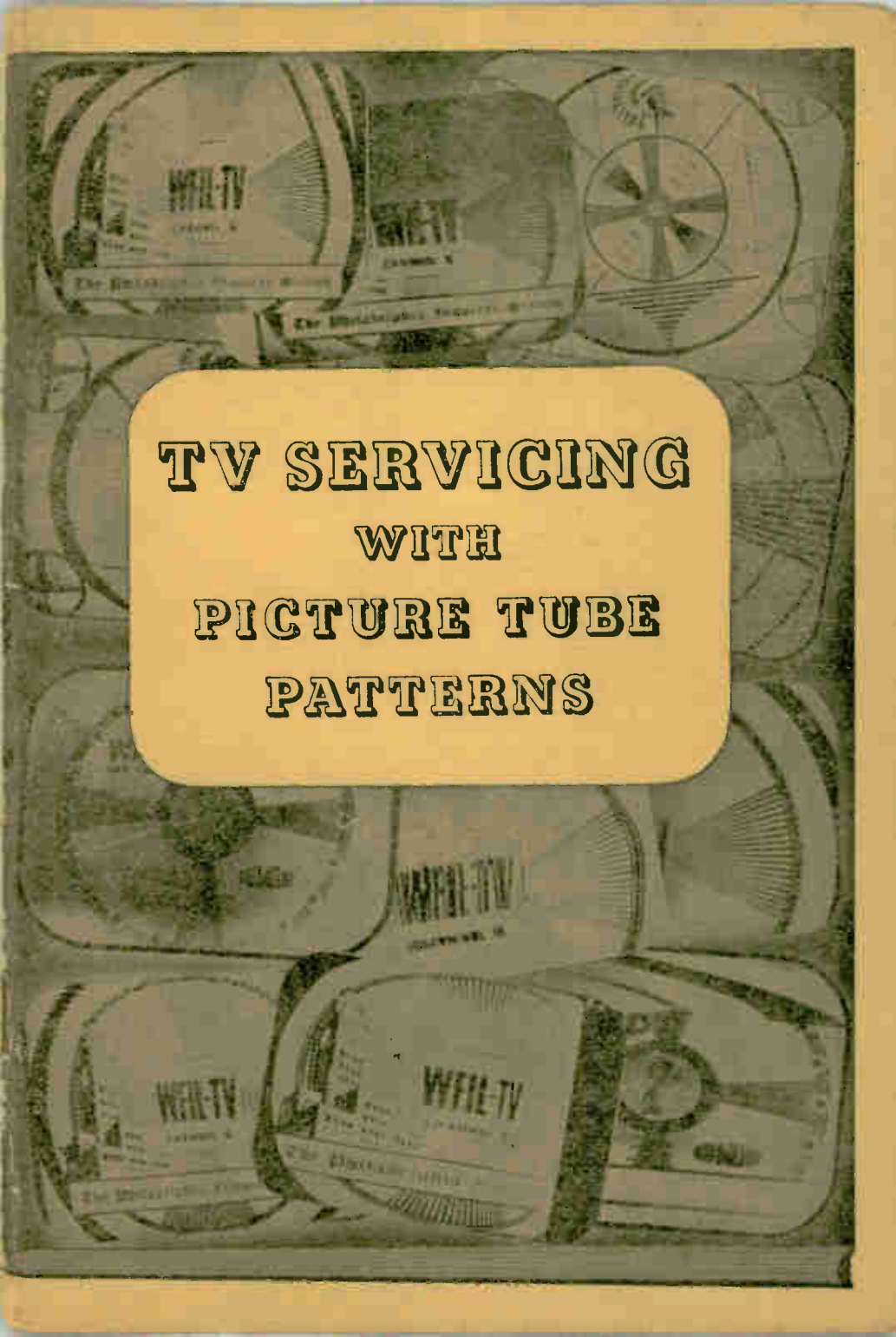
TV SERVICING
WITH
PICTURE TUBE
PATTERNS

# TV SERVICING WITH PICTURE TUBE PATTERNS

A special collection of Picture Tube Patterns and Wave Forms with complete information on "what they mean." Includes recommended service procedure to correct indicated faults.

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# *Introduction*

The purpose of this book is to provide the serviceman with a number of carefully prepared picture tube patterns as an aid to faster analysis of TV troubles. These pictures have been reproduced with the greatest fidelity to enable the practicing serviceman to "spot" the trouble in the receiver.

When a TV serviceman knows approximately where the trouble exists he can then proceed with standard test instruments to *isolate* the trouble. The picture tube patterns in this book show troubles that are found in all TV sets. While many sets have different circuits many TV problems are basically the same in every set.

In addition to the picture tube pattern the publishers have also included many wave forms. These to most servicemen are like a road map to a traveler—they "point the way." A general description of television receivers with complete circuit diagram of a typical commercial receiver is also a part of this book.



*The material in this book has been taken from Coyne's book—"HANDBOOK OF PICTURE PATTERNS AND WAVEFORM ANALYSIS" available through the Educational Book Publishing Div., Coyne Electrical and Television-Radio School, 500 S. Paulina St., Chicago 12, Illinois.*

## TELEVISION SERVICING with PICTURE PATTERNS

Analysis of differences between abnormal and normal test patterns or television pictures often enables a serviceman to determine the kinds of troubles which may be causing the faulty reproduction. Many of the picture patterns that appear on TV receivers and the relation of these pictures to trouble shooting are described in this booklet. As an aid to servicing, methods for trouble correction are included.

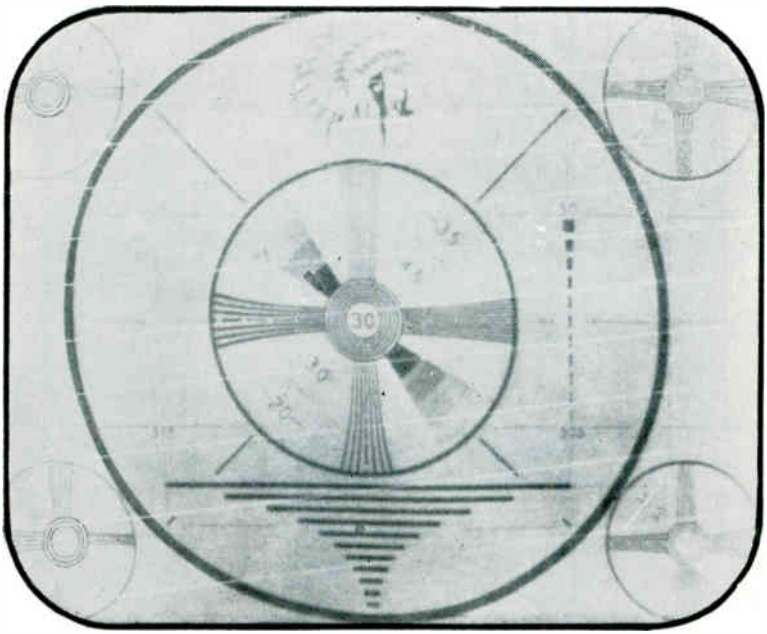
On the following pages under the names ordinarily used to describe the appearance, due to faulty reproduction, are lists of troubles and photographs illustrating these abnormal patterns. The photographs have been provided through the courtesy of Allen B. DuMont Laboratories, Admiral Corporation, RCA, Geneneral Electric Company, Philco Corporation, Sentinel Radio Corporation and Radio Electronics Magazine.

Coyne definitely cautions any inexperienced individual against attempting to service a Television receiver. While certain adjustments for a better picture can be made from the "dials on the front" under no circumstances should anyone but a qualified TV serviceman attempt to service a television set. Even qualified servicemen are advised to observe the following precautions.

1. Extreme caution should be taken in handling the picture tube. The mounting of picture tube is usually constructed to provide adequate protection against implosion while the tube is in the receiver. Extreme caution is recommended when removal or installation of a picture tube is necessary. Here are several things to keep in mind.
2. Shut off power.
3. At no time rest the tube in the deflected yoke.
4. Wear heavy gloves and shatterproof glasses.
5. Advise everyone except qualified servicemen to stay at least 8 feet away from the set while the installing or removal of a picture tube is being done.

In any probing or testing in any part of the set it is recommended that (a) well insulated wire and hooded test clips be used; (b) use good test instruments with all lead wires adequately insulated for the voltages to be encountered. You should use extreme caution in working in or near the high voltage section; (c) do not take anything for granted—test everything—that is the only way to be sure.

# LIST OF ILLUSTRATIONS



***Brightness Excessive or Varying.***

*Causes for trouble.*

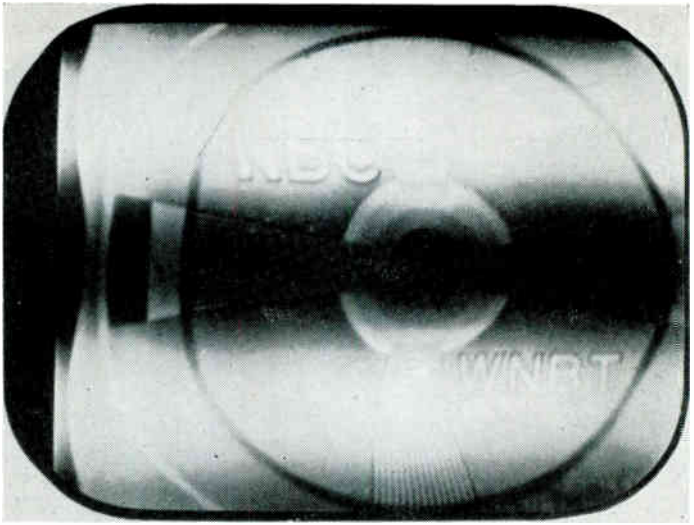
Brightness control turned too high. Vertical retrace lines appear.

Brightness control defective or open circuited.

Open circuit in picture tube grid-cathode circuit.

Trouble in d-c restorer circuits. Brightness varies irregularly.

Oscillation in video i-f amplifier. Picture tube screen becomes brilliant white, with no pattern or picture. Receiver usually must be turned off to stop the oscillation.



***Bars, Horizontal, Wide.***

One or more wide black or dark toned bars separated by light toned spaces of about equal size. The bars remain stationary or nearly so. The condition may be called "hum," because the bars result from faults which would cause hum in a sound receiver.

*Causes for trouble.*

Insufficient filtering in low-voltage B-power supply. Open filter capacitors, etc.

Open or disconnected decoupling capacitors in sound or video circuits.

