak amplitude is applied to the driven element of the picture tube.

Low plate or screen voltage will cause a video amplifier to operate inefficiently; and as a result, there is a loss of over-all gain, and a picture that is low in contrast is produced. In fact, anything that lowers the effective gain of a stage in the video section can cause a picture low in contrast. Usually this reduced gain will not cause any snow to appear in the picture. NOTE: In low-signal areas, such reduction may cause the snow that is already present to become more noticeable.

3. Hum in Picture.

There are usually two types of hum that originate in the video section and affect the picture. These types are 60-cycle and 120-cycle hum, and the effects of each are illustrated in Figs. 7 and 8. Possible causes of hum in the picture are:

a. Heater-to-cathode leakage in the video-amplifier, video-output tube, or picture tube.

b. Open decoupling capacitor in the video section.

c. Excessive ripple in the B+ voltage.

Heater-to-cathode leakage in one of the tubes is the most common cause of 60-cycle hum; however, this type of hum may also be caused by a faulty decoupling network in the power supply. The latter trouble usually allows a vertical-sweep signal to be fed to the video section, and the picture will show symptoms of 60-cycle hum.

Hum of a 120-cycle nature is usually caused by failure of a filter unit in the power supply or by the failure of a B+ decoupling capacitor in the video section.

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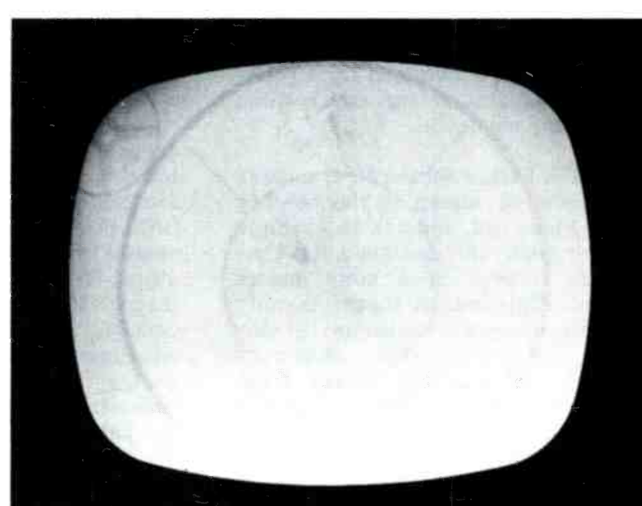

Fig. 6. Dim Picture or Lack of Contrast.

Audio-Facts

FISHER SERIES 80-C MASTER AUDIO CONTROL

by Robert B. Dunham

In observing the trends in the use and design of audio equipment, we can note that home music systems are being made more versatile. They are becoming more elaborate with more facilities being added in the form of equipment such as tuners, recorders, and tape-playback equipment. When equipment is added, it means that additional control circuits must be provided; consequently, we see this trend reflected in the design and development of the new models of preamplifiers and control units. Included in many of these new models are several features which were formerly associated with professional types of equipment. There are numerous inputs and outputs; and there are provisions for equalization and for selecting, controlling, and mixing channels.

The Fisher Series 80-C master audio control shown in the heading and in Figs. 1, 2, and 3 is an example of a versatile unit designed for convenient control of a home music system. This means that it is suitable for use with a simple or elaborate system. The numerous switches and controls on the front panel provide very flexible operation. Some idea of the facilities provided can be had by a little study of the illustrations. The number of controls on the front panel may make the setup appear complicated, but actual operation is not difficult. To describe and discuss the features of the Fisher Series 80-C, we will follow the schematic diagram shown in Fig. 4. Starting at the inputs, we can follow the signal through all the channels to find what happens in each stage.

Tape Input

The tape input is intended for the playback of magnetic tape. A tape-transport mechanism and a playback head are all that are required because this input is for direct connection to the playback head. The Series 80-C master audio control provides the necessary amplification and equalization of the audio signal from the playback head.

When the levers of the phono equalization switches (the high frequency roll-off switch M10 and the low-frequency crossover switch M11) are pushed down to their TAPE (or fifth) position, the tape input is connected to the grid (pin 7) of V1. The signal from the tape input is then fed through V1 to the phono mixer-level control R3. NARTB tape-playback equalization is provided by the feedback network which is connected between the junction of C12 and R3 and the cathode (pin 8) of V1. Most of the resistors and capacitors included in this feedback network are mounted on switches M10 and M11. See Fig. 2.

The setting of the phono mixer-level control R3 determines how much signal will be fed to the phono channel-selector switch M12. When the push button of the selector switch M12 is depressed, the signal path from the mixer-level control R3 will be completed to the grid (pin 2) of the amplifier tube V3A. Depressing the button of switch M12 also serves to light the pilot light for the phono channel.

Since the signals from all inputs are fed to the grid (pin 2) of V3A, we will return to the other inputs before discussing the stages that follow V3A.

Crystal-Cartridge Input

The crystal-cartridge input is to be used with crystal, ceramic, FM, or other constant-amplitude types of phono cartridges. Note that this input is connected through a 100-mmfd capacitor C6 to the same terminal on switch M10 as the magnetic-cartridge input. Because of this arrangement, the crystal-cartridge input makes use of the same equalization that is used for magnetic cartridges.

Magnetic-Cartridge Input

The magnetic-cartridge input accommodates magnetic phono cartridges such as General Electric, Pickering, Audak, and Fairchild.

Since this input and crystal-cartridge input are connected to the same terminal on switch M10, both inputs cannot be used at the same time. Note also that the phono inputs are open when the high-frequency roll-off switch M10 is in its TAPE (or fifth) position.

When M10 is in any one of the first four positions, the signal from either of the phono-input jacks is fed to the grid (pin 7) of V1. It is amplified and equalized in the two preamplifier stages of V1 and then fed to the phono mixer-level control R3. From that point, the signal is fed to the grid (pin 2) of V3A in the same manner described under the heading of "Tape Input."

Suitable high-frequency roll-off is achieved by moving the lever of the high-frequency roll-off switch M10 to the desired position. This switches appropriate capacitors into the feedback circuit to roll off the high frequencies the proper amount.

Low-frequency crossover is selected by moving the lever of the low-frequency crossover switch M11 which switches combinations of resistors and capacitors in the feedback circuit in order to vary the crossover frequency.

Microphone Input

The microphone input will accommodate most dynamic, crystal, and ribbon microphones. It is a high-impedance (18 megohms) input; therefore, a matching transformer must be employed if a low-impedance microphone is used. V2A operates as a preamplifier and has enough gain for satisfactory operation of low-output microphones.

When the button of the microphone channel-selector switch M13 is depressed, the signal is fed from the microphone mixer-level control R4 to the grid (pin 2) of V3A. Switch M13 also lights the pilot light for the microphone channel.

Auxiliary-1, Auxiliary-2, and Tuner Inputs

The auxiliary-1, auxiliary-2, and tuner inputs are identical inasmuch as they are high-level and high-impedance inputs. These characteristics make them suitable for use with signals from sources such as tape recorders, TV sound, and radio receivers.

Each has its own mixer-level control, channel, and channel-selector switch. They differ in that the auxiliary-1 and the tuner inputs each have an AC receptacle controlled by its channel-selector switch. The output of a recorder, for example, can be connected to the auxiliary-1 input; and its AC cord can be plugged into the auxiliary-1 AC receptacle. With this arrangement, no AC voltage will be applied to the recorder until the auxiliary-1 channel-selector switch is depressed. The same automatic ON-OFF feature can be accomplished with a tuner connected to the tuner input and tuner AC receptacle.

Any or all of the five channel-selector switches can be depressed at any one time. Their action is conventional for this type of multiple

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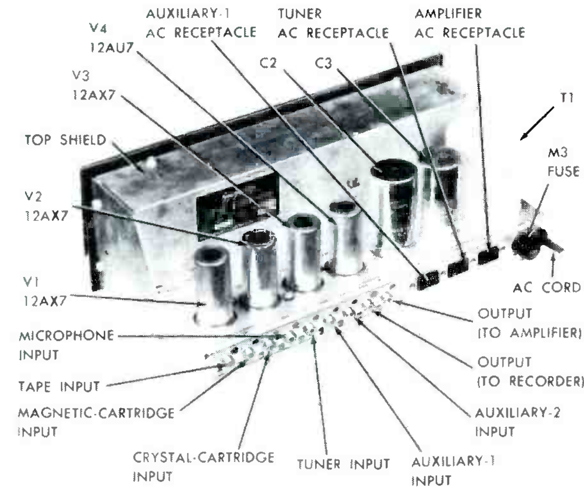


Fig. 1. Rear View of Fisher Series 80-C Master Audio Control.

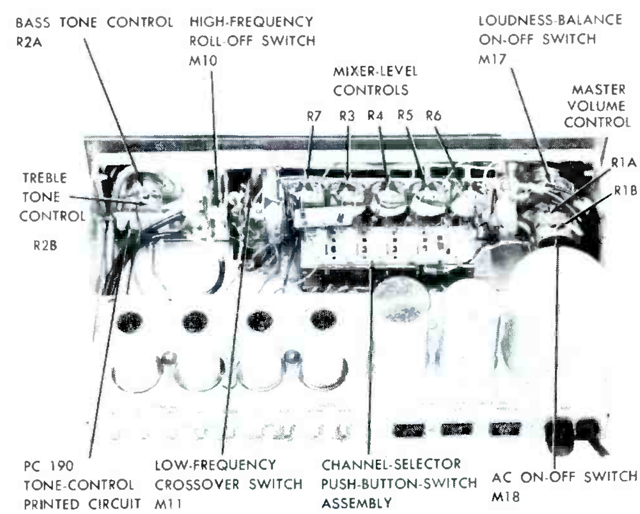


Fig. 2. Rear View of Fisher Series 80-C with Shield Removed

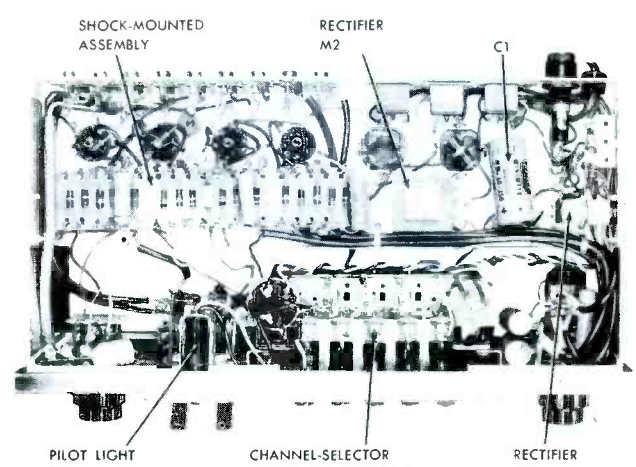


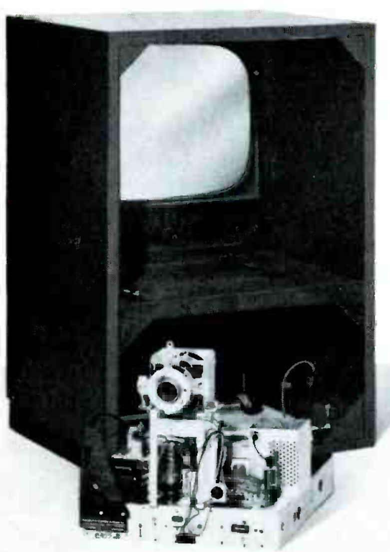
Fig. 3. Bottom View of Fisher Series 80-C.

She: *But, how do I know this is a good tube?*

You: *Because, this is a CBS aluminized Mirror-Back picture tube. There aren't any better.*

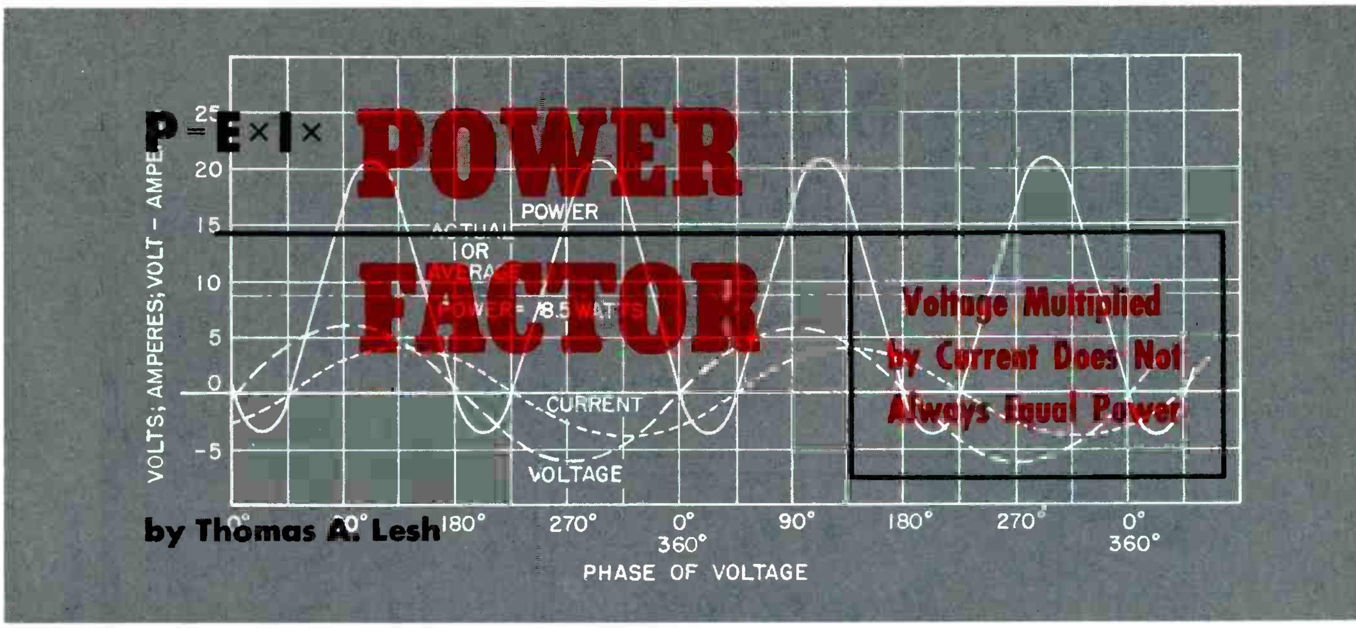
She: *And I see it has the Good Housekeeping Guaranty Seal, too. That's proof enough for me.*

Customer confidence really counts when it comes to the big tube. That's when CBS tube advertising helps you most. For CBS tubes have the Good Housekeeping Guaranty Seal and are nationally advertised to 76.9% of your customers . . . the women of America. And 53% of these women are influenced in their purchases by that seal of approval. You protect yourself and gain your customer's good will when you install a new CBS aluminized Mirror-Back picture tube.



Show her the CBS carton with the Good Housekeeping Guaranty Seal.

CBS-HYTRON, Danvers, Massachusetts . . . A DIVISION OF COLUMBIA BROADCASTING SYSTEM, INC.



POWER FACTOR

Voltage Multiplied by Current Does Not Always Equal Power

by Thomas A. Lesh

Without an understanding of power factor, the technician might be led to doubt the accuracy of his test equipment when he measures power consumption in an AC circuit. If he tries to check a wattmeter reading against the product of a voltmeter reading times an ammeter reading, he may find that the wattmeter reading is in some cases lower.

The reason for this difference is that reactive components (inductors and capacitors) in an AC circuit will store power rather than consume it. Although this stored power is not expended, it still requires current from the AC supply line. If an ammeter is inserted in series with the supply line, it will register both the current which produces the stored power and the current which produces the expended power. A wattmeter, on the other hand, will measure only the power which is dissipated or expended in the load. The way in which a wattmeter is capable of doing this will be discussed later in this article. It is sufficient to state at this time that the reading on a wattmeter is actually equal to the product of voltage times current multiplied by a percentage figure called the "power factor." Stated in equation form, this relationship is:

$$P = EI \times p.f. \qquad (1)$$

where

P = actual power in watts,

E = applied voltage in volts,

I = total current in amperes,

p.f. = power factor.

A percentage of the total current in any given circuit is in phase with the applied voltage. This percentage figure is the power factor, and the inphase current is that which furnishes the true power in the circuit. Since the nature of the current through a circuit depends upon the nature of the total impedance, it can also be said that a percentage of the total impedance is resistive and that this percentage will be equal to the power factor.

For example, the circuit in Fig. 1 has a total impedance which can be expressed by the following equation:

$$Z = \sqrt{R^2 + X_L^2} \qquad (2)$$

$$= \sqrt{300^2 + 400^2} = \sqrt{250,000}$$

$$= 500 \text{ ohms},$$

where

Z = total impedance,

R = resistance,

X_L = inductive reactance.

Since the resistance is 300 ohms and the total impedance is 500 ohms, the power factor of the circuit in Fig. 1 is:

$$p.f. = \frac{300}{500} \times 100\% = 60\%.$$

Reactance may be either inductive or capacitive. If the two kinds are both present in a circuit, their opposing effects tend to cancel each other in such a way that the total impedance of the circuit becomes largely resistive in nature. On the other hand, if the reactance is chiefly of one kind, there will be reactive or stored power in the circuit. Under the latter condition, the circuit has a relatively low power factor and only a small part of the power fed to the circuit is consumed by the circuit.

The amount of power which is consumed by radio and TV sets is relatively small, and the difference between a wattmeter reading and the product of voltage and current values is slight. Low power factor is of much greater concern to utility companies and to factories which use thousands of kilowatts of electricity monthly.

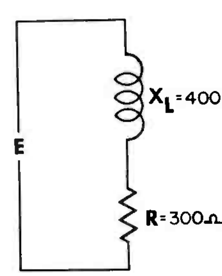
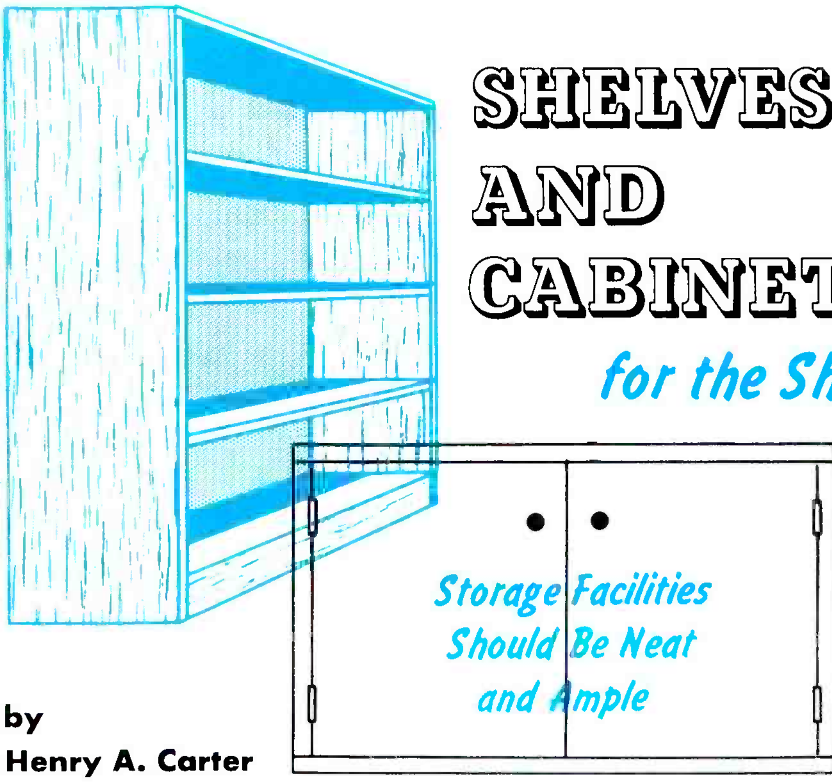


Fig. 1. Sample Circuit With a Power Factor of 60 Per Cent.

One piece of electrical equipment which has a low power factor is the induction motor. A considerable amount of inductive current is developed in this type of motor. If many large motors are operated from one power-distribution system, more than one fourth of the current in the system may be inductive current which is fed back and dissipated in the power lines and generators.

* * Please turn to page 76 * *



SHELVES AND CABINETS

for the Shop

Storage Facilities Should Be Neat and Ample

by
Henry A. Carter

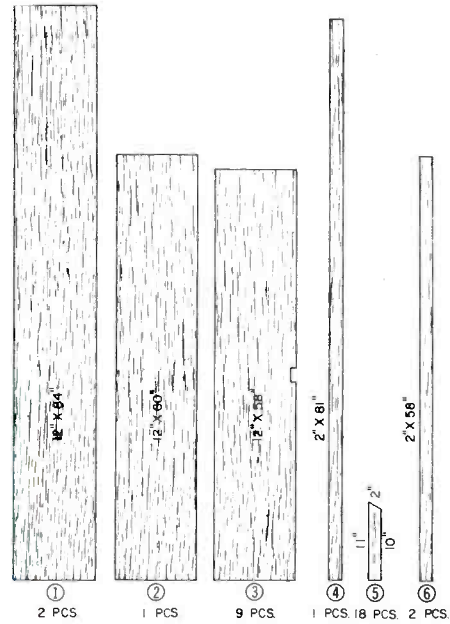


Fig. 2. Outlines of Parts for Shelves in Fig. 1.

Efficiency in a radio or television service shop is dependent upon a combination of many factors. Probably one of the most important is having a place for everything and keeping everything in its place. For maximum efficiency, the parts should be kept in some systematic order. To do this, you need the proper shelves and cabinets. Too much valuable time can be spent in looking for a capacitor in a "grab box" into which everything is thrown together. How very much simpler it would be to open a cabinet in which all the capacitors were sorted and placed in separate compartments according to value.

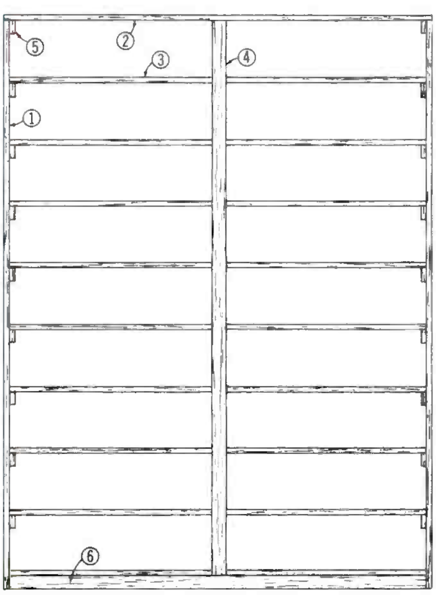


Fig. 1. Sketch of Shelves for Storage of Parts and Radios.

Not only does a neat and orderly arrangement make it easier to locate the components when they are needed, but it has the added convenience of making it easy to estimate the stock at a glance to determine when it is getting low on a particular item.

MATERIAL LIST

Pieces: Part No.	Pieces: Quantity	Dimensions (inches)	Remarks
1	2	1 x 12 x 84	Ends
2	1	1 x 12 x 60	Top shelf
3	9	1 x 12 x 58	Intermediate shelves
4	1	1 x 2 x 81	Center uprights
5	18	1 x 2 x 11	Cleats to be cut at an angle on one end
6	2	1 x 2 x 58	Base rails
-	2	1/4 x 48 x 60	Plywood or tempered Masonite for back
-	1 (gross)	1 1/4	No. 8 wood screws with flat heads

Many manufacturers of small parts are helping the service shops by making available small cabinets in which resistors, capacitors, and other small components may be kept in neat order. These cabinets are free if you buy the parts in large quantities. In addition to getting the cabinet free when buying components in quantity, the prices of the parts are usually lower and money can be saved.

An alternative for the shop owner who does not wish to purchase parts in quantity is that he may purchase ready-made parts cabinets with drawers containing several compartments. These cabinets are very good, especially the ones having label spaces on each compartment and having adjustable dividers.

Although ready-made steel shelves and cabinets are by far the best from the standpoint of durability and easy cleaning, the price is sometimes prohibitive for the small-shop owner who is just starting in business. If time is pressing and you have to pay a workman hourly wages to construct wood shelves and cabi-

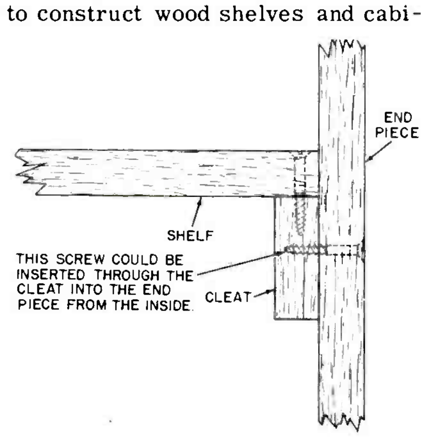


Fig. 3. Shelf and Cleat Attached to the End Piece.

Fig. 4. Typical Homemade Shelves.

Fig. 5. Storage Rack for Chassis.

nets, then it might be advantageous to use steel shelves because they have the advantage of easy and rapid erection. If there is no hurry, the owner can construct wood shelves in his leisure time and have some very good shelves at a reasonable savings.

Planning the Shelves

The most important step with regard to shelves is the planning. The first consideration should concern the items that are to be kept on them. This is necessary in order to determine the depth of the shelves and the spacing between them. The second should concern the space in which they are to be placed so that there would be no danger of making them the wrong size for the space available.

Once the width, depth, and spacing between the shelves are known, it is a good idea to make some kind of sketch to prevent mistakes in dimensions while materials are being figured. The sketch will be the most effective if it is drawn to some specific scale and if it is fairly neat. A sloppy sketch may very well lead to errors that would not be noticed until too late. It is therefore recommended that the drawing be made somewhat like that shown in Fig. 1. This was drawn to scale on graph paper.

After the front view of the sketch is drawn, it is sometimes a good idea to make an outline drawing of the shape and size of each piece to be used. For instance, the rack shown in Fig. 1 may be represented by the drawings in Fig. 2. Notice that the pieces have been numbered so that they would correspond in both figures and in the material list.

Most lumber yards will cut the wood to size for you at very little extra cost. This will make the job much simpler because all that is necessary then is notching the intermediate shelves for the center uprights and assembling the shelving.

Screws should be used instead of nails in the construction. Nails will loosen and make the whole unit wobbly, but screws will keep it rigid. When screws are used, it is necessary to drill pilot holes for them. The drawing in Fig. 3 shows how a cleat is fastened to the end piece and how the shelf is fastened to the cleat. Note that the screws are countersunk.

The photograph in Fig. 4 shows a typical set of shelves built by this construction method. This set was made for storing test instruments when not in use. You will notice that the center uprights were not employed in this rack of shelves. The reason for this was that the shelves were not long enough to warrant the use of center uprights. The spacings between these shelves are 12, 14 1/2, 17 1/2, and 17 1/2 inches, respectively, from top to bottom. The different spacings make these shelves adaptable to many different instruments of various sizes.

(Note the fire extinguisher hanging on the end of the rack. This is a necessary piece of equipment in any shop. It should be of the CO_2 type for electrical fires.)

The back of this particular set of shelves is covered with 1/4-inch Masonite. After completion, the whole assembly was sanded and painted with a good durable paint to preserve the wood and to improve the appearance.

The photograph in Fig. 5 shows a set of shelves that was constructed for the explicit purpose of storing television chassis before they are serviced or delivered. Note that the shelves are spaced far enough apart so that most picture tubes could be placed on end. (The tube should be protected by a soft cloth or by padding underneath the face.) This set of shelves was constructed almost entirely of two-by-fours and 3/4-inch plywood. The two-by-fours were assembled with 1/4-inch bolts that were 3 1/2 inches long; these are known as carriage bolts. They have round heads with square shoulders under the heads, and the shoulders embed themselves into the wood as the nuts are tightened. This action prevents the bolt from turning while the nut is being tightened or loosened. The plywood shelves were covered with 1/4-inch tempered Masonite which will protect the plywood so that it will last much longer. The Masonite can be replaced when it becomes badly worn.

Remember that the more planning and care put into any construction of this sort, the more useful and the better looking it will be. It will always be something you can be proud of, if it is done well.

HENRY A. CARTER

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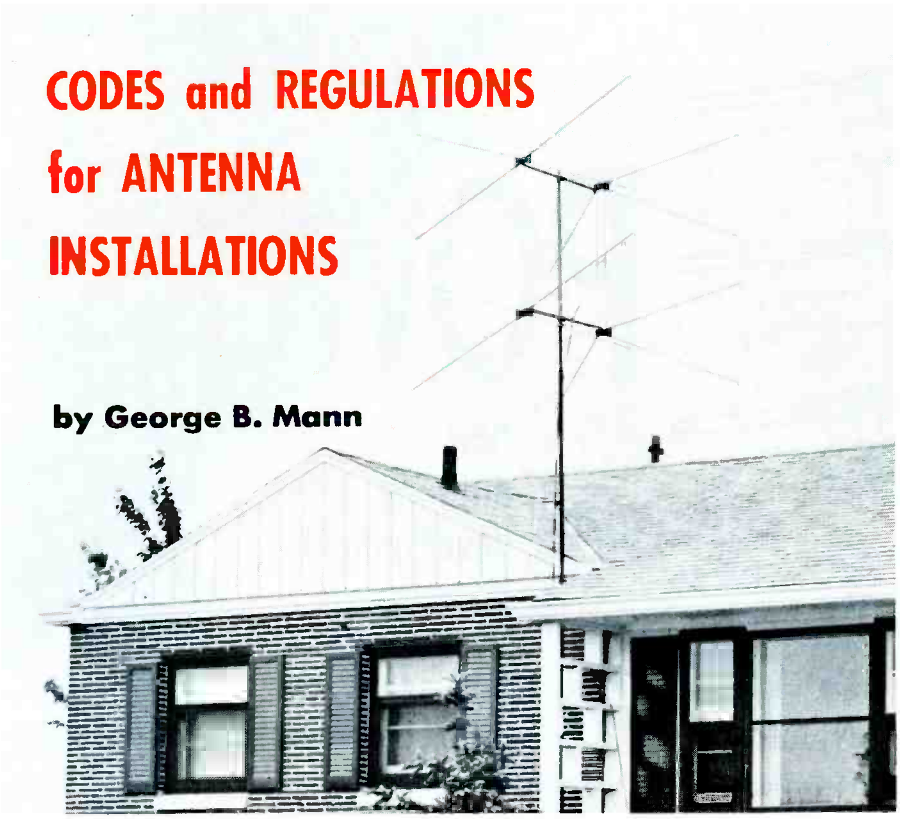
CODES and REGULATIONS for ANTENNA INSTALLATIONS

by George B. Mann



Many regulations governing the installation and maintenance of television antennas are in effect in different parts of the country. Most of these regulations have come into existence as a means of protecting the lives and property of individuals. An antenna structure can present a potential hazard to persons and property. This is particularly true of those antennas which have been improperly installed because they are more susceptible to mechanical failure which causes them to be weakened or to topple over during a storm or high wind. For this reason, antenna technicians should make installations which are reasonably free from hazard and which conform to the regulations that exist in their localities.

Codes and regulations help technicians to know how to make proper installations so that there will be more structures free from hazard. Some of the codes and regulations that exist in various cities are introduced in this article.

For more specific information about codes or regulations in a certain locality, it is advisable to contact your building commission or the office of the city clerk. The regulations pertaining to wiring and lightning protection can be found in the National Electrical Code. Local regulations and special information about equipment and wiring methods can usually be obtained from the electrical inspector in your community.

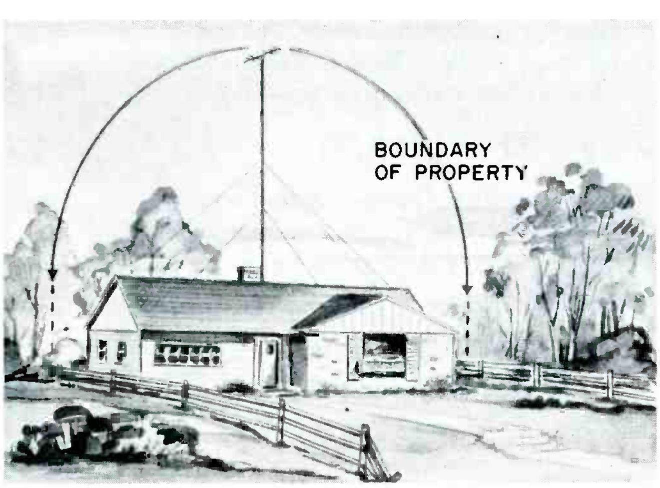


Fig. 1. Height of Mast and Antenna Should Not Exceed Horizontal Distance From Base of Mast to Property Boundary.

The following discussion will present explanations of methods which have been adopted in part by various cities and groups in the country. By employing methods such as these, the technician will be able to install antenna structures that are reasonably free from hazard.

Antenna Mast

Construction

The mast or the supporting structure for the receiving antenna should be mechanically sound and be constructed of a weatherproof metal. When a mast of wood is used to support an antenna, the wood should be impregnated with a weather-proofing substance. In some localities, a wood mast should not be installed upon any roof. If a wood mast is to be used, it must be a pole which is treated with a wood preservative and must be installed with its base in or on the ground.

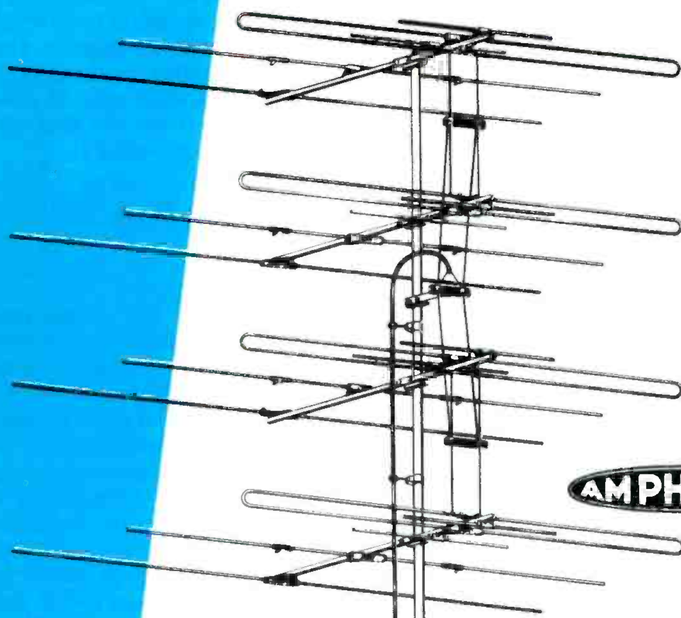
Any antenna mast mounted either on the ground or upon a building should be installed in such a position that if it is toppled or blown over it will not touch or come in contact with public telephone, electric, or utility distribution lines. This stipulation does not apply in the case of service drops to the building. Service drops are the overhead service conductors between the last pole or other aerial support and the first point of attachment to the building. The antenna mast should not be mounted closer to the boundary of the premises than its height (including that of the antenna) above its own mounting base. See Fig. 1.

