

# RAPID TV REPAIR

G. WARREN HEATH



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**RAPID  
TV  
REPAIR**

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**G. WARREN HEATH**

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# introduction

**T**HIS reference guide is intended as an aid to the technician for the rapid servicing of TV sets in the home. While every effort has been made to incorporate the majority of the common troubles encountered, as well as many of the obscure faults, it does not purport to be a cure-all. If the trouble cannot be eliminated, then the set should be pulled and the job completed in the shop.

The hints and suggestions contained in this book are simple and specific. They are based on a minimum use of instruments and other equipment, taking into consideration the limitations imposed by home servicing. In addition to the customary complement of tools, tubes, and accessories, a vtvm is the only other piece of equipment required. A tube manual and manufacturers' schematics of the particular set to be serviced should be included in the technician's kit, whenever this can be done.

It does not necessarily follow that every suggestion is applicable to all makes of sets. Due to differences in circuitry the hint that might eliminate trouble in one set may not do so in another make. However, many suggestions do have a common application.

All of the troubles have been listed alphabetically, and cross-indexed where deemed essential, so that the technician will be able to locate quickly, at all times, the proper page. Every effort has been made to list the individual cures in the order of relative importance, beginning with the controls at the front and rear of the set. In this respect, note that certain controls are synonymous though labeled differently by set manufacturers.

After the controls of the TV receiver have been examined for possible misadjustment, it follows naturally that the tube complement of the set should be carefully checked. The technician

will find helpful a small, portable tube checker which, though not indicating low emission in a tube, will, nevertheless, reveal those tubes which are leaky, gassy, or shorted.

In those instances where some other component is listed as a possible cause of trouble, such as a resistor, capacitor, and transformer, always refer to the heading for that particular component. For example, when selenium rectifiers are mentioned, refer to the particular page covering that component. Complete data will be found that will permit it to be tested properly.

Grateful acknowledgement is made to those who have helped by their valuable suggestions, especially Mr. Henry Trustman, Mr. Michael Chertok, Mr. James A. McRoberts; those manufacturers who have provided schematics and details of their particular sets, especially Admiral Corporation, CBS-Columbia, General Electric Co. (Techni-talk), Magnavox Corporation, Motorola, Inc., Radio Corporation of America and Sylvania Electric Products, Inc. We wish to thank General Cement Mfg. Co. and also RADIO-ELECTRONICS Magazine for the use of considerable technical material.

G. Warren Heath



### Agc (automatic gain control)—defective

Agc is a method of maintaining a uniform level of pix contrast so that the contrast control need not be adjusted repeatedly when the strength of the received signal fluctuates. Early TV sets did

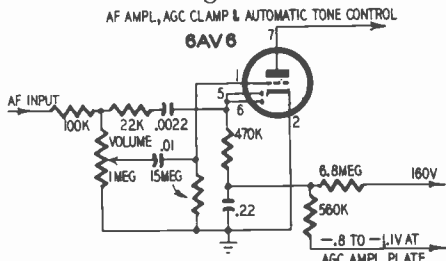


Fig. 1-A. The audio amplifier serves a number of different circuits.

not have agc, but most sets today incorporate some form of it. (See also section on agc clamp and keyed agc.)

There are a number of types of agc, those in general use being rectified agc, rectified agc with delay and clamping network, amplified agc with delay and clamping network, and keyed agc. These generally consist of a single tube or a dual purpose tube such as a 6AL5 video detector and agc; 6AV6, audio amplifier, agc clamp, and automatic tone control (Fig. 1-A); 6T8, audio amplifier and agc, (also used as ratio detector, 1st audio amplifier and agc); 6AN8, 3rd if amplifier, detector and agc.

**SYMPTOMS:** Generally, trouble in agc is indicated if there is too much contrast (sound is good) and contrast control has insuffi-

ent range. Due to overloading (no agc or weak agc) pix quality may become poor on strong stations, even becoming a reversed (negative) picture. (See also negative pix). Pix improves when an attenuator pad is inserted between the antenna and the set, or when a weak signal is received. On weak signals pix quality may be good.

The normal voltage at the grids of the rf amplifier and some video if tubes should range from zero to approximately  $-10$  volts. You can measure the agc voltage as shown in Fig. 2-A. If the bias

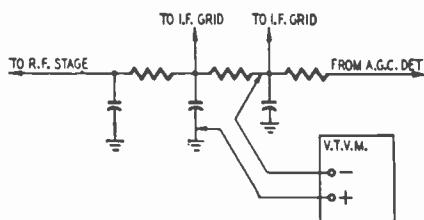


Fig. 2-A. *Measuring the agc voltage.*

on the controlled tube is excessively negative, the pix may become very faint or will be lost entirely, including the sound. On blank channels, noise spots will not appear. A defect in agc can cause no pix (sound and raster ok); no pix or sound (raster ok); pix dark with buzz, pix pulling or bending, tearing, weak and snowy pix with weak sound, and weak pix; or no horizontal and vertical sync, or hum. See Fig. 3-A.

**SERVICE:** First, check the agc control as a dark pix, or no pix and sound will result should the latter be misadjusted. Disconnect the lead-in from the set and loosely couple it to the antenna terminals. Pix improvement indicates possible agc trouble. Then check the agc tube (s); also the agc clamp or gate tube. Check tubes in noise immunity circuits, found in some sets.

Remove the agc tube. This may disable the audio in many sets. Connect a 3-volt battery (or use the setup shown in Fig. 4-A) to the agc line with the positive terminal to chassis or B-return in some sets. Test both the if and tuner (front end) agc lines if separate from each other.

In sets having a separate agc for the front end, connection of the 3-volt battery to this line restoring near normal operation indicates trouble in the tuner or agc circuit. Check for shorts in tuner, such as defective rf tube. If a 3-volt battery applied to the

if agc line restores near normal operation, check the agc diode or detector tube and circuits associated with it, such as the filter and decoupling resistors and capacitors of the if agc bus.

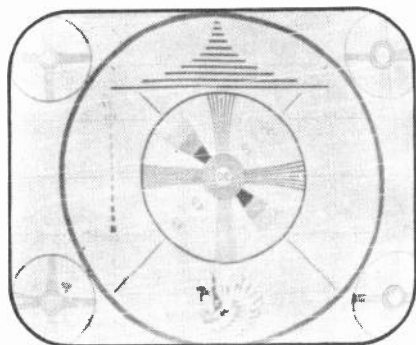


Fig. 3-A. *Effect of defective agc on the test pattern.*

### Agc clamp

**SYMPTOMS:** Open clamp tube causing excessive negative-going agc to be applied to tuner and if stages with consequent reduction of signal, weak pix and poor sync. A shorted clamp tube results in no agc voltage with overloading on all but the weak stations. Possible negative pix, sync clipping and instability.

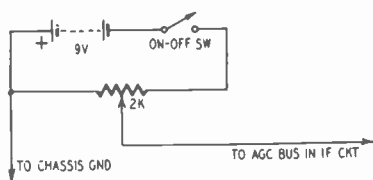


Fig. 4-A. *Bias supply for agc.*

Changes in resistors (see Fig. 5-A) can produce any symptoms in between the above cases. A short on the resistor connected to B+ can damage rf and agc controlled tubes by application of positive voltage to their grids as well as possible destruction of the agc clamp tube. (Refer also to section on keyed agc.)

**SERVICE:** Replace the clamp tube unless an abnormal number of tuner and if tubes are dead. If so, first check the resistor connected to B+. Remove any short. In case of shorted clamp, check rf and/or if tubes controlled by clamped agc. Check all resistors.

The clamp tube may be a triode section, triode, or part of a multi-purpose tube such as an audio tube with diodes.

### Airplane flutter

**SYMPTOMS:** This is caused by airplane overhead making pix intensity rise and fall, producing a changing ghost caused by agc defect. It is especially noticeable in older sets that do not have an agc circuit.

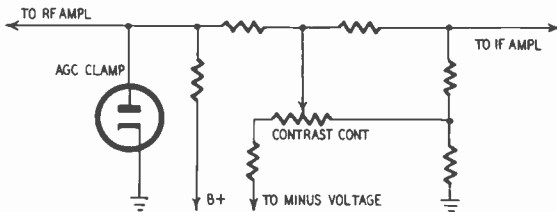


Fig. 5-A. Simple agc clamp circuit.

**SERVICE:** Check agc tube (s), agc control, and various components in the circuit. Some agc circuits, especially those that preceded keyed agc, are useless on airplane flutter.

### Alignment

Proper alignment of a TV set is essential to obtain the best pix and sound. In all instances follow carefully alignment instructions for each set as outlined in manufacturers' notes supplemented by standard textbook procedures. Do not align until you have determined that circuits involved are functioning normally in other respects. Always check tubes in tuner, video if and video detector stages. In sets having a crystal video detector, check forward and reverse resistances. (See also section on video detectors.) Disconnect one side of crystal. Reverse resistance should be high compared to forward resistance—not less than 20 to 1. B+ voltages to tuner and video if stages should agree with manufacturer's service notes before aligning set.

When resolution and quality of pix are good, and no white after black, or black after white smears are visible, but contrast is poor, realignment of video if strip is indicated. When quality of pix is poor, with slight effect from fine tuning control, realignment is not necessary—trouble usually is indicated in video amplifiers or video-detector output. When quality of pix is poor, and is affected

by the fine-tuning control, realignment is probably necessary.

Failure of sound and picture to track (that is, best sound and picture do not occur together) indicates need for realignment of front end or if. Note that the foregoing does *not* mean the brightest picture, as the picture carrier is placed *halfway* up the pix carrier slope on the if curve. See Fig. 6-A.

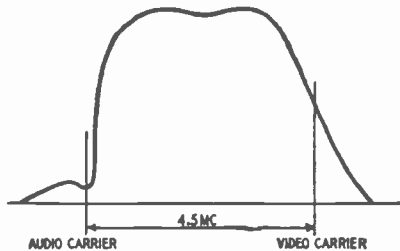
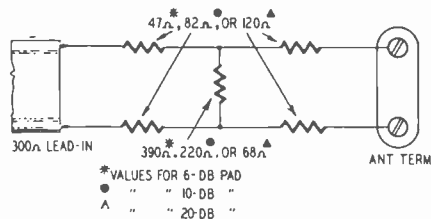


Fig. 6-A. Position of the video carrier on the slope of the if response curve.

Misalignment of the video if strip usually is indicated by any of the following: poor contrast, poor pix detail, smeared or streaky pix, poor sync, poor pix-sound tracking.

Misalignment of the sound if strip usually is indicated by: no sound on all channels, weak or distorted sound, excessive sync buzz and poor pix-sound tracking.

Fig. 7-A. Overloading, due to excessive signal, can be cured by using attenuator pad.



## Antennas

The higher the antenna, the greater the area covered. Always check direction other antennas face. Antenna should clear all trees and buildings, and should not be placed near elevators, metal surfaces or electrical devices. A very strong signal can cause the pix to smear or bounce, due to overloading of rf amplifier tube. Agc may be defective or inadequate. A simple remedy is to insert an attenuator between the transmission line and antenna terminals. See Fig. 7-A. Use 1/2 watt, carbon resistors.

In strong signal areas, an indoor type or built-in antenna may suffice, especially if the set is located on the upper floors of an apartment house. Generally, indoor antennas do not function as satisfactorily on lower floors. Indoor antenna may require adjustment for each channel. Allow ample length of transmission line from indoor antenna to receiver terminals as antenna may have to be put in different spots in the room for various channels. If reception is not ghost-free, it is preferable to use an outdoor antenna. When the set is located within 15 miles of the TV station, a dipole, plain or folded, with or without a reflector, should prove satisfactory. In suburban and fringe areas it may be desirable to use an antenna array of two to four bays. When the signal is weak, with insufficient contrast, it may be necessary (in fringe areas) to install a booster. This is a separate unit containing an rf preamplifier.

In areas near the seashore, the antenna and lead-in frequently become encrusted with salt. This tends to attenuate the signal, causing a weak or washed out pix. In these locations it is advisable to remove the antenna system and hose it with fresh water at regular intervals.

When erecting an antenna always plug the center of the hole of the mast and tape securely to protect from rust. Orient the antenna for best pix on all channels, and for elimination of ghosts. When a private dwelling is directly adjacent to an apartment house, locate the antenna, if possible, on the roof of the apartment. If one antenna touches another (or if there are any loose connections) there will be noise in the sound and pix. When wet weather adversely affects pix quality, tubular twin lead should lessen the condition. When noise and line interference are objectionable, use shielded cable.

Transmission line should avoid pipes, metal objects, wires, and machinery. Do not tape the line to the mast—use stand-off insulators. Twist the transmission line one turn per foot. When attaching transmission line in interiors, be sure tacks do not cause a short or cause a ghost on a channel. Do not permit excess line to coil behind set. Paint on transmission line can affect pix adversely. Intermittent pix may be caused by a break on one side of transmission line. This usually happens at windows.

Before adjusting an outdoor antenna, always disconnect the TV set from the line by pulling the power plug. If sparking occurs at the antenna terminals when the line is connected to set, reverse the power line plug. Try putting small capacitors (100  $\mu\text{mf}$  ap-

proximately, in series between antenna terminals and transmission line.)

To check mismatch, wrap 6 inches of tin foil around the transmission line. Slide the foil along toward the antenna terminals with the set operating. Improved pix quality at some specific point indicates an impedance mismatch. Fasten the foil with Scotch tape to the line at that point. An improved signal indicates that the line is now properly matched. You can also check by attaching 6 feet of 300-ohm line to the antenna terminals of the set. Allow the line to hang loosely behind the set. Short the line by cutting across it with a razor blade, an inch at a time, working toward the set. Mismatch is at specific point of signal increase. Cut line at that point, join the free ends, and leave attached to set. Be sure that a mismatch, when corrected on one channel, does not affect another channel.

To check the transmission line for continuity, disconnect the antenna leads from the receiver terminals. Connect an ohmmeter (set for lowest ohms) across the leads. For a folded dipole type antenna, the reading should not exceed 5 ohms. If you get no reading, short the line at several points working toward the set, until the ohmmeter shows continuity. Replace defective section of line. If transmission line test shows open, it may be cheaper to replace the whole line rather than spend time trying to find the open section.

### **Antennas (uhf)**

Uhf antennas should be mounted at least six feet above tin roofs, gutters and other metallic objects. The positioning is important—directionally, horizontally and proper height. The mast must not vibrate or pix flicker may result. Here are some other suggestions: (1) short lead-in desirable; (2) transmission line must not flap or variation in signal may be caused; (3) keep minimum distance of 6 inches between line and any object.