Locate points at which audible hum is present by using a signal tracer, or use oscilloscope for visual tracing of hum voltages.

***Split Pattern, Top and Bottom.***

A vertical blanking bar runs from side to side of the picture area. The bar may be stationary or slowly moving. The top part of the picture will appear below the bar, and the bottom part will be above the bar. Sometimes there are two complete pictures, each occupying about half the total height in the mask.

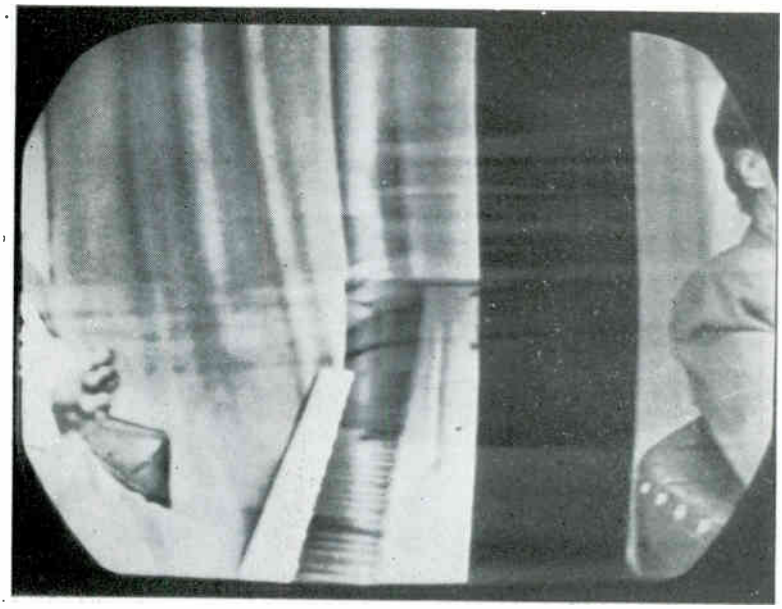
*Causes for trouble.*

Vertical hold control wrongly adjusted.

Faults in the vertical hold control circuit, making the vertical sync frequency too low or half its correct value. Check for leaky or shorted capacitors. Check for shorted resistors. Values of capacitors or resistors may be incorrect.

If there is a vertical afc system for the sweep oscillator, check it as explained for a horizontal afc system in the preceding section.

Sync inverter coupling capacitors leaky or connected wrong.



*Split Pattern, Left and Right.*

A horizontal blanking bar runs from top to bottom of the picture area, remaining stationary or moving slowly. The portion of the picture or pattern which should appear at the left is on the right side of this bar, and the portion which should be at the right is on the left side of the bar.

*Causes for trouble.*

Horizontal hold control wrongly adjusted.

Faults in horizontal afc system for sweep oscillator. Defective tubes, incorrect voltages. Wrong adjustments, as of phasing or lock-in controls. Coupling capacitors open or shorted.

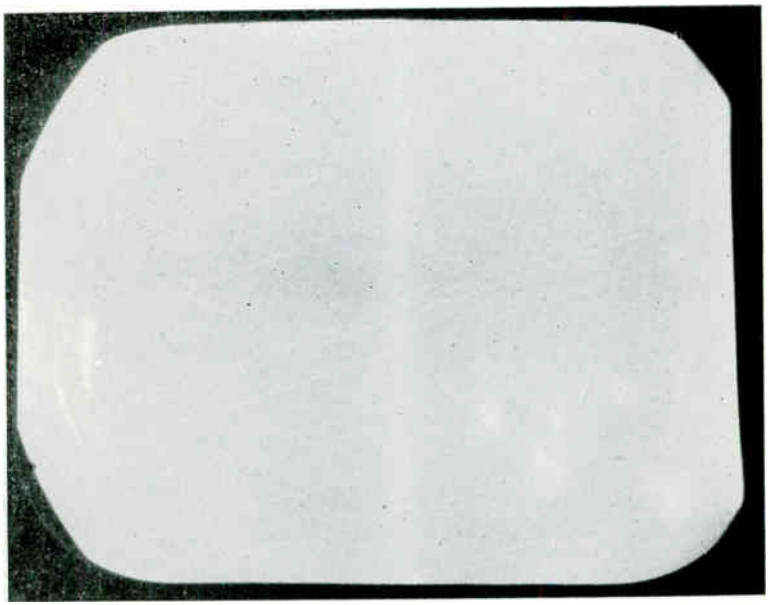
Faults in horizontal hold control circuit, making frequency too low or of half the correct value. Check capacitors and resistors, incorrect values, opens, shorts, and leakage.

Excessive undamped oscillations in horizontal sweep oscillator circuit. Check resistors and decoupling capacitors.

Coupling capacitors for a sync inverter tube leaky or connected wrong.

Defective damper tube.

Oscillation in horizontal deflection coil. Check the bypass capacitor.



***Raster Only, No Pattern or Picture.***

If there is no reproduction of sound, and neither pattern nor picture, the trouble may be any of those listed. If there is reproduction of sound the trouble can be only in parts of the receiver which follow the sound takeoff.

*Causes for trouble.*

Antenna or transmission line open circuited, shorted, have high resistance connections, or for any reason fail to deliver a signal to the receiver.

Dirt, looseness, open connections, or other faults in the tuner.

R-f oscillator or r-f amplifier out of alignment, tube defective, wrong voltages, or other troubles preventing operation.

Video i-f amplifier far out of alignment, defective tube, no voltage on one or more tubes, open or shorted coupling capacitors, etc.

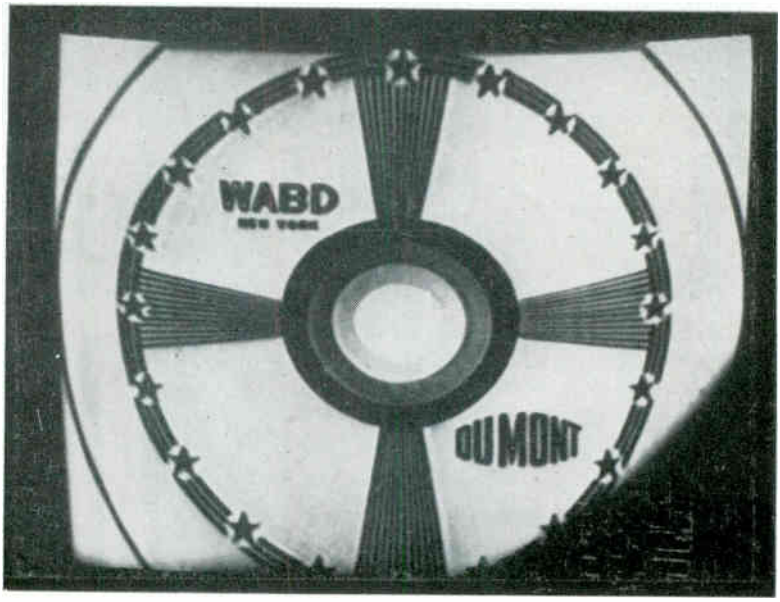
Defective video detector tube or crystal.

Contrast control open circuited or otherwise defective.

Automatic gain control system supplying excessively negative voltage.

Faults in the video amplifier. Check tubes and their voltages, coupling capacitors, resistors, wiring connections, and other causes for no amplification.

Examine all circuits through to the picture tube signal input.




**Shadows.**

*Causes for trouble.*

Ion trap magnet incorrectly adjusted, in wrong position.

Focus coil or magnet not centered around neck of picture tube.

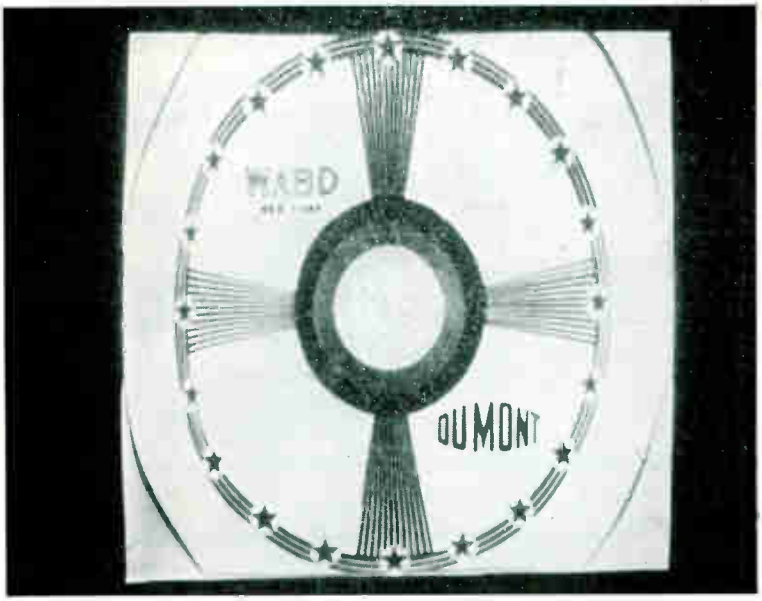
Focus coil or magnet too far back on picture tube neck, too close to base.

Deflection yoke too far back from flared portion of picture tube. It should be as close as possible to the flare.

Frame which carries the yoke and focusing coil or magnet out of position.

Picture tube may require slight rotation around its axis.

Reversing the connections to the focusing coil may help in some cases.




*Size Incorrect.*

Centering control adjustments may have reacted on size.

Sweep oscillator tube defective or supplied with wrong voltages.

Examine circuits which carry sawtooth voltages and currents, and check sawtooth waveforms with oscilloscope.

Trouble in circuits between sweep oscillator and amplifier. Examine coupling capacitors and voltage divider capacitors or resistors.

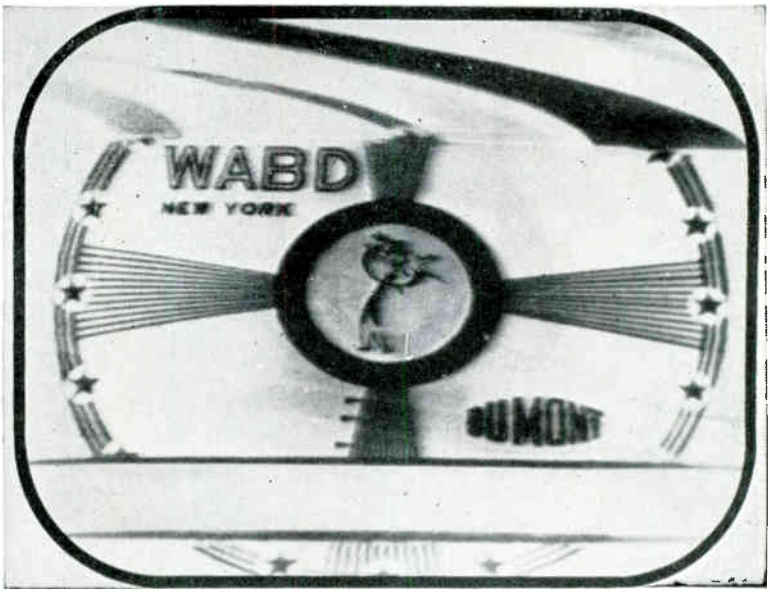
Defective sweep output amplifier tube, or tube supplied with wrong voltages.