In those cases in which it becomes necessary to install an antenna mast near a utility line or near other property which must be protected, a safety line should be attached near the top of the mast below the antenna. This safety line should be secured to an anchor point away from the utility line or other property to be protected. See Fig. 2. If guy wires are used to support the mast, the safety wire should be in addition to these and should be secured to a separate anchor point.

Mounting

A mast which is installed on the roof of a building should be mounted on a separate base of waterproof, noncombustible material. The mounting base should be of reasonably large dimensions so that the weight of the mast and antenna will be evenly distributed over a large area. A

* * Please turn to page 82 * *



POWERAY

AMPHENOL

new antenna development

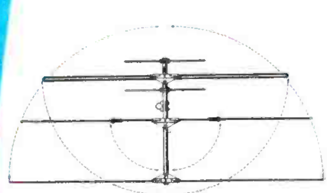
114-096
Four Bay
List 69.75

new FRINGE AREA antenna features revolutionary SLEEVE DIPOLE principle

The reason for the outstanding performance of the new AMPHENOL VHF POWERAY is a new design variation of the sleeve dipole principle. The POWERAY provides better pictures in fringe and deep-fringe areas because *only this new design* properly balances the three important reception factors: high gain, directivity and *exact impedance match* between antenna, lead-in and TV set.

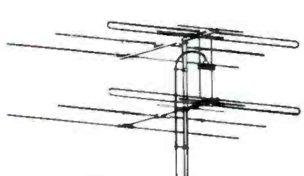
new PRINCIPLE: how it works

The sleeve dipole principle of the POWERAY is based upon resonance of the overall length at a low frequency and resonance of a 3-wire transmission line section at a higher frequency. The result is ideal broadband performance and *proper balance* of very high gain, sharp directivity and exact impedance match.



PREASSEMBLED

The POWERAY is preassembled for less installer-time on the job. All long elements swing out and are held securely in place with a new, positive spring-locking device. The two and four bay models in which the POWERAY is available are quickly connected with one piece stacking harnesses.



114-095
Two Bay
List 34.75

performance proves SUPERIORITY

The POWERAY'S superior design is proved by its superior performance. *Try* the POWERAY for fringe area reception—and *see* for yourself why the POWERAY is the finest antenna ever built for fringe areas!

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Dollar and Sense Servicing

by *John Markus*

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

SIGNS. Plastered on the walls of many IBM factories and offices is the company's motto: THINK. For the last year or so, it has become a fad in other firms to put up such variations of this motto as: THINK OR THWIM. And now comes one that may end the whole game:

TH~~IN~~K

WOIK

LET THE BOSS DO THE THINKING!

NETWORKS. All states except Montana and Idaho now have network TV. These two states do, however, have independent TV stations; consequently, every state in the union now has at least one TV station.

A trip across our country by train or car today gives a dramatic picture of how TV has invaded American life. Antennas sprout from rooftops of practically every farm and home, no matter how isolated. Even the adobe Indian homes at San Ildefonso pueblo in New Mexico now have electricity and TV, much to our disappointment during this summer's vacation in the Southwest. Tall guyed masts anchored to the clay-covered roof logs and branches hold aloft high-gain arrays that bring the white man's entertainment to Indians who enjoy glass in windows, baby-blue pickup trucks, and the many other comforts of civilization while still seriously observing the ancient ceremonials and taboos. Even the famous Hopi snake dance is still performed according to ancient ritual (six rattlesnakes were among the dozens of other types wriggling viciously while held in the mouths of dancers this year). There was no TV among the Navajos, however; they still prefer to be alone in their family hogans, miles from neighbors and power lines.

SMASHING. It is reported that one tube manufacturer is offering 5 cents in credit to service technicians for each tube turned in to its distributors. The old tube is smashed immediately, in the presence of the service technician, to ensure that it cannot get into the hands of racketeers who might clean and rebrand it for resale.

This brings up the need for a silent and efficient tube-smashing machine that automatically collects all the pieces yet permits clear visibility of the smashing action. A fellow gets pretty tired swinging a hammer all day long in between filling orders. Besides, it's a nuisance picking glass and bits of grid wire out of your teeth just because ''smashed with a smile'' is the order of the day; and not all people like the sound of a smashing tube. Wonder how tubes sound going through a garbage disposal unit?

BASEBALL. The trouble with lagging attendance at ball games is not TV but the game itself, according to a recent survey. Chief complaints of fans deal with the difficulty in getting to ball parks, parking troubles after they get there, high admission prices, poor service on tickets, and slow games. As for TV itself, about half the fans think that the length and content of its ball-game commercials are all right as they are, and over half stated that TV had increased their interest in baseball. The survey was initiated by Baseball Commissioner Ford Frick.

HOSPITALIZATION. Father is in a hospital bed, is completely swathed in bandages, and has one leg trussed up high in the air. Mother and son, in for a visit, try to cheer him up with these words: ''The reception has been fine since you fixed the aerial.'' — Another Electrical Merchandising cartoon.

DEMISE. RCA Victor has announced that it will stop producing 78-rpm records next year because the popularity of 45's has made 78's unprofitable. Trade predictions are that this is the beginning of a trend that will be industry-wide by the fall of next year. Hang onto those 78's — they'll be collectors' items in another 25 years.

CHARITY. Painless payroll deduction to cover all charitable organizations has been proposed by the employees' association of Daystrom's Pennsylvania plant. Analysis of contributions by employees over the past three years indicated that a deduction of 1/4 of one per cent of straight 40-hour earnings (20¢ a week for $80-a-week salary). would take care of Red Cross, Community Chest, Heart, Polio, Muscular Dystrophy, Cancer, and Diabetes funds with enough left over for the $1 annual membership fee in this employee association. To eliminate double contributions, a membership card is issued for presentation when solicited at home or elsewhere. Service technicians in large shops might also consider this plan for its all-round fairness and convenience.

* * Please turn to page 65 * *

Notes On TEST EQUIPMENT

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

by Paul C. Smith

Shades of Barney Oldfield or Let Up on That Sweep Control, Pop, There's a Cop Around the Corner!

In this speed-conscious age, when stock cars have speedometers that will register 150 miles per hour (although the cars may not be able to travel that fast) and some airplanes can travel faster than sound, it may be somewhat of a surprise to the technician to learn that he has something on his test bench capable of exceeding these speeds many times over.

We refer to the beam of the oscilloscope as it sweeps across the screen of the tube. For example, let us consider a 5-inch oscilloscope with horizontal amplifiers capable of expanding the sawtooth sweep to six times the screen width, or 30 inches.

The frequency range of the sawtooth sweep extends to an upper limit of about 30 kilocycles. At any frequency which we may select within the range, a fraction of each cycle is taken up by the retrace or flyback of the sweep. This fraction will vary, being larger at the higher sweep rates and smaller at the lower sweep rates. If we choose a moderate sweep rate between 10,000 and 15,000 cycles per second, the time lost during retrace is probably less than 1/10 of a cycle; and we can choose a rate such that the remaining part of the sweep will take 1/10,000 second.

This means that during the active part of the sweep, the beam travels 30 inches in 1/10,000 second; or in other words, at the rate of 300,000 inches per second. We multiply this rate by 3,600 to obtain the rate in inches per hour. Then we divide that answer by 12 x 5280 to obtain miles per hour. Our calculations look like this:

$$\frac{300{,}000 \times 3600}{12 \times 5280} = 17{,}045 \text{ mph.}$$

Stupendous speed, isn't it? In fact, one might almost say astronomical. By a strange coincidence, this is not far from the speed which has been calculated as necessary to maintain a satellite in an orbit about the earth.

Any comparison between the two cases (satellite and electron beam) must end there, however, because the mass and inertia of the moving oscilloscope beam is practically zero, even at such high speeds. This fact enables the beam to change direction instantly so that it can trace such waveforms as that of a square wave and can still maintain a constant rate in a horizontal direction across the face of the tube.

Yes, that little electron beam is capable of enormous speeds. The next time the urge for speed overwhelms you, we suggest that you park your car in the garage and take the controls of ye olde faithful oscilloscope.

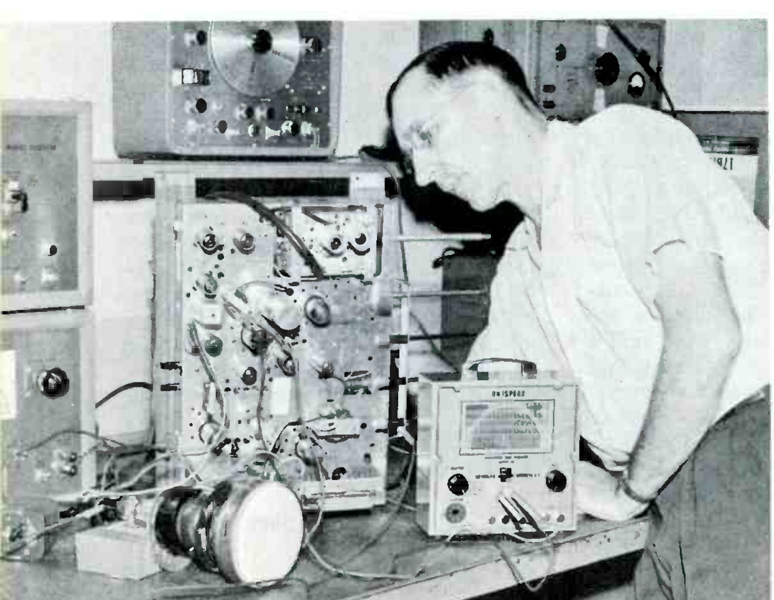

Fig. 1. Authorized UNISPEAK Being Used in Place of the Regular Speaker System of a TV Receiver. Connection Has Been Made from the Output Transformer in the Receiver to the Voice-Coil Jacks on the UNISPEAK.

Authorized Model 401 UNISPEAK

The Authorized Model 401 UNISPEAK is a universal test speaker designed to eliminate the inconvenience of pulling a speaker from the cabinet when a TV chassis is removed to the shop. A picture of the author using this instrument is shown in Fig. 1.

In order to cope with any speaker system that the technician is likely to find, the Model 401 includes an internal speaker, a universal output transformer, and a field choke with a variable resistor which controls the choke current. All the circuit elements of the instrument are available through pin jacks on the front panel. These pin jacks are identified on the front panel by simple schematic diagrams showing the internal connection to each jack. This interesting and convenient feature can be seen in Fig. 2 which is a close-up photograph of a portion of the front panel. In addition to the pin jacks, an octal adapter socket with connections to each element is mounted on the panel. To suit his own particular needs, the technician can make up an adapter cable for this socket.

As a matter of curiosity, we made a small survey to get some idea of the speaker requirements that might arise when a TV chassis is removed to the shop. The investigation revealed that a majority of receivers have the sound-output transformer mounted on the chassis and have leads going to the voice coil of a speaker (or speakers) mounted in the cabinet. In a group of 16 receivers checked, 13 different manufacturers were represented. There were 13 of the receivers with speaker systems mounted in the manner just described. Another receiver used an electrodynamic speaker with the field coil used as a choke. Each of the remaining two receivers had the speaker mounted on the chassis so that the speaker system was left intact when the chassis was removed from the cabinet. These last two examples were both produced by the same manufacturer.

A number of these receivers incorporated two, or even three speakers. The advantages of a unit such as the Model 401 UNISPEAK in such cases is obvious because no technician would wish to drag a three-way speaker system to his shop in order to keep the sound system of the receiver complete.

Connections can be made to the primary winding of the output transformer, to the secondary winding, to the voice coil of the internal speaker, to the choke alone, and to the choke in series with the current-controlling resistor. The output transformer has a center-tapped primary so that either single-ended or push-pull output systems can be accommodated.

The size of the instrument is 8 by 8 by 3 1/2 inches.

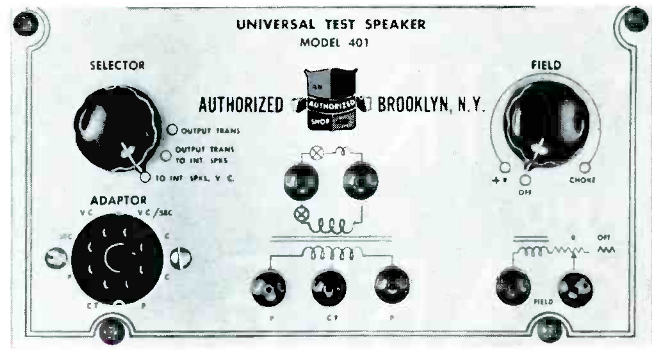

Fig. 2. Front Panel of the Authorized Model 401 UNISPEAK.

Precision Series CR-30 Cathode-Ray Tube Tester

Precision Apparatus Company, Inc., Glendale, L.I., New York, manufactures the Series CR-30 cathode-ray tube tester shown in Fig. 3. This

Fig. 3. Precision Series CR-30 Cathode-Ray Tube Tester.

tester is designed to check all modern cathode-ray tubes including electrostatic and electromagnetic TV picture tubes and oscilloscope tubes. Additional filament voltages are provided in anticipation of future developments in the design of cathode-ray tubes.

By using true beam current, the instrument provides for a test of proportionate screen brightness. It also provides for a test of the operation of accelerating anodes and deflection plates.

A sensitive, bridge type VTVM is used as the indicating device for the tube tests. The power supply to the VTVM is voltage regulated for greater stability. The VTVM circuit is designed for protection against accidental overloads which might be incurred when a defective cathode-ray tube is tested.

Tube elements are selected by means of 14 four-position lever switches by which each element can be selected individually. Shorts, leakage, and indications of filament continuity are shown by a neon lamp. By using the lever switches, the technician can trace a leakage path.

Elements such as deflection plates and accelerating anodes can be checked for continuity by means of a low-current test. In this test, a change of current of only .1 microampere produces a meter variation of approximately five scale divisions.

A roller chart in the instrument has lists of settings for the various cathode-ray tubes which may be checked. The instrument comes supplied with two extension cables. One is terminated with the standard duodecal socket, and the other has insulated clips that may be connected individually to each pin of a cathode-ray tube.

The Series CR-30 cathode-ray tube tester is housed in an attractive hardwood case having a natural finish. A compartment in the case is provided for storage of the connector cables. The size of the instrument is approximately 17 1/4 by 13 3/4 by 6 3/4 inches.

Precision Model E-400 Sweep Generator

The Model E-400 sweep generator shown in Fig. 4 is a product of the Precision Apparatus Company, Inc. This instrument furnishes a sweep signal covering the range from 3 to 900 megacycles in eight bands. The sweep width may be set for a range of 0 to 1,000 kilocycles for FM coverage or a range of 0 to 15 megacycles for television. The sweep width in the UHF band may be even wider than 15 megacycles because of the fact that UHF signals from the generator are harmonics.

When the sweep-width control is at the center or zero position, the sweep width is zero and increases to a maximum width as the control is turned to either extreme of its rotation. On one side of the zero position, the sweep direction is from lower to higher frequencies; and on the other

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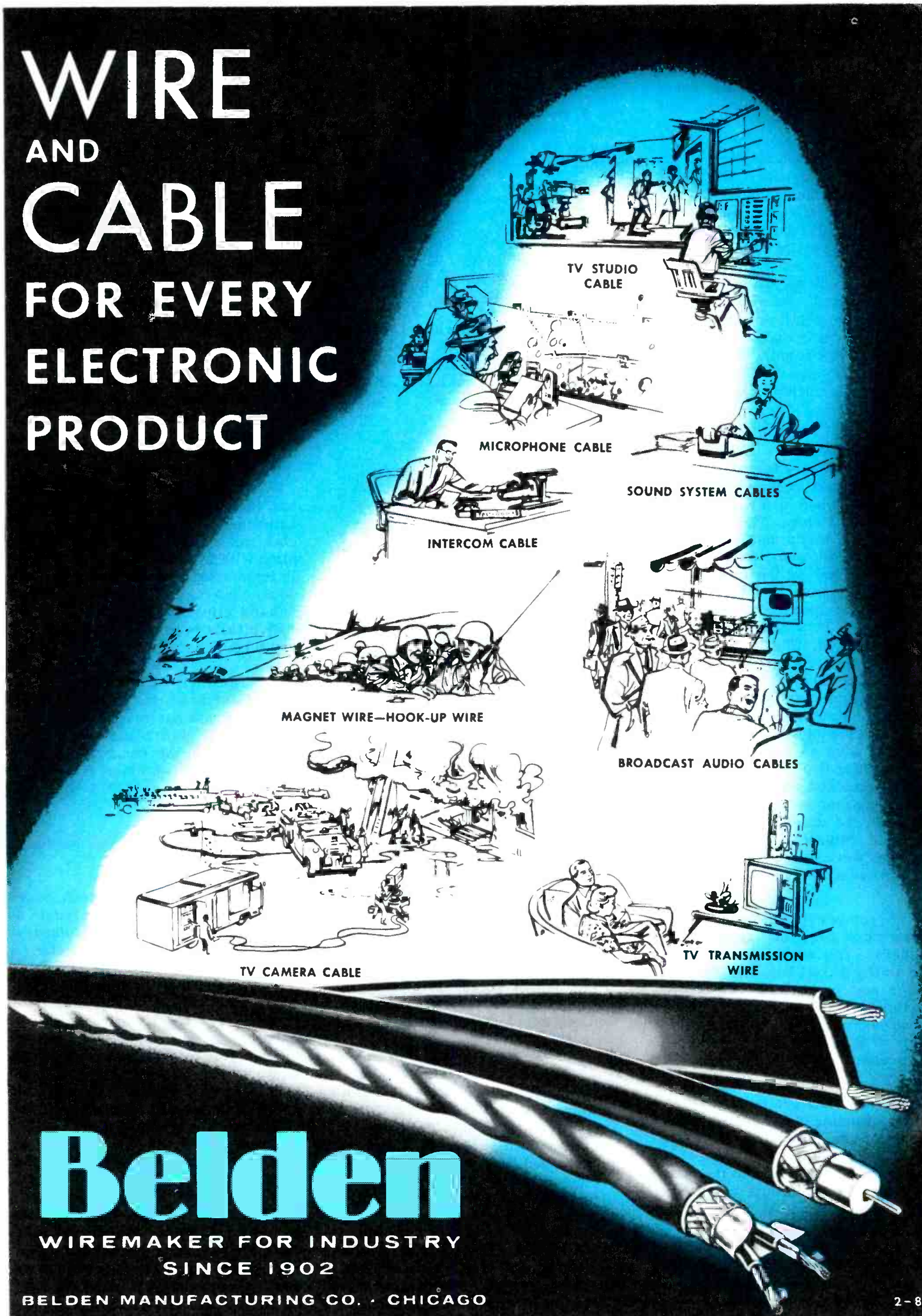
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2-8

Troubles in Video Amplifiers, DC Restorers, and Picture Tubes

(Continued from page 19)

Sometimes a condition similar to that of hum in the picture is produced by oscillations which arise in the video section. Fig. 9 shows a picture with symptoms caused by this type of oscillation. The frequency of the oscillation was low in this case, and the density of the dark bars on the screen could be varied by changing the setting of the contrast control. The cause of the trouble was found to be a leakage resistance of about 800,000 ohms in the coupling capacitor between the video amplifier and the video-output tube.

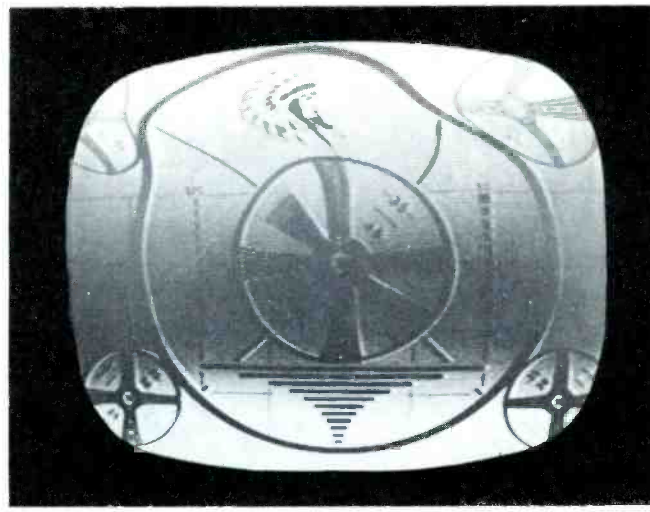

Fig. 7. Picture With 60-Cycle Hum.

4. Darkening of Gray Portions in Picture.

A picture which appears excessively dark and in which the gradations of gray are missing is frequently referred to as having excessive contrast. This symptom is illustrated in Fig. 10.

Possible causes of a darkening of gray portions in the picture are:

a. Improper setting of AGC control or switch.

b. Gassy condition in either the video-amplifier or the video-output tube.

c. Improper bias on the picture tube or on one of the video amplifiers.

d. Shorted cathode-bypass capacitor.

e. Leaky coupling capacitor.

f. Improperly functioning DC restorer.

Anything that will cause a video stage to become overloaded will cause excessive contrast in the picture. Because of the nature of this trouble, it is necessary to take steps to eliminate the AGC network as a possible source of the trouble. This may be done by checking the adjustment of the AGC control or switch. If this adjustment fails to remedy the trouble, then the AGC line should be clamped at a suitable negative level (usually -3 volts). If the picture symptom is still present, it may be assumed that the trouble is not in the AGC system but is located within the video section.

Gassy tubes in the video section will often cause excessive gain, and the contrast in the picture will therefore be abnormally high. Improper bias on a stage can cause excessive contrast and may be traced to one of a number of causes — tube failure, a shorted cathode-bypass capacitor, a leaky coupling capacitor, or a grid-load resistor that has changed value.

An improperly functioning DC restorer may produce the effect of excessive contrast because the brightness of the picture may have to be reduced abnormally in order to eliminate vertical-retrace lines.

5. A 4.5-Mc Beat in Picture.

The symptom which is illustrated in Fig. 11 is caused by the beat signal which is produced when the audio carrier and the video carrier are heterodyned in the video detector. The frequency of this beat signal is 4.5 megacycles; and unless effective measures are employed, the signal may produce an interfering pattern in the picture.

Possible causes of a 4.5-mc beat in the picture are:

a. Misadjusted 4.5-mc trap.

b. Defective capacitor across trap coil in the case of a parallel-resonant network.

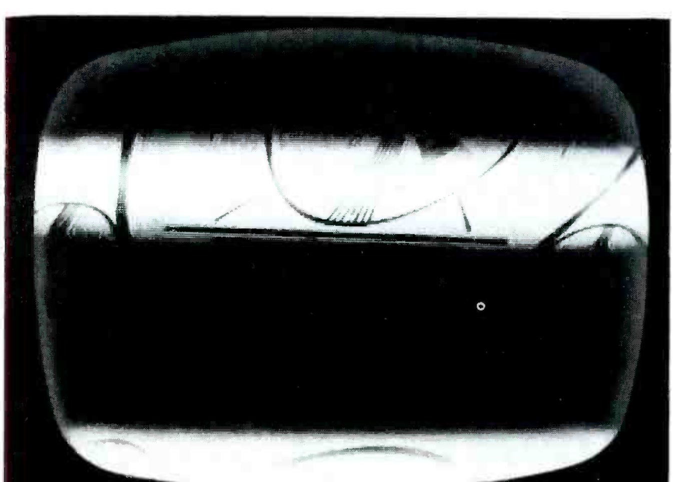

Fig. 8. Picture With 120-Cycle Hum.

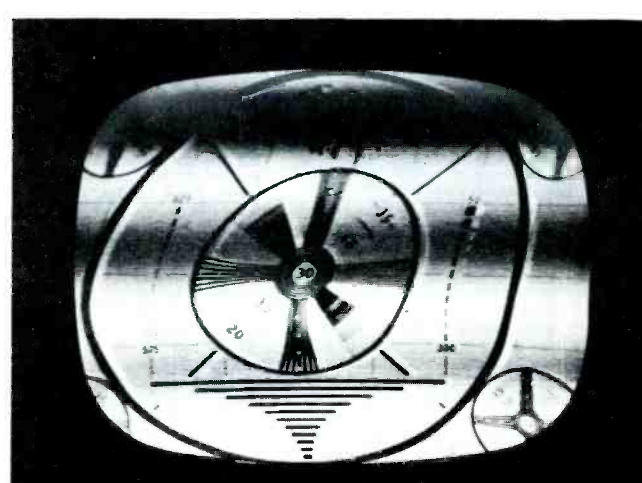

Fig. 9. Picture Indicating the Presence of Undesirable Oscillations in the Video Section.

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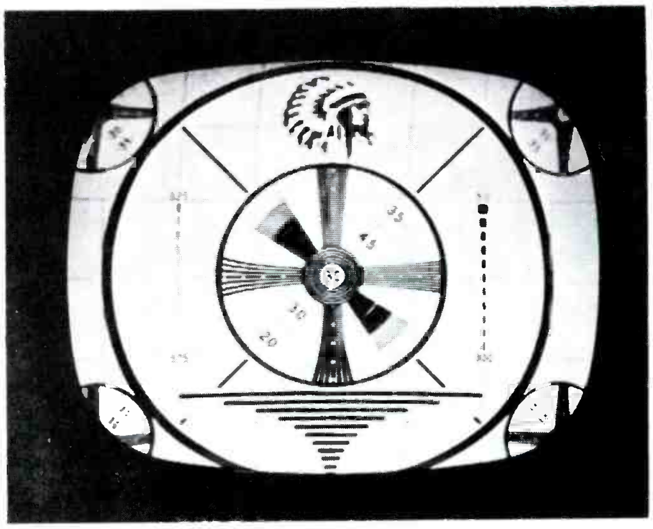


Fig. 10. Darkening of Gray Portions in Picture.

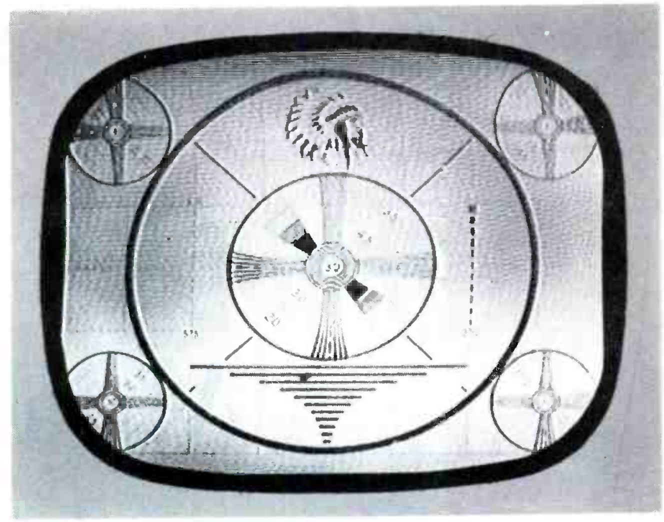


Fig. 11. A 4.5-Mc Beat in Picture.

c. Defective capacitor in series with trap coil in the case of a series-resonant network.

A misadjusted 4.5-mc trap, since it is tuned to a different frequency, allows the 4.5-mc signal to interfere with the picture signal. A defective capacitor either in series or in parallel with the 4.5-mc coil may also cause the trap to be off frequency.

After the video section has been thoroughly checked and eliminated as the source of trouble, the video IF section should be suspected and attempts should be made to correct the fault by realignment of the IF section.

6. Negative Picture.

A negative picture occurs when an amplifier stage is overdriven to the extent that the video signal undergoes a complete polarity reversal. A negative picture is illustrated in Fig. 12. In this illustration, notice that the portions of the test pattern that are normally white have become black and that the portions that are normally black have become white. Notice also that the sync and blanking pulses are white. Normally they would be black.

Possible causes of a negative picture are:

a. Faulty DC restorer, video-amplifier, video-output, or picture tube.

b. Low plate or screen voltage applied to a video-amplifier tube or to a video-output tube.

c. Leaky coupling capacitors in video section. (See C51 or C53 in Fig. 2 and C39 or C40 in Fig. 4.)

d. Improper bias applied to the video-amplifier, video-output, or picture tube.

e. Faulty AGC.

Since a negative picture may be caused by trouble in the tuner, IF, or AGC circuits as well as by troubles in the video section, it is necessary to isolate the trouble to the stage that is actually defective. To do so, check the waveform at the video-detector load with an oscilloscope. If the waveform is satisfactory at that point, the trouble is probably in the video section. If, however, this waveform is not satisfactory, clamp the AGC line (usually at -3 volts DC) and then check the signal again at the detector load. Obtaining a satisfactory waveform when the AGC line is clamped would indicate AGC trouble.

Tubes that draw grid current can cause a negative picture. Tubes that have very low emission can be overdriven, and thus they can also cause a negative picture. Usually, a picture tube that causes a negative picture will be found to be either very gassy or to have an internal short.

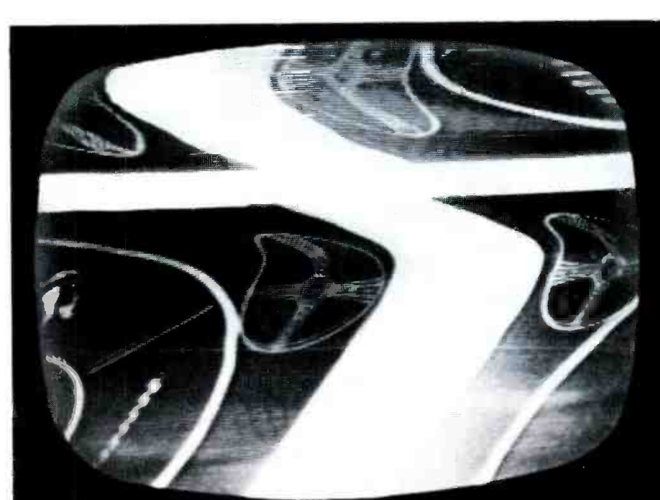
Either low plate or low screen voltage permits a stage to be overdriven, and a leaky coupling capacitor can disturb the bias and cause grid current to flow.

Faulty AGC action can be the result of trouble in the video section. This is especially true in the case of a keyed AGC system in which the grid signal of the keyer tube is obtained from the video-amplifier stage. Since the amount of AGC produced in keyed AGC systems is dependent upon the strength of the incoming signal and since the amount of amplification in the IF section and tuner is dependent upon the amount of AGC produced, anything that causes the loss or degradation of either the video or AGC can set up a chain of events that will result in a negative picture.

7. Smeared Picture.

A smeared picture may appear in one of two forms: (1) black streaks trailing from black or (2) white streaks trailing from black.

Fig. 12. Negative Picture.



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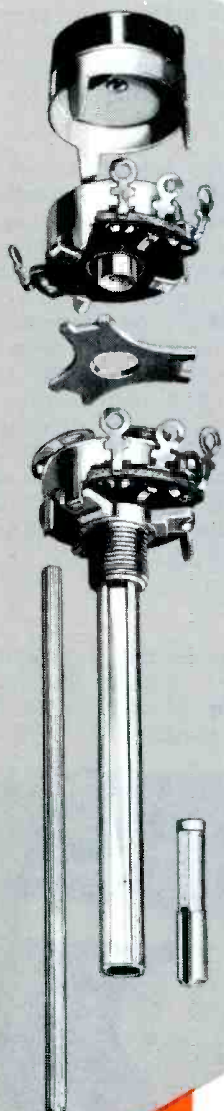

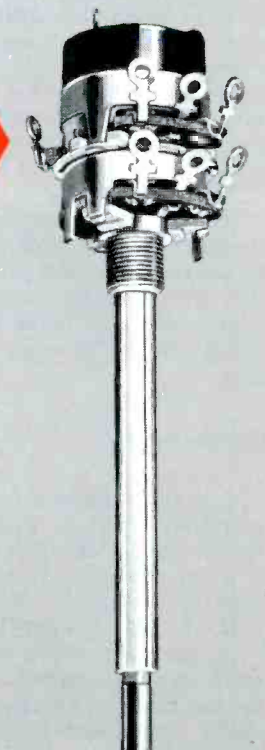

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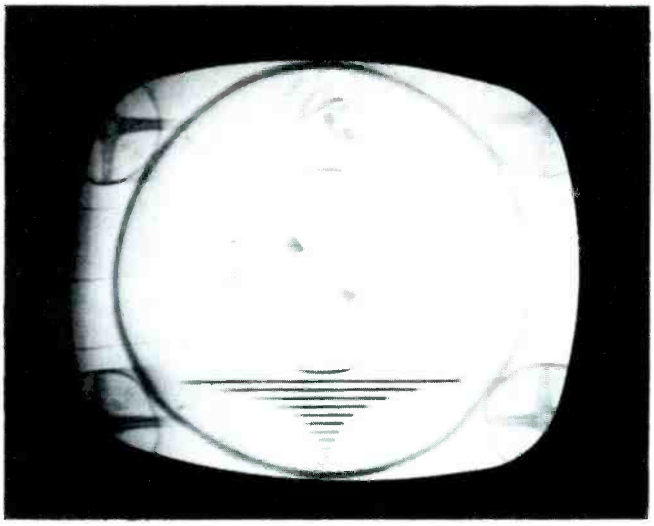


Fig. 13. Smeared Picture Having Black Streaks Trailing from Black.

Fig. 14. Smeared Picture Having White Streaks Trailing From Black.

Fig. 13 is an illustration of blacks trailing from the black portions of the test pattern. Fig. 14 illustrates white streaks trailing from some of the black portions of the test pattern.

Possible causes of a smeared picture are:

a. Defective video-amplifier, video-output, DC restorer, or picture tube.

b. Low value of grid-coupling capacitor. (See C51 or C53 in Fig. 2 and C39 in Fig. 4.)

c. Low value of grid-load resistor. (See R46 or R52 in Fig. 2.)

d. Open cathode-bypass capacitor. (See C50 and C52 in Fig. 2.)

e. Open series-peaking coil. (See L23 and L21 in Fig. 2 and L16 in Fig. 3.)

f. High value of plate-load resistor. (See R44, R48, or R49 in Fig. 2 and R42 and R43 in Fig. 3.)