### **Arcing (see also Corona)**

**SYMPTOMS:** In most instances, arcing will be observed when the insulation resistance of a component breaks down. It is generally indicated in the high voltage section by a hissing or snapping sound, usually accompanied by bluish discharge or ozone smell.

**SERVICE:** Examine carefully all wires in the high-voltage cage, especially any that come from beneath the chassis through a hole in the chassis. Arcing in a dc voltage circuit is indicated by dark

horizontal streaks on screen. Arcing in the horizontal-output transformer produces a hissing sound.

A dc arc is straight and white whereas ac or rf arcing is bent, and blue or green in color. A check may be made by drawing an arc from the high voltage lead to chassis. Be careful—high voltages are dangerous!

Carefully examine all components in the high-voltage section, such as exposed sharp points and all leads for possible breakdown of insulation. Examine the socket and corona shield stand-off insulator of HV rectifier. Where the insulation or distance from a "hot" point or wire to the chassis is inadequate, spray either the wire or the chassis (such as a high-voltage cage side or cover) with anti-corona lacquer. Allow to dry a few minutes before turning on power again.

Arcing may also be observed sometimes at the rim of a metal CRT at the point where the high-voltage is connected. The snap-in terminal or rubber cap at the end of the high voltage anode on a glass CRT or the high-voltage anode cable may be arcing internally, or touching another tube, the metal cage, or fused to another wire.

Further indication of arcing may be observed by moving the yoke leads and noting whether the shape and brightness of raster is affected. If so, look for insulation breakdown of wire inside deflection yoke near the lugs.

Arcing sometimes takes place between the plate cap of the HV rectifier and the top of the high-voltage cage, or on the metal wire holding the high-voltage anode lead. In all instances clean the affected parts carefully or replace them. Arcing frequently is observed between the graphite coating of the CRT and grounding springs of the yoke.

Other components that arc occasionally are the HV rectifier, horizontal-output tube, low-voltage rectifier, vertical-output tube; also the horizontal-linearity coil (this causes vertical white bars to appear on the left side of the screen) and the horizontal oscillator and phasing coils.

Arcing is common in any capacitor in the plate circuit of the horizontal-output tube, resulting in a vertical line on the screen similar to Barkhausen oscillation; in the high-voltage filter capacitor, a condition which can be aggravated by turning down the brightness control; in the high-voltage filter resistor between the



high-voltage rectifier and CRT; also the high-voltage rectifier filament resistor. A defective CRT can also cause arcing.

### Audio output tube—voltage divider

When servicing the low-voltage power supply, consider the increasing tendency of set manufacturers to eliminate dropping resistors as voltage dividers to provide different plate voltages. In some sets voltage division is accomplished by using the audio-output tube (see Fig. 8-A.) as a dropping resistor in series with several other stages, especially the video if tubes.

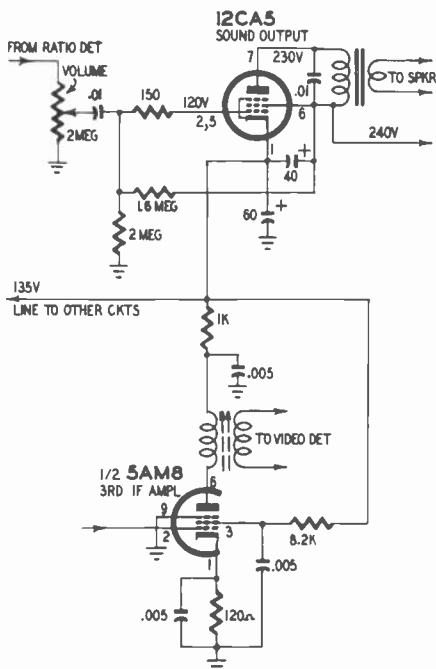


Fig. 8-A. The audio-output tube is sometimes used as a voltage divider.

**SYMPTOMS:** Trouble that can develop from audio defects are motorboating, if oscillation, audio vibrations in the if signal, and overloading of the last if stage causing the tubes eventually to burn out. Additional troubles are no pix, distorted or weak sound, regeneration in if stages and no audio. The agc system, might be affected, causing overloading and pix distortion in the video amplifiers.

Inasmuch as the audio-output tube is used as a voltage divider for if stages, no sound and no pix can result if the tube fails. Ad-

ditional troubles could be poor horizontal and vertical sync, a rise in the screen voltage of the horizontal-output tube resulting in more deflection (a wider picture) and increased high voltage.

Defective electrolytics in the circuit would render the tuner and video if stages inoperative, cause the audio output tube to burn out. When checking, be sure to measure the negative grid voltages on the audio output and video if tubes.

Insufficient negative grid voltage on the audio-output tube, caused by breakdown (or value change) of resistors, would result in distorted sound; raise the voltage on the plates of the video if and sync tubes.

Some sets using this type of dc distribution have the filaments of the audio-output tube and the damper tube tied to B+, though the cathodes are not at the same potential; hence a cathode-filament short in the damper tube would not only cause no high voltage, but no sound.

**SERVICE:** To locate defects, check dc operation. Measure the total voltage and the lowered B+, bearing in mind that the audio output voltage is the difference between the B+ voltage and the video if plate-supply voltage. Electrolytics are the most common complaint, though any defect among the decoupling resistors, video if, bypass capacitors, (and in the heater circuit) would affect both the video if and audio stages.

**Automatic Frequency Control (afc)—see Horizontal circuits**

### **Barber pole effect—horizontal**

**SYMPTOMS:** Usually observed in 630 type sets, consists of light and dark spaces on vertical sync pulse. Sometimes referred to as peppermint candystick.

**SERVICE:** Replace electrolytic filter capacitor in B+ 135-volt line.

### **Barkhausen oscillation**

**SYMPTOMS:** Black vertical line as shown in Fig. 1-B.

**SERVICE:** Try replacing the horizontal-output tube or use magnet type eliminator on the tube. Insert 100-ohm resistors in series with the control-grid and screen-grid leads. These resistors should be mounted right at the tube socket terminals. The trouble may also be caused by the tuner picking up signals radiated by the horizontal-output tube. Some sets use double-shielded tuners to prevent unwanted pickup.

A pseudo-Barkhausen effect may be caused by the yoke and other leads to the horizontal circuits coming too close to the if amplifiers and the tuner. Try dressing away any such leads, including B+ supply leads under the chassis. Try shunting the screen bypass capacitor of the horizontal-output tube with a test capacitor. (The screen bypass may have opened.)

### **Barrel effect on screen**

**SYMPTOMS:** Pix looks large in center and pulled in along edges.

**SERVICE:** Trouble may be caused by an impedance mismatch between the deflection yoke and either the vertical- or horizontal-output transformers. Sometimes occurs when the output transformers are replaced and wrong taps or wrong transformer is used. It may also be produced by shorted turns in yoke winding or misadjustment of 'pin-cushion' magnets in later sets.

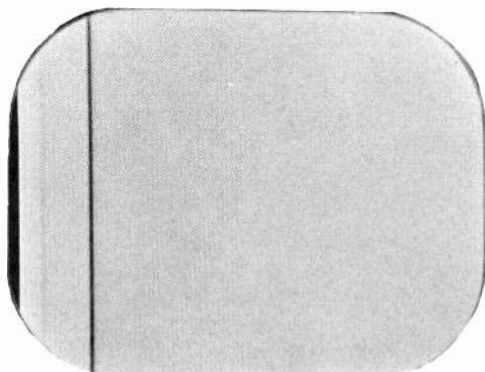


Fig. 1-B. *Appearance of Barkhausen oscillation on screen.*

### **Base of CRT broken**

**SYMPTOMS:** Base is loose. Pix may be intermittent.

**SERVICE:** When it is necessary to replace a broken base on the picture tube proceed as follows:

1. Remove the broken base by unsoldering all the pins, being careful not to damage the wires.
2. Straighten and form the wires so the new base can be easily placed on them.
3. Apply a coat of speaker cement to the glass neck of the tube and to the inside of the new base.
4. Place the new base on the tube, making certain that each wire is inside its proper pin. Hold the socket in place until the cement dries sufficiently hard to permit soldering the pins.

### **Beam bender (see Ion trap)**

### **Bend in pix (see also Distortion and Pulling)**

**SYMPTOMS:** Bending of vertical pix lines. See Fig. 2-B.

**SERVICE:** The symptom indicates possible trouble in horizontal circuits. Check adjustment of horizontal hold and contrast con-

trols; also controls at rear of set such as agc, horizontal lock and horizontal frequency. Phasing controls or ringing circuits in the plate of a multivibrator horizontal oscillator will cause bending if misadjusted. A number of controls are similar in action (though labeled differently by various set manufacturers) such as DX Range Finder (Admiral); Electronic Stabilizer (Arvin); Fringe Compensator Control (Emerson); Fringe Local Switch (Philco);



Fig. 2-B. Vertical wedges show severe bending.

Local-Distance Switch (Crosley-Olympic); Noise Gate Control (Bendix-Crosley); Picture Stabilizer Control (Emerson-GE); Phasing Control (Emerson) and Horizontal Balance Control (Emerson).

Check the horizontal oscillator and output tubes, horizontal discriminator and afc tubes; also sync splitter and separator tubes, noise inverter and also check audio output tubes used as a voltage divider. Check also rf amplifier, video if tubes and video detector.

This trouble may be produced by a defective horizontal-oscillator transformer. Check by removing horizontal-phase detector tube from socket. If bend is still visible (pix will be out of sync) trouble is indicated in horizontal-oscillator circuit. Frequently caused by defective horizontal-oscillator tank coil.

Another cause of bend in the pix is the possibility of video information getting into the sync circuits. If a black object moves through pix vertically, bending may follow this object. Check negative voltages at grids in agc, sync separator, sync amplifier, and horizontal-control circuits; also component values in these circuits.

Ac in the pix can also produce a bend. To check, reduce contrast until no pix can be seen. Advance the brightness control until a raster is visible. If the side of the raster is not straight, but has a bend resembling a sine wave, this would indicate ac in the raster. Appearance of a horizontal black bar means that the ac is in the video circuit. The bar may appear to move up slowly when a pix is received. Presence of two bars indicates ac is 120 cycles instead of 60 cycles. Check all tubes in the video amplifiers for heater-cathode leakage, as well as all electrolytics in low-voltage power supply.

Bending may also be caused by a pulse from the vertical oscillator. The trouble is usually due to insufficient capacitance on the B+ line going to the vertical oscillator. Shunt the existing electrolytic with a unit of equal voltage and capacitance rating.

This trouble also results from vertical pulses getting through into the horizontal afc. Try shunting capacitors on the oscillator control line from control tube (or phase detector) to the horizontal oscillator. This condition may be caused by vertical-and horizontal-hold control ground leads being too close. Disconnect the ground lead from the vertical control and reroute it.

### **Black margin at bottom of pix**

**SYMPTOMS:** Improper pix positioning.

**SERVICE:** Adjust the focus assembly to center pix properly, and be sure height control is adjusted to completely fill mask. Check vertical-output and vertical-oscillator tubes. If this does not overcome condition, check all resistors, capacitors, and other components in the vertical-sweep circuit.

### **Blooming**

**SYMPTOMS:** Pix expands as brightness control is turned up and goes out of focus. Pix disappears as control is turned up higher. Sound is normal.

**SERVICE:** There are several causes of blooming, the most usual being poor regulation in the high-voltage power supply (trouble in the low-voltage supply can cause it too), resulting from:

1. Leakage or breakdown in HV filter capacitor, caused by excessive dust or the proximity of its high side to the chassis.
2. Intermittent HV filter resistor. May have changed value (too high).
3. Defective HV rectifier. Check by substitution.
4. Poor lead dress. Make sure filament leads to HV rectifier, lead

to filter circuit and to second anode of CRT are away from metal. Do not allow leads near glass envelopes of HV rectifier, horizontal-output tube, or damper tube.

5. Try new horizontal-output and damper tubes; also low-voltage rectifier. In those sets using audio output as a voltage divider, that tube should also be checked.

6. Other components that can cause blooming, if defective, are the horizontal-linearity coil, filter choke, selenium rectifiers, horizontal-output transformer, and damper-tube filament transformer.

7. Blooming will also result from a breakdown of various resistors and capacitors, such as: (a) filament dropping resistor of HV rectifier; (b) resistor connecting brightness control to B+; (c) screen-dropping resistor of the horizontal-output tube; (d) resistor between pin 11 (cathode) of CRT and brightness control; (e) capacitor between the plate of the horizontal-discharge tube and the horizontal-drive control; (f) resistors at plate cap of the HV rectifier; (g) cathode resistors of the horizontal-output tube; (h) capacitors on either side of horizontal-linearity coil; (i) cathode bypass capacitor of audio output tube (using stacked B+ supply); (j) filter electrolytics of the B supply.

8. There are other, though less frequently occurring causes. A gassy CRT or one with an internal short can produce blooming. If the yoke has been replaced, blooming may be due to an impedance mismatch between the yoke and horizontal-output transformer. Be sure that the horizontal-drive control is properly positioned.

9. When condition occurs as a result of low line voltage as the brightness control is advanced, replacing the filament resistor of the high-voltage rectifier with one of lower value (example: 4.7 ohms to 3.3 ohms) may help.

### **Blotches, black—right side of screen (snivets)**

**SYMPTOMS:** Elongated black blotches always appearing at right side of screen. May also appear as several dark jagged lines or single, thin, jagged line. Usually observed when no signal is present and on both vhf and uhf channels. More pronounced when indoor or built-in antenna is used.

**SERVICE:** This trouble is due to rf radiation interference, originating in the horizontal-deflection system, generally the horizontal-output tube. Replace. Tube that causes trouble in one set may not do so in another.

If this does not eliminate the trouble, try adjusting the width,

horizontal-linearity and drive controls. Be sure that high-voltage cage is properly shielded and grounded, and dress antenna lead-in away from deflection circuit. Increase the resistance of the horizontal-output tube screen resistor, but not to the extent that width and brightness are reduced. Place ion trap magnet over horizontal-output tube and rotate trap to eliminate snivets.

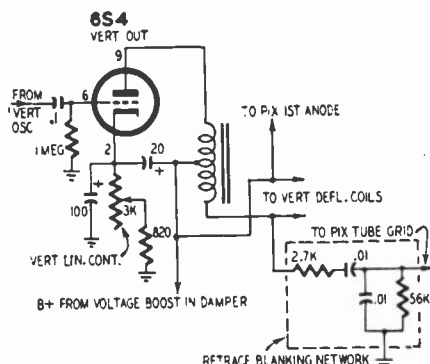


Fig. 3-B. This vertical-output circuit gets its plate voltage from the B+ boost in the damper.