Defective sweep output transformer.

Defective damper tube or incorrect damper adjustments. Only in horizontal magnetic deflection systems.

Picture tube may be gassy.

Size which remains excessive after all adjustments may indicate voltage too low on the high voltage anode or anodes of the picture tube.




*Tear Out.*

*Causes for trouble.*

Horizontal hold control wrongly adjusted.

Contrast control set too high.

Excessively strong signal in channel where trouble appears.

Strong but irregular electrical interference temporarily affecting the horizontal hold control system.

Microphonic tubes anywhere in r-f, video, or sync circuits. Tear out will occur when the receiver is jarred.

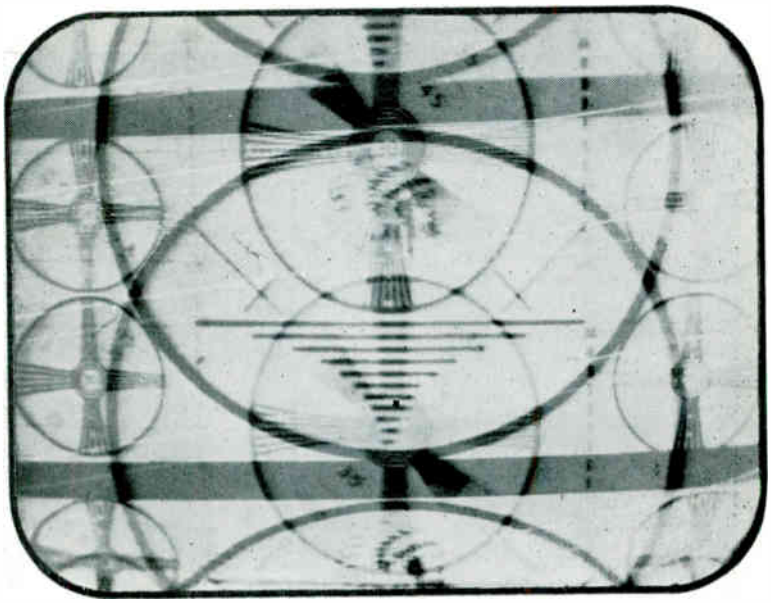
Poor filtering in low-voltage B-supply.

Alignment of video i-f amplifier incorrect, bringing video i-f carrier too low down on the response curve.

Misalignment of traps for accompanying or adjacent sound, allowing audio interference to reach the picture tube input.

Poor low-frequency response in the video detector or video amplifier circuits. Check the tubes, and their plate and grid bias voltages. Look for defective units and incorrect values in coupling capacitors, decoupling capacitors, cathode bypass capacitors, decoupling resistors, and grid resistors.

Incorrect adjustments in the horizontal afc system for the sweep oscillator.



***Movement, Vertical.***

The pattern or picture moves more or less rapidly up or down on the screen of the picture tube, or appears to "roll." Vertical blanking bars appear crosswise of the screen, or, with very slow movement, there may be only one such bar at a time.

*Causes for trouble.*

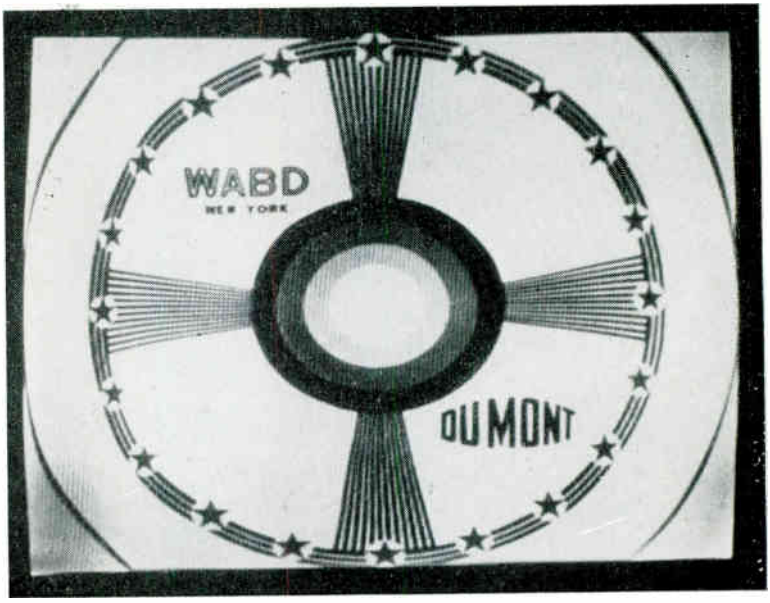
Vertical hold control misadjusted.

Strong reflected signals may interfere with action of the vertical hold system.

Corona or arcing in high-voltage power supply may interfere with vertical hold.

Vertical sweep oscillator tube defective or supplied with incorrect voltages. Opens, leakages, or shorts of capacitors and resistors connected to the grid of the vertical sweep oscillator tube.

Leaky capacitors, or resistors open or shorted, in the integrating filter between the sync section and the vertical sweep oscillator.




***Lines, Narrow, Allover Pattern.***

Due to beat interference from radio frequency and television frequency signals or voltages originating from outside or within the receiver. The number of cycles per second of the interfering frequency is equal approximately to the number of lines, either light or dark, but not both, multiplied by 15,750. The lines may lie vertically or diagonally on the picture tube screen. They weave or ripple and change their direction.

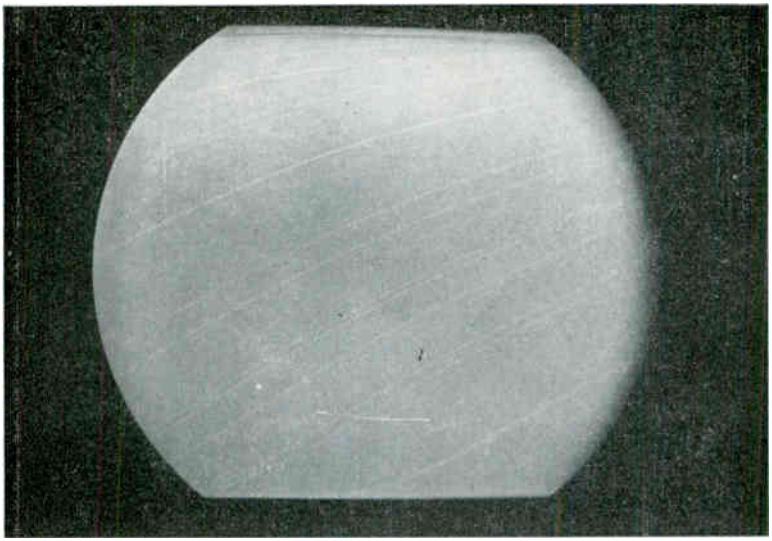
*Causes for trouble.*

Interference from f-m radio broadcasting stations operating in the area where the receiver is located. Change the direction of the receiving antenna. Tune an antenna trap to the interfering frequency. Check the transmission line for possible signal pickup.

Interference from nearby short-wave transmitters. Same remedies as for f-m interference.

Interference from television channels other than the one to which the receiver is tuned. Try adjusting the fine tuning control.

Beating frequency of 4.5 megacycles from sound section of a receiver having intercarrier sound system, or getting past the sound takeoff and reaching the picture tube grid cathode circuit through all or part of the video amplifier. Check dressing of all grid and plate leads following the takeoff.



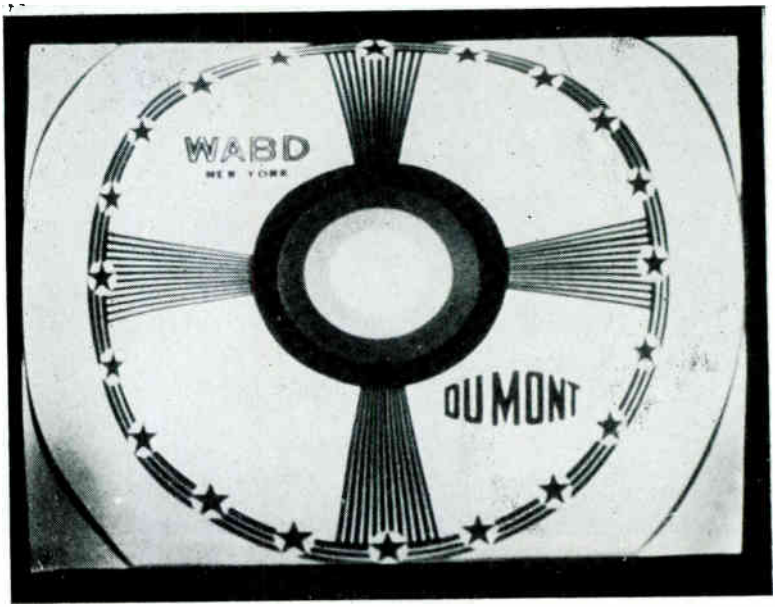
***Lines, White, Curved and Sloping.***

These are called vertical retrace lines. The photograph shows such lines on a plain raster. They appear similarly on patterns and pictures.

*Causes for trouble.*

Brightness control too high, contrast too low, or both together. Adjust one or both controls.

Vertical hold control slightly out of adjustment. The retrace lines will appear only while the picture or pattern moves slowly up or down. Adjust the control.




***Lineary Poor, Vertical.***

With poor vertical linearity the pattern or picture is compressed or flattened from above, below, or from both directions.

*Causes for trouble.*

Vertical linearity control wrongly adjusted.

Defective capacitors or resistors, fixed or adjustable, in vertical linearity control circuits.

Vertical sweep oscillator tube defective, or supplied with wrong voltages.