A smeared picture like that illustrated in Fig. 13 is caused by excessive low-frequency response coupled with poor high-frequency response. Tubes with a low g_m value can cause a smearing of the blacks because a tube with a satisfactory g_m value is required to reproduce faithfully the higher frequencies. An increase in the value of a plate-load impedance can also cause a smearing of blacks. This increase may be due either to an open series-peaking coil or an increase in the ohmic value of a plate-load resistor.

A smeared picture of the type illustrated in Fig. 14 is caused by phase distortion at low frequencies. A coupling capacitor with a value that is too low can produce phase distortion and loss of low frequencies. In addition, a cathode-bypass capacitor of low value can also reduce the low-frequency response of an amplifier.

8. Loss of Picture Detail.

The photograph of Fig. 15 represents a trouble symptom in which the picture images lack fine detail. The vertical wedge in the test pattern tends to blur or drop out, and the gradations from white to black are not distinct. The over-all picture may appear to be out of focus.

This condition often results from a defective focus circuit, improper alignment, insufficient high voltage, or a decrease in B+ supply voltage; however, this discussion will deal with troubles that may develop in the video-amplifier, DC restorer, and picture-tube circuits.

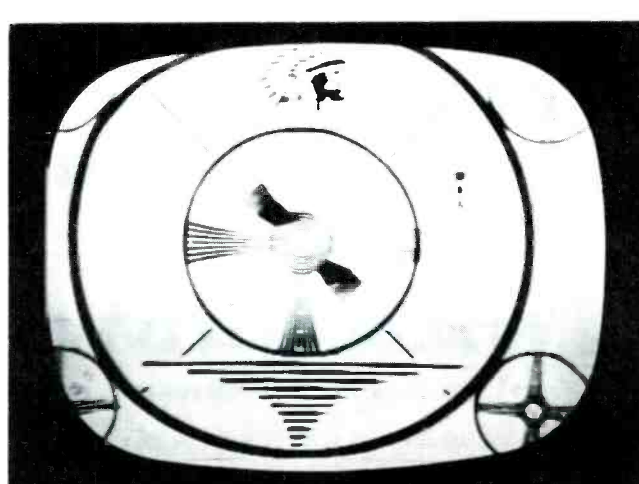
In order to isolate the cause of a loss of picture detail, there are several preliminary steps that can be taken. When the sound is normal, it might be assumed that the RF and IF sections are satisfactory in a receiver employing an intercarrier system. This indication will, of course, not hold true in all cases.

Check the operation of the focus control and its effect upon the line structure of the raster. If the operation of this control is found to be relatively normal, a voltmeter check of the low-voltage supply will quickly eliminate this section as the one at fault.

Insufficient high voltage will usually cause a picture that blooms or increases in size when the brightness control is advanced as shown in Fig. 16. If these checks fail to localize the trouble to a certain section of the receiver, a further check of the video-amplifier, DC restorer, or picture-tube circuits should be made.

Poor response in a video-amplifier stage will cause loss of picture detail. Voltage measurements of this stage may reveal that the tube is operating with incorrect

Fig. 15. Loss of Picture Detail.



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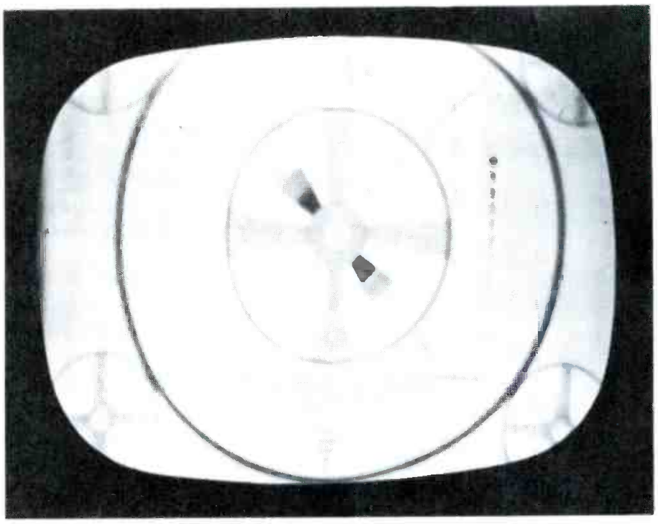

Fig. 16. Picture That Is Blooming and Out of Focus.

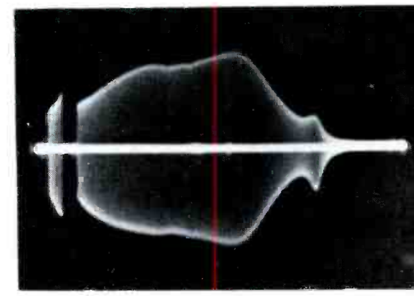

Fig. 17. Satisfactory Response Pattern Obtained From Video Sweep Generator.

bias, and a loss of amplification at the higher frequencies often results. The voltmeter method of checking a video-amplifier stage is not always conclusive proof that the frequency response of the stage is normal. One means of determining the frequency response is to use a sweep generator and an oscilloscope in much the same manner as when performing the video IF alignment.

The quality of the test equipment to perform this operation is very important. In order that an accurate indication will be reproduced on the oscilloscope, the sweep generator should have a relatively high output and the oscilloscope should have a sufficiently wide response. In order to check the test equipment, connect the generator output directly to the vertical-input terminals of the oscilloscope and adjust the generator controls to provide a center frequency of 4.5 megacycles with a 9-mc sweep width. Connect the horizontal sync voltage from the generator to the horizontal-input terminals of the oscilloscope. This setup should produce a pattern similar to that shown in Fig. 17. If such a pattern cannot be obtained, the equipment is not suitable for checking the video-amplifier response by the method that follows.

To prevent loading of the generator, it may be necessary to remove the video-detector load and to replace it with a high-impedance circuit from the video-amplifier grid to ground. A 470K-ohm resistor and a 1.5-volt battery may be connected as shown in Fig. 18 in order to serve this purpose.

Connect the sweep generator through either a .1-mfd or a 1.0-mfd coupling capacitor to the input of the amplifier, and set the center frequency at 4.5 megacycles with a 9-mc sweep. Using a high-impedance probe, connect the oscilloscope to the output of the amplifier. Connect the horizontal-sync voltage from the generator to the horizontal-input terminals of the oscilloscope. Adjust the oscilloscope so that the sweep voltage from the generator will provide a horizontal trace. The pattern observed should represent the response curve of the amplifier at all frequencies from approximately 30 cycles to 4 megacycles. A typical response curve of a video amplifier is shown in Fig. 19. Any deficiency in frequency response will be represented by a dip or sag in the curve. If a soundtrap is included in the circuit under test, an extreme dip will be observed in the curve at 4.5 megacycles. A marker generator can be coupled to the input of the amplifier, and the marker signal can be used to identify any frequency point along the response pattern. When the service technician requires peak performance from any video-amplifier stage, he may find the foregoing response check very helpful.

Possible causes for loss of picture detail are:

a. Defective video-amplifier or DC restorer tube.

b. Poor video response. (Check all components which can affect tube bias.)

c. Low cathode emission in picture tube.

d. Open peaking coil. (See L19, L21, or L23 in Fig. 2 and L14 or L16 in Fig. 3)

e. Open or leaky coupling capacitor. (See C51 or C53 in Fig. 2, C43 in Fig. 3, and C39 in Fig. 4.)

f. Defective component in DC restorer circuit. (See C40, R35, R36, or R53 in Fig. 4.)

g. Poor high-frequency response caused by improper alignment.

h. Video-detector load resistor decreases in value. (See R40 in Fig. 2 and R32 in Fig. 3.)

A blurred picture from a strong input signal may result from a limiting action in the video-amplifier stage. This trouble will usually be accompanied by a loss of synchronization.

When the coupling capacitor between the video amplifier and the picture tube develops leakage, the picture will often have a blurred appearance and the raster cannot be extinguished by use of the brightness control even when the contrast control is at its minimum setting. Shorted elements in the picture tube can also produce this effect.

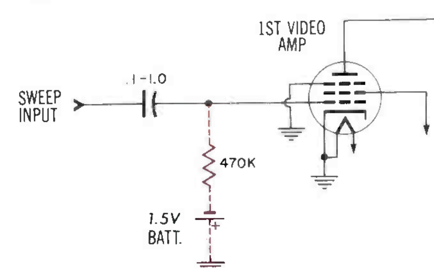

Fig. 18. Circuit Which Can Be Used When Connecting Video Sweep Generator to Input of Video Amplifier.

9. Horizontal Pulling in Picture.

Distortion introduced into the picture by a faulty video-amplifier, DC restorer, or picture-tube circuit may take many forms. One of the more common troubles is that of a pulling picture. The photograph of

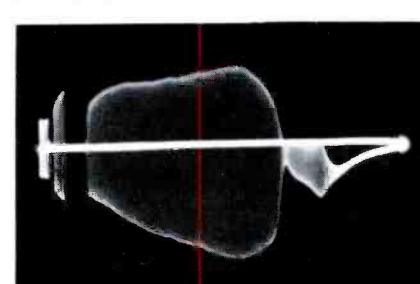

Fig. 19. Typical Response Curve of a Video Amplifier.

Fig. 20 illustrates a picture with this trouble symptom. If the picture tends to bend or pull horizontally, the horizontal oscillator is momentarily trying to lose synchronization with respect to the incoming signal. This condition may be caused by sync-pulse distortion or by some type of hum modulation which is reaching the horizontal oscillator.

There are a few preliminary checks which can be made in order to isolate the cause of horizontal pulling. Adjust the centering so that the edge of the raster will be visible. Set the channel selector on a nonoperating-channel position, and observe the edge of the raster. If there is no pulling under these conditions, the trouble must be in a stage through which video or sync signals pass.

Another check can be made with receivers that have the sync take-off point located after the stage containing the contrast control. In such receivers, if the contrast control is advanced and the pulling increases, it is an indication that the trouble is developing before the signal reaches the video-output stage. On the other hand, if the pulling decreases as the control is advanced, then the distortion is being introduced in the video-amplifier, DC restorer, or sync stages.

If the set is removed from the cabinet, a further check may be made in order to isolate the trouble to either the video or sync sections. Disconnect the sync input to the first sync stage. The picture may be observed momentarily by adjusting the horizontal and vertical hold controls. If the picture pulling is no longer evident, then the trouble will usually be found in the video-amplifier or DC restorer circuits.

A more severe case of picture pulling is illustrated in Fig. 21. In addition to the pulling condition, this symptom also reveals brightness modulation which is evident by the dark hum bar across the screen. One of the most common causes for this trouble is heater-to-cathode leakage in the video-amplifier or DC restorer tube.

Poor low-frequency response in a video-amplifier stage will often produce distorted sync pulses that can result in picture pulling. Unstable vertical synchronization will usually accompany this condition.

Possible causes of horizontal pulling in the picture are:

a. Heater-to-cathode leakage in the video-amplifier or DC restorer tube.

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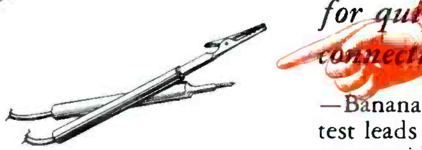

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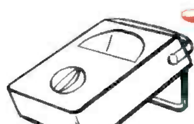

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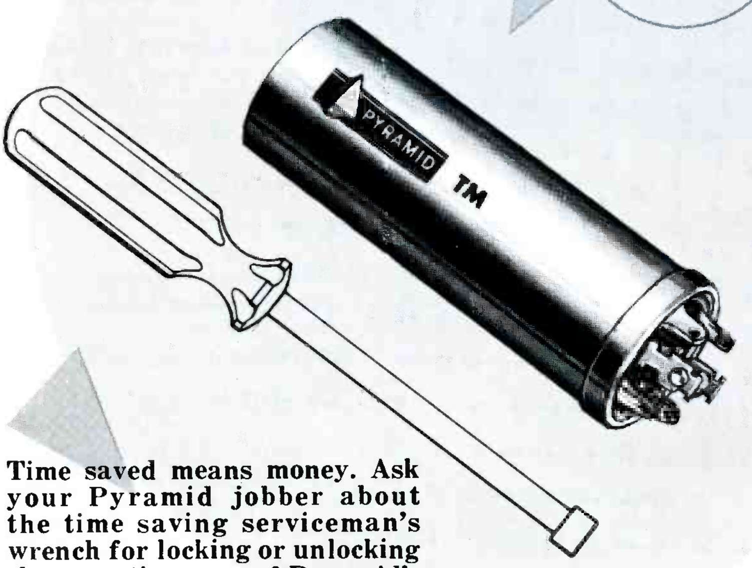

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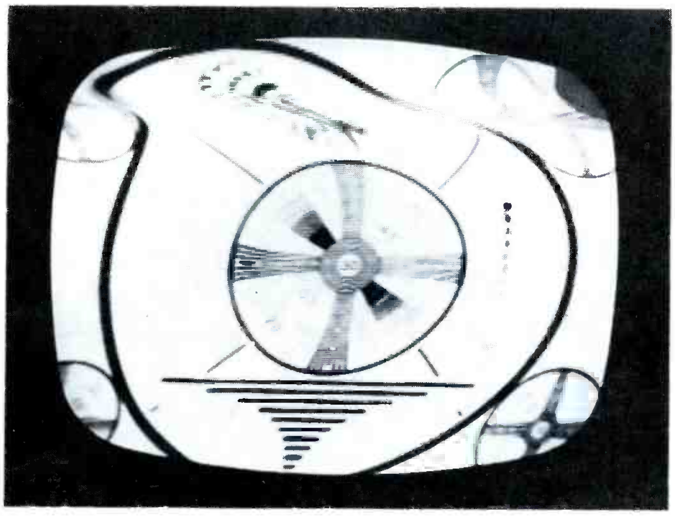

Fig. 20. Horizontal Pulling in Picture.

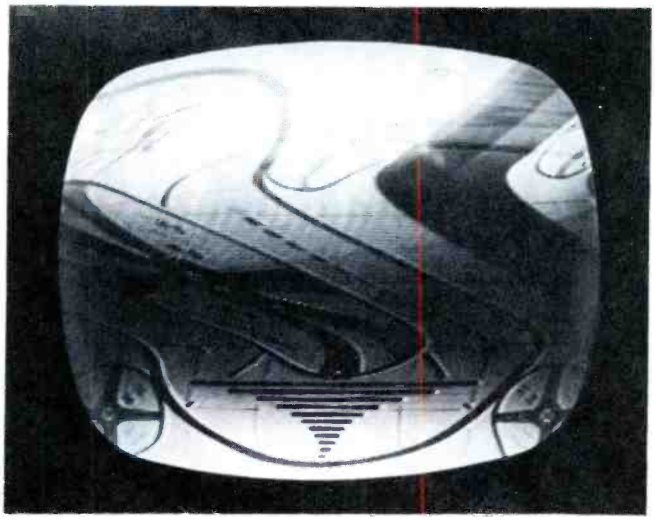

Fig. 21. Severe Horizontal Pulling Accompanied by Brightness Modulation.

b. Excessive gain in the video-amplifier tube. (Check for gassy tube or improper bias.)

c. Leaky coupling capacitor. (See C51 or C53 in Fig. 2 and C39 in Fig. 4.)

d. Plate-load resistor increased in value. (See R44, R48, or R49 in Fig. 2 and R42 or R43 in Fig. 3.)

e. Poor low-frequency response. (See C50, C51, or C52 in Fig. 2 and R42 or R43 in Fig. 3.)

f. Shorted contrast control.

g. Faulty decoupling network in the plate circuit of the video amplifier.

h. Undesired magnetic field acting upon the electron beam in the picture tube.

If the video-amplifier stage is overdriven, there could be sync-pulse clipping which may produce picture pulling. All components affecting the bias of the video-amplifier tube should be checked. Keep in mind that an excessively strong signal applied to the video amplifier will also cause this stage to become overloaded. A kink or bend in one section of the picture may result from an undesired magnetic field located near the picture tube or from a magnetized picture tube. This type of distortion will also appear in the raster with no signal applied.

10. Ringing in Picture.

Ringing in the picture may be from an excessive high-frequency response in the video-amplifier stage. The increased signal amplification at the higher frequencies may tend to cause the high-Q video circuits to break into transient oscillations. Ringing is evident in the test pattern shown in Fig. 22.

It may be noticed from the photograph that the black objects on the screen are followed by additional black lines which are often referred to as "echoes" or "overshoots." The echoes will appear equally spaced and progressively weaker the farther they are displaced from the normal objects.

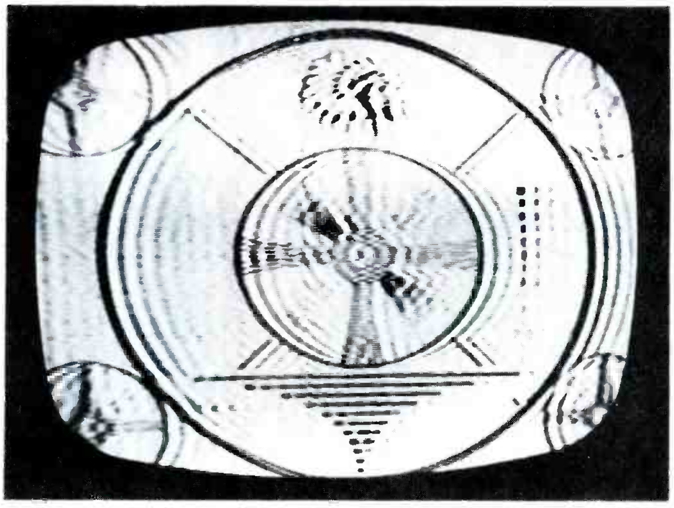

Fig. 22. Ringing in Picture.

Possible causes of ringing in the picture are:

a. Improper placement of components or poor lead dress in the video-amplifier circuit.

b. Defective video-amplifier tube.

c. Open screen-bypass capacitor. (See C41 in Fig. 3.)

d. Peaking coil of incorrect value. (See L19, L21, L22, L23, or L24 in Fig. 2 and L14, L16, or L17 in Fig. 3.)

e. Open decoupling capacitor in video-amplifier plate circuit.

f. Open shunt resistor across series-peaking coil. (See R42, R43, or R47 in Fig. 2 and R35 in Fig. 3.)

g. Cathode resistor increased in value. (See R45 or R50 in Fig. 2.)

h. Open cathode-bypass capacitor. (See C50, C52, or C92 in Fig. 2.)

i. Detector-load resistor decreased in value. (See R40 in Fig. 2 and R32 in Fig. 3.)

j. Improper shielding.

The series-peaking coils employed in the plate circuit of the video amplifier usually have resistors connected across them in order to eliminate transient oscillations which can occur because of the high-Q resonant effects of the coil. The leads of the peaking coil are left long so that the coil can be placed away from the chassis to prevent any change in the inductive fields about the coil. Care should always be taken when

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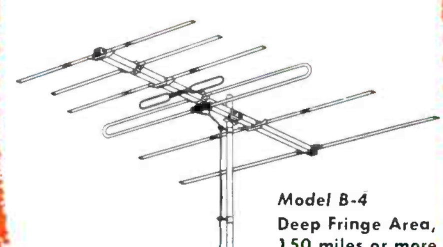

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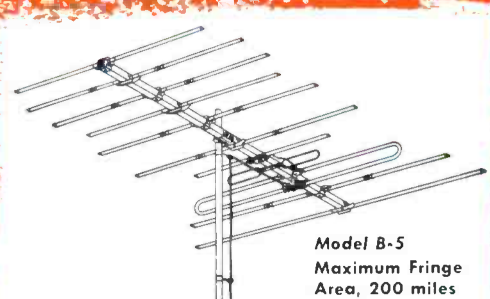

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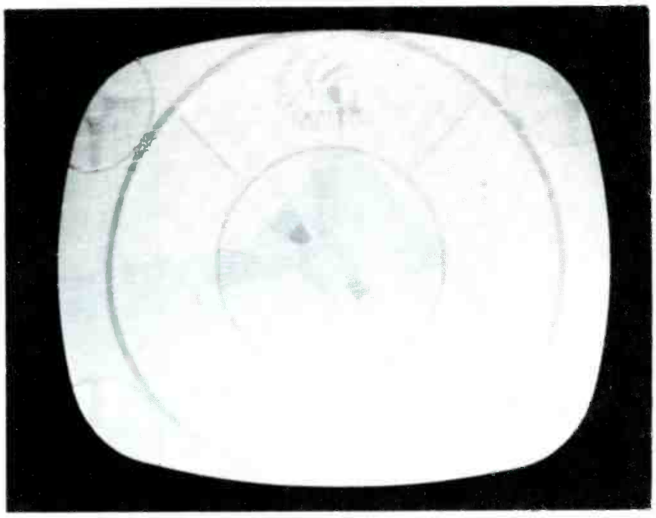

Fig. 23. Retrace Lines Visible.

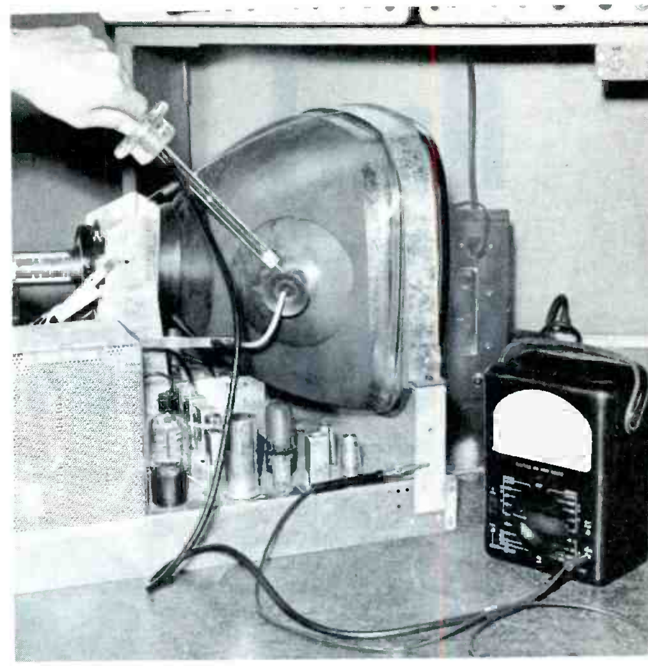

Fig. 24. Measuring Second-Anode Voltage With a High-Voltage Probe.

replacing peaking coils. Inductance values and lead dress are often critical in these circuits.

11. Retrace Lines Visible.

Another common trouble symptom encountered in TV servicing is that of visible retrace lines in the picture. See Fig. 23. The appearance of vertical-retrace lines could easily be from inadequate signal strength caused by a defective video-amplifier stage. A faulty DC restorer circuit will also produce this symptom. When the DC restorer is not operating properly, the blanking and sync pulses will not remain at the same level; thus, with the picture tube placed at a fixed bias, some of the blanking pulses will not be sufficiently negative to cut off the tube during retrace time. Under this condition, some of the retrace lines would become visible and at the same time the over-all quality of the picture would suffer.

Defective components in the brightness-control circuit or shorted elements in the picture tube may cause the brightness control to become ineffective in reducing the brightness level of the picture. In some cases, a voltage check at the picture-tube grid will reveal a leaky coupling capacitor which has also been known to produce this symptom.

Leaky or shorted elements in a picture tube will not always show up by a resistance measurement. Sometimes by slightly jarring the neck of the tube while it is in operation an intermittent condition may be discovered, in which case the trouble would be isolated to the picture tube.

Possible causes of visible retrace lines are:

a. Defective video-amplifier, DC restorer, or picture tube.

b. Weak video signal applied to the picture tube. (Check video-amplifier gain.)

c. Faulty components in DC restorer circuit. (See C40, R36, R35, R37, or R53 in Fig. 4.)

d. Defective brightness or contrast control.

e. Faulty components in retrace-blanking circuit. (See C93, C92, R56, or R57 in Fig. 2 and R76, C70, C69, or R75 in Fig. 3.)

f. Open grid resistor in video-amplifier circuit. (See R46 in Fig. 2.)

g. Misadjusted or weak ion trap in receiver that does not employ a retrace-blanking network.

This trouble symptom is not always caused by a defective video or picture-tube circuit. A weak or misadjusted ion trap will usually require that the brightness control be set at maximum in order for a picture with adequate illumination to be obtained. Retrace lines are more likely to become visible with the control set in this position.

12. No Raster.

Loss of raster may or may not be accompanied by sufficient sound. In the case of no raster and no sound, the fault will often result from a deficiency in the low-voltage supply. This assumption will not always hold true for those receivers employing a series-filament arrangement.

It is possible that a drop in the low-voltage supply will render the horizontal oscillator inoperative and consequently will cause a condition of no raster, but the voltage that remains may be capable of reproducing the sound. The technician should remember that certain defective components in any section of the receiver can affect the low-voltage supply.

The first test to be made in order to isolate the trouble causing no raster is a check for the presence of high voltage. The ideal manner in which to measure the high voltage is by using a voltmeter with the proper high-voltage probe. See Fig. 24.

The majority of picture tubes used in the field today require high voltages from 9,000 to 20,000 volts, depending upon the tube size and deflection angle. In most cases, insufficient high voltage will cause the raster to be completely extinguished.

If a suitable meter and a high-voltage probe are not available, the service technician may perform the high-voltage test by arcing the anode lead to the chassis. A continuous arc of at least one-half inch should be obtained. If it is necessary to touch the anode cap to the chassis before drawing an arc and if the arc has a reddish-yellow cast, the high voltage is probably too low for a raster to be produced. Because of the extreme shock hazard, care should always be taken when performing this test.

If the set has high voltage and the ion trap has not been disturbed,

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In the circuits under discussion, possible causes for no raster are:

a. Defective picture tube.

b. Faulty brightness control.

c. Improper picture-tube bias.

d. Shorted elements in video-amplifier or DC restorer tube.

e. Shorted screen capacitor. (See C41 in Fig. 3.)

f. Direct B+ short in video amplifier or picture-tube circuits.

g. Shorted coupling capacitor in circuit for vertical-retrace blanking. (See C70 in Fig. 3.)

h. Defective or misadjusted ion trap.

A picture tube can develop poor cathode emission, or one of the tube elements may open or become shorted. This would result in a loss of raster. Many of these defective picture tubes can be restored to relatively normal operation by using a cathode-ray-tube rejuvenator. There are a number of these electrical devices now available to the service industry.

13. Loss of Synchronization.

Loss of synchronization, as illustrated by the picture in Fig. 25, is usually caused by a failure in the sync section itself. In many instances, however, this condition will develop as a result of a defective video-amplifier or DC restorer stage. In the latter case, the symptom will usually appear as vertical flopover accompanied by unstable horizontal synchronization.

A frequent cause of this trouble symptom is poor low-frequency response in the video-amplifier stage. One method of checking the low-frequency response is to adjust the hold controls until the vertical-blanking signal appears momentarily on the screen. Increase the brightness level, and observe the vertical-sync pulse. If this portion of the signal does not appear darker than the darkest picture element, either the low-frequency response is poor or the sync pulses are being clipped by some limiting action.

Possible causes for loss of synchronization are:

a. Defective video-amplifier or DC restorer tube.

b. Plate-load resistor increased in value. (See R44, R48, or R49 in Fig. 2 and R42 or R43 in Fig. 3.)

c. Open screen-bypass capacitor. (See C41 in Fig. 3.)

d. Incorrect value of grid or cathode resistors in video-amplifier circuit.

e. Improper shielding that causes pickup of external interference.

f. Defective component in sync take-off circuit. (See R60 or C63 in Fig. 3.)

g. Improper grid bias on a stage before the sync take-off point.

When a video-amplifier or DC restorer tube develops heater-to-cathode leakage, the picture will often roll vertically and bend or wave horizontally. All cases of heater-to-cathode leakage introduce some degree of hum modulation into the signal. If the hum is severe, it will also cause brightness modulation. This modulation usually becomes more apparent at lower brightness levels. Under these conditions, a dark area will appear either at the top or at the bottom half of the screen.

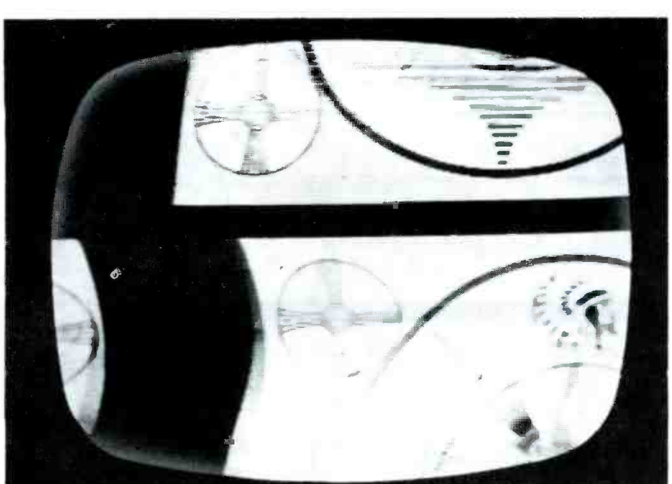


Fig. 25. Loss of Synchronization.

14. Intermittent Picture.

Intermittent troubles of any nature are usually the hardest for the service technician to isolate. In many instances, a long operational check is necessary before the trouble symptom appears and before the test equipment can be put to use. Some trouble symptoms only occur after the receiver has been on for an appreciable amount of time. This situation often indicates that the heat generated within the receiver is affecting one or more of the components. As an aid in localizing the cause of an intermittent trouble, a heat lamp may be used. The heat radiated by the lamp will usually cause a faulty component to break down completely, and then the component may be located by a step-by-step procedure.

Other intermittent faults may be detected by jarring some of the components located in a suspected area. A loss of the sound or raster may accompany an intermittent picture trouble. These additional symptoms will also help in isolating the trouble to a certain section of the receiver.

Possible causes for an intermittent picture are:

a. Defective video-amplifier or DC restorer tube.

b. Intermittent picture tube having open or shorted elements.

c. Poor solder joints in video-amplifier or picture-tube circuits.

d. Resistor changing value with heat.

e. Capacitor opening or shorting as the temperature increases.

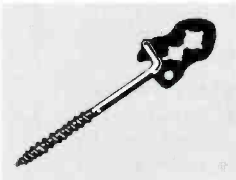
f. Dirty or open contrast or brightness control.

g. Drops of solder or other foreign material causing an intermittent short.

h. Defective tube socket. (Connection breaks as heat increases.)

i. Leads shorted or connections broken.

One symptom or condition frequently encountered in the field is that in which the picture and raster show evidence of an intermittent condition when the base of the picture tube is tapped. This is usually an indication of a defective picture tube, but a thorough check of the tube-socket connections should be made before the chassis is removed from



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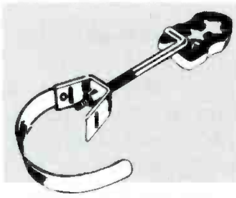

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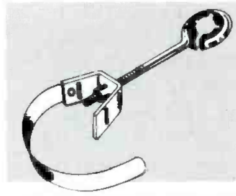

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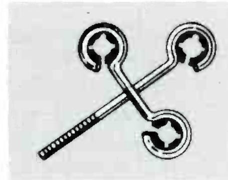

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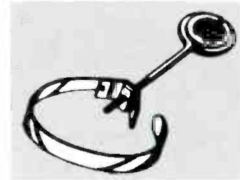

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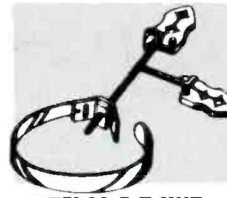

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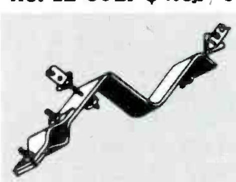

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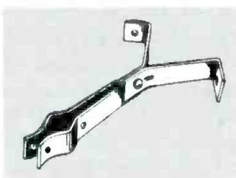

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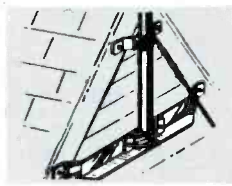

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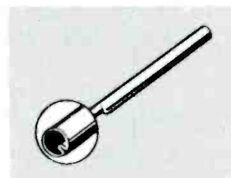

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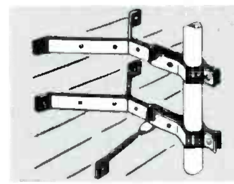

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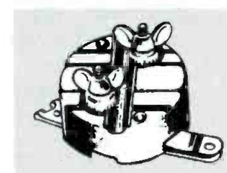

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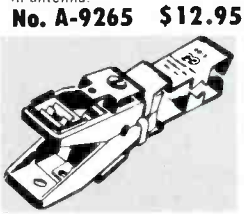

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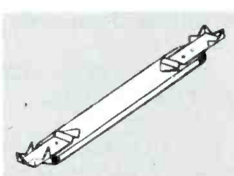

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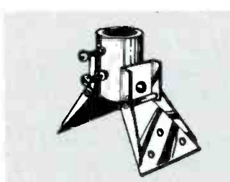

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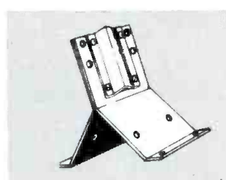

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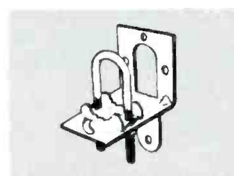

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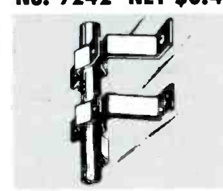

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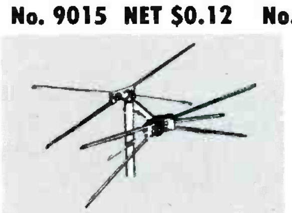

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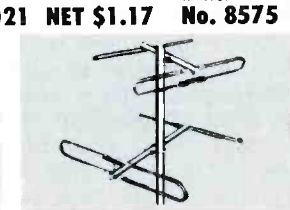

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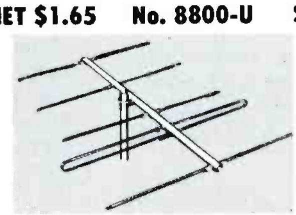

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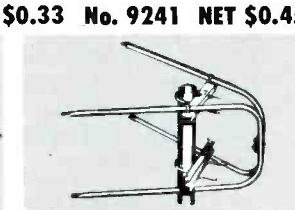

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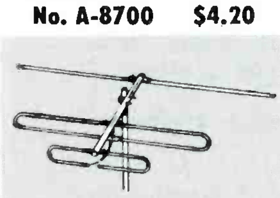

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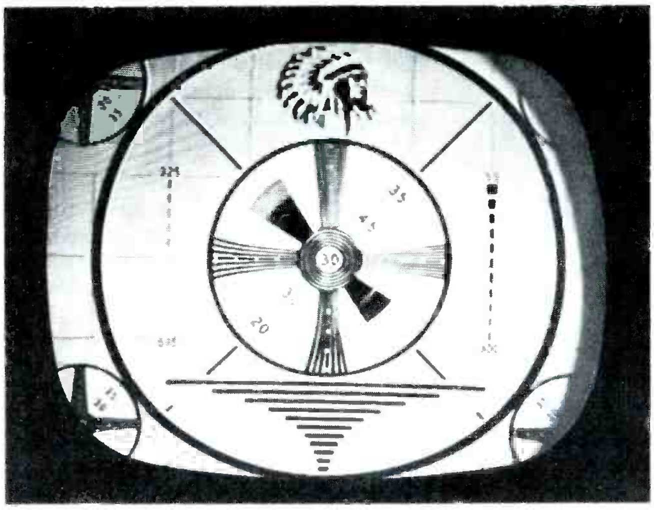


Fig. 26. Neck Shadow.