## Boost voltage

Most sets have a B+ boost circuit derived from the action of the damper tube in the high-voltage circuit.

**SYMPTOMS:** Low boost voltage is evidenced by abnormally low horizontal sweep, low brightness due to low high voltage, and lowered vertical sweep if the vertical oscillator or amplifier is fed from the boosted B+. A vertical-output circuit working from boosted B+ is shown in Fig. 3-B, Picture may be visible, but focus will be poor.

**SERVICE:** Substitute horizontal oscillator, horizontal output, and damper tubes. Check any tubes and associated components connected to the boosted B+ such as vertical oscillator, amplifier and audio output in some sets. Tubes may lower the B+ boost if gassy or draw excessive current due to improper bias.

Defective flyback transformer, horizontal linearity coil and capacitors connected to it can cause lowered B+ boost. Any part in the secondary of the flyback (such as the yoke and its capacitor) can affect the B+ boost. Suspect all components in the yoke-damper circuit, including a bad width coil (can absorb too much energy from the flyback).



When trouble develops in a vertical circuit operating from the B+ boost line, check the electrolytic decoupling capacitor at the B+ feed line. The boost voltage may be increased by connecting the vertical sweep to another B+ source.

The B+ boost is measured from the low end of the primary of the flyback, whether a transformer or autotransformer, to B- (or quite often, to the chassis). The value may range from about

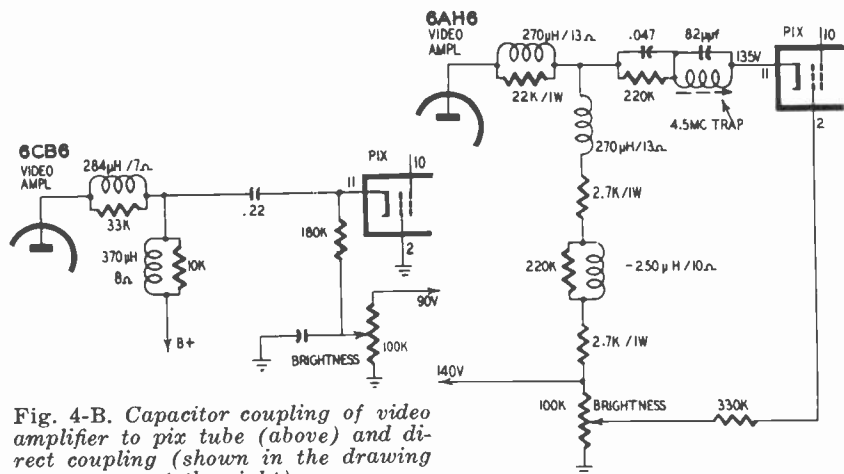


Fig. 4-B. Capacitor coupling of video amplifier to pix tube (above) and direct coupling (shown in the drawing at the right).

350 to 550 volts, which includes the normal B+ derived from the low-voltage power supply.

### Booster signal overload

**SYMPTOMS:** Pulling and distortion of picture.

**SERVICE:** Severe pulling is usually indicative of clipped sync, an overloaded agc system, or an oscillating stage in either booster or receiver due to excessive signal amplitude.

These symptoms indicate excessive output from the booster because the trouble disappears when you detune. Inasmuch as most boosters have no way of controlling gain, use low-value resistors across the transmission line (values determined experimentally).

### Bounce (See Jitter)

### Bow-tie pattern

**SYMPTOMS:** Pix has the pattern of a bow-tie in the center of the screen, appearing horizontally.

SERVICE: Caused by incorrect wiring of the vertical-yoke winding.

### Brightness circuit

Several methods are used to couple the video signal to the CRT input, all of which can cause brightness trouble. See Fig 4-B. When a coupling capacitor is used between the video amplifier and grid of the CRT, a dc restorer circuit generally is incorporated, and the brightness control is in the cathode circuit of the CRT. A defective capacitor between cathode and ground would cause excessive brightness. In circuits using a dc restorer, always check that tube when incorrect brightness is involved; also the resistor and capacitor in the line feeding a signal to the dc restorer circuit from the video amplifier. The grid-leak network in the circuit should also be checked.

Almost all receivers have dispensed with dc restorers, even though capacity coupling is used. Most of the older sets, many of which are still in use, have dc restorers. Dc restorers are being used in color receivers.

Connect a vtvm between the grid and cathode of the CRT. The negative voltage at the grid should vary from a low reading to more than 50 volts when the brightness control is rotated; if not, check the resistor network of the brightness control for defect. The brightness control may vary either the control grid or cathode of the picture tube and is often the tube electrode to which the video signal is *not* applied. (This electrode is sometimes called the undriven element.) Also check the voltage between the cathode and control grid of the pix tube. A lower-than-normal voltage indicates a defective coupling capacitor.

Direct coupling between the video amplifier and the CRT is common. When checking, a positive voltage should ordinarily be expected between grid and B-, and also between cathode and B-. However, there should be a negative voltage at the grid of the CRT with respect to the cathode. In this circuit, when brightness is incorrect, check the video amplifier tube and its load resistor; also the resistor network of the brightness control.

Other circuits which can affect brightness are: vertical retrace blanking network, consisting of several resistors and capacitors between brightness and vertical circuits; agc; horizontal oscillator, (especially when brightness is delayed) and output tubes; damper tube and high-voltage rectifier; insufficient low voltage (usually accompanied by reduced width and height) caused by

defective low-voltage rectifier and/or filter capacitors; or audio-output tube in some sets.

A defective CRT usually produces poor brightness and contrast; images on the screen become silvery when these controls are advanced.

### **Brightness, excessive**

**SYMPTOMS:** Brightness is excessive and cannot be reduced by the brightness control. Test shows B-plus voltage on the control grid of the picture tube even with the coupling capacitor disconnected. Picture tube socket is good.

**SERVICE:** These checks indicate a defective picture tube which should be replaced. Leakage exists between grid 1 and grid 2. Some technicians, on occasion, have been able to correct the internal defect by high-voltage arcing. Remove the picture-tube socket and ground pin 2, the control grid. Connect a high-voltage insulated probe to the high-voltage connector (this is removed from the tube and connected to the probe). The probe is applied to pin 11 of the tube. This causes an intense high-voltage arc between the cathode and grid of the tube and often burns away any shorting flakes of conductive material or any coatings which have formed between terminals. Repeat this by applying the high-voltage probe to pin 10 (grid 2). This arcs between grid 2 and grid 1 and helps eradicate any leakage.

Of course this procedure is dangerous because of the high voltage. And no guarantee of success can be made.

Excessive brightness indicates a defect in the brightness-control circuit or an abnormal increase in the high voltage. This would cause retrace lines to appear because the low bias would not allow the tube to cut off during blanking pulse periods. If the high voltage is excessive it may be caused by a slightly gassy high-voltage rectifier or horizontal-output tube. This would also cause some picture shrinkage.

Check the brightness control and measure the voltage between the cathode and grid of the picture tube. See if the brightness control gives a substantial variation, and whether the voltage is negative with respect to the cathode through a range to approximately 50 volts. Check all capacitors associated with both the cathode and grid of the picture tube, for a leaky one will allow B+ to get to these tube elements and upset the bias level. This, as well as other circuits which draw excess current, can cause abnormal

drain from the power supply and may necessitate a low-voltage rectifier replacement.

After correcting the excess brightness condition the current drawn from the power supply should be more nearly normal. If not, take a resistance reading to localize the partial short which is causing the additional current drain. Make sure filter capacitors are not contributing to this condition by having too low a leakage resistance.

When the left side of the screen is excessively bright, try replacing the damper tube.

### **Brightness, insufficient**

**SYMPTOMS:** Dark pix, even though brightness control is at maximum clockwise position. Retrace lines do not appear at any setting of the brightness control.

Insufficient brightness can occur when the last video amplifier is directly coupled to the CRT. Correct voltages must be maintained on cathode and control grid, and the latter must be negative with respect to cathode. (This is true even though both electrodes may be positive with respect to chassis.) Control-grid voltage should vary more or less with respect to cathode as the brightness control is rotated.

**SERVICE:** The most obvious trouble is insufficient high voltage or a defective CRT. Check both at the same time by removing the high-voltage lead from the CRT. Turn the set on and bring the metal end of the high-voltage lead close to second-anode button of CRT. A healthy spark should be observed. If not, bring the high voltage lead close to chassis. If a good-sized spark is observed, then the CRT is defective or some other component in that circuit. If a weak spark is observed, the trouble is in the high-voltage power supply. If a high-voltage probe is available, measure the high voltage. If blooming is not present, then the damper, hv rectifier and horizontal-output tubes probably are in good condition. Check the horizontal-oscillator tube and other tubes that might contribute to insufficient brightness, such as dc restorer, agc tubes, tubes in the sync circuit (especially if it is a 12AU7), video amplifier tube. In those sets having an audio output tube as a voltage divider, check that tube.

Although sparking the HV lead to the chassis is common practice, it does impose a severe overload on the HV supply. A much better, and certainly a much more informative method, is to use a HV probe and a vtvm.

The ion trap is a critical adjustment and is often moved by set owners with itchy fingers. The magnet may also be weak. Replace with known good unit and readjust for maximum pix brightness.

Be sure the yoke is against the tube flare, and adjust the focus unit. Position it so that no shadows are visible on the tube face when the ion trap is adjusted.

Low B+ voltage may also be the cause. Measure the B+ supply voltages. Replace the low-voltage rectifier and check selenium rectifiers if they are used.

In sets where the boosted B+ is connected to the vertical circuit, a darkened pix can be caused by a defective capacitor between the grid of the vertical oscillator and the plate of the vertical-output tube, due to excessive drain on the boosted B+ supply which affects the high-voltage circuit.

Check the brightness control. This control receives considerable abuse. Connect a vtvm from the center arm of the potentiometer to either end. Rotate the variable arm and watch the meter needle. The resistance should increase and decrease smoothly. If not, replace the control. Check other components, if any, associated with the brightness control.

Check the CRT for gassy condition; it may be weak, too.

### **Brightness—no control**

**SYMPTOMS:** Brightness will not decrease when the brightness control is rotated.

**SERVICE:** Measure voltages on the brightness control as it is rotated over its entire range.

Can also be caused by a leaky grid-coupling capacitor of the CRT. Check also for leakage between the elements of the CRT which may show a high resistance in a continuity check or may only be evident when the tube is heated. The fault may sometimes be corrected by jarring the neck of the tube. In stubborn cases, the fault may be cleared by burning the short free with the high-voltage lead. For this purpose, all but one pin should be connected to ground and the high voltage lead carefully arced to the remaining pin. In the case of heater-cathode leakage, rather than tube replacement, it may be less expensive to isolate the heater from ground by use of a separate filament transformer.

Other components that could contribute to this condition are:

1. Video amplifier tube, defective—perhaps gassy.

2. Resistor between pin 11 (cathode) of the CRT and the brightness control.
3. Capacitor connected to cathode of CRT.
4. Plate load resistor of 2nd video amplifier.
5. When brightness increases to a certain point by advancing control, then dims, check the horizontal-output tube, damper tube and HV rectifier.

### **Brightness range, reduced (see Blooming)**

### **Brightness, wavering**

**SYMPTOMS:** Slight changes appear in picture brightness.

**SERVICE:** Look for an intermittent condition in the high-voltage filter capacitor. Check by disconnecting one lead. If the fluctuations stop, replace the capacitor.

This trouble may arise from a bad tube in the sweep system, or a defective part between the horizontal-sweep oscillator and the input to the horizontal-output tube. The defective component increases horizontal drive, and this in turn increases the high voltage, and thus the brightness. The increased drive and high voltage also increase the output from the voltage-boost system. Inasmuch as the voltage boost system may feed both the horizontal-sweep oscillator plate potential as well as the B+ for the vertical-sweep oscillator, the change may be sufficient to upset both vertical and horizontal synchronization.

The increased voltage boost may feed the vertical-sweep output tube plate via the primary of the vertical-output transformer, and the increased voltage here increases height.

Try new horizontal-oscillator and horizontal-output tubes. If this does not help, check all components for correct values (between the horizontal oscillator and the grid of the horizontal-output tube). Keep a vtvm across one voltage source at a time to see if this changes when brightness advances. Note: trouble in horizontal afc control tubes have caused this complaint also.

### **Burn on screen (see also Ion burn)**

**SYMPTOMS:** Dark brown area on face of CRT, making part of screen useless.

**SERVICE:** This defect comes from a lack of deflection when the CRT has adequate high voltage, causing the scanning spot to concentrate at center of screen and burning the fluorescent coating. When this spot is observed, the brightness should be turned down

or the set switched off. If the dark brown spot appears permanent, and affects the pix, it is advisable to replace the CRT. This condition is also due to age of CRT.

## **Buzz**

**SYMPTOMS:** Excessive buzzing sound when set is tuned to station.

**SERVICE:** Adjust specific control, usually on rear apron of set, intended by manufacturer to minimize this condition, such as: agc control, area selector switch (Motorola); buzz control (Arvin-Raytheon-Zenith); DX range finder (Admiral); electronic stabilizer (Arvin); fringe-compensator control (Emerson); fringe-lock control (Zenith); locality-adjuster switch (Sentinel); local-distance switch (Crosley-Olympic); noise-gate control (Crosley-Bendix); picture stabilizer (Emerson-GE); and quieting control (Westinghouse). Be sure that the fine tuner and contrast controls are properly positioned.

Intercarrier sets having only one 4.5-mc if stage (with sound take-off at the video amplifier, usually found in moderately-priced sets) frequently develop buzz, especially when the contrast control is rotated. This is due to overloading of the video amplifier. Buzz may also be noted in any stage through which both video and audio passes when overloading develops. Check for insufficient bias voltage.

In sets with sound take-off at the video detector, the agc generally stops overloading; hence when buzz develops check agc circuit for breakdown.

In intercarrier sets, buzz is usually produced by trouble in the sound if and detector stages. This can be caused by misalignment of the video if strip (and particularly the ratio-detector transformer), possibly due to dust, humidity or aging of components; a defective video detector tube or crystal; misadjusted trap in the video if strip; or an excessive signal fed to the sound if strip.

A frequent cause of intercarrier buzz is a dried out amplitude limiting capacitor on the ratio detector. (This is a small electrolytic or may be a paper capacitor across the output of the ratio detector.) Try shunting.

Buzz on one channel only may be caused by the station transmitter.