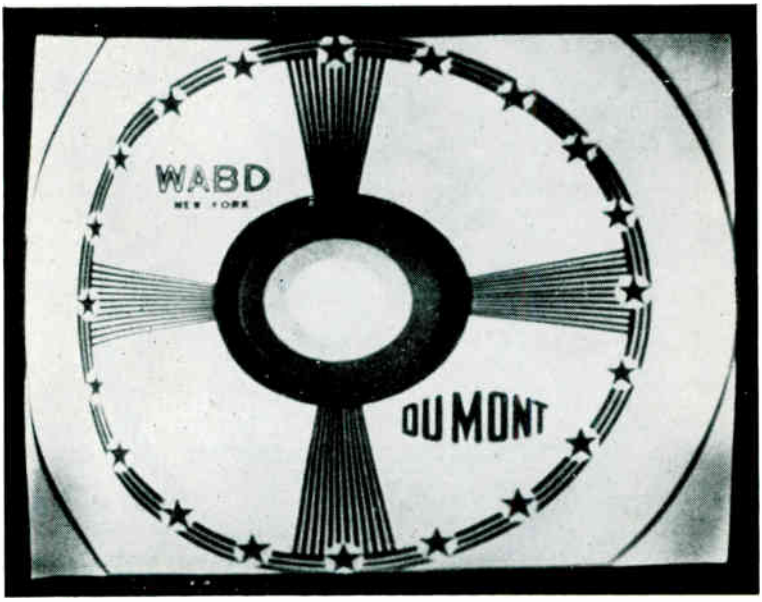
Vertical sweep amplifier tube defective, or supplied with incorrect voltages.

Trouble in any parts which follow the vertical sweep oscillator, and which carry sawtooth voltages and currents.

Vertical sweep output transformer defective.

Shorted turns in a vertical deflection coil.

Poor filtering of low-voltage B-power supply.




***Linearity Poor, Horizontal.***

Linearity is the name given to distortion of outlines or of proportions in television patterns and pictures. With poor horizontal linearity there may be stretching at the right and crowding at the left, as in the photograph, or there may be stretching at the left with crowding at the right. Circles become deformed.

*Causes for trouble.*

Horizontal linearity control or controls misadjusted.

Horizontal drive control or peaking control misadjusted.

Defective inductors, capacitors, or resistors, fixed or adjustable, in horizontal linearity control circuits.

Horizontal sweep oscillator tube defective, or supplied with incorrect voltages on its elements.

Horizontal sweep amplifier tube defective, or supplied with incorrect voltages.

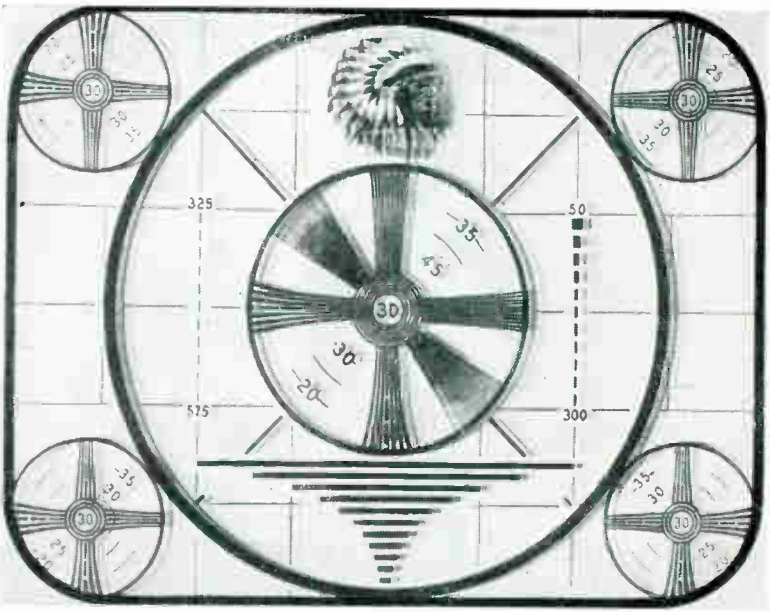
Defective damper tube in magnetic deflection system.

Trouble in any circuits or parts which follow the horizontal sweep oscillator, and in which are sawtooth voltages and currents.

Horizontal sweep output transformer defective.

Shorted turns in horizontal coil or coils of the deflection yoke.

Poor filtering of low-voltage B-power supply.



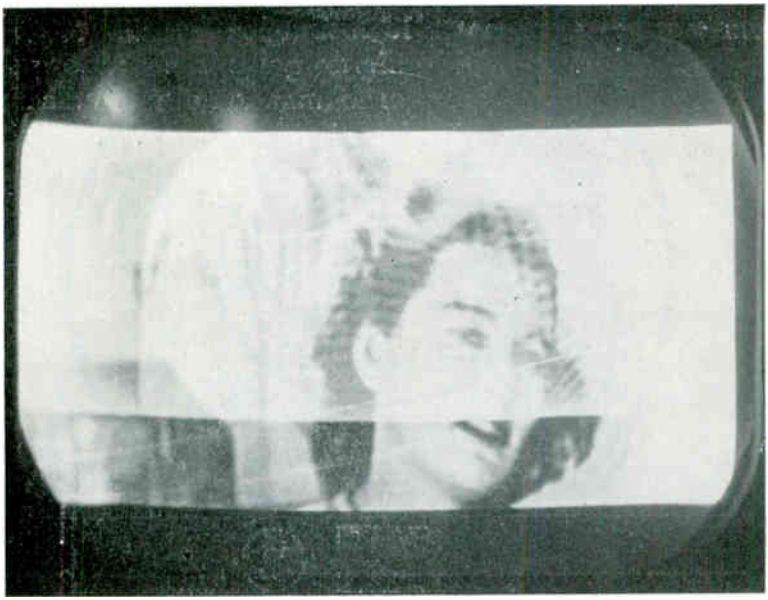

***Ghosts.***

There are multiple images in the test pattern or picture. The displaced images, of which there may be one or more, may be so close to the principal image or may be so faint as to cause only a blurring effect. In other cases the displaced images may be at a considerable fraction of inch from the principal image, and may be distinct.

*Causes for trouble.*

Part of the transmitted signal is being reflected from large conductive or semi-conductive objects, such as buildings, bridges, tanks, or steep hills, and the reflected portion is reaching the receiver antenna a fraction of a second later than the direct signal. Try rotating the receiving antenna to reject the reflected signal without too much loss of direct signal. Fit a reflector, and possibly also a director, on the antenna. Try the antenna in various locations.

Incorrect matching of impedances between antenna and transmission line, or between transmission line and receiver input. There are standing waves on the line. Use antenna and transmission line whose impedances match that of the receiver and of each other.

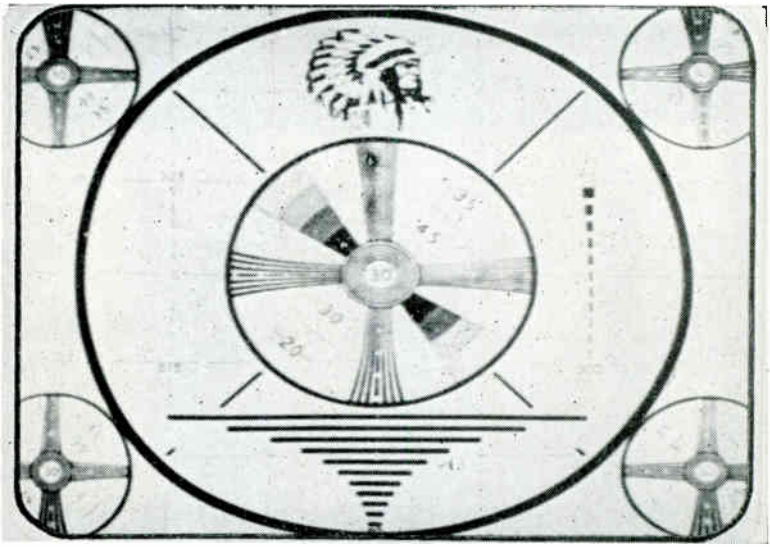


***Folded Pattern, Vertically.***

*Causes for trouble.*

Vertical hold control incorrectly adjusted.

Faults in vertical hold control circuit causing vertical deflection frequency which is too high.



***Definition Poor, Detail Lacking.***

Poor definition which is not due to faults in focusing nearly always results from lack of response or lack of sufficient gain at the high video frequencies. Such lack of high frequency response is evident when lines and spaces of the vertically extending resolution wedges blur or run together a short distance inside the upper and lower sides of the pattern.

*Causes for trouble.*

Contrast control too high.

Fine tuning control misadjusted.

Weak received signal.

Ghost images. See troubles listed under *Ghosts.*

Video i-f amplifier incorrectly aligned. Not enough gain or response toward the sound intermediate frequency side of the response curve.

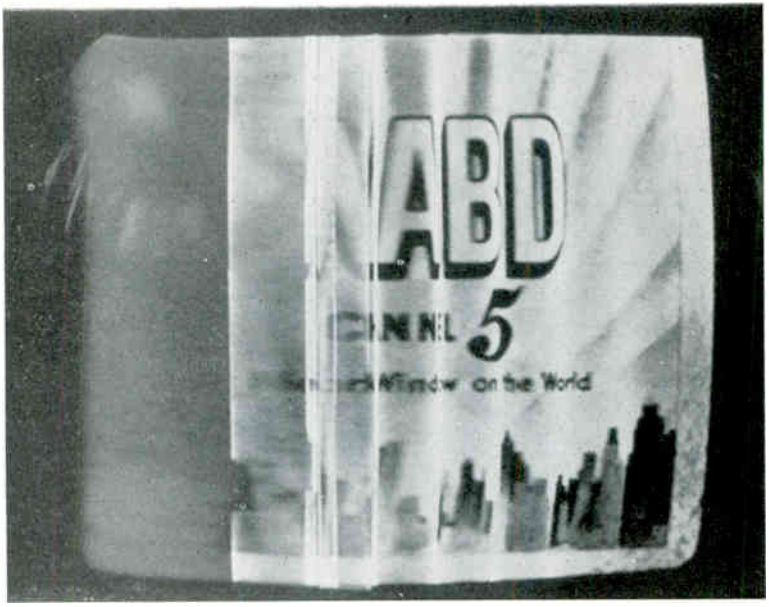
R-f amplifier or antenna coupling not aligned to provide sufficiently wide band pass.

Voltage too low on high-voltage anode or anodes of picture tube. Check the high-voltage power supply.

Video detector and/or video amplifier have poor response at the higher video frequencies. Coupling capacitors may be leaky or shorted. Peaking coils may be shorted. Try temporarily shorting each peaker. If this causes no change in definition, the shorted coil probably is defective.