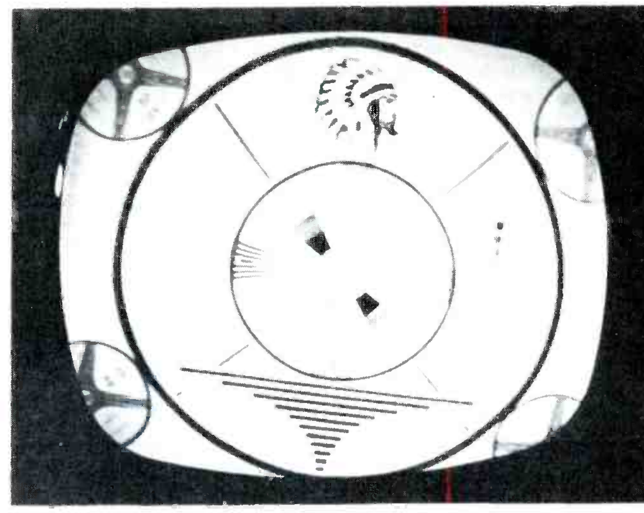


Fig. 27. Tilted Raster.

the cabinet. In some cases, the picture tube may develop a cold-solder connection in the base pins. This ailment can often be cured by merely heating the tube pins with a soldering iron.

Miscellaneous Symptoms

In addition to the foregoing common symptoms, some mention should be made of certain symptoms that are indications that the setup of the picture tube is incorrect. These miscellaneous symptoms are listed as follows:

15. Neck shadow.

16. Tilted raster.

17. Picture out of focus.

18. Improper centering.

Most of these symptoms are caused by troubles which can be remedied by mechanical means or by a control adjustment.

15. Neck Shadow.

Neck shadow is illustrated in Fig. 26. This symptom occurs when the electron beam is prevented from reaching a portion of the picture-tube screen. The beam is deflected improperly by the magnetic fields which are present in the tube, and the beam strikes the glass in the neck of the picture tube instead of reaching the outer edge of the screen.

Possible causes of neck shadow are:

a. Misadjusted centering mechanism.

b. Misadjusted ion trap.

c. Misadjusted focus.

d. Yoke not forward far enough on neck of picture tube.

e. Low B+ voltage.

f. Low second-anode voltage to picture tube.

16. Tilted Raster.

A tilted raster is shown in Fig. 27. This symptom is always caused by the yoke being tilted. The yoke should be loosened and then rotated until the scanning lines are horizontal.

17. Picture Out of Focus.

An out-of-focus picture is illustrated in Fig. 28. Possible causes of an out-of-focus condition are:

a. Misadjusted focus control.

b. Misadjusted focus magnet.

c. Focus coil or magnet not properly positioned.

d. Defective focus coil or magnet.

e. Low B+ voltage.

f. Low second-anode voltage to picture tube.

g. Defective picture tube.

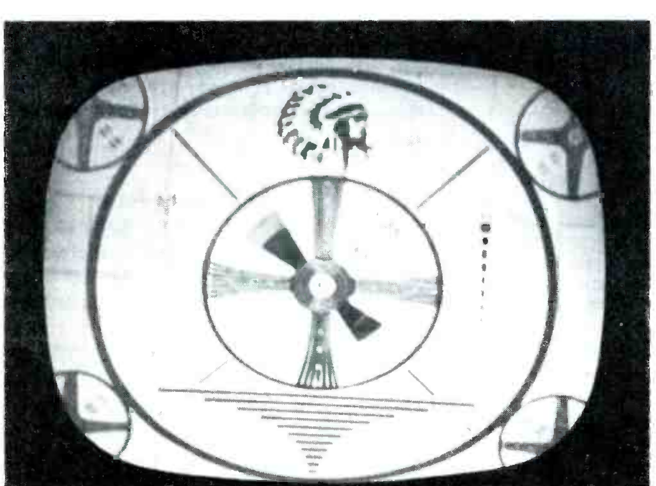


Fig. 28. Picture Out of Focus.

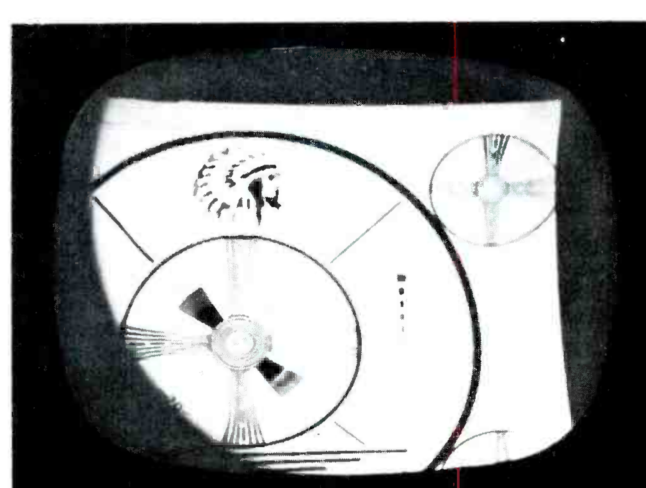


Fig. 29. Improper Centering.

18. **Improper Centering.**

A picture that is improperly centered both vertically and horizontally is illustrated in Fig. 29. Possible causes of improper centering are:

a. Misadjusted centering control.

b. Low B+ voltage.

c. Focus assembly not properly positioned.

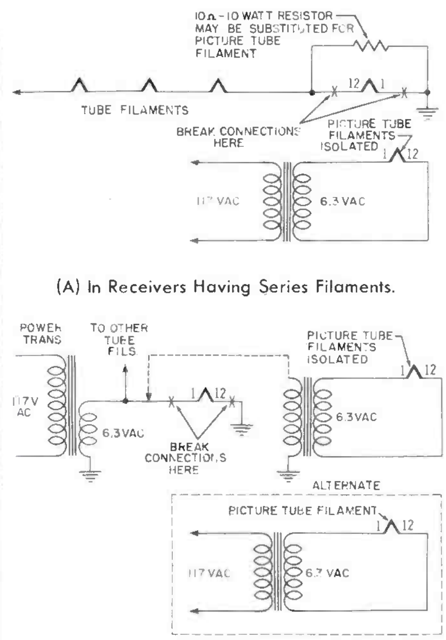
d. Yoke not properly positioned.

Other Picture-Tube Troubles

Many trouble symptoms can develop as a result of inherent defects in the picture tube proper. Defective tube elements, improper screen coating, or gas in the tube may result in poor contrast, low brightness, or incorrect focus. These defects may occur because of poor workmanship at the factory or because of damage during shipment. Symptoms of poor contrast, low brightness, or poor focus can also be caused by an excessive amount of dust on the face of the picture tube and on the protective glass, although the customer will often think that there is some electrical defect within the receiver. A thorough cleaning job will do the trick.

Permanent damage to the picture-tube screen often comes from a misadjusted ion trap. An ion burn takes the form of a light yellowish or brown spot near the center portion of the screen. The majority of picture tubes will produce a raster with the ion trap set in two different positions. The correct position is the one nearest the base of the tube. The ion trap, or beam bender, should never be adjusted to compensate for neck shadow if the brightness must be sacrificed.

When a picture tube develops heater-to-cathode leakage, there will usually be an undesired brightness modulation in the picture. If a picture-tube rejuvenator fails to burn off this short, another alternative would be to isolate the heater by using a separate filament transformer. Wiring instructions for installing a filament transformer of this type are given in the schematic diagram shown in Fig. 30. Physical mounting of this additional unit is left to the ingenuity of the service technician.

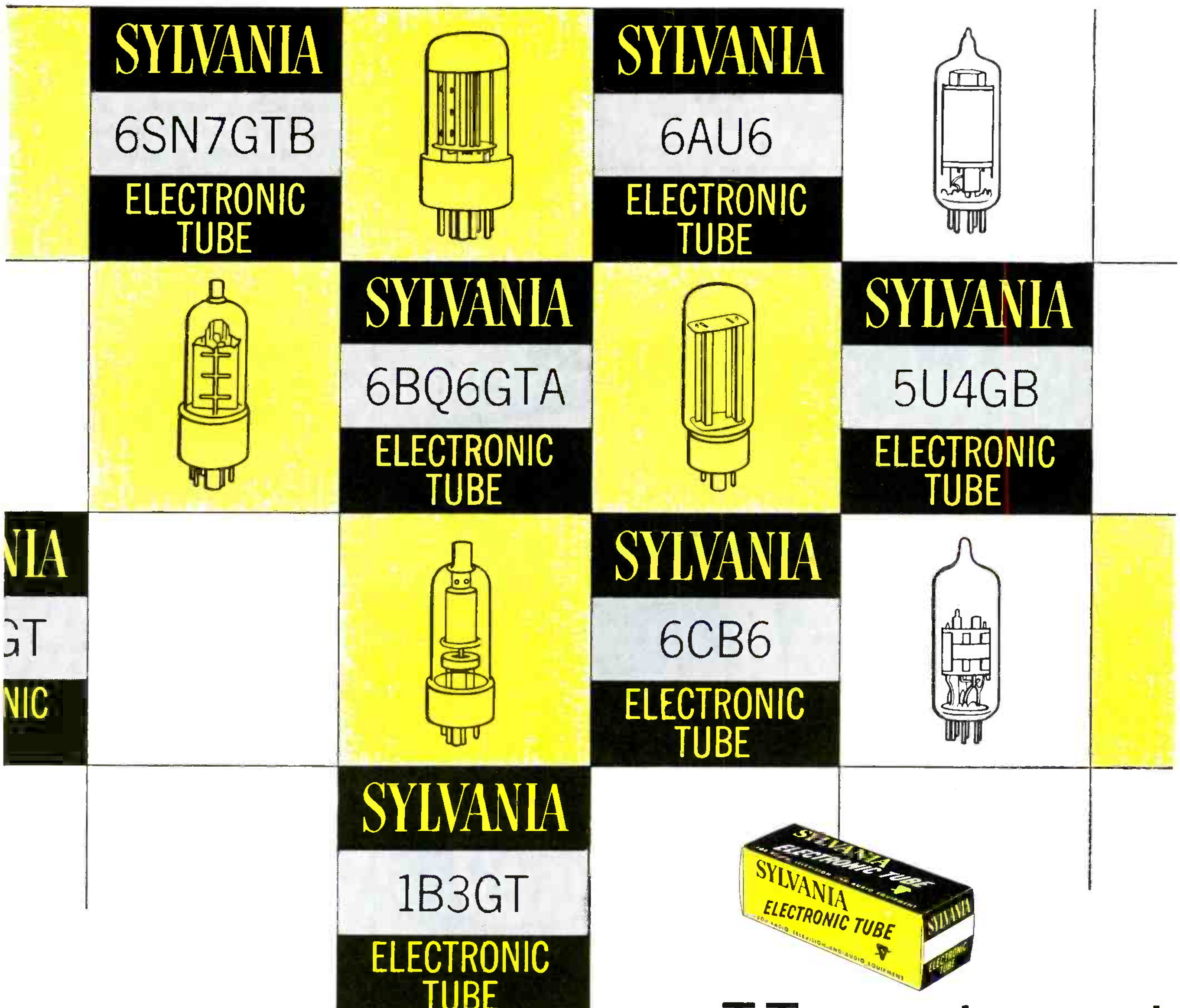


(A) In Receivers Having Series Filaments.

(B) In Receivers Having Parallel Filaments.

Fig. 30. Circuit Modifications Needed for Installation of Filament Transformer for a Picture Tube With Heater-to-Cathode Leakage.

CALVIN C. YOUNG, JR.



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Audio Facts

(Continued from page 21)

push-button switch. Any switch which is in its ON position will be released and will return to its OFF position when another push button is being depressed, unless it is held in the ON position while the other button is being depressed. This might sound confusing, but push-button switches such as these are very convenient; and we must admit that push buttons hold a certain fascination for many people.

Any or all of the five channels can be connected to the grid (pin 2) of V3A at the same time. The signals from these channels can be mixed and controlled by the mixer-level controls. Isolation of signals is provided by the isolation resistors R19, R22, R23, R24, and R25 connected in series with each mixer-level control.

Audio Amplifier, Tone Control, and Audio Output

The high input impedance of the amplifier stage V3A reduces loading on channel circuits and aids in maintaining stability even though several channels are used at the same time. The high input impedance is a result of the negative-feedback loop composed of R29 connected from the junction of C19 and R1A to the grid (pin 2) of V3A.

The four negative-feedback loops employed in this unit are responsible to a great degree for the stable and satisfactory operation. Every stage other than the microphone preamplifier V2A is included within a feedback loop. The feedback circuit used in the phono preamplifier section to obtain equalization and the loop around V3A and V4A have been mentioned. The other two, one in the tone-control section and one in the output stages, will be discussed with their associated circuits.

The amplifier stage V3A is direct-coupled to the grid (pin 2) of V4A, which is a cathode-follower stage. The cathode follower is used at this point in the circuit to obtain a comparatively low-impedance output for connection to a recorder input and to the loudness-balance circuit. A low-impedance recorder output permits the use of a long shielded cable without loss of high frequencies.

The recorder output is used to feed a signal to the input of a tape, wire, or disk recorder which contains its own amplifier. This output

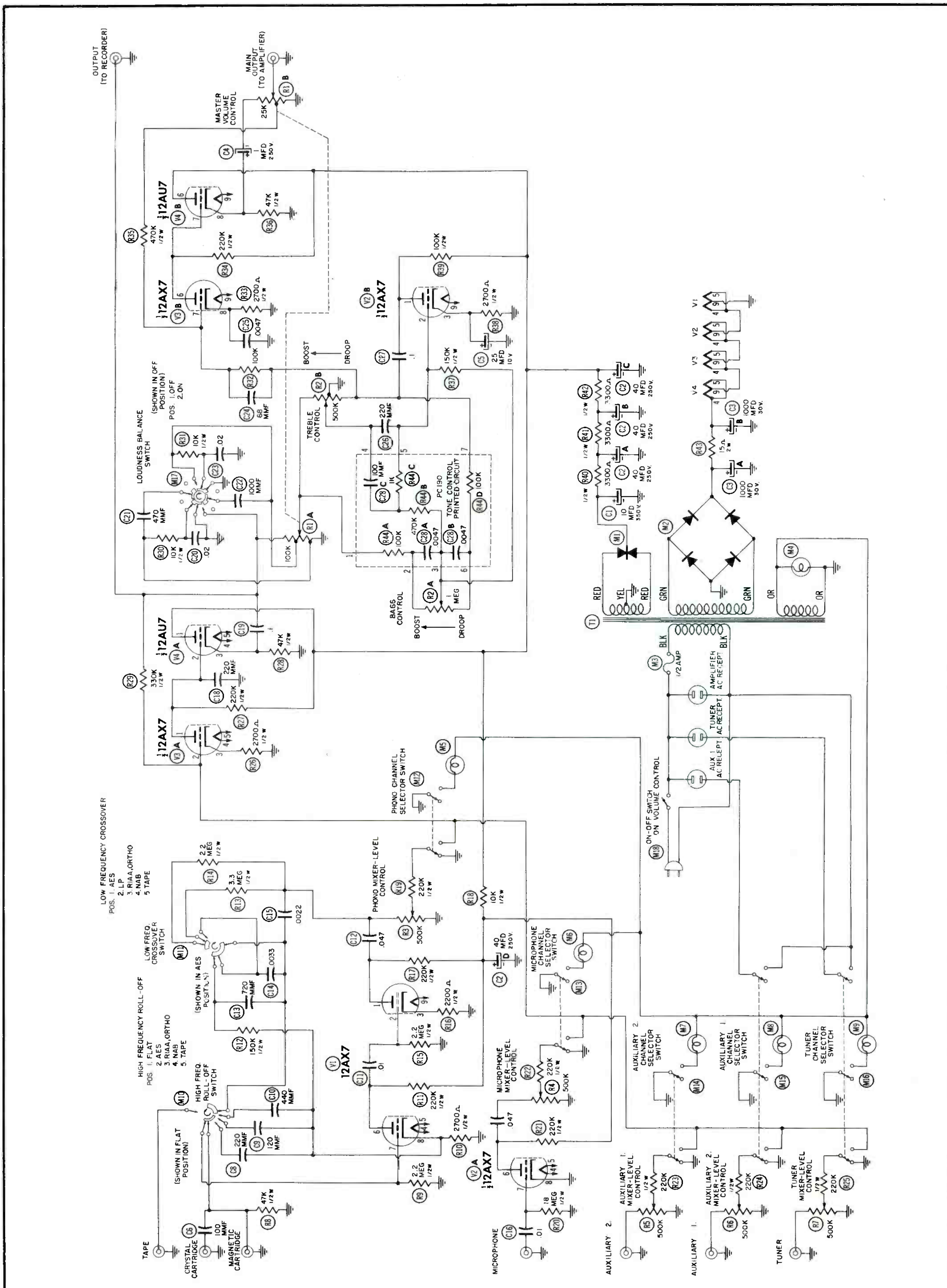

Fig. 4. Schematic Diagram of Fisher Series 80-C Master Audio Control.

is not affected by the master volume control or the tone controls. In this way, the controls on the recorder can be adjusted and a recording can be made while it is being monitored with the system connected to the main output of the Fisher Series 80-C.

The signal is fed from the cathode (pin 3) of V4A to the first section R1A of the master volume control. The second section R1B of this dual control is located in the output circuit. When the loudness-balance switch M17 is in its OFF position, the master volume control operates as a conventional volume control. When the switch M17 is turned to its ON position, C20, C21, C22, and C23 are connected into the circuits which connect to the taps on R1A. With these capacitors in the circuit, the control then operates as a loudness control which compensates for the loudness characteristic of the ear as the level of the sound is varied by the turning of the control.

The signal from the first section R1A of the master volume control is fed to the tone-control circuits. These are feedback type circuits using a separate bass control R2A and a treble control R2B in conjunction with a PC190 printed-circuit tone-control unit. Wide ranges of bass and treble boost or droop are provided by these stable circuits.

The signal is fed from the tone-control section to the grid (pin 7) of V3B. V3B is an amplifier stage which is direct-coupled to the grid (pin 7) of the cathode-follower output stage V4B. A feedback circuit is connected from the tap on the second section R1B of the master volume control to the grid (pin 7) of V3B.

As with the recorder output, the cathode-follower output stage V4B permits the use of a long shielded output cable without a loss of high frequencies.

The recommended load impedance, for both the recorder and the main output, is 100,000 ohms or more with a capacitance of 2,500 micro-microfarads or less.

Maximum gain figures (as specified by the manufacturer) are as follows:

High-level inputs to main output, 21 db.

Low-level inputs to main output, over 53 db.

High-level inputs to recorder output, 3 db.

Power Supply

A full-wave selenium rectifier M1 is used with adequate filtering to supply the plate voltages. A bridge type of selenium rectifier M2 with a filter using two 1,000-mfd, 30-volt capacitors and a 15-ohm, 2-watt resistor supplies DC for the filaments of the four dual-triode tubes. One secondary winding on the power transformer provides 6.3 volts AC to light the six pilot lamps. A 1/2-ampere fuse M3 is located in the primary of the power transformer.

Only the chassis of this unit is shown in the illustrations, but blonde or mahogany cabinets are available. Data and instructions for mounting the chassis and panel in equipment cabinets are supplied with the Fisher Series 80-C master audio control.

ROBERT B. DUNHAM

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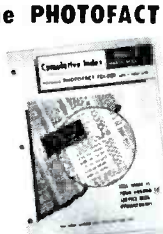

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14. Top and bottom views are shown. Top view is positioned as chassis would be viewed from back of cabinet.
15. Blank pin or locating key on each tube is shown on placement chart.
16. Tube charts include fuse location for quick service reference.

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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HELPS YOU EARN MORE DAILY

Notes on Test Equipment

(Continued from page 31)

side, the direction is reversed. By means of the sweep-width control, the operator can make the higher frequencies fall at either the right or the left of the response curve, as preferred.

The eight bands are obtained by use of only three positions of the band-selector switch. A fourth position provides for operation of the crystal oscillator only.

Four sockets are provided on the front panel for plug-in crystals, and any one of these crystals can be selected by means of a four-position crystal-selector switch. The crystal output may be used internally as a

Fig. 4. Precision Model E-400 Sweep Generator.

marker signal for the response curve or externally as a calibrating signal for other generators. Two crystals are supplied with the instrument.

At the same time that a crystal marker signal is applied internally, another marker signal may be introduced from an external source; therefore, two markers separated by the frequency of the crystal oscillator can be provided. In this manner, both video and sound markers may be obtained at the same time through proper choice of frequencies.

The strength of the crystal marker signal can be controlled by the CRYSTAL MARKER AMPLITUDE control. The crystal oscillator can be turned on or off by means of a CRYSTAL MARKER switch.

With the SWEEP RANGE switch in the EXT. DEV. position, an external deviation signal can be applied to the reactance modulator to drive the sweep. With the switch in the DEV. OFF position, the signal becomes an ordinary RF signal instead of a sweep

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MORE CONTRAST

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Tung-Sol has developed a unique "fogging" method of backing up the phosphor screen with a mirror-like aluminum reflector. This reflector prevents light radiating uselessly back into the tube. It brings out all the detail of which the receiver circuit is capable. So smooth and true is the Tung-Sol aluminum reflector that mottling, streaks, swirls, "blue-edge", "yellow-center" and other objectionable irregularities are eliminated.

Tung-Sol pin-point-focused electron gun assures a steady, brilliant picture—free from alternate fading and overlighting. Tung-Sol's exacting standards of quality control, manufacture and testing further guarantee the high uniformity and maximum performance of the "Magic-Mirror" TV Picture Tube.

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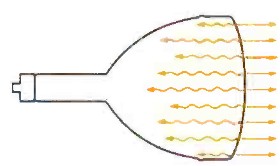
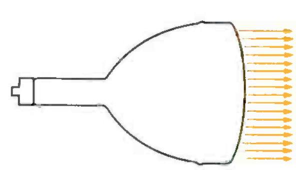


ORDINARY TUBE—Only *half* the light produced by the phosphor screen is utilized in the picture. Other half radiates wastefully back into tube.

RESULT—A light background within the tube which reduces picture contrast.



MAGIC-MIRROR ALUMINIZED TUBE — Aluminized reflector allows electron beam through. Blocks wasted light from backing up into tube. Reflects *all* the light into picture.

RESULT—Pronounced increase in contrast to make a bright, clear, more realistic picture.

TUNG-SOL ELECTRIC INC., Newark 4, N. J.

Sales Offices: Atlanta, Chicago, Columbus, Culver City (Los Angeles), Dallas, Denver, Detroit, Montreal (Canada), Newark, Seattle.

Tung-Sol makes All-Glass Sealed Beam Lamps, Miniature Lamps, Signal Flashers, Aluminized Picture Tubes, Radio, TV and Special Purpose Electron Tubes and Semiconductor Products.

signal. An external audio-modulation signal can be applied through the AUDIO MOD. jacks to either the sweep signal or the RF signal.

The power line switch is combined with the PHASE CONTROL. The signal for driving the horizontal sweep of an oscilloscope is obtained from the HOR. SWEEP connector on the front panel. A blanking switch is provided to eliminate one trace in a dual response curve so that a zero base line will be obtained.

R.F. LEVEL and R.F. OUTPUT controls provide complete control of the strength of the signal obtained from the OUTPUT jack. Two grounding posts are provided for complete grounding facilities. The output cable has a termination box with taps for high impedance (90 ohms) or low impedance (15 ohms). A toggle switch on the box permits the termination networks to be thrown in or out of the circuit.

The instruction manual contains operating instructions with many illustrations, response curves, and alignment hints.

The size of the instrument case is approximately 13 by 11 1/2 by 6 1/2 inches.

Win-Tronix Model 810 Flyback and Yoke Tester

The Win-Tronix Model 810 flyback and yoke tester is shown in Fig. 5. It is designed to test special TV components such as flyback transformers and deflection yokes in both color and monochrome receivers.

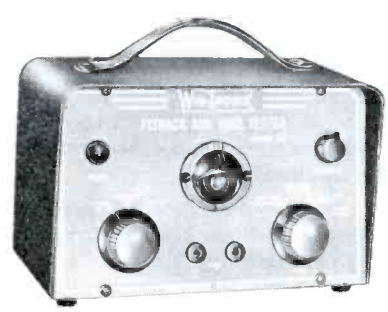


Fig. 5. Win-Tronix Model 810 Flyback and Yoke Tester.

The Model 810 will indicate continuity and shorts in these components, and a short of only one turn in a component can be detected. It will also indicate the condition of bypass and electrolytic capacitors, provided the capacity is .0047 microfarad or greater.

The short test is based upon the loading effect which a low-Q

circuit (such as that of a shorted transformer) will have when this circuit is connected across a sensitive oscillator circuit. The load imposed by the shorted component will cause a change in the operation of the oscillator, and this change is shown by an indicating device.

A number of other testers of this nature use meters as the indicating devices; but in the Model 810, a neon bulb (NE 48) is used.

Before the yoke or flyback transformer is connected, the CALIBRATE control of the tester is adjusted so that the neon indicator is at its most sensitive point (the point at which the indicator is barely flickering). Under these conditions, only a very small amount of load is necessary to cause the neon indicator to be extinguished.

The signal developed at the grid of the oscillator is shown in Fig. 6. It is of a pulsed or interrupted nature and was chosen in order that operating conditions which are more nearly normal for the components tested could be obtained.

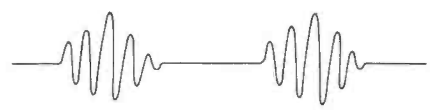


Fig. 6. Waveform of Test Signal Used in the Win-Tronix Model 810 Flyback and Yoke Tester.

The switch labeled TYPE has five separate positions or settings: one for calibrating or setting the sensitivity of the neon indicator and one each for testing iron-core flybacks, air-core flybacks, monochrome yokes, and color yokes. These components can be tested for either continuity or shorts. The continuity test places the component in series with the neon indicator and a voltage source. If there is continuity, the neon indicator will light.

When the instrument is used to test bypass capacitors, the charge current which flows when the test leads are first connected across the capacitor will cause the neon indicator to flash momentarily. A continuous glow or an intermittent flashing of the neon lamp indicates a shorted or leaky capacitor.

The test for an electrolytic capacitor gives an indication governed by the amount of leakage present in the capacitor. Open, shorted, or leaky conditions can be detected by means of this test.

The approximate size of the instrument is 8 by 5 by 5 1/2 inches.

PAUL C. SMITH

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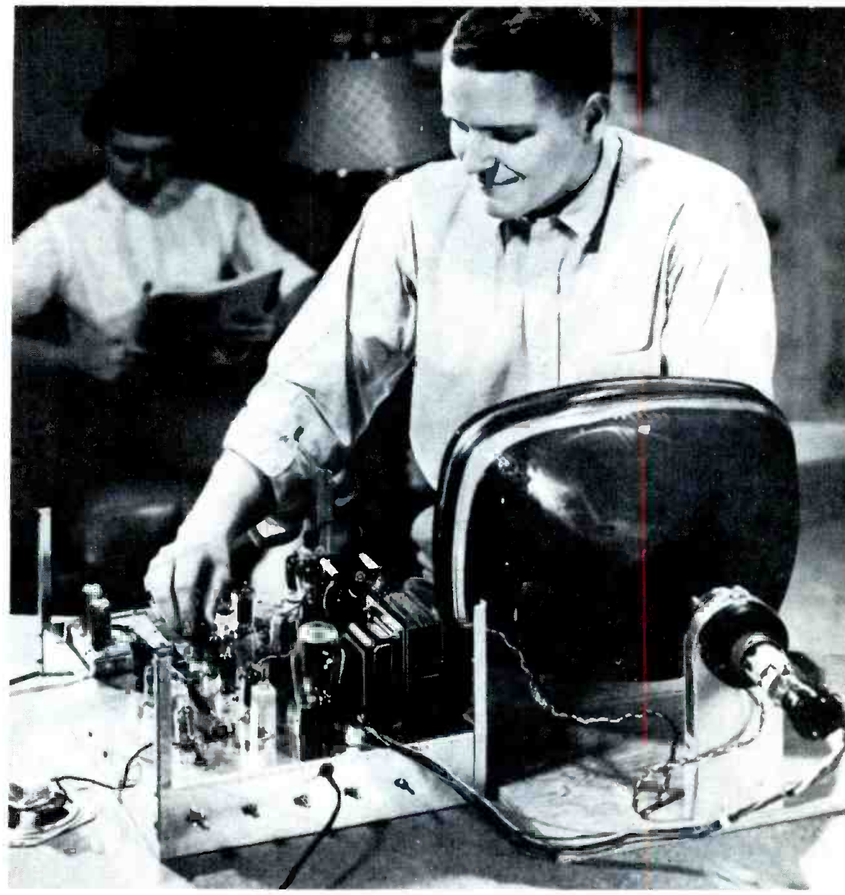

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SOME CASE HISTORIES of TEST-EQUIPMENT TROUBLES

As a rule, the technician can expect many hours of trouble-free service from his test equipment. Eventually, however, some trouble may develop; and the instrument must be repaired before it can be returned to normal use.

The troubles may be of a mechanical nature such as, for example, loose knobs and dial drives or worn switch contacts. Or, they may be of an electronic nature; and our experience has been that the majority of the troubles fall into this category. Examples of this type of trouble are defective vacuum tubes, shorted or open capacitors, and resistors that have departed radically from their nominal values.

In spite of the large number and variety of instruments that are available in our laboratories, it has not been necessary to make many repairs. We have endeavored to keep a record of most of these repairs except those of an insignificant nature.

Is the Test Equipment Really at Fault?

Some weaknesses may develop so gradually that they may escape notice unless a direct check is made for the sole purpose of determining the condition of the instrument. Gradually weakening tubes or slowly changing resistance values may not produce a sudden change in performance but only a gradual decrease in efficiency.

In other cases, even though the change is sudden, the fact that the equipment has performed satisfactorily for a long time may lead the technician to suspect trouble in the receiver or electronic equipment being serviced rather than in the test equipment itself. If there is some doubt as to which is at fault, a comparison with similar test equipment is a valuable check for normal performance. If the faulty instrument is a measuring device such as a meter or oscilloscope, the application of a voltage of known amplitude and waveform will give an idea of the condition of the instrument.

Locating the Trouble

The ease with which the service technician can locate troubles in his test equipment will depend to a great extent on how familiar he is with its operating theory. The same trouble-shooting procedure that he uses on a receiver will also work on a piece of test equipment since many of the circuits of each are similar in operation. A schematic diagram of the instrument with proper voltages and resistances indicated at important points will be a great help.

It might be well at this point to discuss some case histories. The symptoms of the trouble will be mentioned first, then the line of reasoning which led to the location of the trouble will be described, and finally any steps which were taken to repair the equipment will be given. Once the trouble has been located, the remedy will usually be obvious.

Case History No. 1

The instrument was an oscilloscope. The symptom was an erratic sweep — the sweep lines were uneven in length. This effect can sometimes be obtained by applying too much sync signal to an oscilloscope. It was noticed that the oscilloscope would synchronize on a 60-cycle signal but not on a 15,750-cycle signal.

This seemed definitely to indicate that the trouble must lie somewhere in the synchronization system. A 6J6 tube is used as the sawtooth-sweep oscillator of this oscilloscope, and the sync signal is applied to one section of the tube. A good rule to follow in receiver servicing is to check tubes first before proceeding with other tests, and we extended the rule to apply in this case also. The 6J6 was tested in a tube checker and proved to have a heater-to-cathode short in one section and a grid-to-cathode short in the other section of the tube. Replacement of the 6J6 tube cleared up the trouble.

Case History No. 2

The instrument was another oscilloscope. The symptom was a blown fuse. Fuses have been known to blow for no apparent reason other than old age or continued jarring, so the first step was to replace the fuse. When the fuse was replaced, no sweep could be obtained; and this indicated that there was some definite trouble which caused the fuse to blow.

The tubes of the sweep circuit were checked first but were found to be normal. The 5Y3 low-voltage rectifier tube was checked next and proved to be defective. The exact nature of its defect was not determined, but it was thought that a portion of the filament was shorted to itself. This type of short would not be shown by the tube checker; however, the fuse lamp of the tube checker glowed brightly, indicating a heavy current drain by the 5Y3 tube. When the defective 5Y3 tube was replaced, the oscilloscope was restored to normal operation.

Case History No. 3

This was a case of hum in the vertical-amplifier section of an oscilloscope. As it developed, there was also reduced amplification in this section; but this symptom was not so obvious as the hum.

Lest the reader get the idea that oscilloscopes are particularly prone to develop troubles, it might be well to point out that the quantity of parts and tubes and the amount of circuitry in an oscilloscope far exceed those of most other test instruments. If we therefore make a part-by-part comparison, the oscilloscope does not fare so badly; although the number of failures per oscilloscope might appear to be higher than the number of failures in another type of instrument.

In tracing the trouble, the tubes were tested first for possible shorts or reduced transconductance, but nothing unusual was found by these tests. Next, the grids of the stages in the vertical-amplifier circuit were shorted one at a time to the chassis to see if this would eliminate the hum signal. The oscilloscope utilized a push-pull circuit for the vertical amplifier, and it was noticed that the hum signal was unchanged when any grid on one side of the push-pull circuit was shorted; but if any grid on the other side were shorted, a change was seen. This clue led to the discovery that one of the coupling capacitors to the deflection plates was open. With only one side of the push-pull circuit effective, its hum-cancelling properties were nullified, with the result that hum appeared on the oscilloscope screen. The open capacitor was also the cause of the apparent reduction of amplification in the vertical-amplifier circuit.