Buzz may be produced by low agc voltages affecting rf and if amplifiers; low plate and screen voltages, or a weak tube. Frequently, buzz can be heard with a strong signal (sometimes ac-

accompanied by pix distortion), but disappearing with a weak signal. Occasionally buzz will be heard only with a weak signal produced by unbalance in the ratio detector and caused by defective ratio-detector capacitors ( $C_a$  and  $C_b$  in Fig. 5-B), or resistors ( $R_a$  and  $R_b$  in Fig. 5-B).

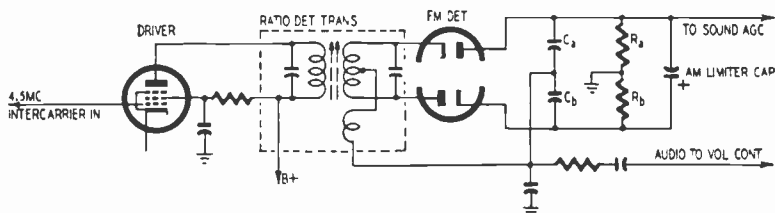


Fig. 5-B. *Typical ratio-detector circuit.*

Buzz often is caused by a mismatch between the lead-in and front end of the set; also lead-in taped to metal pipes or draped on metal gutters or under metal window sashes. Intensity of mismatch buzz varies from channel to channel and is usually noted only on one or two channels. Alignment buzz usually will be noted on all channels. If buzz changes to a higher pitch when the vertical hold is rotated, the trouble is usually located in the vertical-output transformer or the vertical-deflection coils.

If station buzz is excessive and is not caused by the contrast control being advanced too far clockwise, adjust the ratio detector secondary tuning slug for minimum buzz. Make sure that this position is between two maximum buzz peaks which will be noticed when the tuning slug is turned to the right and to the left of the minimum buzz position.

An annoying noise which sounds like intercarrier buzz sometimes occurs in split-sound and intercarrier models. In several instances, this trouble has been traced to ineffective grounding of the outer coating on the picture tube caused by bent or missing grounding springs. This trouble can be cleared up by providing a good connection between ground and the outer coating of the tube.

Buzz is sometimes caused by improper alignment in the tuner. With the tuner frequency adjusted to favor one segment of the bandpass over the other, the hum or buzz becomes more pronounced. Buzz can be caused by too much sound due to excessive response of if and/or front end around pix carrier. The sound must be one-fifth of the amplitude of the pix carrier at the input



to the video detector. (Refer to section on alignment.)

An annoying buzz is sometimes present in the audio of TV sets which use a 6T8 as a sound detector and first-audio tube. This buzz which can be heard with the volume control turned all the way down, is comparatively common when the 6T8 is located under or close to the picture tube. Eliminate this trouble by placing a well-grounded shield over the 6T8. (Be careful of lead dress on 6T8 wiring, too.)

### Buzz control (gated-beam type FM detector)

**SYMPTOMS:** The gated-beam FM detector circuit (Fig. 6-B) becoming increasingly employed by set manufacturers, incorporates a 6BN6 tube serving as a limiter-detector in the audio circuit.

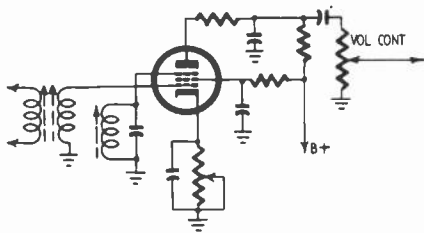


Fig. 6-B. Gated beam FM detector circuit.

**SERVICE:** A variable cathode resistor, termed the buzz control regulates intercarrier buzz. The circuit may be aligned using the regular TV signal. Connect a low ohm resistor across the antenna terminals to reduce signal strength. When a hissing is noted, adjust slugs in sound take-off transformer between sound amplifier and 6BN6, and quadrature coil, in conjunction with buzz control to produce sharpest sound with minimum of buzz. Hiss should be heard during adjustments; if it disappears, further reduce input signal.

If buzz cannot be eliminated replace 6BN6 tube; agc system may need adjustment or video if tubes require alignment. Defective bypass capacitors in 6BN6 circuit will cause buzz or distortion of sound. Replacements should be positioned exactly as original component without disturbing lead-dress.

### Buzz, cross-modulation

**SYMPTOMS:** This type of buzz varies in tone and intensity on different televised scenes.

**SERVICE:** Try new tubes in all sections passing both sound and pix signals. In intercarrier sets, check the video-amplifier tube, all sound if amplifiers, af amplifiers, sound detector, and video-detector tubes. Adjust individual oscillator slugs in the tuner.

### **Buzz, high voltage**

**SYMPTOMS:** The intensity decreases when the brightness control is turned down. Buzz lessens when contrast is turned down. It ceases when the high voltage lead is disconnected from the CRT or when the socket is removed from the rear of the CRT. This buzz is due to holes in the high-voltage current when the vertical retrace occurs—that is, during vertical blanking time. The change in beam current will produce an audible sound if coupled to the sound by any means whatsoever.

**SERVICE:** May possibly be corrected by making good connection between chassis and outer coating of glass type CRT. Dress of leads away from all audio sections is important.

### **Buzz, vertical**

**SYMPTOMS:** Tone and intensity remain unchanged when variations in pix occur. Tone of buzz varies when the vertical-hold control is rotated. Buzz disappears when vertical-oscillator tube is removed. Buzz will be present on all channels including blank channels, and continues if a tube in the sound if amplifier circuit is removed.

**SERVICE:** Try shielding the vertical-output transformer. Check the electrolytic filter capacitors in the B+ supply to the vertical section. Also try shunting electrolytic bypass capacitors in audio circuit B+ supply. When vertical buzz develops, if set has a 6J5-GT glass tube in the audio stage, replace it with a 6J5 metal type.

## Capacitors

On visual examination any capacitors that appear discolored, burned, or have wax insulation that has melted, especially electrolytics, (or capacitors that are hot to the touch) should be replaced.

Generally, when replacing capacitors use an identical component, with special regard to tolerance, temperature coefficient requirements, and polarity positioning. Capacitors of higher voltage rating are satisfactory providing space permits their use.

Defective plate, screen bypass and coupling capacitors cause low voltages. Disc ceramic capacitors are preferred. Ceramic tubular capacitors can replace old style micas and paper tubulars, and may be used in any circuit.

Ceramic capacitors for HV power supply should be replaced with regard to terminals—same as original—to eliminate any mounting problem.

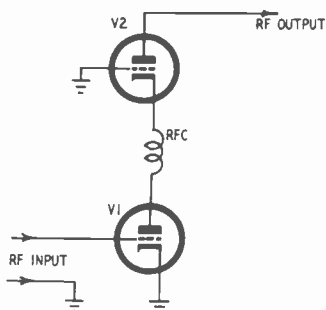
Mica capacitors in ratio detectors are seldom faulty. De-emphasis capacitors and electrolytic stabilizing capacitors in audio circuits frequently cause trouble. In sets having a blocking oscillator in the horizontal circuit, check the capacitor connected between the blocking transformer in series with resistor connected to horizontal-hold control and, in multivibrator circuits, examine the capacitor in parallel with horizontal-frequency coil; also the capacitor connected between plate of tube in series with resistor connected to horizontal hold. These frequently fail, affecting stable operation of horizontal-hold control.

In the vertical circuit, capacitors in the integrator, when faulty, should be replaced. Other common capacitor troubles are the balancing capacitor across the horizontal-deflection coil (defective capacitor here causes waving in the upper right or left corner of the pix and/or keystone) and capacitor connected to brightness control, which will cause a condition of no pix or raster.

## Cascode tuner

**SYMPTOMS:** Repeated tube failure in front end. Weak pix. Snow.

**SERVICE:** Cascode circuitry creates certain characteristic troubles.



*Fig. 1-C. Simplified circuit of the cascode tuner. The two tubes are connected in series across the B+ line. Because the cathode of V2 is about 125 volts above ground, there can be a breakdown between the filament and cathode.*

While the cathode of V1 (Fig. 1-C) is at ground potential, the cathode of V2 is about 125 volts above ground. Thus, while a heater-cathode leakage is of little consequence in V1, it can cause a great deal of trouble in V2. Because of the large potential difference between heater and cathode of V2 these elements frequently short.

A heater-cathode short in V2 grounds its cathode, thus eliminating the input signal to V2 and placing a positive bias of about 125 volts on the grid (this bias voltage will read much less because of heavy grid current flow). More important, however, is the great increase in plate current which in most cases will burn out R1 (Fig. 2-C) the plate resistor. Thus, in cases of snow, replacement of this tube should be the first order of business.

A burned-out R1 should never be considered positive proof of a shorted tube. A shorted 47- $\mu\text{mf}$  bypass capacitor will produce the same effect since it would ground the B plus line through R1.

As the result of excessive current flow, due to tube or component failure, R1 often decreases in value, shortening the life of all subsequent tubes used in this circuit. Thus, measurement of this resistor is a most important check when servicing this circuit. If a 1/2-watt resistor is being used, replace it with a 1-watt unit (space permitting).

Except for the dc relationship of V1 to V2 and the relatively high potentials on the grid and cathode of V2, the cascode amplifier is aligned and serviced in all other respects the same as other amplifiers.

### Centering, intermittent (horizontal)

**SYMPTOMS:** Intermittent, horizontal shift of pix. See Fig. 3-C.

**SERVICE:** This may be caused by variations in the direct current

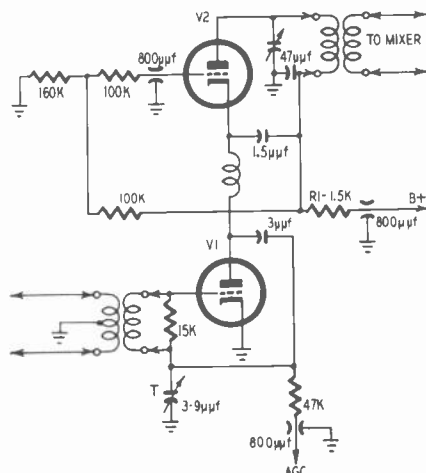


Fig. 2-C. *Circuit of the cascode tuner.*

flowing through the horizontal-deflection windings. It may also be due to a defect in the low-voltage power supply, or in the low-resistance centering control. (Only few sets have such a control.) If the control needs replacement, substitute a wire-wound unit. Connect a vtvm across the B+ output and check for voltage variations. Voltage should be maximum when set is turned on and decrease smoothly as set warms up. Erratic voltage changes indicate power-supply trouble.

### Centering, intermittent (vertical)

**SYMPTOMS:** Pix shifts position vertically, leaving dark area at bottom or top of screen.

**SERVICE:** Check tubes in the vertical-sweep circuit. Also check the low-voltage power supply feed to the vertical-deflection coils. Check for defective components in the vertical-output circuit, especially where voltage is fed to the vertical oscillator and output

tubes. Check vertical-size control for intermittent contact condition or change in value.

A change in the horizontal circuit flyback characteristics will affect the vertical circuit through the B+ boost derived from the damper tube. This is true in some sets only. Replace the tube and check components in the boost system.

A variation in the line voltage can also produce this symptom of vertical shift.

### Centering TV pix

**SYMPTOMS:** Picture has shifted. Dark, crescent-shaped area around the left side and bottom of the picture. See Fig. 4-C.



*Fig. 3-C. Pix is improperly centered due to intermittent horizontal shift.*

**SERVICE:** Accidental shifting of deflection yoke and focus unit (when installing new picture tube) produces this effect. The yoke and focus unit are usually mounted in brackets which permit the units to be shifted slightly in all directions. Moving the deflection yoke toward the rear or shifting the focus unit to one side or rotating it about either axis will produce this trouble.

Check the deflection yoke and make sure that it fits snugly against the flare of the tube. Rotate it so the edges of the raster are square with the mask. Loosen the focus-unit adjusting screws and move the unit slightly toward the base of the tube setting it in the position which gives uniform focus over the greatest picture area. Move the unit back and forth, from side to side, and swing it about both axes to obtain proper centering without neck shadow. Do not try to adjust the focus unit for maximum brightness at the expense of focus and centering.

## Chassis, hot

Some models of certain manufacturers constitute a shock hazard, especially so-called economy sets, since one side of the power line is connected to the chassis. Use an isolation transformer when servicing these receivers, or *be careful*. Run an ac voltage check between exposed chassis and grounded pipe (cold-water line). If chassis is hot, transpose line plug. All sets having selenium rectifiers instead of a power transformer are suspect. In such in-

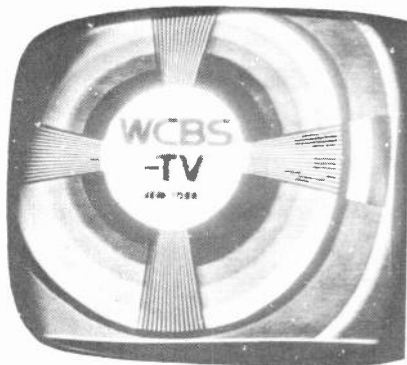


Fig. 4-C. *Shifting of pix by misadjusted focus assembly.*

stances tubes usually are in series unless a filament transformer is used.

## Chassis, remounting

To replace chassis in correct position in cabinet after pulling, first draw an outline of sides and rear chassis on wooden shelf with pencil. Re-install chassis along guide lines.

## Cloudy pix

**SYMPTOMS:** Pix seems hazy and unclear. Adjustment of focus control does not help. High voltage is normal.

**SERVICE:** If the pix approaches but does not go through focus, trouble lies in the focus coil, or focus-coil circuit. If focalizer (PM focus) is used, adjust slugs or try a new unit.

Otherwise, if a signal generator is available, connect the hot side to the control grid of each tube starting with the CRT and moving back to pix detector. Set generator on broadcast band—anywhere between 500 and 1,500 kc—with modulation on. Exact

frequency of generator is not important. Rotate the generator dial until black bars appear on screen. Bars should be sharp and clear. Defect is in the stage that causes bars to become fuzzy. Maintain signal generator test signal at low level. If bars are fuzzy when test signal is applied to CRT, that tube is probably defective.

Improper focus can be caused by wrong voltages applied to the focus potentiometer, defective focus bypass capacitor, if used; bad

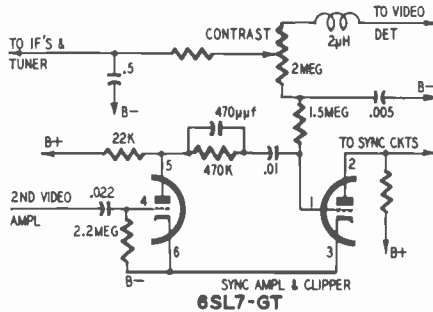


Fig. 5-C. Contrast-control circuit.

focus coil; excessive B+ drain through the focus coil due to shorts; or improper positioning of focus coil.