Interlacing defective. Trouble in the sync section.

Focusing poor. See troubles listed under *Focus Poor.*




***Folded Pattern, Horizontally.***

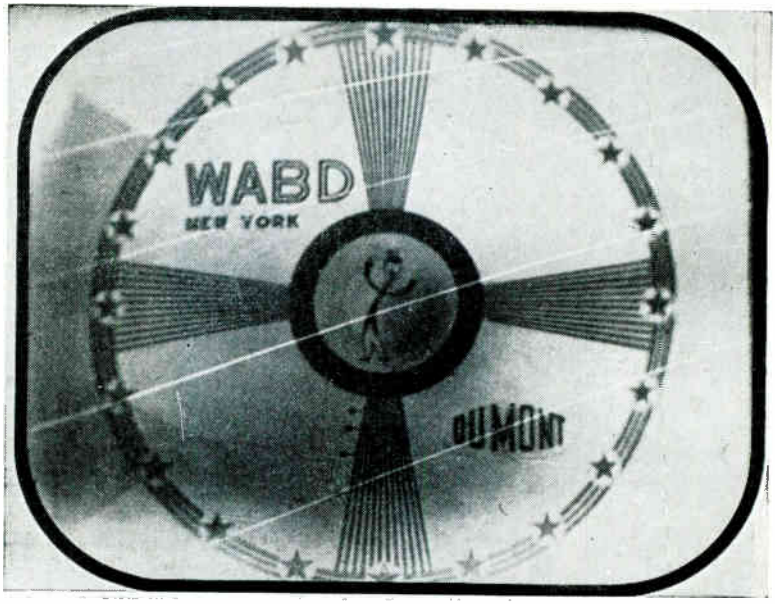
The picture or pattern appears as though it has been pushed together from left to right.

*Causes for trouble.*

Incorrect adjustment of horizontal drive control.

Insufficient sawtooth voltage from horizontal sweep oscillator or amplifier.

Trouble in damper circuit of magnetic deflection system, or defective damper tube.




**Contrast Insufficient.**

*Causes for trouble.*

Contrast control adjusted too low.

Brightness control too high. Causes vertical retrace lines as in photograph.

Weak signal reaching the antenna coupling input at the tuner. Check the transmission line, the antenna, and their connections. Built-in or indoor antenna may not deliver enough signal where the receiver is located.

Video i-f amplifier wrongly aligned, or has defective tube.

R-f amplifier or antenna coupling, or both, misaligned. Defective tube in r-f amplifier position.

R-f oscillator wrongly aligned, or weak tube.

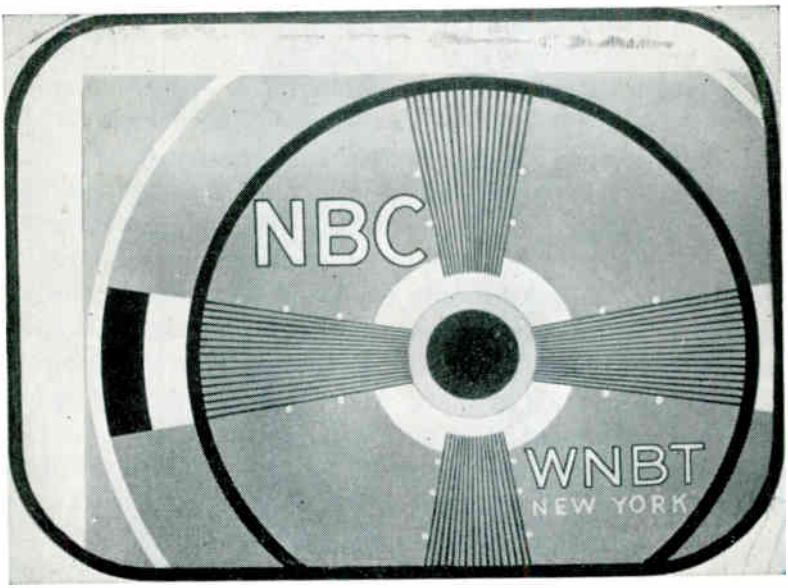
Defective tube or crystal for video detector.

Automatic gain control providing excessive negative bias.

Video amplifier tube defective.

Fault in d-c restorer circuit, or defective tube.

Picture tube defective, or so old as to have poor emission.




***Centering Incorrect.***

Picture or pattern may be too high or too low, incorrect vertical centering, or it may be too far to the right or left, incorrect horizontal centering, or there may be incorrect centering in both directions at once, as in the photograph.

*Causes for trouble. Magnetic deflection.*

Focusing control wrongly adjusted.

Ion trap magnet in wrong position on picture tube neck, or weak.

Horizontal hold control misadjusted.

Focusing coil axis direction requires adjustment. Should be in line with picture tube axis.

Focusing coil too far forward or back. Usually should be 1/4 to 3/8 inch from the deflection yoke.

Focusing coil short circuited.

Deflection yoke too far back on neck of picture tube, or not centered around neck.

Defective bypass capacitor on focusing control.

*Causes for trouble. Electrostatic deflection.*

Centering control or controls wrongly adjusted.

Horizontal hold control misadjusted.

Picture tube shield magnetized.

Leaky capacitor or capacitors between outputs of deflection amplifiers or oscillators and the picture tube deflection plates.

**Locating and Orienting the Antenna.** — If the locality is a fringe area or if signals are known to be generally weak, it is worth while to mount the antenna at the highest practicable point. In many cases an extra five or six feet makes the difference between very poor and good reception. At the selected point it must be possible, of course, to erect a mast and needed guy wires without too much trouble. Always keep the antenna as far as possible from sources of electrical interference. Such sources include automobile traffic, public garages, buildings having many electrical machines, electric signs, X-ray and other kinds of medical laboratories. Keep away from large metal objects, such as metal roofs, gutters, and vent pipes.

When a tentative position for the antenna has been selected it is necessary to make a test of actual reception before final installation. With a transmission line of approximately correct length connected to the antenna and to the receiver, the antenna is moved about and rotated as to reception direction while observing the resulting signal strength and quality. This work is done most easily and quickly with one person moving the antenna while another watches the picture tube of the receiver. There must be some means of communication. The most popular means is a pair of self-energized phones, the kind which work without batteries or other external power, connected together by a cable running from receiver to the antenna location. Many manufacturers discourage the practice of connecting phones through the transmission line, although this sometimes is done with 75-ohm lines.

If the work must be done without the assistance of a helper it is possible to connect to the receiver, somewhere between the video detector load and the picture tube input, a high-resistance voltmeter or a microammeter which is taken to the

antenna location. Meters designed for this purpose are available. Any sensitive voltmeter or current meter may be used provided there is a rectifier and filter at the receiver end of the connecting line, so that the high-frequency signals produce a direct current or voltage in the long connecting line and the meter.

A detector probe such as used with an oscilloscope or an electronic voltmeter for high-frequency measurements is entirely satisfactory for use at the receiver. The scheme of connections is illustrated by Fig. 9-18. The high side of the probe may be connected to either the video detector load, the plate of one of the video amplifier tubes, or the control grid or

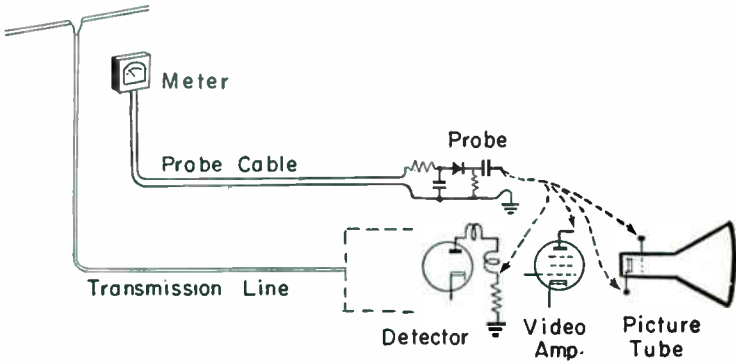



*Fig. 9-18.—Connections for a meter which is carried to the antenna location during orientation.*

cathode of the picture tube, whichever of these latter two elements is used for input to the picture tube in the receiver being handled. The other lead of the probe is grounded to the chassis. The cable from probe to meter may be 50 to 100 feet long, or even longer. Flexible lamp cord will do for this line, or any kind of transmission line may be used.

The receiver should be tuned to some channel, preferably one for which reception is known to be relatively weak. If a second person is watching the picture tube at the receiver the contrast control should be turned well down and all observations made on a test pattern, not a program picture. If the

**ALIGNMENT.** — Alignment of a television receiver means the process of adjusting certain of its tuned circuits for suitable amplification or gain, or to specified band-pass characteristics throughout bands of carrier frequencies in the various channels, and at intermediate frequencies for which the receiver is designed. Alignment adjustments are found in the tuner section, in intermediate-frequency amplifiers for video and sound, and in the inputs to video detectors and sound detectors.

The shaded blocks of Fig. 1-1 indicate tuned circuits which may be aligned. Tubes are represented by circles. The transformer (coupling) between antenna and r-f amplifier may or

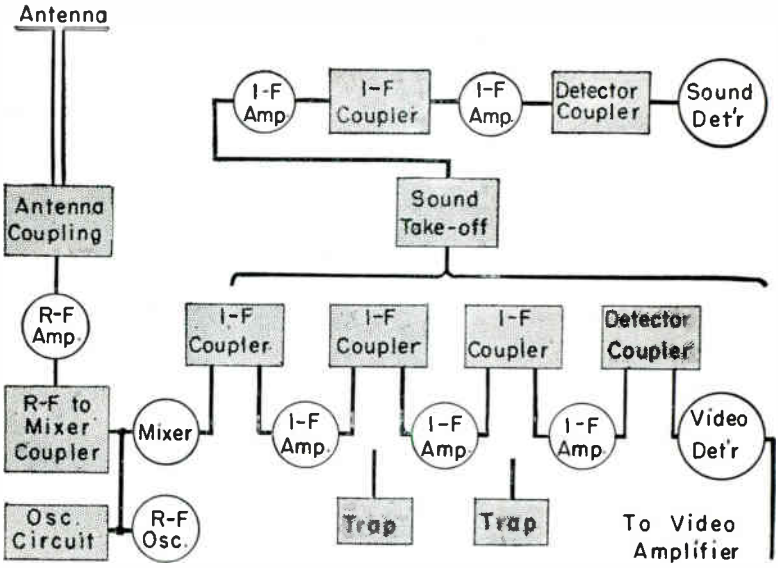



*Fig. 1-1.—Parts or circuits of a television receiver in which there are adjustments for alignment.*

may not be adjustable. The transformer between the r-f amplifier tube and the mixer tube usually is adjustable. The tuned circuit for the r-f oscillator nearly always is designed for alignment. Intermediate-frequency transformers between mixer, i-f amplifiers, and video detector always are adjustable. Adjustably tuned interference traps are coupled to the video i-f amplifier stages of some receivers, and sometimes at the antenna transformer and preceding the sound takeoff. The sound takeoff may or may not be adjustably tuned. If there is more than one sound i-f amplifier each interstage transformer is adjustable, as is also the input transformer for the sound detector or demodulator.