Case History No. 4

This was a case of a VTVM which could not be adjusted to zero on the lower ranges. The meter needle was off zero in one direction for the AC and the negative DC ranges and in the other direction for the positive DC ranges.

Tubes were checked first both by using a tube checker and by substitution, but no defect in them was noted. It was decided next to check the voltages. No reference voltages were available, but all voltage readings seemed to be reasonable. By means of an ohmmeter check, the trouble was located. A half-watt, carbon resistor in the cathode circuit of the bridge amplifier tube had changed from its rated value of 220K ohms to 1.5 megohms. When this resistor was replaced, the VTVM was restored to normal operation.

Case History No. 5

In this case, a combination VTVM and VOM would give no readings on the 60-volt, 300-volt, and 1,200-volt AC ranges. This trouble was comparatively easy to locate. The schematic was consulted, and the components common to these ranges were examined. A resistor in the voltage-divider network was found to be open.

Case History No. 6

This was another oscilloscope trouble — the horizontal traces were compressed at one end. This symptom might have been caused by the sweep-oscillator tube itself or by some nonlinear operation of the horizontal-amplifier circuits. When the horizontal-gain control was varied through its range, the trace remained compressed at one end, even though the width of the sweep varied. This seemed to indicate that the trouble was not in the amplifier section; consequently, the sweep-oscillator tube was checked and proved to be defective. A new 884 sweep-oscillator tube cured the trouble.

To Repair or Not to Repair?

The aforementioned troubles were easily corrected. Half of the troubles required merely the replacement of tubes. Of course, the technician will not always find that repairs can be made so easily; and in some cases, repair may not be advisable. Even the replacement of a tube may involve complications if the tube is in a critical frequency-determining circuit, as it might be in some high-frequency generators.

The technician will probably feel like steering clear of repairs involving VHF or UHF circuits of a frequency-determining nature or of repairs involving some new and complicated circuit. Some manufacturers advise against any repairs other than those performed by authorized personnel, and the technician will probably not care to take the chance of voiding the manufacturer's guarantee in such cases.

The foregoing cases were not selected as the simplest examples in our notebook of case histories; however, it is probable that the majority of troubles which the technician may meet in his own equipment will be of an equally simple nature and can be easily repaired by him.

PAUL C. SMITH

Dollars & Sense Servicing

(Continued from page 29)

TRADE-INS. The auto industry sells cars by adding something new each year to make the old models seem obsolete faster, then it offers tantalizingly high trade-in allowances for the old bus. It works, even though most everyone knows that the new-car list prices are made high for just that very purpose.

The television industry, on the other hand, keeps its dealer discounts so low that trade-in allowances are scarcely any more than the old set is worth. To make matters still worse, General Electric is now making available a covering material that will give old sets that new look for just a few dollars. It's a plastic material that sticks to any surface without glue, and it comes in four solid colors as well as in three plaids and three wood grains. If interested, see your General Electric tube distributor; this may be just the thing to spruce up those trade-ins so they'll sell faster. The big question is, "Do modernized old sets hurt the sale of new sets?"

SUNSPOTS. Another cycle of spots on Old Sol comes around in the next few months and lasts for several years. It may very well bring an epidemic of unfixable TV complaints. The trouble occurs because the sunspots make ionospheric layers reflect higher frequencies back to earth. TV signals on the lower channels (2, 3, and 4) are then reflected back to earth some thousand or so miles away and there cause interference with local TV signals.

First signs of the interference are usually dark horizontal lines moving up or down on the screen. Line pairing may also occur. A while later, the local signal may start to lose sync and get worse and worse until finally the distant signal may take over entirely. The transistion may sometimes take several hours, and then again it may happen so fast that the set seems to have been switched.

In some situations, an improved antenna array may help; but in general, there's not much that can be done about this type of interference. Remember that it occurs on low-channel stations; the viewer can therefore tune to higher-frequency stations when the trouble gets too annoying.

DEFINITIONS. For those wanting a good start toward becoming automation specialists, Minneapolis-Honeywell published in its magazine "Instrumentation" some interesting definitions of the new terms that have come up. We liked the D-terms best, so here they are as a sample:

damping — A characteristic which is built into wives and which functions when husbands bring up the subject of conventions.

data handling system — A ladies' bridge club.

dead band — A dance orchestra at 3 a.m.

derivative action — The act of finding out where you've been before you get there.

deviation — The opposite of multiplication.

differential gap — The difference between your pay check and your monthly bills.

digital computer — A guy who counts on his fingers.

digital converter — A power saw.

discrete units — Units that have been un-creted.

The chances are pretty good that you can get the complete set of these confusing definitions, along with the Honeywell Automation Dictionary that gives more useful but still nontechnical definitions, by shooting a letter of request to Minneapolis-Honeywell Regulator Co., Wayne & Windrim Aves., Philadelphia 44, Pa.

TAPE. Home sales of reels of prerecorded magnetic tape average around 600 copies of each selection, with most going to high-fidelity enthusiasts, according to Electronics magazine. The saturation market today is only about 4,000 copies. Chief drawbacks of tape are listed as loading difficulties, awkwardness in handling short selections, danger of accidental erasure, and higher cost (partly due to the fact that the base material for a disk costs only about 19 cents as compared to a dollar approximately for comparable magnetic tape). In the background-music field in industry, tape has taken over almost exclusively, however.

TICKTACKTOE. If your lifetime ambition is to build a machine that will never lose a game of ticktacktoe, you can learn how to build one for just $28. This gets you a course in baby computers, including construction plans for a robot ticktacktoe player, electrical combination locks, puzzle-solving machines, secret coders and decoders, and a machine to play Nim. Publisher is Edmund C. Berkeley & Associates, 815 Washington St., Newtonville 60, Mass. Despite the games, the course gives serious and worth-while training in elementary computer design for those seeking to break into this rapidly advancing new field.

FIZZLES. Not so good are the recently released results of four testing programs of guided missiles which are now obsolete — even when these results are compared with the performance of TV sets. Of the 68 captured V-2 rockets that were later launched in the United States, only 32 worked at all well; 13 only just managed to get going; and 23 fizzled completely. The electronic guidance system was the cause of 60 per cent of these failures.

The Viking, which is our own modified version of the V-2, was still worse; nine tests gave three good flights, one just acceptable, and five flops. The Bumper, a two-stage missile that was basically a V-2 with a small rocket mounted on its nose, had two good flights out of eight tries. The Hermes ground-to-air missile designed for 6-minute flights averaged only 20 seconds per flight in the first series of tests and 160 seconds in the second series.

Modern missiles such as the Nike do much better, though their performance records have not been released. There are still some fizzles, however, judging from the number of articles published recently on reliability of components and equipment.

Even with practically unlimited funds, it is still not possible to build in large quantity a piece of complex equipment or even a single component that will never fail under any condition; therefore, don't feel bad if you get a callback on a TV set right after a complete overhaul. Just explain to the customer that even million-dollar missiles have fizzles now and then and that he should be thankful it's a TV fizzle rather than an H-bomb missile running out of control over his head.

MOTELS. Although the older motels prefer coin-operated TV sets, the approximately 3,000 new motels going up each year are putting in regular TV sets for free use along with the rest of the furniture. Initial installations can be financed along with furniture and construction costs. The TV sets can be paid for out of slightly higher room rates. One cost figure covering installation, service and carrying charges, and amortization is 22 cents a day.

Older motels generally do not have the cash nor the desire to undertake outright purchase or to pay fixed rental fees. Instead, they are usually served by a local distributor or dealer who handles everything, empties the coin boxes regularly, and gives the motel from 10 to 25 per cent of the gross take.

Most important to the success of hotel-motel TV is good service. Hotels in particular should appreciate this. It's definitely annoying, knowing that you're paying plenty extra for that set in your hotel room, to turn it on and get a messy picture or none at all — yet that's been our personal experience in quite a few hotels lately.

SUBDEC. This newly coined word stands for submarine decoy, an electronic gadget that makes noises exactly like a submarine. Several of the decoys can be fired from regular torpedo tubes or from flare guns when the going gets tough on a submarine, to confuse completely the enemy destroyers or submarine chasers. Still secret are the details of how it simulates the gear whine, propeller thrashing, and other noises made by a submarine in operation.

Synthetic sounds can take care of enemy listening devices, but what about sonar? Does the gadget also transmit a sonar beep each time it is hit by a sonar beam, in imitation of the beep reflected by a regular sub? The answer has probably not been released as yet.

PINCUSHIONS. A 12-hole plastic cap that fits over the base of a picture tube to cushion its pins has been brought out by Sylvania. It prevents accidental damage to pins during shipping or while the tube is on the service bench, and makes it easier to slide the ion trap over the tube base.

JOHN MARKUS

(Advertisement)

latest JACKSON tube test data

TUBE TYPE	MODEL 648 FIL.	CIRCUIT D	CIRCUIT E	PLATE TEST	MODEL 715/115 FIL.	X	PLATE	YZ
6CH7	6.3	A1237	A 45	41V	6.3	7	17	2LR
			A 89	41V			17	4NR
6CR6	6.3	AC123	AC456	25YZ	6.3		22	2JMNR
		C123	7	80X			33	6Q
12AB5	12.6	129	B346	35W	12.6	46	18	7JKS
12CR6	12.6	AC123	AC456	25YZ	12.6	-	22	2JMNR
		C123	7	80X			33	6Q
Latest Chart Form 648-14					Latest Chart Form 715/115-8			

MODEL 49	TUBE TYPE	SEC.	A	B	C	D	CATH. SHORTS	E
Latest Chart Form 49-3	6CH7	T	6.3	4	9X	12	3	30
		T	6.3	4	9X	67	8	30
	6CR6	P	6.3	3	X	567	1	32
		D	6.3	3	-	2X.	1	47
	12AB5	P	12.6	4	68	139	7	6
	12CR6	P	12.6	3	X	567	1	32
		D	12.6	3	-	2X.	1	47

Examining Design Features

(Continued from page 15)

chassis now adopted by the majority of TV manufacturers has demanded the use of smaller, lightweight components. This has, in some instances, affected the design and construction of flyback transformers. Many of the latest flyback units feature smaller cores and windings with a noticeable reduction in the size of the terminal boards used. In some receiver designs, the high-voltage cage has even been eliminated in order to conserve space. The autoformer shown in Fig. 2 is employed in the Setchell-Carlson Model P-61, and it mounts on a vertical chassis without a high-voltage cage. This unit has an AFC/AGC winding and employs a small circular terminal board.

The flyback pictured in Fig. 3 is of an unusual design and is employed in the Sylvania Model 612MU. This unit has a relatively small autoformer type winding and drives a 21-inch picture tube. The Emerson Model 1066D incorporates a somewhat different style of flyback transformer like that shown in Fig. 4. The transformer windings are wound in layers around a small 3/8-inch core and are electrically connected as an autoformer.

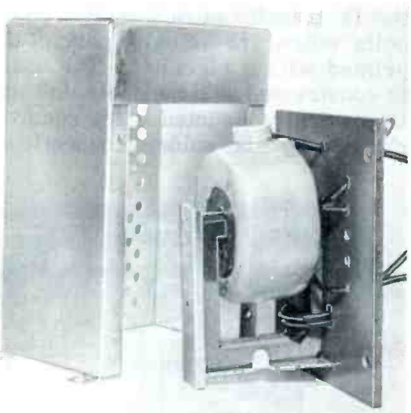

Fig. 4. Flyback Transformer and High-Voltage Cage Used in Emerson Model 1066D.

An example of critical mounting space is illustrated in the photograph in Fig. 5. This unit is employed in the General Electric Model 21T17 which uses a 21YP4A picture tube. The autoformer action develops a maximum high voltage of 17.5 kilovolts. The circuit employs a conventional 6BQ6GA output tube, a 6AX4 damper, and a 1B3GT rectifier. This transformer is mounted in a can approximately the size of a normal coffee can. The leads of the high-voltage rectifier are well protected by large feed-through insulators, which are also visible in Fig. 5.

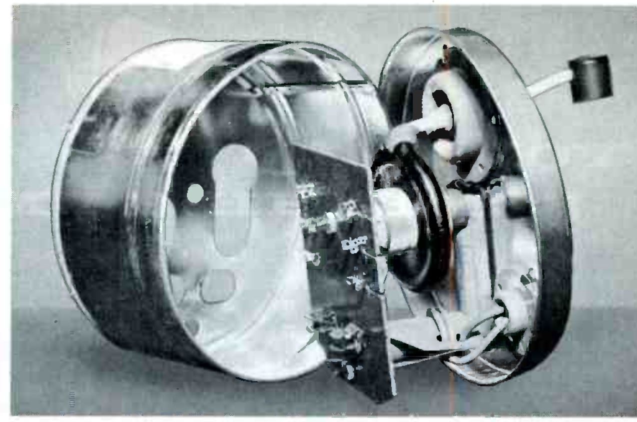

Fig. 5. Flyback Transformer Employed in General Electric Model 21T17. Note the Unusual Mounting Style and High-Voltage Can.

The small size of the complete chassis and particularly the small space allotted to the flyback transformer in many of the new receivers points up the need for extreme care in selecting the proper flyback replacement. Proper lead dress also becomes an increasingly important factor.

The wide deflection angle required by many of the newer picture tubes has brought about a change in the design of the deflection yoke. Yoke inductances have been increased because of additional turns of wire necessary to produce adequate deflection with a reasonable amount of drive. The additional turns also account for the higher inductances found in many of the new flyback transformers.

Another design trend which has been noticed during this year is the elimination of the width and linearity controls from the flyback circuit. Increasing numbers of the smaller inexpensive receivers are without these controls, but the receivers usually require more exacting circuit design.

RCA Printed Type Components

The printed-wiring board shown in Fig. 6 represents the video IF strip employed in the RCA Model 17-S-6022 television receiver. Noticeable features of this circuit are the IF transformers and RF choke coils which are actually part of the printed-wiring circuitry. The board is constructed as a separate unit and is physically mounted on the receiver chassis by six solder connections.

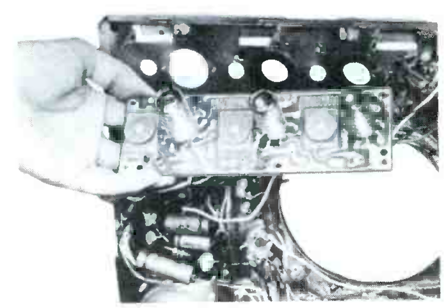

Fig. 6. Printed Video IF Strip Employed in the RCA Model 17-S-6022 Television Receiver.

The IF transformers consume very little chassis space and consist of flat copper inductors which have been etched into the printed-wiring board in a rectangular pattern. The transformers are adjusted in a manner similar to conventional transformers that are bifilar wound; however, a flat circular metal disc replaces the old type of core or slug. This disc is mounted in a parallel plane with the transformer windings, and it is supported by a screw type of shaft that extends through the printed-circuit board. While the shaft is being rotated, the distance between the printed windings and the metal disc is varied, and thus the effective inductance of the transformer is increased or decreased. Tuning adjustments for these IF transformers are accessible through holes in the chassis, which can be seen in Fig. 6. The three stages of video IF amplification are stagger tuned and designed to operate in the 40-mc range of frequencies.

An insulation material of fiber glass is applied to the IF transformer windings before the dip-solder operation so that the windings will not become coated with solder. In addition to this precaution, a glass type of cloth is bonded directly to the printed transformer to provide an insulation against arc-over. The printed IF transformers may be replaced by conventional bifilar-wound units. The first step in replacing a defective transformer of this type is to remove the adjustment screw and disc; then unsolder the original windings from the printed-wiring connections. Next, enlarge the screw hole to accommodate a replacement which has had the mounting clip removed. Cement the new coil form to the board. Make sure that the terminals are in a convenient position for wiring. When replacing either of the first two printed IF transformers, it may be necessary to add a 56K-ohm resistor across the primary winding of the replacement unit in order to obtain proper bandpass.

The use of RF chokes in the filament string of the video IF strip is another noticeable departure from the conventional printed circuit. The choke inductances are etched onto the wiring board in a zigzag pattern in a manner similar to that of the printed IF transformer, and each choke is about 1 3/4 inches in length. Two of these printed chokes are employed in this receiver and may be seen in the photograph of Fig. 6 near the top of the printed-wiring board. Should it become necessary to replace a damaged printed choke, a conventional filament choke may be connected to the original printed-wiring circuit.

Servicing Aid for Color TV

Servicing of the Hoffman Model 21M1100A color receiver is made much easier by a hinged panel which forms one side of the cabinet. The new Hoffman receiver is shown in Fig. 7 with the panel open and the underchassis wiring exposed. The rear cover must be taken off and the two nuts holding the panel must be removed before the panel is free to swing outward. This is done as a safety precaution because the interlock is automatically broken and the

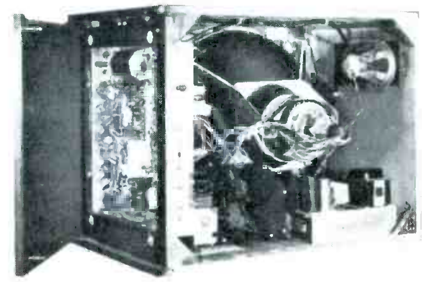

Fig. 7. The Hoffman Model 21M1100A Color Television Receiver.

receiver is without power when the back is removed. This hinged panel facilitates the testing and replacement of all components without chassis removal and should prove to be a great benefit to the service technician.

Resistors in Series-Filament Circuits

The past year has brought with it a new look in television design, namely, the vertical chassis. A majority of the leading TV manufacturers are now featuring small lightweight vertical chassis that employ selenium rectifiers and no heavy power transformer. In order that filament voltage will be supplied to the tubes in these new chassis, the heaters are connected in series across the AC power line. Previous series heater arrangements have not proved too practical because of the widely different warm-up periods existing in the tubes which were available in the past. The unequal filament characteristics of these older types of tubes resulted in frequent filament burnouts. Many earlier designs incorporated shunt resistors in the filament circuits, and this also contributed to tube failure whenever the resistors would change value.

In order to overcome these conditions, new tubes which were especially designed for use in series-filament strings were developed. All heaters in this new line of tubes draw 600 milliamperes of current and are constructed to have controlled heating time so that voltage fluctuations during the warm-up period will be eliminated. Many resistors of special design are used in series-filament circuits. Voltage-dropping and surge-limiting resistors play important parts in providing the tubes with proper heater voltages. A brief description of the illustration presented in Fig. 8 is intended to

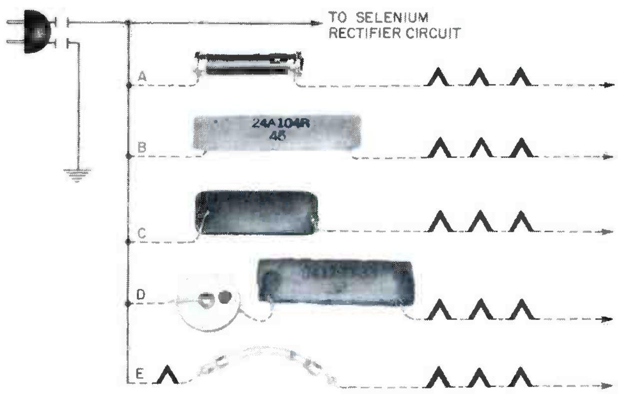

Fig. 8. Various Types of Filament Resistors Now Being Used in the Newer Television Chassis. Branches A Through E Represent Partial Circuits Taken From a Few Individual Receivers.

acquaint the reader with a few of the resistors now being used in the filament circuits of some of the latest TV designs.

The resistor shown in branch A of Fig. 8 is employed in the Motorola Chassis TS-530. This resistor has a negative temperature coefficient, and it acts as a surge limiter during the warm-up period. The characteristics of this component cause it to decrease in resistance as its temperature increases. It has a resistance of approximately 250 ohms at normal room temperature and decreases in resistance at the same rate that the tubes warm up until, at operating temperature, the resistance has gradually dropped to approximately 19 ohms. This resistor is also small in size to have a power rating of 7 watts.

The new Hallicrafters Chassis A1900D employs a familiar type of filament-dropping resistor that may be seen in branch B of Fig. 8. This unit is a sugar-coated wire-wound resistor rated at 20 watts, and it drops approximately 27 volts at normal operating current. It is mounted on a terminal strip located to the rear of the vertical chassis to afford adequate ventilation.

The resistor pictured in branch C of Fig. 8 appears in the Truetone Chassis 21T29. This chassis is not designed for the new 600-ma tubes; however, it makes use of a series-parallel filament circuit in which three 25-volt, 300-ma tubes are connected in series; and the remaining tubes are arranged in parallel and supplied by a filament transformer. The wire-wound resistor found in the series circuit has a value of 133 ohms and a power rating of 15 watts.

Another typical example of the new 600-ma series-filament circuits is reflected in the RCA Chassis KCS94. The two series resistors used in this design are shown in branch D of Fig. 8. The circular-disc type pictured at the left is a special surge-limiting resistor with a negative temperature coefficient. Its body is one inch in diameter and 1/8 inch thick. This unit has an approximate resistance of 450 ohms when cold and 9.5 ohms when hot. When the receiver is first turned on, the high resistance offered by this component reduces the usual surge current. In some conventional parallel-filament circuits, the initial surge current may be as high as seven times that of the normal current. In the new RCA circuit, however, the surge current never exceeds more than one and one half times normal current; and the tubes reach operating condition in about 30 to 45 seconds.

In addition to this surge resistor, a 38-ohm dropping resistor is employed. It is also a 20-watt wire-wound unit similar to that referred to in branch B of Fig. 8. The receiver manufacturer states that greater reliability can be expected with this arrangement than with conventional parallel-heater circuitry.

The flexible resistor shown in branch E of Fig. 8 represents another type of series-filament resistor currently employed in the Airline Model GSL-4013A. This resistor has a resistance of 9.5 ohms and a power rating of only 3.5 watts. In this circuit, a 19AU4 filament is connected ahead of the dropping resistor. A 6SN7GTB tube and a 25CD6GA tube are part of the series string, and they must be replaced with the same types of tubes. Similar tubes such as the 6SN7GT, 6SN7GTA, or 25CD6G are not suitable replacements because of the extreme difference in heater characteristics.

If it becomes necessary to replace a defective filament resistor, care should be taken in choosing the correct type and value. In the case

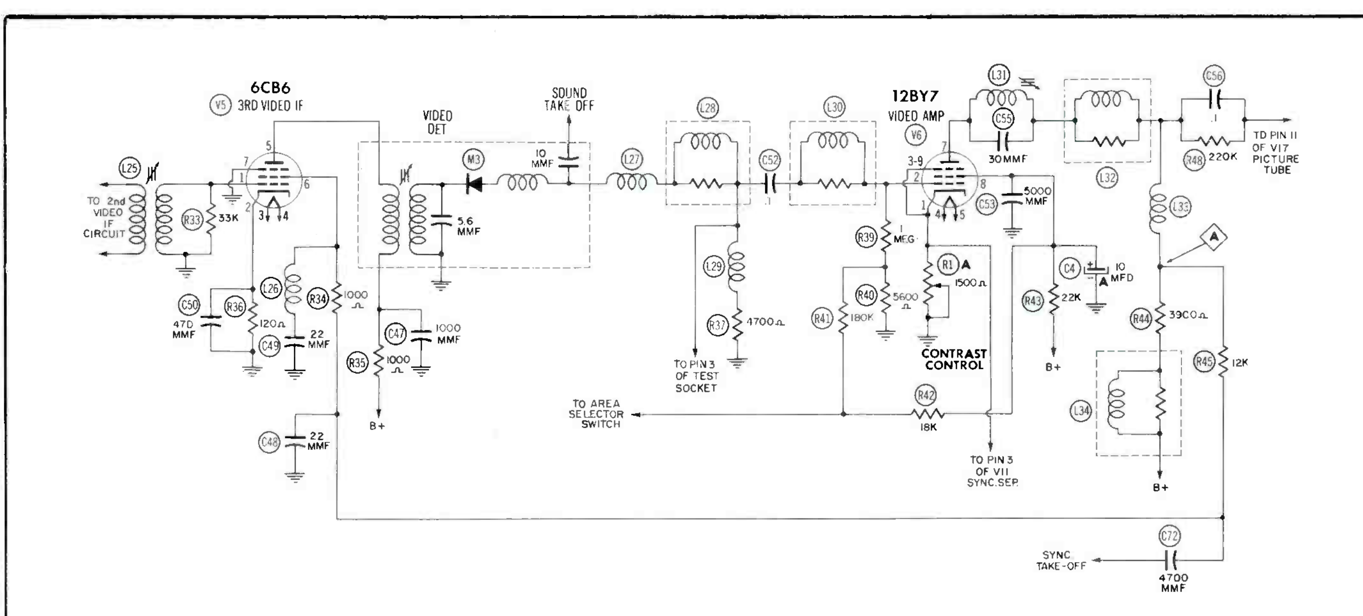

Fig. 9. Partial Schematic Diagram of Motorola Chassis TS-609 With Frame-Lock Circuit.

of a temperature-compensating resistor, an exact replacement should be obtained. Replacements for the filament-dropping resistors should always have adequate power-dissipating qualities, and their tolerance should never exceed 10 per cent.

Motorola Frame-Lock Circuit

The Motorola TV Chassis TS-609 incorporates a unique method of solving some of the problems encountered in fringe areas. In many of these areas, the signal-to-noise ratio is very poor. Reception is often marred by such troubles as horizontal pulling and vertical flop-over. In order to cope with these troubles, Motorola has used a type of noise-inverter circuit which they call a "frame-lock" circuit.

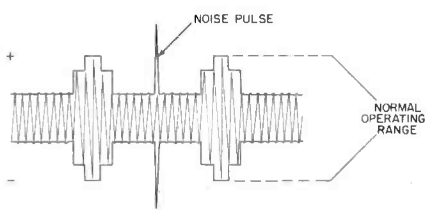

Fig. 10. Noise Pulse in Signal at Input to Third Video IF Amplifier.

A partial schematic diagram showing only the third IF amplifier, video detector, and video amplifier of the Motorola Chassis TS-609 is illustrated in Fig. 9. The third video IF tube V5 is operated as a class-A amplifier at the video intermediate frequency. Screen voltage for this tube is obtained from the B+ line through the series components L34, R44, R45, and R34. The screen is bypassed by the series-resonant circuit composed of L26 and C49. These last two components form a bandpass filter which has a low impedance to frequencies in the IF range but a rather high impedance to the video and noise frequencies.

With these facts in mind, the function of the noise-inverter circuit may be more clearly understood. If a noise pulse of sufficient amplitude appears in the composite video signal at the input to V5, as shown in Fig. 10, the tube will be driven toward saturation by the positive excursion of the noise pulse. This condition will cause the screen voltage to drop for the duration of the noise pulse. This sudden drop in screen voltage develops a negative pulse at point A. The width of this pulse is directly proportional to the width of the original noise pulse applied to the control grid of V5.

At the same instant that a negative pulse is developed at point A, the video signal with the noise pulse is coupled to the video-detector stage. At the output of the crystal detector, the polarity of the noise pulse is negative. See Fig. 11. This signal is then amplified and inverted by the video amplifier V6. Thus, a positive noise pulse which has been limited slightly will appear at the plate of V6. The positive noise pulse passed by the video amplifier and the negative pulse derived from the screen grid of V5 are approximately equal in amplitude but are opposite in polarity. These two pulses occurring at the same instant and having the same pulse width will tend to cancel each other at point A; therefore, these pulses will never actually appear across the video-output load.

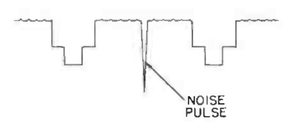

Fig. 11. Noise Pulse in Signal at Output of Crystal Detector.

The resulting signal which is fed to the sync section through capacitor C72 is relatively free of interfering noise peaks.

The manufacturer has tentatively designed a variation of this circuit to be used in those Motorola chassis which employ a keyed AGC system. The modifications in this new circuit may be seen in the simplified schematic diagram of Fig. 12.

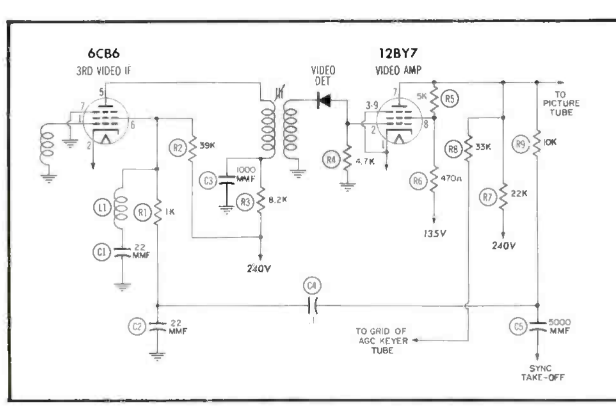

Fig. 12. Modified Frame-Lock Circuit for Sets Having Keyed AGC Systems.

(This schematic diagram does not necessarily represent actual wiring employed in any of this manufacturer's receivers.) In this circuit, the third video IF amplifier obtains its screen voltage from a 240-volt supply through resistor R2. Any noise pulse introduced to the grid of the third IF stage will result in a negative pulse appearing on the screen; however, a coupling capacitor C4 has been added to eliminate any DC path between the screen grid of the video IF amplifier and the grid of the AGC tube. In other respects, the circuit in Fig. 12 operates in a similar manner to the circuit in Fig. 9.

LESLIE D. DEANE

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1. The names and addresses of the publisher, editor, managing editor, and business managers are:

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4. Paragraphs 2 and 3 include, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting; also the statements in the two paragraphs show the affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner.

(Signed) HOWARD W. SAMS, Publisher

Sworn to and subscribed before me this 28th day of September, 1955.

(Seal) Frances T. Dobbs, Notary Public

Power Factor

(Continued from page 23)

The burden of this inefficiency must be borne by the power company in that the company will have to furnish greater current output as well as generators, lines, and transformers which are capable of handling this greater current. Many power companies, therefore, offer reduced rates to customers who use great amounts of power and who combat low power factor with corrective measures. One method which can be used to raise the power factor of an inductive motor is to connect a large capacitor in parallel with it.

The effect of the capacitor is to create a circuit which is parallel resonant at 60 cycles. The large reactive currents are then confined within the resonant circuit in the same manner that the currents in the tuned plate circuit of a transmitter are confined.

If either inductive or capacitive reactance predominates over resistance in a circuit, the phase of the current in the circuit will be shifted with respect to the phase of the voltage in the circuit. If the load is almost completely capacitive, the current will lead the voltage by nearly 90 degrees; and if the load is nearly all inductive, the current will lag the voltage by almost 90 degrees. The conditions which produce a large phase angle between applied voltage and total current are the same as the conditions which cause the power factor of a circuit to be low.

The Wattmeter

A wattmeter compensates for power factor and measures the actual power which is consumed by a load. Fig. 2 shows a simplified schematic diagram of a wattmeter movement. The lower coil, fixed in position and wound of heavy wire, is connected in series with one side of the power line. The strength and polarity of the magnetic field of this coil are determined by the current which passes through the load. The upper coil, movable and wound with many turns of fine wire, is placed in parallel with the load. The strength and polarity of the magnetic field of this coil are determined by the voltage across the load. The magnetic fields of the two coils interact, and the total magnetic force on the movable coil is proportional to the product of the voltage and the current. Because of the inertia of the meter movement, however, the pointer of the wattmeter will register the average of all the products of instantaneous voltage times instantaneous current. This average will be the actual power consumed by the load.

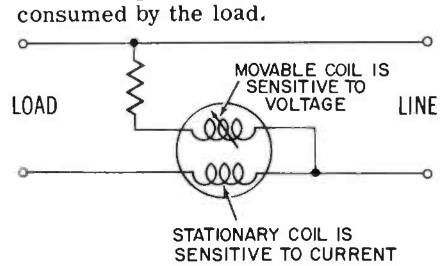
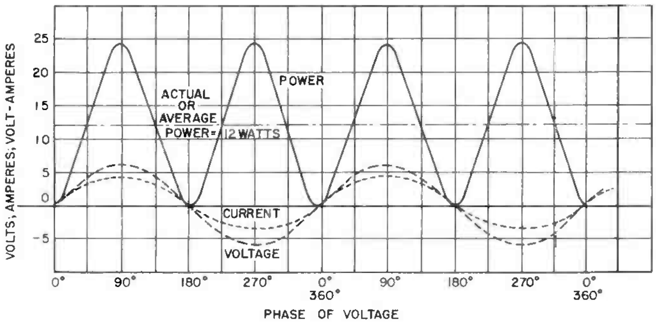


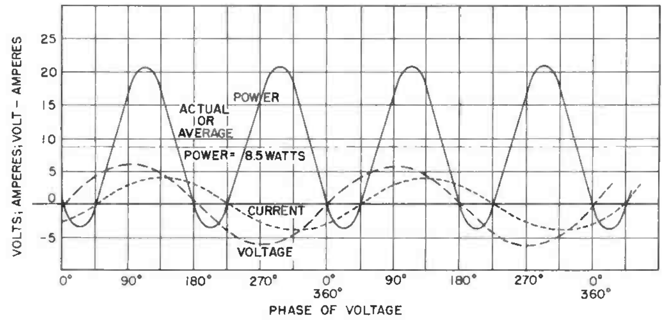
Fig. 2. Simplified Diagram of a Wattmeter.

When a wattmeter is connected to a purely resistive circuit, the polarity of the voltage across the movable coil is reversed every half cycle at the same instant that the polarity of the current through the fixed coil is reversed. The forces of the two magnetic fields tend to deflect the pointer in the same direction at all times.

If the wattmeter is used to measure power in a reactive circuit, the polarity of the magnetic field of one coil in the meter is reversed with respect to that of the other coil during the brief intervals when the



(A) When Current Is in Phase With Voltage.



(B) When Current Lags Voltage by 45 Degrees.

Fig. 3. Voltage, Current, and Power Curves.

voltage and current are not of the same polarity. The movable coil momentarily tries to change its direction of rotation, and the average deflection of the pointer is less than it would be if the circuit were purely resistive.

The graphs of Fig. 3 are presented to demonstrate that the actual power indicated by the wattmeter is reduced during conditions of low power factor. The voltage curve on each graph is a sine wave of AC voltage with a peak-to-peak amplitude of 12 volts. The current curve is a sine wave with a peak-to-peak amplitude of 8 amperes. These values of current and voltage are assumed for both sets of graphs. Each point on the power curve for each graph represents apparent power in volt-amperes at a particular instant.