## Cogwheel (see Pie-crust effect)

### Contrast (excessive)

**SYMPTOMS:** Dark pix that does not respond to action of contrast control, partially or completely. See Fig. 5-C.

**SERVICE:** Check controls on rear apron of set such as agc control, DX Range Finder (Admiral), and similar controls for misadjustment. This condition can also be caused by defective tubes. Check (by substitution) agc, rf amplifier, mixer oscillator, video if amplifiers, video detector, video amplifier and low-voltage rectifier tubes.

Other components, if defective, that could cause excessive contrast are: cathode-bypass capacitor of the video amplifier; grid-return resistor of the video amplifier; coupling capacitor at the grid of the 1st video if amplifier; pulse coupling capacitor between HV and agc tube; agc delay resistors; video if coils; video-detector load resistor.

When pix becomes exceptionally dark on strong stations, check video detector. See Fig. 6-C. (Refer also to section on agc.)



**Contrast, insufficient**

The contrast control may be either in the video if section or the video amplifier. In sets of early vintage, without agc, the contrast control had to be varied to adjust the amount of signal at the video detector; in sets with agc, the contrast control is in the video amplifier section. See Fig. 7-C.

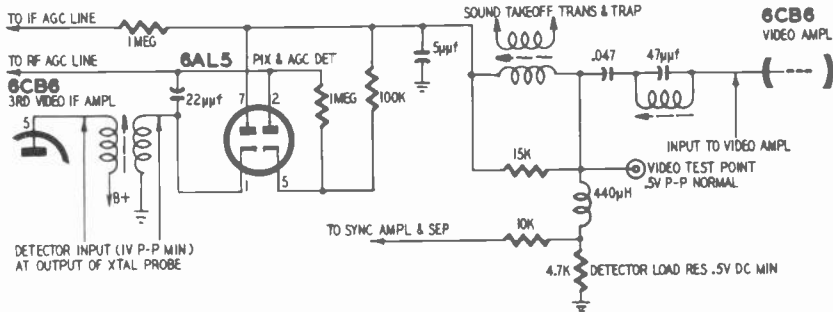


Fig. 6-C. Schematic diagram of a representative video-detector circuit.

**SYMPTOMS:** Rotating the contrast control to full clockwise position does not result in good contrast. Maximum contrast setting does not give typical symptoms of overloading (bending or horizontal tearing).

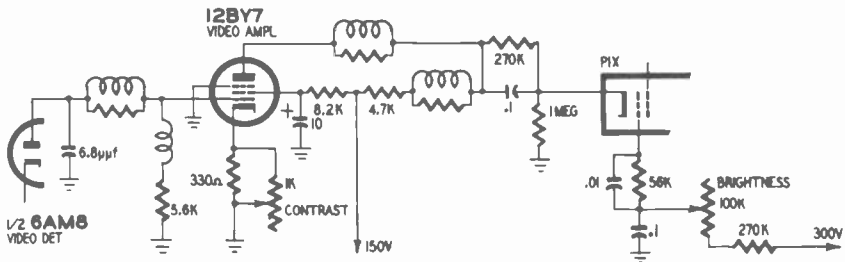


Fig. 7-C. Contrast control in the cathode circuit of the video amplifier. Compare with that shown in Fig. 5-C.

**SERVICE:** Lack of contrast means insufficient gain somewhere along the line from tuner to the input of the CRT. The most common cause is a weak tube in the tuner, video if, video detector or video-amplifier stages.

To find the defective stage, inject a signal at the input of each stage, starting with the CRT and going back to the antenna. Use a modulated RF signal from the generator, with any frequency that will produce bars on the screen. It will be noted that as the frequency of the signal generator is varied, the bars will be horizontal or vertical, few or many in number. This is not important.

The intensity of the bars should become greater as the generator lead is moved back from stage to stage. Any circuit causing a reduction in signal strength is the defective stage. If you do not have a portable signal generator, use the receiver filament voltage (do not use rectifier filament) as a signal source, as shown in Fig. 8-C. Click testing may be helpful.

Make sure the customer has not tampered with alignment or with the agc control. Check agc tubes and circuit components. Trouble can be due to insufficient signal strength.

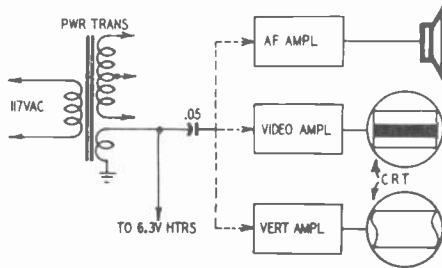


Fig. 8-C. Filament voltage can be used as a signal source.

If other sets in same area have identical trouble, try increasing the video-detector load resistor to approximately 6,000 ohms (20%), and the size of video-amplifier plate load resistors (20-25%). Use larger size cathode-bypass capacitors in the video-amplifier stages. These measures will increase signal strength, but will also reduce pix quality.

Other components that might be checked, as an outside possibility, are the audio-output tube and low-voltage rectifier. Low line voltage could be responsible for insufficient contrast, and a break in the transmission line would have the same effect. Do not overlook the fact that antennas and transmission line may need replacement.

### Contrast, delayed

**SYMPTOMS:** Poor contrast when set is first turned on, improving after several minutes of operation.

**SERVICE:** This is caused by inadequate cathode emission. Trouble can be either a slow-heating filament, or a cathode with decreased emitting ability. The only cure is tube substitution, starting at tuner and progressing stage by stage to the video output tube. Condition may also apply to the CRT.

## Corona (see also Arcing)

**SYMPTOMS:** Loss of high-voltage. Very fine, hard-to-see blue flame. Crisp odor (ozone).

Strictly speaking, corona, light blue in color and producing a sizzling or hissing sound, and arcing, producing a snapping sound accompanied by a bluish discharge, are somewhat different. For all practical purposes, however, they may be considered identical. Actually, corona is more apt to be observed in locations where humidity is excessive, causing ionization in the air and producing ozone, a colorless gas with a pungent, characteristic odor. Corona may also be present as the result of grit or dust particles adhering to high voltage components. Other causes of corona are sharp or jagged edges of parts at high potential and close proximity of the high-voltage lead to the chassis or another component near chassis potential.

Corona may best be observed in a darkened room. Generally corona causes a dim pix and at times a snowy appearance. When continued over a sustained period, corona may cause loss of power, a breakdown of insulation, and arcing.

Corona is apparent usually in reduced brightness and a buzzing sound, regardless of the volume control setting. The decrease in brightness is caused by the extra loading which the corona presents to the high-voltage circuit, and which decreases the second-anode potential.

**SERVICE:** The cheaper fiberboard type high-voltage insulation materials tend to absorb moisture in those areas where humidity is high. This causes loss of high voltage and severe corona troubles. In one 16-inch set, a faint blue was observed all over the insulation and high-voltage leads when a blanket was thrown over the high-voltage cage to darken it. The condition was cleared up by replacing the fiberboard with plastic and the socket with a porcelain type.

Severe corona will often cause a horizontal-output tube to fail within a few weeks. Metal shielding which is too close to the plate cap of the output tube will show a polished or bright circle opposite the cap if corona exists at this point.

Corona discharge in some TV sets and oscilloscopes is annoying because its effects are often mistaken for other faults and its source is sometimes hard to localize. In a TV receiver this trouble is likely to cause breaks in the line structure of the raster, variations in brightness, and sometimes irregular black bars on the screen. In a scope, it causes variations in intensity and erratic breaks in

the trace. You may hear clicks or frying sounds from the high-voltage compartment or the base of the CRT.

If corona discharge is suspected, sniff around the back of the set. If you smell ozone, turn out the lights and look over the power supply, the CRT and rectifier sockets, and the high-voltage leads. Watch for a bluish glow. Try blowing your breath on the high-voltage point. When you locate the source of trouble, dress down all sharp corners and edges and smooth off rough solder joints with a hot iron.

If the discharge is on an insulator, replace it because it has probably broken down under the high potential. Discharge from a lead can be cured by replacing the lead with one designed for high-voltage operation. Keep the lead as much in the clear as possible. If this fails, try increasing the size of the offending conductor or connection. Keep everything as large and smooth as possible.

In many cases the arc can be seen clearly or, when the compartment is darkened, the bluish glow of a corona discharge is visible. The cure for this is simply to smooth out all sharp points in the wiring and clean the insulating surfaces. The application of a little polystyrene coil dope often works wonders. Acrylic resin, available in pressurized cans, makes spraying of high-voltage components easy. When using such a spray, make sure all tubes are in their sockets. Otherwise, spray may get into the socket, resulting in poor contact with tube pins.

Very often the discharge is so fine that it cannot be seen and the sharp point or leaky insulation is hard to find. A good way to locate such a defect is to use a rod of good insulating material such as Polystyrene, Lucite, or Plexiglas about a foot long. By touching the tip of this rod to different solder joints, wires, tube pins, etc., it will be possible to find one where the rod will stop the discharge.

Dust and dirt on insulating material often form a leakage path for corona or arcing. A good cleaning with any of the commercially available solvents and subsequent application of coil dope will clear it up.

### **Corona (at second anode)**

**SYMPTOMS:** Decomposition of anode rubber cap.

**SERVICE:** Certain types of rubber anode caps gradually become conductive due to a chemical decomposition of the rubber. This produces a leakage path across the insulated area of the glass

around the anode button and often results in corona or arcing problems. Ordinarily, wiping the glass under the rubber cap does not remove the deposit that results from the decomposition of the rubber.

The suggested cure for this condition is to trim off the flange portion of the rubber cap to a point where no rubber touches the glass. This will leave only the sleeve portion of the cap which serves as a support for the lead into the connector.

Clean the glass around the anode button with water and a scouring compound such as Bon Ami. The area around the anode button should be scoured and then thoroughly dried and polished with a clean dry cloth so that no residue remains. If these instructions are carried out, no further trouble of this nature should be experienced.

### **CRT (cathode-ray tube)**

Voltages can be checked by removing socket from the CRT and taking readings from pin numbers of socket. When the pix tube does not light, measure filament voltage—ac between 1 and 12 of socket—should be 6.3 volts. This will be about 117 volts ac in series string sets, if the CRT filament is open.

Filaments may also be checked by removing socket from base of tube and inserting leads connected to Mazda 44 lamp into filament connections. If bulb lights, CRT is defective. Use two Mazda 44's in parallel on series string heaters.

Remove 2nd anode connector from CRT and measure high voltage, using high-voltage probe. Approximate voltages are:

10 to 14 inch CRT	9 to 12 kv
16 to 17 inch CRT	12 to 14 kv
19 to 21 inch CRT	14 to 16 kv
27 to 30 inch CRT	18 to 20 kv

When high voltage is present but no raster, and CRT is suspected, check dc voltages. Measure the voltage between pin 2 grid (negative lead) and pin 11 cathode (positive lead) with a vtvm set on the 100 volt dc range. Tune station, contrast at center of range, brightness minimum. Grid should be negative with respect to cathode. Minimum reading 40 volts. Rotate brightness throughout range. Reading should be not more than 10 volts. Wide variations indicate defective brightness control. CRT tube will cut off when grid is about  $-55$  volts with respect to cathode.

The voltage between pin 10 and ground should measure a minimum of 200 volts dc to a high of about 550 volts dc. Compare

voltages with those indicated on manufacturer's schematic.

In sets having the video amplifier directly coupled to the cathode of the CRT, check that tube and circuit components before discarding pix tube.

In the CRT, a short between grid and cathode produces lack of control of brightness, excessive brightness with retrace lines, and poor sync. To test for a short, permit the pix tube to warm up for several minutes, then turn off set, remove socket from rear of tube and quickly measure resistance (high setting) between pins 2 and 11; and between pins 11 and 12.

pins 2-11      grid-cathode short      250,000 to 420,000 ohms

pins 11-12      cathode-heater short      low resistance

(Test quickly before CRT cools off.)

### **CRT, arcing**

**SYMPTOMS:** Arcing in neck of newly installed pix tube; practically no interference with pix.

**SERVICE:** Caused by loose particles in neck of tube, working into gun structure, resulting in arcing. When particles are burned out, arcing stops. Seldom causes permanent damage to pix tube.

### **CRT, common troubles**

Common troubles are low emission from cathode and open heater of pix tube. Heater operation can be checked by examining neck of tube near base to ascertain if it is lighted. Generally, low emission will result in a weak pix. A gassy tube will cause blooming. If brightness control affects stability of pix, CRT is probably gassy.

When there is a gradual decrease in brightness (over a period of time), even when control is advanced, and discoloration is observed, the phosphor materials in the tube are losing their useful properties; hence pix tube should be replaced.

A gassy pix tube may cause grid to become more positive than normal. Pix usually turns negative. To check for gassy condition; permit CRT to warm up, move the socket and measure dc voltage between pins 2 and 11 of tube. If pin 2 is negative, tube is not gassy; if pin 2 is positive, tube is gassy.

Glass tubes (21" and larger) may develop spitting and frying noise during humid weather. Check glass shoulder between cone and neck of tube; if you see dark spots between shoulder and deflection coil supports, wipe shoulder with cloth.

Defective CRT may cause excessive brightness, horizontal tear-

ing, critical vertical hold, vertical jitter and a weak, washed out pix. For intermittent brightness condition, tap neck of tube. If pix increases in brightness or multiple bars are observed, tube is defective.

### **CRT, condensation**

**SYMPTOMS:** In cold weather, face of CRT fogs when chassis is replaced in cabinet after having been exposed to cold air in transit; chassis cannot be permanently installed until set undergoes thorough warmup.

In severe cases, arcing may occur between anode connector and CRT coating; sometimes producing a ticking sound and black streaks in pix.

**SERVICE:** Wipe off condensation at frequent intervals until fogging stops, or use an electrical drying instrument to blow warm air on screen of pix tube.

### **CRT, dirty**

**SYMPTOMS:** Pix seems weak, smeary. All tubes in good condition but reception is poor on all channels. Sound is good.

**SERVICE:** The high electrostatic charge on the face of the pix tube attracts dust. This forms a fine uniform film of dirt across the screen, even though it is covered by a mask. Fig. 9-C shows pictures taken before and after cleaning the tube. Pull plug from line and make sure that there is no voltage or charge on tube. Clean face carefully with soft cloth and lukewarm water. Do not use soaps, abrasives or cleansers. Clean mask at the same time.