The order in which circuits or sections of the receiver are aligned depends on several factors. If trouble is indicated as being in some one section, because of observed symptoms or as the result of tests, and if the trouble appears due to misalignment, that is the section to be first aligned. If the entire receiver is to be realigned, or the adjustments checked, this work usually begins at the transformer preceding the video detector. Adjustments then are continued back to the transformer following the mixer. Traps in this portion of the receiver are aligned along with the transformers. Next would come the sound section, commencing at the transformer preceding the detector and following back to the sound takeoff. Final steps would include alignment of the r-f oscillator, the r-f to mixer transformer, and the antenna transformer.

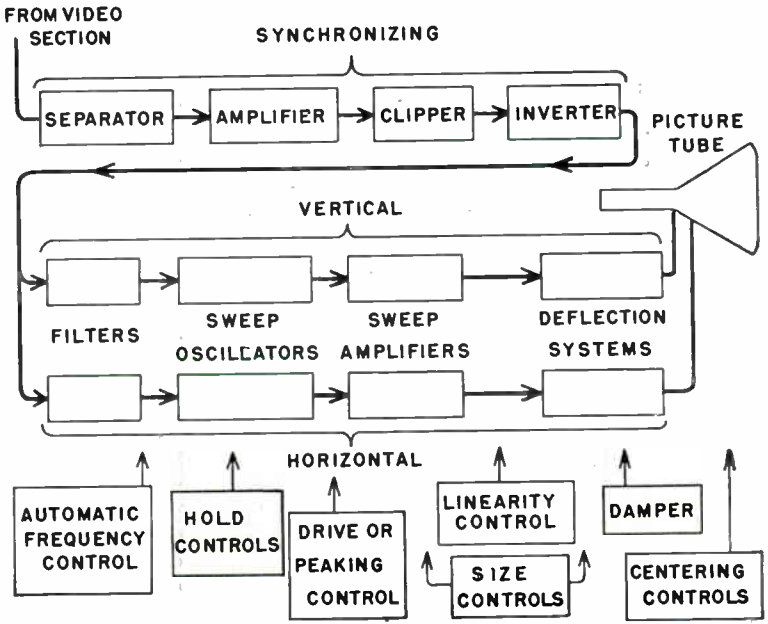



Fig. 124-4—Principal parts in the sweep section of a typical television receiver.

**WAVEFORMS.** — A waveform trace on the screen of an oscilloscope exhibits the voltage variations or the "shape" of the compositive television signal and of other voltages derived from or controlled by the signal.

Waveforms may be observed at the output of the video detector and at all points from there to the picture tube. The signal may be followed from the video detector through the video amplifier to the signal input at the picture tube grid or cathode. The signal may be followed also from the video detector through the sync and sweep sections to the deflection coils or the deflection plate connections for the picture tube.

For checking waveforms at all points through the video amplifier and also through the sync section as far as inputs to the sweep oscillators it is necessary to employ an input signal from a regular television transmission or one from a television pattern generator. When using a signal from a television transmission it is preferable to work with a test pattern rather than a picture in which there is movement. From the outputs of the sweep oscillators through the picture tube deflection systems it is not necessary to have an input signal, since the oscillators themselves will control sweep of the electron beam in the picture tube by providing necessary voltages.

For observation of waveforms the vertical input of the oscilloscope is connected between the point where the signal or voltage waveform is to be observed and chassis ground or B-minus. Voltage at the point of test must be no greater than the rated maximum vertical input voltage for the oscilloscope. To help isolate the tested circuit from capacitance of the oscilloscope input it is advisable to use a series resistor of about 100,000 ohms on the receiver end of the vertical input cable.

To observe waveforms related to vertical deflection the internal sweep of the oscilloscope is set for 60 cycles per second to cover a period of one field, for 30 cycles to cover two fields, or for 20 cycles to cover three fields on the same trace. To observe horizontal deflection waveforms the internal sweep of the oscilloscope is set for 15,750 cycles per second to observe one line period, for 7,875 cycles to observe two lines, or for 5,250 cycles to observe three lines on a single trace. Usual practice is to employ a trace covering two fields or two lines.

The composite television signals from different transmitters may show variations in apparent form. The shapes of all traces and the details which may be seen are affected by frequency response characteristics and such features as linearity in the oscilloscope. There may be slight differences between waveforms taken from different receivers of the same model. Waveforms taken from sync and sweep sections will conform to the operating principles employed in the receiver being tested. The height of traces taken from points between video detector and inputs to the sweep oscillators is altered by adjustment of the contrast control, while adjustment of size controls varies the height of traces taken from sweep circuits which follow the oscillators.

Examples of typical waveforms and descriptions of what they indicate are shown in articles listed below.

*Amplifiers, sweep*
*Clippers or limiters*
*Deflection, electrostatic*
*Deflection, magnetic*
*Drive controls*
*Filters*
*Restoration, d-c*
*Scanning*
*Separation, sync*
*Signal, television*
*Sync section*

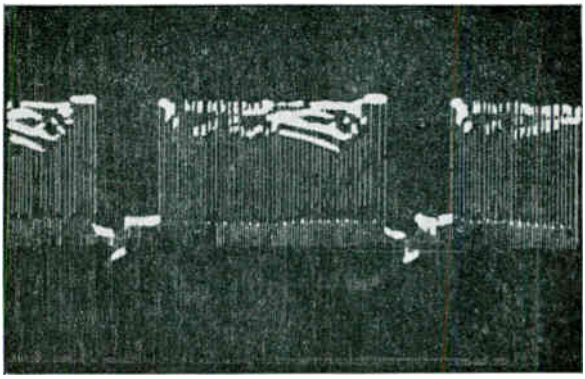


*Fig. 139-1.*

*Fig. 139-1:* Taken at the top of the video detector load resistor. This is the output of the video detector and the input to the grid circuit of the video amplifier. Here appears the entire composite television signal with picture variations, positive, at the top and with sync pulses, negative, at the bottom. Two vertical blanking intervals are plainly visible between the fields. During each blanking interval there appear in order, from left to right, the equalizing pulses which follow one field, then the vertical sync pulses at the bottom-most points along the trace, and finally the remaining equalizing and horizontal sync pulses which precede the next field.

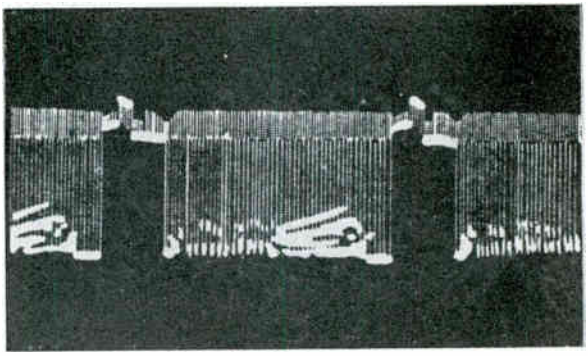


*Fig. 139-2.*

*Fig. 139-2:* Taken at the plate of the video amplifier tube. Here again is the complete compositive signal, but now the polarity has been inverted to make sync pulses positive and picture variations negative. This waveform is applied to the cathode of the picture tube, which is the point of signal input to the picture tube of this particular receiver.

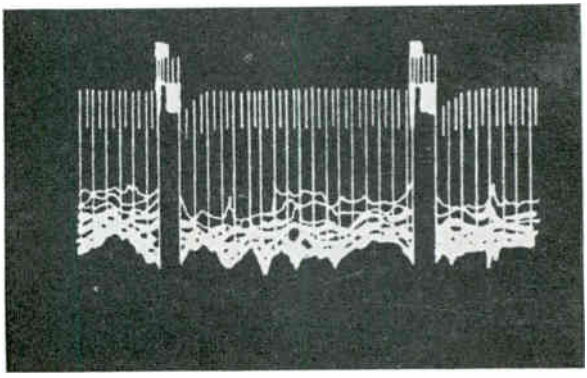


*Fig. 139-3.*

*Fig. 139-3:* Taken at the grid of the first tube in the sync section, which is a sync amplifier. The signal shown here comes from the output of the video amplifier, and accordingly is of the same polarity and has the same general characteristics as shown in Fig. 139-2.

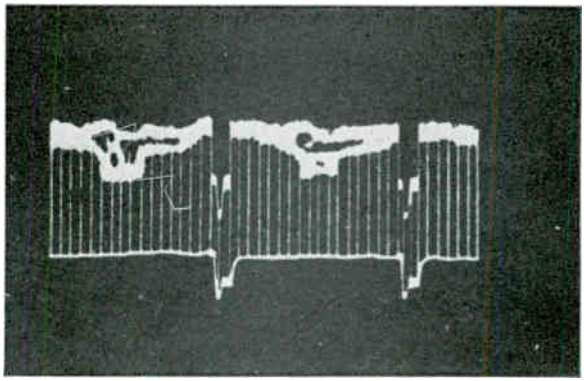


Fig. 139-4.

*Fig. 139-4:* Taken at the plate of the sync amplifier tube. The polarity has been inverted with respect to polarity in Fig. 139-3. The peak-to-peak voltage of this amplifier output waveform actually is about four times as great as voltage at the input to the tube.

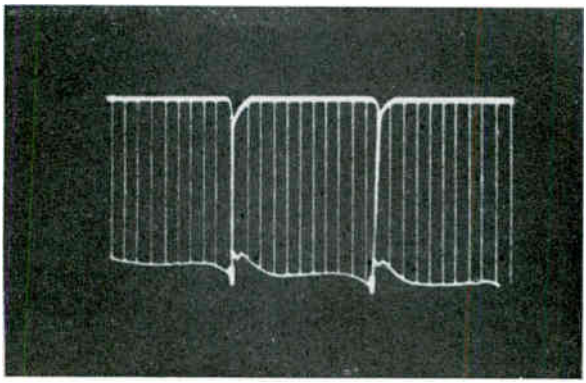


Fig. 139-5.