If the circuit is purely resistive, the voltage and the current will be in phase, as they are in the graph of Fig. 3A. In this case, the product of voltage and current values will always be positive; consequently, the power curve does not extend below the zero axis. This is true even during the negative half cycles of current and voltage, because a rule of algebra states that a minus quantity times a minus quantity equals a plus quantity. The axis of the power curve represents the actual or average power and is the level which will be indicated by a wattmeter.

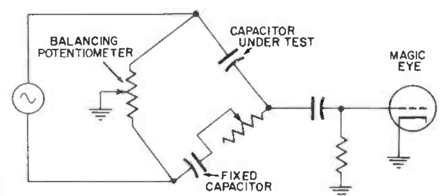
If capacitive or inductive reactance is introduced into the circuit, the current will lead or lag the voltage. In the graph of Fig. 3B, it is assumed that the phase of the current lags the phase of the voltage by 45 degrees. There are short intervals during which either the current or the voltage is positive while the other is negative. During these intervals, the power curve dips below the zero axis (because a plus quantity times a minus quantity equals a minus quantity.)

It can be observed that the peak-to-peak amplitude of the power curve in Fig. 3B is the same as it is in Fig. 3A. The actual or average power which can be measured with a wattmeter is represented again in Fig. 3B by the axis of the power curve; however, the axis of this power curve is at a different level because portions of the curve are below the zero axis.

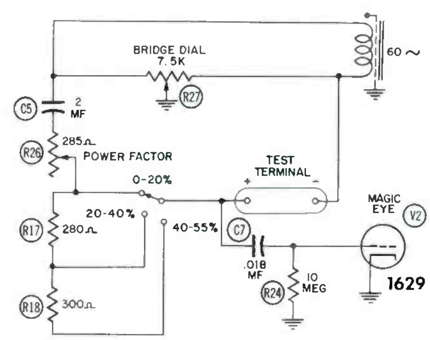
Power Factor of Capacitors

Power factor is present in capacitors as well as in power lines; but for capacitors, the goal is a low rather than a high power factor. The power factor of a capacitor is the percentage figure represented by the ratio between the amount of power dissipated in the capacitor and the total number of volt-amperes of input. The power losses in capacitors occur mostly in the dielectric. Each material used as a dielectric has its own characteristic power factor. For mica, ceramic, and paper capacitors, this figure is considerably less than one per cent. Electrolytic capacitors are the ones that are most subject to a high power factor, and the factor becomes higher with age. A capacitor tester generally incorporates a circuit with which the technician can check the power factor of electrolytics.

The internal loss of a capacitor can be treated as though it were the power dissipation of a resistor placed in series with the capacitor. In the simple capacitance bridge shown schematically in Fig. 4A, a variable resistor is placed in series with a fixed capacitor of known value to make an increase possible in the apparent power factor of the fixed capacitor. The calibrated power factor of the known capacitor can thus be balanced against the unknown power factor of the capacitor which is being tested, and the unknown power factor will be indicated.



(A) Typical Simplified Circuit.



(B) Circuit in Sprague Model TO-4 Tel-Ohmike.

Fig. 4. Bridge Circuit for Measuring Power Factor of a Capacitor.

The variable resistor is used to produce an exact balance of the bridge after the main balancing potentiometer has been adjusted. The dial attached to the main potentiometer indicates the value of the unknown capacitor, and the dial on the smaller potentiometer indicates the power factor. The tube in the circuit is a cathode-ray magic eye. Maximum width of the shadow on the face of the tube indicates that the bridge is balanced.

Fig. 4B is a schematic diagram of an actual circuit using the same design as the circuit shown in Fig. 4A.

The bridge circuit in Fig. 4B is found in the Sprague Model TO-4 Tel-Ohmike. The power-factor dial is calibrated in three percentage ranges of 0 to 20, 20 to 40, and 40 to 55. The higher ranges are obtained by placing fixed resistors in series with the variable resistor.

According to the recommendations of manufacturers of capacitor testers, a new electrolytic capacitor of low voltage rating can have a larger allowable power factor than one of high voltage rating. The following table shows the maximum permissible power factors for new electrolytic capacitors.

VOLTAGE RATING (working volts DC)	FACTOR POWER (percentage)
300 or more	15
150	20
25	30

The power factor of most new electrolytic capacitors will actually be much lower than these maximum limits. An increase in the power factor of a capacitor will have the effect of reducing the capacitance, because a greater proportion of the applied power is consumed instead of being stored. Replacement of old capacitors is recommended if the power factor is more than twice the figure listed in the table.

A nine-year-old filter capacitor containing two 20-mfd sections, each rated at 150 volts, was tested during the overhauling of an old radio receiver. The power factor of the input section was 15 per cent, and the figure for the second section was 20 per cent. No leakage was indicated in the test. The capacitance of each section had decreased to 15 microfarads.

Since the size of the input capacitor largely determines the B+ voltage in a conventional AC-DC power supply, a new capacitor was tried in the circuit to see whether the B+ voltage would rise. The new unit had a capacitance of 22 microfarads in each section, and the power factor of each section was 4 per cent. When the new capacitor was connected into the circuit, the potential at the input of the filter rose from 105 to 112 volts, and the B+ value was increased from 82 to 86 volts.

The voltage furnished by the old filter capacitor was slightly low, but it was still within reasonable limits for the circuit in which the capacitor was used. Whether high power factor in a capacitor will seriously affect the performance of a particular circuit is dependent on the physical placement and circuit connections of the capacitor. Losses of power within a capacitor cause it to heat abnormally, and it will break down sooner if it is in a crowded location where the heat cannot be dissipated. A circuit which requires a specific value of capacitance within close limits will be affected noticeably by the losses resulting from an increased power factor.

It should be repeated that the technician does not ordinarily have a service problem in regard to low power factor produced in the AC line by electronic equipment. In our laboratories, a number of television sets were checked for power factor by wattmeter, ammeter, and voltmeter measurements. The results showed a range of power factor from 87 to 97 per cent. Some of the departure from 100 per cent was probably due to the fact that the power factor already present in the AC line was low from other causes, but the variations from set to set were caused by the differences in the reactance values of the different circuits.

The measured power factor was affected only slightly when other equipment was plugged into the same line with the set which was being tested. Even the addition of a 1-horsepower electric motor, which operated at a power factor of 25 per cent under a light load, failed to lower the power factor of the television set by more than 1 per cent.

It is apparent that very heavy reactive loads, such as groups of motors and transformers, would have to be placed across the AC line before the power factor in the line would drop to an objectionable level. A line which is loaded down in this manner is subject to low line voltage and poor voltage regulation. A low power factor in the line affects the performance of radio and television equipment much more than a low power factor in the equipment affects the line.

THOMAS A. LESH

WOMEN. Over in England, more and more women are being employed by radio and TV service shops. One shop asserts that the greater manual dexterity of the female is a major advantage. Going still further, it hires only married women who have had at least one child, on the theory that their experience with crying babies makes them more sensitive to the slight differences in sounds produced by ailing sets.

MARKUS . . *Dollar and Sense Servicing*

Know Your Oscilloscope

(Continued from page 11)

always negative and so is always attracted to the positive plate.

The amount of deflection varies directly with the magnitude of the voltage on the deflection plates. For example, if a potential difference of four volts between a pair of plates causes the beam to move one inch at the screen, a difference of eight volts will cause it to move two inches, and so on.

If an alternating voltage of sufficient magnitude is applied to the vertical plates, the beam will move and will produce a vertical line extending from top to bottom of the screen; and similarly, the proper voltage applied to the horizontal plates will produce a horizontal line across the screen. By the proper choice of voltages for both sets of plates, the beam can be made to strike any point on the oscilloscope screen.

There are a number of interesting facts that can be mentioned concerning the deflection system of the cathode-ray tube. The deflection sensitivity of a cathode-ray tube and of the entire oscilloscope is of great interest to the technician because it determines the weakest signal which can be successfully viewed with the instrument. Anyone who has consulted a tube manual about cathode-ray tubes may have noticed that deflection sensitivities can cover a wide range, depending upon the choice of voltages used. The sensitivities are also different for the two pairs of deflection plates, one sensitivity being greater than the other. For example, one tube manual lists the following sensitivities for a 5CP-1A cathode-ray tube. When the voltage of anode No. 3 is twice that of anode No. 2, the sensitivity is 39 to 53 volts DC per inch for every thousand volts supplied to anode No. 2. This range applies to one set of deflection plates. For the other set under the same voltage conditions, the sensitivity is 33 to 45 volts DC per inch per thousand volts supplied to anode No. 2. A different set of sensitivity figures is listed for the tube when anode No. 2 and anode No. 3 have equal voltages.

The pair of plates having the highest sensitivity (that is, requiring the smallest number of volts per inch of deflection) is always the pair nearest the base of the tube. The reason can readily be seen by examining Fig. 4. Equal voltages on each pair of plates will swing the

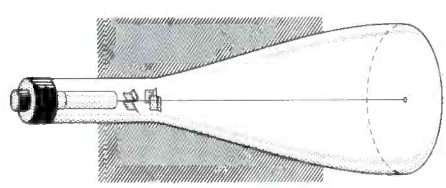


Fig. 4. Path of Electron Beam Through Deflection-Plate Assembly.

beam through equal arcs of travel; but since the pair nearest the base is in effect swinging a longer beam, the signal on that pair will cause the spot to travel a greater distance on the screen of the tube.

Either pair of plates can be used for the vertical system, and the rotational position of the tube about its long axis determines which pair. In order that the highest possible deflection sensitivity may be obtained for the vertical system, it has become common practice for the cathode-ray tube to be positioned so that the pair of plates closest to the base will produce vertical deflection. The horizontal-deflection plates are usually driven by a stronger signal and are located farther from the base than the vertical-deflection plates.

Part II of "Know Your Oscilloscope" will appear in this magazine soon and will cover basic information about the operation of specific circuits in the oscilloscope.

PAUL C. SMITH

Codes and Regulations for Antenna Installations

(Continued from page 27)

large base will prevent roof damage and will also conform closely to the current building codes which govern

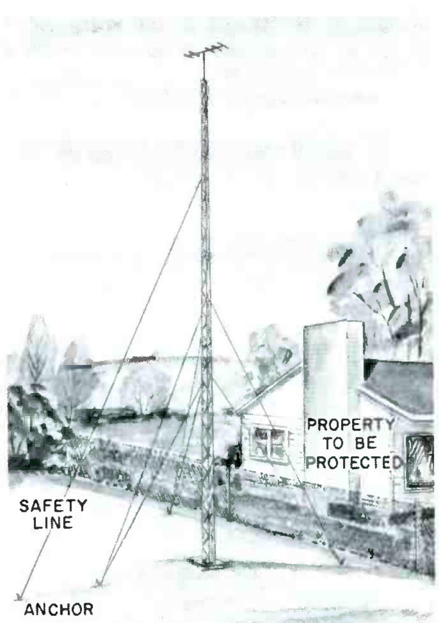


Fig. 2. When Antenna Mast Is Potential Hazard to Adjacent Property, Safety Line Must Be Secured to Mast on Side Away From Endangered Property.

the amount of weight per square foot that a roof structure can safely support.

Guy Wires

Material

The guy wires used to secure an antenna mast or support should be of a stranded type. A five-strand 20-gauge wire is recommended. In some localities, a six-strand 20-gauge or larger wire is required by the city code. A single-strand solid wire does not afford enough margin of safety, and it is not recommended for the guying of any structure.

The guy wire should be galvanized or treated to make it corrosion resistant. All other hardware used in making the antenna installation should be similarly treated to prevent corrosion damage.

The path of the guy wire should be open and clear between the anchor point and the ring or tie point on the antenna mast. The guy wire should not touch or come in contact with any obstructions such as roof edges, chimneys, or vent pipes.

Anchors

When the antenna is installed on the roof of a wood-frame building, the guy anchors should be set at least two inches into a solid structural member. An installation using only three anchors for the guy wires should have the anchors spaced 100 to 140 degrees apart around the mast. The anchors should not be placed closer to the base of the mast than one half the height of the mast.

Turnbuckles

When a guy wire is secured by a turnbuckle, the guy wire should be threaded through the turnbuckle to prevent the latter from turning. See Fig. 3.

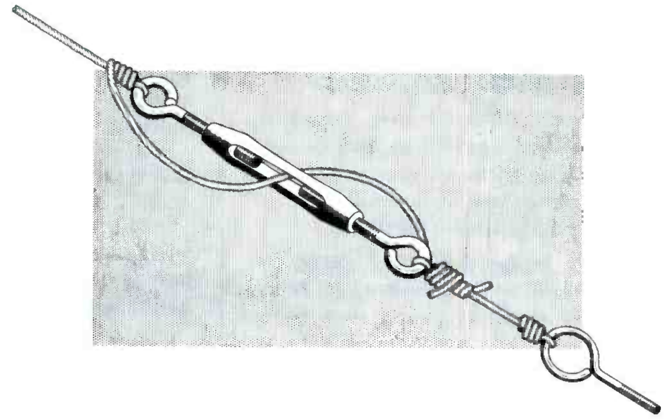


Fig. 3. Thread Guy Wire Through Turnbuckle to Prevent Turnbuckle From Turning.

Restrictions

Antenna guy wires should not be run over any street, alley, or public thoroughfare. Many cities have ordinances which prohibit running guy wires in this manner, and special permission should be received from the city in cases in which it becomes necessary to run guy wires over public ways. Guy wires should not be anchored to structures supporting public utility or power lines.

Transmission Line Outside the Building

The outside lead-in conductors for the antenna should not be run above electric power circuits, and the lead-in should be installed well away from all such electric wiring. The lead-in should be installed so that there can be no possible accidental contact with such power circuits. It is also recommended that the lead-in should be installed so that it will not run under any power conductors. If running the lead-in near an electric conductor cannot be avoided, a distance of at least two feet should be maintained between the lead-in and the electric wiring.

Transmission Line Inside the Building

Antenna lead-ins inside a building should be installed so that at least two inches of clearance will be maintained between the lead-in and any power conductor or wiring system in the building. When it is necessary to run the lead-in closer than two inches to an electric conductor, the lead-in must be permanently separated from the conductor by a firmly fixed nonconductor such as porcelain or flexible tubing.

Leads for control of antenna rotators should be installed in the same manner as the transmission lines. The rules which apply to the lead-in also apply to conductors for rotators.

Facts About Lightning

When an outdoor installation of a television antenna is made, the question of lightning protection arises. Many people are primarily concerned with protecting an installation against a direct strike of lightning; however, the danger that lightning will strike an antenna installation directly is very small. On the other hand, the induced effect of lightning can be of serious consequence. Before the grounding and protection of installations against lightning are discussed, the effects of these induced voltages should be considered.

Induced Voltages

A lightning discharge taking place miles away will create an induced voltage in a conductor in much the same way that a station transmitter induces a signal in a receiving antenna. This voltage is induced by the electrostatic and electromagnetic fields produced by the lightning discharge. Nearby lightning can induce high voltages in metal objects that are insulated; consequently, electrical discharges may occur between these objects and the earth or between them and other objects in the vicinity. These discharges are sometimes severe enough to damage materials, cause fires, and injure persons. In the case of an antenna installation that is not properly grounded, the television set can be seriously damaged by charges which are induced in the antenna and carried into the set by the way of the lead-in.

Bound Charges

A charged cloud above the earth will create an electrostatic field between it and the earth. This will cause an ungrounded mast and antenna in this field to take on a charge of opposite polarity to that of the cloud. The charge will accumulate as a result of leakage through insulation and also through the equipment to which the lead-in is attached. This charging of the antenna takes place over a reasonable period of time and does not damage the equipment or other material through which the leakage takes place.

The charge will be held or bound to the antenna by the electrostatic field between the cloud and the earth, and it will remain on the antenna as long as the cloud stays charged. At the instant the cloud discharges to another cloud or to the earth, this bound charge on the antenna is released even though the lightning flash may take place a mile or so away. The release of this bound charge has the effect of suddenly applying a very high voltage between the antenna and the earth.

If the installation is not grounded and has no lightning protection, the released charge will surge through the antenna lead-in to damage the receiver and also to create a fire hazard and possible shock injury to persons inside the building.

The voltage induced in a metal structure can be comparable to the voltage in a main stroke of lightning if the structure is in the immediate vicinity of the lightning discharge. An installation must be protected against the induced effects of a lightning flash in the same manner that it must be protected against a direct hit by the lightning bolt itself.

The ground wire and the lightning arrester are attached to a metal antenna structure to provide a low-impedance path to ground for the released charge on the antenna. The ground wire and lightning arrester will not prevent lightning from striking but will aid in preventing damage to persons and equipment near the structure.

Experiment and observation have provided data about the characteristics of lightning. From this information, a set of rules and regulations have been compiled which if followed will provide a large degree of protection from lightning damage.

Ground Wire or Conductor

The ground conductor for a receiving antenna and mast may be run either inside or outside the building. The conductor should be run from the mast or metal antenna support to the grounding electrode in as straight a line as possible and with no sharp bends.

The antenna ground conductor may be uninsulated. The wire should not be smaller than No. 14 copper wire, No. 12 aluminum wire, or No. 17 copper-clad steel wire. These are the minimum wire sizes that should be used for proper lightning protection. A conductor that is installed entirely inside a building should not be smaller than No. 18 wire. Wire sizes larger than these may be used.

The ground conductor should be fastened securely in place and may be attached directly to a surface without the use of standoff supports except in localities where regulations require that the ground wire be supported. The ground conductor should be securely connected to an underground water-piping system that supplied a community or to a local piping system, provided that the buried portion of the system is more than ten feet under the ground.

If such a system is not available, the ground wire may be attached to an underground gas-piping system or to any other metallic underground system. Where these systems are not available, an electrode consisting of a driven pipe, driven rod, a buried plate, or other device approved by the National Electrical Code for grounding electrodes should be used for connection of the ground wire.

Lightning Arrester

The term "lightning arrester" is a misleading name for this protective device because it does not stop nor arrest the lightning. The lightning arrester is a device used to present a shorter and a safer path for the lightning discharge to take in getting to the ground.

The lightning arrester does not present a short to ground, but it does usually provide a very small gap over which the discharge may take place. The small gap of the arrester is a lower impedance path to ground than the path through the receiver or other equipment.

Some types of lightning arresters use a gas tube as a conducting path to ground. The spark gap or the gas tube presents an open circuit to ground except when the induced voltage of a lightning discharge is applied across the terminals. The air in the gap or the gas in the tube ionizes and becomes a short circuit only during the time such a voltage is applied across it. Once the charge is dissipated, the lightning arrester becomes an open circuit to normal signals on the lead-in.

Each lead-in from an outside receiving antenna should be protected by a lightning arrester outside the building. If the arrester is placed inside the building, it should be installed as close as possible to the point of entrance into the building.

Lightning arresters used for protection of an antenna installation should be of a type approved for this purpose by the Underwriters' Laboratories, Inc. When the ribbon or ladder type of lead-in is used, a lightning arrester must be installed in each conductor.

Special types of lightning arresters can be purchased at most wholesalers for radio and television parts. One of these arresters will provide protection for both conductors in one unit. If the lead-in is of the coaxial type, the outer metal shield must be grounded directly or protected by a lightning arrester.

The foregoing material has been gathered from existing city ordinances and from the National Electrical Code book. Any one city ordinance will not, as a general rule, cover all of the points that have been discussed here; but it will cover a majority of them. In addition, most city ordinances cover such items as penalties for violations, methods of inspection, permits, and licenses for making installations.

The material that may be included in a city ordinance might best be shown by presenting the following example of such a city ordinance.

An ordinance governing the installation, repair, and maintenance of television, AM, and FM receiving and transmitting antennas within the city limits of the City of - - - - -.

Section 1. That for the better protection of life and property and in the interest of public safety, the following rules and regulations be, and the same are, hereby adopted for the installation of outdoor television, AM, and FM receiving and transmitting antennas within the City of - - - - -

Section 2. No installation of television sets shall be made forward of nor visible from the front seats of all or any motor-operated vehicle, and it shall be unlawful to operate any such installation within the City of - - - - -; otherwise, the provisions of this chapter shall not apply to motor vehicles.

Section 3. These specifications shall apply to television, AM, FM, amateur, and commercial receiving and transmitting antennas.

Masts or antennas must be of noncombustible and noncorrosive material except that in the case of ground support, a wooden pole may be used when adequately treated with a wood preservative. When a mast or antenna is installed on a roof, it must be mounted on its own platform and be securely anchored with guy wires. Masts and antennas must not be fastened to the roof or supported by combustible members or materials.

Outdoor antennas must be of an approved type and shall not exceed the maximum height of 50 feet above a roof support or 70 feet above ground support. In areas where reception may be affected by the obstruction of tall buildings, antennas in excess of the above specified height may be installed only when approved by City Council. Every antenna must be adequately grounded for protection against a direct stroke of lightning, with the ground wire as specified in the 1947 National Electrical Code as the same may be amended. In no case shall an antenna be installed nearer to street or sidewalk than the height of the antenna plus 10 feet unless approved by City Council. Anchor points for antennas, masts, and guy wires must be anchor screws or lead expansions shields drilled into solid block, concrete, or other noncombustible construction. No wires, cables, or guys shall cross or extend over any part of a public street, way, or sidewalk.

In case of an amateur or domestic receiving antenna where the set is installed in a private residence, the antenna may be installed on the roof of a frame structure provided the supports and anchor screws are securely fastened to rafters or beams or other substantial members, and provided further that no antenna installed on the roof of a frame construction or in any way supported by material of combustible construction shall exceed a height of thirty feet above the roof of the building.

Transmission lines must be kept at least twelve inches clear of existing telephone or light wires. Rawl plugs are approved only for supporting transmission lines. Standoff support insulators must be used at least every ten feet in running the transmission line down the building.

Lightning arresters shall be approved by the Underwriters' Laboratories, Inc., and both sides of the line must be adequately protected with proper arresters or neon lamps to remove static charges accumulated on the line, except when a folded dipole or other type of antenna is used which is already grounded to the mast. When lead-in conductors of polyethylene ribbon type are used, lightning arresters must be installed in each conductor. If a coaxial cable is used for the lead-in, suitable protection may be provided without lightning arresters by grounding the exterior metal sheath.

Antennas shall be designed and installed in such manner as to resist a wind pressure of 25 lbs. per sq. ft., and in no case shall guy wires be less than 3/32-inch, 5-strand cable, or equivalent, galvanized. Rawl plugs must NOT be used for securing guy wires or mounting brackets.

Ground wire must be of the type approved by the 1947 issue of the National Electrical Code, as the same may be amended, for grounding masts and lightning arresters, and must be installed in a mechanical manner with as few bends as possible, maintaining a clearance of at least 2 inches from combustible material.

Ground straps for grounding masts and attaching arresters to water pipe must be approved ground fittings.

The miscellaneous hardware such as brackets, turnbuckles, thimbles, clips, etc., must be hot-dipped galvanized, or similarly treated for weather protection. The turnbuckles must be protected against turning by threading the guy wires through the turnbuckles.

Section 4. No electrical materials, devices, or apparatus designed for attachment to or installation on any electrical circuit or system for television, AM, FM, amateur, and commercial receiving and transmitting antennas shall be installed, used, sold, or offered for sale for use in the City of - - - - -, unless they are in conformity with the approved methods of construction for safety to life and property.

Conformity of electrical materials, devices, or apparatus with the standards of the Underwriters' Laboratories, Inc., are approved for use in the City of - - - - -.

The maker's name, trade-mark, or other identification symbol shall be placed on all electrical devices which use 115 volts or more and which are sold, are offered for sale or use, or are used in the City of - - - - -. These markings and others such as voltage, amperage, wattage, and power-factor, or appropriate ratings described in the National Electrical Code are necessary to determine the character of the material, device, or equipment and the use for which it is intended.

Section 5. Work shall not be commenced on the installation of receiving or transmitting antennas before a permit therefor is obtained from the Building Inspection Division. An inspection fee of $ - - - shall be paid for each permit.

A reinspection fee of $ - - - shall be made for each trip when extra inspections are necessary for any one of the following reasons:

1. Wrong address.

2. Condemned work resulting from faulty construction.

3. Repairs or corrections not made when inspector is called.

4. Work not ready for inspector when called.

Section 6. The 1947 issue of the National Electrical Code, as the same may be amended, is hereby adopted and approved as a part of this ordinance as a minimum standard.

Section 7. The Chief Electrical Inspector and his representatives are hereby empowered to inspect or reinspect any wiring, equipment, or apparatus conducting or using electric current for television, AM, FM, amateur, and commercial receiving and transmitting antennas in the City of - - - - - ; and if conductors, equipment, or apparatus are found to be unsafe to life or property, the inspector shall notify the person, firm, or corporation owning or operating the hazardous wiring or equipment to correct the condition within the time specified by the inspector. Failure to correct violations in the specified time constitutes a violation of this ordinance.

Section 8. In the event that any section, subsection, sentence, clause, or phrase of this ordinance shall be declared or adjudged invalid or unconstitutional, such adjudication of invalidity shall in no manner affect the other sections, subsections, sentences, clauses, or phrases of this ordinance.

Section 9. The provisions of this ordinance shall not apply to commercial broadcasting and other commercial transmitting stations and shall not apply to residential installations provided the height of the antenna does not exceed 15 feet above a roof support or 25 feet above a ground support.

The rules and regulations presented in this article are intended to aid the antenna technician in performing a better service to his customer and also to bring to the technician's attention the existence and purpose of codes and regulations pertaining to installations of TV antennas.

It is advisable to contact a local authority for specific information about codes and regulations. City regulations can be obtained from one of the following:

1. Office of City Clerk.

2. Superintendent of Buildings.

3. Electrical Inspectors.

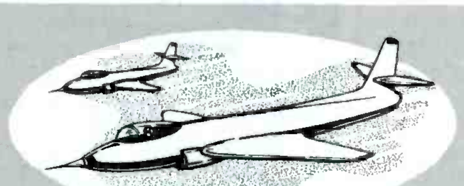
The National Electrical Code may be purchased from one of the following:

1. Local Electrical Union.

2. Superintendent of Buildings.

3. Superintendent of Documents, Washington 25, D.C.

GEORGE B. MANN



TRANSISTORS. By replacing tubes with transistors as completely as possible in a jet fighter, Douglas Aircraft estimates that a saving of $50,000 per plane could be achieved, even though the transistors cost some $3,000 more than tubes. Reduced weight and size and reduced power and heat dissipation are the chief advantages of transistors in aircraft. The chief drawback that prevents complete change-over today is the poorer over-all reliability of transistors, but reliability is being improved steadily as production rises.

In airborne electronic equipment now under development, 22 per cent of all sockets are intended to hold transistors and 11 per cent are intended to hold magnetic amplifiers, according to a recent Aviation Week survey. By 1957 it is expected that designers will be providing for tubes in only about 35 per cent of their airborne sockets. Also by that year, General Electric estimates that transistor prices will become competitive with those of tubes. Today, however, the rate of production is 200 tubes for each transistor turned out.

MARKUS . . *Dollar and Sense Servicing*

Shop Talk

(Continued from page 9)

the output transformer, and the capacitor in the cathode circuit of the output tube.

Concerning the charge and discharge circuit, an incorrect value of capacitance (on the low side) will affect vertical linearity and size. It may be possible to bring the size back to normal by rotating the height control, but the limits within which the linearity can be corrected (by the linearity control) are much narrower. Continued reduction in capacitance value will quickly lead to the occurrence of foldover. On the other hand, if too large a capacitance is used, a small picture will be produced because of the excessive slowness of the charging of the RC network.

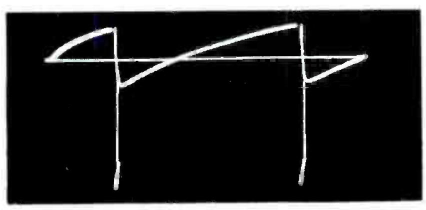


Fig. 3. Waveform Produced by the Action of the RC Circuit in the Oscillator Stage.

The purpose of the resistance in the charge and discharge circuit is to provide a negative-going spike (see Fig. 3) in the sawtooth deflection wave. It is important, once the electron beam has been brought to the bottom of the screen, to bring about retrace in as short a time as possible. The deflection-voltage decrease, which occurs after the sawtooth deflection wave has reached its maximum level, causes the inductance of the deflection coils to assume greater significance than it does during the slow rise in voltage during the trace interval. The effect of this inductance is to prolong the current flow rather than to permit it to drop sharply to the desired level for the start of the next sweep. If the vertical-output tube is permitted to conduct during this retrace interval, the slow letdown effect will be exaggerated and visible retrace lines will appear across the top of the picture. In other words, the blanking has been removed before the retrace has been completed.

To avoid this situation, the spike is added to the vertical-deflection voltage so that the tube will be driven into cutoff at the end of the trace interval. Retrace will therefore be accomplished in its normal time. From this, we see that a peaking resistance of too small a value may cause the vertical-retrace lines to appear at the top of the screen. On the other hand, the use of a large resistor may lead to the appearance of ringing in the deflection-coil circuit.

Another critical item in the vertical system is the output transformer. The purpose of this transformer is to match the low impedance of the deflection yoke to the high impedance of the output tube. It does this by employing a turns ratio of 5 to 1 or higher. This particular characteristic of a vertical-output transformer is a significant guide to its replacement. Replacement transformers which adhere as closely to this ratio as possible should be chosen; and any variations, if unavoidable, should be restricted to 10 per cent or less.

One of the reasons for this stems from the fact that the impedance ratio between the primary and secondary does not vary according to the turns ratio but instead it varies according to the square of the turns ratio. Thus, if we assume a turns ratio of 10 to 1 from primary to secondary, the impedance from primary to secondary will be 100 to 1. A 10-per-cent change in the turns ratio (let us say to a value of 11 to 1) will raise the impedance ratio from 100 to 1 to 121 to 1.

The visual consequences of mismatching may vary from a simple case of nonlinearity to an extreme case in which there is a combination of reduced height, poor linearity, and foldover. In addition, impedance mismatch will usually be accompanied by an increase in output-tube plate current. This in itself can lead to additional troubles such as lowering the over-all B+, overheating the vertical-output transformer, and shortening the life of the output tube.

Another consideration in choosing replacement for the vertical-output transformer is its current-carrying capacity. Failure to provide enough leeway will cause this component to operate at a high temperature, and the possibility of eventual failure is increased.

The third critical component in the vertical system is the capacitor which shunts the vertical-linearity potentiometer in the cathode circuit of the output tube. Too small a value will lead to nonlinearity (at first) and foldover. Keep as close to the original value as possible; and if the exact value cannot be duplicated, use a capacitor with a higher value.

In the horizontal-deflection system, there is the phase detector, the horizontal oscillator, and the output amplifier. Beyond the output transformer, there is the high-voltage rectifier and the damper tube. Because of the interrelationship between the output and input stages of this section, it is not advisable to deviate from the original values and component ratings. The damper tube, for example, develops a boost B+ voltage which is always used by the output amplifier and frequently by the oscillator as well. In this "dog-chasing-its-tail" situation, any change which alters the boost B+ voltage will also affect the operation of the stages it feeds. By the same token, anything that deviates from the norm in the oscillator or output stage will affect the boost B+.

In the phase detector, time constant and balance are important. Upset the balance and you impair the ability of the circuit to keep the horizontal oscillator on frequency, and in turn this leads to such annoying conditions as a critical hold-in range and frequent loss of synchronization. Change the time constant of the network and the circuit may become more susceptible to noise and interference pulses; a change may also bring with it a "piecrust" effect.

The horizontal-output transformer and the coils with which it operates (the width, linearity, and deflection-yoke coils) must all be properly matched to each other or horizontal nonlinearity, blooming, insufficient width, and low second-anode voltage may result. For example, a lowered inductance of the width coil can cause the right side of the picture to be crowded. If the same condition occurs in the linearity coil, the range of the coil is also reduced and the proper setting cannot be attained. All these are good and sufficient reasons why the service technician should use every available means to match replacement components accurately.

REVIEW

Some of the first and most important questions that the beginning TV service technician asks are, "When do I take a chassis into the shop?" or "At what point do I stop trying to fix the set in the home?" This is frequently a ticklish problem because, on the one hand, there is your time and labor to consider and, on the other hand, there is the implicit trust which the customer places in you to get the job done as quickly and as reasonably as possible.

As the reader can appreciate, this is not a problem that lends itself to an easy solution. However, certain general rules can be established; and from these, the technician can work out what to him seems like a fair solution to this problem. There is an article which should prove extremely helpful along these lines in the June 1955 issue of Radio & Television News Magazine. The author of the article is Art Margolis; and the title is, appropriately, "When Should You Pull a Chassis?"

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

Some service companies advocate removing a chassis whenever replacement of the picture tube is involved. They advance two reasons for this: (1) another trip is necessary to deliver the new tube anyway and (2) it is easily possible to make a wrong diagnosis and blame the picture tube when, in fact, some other component might be defective. In this second instance, if you leave the set in the home, the customer will see that your diagnosis was wrong when the new tube is installed and thereby will lose his confidence in you.

In other firms, the service technician is given greater leeway. If he is absolutely certain the picture tube is bad, then the set need not be taken to the shop; but if any doubt exists, the order is to bring in the chassis.

On occasion, a customer may wish to have the replacement picture tube installed in his home. In this case, the service-technician has no choice but to accede to his customer's wishes and to hope that a replacement picture tube will cure the trouble. If it does not, the technician should admit his error and should offer to fix the set in the shop. The customer will usually be happy to know that he does not need an expensive picture tube and will overlook the technician's error in diagnosis.

What about repairs other than the replacement of the picture tube? Some companies set a time limit of one hour per job in the home. If a technician finds that he cannot repair a particular set in that length of time, the chassis should be taken into the shop. Within that time, parts that are definitely proved bad and can be easily replaced may be changed in the home. This includes tubes, fuses, capacitors, resistors, selenium rectifiers, and the like. On one service call, Mr. Margolis relates, the symptoms were poor synchronization and a drifting pattern across the picture. A tube check revealed that there were no defective tubes. The set was taken out of the cabinet, and the technician checked around the sync-separator tubes with an ohmmeter. There he discovered a shorted capacitor. When another was substituted in its place, the set worked fine.

It is important, however, to make sure that a trouble has been corrected. On another job, a 21-inch receiver displayed a small square of light on the screen. The technician changed the low-voltage rectifier tubes, and the picture spread out; however, it still did not completely fill the screen. A slight 120-cycle ripple could also be detected at the sides of the picture. The only obvious thing to do under these circumstances was to take in the set. In the shop, one of the filter capacitors was discovered to be bad.