### **CRT, excessive bias**

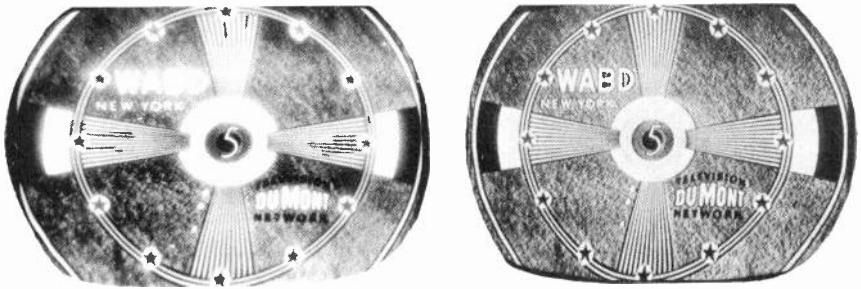
**SYMPTOMS:** Sound good, no raster. High voltage normal. Excessive cathode voltage. Also, with no raster, there is momentary flash of light on screen when set is switched off.

**SERVICE:** The high cathode voltage indicates above-normal bias which is cutting off tube emission. First, take a voltage reading between the picture tube grid and cathode as the brightness control is varied. The voltage should vary from a low value to well over 50 volts (grid minus with respect to cathode). In all probability you will find the grid-cathode voltage relationship remains unchanged because of a defective brightness control, or bad resistors and capacitors in these circuits. Use an ohmmeter for isolation of the component which is causing the trouble.

## CRT, magnetized

**SYMPTOMS:** Pix is nonlinear. Rotation of linearity controls does not improve pix.

**SERVICE:** This trouble exists in metal-cone pix tubes. May be checked by holding a small compass near the metal cone with the set switched off. Move the compass over the entire surface area. A strong movement of the needle indicates a magnetized spot.



*Fig. 9-C. A photo of the face of the picture tube (before cleaning) is shown at the left. The photo at the right shows the same test pattern after the screen and the mask were cleaned. The high voltage of the picture tube seems to attract dust and will deposit a uniform layer of it over the screen.*

Connect a filter choke, unshielded, in series with 10-watt electric light bulb and plug in to ac line. Move the core of the choke close to the affected area of the cone for about half a minute. Do not turn off power to the choke coil until it has been moved several feet away from the cone. Recheck with compass and repeat procedure, if necessary.

Keep magnets, PM focus units, etc. away from metal cone of CRT. If cabinet size permits, mount speaker as far away from pix tube as possible.

## CRT, transparent face

**SYMPTOMS:** All or portion of pix may be missing (remaining part clearly observed), with fine white deposit on inside of pix tube; viewer may look into tube and observe gun elements.

**SERVICE:** Phosphor materials coating screen have dropped, forming a white deposit. Tube is defective and should be replaced.



## Dark pix

**SYMPTOMS:** Picture is excessively dark, but not fuzzy or negative.

**SERVICE:** Does the brightness control still function to increase and decrease brightness? If so, the trouble may be a defective contrast control. Can the contrast be varied though the picture still remains dull? Perhaps the fault is in the brightness control or its associated resistor network. Pix tube may be old. Also, check high-voltage supply.

## Dc restoration, poor

**SYMPTOMS:** Poor dc restoration, making upper part of picture background appear gray, as shown in Fig. 1-D. Restorer generally consists of duodiode or germanium crystal, 1N34, coupled to video output. For all practical purposes, the dc restorer acts as an automatic-brightness control, hence must function properly if brightness is to be satisfactory. See Fig. 2-D.

Restorer failure causes darker pix, requires higher than normal setting of brightness control, and vertical-retrace lines to appear. Pix may become washed out. Sync lock may be affected, with critical horizontal and vertical-hold controls, especially the latter. A cathode-filament short in the dc restorer tube can cause pix distortion and a 60-cycle hum bar on the screen. It may also cause raster bending due to hum passage on through sync circuitry, if the sync is taken off the dc restorer, a common practice in earlier sets.

**SERVICE:** In all cases, check dc restorer tube and components feeding signal to restorer circuit (resistors and capacitors).

Dc restoration is not necessary with direct video coupling, and you should not get symptoms of poor dc restoration unless your video-output amplifier tube is giving trouble. It is also possible that the voltage relationships between the grid and cathode of the picture tube have been upset by aging resistors or poor low-voltage power-supply regulation.



*Fig. 1-D. Poor dc restoration results in a gray picture. Dc restorers are found in old receivers, many of which are still in use.*

In some receivers with two-stage video amplifiers, the dc component is restored between the first and second video amplifiers by driving the second amplifier grid which sets the black level in the picture. The RCA 630 type receiver uses this restoration method in addition to a regular dc restorer tube in the picture-tube grid circuit. Defective restoration will affect the average background of televised scenes as well as relative degrees of brightness on the screen.

Dc restoration is used only in very old receivers and is not included in modern sets, whether the video amplifiers are direct coupled or capacitively coupled to the picture tube. However, dc restorers are being used in color television receivers.

### **Definition, loss of**

**SYMPTOMS:** Absence of fine detail in picture. Faces look washed out. Trouble comes from loss of higher video frequencies (2 to 4.5 mc.) in video, pix detector, if, or tuner. See Fig. 3-D.

**SERVICE:** This trouble is frequently caused by a defect in the focus circuit, low high voltage, poor B+ voltage.

Check the individual oscillator slugs in the tuner; also the rf

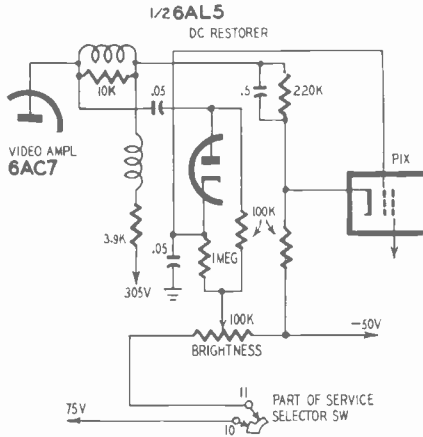


Fig. 2-D. The dc restorer acts as an automatic brightness control.

amplifier, mixer-oscillator tube, video if amplifiers and video detector. Realignment may be necessary. Misalignment can be caused by owner tampering or by creeping of slugs due to vibra-



Fig. 3-D. Poor pix detail because of loss of higher video frequencies.

tion. A weak video amplifier tube can produce a grey and/or washed out pix. Check resistance value of the video-detector load resistor. Replace if value has increased by more than 20%.

## Deflection yoke

**SYMPTOMS:** Shadows at edges of raster. Incorrect pix height

## DEFLECTION YOKE CHECK LIST

SYMPTOMS	SERVICE
Bow tie pattern-horizontal.	Incorrectly wired vertical windings.
Bow tie pattern-vertical.	Incorrectly wired horizontal windings.
Focusing not uniform.	Usually caused by incorrect yoke and focus magnet ring replacement.
Horizontal foldover with nonlinearity.	Defect in horizontal windings.
Height insufficient, with vertical nonlinearity.	Defective resistors across vertical windings.
Pix improperly centered with neck shadow.	Yoke incorrectly positioned. Centering and/or width controls misadjusted.
	Misadjusted focus magnet ring.
Raster sides bulging (barreling).	Conventional wound yoke substituted for cosine yoke.
Raster sides concave (pin-cushioning).	Cosine yoke substituted for conventional wound yoke.
Pix reversed horizontally.	Horizontal winding leads reversed.
Pix reversed vertically.	Vertical winding leads reversed.
Raster with shadow at edges.	Deflection angle of yoke replacement incorrect or yoke improperly positioned on neck of CRT.
	Also, misadjusted focus magnet.
Trapezoidal raster, height insufficient (keystoning).	Defective vertical windings or resistors—usually 560 ohms.
Trapezoidal raster, width insufficient.	Defective horizontal windings or capacitor—usually 56 $\mu\text{mf}$ .
Vertical lines, white to dark (ringing).	Incorrect capacitor, or no capacitor across high side of horizontal yoke—usually 56 $\mu\text{mf}$ .
Vertical shaded bars—1 or 2 (cross-modulation).	Try connecting 270 $\mu\text{mf}$ capacitor between center tap of vertical winding and low side of horizontal winding.
Wavy line-horizontal, in center of screen.	Defective vertical windings.
Wavy line-vertical, in center of screen.	Defective horizontal windings.

and width. Defective yoke, producing keystone horizontally and/or vertically.

**SERVICE:** Correct positioning of yoke. Should be close to bell or flare of pix tube. Breakdown of damping resistors across vertical windings and capacitor across horizontal winding can cause pix distortion, ripples in pix, and keystone. When yoke has shorted turns, one coil will be hotter to the touch than the other. A variety of troubles may develop from a defective yoke. Refer to the check list on the facing page.

### Differentiator circuit

**SYMPTOMS:** Loss of horizontal sync. Unstable or critical horizontal-hold control.

**SERVICE:** Differentiator is an R-C network (high-pass filter) used to separate horizontal pulses for triggering the horizontal

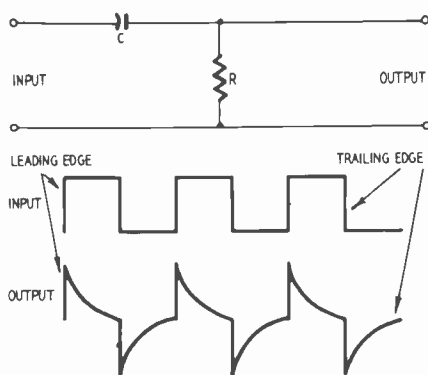


Fig. 4-D. *Effect of differentiator on horizontal-sync pulses.*

oscillator. See Fig. 4-D. From sync separator, the output is usually fed to afc circuit of horizontal-sweep system. Check for defective capacitors or resistors in differentiator circuit. Test these small-valued capacitors by substitution, and not by shunting.

### Distortion—60 cycle (see also various Hum classifications)

**SYMPTOMS:** Sides of raster or pix have an S shape. Wide horizontal bar across screen. See Fig. 5-D.

**SERVICE:** Symptoms listed can occur independently. Distortion of raster sides is due to hum in sweep circuits. Bar across screen

is caused by hum in any stage that is used to amplify the pix signal. In the latter instance, the trouble may be due to heater-cathode leakage in any tube from the tuner to the input of the CRT. If a scope is available, check the video amplifier. For stages prior to the video detector, use a detector-type probe in series with hot lead of scope.



Fig 5-D. *Distortion due to hum voltage*

Trouble may also be due to hum modulation caused by insufficient filtering. Measure the B+ voltage. If voltage is low, replace LV rectifier and check again. If voltage stays low, or rises only slightly, one or more of the low-voltage filter capacitors should be replaced.

Rare cases have been reported in which unshielded twin lead has picked up sufficient 60-cycle voltage to cause bars to appear on screen. Short antenna input with wire or screwdriver. If bars disappear, trouble is in antenna or transmission line, or both.

Filament wires should be kept away from sensitive grid leads. Using a plastic probe, push filament wires around while watching screen. Fasten filament leads in the position giving the least interference.

### **Distortion, top of pix (see also Bend in pix)**

**SYMPTOMS:** In numerous modern television sets the vertical and horizontal hold controls are located near each other on a small subpanel or equivalent near the front of the chassis (see photo,

Fig. 6-D). The chassis ground currents from these controls will thus mix.

The chassis has relatively low resistance and reactance, hence a low impedance to currents of these frequencies. But the large flyback pulse of the vertical oscillator can feed directly into the horizontal-oscillator circuit and distort the first few lines of the picture. Additional afc control line filtering will not help much in this situation; neither will more complete filtering of the B-plus

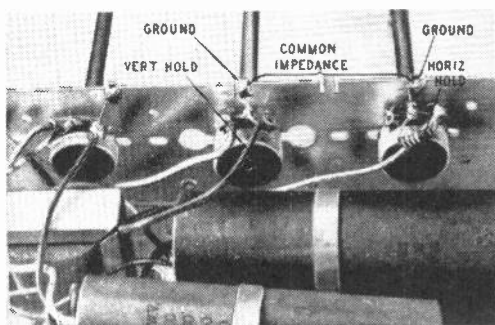


Fig. 6-D. Photo shows close positioning of vertical- and horizontal-hold controls.

line to the vertical output tube remedy this situation appreciably.

**SERVICE:** The cure is to disconnect the ground lead from the vertical control and reroute it via a wire—or, if available, braid—to the main chassis, as remote as possible from the ground of the horizontal control. Keep this new grounding point away from the other horizontal circuit grounds. In some cases tying the grounds together with heavy braid will do the job.

Even a small fraction of an ohm of impedance may develop an interfering voltage. For large voltages or very high frequencies, the chassis ceases to be an unipotential ground.

### Double pix (vertical)

**SYMPTOMS:** Two pictures appear, one on top of the other (as shown in Fig. 7-D) though not superimposed. Vertical-hold control will stop double pix from rolling.

**SERVICE:** Caused by vertical oscillator working at 30 cycles per second instead of 60 cycles, due to increase in time constant of vertical-oscillator circuit.

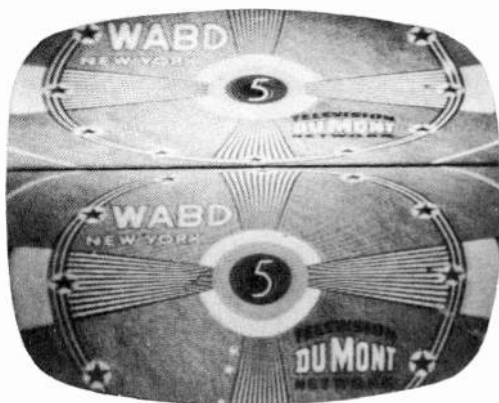
If oscillator grid capacitor has previously been replaced, make

sure that value is correct; also be sure resistors in grid circuit have not increased in value. Check vertical-hold control. When accompanied by decrease in height at top and bottom, check vertical-oscillator tube.

### **Double pix (similar to ghosts)**

**SYMPTOMS:** Double image observed on screen.

**SERVICE:** On rare occasions this trouble is caused by an incorrect adjustment of the horizontal-drive control. May also be due to a defective grid-return resistor connected to the horizontal-output tube.



*Fig. 7-D. Double pix caused by vertical oscillator working at 30 cps.*

### **Drift, oscillator (in tuner)**

**SYMPTOMS:** Pix and sound drift in and out, requiring frequent adjustment of fine-tuning control. Sometimes drift is so severe that fine-tuning control cannot bring back pix and sound.