*Fig. 139-5:* Taken at the plate of the second tube in the sync section, which is operated as a separator. Picture variations have all but disappeared from the signal, while the vertical sync pulses have been retained. Polarity has not been inverted, because signal input is to the cathode rather than the grid of this separator.

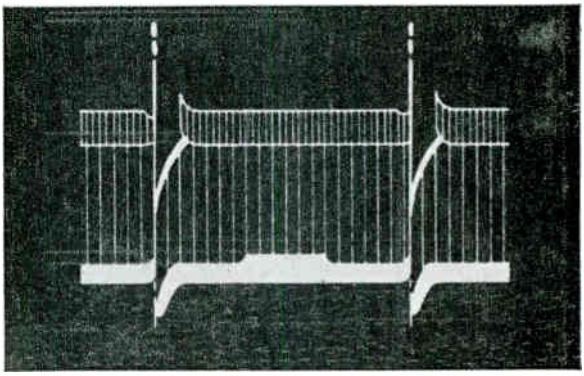


Fig. 139-6.

*Fig. 139-6:* Taken at the plate of the third tube in the sync section, which is operated as a clipper. Polarity has been inverted with respect to that of Fig. 139-5. Vertical sync pulse voltage peaks have become very pronounced. This is the signal which goes to the integrating filter located between the sync clipper and the input for the vertical sweep oscillator.

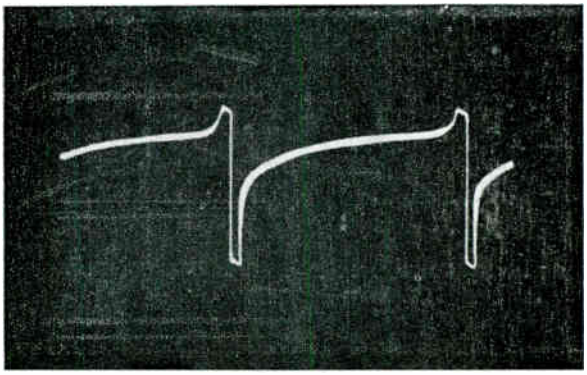


Fig. 139-7.

*Fig. 139-7:* Taken at the grid of the vertical sweep oscillator, which is a blocking type. Note the sudden changes of potential in the negative direction, downward on the trace, as the oscillator blocks. Then comes the quick partial recovery in the positive direction and the more gradual change preceding the positive peak that triggers this oscillator.

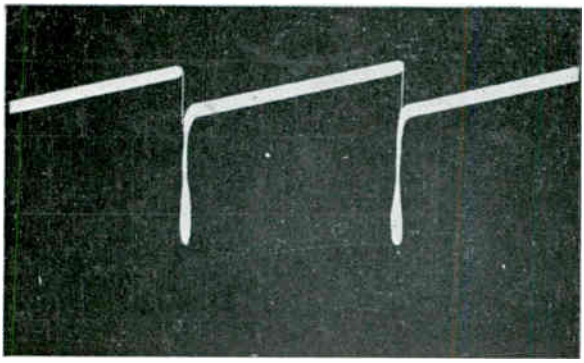


Fig. 139-8.

*Fig. 139-8:* Taken at the grid of the vertical sweep amplifier which follows the vertical oscillator. This is the sawtooth voltage combined with negative (downward) peaks as required for magnetic deflection.

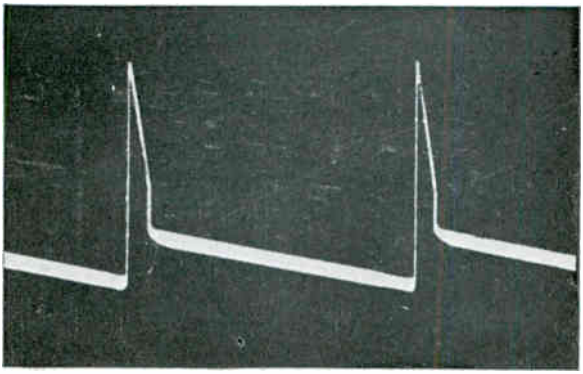


Fig. 139-9.

*Fig. 139-9:* Taken at the plate of the vertical sweep amplifier. Polarity has been inverted with respect to the previous trace, taken at the grid of the same tube. Peak-to-peak voltage here is about 18 times as great as at the grid.

*Fig. 139-10:* This final trace for the vertical deflection system is taken from the circuit which includes the secondary winding of the vertical output transformer and the two ver-

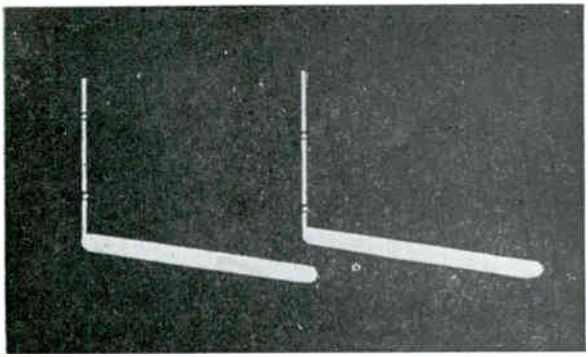


*Fig. 139-10.*

tical deflection coils of the yoke on the picture tube. Peak-to-peak voltage is between one-ninth and one-tenth of that at the plate of the vertical sweep amplifier, which connects to the primary of the output transformer.

Traces which are to follow in Figs. 139-11 to 139-24 are taken with the internal sweep of the oscilloscope adjusted for 7,875 cycles per second or to the frequency which produces two horizontal line periods. All these traces show waveforms associated with horizontal sync pulses and horizontal deflection voltages.

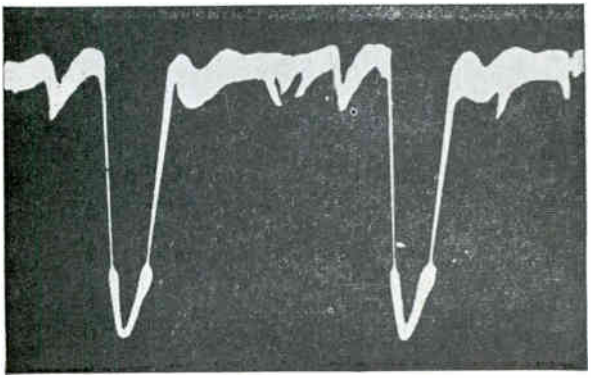


*Fig. 139-11.*

*Fig. 139-11:* From the top of the video detector load resistor. Here are two horizontal sync pulses of negative polar-

ity, also the horizontal blanking intervals, and the picture variations occurring between the blanking intervals.

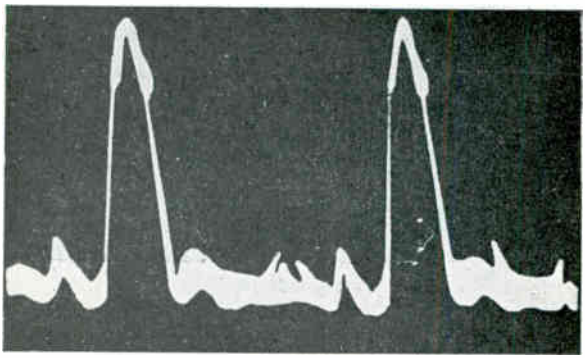


Fig. 139-12.

*Fig. 139-12:* From the plate of the video amplifier tube. Except for inversion of polarity this trace is similar to the one taken from the grid of this tube. Peak-to-peak voltage has been increased about nine times.

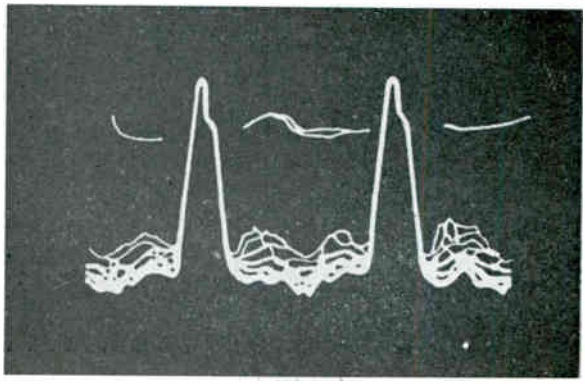


Fig. 139-13.

*Fig. 139-13:* From the grid of the sync amplifier, the first tube in the sync section. This signal comes from the output of the video amplifier, and is of the same polarity as in Fig. 139-12.

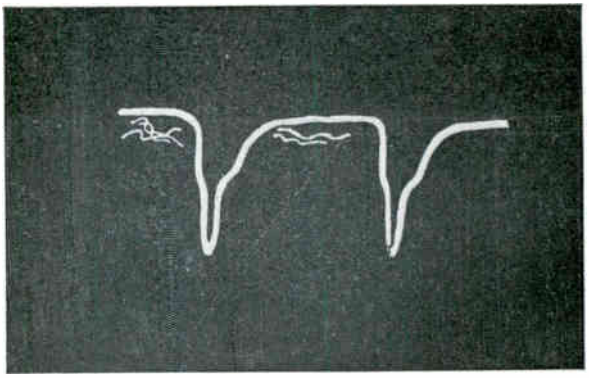


Fig. 139-14.

*Fig. 139-14:* From the plate of the sync amplifier. Polarity has been inverted. Voltages for picture variations have very nearly disappeared, while horizontal sync pulses have become distinct.

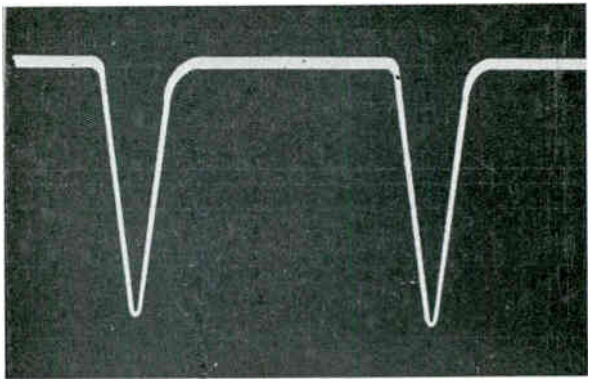


Fig. 139-15.

*Fig. 139-15:* From the plate of the sync separator tube. Only the horizontal sync pulses now remain. There has been no inversion of polarity, due to use of cathode input to this tube.