Many companies caution against repairing in the home a receiver that has an intermittent trouble. They feel that the set is best serviced in the shop where it can be given a 2- or 3-day continuous-operation test. Intermittent symptoms have a way of disappearing for a while and then cropping up again when you least expect them to.

One firm sends only the better service technicians to tackle intermittent troubles in the home, if they learn beforehand that the set is operating intermittently. (This information is obtained by questioning the set owner when he first calls in.) The customer is instructed to turn on the set and to leave it on for several hours before the service call is made. By this time, the intermittent symptom often turns into a full-fledged fault; then locating it is made much easier.

There are some troubles which may be very obvious, yet these should seldom be corrected in the home. Included in this group are troubles with faulty tube sockets and flyback transformers, troubles in tuners, and replacement of power transformers. In each instance, a considerable amount of labor is involved; and to achieve the repair in the home would result in a messy job. Many companies have found that the service technician who sweats and struggles over a job seldom impresses the owner even if the set is fixed perfectly. They feel that the extensive dirty work should be done in the privacy of the shop rather than on the living-room floor of the owner's home.

One service technician spent two exhausting hours on one such job, and all the thanks he got was a complaint lodged with his boss by the customer that the man was inexperienced because it took him so long to do the job and because he had to consult a schematic diagram to locate the trouble.

If you do not know (without really "digging") the exact part that is causing the trouble in a TV set, the chances are that the repair job should be done in the shop. On the other hand, a good many troubles stem from defective tubes, and there is no excuse for taking in a set under these conditions. Give the customer full consideration by doing as thorough an inspection as you can in the time allotted; but if you decide definitely that the job needs shop work, do not let yourself be talked out of it.

A not uncommon condition plaguing many sets is that of poor alignment. This, of course, is not usually the reason why you were called in (except in rare instances). But if you feel that a realignment and readjustment of a set would produce a marked improvement in reception, then the suggestion should be made to the set owner. If he decides against it, there is nothing you can do except repair the set only for its immediate and obvious trouble — the one that you were called in to repair. Make a record of your suggestion; and if the set ever gets to the shop, then the recommendation should be made again. Alignment or lack of it causes more obvious defects in a color TV receiver; a monochrome receiver can stand a considerable amount of misalignment before the picture becomes intolerable.

It should be emphasized again that the foregoing recommendations as to when a set should be taken to the shop are not hard and fast rules by any means. A lot will depend upon the amount of equipment you carry with you on outside calls and the extent of your own personal ability. Many service shops have found it is not economically desirable to spend more than one hour on any home call. They have also found that the experienced service technician has a good idea of the complexity of the job within the first half hour. When all these factors are taken into consideration, the suggestions made in this article appear to represent a reasonable basis on which to develop your own judgment concerning removal of a chassis.

MILTON S. KIVER

PF REPORTER

CATALOG and LITERATURE SERVICE

valuable manufacturers' data available to our readers

1L. B & K (B & K Manufacturing Co.)

Bulletin No. 500 describing DYNA-QUIK Model 500, a new dynamic mutual conductance tube tester that completely tests, with laboratory accuracy, 99% of all tubes; and Bulletin 104-R describing two new B&K Cathode Rejuvenator Testers—the CRT 400 and the CRT 200. *See advertisement page* 50.

2L. BLONDER-TONGUE (Blonder-Tongue Labs, Inc)

New installation and catalog material covering antenna boosters, cable stripper and TV set couplers. *See advertisement page* 82.

3L. BUSSMANN (Bussmann Mfg. Co.)

Bulletin showing fuses and fuse-holders adapted to protection of TV and other electronic equipment (Form SFB). *See advertisement page* 16.

4L. CBS (CBS-Hytron)

CBS-Hytron Tool Catalog, PA-6A describes all CBS-Hytron service technician's tools to date. *See advertisement page* 22.

5L. CENTRALAB (Centralab, Division of Globe-Union, Inc.)

Bulletin 42-223 describing Centralab Fastatch Control Cabinet FR-22, shelf kit of 22 most popular TV dual replacements in easy to use "Fastatch" construction. Values used in 80% of dual concentric TV controls. *See advertisement page* 85.

6L. CLAROSTAT (Clarostat Mfg. Co., Inc.)

Thermally Similar Resistor Assembly, Form No. 754288010. *See advertisement page* 5.

7L. CORNELL-DUBILIER (Cornell-Dubilier Electric Corp.)

Auto Radio—Communications and Heavy Duty Vibrator Replacement Guide and Handbook. *See advertisement page* 69.

8L. ELECTRONIC TEST (Electronic Test Instrument Corp.)

Vitameter Brochure. *See advertisement page* 90.

9L. GENERAL CEMENT (General Cement Mfg. Co.)

G-C Catalog and G-C Printed Circuit Service Manual. *See advertisement page* 48.

10L. GERNSBACK (Gernsback Publications, Inc.)

Descriptive literature on the Gernsback Library Books. *See advertisement page* 86.

11L. GRAMER-HALLDORSON (Gramer-Halldorson Transformer Corp.)

New 1956 Catalog G-25 describing entire line of Transformers and featuring a new complete line of Flybacks and 12 volt Vibrator Transformers. *See advertisement page* 92.

12L. HYCON (Hycon Manufacturing Co.)

Catalog and spec sheets on all Hycon instruments. *See advertisement page* 70.

13L. IRC (International Resistance Co.)

Form S-021—Catalog DC55 Standard Catalog of Replacement Parts. *See advertisement* 2nd Cover.

14L. JFD (JFD Manufacturing Co.)

1955-1956 TV Antenna Catalog comprising largest antenna, rotator, tubing lines. *See advertisement page* 4.

(*Continued on next page*)

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☐ Other (Please explain) ____________________

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(Continued)

15L. JENSEN (Jensen Industries, Inc.)

Wall Chart—New 1956, completely illustrated; contains all up-to-date replacement needle information, including point size, point material, cartridge numbers; list price. *See advertisement page* 59.

16L. MALLORY (P.R. Mallory & Co., Inc.)

20-page capacitor cross reference guide for all "can" type electrolytics. *See advertisement pages* 14, 36.

17L. PERMO (Permo, Inc.)

Numerical Listing Form No. PPSL-7 and Dealer Price Schedule Form No. DPS-7. *See advertisement page* 90.

18L. RADIART (The Radiart Corporation)

CDR Rotor Catalog illustrating complete line of CDR Rotors we are manufacturing at the present time. Our form F-904. *See advertisement page* 1.

19L. RAYTHEON (Raytheon Manufacturing Co.)

Raytheon "Ball of Fire" Business Builders. A customer producing collection of sales stimulators and shop aids. Full color illustrative booklet on advertising helps and store displays, service helps, shop forms and supplies. *See advertisement page* 26.

20L. TACO (Technical Appliance Corp.)

Catalog on Trapper Antennas, localized for metropolitan, suburban and fringe locations. *See advertisement page* 40.

21L. TRIAD (Triad Transformer Corp.)

New Triad TV Replacement Guide, TV-155, listing Triad correct replacement transformers for television use showing recommended Triad items for more than 100 television manufacturers and over 5800 models. *See advertisement page* 81.

22L. TRIPLETT (Triplett Electrical Instrument Co.)

Model 310 Mighty Mite Volt-Ohm-Milliammeter. *See advertisement page* 41.

23L. TURNER (The Turner Company)

Bulletin No. 968 describing new Turner high fidelity lavalier-type dynamic microphone. *See advertisement page* 80.

24L. WELLER (Weller Electric Corp.)

New low-priced Model 8100K Soldering Kit. *See advertisement page* 68.

25L. WINEGARD (Winegard Company)

4-page folder on Winegard Pixie TV Antennas, describing revolutionary new Winegard DICON Element and other new features. *See advertisement page* 54.

26L. XCELITE (Xcelite, Incorporated)

Illustrated folders on new chrome plated reamers and pliers, also new "99 JUNIOR" kit; catalog on full line of screwdrivers, nut drivers, pliers, wrenches. *See advertisement page* 77.

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PF REPORTER

INDEX TO ADVERTISERS
November, 1955

While every precaution is taken to insure accuracy, we cannot guarantee against the possibility of an occasional change or omission in the preparation of the REPORTER.

NOV.-DEC. 1955 NO. 53

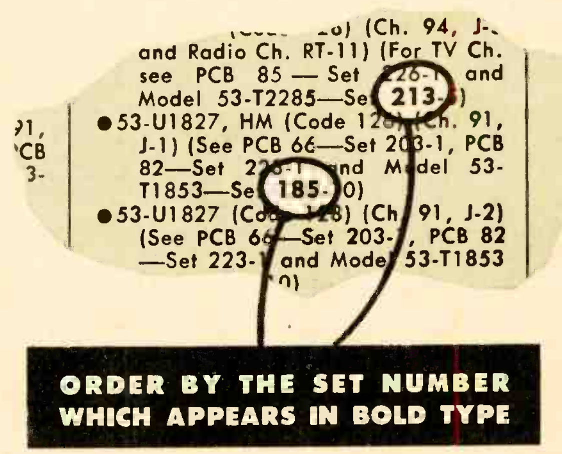
SAMS INDEX TO PHOTOFACT FOLDERS

NO. 53: SETS NUMBERS 1 THROUGH 296

YOUR INDEX TO THE WORLD'S FINEST ELECTRONIC SERVICE DATA: FIND THE FOLDER SET YOU NEED . . . GET IT FROM YOUR DISTRIBUTOR

IT'S EASY TO USE THIS INDEX

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



IMPORTANT:

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

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

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

CURRENT ONLY UNTIL JANUARY 15, 1956: Keep the latest SAMS INDEX handy always . . .

Sams Index to PHOTOFACT FOLDERS

Covering Folder Sets Nos. 1 through 296 · Nov.-Dec., 1955 · No. 53

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.

ADMIRAL—Cont.

- ●Models 36X35, 36X36, 36X37 (See Ch. 24E1 and Ch. 5B2)
- ●Models 36X35A, 37X36A, 36X37A (See Ch. 24E1 and Ch. 5D2)
- ●Models 37F15, A, B, 37F16, A, B (See Ch. 21G1 or Ch. 21Q1 and Ch. 5D2)
- ●Models 37F27, A, B, 37F28, A, B (See Ch. 21G1 or 21Q1 and Ch. 5D2)
- ●Models 37F35, A, B, 37F36, A, B (See Ch. 21G1 or 21Q1 and Ch. 5D2)
- ●Models 37F55, 37F56, 37F57 (See Ch. 21G1 or 21Q1 and Ch. 5D2)
- ●Models 37K15, A, B, 37K16, A, B (See Ch. 21G1 or 21Q1 and Ch. 3C1)
- ●Models 37K27, A, B, 37K28, A, B (See Ch. 21G1 or 21Q1 and Ch. 3C1)
- ●Models 37K35, A, B, 37K36, A, B (See Ch. 21G1 or 21Q1 and Ch. 3C1)
- ●Models 37K55, 37K56, 37K57 (See Ch. 21G1 or 21Q1 and Ch. 3C1)
- ●Models 37M15, 37M16 (See Ch. 21G1 or 21Q1 and Ch. 3C1)
- ●Models 37M25, 37M26, 37M27 (See Ch. 21Z1)
- ●Models 39X16, A, 39X17, A (See Ch. 24G1 and Ch. 5B2)
- ●Models 39X16B, 39X17B (See Ch. 24G1 and Ch. 5D2)
- ●Model 39X17C (See Ch. 21J1)
- ●Models 39X25, 39X26 (See Ch. 24F1 and Ch. 5D2)
- ●Models 39X25A, 39X26A (See Ch. 21J1)
- ●Models 39X35, 39X36, 39X37 (See Ch. 21J1 and Ch. 3C1)
- ●Models 47M15, A, 47M16, 47M17 (See Ch. 21W1)
- ●Models 47M35, 47M36, 47M37 (See Ch. 21Z1)
- ●Models 52M15, 52M16, 52M17 (See Ch. 21Y1)
- ●Models 57M10, 57M11, 57M12 (See Ch. 21Z1A)
- ●Model 121DX10 (See Ch. 19C1)
- ●Model 121DX11 (See Ch. 19F1A)
- ●Model 121DX12 (See Ch. 19C1)
- ●Model 121DX12A (See Ch. 19C1 or 19F1)
- ●Model 121DX16 (See Ch. 19C1)
- ●Model 121DX16A (See Ch. 19C1 or 19F1)
- ●Model 121DX16L (See Ch. 19K1)
- ●Model 121DX17 (See Ch. 19C1)
- ●Model 121DX17A (See Ch. 19C1 or 19F1)
- ●Model 121DX17L (See Ch. 19K1)
- ●Models 121K15, 121K16, 121K17 (See Ch. 21M1)
- ●Models 121K15A, 121K16A, 121K17A (See Ch. 22M1)
- ●Model 121M10 (See Ch. 22M1)
- ●Models 121M11, 121M12 (See Ch. 21M1)
- ●Models 121M11A, 121M12A (See Ch. 22M1)
- ●Model 121UDX12 (See Ch. 19J1)
- ●Models 121UDX16L, 121UDX17L (See Ch. 19L1)
- ●Model 122DX12 (See Ch. 22F2)
- ●Model 122UDX12 (See Ch. 22G2)
- ●Model 221DX15 (See Ch. 19C1)
- ●Model 221DX15A (See Ch. 19C1 or 19F1)
- ●Model 221DX15L (See Ch. 19K1)
- ●Model 221DX16 (See Ch. 19C1)
- ●Model 221DX16A (See Ch. 19C1 or 19F1)
- ●Model 221DX16L (See Ch. 19K1)
- ●Model 221DX17 (See Ch. 19C1)
- ●Model 221DX17A (See Ch. 19C1 or 19F1)
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- ●Model 221DX26A (See Ch. 19F1)
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- ●Models 221K16, A (See Ch. 21K1)
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- ●Models 221K35, 221K36 (See Ch. 21K1)
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- ●Model 221UDX26L (See Ch. 19L1)
- ●Model 222DX15 (See Ch. 19H1)
- ●Model 222DX15B (See Ch. 22M2)
- ●Model 222DX15S (See Ch. 22C2)
- ●Model 222DX16 (See Ch. 22C2)
- ●Model 222DX16B (See Ch. 22M2)
- ●Model 222DX17 (See Ch. 22C2)
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- ●Models 222DX26, 222DX27 (See Ch. 22C2)
- ●Model 222DX27B (See Ch. 22M2)
- ●Models 222DX48, 222DX49 (See Ch. 22C2)
- ●Models 222UDX15, 222UDX16, 222UDX17 (See Ch. 22N2)
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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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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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●15W214 (Ch. CT-122) (Ch. Series CX-37) (See PCB 113—Set 264-1 and Ch. CT-75—Set 203-4)
●15W214-1 (Ch. CT-124) (Ch. Series CX-37-1) (See PCB 113—Set 264-1 and Ch. CT-75—Set 203-4)
●15W214BD-1 (Ch. CT-134) (Ch. Series CX-37-1) (See PCB 113—Set 264-1 and Ch. CT-75—Set 203-4)
●15W214MD-1 (Ch. CT-134) (Ch. Series CX-37-1) (See PCB 113—Set 264-1 and Ch. CT-75—Set 203-4)
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●16T244BS (Ch. CT-130) (Ch. Series CX-37) (See PCB 113—Set 264-1 and Ch. CT-75—Set 203-4)
●16T244BS-1 (Ch. CT-131) (Ch. Series CX-37-1) (See PCB 113—Set 264-1 and Ch. CT-75—Set 203-4)
●16T244ES (Ch. CT-130) (Ch. Series CX-37) (See PCB 113—Set 264-1 and Ch. CT-75—Set 203-4)
●16T244ES-1 (Ch. CT-131) (Ch. Series CX-37-1) (See PCB 113—Set 264-1 and Ch. CT-75—Set 203-4)
●16T244M (Ch. CT-95) (Ch. Series CX-37) (See PCB 113—Set 264-1 and Ch. CT-75—Set 203-4)
●16T244M-1 (Ch. CT-112) (Ch. Series CX-37-1) (See PCB 113—Set 264-1 and Ch. CT-75—Set 203-4)
●16T244MS (Ch. CT-130) (Ch. Series CX-37) (See PCB 113—Set 264-1 and Ch. CT-75—Set 203-4)
●16T244MS-1 (Ch. CT-131) (Ch. Series CX-37-1) (See PCB 113—Set 264-1 and Ch. CT-75—Set 203-4)
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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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- ●19C214M (Ch. CT-143) (Ch. Series CX-37) (See PCB 113—Set 264-1 and Ch. CT-75—Set **203**-4)
- ●19C214M-1 (Ch. CT-144) (Ch. Series CX-37-1) (See PCB 113—Set 264-1 and Ch. CT-75—Set **203**-4)
- ●19C214MD (Ch. CT-145) (Ch. Series CX-37) (See PCB 113—Set 264-1 and Ch. CT-75—Set **203**-4)
- ●19C214MD-1 (Ch. CT-146) (Ch. Series CX-37-1) (See PCB 113—Set 264-1 and Ch. CT-75—Set **203**-4)
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- ●23C214B (Ch. CT-143) (Ch. Series CX-37) (See PCB 113—Set 264-1 and Ch. CT-75—Set **203**-4)
- ●23C214B-1 (Ch. CT-144) (Ch. Series CX-37-1) (See PCB 113—Set 264-1 and Ch. CT-75—Set **203**-4)
- ●23C214M (Ch. CT-143) (Ch. Series CX-37) See PCB 113—Set 264-1 and Ch. CT-75—Set **203**-4)
- ●23C214M-1 (Ch. CT-144) (Ch. Series CX-37-1) (See PCB 113—Set 264-1 and Ch. CT-75—Set **203**-4)
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- ●319AX (Ch. CT-27) (Ch. CX-33DX) (See Ch. CT-27—Set **160**-2)
- ●320 (Ch. C-289) (Ch. Series CX-33L) (See PCB 13—Set 122-1, PCB 24—Set 142-1 and Model 323M—Set **112**-3)
- ●320BX, MX (Ch. CT-27) (Ch. Series CX-33DX) (See Ch. CT-27—Set **160**-2)
- ●321 (Ch. C-281) (Ch. Series CX-33) (See PCB 13—Set 122-1, PCB 24—Set 142-1 and Model 323M—Set **112**-3)
- ●321A (Ch. C-298) (Ch. Series CX-33) (See PCB 13—Set 122-1, PCB 24—Set 142-1 and Model 323M—Set **112**-3)
- ●321AX (Ch. CT-27) (Ch. Series CX-33DX) (See Ch. CT-27—Set **160**-2)
- ●322B, M (Ch. C-281) (Ch. Series CX-33) (See PCB 13—Set 122-1, PCB 24—Set 142-1 and Model 323M—Set **112**-3)
- ●322RAB, RAM (Ch. C-298) (Ch. Series CX-33) (See PCB 13—Set 122-1, PCB 24—Set 142-1 and Model 323M—Set **112**-3)
- ●322RA-X (Ch. CT-27) (Ch. Series CX-33DX) (See Ch. CT-27—Set **160**-2)
- ●322RB, RM (Ch. C-281) (Ch. Series CX-33) (See PCB 13—Set 122-1, PCB 24—Set 142-1 and Model 323M—Set **112**-3)
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- ●325AF (Ch. C-298) (Ch. Series CX-33) (See PCB 13—Set 122-1, PCB 24—Set 142-1 and Model 323M—Set **112**-3)
- ●325AFX (CT-27) (Ch. Series CX-33DX) (See Ch. CT-27—Set **160**-2)
- ●325F (Ch. C-281) (Ch. Series CX-33) (Also see PCB 13—Set 122-1 and PCB 24—Set 142-1) **112**—3
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- ●327M (Ch. C-285) (Ch. Series CX-33) (For TV Ch. only see PCB 13—Set 122-1, PCB 24—Set 142-1 and Model 323M—Set **112**-3)
- ●328 (Ch. C-299) (Ch. Series CX-33) (For TV Ch. only see PCB 13—Set 122-1, PCB 24—Set 142-1 and Model 323M—Set **112**-3)
- ●328CX, X (Ch. CT-37) (Ch. Series CX-33DX) (See Ch. CT-27—Set **160**-2)
- ●331B, M (Ch. C-303) (Ch. Series X-33) (See PCB 13—Set 122-1, PCB 24—Set 142-1 and Model 323M—Set **112**-2)
- ●331BX, MX (Ch. CT-38) (Ch. Series CX-33DX) (See Ch. CT-38—Set **160**-2)
- ●332B, M (Ch. C-286, C-204) (Ch. Series CX-33) (See PCB 13—Set 122-1, PCB 24—Set 142-1 and Model 323M—Set **112**-3)
- ●333M (Ch. C-286) (Ch. Series CX-33) (See PCB 13—Set 122-1, PCB 24—Set 142-1 and Model 323M—Set **112**-3)

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- ●334M, 335B, M (Ch. C-303) (Ch. Series CX-33) (See PCB 13—Set 122-1, PCB 24—Set 142-1 and Model 323M—Set **112**-3)
- ●335BX, MX (Ch. CT-38) (Ch. Series CX-33DX) (See Ch. CT-38—Set **160**-2)
- ●336C (Ch. C-296) (Ch. Series CX-33) (See PCB 13—Set 122-1, PCB 24—Set 142-1 and Model 323M—Set **112**-3)
- ●336CX, FX (Ch. CT-38) (Ch. Series CX-33DX) (See Ch. CT-38—Set **160**-2)
- ●337CMX (Ch. CT-47) (Ch. Series CX-33DX) (For TV Ch. only see Ch. CT-27—Set **160**-2)
- ●337M (Ch. C-292) (Ch. Series CX-33K) (For TV Ch. only see PCB 13—Set 122-1, PCB 24—Set 142-1 and Model 323M—Set **112**-3)
- ●337RACMX (Ch. CT-39) (Ch. Series CX-33DX) (For TV Ch. only see Ch. CT-27—Set **160**-2)
- ●337RCMX (Ch. CT-47) (Ch. Series CX-33DX) (For TV Ch. only see Ch. CT-27—Set **160**-2)
- ●337RM (Ch. CT-39) (Ch. Series CX-33DX) (For TV Ch. only see Ch. CT-27—Set **160**-2)
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- ●339MX (Ch. CT-38) (Ch. Series CX-33DX) (See Ch. CT-38—Set **160**-2)
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- ●3005 (Ch. C-268) (Ch. Series CX-32) (See Ch. CX-32—Set **93A**-5)
- ●3006-M (Ch. C-274) (Ch. Series CX-31) (See Ch. CX-31—Set **93A**-5)
- ●3007 (Ch. C-276) (Ch. Series CX-30) . . . . . . **99A**—2
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- Ch. C-272 (See Model 3001)
- Ch. C-274 (See Model 3006-M)
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- ●Ch. CT-99 (Ch. Series CX-37) (See PCB 113—Set 264-1 and Ch. CT-75—Set **203**-4)
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- ●Ch. CT-115 (Ch. Series CX-37) (See PCB 113—Set 264-1 and Ch. CT-75—Set **203**-4)
- ●Ch. CT-116 (Ch. Series CX-37-1) (See PCB 113—Set 264-1 and Ch. CT-75—Set **203**-4)
- ●Ch. CT-121 (Ch. Series CX-37) (See PCB 113—Set 264-1 and Ch. CT-75—Set **203**-4)
- ●Ch. CT-122 (Ch. Series CX-37) (See PCB 113—Set 264-1 and Ch. CT-75—Set **203**-4)
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- ●Ch. CT-129 (Ch. Series CX-37-1) (See PCB 113—Set 264-1 and Ch. CT-75—Set **203**-4)
- ●Ch. CT-130 (Ch. Series CX-37) (See PCB 113—Set 264-1 and Ch. CT-75—Set **203**-4)
- ●Ch. CT-131 (Ch. Series CX-37-1) (See PCB 113—Set 264-1 and Ch. CT-75—Set **203**-4)
- ●Ch. CT-134 (Ch. Series CX-37-1) (See PCB 113—Set 264-1 and Ch. CT-75—Set **203**-4)
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NOTE: PCB Denotes Production Change Bulletin.   Production Change Bulletin Nos. 1 Through 63 Are All Contained in Set No. A-200   ● Denotes Television Receiver.
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NOTE: PCB Denotes Production Change Bulletin. Production Change Bulletin Nos. 1 Through 63 Are All Contained in Set No. A-200
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 ● Denotes Television Receiver.
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- ●17T9E (Ch. TS-325A, B) (See Model 17F12—Set **171**-8)
- ●17T9EF (Ch. TS-401) (See PCB 49—Set 183-1 and Model 21F1—Set **173**-9)
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- ●17T14Y (Ch. VTS-410Y) (See PCB 76—Set 217-1 and Model 17T13—Set **194**-9)
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- ●20T3, 20T3B (Ch. TS-307) **183**—9
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- ●21C1BD, BDY (Ch. WTS-292A, AY, B, BY, C, CY) (See PCB 63—Set 197-1, PCB 73—Set 214-1 and Model 21C1—Set **191**-13)
- ●21C1BY (Ch. TS-292AY, BY, CY) (See PCB 63—Set 197-1, PCB 73—Set 214-1 and Model 21C1—Set **191**-13)
- ●21C1D, DY (Ch. WTS-292A, AY, B, BY, C, CY) (See PCB 63—Set 197-1, PCB 73—Set 214-1 and Model 21C1—Set **191**-13)
- ●21C1Y (Ch. TS-292AY, BY, CY) (See PCB 63—Set 197-1, PCB 73—Set 214-1 and Model 21C1—Set **191**-13)
- ●21C2 (Ch. TS-502) (Also see PCB 106—Set 253-1) ....**237**—8
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- ●21F2, B (Ch. TS-292A, B, C and Radio Ch. HS-316A) (Also see PCB 63—Set 197-1 and PCB 73—Set 214-1) **191**–13
- ●21F2BY, 21F2F, FB, FBY, FY (Ch. WTS-292A, AY, B, BY, C, CY and Radio Ch. HS-316A) (See PCB 63—Set 197-1, PCB 73—Set 214-1 and Model 21C1—**191**-13)
- ●21F2Y (Ch. TS-292AY, BY, CY and Radio Ch. HS-316A) (See PCB 63—Set 197-1, PCB 73—Set 214-1 and Model 21C1—Set **191**-13)
- ●21F3, B (Ch. TS-292A, B, C) (Also see PCB 63—Set 197-1 and PCB 73—Set 214-1). **191**–13
- ●21F3BD, BDY (Ch. WTS-292A, AY, B, BY, C, CY and Radio Ch. HS-316A) (See PCB 63—Set 197-1, PCB 73—Set 214-1 and Model 21C1—Set **191**-13)
- ●21F3BY (Ch. TS-292AY, BY, CY and Radio Ch. HS-316A) (See PCB 63—Set 197-1, PCB 73—Set 214-1 and Model 21C1—Set **191**-13)
- ●21F3D, DY (Ch. WTS-292A, AY, B, BY, C, CY and Radio Ch. HS-316A) (See PCB 63—Set 197-1, PCB 73—Set 214-1 and Model 21C1—Set **191**-13)
- ●21F3Y (Ch. TS-292AY, BY, CY and Radio Ch. HS-316A) (See PCB 63—Set 197-1, PCB 73—Set 214-1 and Model 21C1—Set **191**-13)
- ●21F5, B (Ch. TS-502, QTS-502 and Radio Ch. HS-409) (Also See PCB 106—Set 253-1) ..**237**—8
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- ●21K4BD, BDY (Ch. WTS-292A, AY, B, BY, C, CY) (See PCB 63—Set 197-1, PCB 73—Set 214-1 and Model 21C1—Set **191**-13)
- ●21K4BY (Ch. TS-292AY, BY, CY) (See PCB 63—Set 197-1, PCB 73—Set 214-1 and Model 21C1—Set **191**-13)
- ●21K4C, CB, CBY, CW, CWY, CY, D, DY (Ch. WTS-292A, AY, B, BY, C, CY) (See PCB 63—Set 197-1, PCB 73—Set 214-1 and Model 21C1—Set **191**-13)
- ●21K4W (Ch. TS-292A, B, C) (Also see PCB 63—Set 197-1 and PCB 73—Set 214-1) **191**–13
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- ●21K4WY, 21K4Y (Ch. TS-292AY, BY, CY) (See PCB 63—Set 197-1, PCB 73—Set 214-1 and Model 21C1—Set **191**-13)
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- ●21K5BY (Ch. TS292AY, BY, CY) (See PCB 63—Set 197-1, PCB 73—Set 214-1 and Model 21C1—Set **191**-13)
- ●21K5D, DY (WTS-292A, AY, B, BY, C, CY) (See PCB 63—Set 197-1 PCB 73—Set 214-1 and Model 21C1—Set **191**-13)
- ●21K5Y (Ch. TS-292AY, BY, CY) (See PCB 63—Set 197-1, PCB 73—Set 214-1 and Model 21C1—Set **191**-13)
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- ●21K7 (Ch. TS-292A, B, C) (Also see PCB 63—Set 197-1 and PCB 73—Set 214-1) **191**–13
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- ●21K7Y (Ch. TS-292AY, BY, CY) (See PCB 63—Set 197-1, PCB 73—Set 214-1 and Model 21C1—Set **191**-13)
- ●21K9, Y (Ch. WTS-292A, AY, B, BY, C, CY) (See PCB 63—Set 197-1, PCB 73—Set 214-1 and Model 21C1—Set **191**-13)
- ●21K10 B, BY, Y (Ch. VTS-292A, AY, B, BY, C, CY) (See PCB 63—Set 197-1, PCB 73—Set 214-1 and Model 21C1—Set **191**-13)
- ●21K11, B, BY, Y (Ch. VTS-292A, AY, B, BY, C, CY) (See PCB 63—Set 197-1, PCB 73—Set 214-1 and Model 21C1—Set **191**-13)
- ●21K12A, AB, AW (Ch. WTS-502) (Also See PCB 106—Set 253-1) ....**237**—8
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- ●21K12G (Ch. RTS-502) (See PCB 106—Set 253-1 and Model 17K17—Set **237**-8)
- ●21K13 (Ch. TS-502) (Also See PCB 106—Set 253-1) ....**237**—8
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- ●21K13B (Ch. TS-502) (Also See PCB 106—Set 253-1) ....**237**—8
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- ●21K18, B (Ch. PTS-502) (See PCB 106—Set 253-1 and Model 17K17—Set **237**-8)
- ●21K19, B (Ch. WTS-518) (Also See PCB 124—Set 280-1)...**269**—9
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NOTE: PCB Denotes Production Change Bulletin. Production Change Bulletin Nos. 1 Through 63 Are All Contained in Set No. A-200. Production Change Bulletin Nos. 64 Through 104 Are All Contained in Set No. A-250. ● Denotes Television Receiver.