**SERVICE:** Oscillator frequency in the tuner (front end) is changing. Try a new oscillator tube. Trouble is most likely caused by defective frequency-compensated component in the oscillator circuit in the tuner; hence, check resistors and capacitors carefully. Do not replace units with ordinary parts. Contact manufacturer, or his distributor, and get exact parts replacement, as components are probably temperature compensated. May also be advisable to adjust individual oscillator slugs in tuner. This condition can also be caused by fluctuating line voltage.

Blocking of ventilation openings on top sides, bottom or back of cabinet can cause this drift.



## Drive, excessive horizontal

**SYMPTOMS:** Short life of horizontal-output tube. High-voltage fuse may blow. Overdrive lines appear on screen. Pix may stretch

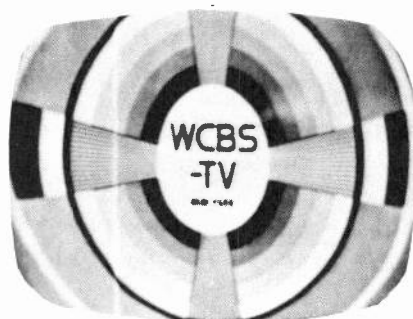


Fig. 8-D. *Overdrive indicated by vertical white line.*

on left-hand side, sync is not steady. See Fig. 8-D.

**SERVICE:** Horizontal-drive not properly positioned. Improper drive increases current flow through horizontal-output tube and shortens its life. This condition can cause horizontal-output transformer to overheat, weaken insulation, and eventually burn out. Incorrect adjustment can also cause vertical ragged edges in pix, or, in severe cases, a double image will be produced.

Typical horizontal-drive controls are illustrated in Fig. 9-D.

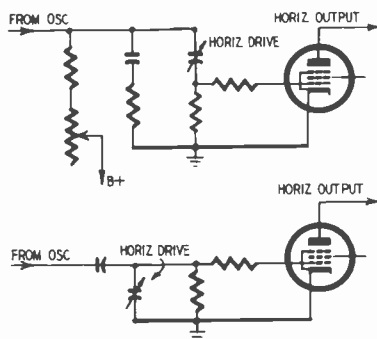


Fig. 9-D. *Typical horizontal-drive control circuits.*

**Echo (see Ringing in pix)**

**Egg-shaped test pattern; improper distribution of pix**

**SYMPTOMS:** A common complaint among set owners who con-

stantly endeavor to make adjustments themselves. This will affect a televised program by causing elongation of persons, either vertically, horizontally, or both.

**SERVICE:** Check adjustment of vertical size, linearity and centering controls when receiving program. Remove vertical-output tube. This will result in a horizontal white line. Adjust centering control until line is in vertical center of screen. Replace vertical-output tube and adjust vertical size and linearity controls for correct pix. Rotate vertical hold to allow pix to roll slowly. See Fig. 1-E. Blanking bar should not change thickness going from top to bottom.

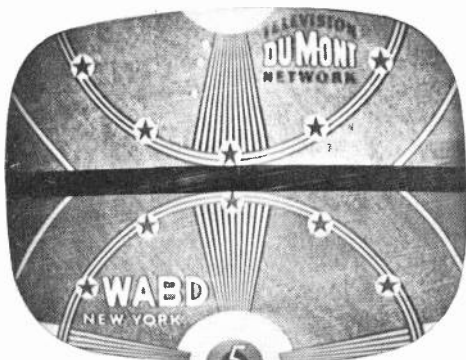


Fig 1-E. *Rolling pix vertically permits examination of blanking bar.*

Many modern receivers use series filaments, so that it is not always feasible to remove the vertical-output tube. A dummy tube, with all pins except filament clipped off, can be used.

### Flashes in pix

**SYMPTOMS:** Flashes or streaks are observed in pix. Often observed in sets with cascode type tuners.

**SERVICE:** Check all channels. If none on blank channels, trouble probably is in tuner. Frequently caused by defective antenna system. Check by substituting an indoor antenna. Try to supply your own in preference to that provided by customer. If condition disappears, check antenna and lead-in for loose connections, broken wires, lead-in contacting metal parts of roof, and tree foliage touching antenna. If all channels are affected, check rf or mixer, damper and horizontal-output tubes. Tap fine-tuning control. If flashes are observed in pix, tuner probably is dirty.

### Flicker, slow

**SYMPTOMS:** Often referred to as "airplane type" flicker because it resembles the effect produced by an airplane flying overhead. It may be due to fluctuating line voltage, faulty receiver installation or a defective tube.

**SERVICE:** To check, measure the line voltage with an undamped 0-150-volt ac voltmeter. If variations are excessive, call the service department of local electric utility company for proper action. (In rural or remote areas, a suitable constant-voltage transformer at the set may be necessary.) Check the installation, and correct obvious faults (loose or swaying lead-in, antenna, etc.).

## Focus

**SYMPTOMS:** Improper focus, resulting in blurred pix. See Fig. 1-F.

**SERVICE:** Check focus control adjustment (poorest focus should be at either end) ion trap, and the possibility of low-line voltage. Check by substitution of HV rectifier, horizontal-output, and horizontal-oscillator tube. When the focus control has no effect, check CRT for gassy condition.

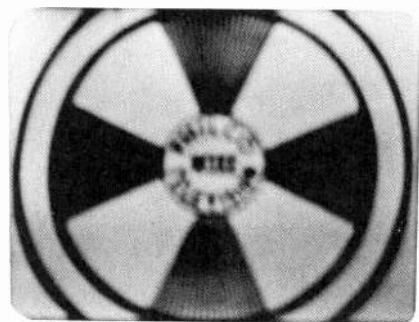


Fig 1-F. *Blurred pix due to poor focus.*

The focus coil often forms part of the cathode, screen, or plate circuit of the audio-output tube. See Fig. 2-F. Focus is controlled by a potentiometer placed in the cathode circuit of the same tube. The focus coil is usually bypassed by a large electrolytic capacitor. Any of the usual troubles in the audio stage can cause an out-of-focus condition—leaky coupling capacitors, defective output tube, shorted screen, plate or cathode bypass capacitors, open output transformer primary, and defective audio-amplifier tube. If the speaker should become detached, the focus coil would lose voltage and be inoperative.

Low B+ voltage will affect focus; therefore filter electrolytics, LV rectifier and selenium rectifiers should be checked. A defective deflection yoke is another possibility.

When best focus is obtained at extreme end of focus control, check for defective resistor in circuit, or LV rectifier. Raster with shadows indicates focus coil may need adjustment. Correct position is about  $\frac{3}{8}$ " at rear of deflection yoke, for many sets. On sets with permanent-focus magnet, adjust shorting screw of magnet.

Modern receivers' do not have electromagnetic or combined EM-PM focus units. A permanent magnet with screws or slugs (for adjusting the strength of the focus unit) is used instead. However, many of the older sets still being used have electromagnetic focus.

Trouble will be encountered with PM and EM-PM focus assemblies, if these are not properly handled. These types (unlike the older EM) depend on the magnetic field surrounding a permanent magnet for focusing. Permanent magnets are affected by heat; should not be dropped, or struck. Even a slight jar or striking with a tool can cause these units to lose enough magnetism so that focusing becomes poor. The PM units have one or more adjustable slugs. Always use a brass or other non-magnetic screwdriver for adjusting.

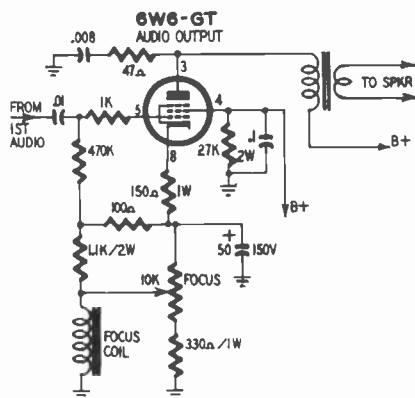


Fig. 2-F. *Focus coil in audio-output circuit.*

Erratic focus can be due to a defective focus potentiometer. See Fig. 3-F. Connect a vtvm from center arm of the potentiometer to either end. Rotate the variable arm and watch meter needle. Needle movement should be smooth. If jumpy, replace control.

### Focus, narrow

**SYMPTOMS:** Good focus cannot be obtained across most of tube face. Adjusting the focus control causes the center focused area to split into two sections.

**SERVICE:** In some of the older sets, focus coils are often placed in series with the B+ supply. Trouble can be due to breakdown between coil windings or from coil windings to focus coil case. Replace with a new unit. Trouble may also arise from intermittent loads, such as partial shorts in B+. You can substitute a modern focus ring for the electromagnetic focus unit but the old focus coil must remain as part of the circuit. (Extend the leads to the coil so that it can be mounted out of the way.) You can also substitute a

resistor for the coil. The resistance will be the same as that of the coil. You will have to calculate the wattage rating.

### Focus, no control (see Blooming)

**SYMPTOMS:** Pix goes out of focus as brightness control is advanced. Focus control is ineffective.

**SERVICE:** Trouble is in high-voltage power supply. Refer to section on blooming for details.

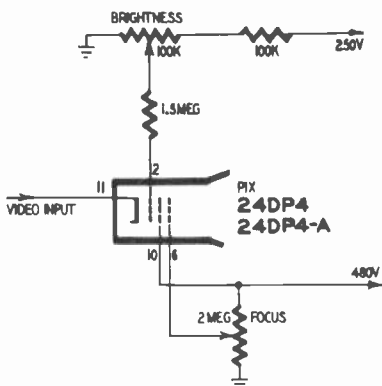


Fig. 3-F. This circuit uses electrostatic focusing.

### Focus, poor—with 19AP4-A metal tubes

**SYMPTOMS:** Poor focus condition, especially at center of pix, generally observed in sets using 19AP4-A metal tubes.

**SERVICE:** This is a common trouble with replaced 19AP4-A metal tubes, caused by changes in electrical design of tube. Can usually be overcome by lowering dc plate voltage to horizontal-output tube. Insert a 1,000 ohm, 5- to 10-watt resistor between the horizontal-output transformer and boost-voltage source (linearity coil).

### Foldover, horizontal

**SYMPTOMS:** Foldover appears on the left or right side of the picture and can be shifted slightly by adjusting the horizontal-hold control or the phasing slug on some types of horizontal-oscillator transformers. See Fig. 4-F.

**SERVICE:** The origin of this defect usually lies in the inherent time constant of either the flyback transformer, the deflection yoke, or both. Excess capacitance in the horizontal-output circuit

(this includes damper, HV, and yoke circuits) will lengthen the retrace time. With most high-efficiency transformers the entire pix information is not contained in a single line, but continues for a short period of the otherwise invisible retrace, giving the appearance of a transparent folding-over of the pix on the edge.

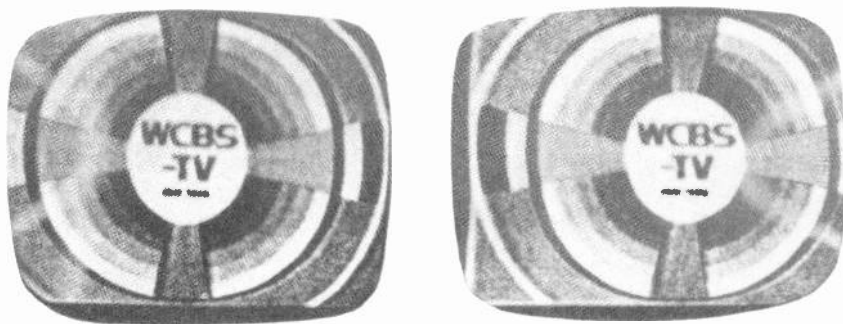


Fig. 4-F. *Foldover can appear at left side of screen (pix at left) or at right side (see pix at the right).*

In some instances foldover can be reduced or eliminated by proper alignment of the horizontal-oscillator transformer, or by using a properly matched flyback and yoke combination. Since very few high-efficiency flyback transformers have the required short time constant, the next best approach is to eliminate not the foldover, but its annoying appearance.

The flyback pulse voltage present at the "hot" side of the horizontal yoke is a strong positive pulse which occurs at exactly the same time and for the same duration as the horizontal retrace. This pulse can be used to eliminate the foldover effect. One simple scheme is to connect a portion of this pulse to the first anode of the picture tube, an element which is usually connected to a 350- to 400-volt B+ point. A voltage divider is made as shown in Fig. 5-F and the values of R1 and R2 are adjusted to blank out the foldover without affecting the rest of the picture. If too strong a pulse is used the left side of the picture will appear darkened. If the pulse is too weak, the foldover will remain visible. A good starting value for R1 is 100,000 ohms and for R2 between 330,000 and 470,000 ohms. Both resistors should be 1-watt types to avoid deterioration under the high pulse voltages. If too much pulse results, increase the value of R1; if too little is present, reduce R1. The lead to the first anode of the picture tube is usually a bright red wire going directly from the socket to a B+ point.

It can be argued that by this method a part of the picture is lost. This is true, but the portion is only a very thin strip, normally at the extreme right of the picture, and it is doubtful that any viewer would ever miss this tiny edge. In any event, the elimination of the foldover is usually such a great improvement that it far outweighs the small loss which is often blanked out by the mask anyway.

Horizontal foldover can also be caused by defects in the horizontal-oscillator section. Try tube replacements there as well as checking the parts.

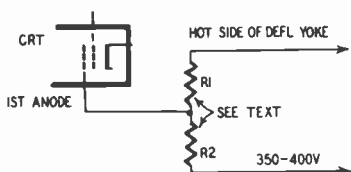


Fig. 5-F. This circuit can be added to the receiver to eliminate foldover effect.

**SYMPTOMS:** Foldover at left side of pix.

**SERVICE:** Generally trouble will originate at, or after, the horizontal-linearity coil. Check the following components: damper tube; horizontal-deflection yoke (measure resistance across windings); B+ boost capacitor; grid-coupling capacitor (horizontal-output tube); cathode capacitor (damper tube); width coil; horizontal-output tube; capacitor paralleling the linearity coil.

**SYMPTOMS:** Foldover at right side of pix.

**SERVICE:** Generally trouble will originate before the linearity coil. Check the following components: horizontal-output tube; screen capacitor, screen resistor, grid resistor (horizontal-output tube); horizontal-output transformer.

Check the coupling capacitor from the plate of the horizontal oscillator to the control grid of the horizontal-amplifier tube. Leaky capacitor will put B+ on control grid of horizontal-amplifier tube, distorting the sawtooth-current wave in horizontal-deflection coils.

**SYMPTOMS:** Foldover in the center of the picture.

**SERVICE:** Can be caused by an open component in the linearity-coil circuit. Check the grid-coupling capacitor of the horizontal-output tube too. This trouble can also be caused by a defective sync limiter tube, or voltages applied to it.