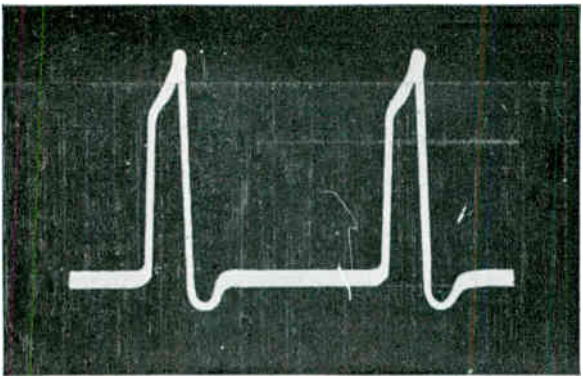


Fig. 139-16.

*Fig. 139-16:* From the plate of the sync clipper tube. This waveform is the input to the differentiating filter located between the clipper and the horizontal oscillator control tube of the horizontal afc system.

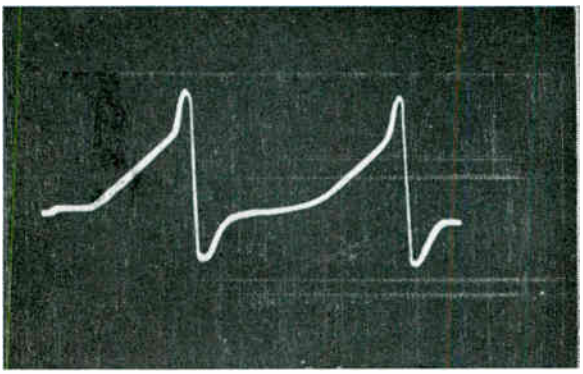


Fig. 139-17.

*Fig. 139-17:* From the top (ungrounded side) of the lock-in control capacitor in the grid circuit of the control tube of the horizontal afc system. This voltage results from combination of the output from the differentiating filter and a feedback voltage from the horizontal sweep output circuit, as required for this method of oscillator control. The waveform shown here is taken while a transmitted television signal is being received. The sharp or narrow positive peaks

represent synchronizing voltages which result from horizontal sync pulses in the signal.

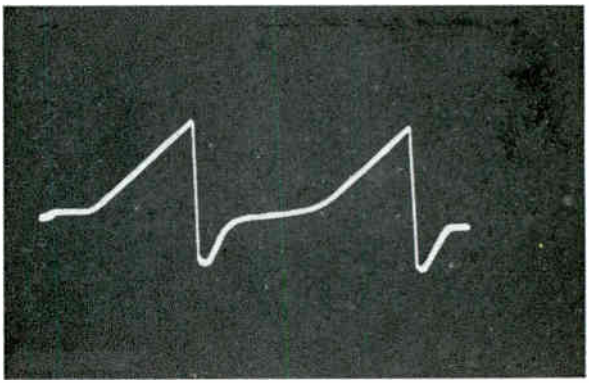


*Fig. 139-18.*

*Fig. 139-18:* This is the same as the previous trace, except that it is taken while no transmitted signal is being received. Note the absence of positive synchronizing peaks at the tops of the sawtooth portions of the wave.

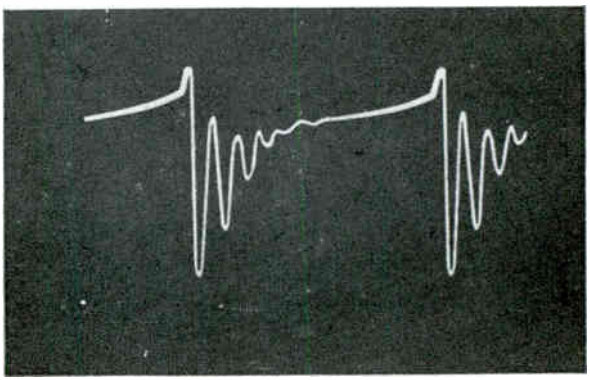


*Fig. 139-19.*

*Fig. 139-19:* From the grid of the horizontal sweep oscillator. Average grid voltage is controlled by biasing effect developed in the grid-cathode circuit of the control tube as explained in the article *Oscillator, Television Sweep, Control of* under the sub-heading *Triode Afc Control Tube.* The trace is taken while no signal is being received.

# TROUBLE SHOOTING PROCEDURE

The several sections which may be considered during trouble location are listed below and shown by Fig. 130-1.

*1. Power supply.* This section extends from the plug inserted in the building power line receptacle through the voltage dividers of both low-voltage and high-voltage power supply systems.

*2. Sound section.* This section extends from the sound takeoff through to the speaker.

*3. Sweep section.* This section extends from the vertical and horizontal sweep oscillators through the deflection coils or plates and includes the beam deflection functions in the picture tube.

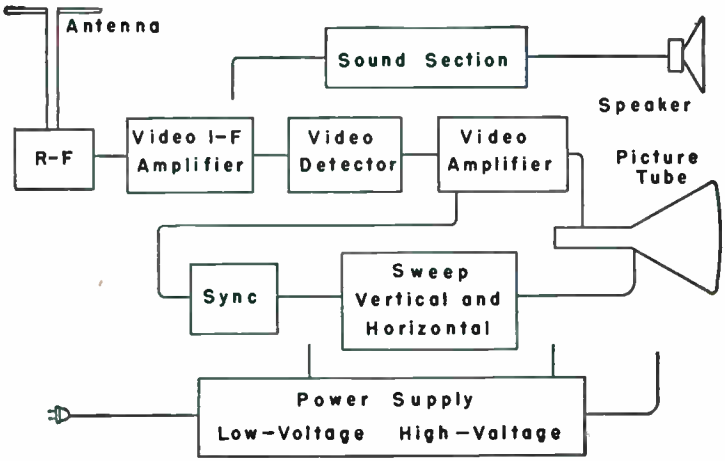



*Fig. 130-1.—Sections of receiver to be considered during location of troubles.*

*4. Sync section.* This section begins at the sync takeoff from the video amplifier or detector and extends to the inputs of the sweep oscillators.

*5. Video amplifier.* This portion of the receiver extends from the video detector through the grid-cathode signal input of the picture tube.

6. *Video detector.* Located between the video i-f amplifier and video amplifier.

7. *Video i-f amplifier.* This amplifier system extends from the output of the mixer or converter tube to the signal input for the video detector.

8. *R-f section.* This section includes the channel selector or tuner, the r-f amplifier, r-f oscillator, and mixer.

9. *Antenna system.* Including the outdoor, indoor, or built-in antenna, and also the transmission line.

Preliminary examination for determining in which section the trouble probably exists may be carried out by observing the screen of the picture tube, listening to the speaker, using a signal generator, and sometimes an oscilloscope or other testing instruments.

The exact procedure followed during trouble location depends largely on the kind of equipment available and on the experience and preferences of the technician. If experience has shown that the receiver being worked upon is likely to develop certain kinds of trouble, and if evidences of such trouble are present, it is that trouble that should be looked for without delay. Methods described in this article assume that no such information on probable troubles exists.

When preparing to locate trouble the receiver switch should be turned on and the channel selector set for a channel in which a station should be transmitting at the time of testing. Analysis then may be carried out in the following steps, which list parts that should be examined for each class of symptoms.

**A.** No picture or pattern, no raster, no sound. Glass tubes do not light nor metal tubes become warm. Examine the following parts.

1. Line plug and its contacts in the outlet receptacle.
2. Line cord or extension cord from plug to receiver.
3. On-off switch in the receiver.
4. Any interlock switch that may have been opened by removal of a cover or panel on chassis or cabinet.

**B.** No picture or pattern, and no sound. There is a raster, either uniform or mottled.

1. Change the selector to another channel or to several other channels where stations are known to operate. The first station may be off the air. If the trouble exists only on some channels, but not on all, the fault must be in the tuner or channel selector, in the tuned couplings of the r-f section, or in the r-f oscillator. If the same symptoms exist on all channels the fault may be in any of the following.
2. Antenna or transmission line.
3. R-f section, including its tubes.
4. Video i-f amplifier stages which carry signals for both picture and sound.
5. Video detector, if the receiver has intercarrier sound.
6. Sync section. Since there is a raster, the vertical and horizontal sweep sections must be operating.

**C.** No sound. There is a picture or pattern.

1. Sound section. Troubles described later in this article.
2. R-f oscillator out of alignment or fine tuning incorrectly adjusted in receivers using dual or split sound system.

**D.** No distinct picture or pattern. There is a raster, either uniform or mottled. There is sound.

1. Sync section. If neither of the hold controls have material effect on the appearance of picture, pattern, or raster it is probable that trouble exists in the sync section.
2. Video amplifier.
3. Video detector.
4. Video i-f amplifier, beyond the point of sound take-off.

**E.** No picture, pattern, or raster, but only a horizontal or vertical line on the picture tube screen. There is sound.

1. Sweep section. If there is only a vertical line, trouble is in the horizontal sweep system, if only a horizontal line the trouble is in the vertical sweep.

**ıd Section Troubles** — Causes for faulty reproduction of ınd are, in general, the same as found in parts of f-m ound receivers which follow the mixer or converter tube in such receivers. In a television set these faults will be in parts which follow the sound take-off. Articles which treat these parts are under the following headings.

*Detector, ratio*
*Discriminators.*
*Intercarrier sound.*
*Limiters, f-m sound.*
*Modulation, frequency.*
*Sound, television.*

A fault peculiar to receivers employing the intercarrier sound system is called intercarrier buzz. This is a distinct 60-cycle buzz, not a hum, due to amplitude modulation of the 4.5 mc sound carrier. The buzz may result from a temporary decrease of carrier signal strength from the transmitter being received, or may result when a nearly white picture suddenly follows a much darker one. The buzz may be due to any of the following faults in the receiver or its operation.

1. Contrast control too high, which may cause picture distortion as well as buzz.
2. Fine tuning incorrectly adjusted for channel being received.
3. R-f oscillator not correctly aligned for channel where buzz appears.
4. Ratio detector or discriminator incorrectly aligned.
5. Inoperative limiter tube or stage preceding a discriminator.
6. Large capacitor on output of ratio detector open or disconnected.
7. Video amplifier overloaded or supplied with plate and screen voltages which are too low.

In receivers having dual channel or split sound systems the sound may disappear or become weak and distorted while the picture remains good, a trouble usually due to shifting of r-f oscillator frequency. The fine tuning control may be wrongly adjusted or there may be incorrect alignment of the oscillator for the channel in which this trouble occurs. The trouble may result from gradual drift of oscillator frequency as the circuit parts warm up during operation. It should be possible to correct this drift by use of a fine tuning control.