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●A-T1816 (Code 129) (Ch. 81A, D-81) (Also See PCB 115—Set 267-1) ... 227-10
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●A-T1856, HM, L, W (Code 123) (Ch. 81, H-1, H-1A) (See PCB 83—Set 224-1 and Model 53-T1824—Set 201-7)
●A-T1856W (Code 129) (Ch. 81A, D-81) (Also See PCB 115—Set 267-1) ... 227-10
●A-T1858 (Code 128) (Ch. 91A, J-2) (See PCB 66—Set 203-1, PCB 82—Set 223-1 and Model 53-T1853—Set 185-10)
●A-T2230, L (Code 123) (Ch. 81, H-1, H-1A) (See PCB 83—Set 224-1 and Model 53-T1824—Set 201-7)
●A-T2230 (Code 129) (Ch. 81A, D-81) (Also See PCB 115—Set 267-1) ... 227-10
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●A-T2262HM (Code 123) (Ch. 81, H-1, H-1A) (See PCB 83—Set 224-1 and Model 53-T1824—Set 201-7)
●A-T2266, L, A-T2271HM (Code 128) (Ch. 91A, J-2) (See PCB 66—Set 203-1, PCB 82—Set 223-1 and Model 53-T1853—Set 185-10)
●A-T2272, L (Code 123) (Ch. 81, H-1, H-1A) (See PCB 83—Set 224-1 and Model 53-T1824—Set 201-7)
●A-T2272 (Code 129) (Ch. 81A, D-81) (Also See PCB 115—Set 267-1) ... 227-10
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●A-T2274S (Code 128) (Ch. 91A, J-2) (See PCB 66—Set 203-1, PCB 82—Set 223-1 and Model 53-T1853—Set 185-10)
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●A-T2280, A-T2281 (Code 128) (Ch. 91A, J-2) (See PCB 66—Set 203-1, PCB 82—Set 223-1 and Model 53-T1853—Set 185-10)
●A-T2288, HM (Code 123) (Ch. 81, H-1, H-1A) (See PCB 83—Set 224-1 and Model 53-T1824—Set 201-7)
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●A-UT1816, L, A-UT1817 (Code 123) (Ch. 81, H-1, H-1A) (For TV Ch. See PCB 83—Set 224-1 and Model 53-T1824—Set 201-7, For UHF Tuner See Model UT21B—Set 223-9)
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●A-UT2230, A-UT2232 (Code 123) (Ch. 81, H-1, H-1A) (For TV Ch. See PCB 83—Set 224-1 and Model 53-T1824—Set 201-7, For UHF Tuner See Model UT21B—Set 223-9)
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●A-UT2272 (Code 123) (Ch. 81, H-1, H-1A) (For TV Ch. see PCB 83—Set 224-1 and Model 53-T1824—Set 201-7, for UHF Tuner see Model UT21B—Set 223-9)
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●A-UT2277, A-UT2279 (Code 123) (Ch. 81, H-1, H-1A) (For TV Ch. See PCB 83—Set 224-1 and Model 53-T1824—Set 201-7, For UHF Tuner See Model UT21B—Set 223-9)
●A-UT2280, A-UT2281 (Code 128) (Ch. 91A, J-2) (See PCB 66—Set 203-1, PCB 82—Set 223-1 and Model 53-T1853—Set 185-10)
●A-UT2288 (Code 123) (Ch. 81, H-1, H-1A) (For TV Ch. see PCB 83—Set 224-1 and Model 53-T1824—Set 201-7, for UHF Tuner see Model UT21B—Set 223-9)
●A-UT2289 (Code 128) (Ch. 91A, J-2) (See PCB 66—Set 203-1, PCB 82—Set 223-1, and Model 53-T1853—Set 185-10)
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● 52-T1841L (Code 123) (Ch. 37, C2) (See Model 51-T1800—Set **148**-13)
● 52-T1842 (Code 121) (Ch. 41, D1, D1A) (See PCB 56—Set 190-1 and Model 52-T2106—Set **171**-9)
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● 52-T1842L (Code 124) (Ch. 33, C2) (See Model 52-T1842—Set **148**-13)
● 52-T1844 (Code 121) (Ch. 41-D1, DA1) (See PCB 56—Set 190-1 and Model 52-T2106—Set **171**-9)
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● 52-T1850 (Code 121) (Ch. 41, D1, D1A) (See PCB 56—Set 190-1 and Model 52-T2106—Set **171**-9)
● 52-T1850-W (Code 124) (Ch. 71, G1) (Also see PCB 57—Set 191-1) .... **179**—9
● 52-T1882 (Code 121) (Ch. 44, D4, D4A) (Also see PCB 57—Set 191-1) .... **181**—9
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● 52-T1883 (Code 121) (Ch. 44, D4, D4A) (Also see PCB 57—Set 191-1) .... **181**—9
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● 52-T2182 (Code 121) (Ch. 44, D-4, D-4A and Radio Ch. RT-6) (For TV Ch. see PCB 57—Set 191-1 and Model 52-T2282—Set **181**-9, for Radio Ch. see Set **159**-2A)
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● 53-T1827, -F, -HM (Code 128) (Ch. 91, J-2) (See PCB 66—Set 203-1, PCB 82—Set 223-1 and Model 53-T1853—Set **185**-10)
● 53-T1852 (Code 123) (Ch. 81, H-1, H-1A) (Also see PCB 83—Set 224-1) .... **201**—7
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● 53-T2271 (Code 126) (Ch. 91, J1) (Also see PCB 66 — Set 203-1) .... **185**—10
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● 53-U1827, HM (Code 126) (Ch. 91, J-1) (See PCB 66—Set 203-1, PCB 82—Set 223-1 and Model 53-T1853—Set **185**-10)
● 53-U1827 (Code 128) (Ch. 91, J-2) (See PCB 66—Set 203-1, PCB 82 —Set 223-1 and Model 53-T1853 —Set **185**-10)
● 53-U1852 (Code 123) (Ch. 81, H-1, H-1A (For TV Ch. see PCB 83—Set 224-1 and Model 53-T1824—Set **201**-7, for UHF Tuner see Model UT21A—Set **223**-9)
● 53-U1853, L (Code 126) (Ch. 91, J-1) (See PCB 66—Set 203-1, PCB 82—Set 223-1 and Model 53-T1853—Set **185** 10)
● 53-U2124 (Code 123) (Ch. 81, H-1, H-1A) (For TV Ch. see PCB 83—Set 224-1 and Model 53-T1824—Set **201**-7, for UHF Tuner see Model UT21A—Set **223**-9)

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● 53-U2125 (Code 123) (Ch. 81, H-1, H-1A) (For TV Ch. see PCB 83—Set 224-1 and Model 53-T1824—Set **201**-7, for UHF Tuner see Model UT21A—Set **223**-9)
● 53-U2226 (Code 123) (Ch. 81, H-1, H-1A) (For TV Ch. see PCB 83—Set 224-1 and Model 53-T1824—Set **201**-7, for UHF Tuner see Model UT21A—Set **223**-9)
● 53-U2227 (Code 123) (Ch. 81, H-1, H-1A) (For TV Ch. see PCB 83—224-1 and Model 53-T1824—Set **201**-7, for UHF Tuner see Model UT21A—Set **223**-9)
● 53-U2255 (Code 123) (Ch. 81, H-1, H-1A) (For TV Ch. see PCB 83—Set 224-1 and Model 53-T1824—Set **201**-7, for UHF Tuner see Model UT21A—Set **223**-9)
● 53-U2260 (Code 123) (Ch. 81, H-1, H-1A) (For TV Ch. see PCB 83—224-1 and Model 53-T1824—Set **201**-7, for UHF Tuner see Model UT21A—Set **223**-9)
● 53-U2266, L (Code 126) (Ch. 91, J-1) (See PCB 66—Set 203-1, PCB 82—Set 223-1 and Model 53-T1853—Set **185**-10)
● 53-U2266 (Code 128) (Ch. 91, J-2) (See PCB 66—Set 203-1, PCB 82—Set 223-1 and Model 53-T1853—Set **185**-10)
● 53-U2269 (Code 126) (Ch. 91, J-1) (See PCB 66—Set 203-1, PCB 82 —Set 223-1 and Model 53-T1853 —Set **185**-10)
● 53-U2271 (Code 126) (Ch. 91, J-1) (See PCB 66—Set 203-1, PCB 82 —Set 223-1 and Model 53-T1853 —Set **185**-10)
● 53-U2271 (Code 128) (Ch. 91, J-2) (See PCB 66—Set 203-1, PCB 82 —Set 223-1 and Model 53-T1853 —Set **185**-10)
● 53-U2272 (Code 123) (Ch. 81, H-1, H-1A) (For TV Ch. see PCB 83—Set 224-1 and Model 53-T1824—Set **201**-7 for UHF Tuner see Model UT21A—Set **223**-9)
● 53-U2285 (Code 126) (Ch. 94, J-4 and Radio Ch. RT-8) (See PCB 85 —Set 226-1 and Model 53-T2285 —Set **213**-5)
● 53-U2286 (Code 126) (Ch. 94, J-4 and Radio Ch. RT-10) (For TV Ch. Only see PCB 85—Set 226-1 and Model 53-T2285—Set **213**-5)
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NOTE: PCB Denotes Production Change Bulletin. Production Change Bulletin Nos. 1 Through 63 Are All Contained in Set No. A-200 ● Denotes Television Receiver.
Production Change Bulletin Nos. 64 Through 104 Are All Contained in Set No. A-250

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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
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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.

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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●H-650T17 (Ch. V-2192-4) (See Model H-640T17—Set **133**-15)
●H-650T17 (Ch. V-2200-1) (Also see PCB 42—Set 176-1) **154**–15
●H-651K17 (Ch. V-2192) (See Model H-639T17—Set **133**-15)
●H-651K17 (Ch. V-2200-1) (Also see PCB 42—Set 176-1) **154**–15
●H-652K20 (Ch. V-2194-2, -3) (See PCB 31—Set 157-3 and Model H-642K20A—Set **137**-16)
●H-652K20 (Ch. V-2201-1) (Also see PCB 42—Set 176-1) **154**–15
●H-653K24 (Ch. V-2202-2, V-2210-1) (Also see PCB 35—Set 164-1) **160**–13
●H-654T17 (Ch. V-2175-3, -4, V-2192, -1) **133**–15
●H-655K17 (Ch. V-2192 -4, -5, -6) (See PCB 28—Set 150-1 and Model H-640T17—Set **133**-15)
●H-655K17, H-656K17, H-657K17 (Ch. V-2200-1) (Also see PCB 42—Set 176-1) **154**–15
●H-657K17 (Ch. V-2192-4, -5, -6) (See PCB 28—Set 150-1 and Model H-639T17—Set **133**-15)
●H-658T17 (Ch. V-2192, -1) (See PCB 28—Set 150-1 and Model H-639T17—Set **133**-15)
●H-659T17 (Ch. V-2204-1) (Also see PCB 42—Set 176-1) **154**–15
●H-660C17, H-661C17 (Ch. V-2203-1 and Radio Ch. V-2180-3) (Also see PCB 46—Set 180-1) .. **157**–12
●H-662K20 (Ch. V-2201-1) (Also see PCB 42—Set 176-1) **154**–15
●H-663T17 (Ch. V-2192-2) (See PCB 28—Set 150-1 and Model H-639T17—Set **133**-15)
●H-663T17 (Ch. V-2204) (Also see PCB 42—Set 177-1) **154**–15
●H-664K17 (Ch. V-2200-1) (Also see PCB 42—Set 176-1) **154**–15
●H-665T16 (Ch. V-2206-1) (See PCB 42—Set 176-1 and Model H-648T20—Set **154**-15)
●H-667T17, H-668T17 (Ch. V-2216-1) (Also see PCB 40—Set 172-1) **167**–15
●H-673K21 (Ch. V-2217-1) (See Model H-667T17—Set **167**-15)
●H-676T21 (Ch. V-2217-1) (See Model H-667T17—Set **167**-15)
●H-678K17, H-679K17 (Ch. V-2216-1, -2, -3) (Also see PCB 40—Set 172-1, PCB 45—Set 179-1 and PCB 52—Set 186-1) **167**–15
●H-681T17 (Ch. V-2215-1) (See PCB 45—Set 179-1, PCB 52—Set 186-1 and Model H-667T17—Set **167**-15)
●H-688K24 (Ch. V-2219-1) (Also see PCB 52—Set 186-1) **174**–14
●H-689T16 (Ch. V-2214-1) (See PCB 40—Set 172-1, PCB 58—Set 192-1 and Model H-667T17—Set **167**-15)
●H-690K21, H-691K21 (Ch. V-2217-1) (See Model H-667T17—Set **167**-15)
●H-692T21 (Ch. V-2217-2, -3) (See PCB 43—Set 177-1, PCB 52—Set 186-1 and Model H-667T17—Set **167**-15)
●H-695K21 (Ch. V-2217-2, -3) (See PCB 43—Set 177-1, PCB 52—Set 186-1 and Model H-667T17—Set **167**-15)
●H-699K17 (Ch. V-2216-2, -3) (See PCB 40—Set 172-1, PCB 45—Set 179-1, PCB 52—Set 186-1 and Model H-667T17—Set **167**-15)
●H-700T17, H701T17 (Ch. V-2216-2, -3) (See PCB 40—Set 172-1, PCB 45—Set 179-1, PCB 52—Set 186-1 and Model H-667T17—Set **167**-15)
●H-701K21 (Ch. V-2217-2) (See PCB 43—Set 177-1 and Model H-667T17—Set **167**-15)
●H-702K17, H-703K17 (Ch. V-2216-2, -3) (See PCB 40—Set 172-1, PCB 45—Set 179-1, PCB 52—Set 186-1 and Model H-767T17—Set **167**-15)
●H-704T17 (Ch. V-2216-2) (See PCB 40—Set 172-1, PCB 45—Set 179-1, PCB 51—Set 185-1, PCB 52—Set 186-1 and Model H-667T17—Set **167**-15)
●H-704T17 (Ch. V-2216-4, -5) **202**–10
●H-705K17 (Ch. V-2216-2, -3) (See PCB 40—Set 172-1, PCB 45—Set 179-1, PCB 52—Set 186-1 and Model H-667T17—Set **167**-15)
●H-706T16 (Ch. V-2207-1) .. **193**–12
●H-708T20 (Ch. V-2220-1, -3, -11) **193**–12
●H-710T21 (Ch. V-2217-2, -3) (See PCB 40—Set 172-1, PCB 43—Set 177-1, PCB 52—Set 186-1 and Model H-667T17—Set **167**-15)
●H-710T21 (Ch. V-2217-4, -5) **202**–10
●H-711T21 (Ch. V-2217-2, -3) (See PCB 40—Set 172-1, PCB 43—Set 177-1, PCB 52—Set 186-1 and Model H-667T17—Set **167**-15)
●H-711T21 (Ch. V-2217-4, -5) **202**–10
●H-713K21 (Ch. V-2217-2, -3) (See PCB 40—Set 172-1, PCB 43—Set 177-1, PCB 52—Set 186-1 and Model H-667T17—Set **167**-15)
●H-714K21 (Ch. V-2217-2, -3) (See PCB 40—Set 172-1, PCB 43—Set 177-1, PCB 52—Set 186-1 and Model H-667T17—Set **167**-15)
●H-714K21 (Ch. V-2217-4, -5) **202**–10
●H-715K21 (Ch. V-2217-2, -3) (See PCB 40—Set 172-1, PCB 43—Set 177-1, PCB 52—Set 186-1 and Model H-667T17—Set **167**-15)

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●H-715K21 (Ch. V-2217-4, -5) **202**–10
●H-718K20 (Ch. V-2220-2) . **193**–12
●H-720K21 (Ch. V-2217-2, -3) (See PCB 40—Set 172-1, PCB 43—Set 177-1, PCB 52—Set 186-1 and Model H-667T17—Set **167**-15)
●H-720K21 (Ch. V-2217-4, -5) **202**–10
●H-721K21 (Ch. V-2217-2, -3) (See PCB 40—Set 172-1, PCB 43—Set 177-1, PCB 52—Set 186-1 and Model H-667T17—Set **167**-15)
●H-721K21 (Ch. V-2217-4, -5) **202**–10
●H-722K21 (Ch. V-2217-2, -3) (See PCB 40—Set 172-1, PCB 43—Set 177-1, PCB 52—Set 186-1 and Model H-667T17—Set **167**-15)
●H-722K21 (Ch. V-2217-4, -5) **202**–10
●H-723K21 (Ch. V-2217-5) . **202**–10
●H-724T20, H-725T20 (Ch. V2220-2) **193**–12
●H-730C21 (Ch. V-2218-1 and Radio Ch. V-2180-9, -10) **190**–16
●H-730C21 (Ch. V-2218-2 and Radio Ch. V-2180-9, -10) (Also see PCB 59—Set 193-1 and PCB 68—Set 205-1) **190**–16
●H-730C21 (Ch. V-2218-11 and Radio Ch. V-2180-9, -10) (Also see PCB 59—Set 193-1) **190**–16
●H-732C21 (Ch. V-2218-1 and Radio Ch. V-2180-9, -10) **190**–16
●H-732C21 (Ch. V-2218-11 and Radio Ch. V-2180-9, -10) (Also see PCB 59—Set 193-1) **190**–16
●H-733C21 (Ch. V-2218-1 and Radio Ch. V-2180-9, -10) **190**–16
●H-733C21 (Ch. V-2218-11 and Radio Ch. V-2180-9, -10) (Also see PCB 59—Set 193-1) **190**–16
●H-736T17 (Ch. V-2227-1) (Also see PCB 89—Set 233-1) **214**–10
●H-737T17 (Ch. V-2216-5) . **202**–10
●H-737T17 (Ch. V-2232-2) . **212**—9
●H-738T17 (Ch. V-2227-1) (Also see PCB 89—Set 233-1) **214**–10
●H-739T17, H-739TU17 (Ch. V-2227-2) **214**–10
●H-740T21, H-742K21, H-743K21 (Ch. V-2233-1) (Also See PCB 99—Set 244-1) .... **212**—9
●H-746K21, H-746KU21, H-747K21, H-747KU21 (Ch. V-2233-4) **215**–16
●H-750T21 (Ch. V-2233-3) . **212**—9
●H-751T21 (Ch. V-2217-4, -5) **202**–10
●H-751T21 (Ch. V-2233-2) . **212**—9
●H-752T21 (Ch. V-2233-2) . **212**—9
●H-753K21 (Ch. V-2233-3) . **212**—9
●H-754K21 (Ch. V-2217-4, -5) **202**–10
●H-754K21 (Ch. V-2233-2) . **212**—9
●H-755K21 (Ch. V-2233-2) . **212**—9
●H-756K21 (Ch. V-2217-4, -5) **202**–10
●H-756K21 (Ch. V-2233-2) . **212**—9
●H-757K21 (Ch. V-2217-4, -5) **202**–10
●H-757K21 (Ch. V-2233-2) . **212**—9
●H-758K21 (Ch. V-2217-4, -5) **202**–10
●H-758K21 (Ch. V-2233-2) . **212**—9
●H-759K21 (Ch. V-2217-4, -5) **202**–10
●H-759K21 (Ch. V-2233-2) . **212**—9
●H-760T21 (Ch. V-2233-2) . **212**—9
●H-760TU21 (Ch. V-2233-2) **212**—9
●H-761T21 (Ch. V-2233-2) . **212**—9
●H-761TU21 (Ch. V-2233-2) **212**—9
●H-769T21 (Ch. V-2263-12, -14) **253**–17
●H-769TU21 (Ch. V-2273-122) **253**–17
●H-770T21A (Ch. V-2263-12) **253**–17
●H-770TU21A (Ch. V-2273-122) **253**–17
●H-771T21A (Ch. V-2263-12) **253**–17
●H-771TU21A (Ch. V-2273-122) **253**–17
●H-786K21 (Ch. V-2263-12) **253**–17
●H-786KU21 (Ch. V-2273-122) **253**–17
●H-787K21 (Ch. V-2263-12) **253**–17
●H-787KU21 (Ch. V-2273-122) **253**–17
●H-795T27, H-795TU27 (Ch. V-2250-1) (Also see PCB 105—Set 252-1) **241**–12
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●H-798TU17 (Ch. V-2270-122, -124) **255**–17
●H-799T17 (Ch. V-2260-12, -14) **255**–17
●H-799T17, B (Ch. V-2310). **281**–10
●H-799TU17 (Ch. V-2270-122, -124) **255**–17
●H-799TU17, B (Ch. V-2320) **281**–10
H-802 (Ch. V-11900-1, -2, -3, -4, -5, V-11213) Tel. UHF Conv. **209**–13
●H-815T24, H-815TU24 (Ch. V-2250-1, -4) (Also see PCB 105—Set 252-1) **241**–12
●H-817K24, H-817KU24 (Ch. V-2250-1, -4) (Also see PCB 105—Set 252-1) **241**–12
●H-822K21 (Ch. V-2263-12) **253**–17
●H-822KU21 (Ch. V-2273-122) **253**–17
●H-823K21 (Ch. V-2263-12) **253**–17
●H-823KU21 (Ch. V-2273-122) **253**–17
●H-827T21 (Ch. V-2263-12, -13, -14, -15) **253**–17
●H-827TU21 (Ch. V-2273-122, -134) **253**–17
●H-828T21 (Ch. V-2263-12, -13, -14, -15) **253**–17
●H-828TU21 (Ch. V-2273-122, -134) **253**–17
●H-829T21 (Ch. V-2263-12, -13, -14, -15) **253**–17

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●H-829TU21 (Ch. V-2273-122, -134) **253**–17
●H-830K21 (Ch. V-2263-11, -12, -13, -14) **253**–17
●H-830KU21 (Ch. V-2273-111, -122, -124, -132, -134) **253**–17
●H-831K21 (Ch. V-2263-11, -12, -13, -14) **253**–17
●H-831KU21 (Ch. V-2273-111, -122, -124, -132, -134) **253**–17
●H-834K21 (Ch. V-2263-22) **253**–17
●H-834KU21 (Ch. V-2273-222) **253**–17
●H-835K21 (Ch. V-2263-22) **253**–17
●H-835KU21 (Ch. V-2273-222) **253**–17
●H-836T21 (Ch. V-2263-35) **253**–17
●H-836TU21 (Ch. V-2273-322) **253**–17
●H-838K21 (Ch. V-2263-15) **253**–17
●H-838K21A (Ch. V-2263-15) (See Model H-769T21—Set **253**-17)
●H-838K21B (Ch. V-2313-15, -25, -35) (Also See PCB 127—Set 286-1) **270**–18
●H-838KU21 (Ch. V-2273-122) **253**–17
●H-838KU21A (Ch. V-2273-124) (See Model H-769TU21—Set **253**-17)
●H-838KU21B (Ch. V-2323-101, -122, -124, -201, -301) (Also See PCB 127—Set 286-1) **270**–18
●H-839K21 (Ch. V-2263-15) **253**–17
●H-839KU21 (Ch. V-2273-122) **253**–17
●H-840CK15 (Ch. V-2284-15) **259**–15
●H-841T21 (Ch. V-2313-15, -25, -35) (Also See PCB 127—Set 286-1) **270**–18
●H-841TU21 (Ch. V-2323-101, -122, -124, -201, -301) (Also See PCB 127—Set 286-1) **270**–18
●H-842T21 (Ch. V-2313-15, -25, -35) (Also See PCB 127—Set 286-1) **270**–18
●H-842TU21 (Ch. V2323-101, -122, -124, -201, -301) (Also See PCB 127—Set 286-1) **270**–18
●H-843K21 (Ch. V-2313-15, -25, -35) (Also See PCB 127—Set 286-1) **270**–18
●H-843KU21 (Ch. V-2323-101, -122, -124, -201, -301) (Also See PCB 127—Set 286-1) **270**–18
●H-844K21 (Ch. V-2313-15, -25, -35) (Also See PCB 127—Set 286-1) **270**–18
●H-844KU21 (Ch. V-2323-101, -122, -124, -201, -301) (Also See PCB 127—Set 286-1) **270**–18
●H-847K21 (Ch. V-2313-15, -25, -35) (Also See PCB 127—Set 286-1) **270**–18
●H-847KU21 (Ch. V-2323-101, -122, -124, -201, -301) (Also See PCB 127—Set 286-1) **270**–18
●H-848K21 (Ch. V-2313-15, -25, -35) (Also See PCB 127—Set 286-1) **270**–18
●H-848KU21 (Ch. V-2323-101, -122, -124, -201, -301) (Also See PCB 127—Set 286-1) **270**–18
●H-853K24 (Ch. V-2314-15, -25) **274**–16
●H-853K24A (S), (V) (Ch. V-2318-11, -15, -21, -25) **296**–11
●H-853KU24 (Ch. V-2324-203) **274**–16
●H-853KU24A (Ch. V-2328-101, -201) **296**–11
●H-854K24 (Ch. V-2314-15, -25) **274**–16
●H-854K24A (S), (V) (Ch. V-2318-11, -15, -21, -25) **296**–11
●H-854KU24 (Ch. V-2324-203) **274**–16
●H-854KU24A (Ch. V-2328-101, -201, ... **296**–11
●H-861T21 (Ch. V-2313-15, -25, -35) (Also See PCB 127—Set 286-1) **270**–18
●H-861TU21 (Ch. V-2323-101, -122, -124, -201, -301) (Also See PCB 127—Set 286-1) **270**–18
●H-862T21 (Ch. V-2313-15, -25, -35) (Also See PCB 127—Set 286-1) **270**–18
●H-862TU21 (Ch. V-2323-101, -122, -124, -201, -301) (Also See PCB 127—Set 286-1) **270**–18
●H-863T21 (Ch. V-2313-15, -25, -35) (Also See PCB 127—Set 286-1) **270**–18
●H-863T21A (Ch. V-2263-35) (See Model H-769T21—Set **253**-17)
●H-863TU21 (Ch. V-2323-101, -122, -124, -201, -301) (Also See PCB 127—Set 286-1) **270**–18
●H-863TU21A (Ch. V-2273-324) (See Model H-769TU21—Set **253**-17)
●H-864T21 (Ch. V-2313-15, -25, -35) **270**–18
●H-864T21A (Ch. V-2263-35) (See Model H-769T21—Set **253**-17)
●H-864T21, B (Ch. V-2313-15, -25, -35) (Also See PCB 127—Set 286-1) **270**–18
●H-864TU21 (Ch. V-2323-101, -122, -124, -201, -301) (Also See PCB 127—Set 286-1) **270**–18
●H-864TU21A (Ch. V-2273-324) (See Model H-769TU21—Set **253**-17)
●H-864TU21B (Ch. V-2323-101, -122, -124, -201, -301) (Also See PCB 127—Set 286-1) **270**–18
●H-865T21 (Ch. V-2313-15, -25, -35) **270**–18
●H-865T21A (Ch. V-2263-35) (See Model H-769T21—Set **253**-17)
●H-865T21, B (Ch. V-2313-15, -25, -35) (Also See PCB 127—Set 286-1) **270**–18
●H-865TU21A (Ch. V-2273-324) (See Model H-769TU21—Set **253**-17)
●H-865TU21 (Ch. V-2323-101, -122, -124, -201, -301) (Also See PCB 127—Set 286-1) **270**–18

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○H-865TU21B (Ch. V-2323-101, -122, -124, -201, -301) (Also See PCB 127—Set 286-1) **270**–18
●H-866T21 (Ch. V-2313-15, -25, -35) (Also See PCB 127—Set 286-1) **270**–18
●H-866T21A (Ch. V-2263-35) (See Model H-769T21—Set **253**-17)
●H-866T21B (Ch. V-2313-15, -25, -35) (Also See PCB 127—Set 286-1) **270**–18
●H-866TU21 (Ch. V-2323-101, -122, -124, -201, -301) (Also See PCB 127—Set 286-1) **270**–18
●H-866TU21A (Ch. V-2273-324) (See Model H-769TU21—Set **253**-17)
●H-866TU21B (Ch. V-2323-101, -122, -124, -201, -301) (Also See PCB 127—Set 286-1) **270**-18
●H-867T21 (Ch. V-2313-15, -25, -35) (Also See PCB 127—Set 286-1) **270**–18
●H-867T21, B (Ch. V-2312) . **281**–10
●H-867TU21, A (Ch. V-2323-101, -122, -124, -201, -301) (Also See PCB 127—Set 286-1) **270**-18
●H-867TU21, B (Ch. V-2322) **281**–10
●H-868T21 (Ch. V-2312) ... **281**–10
●H-868T21 (Ch. V-2313-15, -25, -35) (Also See PCB 127—Set 286-1) **270**–18
●H-868TU21 (Ch. V-2322) .. **281**–10
●H-868TU21, A (Ch. V-2323-101, -122, -124, -201, -301) (Also See PCB 127—Set 286-1) **270**-18
●H-869K24 (Ch. V-2314-15, -25) **274**–16
●H-869K24A (S), (V) (Ch. V-2318-11, -15, -21, -25) **296**–11
●H-869KU24 (Ch. V-2324-203) **274**–16
●H-869KU24A (Ch. V-2328-101, -201) **296**–11
●H-870K24 (Ch. V-2314-15, -25) **274**–16
●H-870K24A (S), (V) (Ch. V-2318-11, -15, -21, -25) **296**–11
●H-870KU24 (Ch. V-2324-203) **274**–16
●H-870KU24A (Ch. V-2328-101, -201) **296**–11
●H-871T21 (Ch. V-2313-15, -25, -35) (Also See PCB 127—Set 286-1) **270**–18
●H-871TU21 (Ch. V-2323-101, -122, -124, -201, -301) (Also See PCB 127—Set 286-1) **270**–18
●H-872T21 (Ch. V-2313-15, -25, -35) (Also See PCB 127—Set 286-1) **270**–18
●H-872TU21 (Ch. V-2323-101, -122, -124, -201, -301) (Also See PCB 127—Set 286-1) **270**–18
●H-873T21 (Ch. V-2313-15, -25, -35 (See Model H-838K21B — Set **270**-18)
●H-873T21A (Ch. V-2263-35) (See Model H-769T21—Set **253**-17)
●H-873TU21 (Ch. V-2323-101, -122, -124, -201, -301) (See Model H-838KU21B—Set **270**-18)
●H-873TU21A (Ch. V-2273-324) (See Model H-769TU21—Set **253**-17)
●H-875T24, A, C (Ch. V-2314-15, -25) **274**–16
●H-875T24B (S), (V) (Ch. V-2318-11, -15, -21, -25) **296**–11
●H-875TU24, C (Ch. V-2324-203) **274**–16
●H-875TU24B (Ch. V-2328-101, -201) **296**–11
●H-876T24 (Ch. V-2314-15, -25) **274**–16
●H-876T24B (S), (V) (Ch. V-2318-11, -15, -21, -25) **296**–11
●H-876TU24, A (Ch. V-2314-15, -25) **274**–16
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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
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NOTE: PCB Denotes **P**roduction **C**hange **B**ulletin. Production Change Bulletin Nos. 1 Through 63 Are All Contained in Set No. A-200 ● Denotes Television Receiver.
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(CM-1) indicates service data also available in Howard W. Sams 1947 Record Changer Manual. (CM-2) indicates service data available in Howard W. Sams 1948 Record Changer Manual. (CM-3) indicates service data available in Howard W. Sams 1949, 1950 Record Changer Manual. (CM-4) indicates service data available in Howard W. Sams 1951, 1952 Record Changer Manual. (CM-5) indicates service data available in Howard W. Sams 1953 Record Changer Manual.

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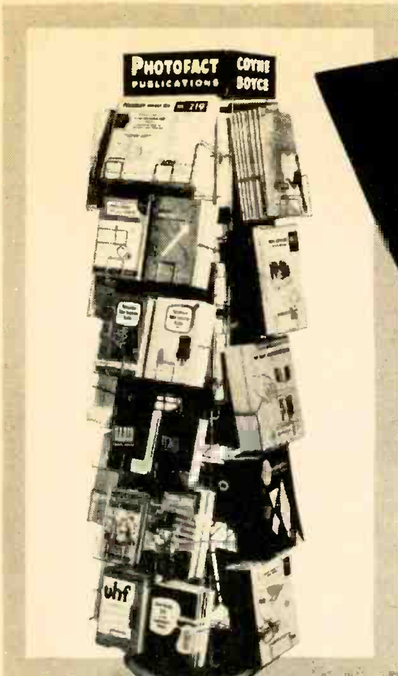

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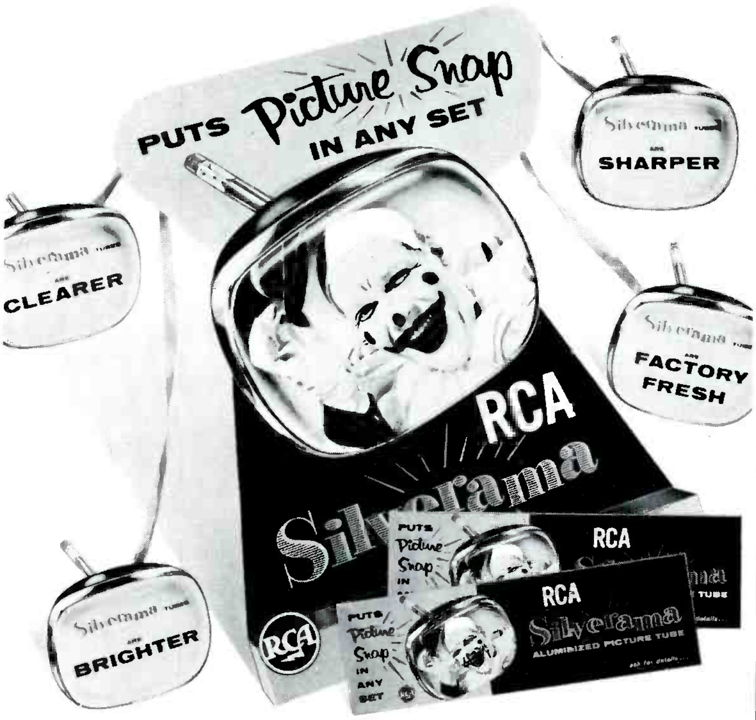
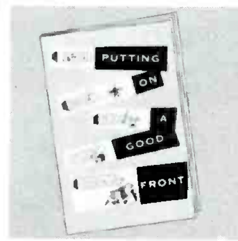


Window Display Kit, Streamers, and Hanger...dramatic, eye-catching traffic stoppers! These tell your neighbors *your store* is "Hq" for the great new "SILVERAMA" Picture Tube! See your RCA Distributor for full details on the "SILVERAMA" Window Display Contest!

SALES PROMOTION

Merchandising Booklet . . . the top secrets of "putting on a good front" window display are revealed to you. Shows you how to "stop them . . . so you can sell them!"



Direct Mail Piece . . . handy self-mailer or envelope stuffer. Ties your name and shop in with RCA "SILVERAMA" national advertising campaigns!

ADVERTISING

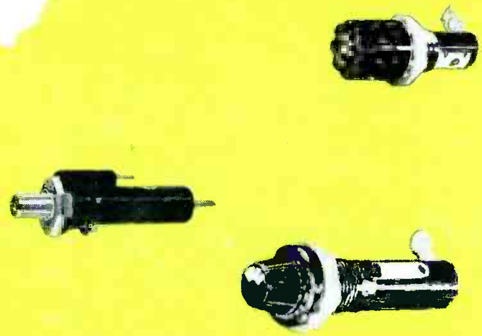
National Magazines . . . "Advertised in Life" . . . and in TV Guide! Important, consistent, big ads in these top magazines tell your customers about the wonders of RCA "SILVERAMA." Be ready for the demand. Contact your RCA distributor!

Local Newspapers . . . ad mats available to your distributor will feature names and addresses of service-dealers handling RCA "SILVERAMA". Be sure *your name* is on the list. Contact your RCA Tube Distributor!

Radio and TV . . . "Milton Berle" and "Martha Raye" coast-to-coast TV Shows, and network radio programs such as "Monitor", and "Fibber McGee and Molly" will bring the RCA "SILVERAMA" story right into your customers' homes . . . send them to your shop. Be ready. Contact your RCA Tube Distributor!

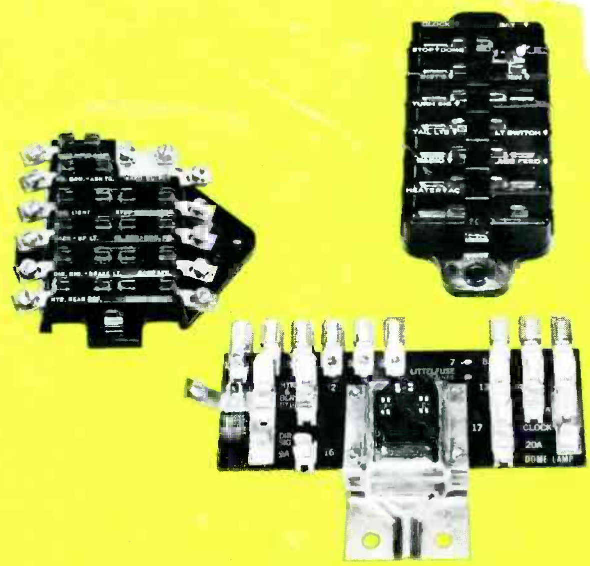
There's more, too! And your RCA TUBE DISTRIBUTOR has the complete story. Cash in on the new, dynamic RCA "SILVERAMA" campaign. SEE YOUR RCA TUBE DISTRIBUTOR *NOW!*

RADIO CORPORATION of AMERICA
TUBE DIVISION — **HARRISON, N. J.**



holders

for all types of fuses, resistors, capacitors and other small tubular components. A broad standard line of stock items for your selection and convenience.



facilities

for research, design, product development, tooling and production of special items for electronic, electrical and automotive applications—fuses, circuit breakers, fuse blocks, in-line holders and harnesses, terminal blocks and low voltage lamp assemblies.

NEW ENGINEERING CATALOG NUMBER 14

We are always at your service to make recommendations and develop the solution to any circuit protection problem.

A Littelfuse field representative will be glad to come to you.

LITTELFUSE

DES PLAINES, ILL.