## Foldover, vertical

**SYMPTOMS:** Foldover at top or bottom of pix. See Fig. 6-F.

**SERVICE:** Vertical-linearity control affects upper part of pix, and vertical-size control changes overall size, especially bottom of pix. Misadjusted centering control and linearity control may cause folding at top. Misadjusted vertical-size control may cause folding at bottom.

Foldover at the bottom usually indicates trouble in the cathode circuit of the vertical-output tube. Check the vertical oscillator and output tubes by substitution; also the LV rectifier.

May also be caused by a defective vertical-blocking oscillator, vertical-output transformer, or deflection yoke. Low line voltage can produce foldover.

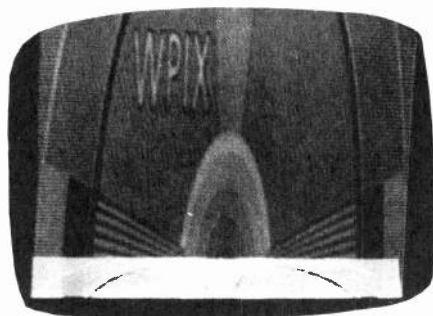


Fig. 6-F. Photo shows vertical foldover.

A number of capacitors and/or resistors, if defective, can cause this condition. A common trouble is the coupling capacitor between the vertical oscillator and output tube. In the oscillator circuit, check plate resistor and capacitor, cathode bypass capacitor, capacitor between vertical-blocking oscillator and ground; and resistor and capacitor between vertical-blocking oscillator and sync amplifier. In the output circuit check cathode capacitor and grid resistor.

## Fuse in high-voltage supply, blown

**SYMPTOMS:** No high voltage.

**SERVICE:** This may or may not indicate trouble. Sometimes the fuse in series with the primary of the flyback transformer will blow due to a temporary overload condition. The fuse may blow due to corrosion of its contacts or contacts of the fuse holder. Sometimes a loose fit is responsible. Check before renewal. Replace with size and type recommended by manufacturer.

Examine glass body interior of fuse that has blown. If a small segment of the fuse has been melted, trouble is in the horizontal circuit. If the fuse link has vaporized against the fuse body, trouble may be the vertical-output tube.

An excessively gassy horizontal-output tube can blow the fuse. Presence of gas inside the horizontal-output tube can be checked in two ways. If, during operation, a slight blue glow appears in tube, then tube is gassy. This blue glow is normal; does not cause fuse to blow. Remove tube and examine inside, near the base. If a whitish deposit is observed, tube is definitely defective. Make sure set has correct amount of horizontal drive. Excessive drive plus slightly gassy tube (no white deposit) can increase plate current of horizontal-output tube to point where fuse will blow.

When a high voltage fuse has blown, remove from holder. Clip a Mazda 47 bulb across terminals of holder, then adjust horizontal-linearity coil for minimum glow of bulb. This is correct adjustment, and should help prevent fuse from blowing.

If the fuse does not blow at once, but only after the set has been in operation for a short time, check the damper tube. Trouble is caused by a thermal short. This means damper tube is OK while cold, develops heater-cathode short when filament expands due to heat. Cathode of damper tube is usually several hundred volts above ground, hence short blows fuse. Also check for arcing from damper tube heater wires to chassis. Tape wires with plastic tape. Check high-voltage rectifier socket for possible defect.

While fuse to protect the high voltage supply usually is a 0.25 ampere rating, some go up to 0.6 ampere; hence, if high-rated fuse is replaced by usual 0.25 ampere type, fuse will blow repeatedly, but trouble will not be due to defect in set. Using fuse rated higher than required is no protection, and can damage the horizontal-output tube and flyback transformer.

**Gated agc—See Keyed agc**

**Gear tooth effect on screen; vertical lines of pix unstable—wavy**

**SYMPTOMS:** Usually observed in GE sets using Gruen afc in horizontal circuit, though some other manufacturers now use this system.

**SERVICE:** Caused by breakdown in anti-hunting network of afc system (located between horizontal-phase detector and reactance tubes) consisting of resistor and capacitor in parallel, and series resistor and capacitor connected to grid of reactance tube. See Fig. 1-G.

**Germanium crystals**

Generally used as video detectors and uhf mixers. Partial defects in crystals are common, causing weak pix, no contrast, unstable vertical and horizontal lock-in or intermittent operation. A 100% defective crystal will prevent any signal from passing through. In conventional (split-sound) sets this will affect pix only; in intercarrier sets both audio and video will be lost. A 50% loss will prevent the second detector, if a germanium crystal, from properly mixing sound and pix carriers. The video will come through reasonably well, but the sound will be weak or absent in intercarrier receivers.

To check, disconnect from circuit. Place ohmmeter across terminals. A low resistance, 400 ohms or less, should be noted in one direction, and a high resistance, 10,000 ohms or more, when the

leads are reversed. Any ratio less than 1:25 indicates substandard crystal.

Several precautions are necessary when replacing a germanium crystal. If the crystal is not connected with proper polarity, a negative pix will result. Pix will also roll and tear. The negative side of a germanium crystal is either coded with a green color or else it will be marked minus. The positive end may not be

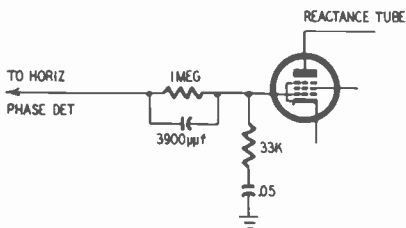


Fig. 1-G. Anti-hunting network is connected between the horizontal-phase detector and the reactance-tube control grid. A defect here produces a gear tooth effect on the screen.

marked, or it may be marked +. When shown on a circuit diagram, the negative side of the crystal (cathode) is a straight line or a thin bar. The positive end (anode) resembles an arrowhead. Sometimes the negative end is marked cathode or simply cath or K.

Crystals are sensitive to heat. When soldering a crystal in place use a pair of long-nose pliers with the thickest portion of the pliers across the crystal lead (that is, the pliers should be between the soldering iron and body of the crystal). The pliers will act as a thermal shunt, keeping the heat from going into the crystal.

## Ghosts

**SYMPTOMS:** Multiple images on screen.

**SERVICE:** In many TV installations, the location and type of antenna and the length and type of transmission line may produce a mismatch which will cause ghosts. To solve this problem and to prevent complaints, use the tubeless phasing unit shown in the diagram, Fig. 2-G. By shunting the noninductive potentiometer across the line and grounding its arm through a 330-ohm resistor, you can vary the over-all impedance to a point where it matches the receiver and eliminates the troubles caused by a mismatch of this type. The action of the control is to load one side of the line, permitting the other to balance and present an even load to the input of the set.

There are various types of ghosts:

### Double image

Incorrect adjustment of horizontal-drive control. Check horizontal-output tube and its grid resistor.

## Leading

Generally several images on left side of pix. Lead-in may be too long. Shield rf and mixer circuits. Check grid resistor in rf amplifier circuit. Reorient antenna.

A ghost, as the result of direct pickup, will change when anyone comes near the set. It is sometimes possible to eliminate ghosts by connecting an adjustable-V indoor antenna to set terminals in parallel with outdoor antenna.

*Fig. 2-G. This simple resistive unit can help minimize ghosts due to an impedance mismatch. The fixed resistor can be a half-watt unit. Adjust the potentiometer for best reception on that channel giving the most trouble. The unit can be mounted near the antenna-input terminals and seldom requires further adjustment after being set.*



## Multiple images (more than two)

Three or more images to the right of main object. Evenly spaced, progressively weaker. Generally observed on weak stations. If ghosts are caused by reflection in an overlong lead-in, a change will be noted by holding the line in the hand.

Rotate fine-tuning control. Change in images indicates trouble in set. To check, disconnect transmission line. If black streaks are observed on screen when tuned to blank channel, regeneration is present. Check bypass capacitors in pix if amplifiers (screen, plate and grid circuits). Check tubes in video circuits. If ghosts are observed on all channels, check video amplifier plate-load resistor and peaking coils. See ringing as very frequent cause.

Check for proper bias and agc voltages in video if amplifiers. Check if alignment for proper frequency-response characteristics, noting particularly any pronounced peaks. Check decoupling networks in if amplifiers.

## Trailing (Not changed by tuning)

Observed on right side of pix. Orient antenna. Try attenuation pad between transmission line and input terminals. Check transmission line for mismatch. Disconnect one side of line from set. Rotate fine-tuning control. No change in images indicates mismatch. Check transmission line for defect. Install new antenna. Connect a tuning stub 18" long with trimmer 1.5 to 15  $\mu\mu\text{f}$  across end connected to antenna terminals of set. Adjust trimmer.

## **Tunable**

Rotate fine-tuning control. Varies spacing between ghosts, also shading. Contrast may be reversed. Check tubes in video if section and tuner or bypass capacitors by substitution.

## **Ghosts, intermittent (see also Ringing)**

**SYMPTOMS:** Picture seems to have a ghost after set warm-up. Picture also becomes slightly blurred. Condition exists on all channels and is affected by fine tuning. All tubes check good.

**SERVICE:** True ghost reception can only be caused by receiving a reflected signal as well as a direct signal from the station simultaneously. What often appears as a ghost, however, is the condition known as *echo* effect in which picture displacement varies from a small separation to as much as an inch or two, depending on arrival time and screen size. An intermittent ghost can be caused by a defective component which changes the resonant condition of the tuner resulting in a blurred picture and echo effect (due to phase shift).

An intermittent shunting resistor across the grid coil of the rf amplifier can bring this about. Inasmuch as there also are resistors across the primary and secondary of the transformer between the rf amplifier and the mixer, these could give trouble. Check these as well as tubes and other parts in the tuner. A change of value with a reduction of bandwidth would destroy fine detail. A change in intensity or the high-frequency sideband components would also cause an echo effect (ringing) due to excess amplification of high video frequencies.

## Halolight

**SYMPTOMS:** Several troubles develop in the gas tube surrounding the outside of the CRT, a feature of Sylvania TV sets, such as blinking, flickering, failure of tube to light, tube burns too brightly.

**SERVICE:** In 17" and 20" sets 2,000-volt transformers are utilized; 21" sets have 1,200-volt transformers; and 24" sets use 1,800-volt transformers.

## Blinking

When tube lights intermittently always check power unit. Trouble usually is defective current-limiting resistors or switch. If condition continues trouble may be plastic sleeve at each end of tube. All minute cracks and punctures should be covered with several layers of cambric tape. If no relief, disconnect tube from power unit, holding it to light. Tap ends of tube and look for small blob of mercury. If none is observed, tube should be replaced.

## Flickering

Condition may often be overcome by coating tube with special silicon obtainable from Sylvania. When condition continues, particularly in dry weather, tube probably has aged. Remove one current-limiting resistor in power unit and replace with resistor having a value 20% less. Flickering may be observed when set

is first turned on but ceases after operating tube at maximum brightness for about 15 minutes.

### **Tube does not light**

Measure voltage to supply leads from special socket in power unit, consisting of transformer, brightness control, and current-limiting resistors. If voltage is adequate connect set to Variac or other source of 128 volts ac. Tube is defective if it fails to light. (This test should be made as quickly as possible.)

In hot and humid weather tube frequently does not light in sets prior to 1954. To remedy, remove tube from light shield and brush on a thin coating of silicon.

### **Tube burns too brightly**

Light level may be decreased by replacing one of current-limiting resistors by another resistor of higher value, not more than 20%.

### **Replacement of tube**

When replacing tube be sure mask and light shield fit tightly together, otherwise light may shine on CRT causing a hazy glow at edges of screen. Always wash mask and light shield with soap and water to remove all smudges and dust.

### **Height (excessive)**

**SYMPTOMS:** Pix expands off screen, cutting off heads or legs of persons. A common complaint, usually caused by set owners manipulating controls at rear of set.

**SERVICE:** Check vertical size and linearity controls for misadjustment. Check HV rectifier by substitution. Replace plate resistor and capacitor of vertical-output tube.

### **Height (insufficient)**

**SYMPTOMS:** Size of pix, vertically, does not fill screen. A common complaint, sometimes caused by set owners manipulating controls at rear of set.

Check vertical size and linearity controls for misadjustment. See Fig 1-H. May be caused by weak vertical-oscillator or vertical-output tubes, LV rectifier or low line voltage. In sets having damper output connected to both vertical and horizontal ampli-



fiers, defective damper and/or any tube in horizontal circuit can cause reduction of boosted B+ voltage, affecting height. Check cathode-to-ground voltage of damper tube. In such sets incorrect adjustment of horizontal drive or defective capacitor in B+ boost circuit can cause loss in height. Voltage may be low in vertical-deflection circuits because of defective resistors or capacitors in vertical circuits, such as cathode bypass capacitor, plate resistor and capacitor of vertical-output tube. Insufficient height can be

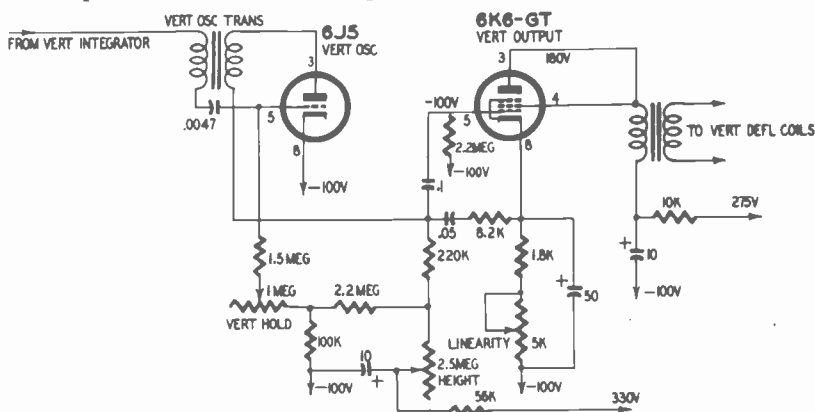


Fig. 1-H. Circuit shows location of vertical hold, size, and linearity controls.

due to a defective coupling capacitor (low capacitance) between the vertical oscillator and output tube; excessive leakage is usually indicated by white horizontal line at bottom of pix.

Also check the plate resistor of the vertical oscillator; capacitors connected to the red lead of vertical-oscillator transformer; capacitors in integrator network; and boost-voltage feed resistor to the vertical circuit.

When condition is accompanied by slight nonlinearity, this may indicate defective plate-load resistor in vertical-oscillator circuit. Extreme decrease in height accompanied by nonlinearity at bottom is due to a defective bypass capacitor in the vertical-output circuit.

Check also decoupling resistor of vertical amplifier, and try replacing resistor in series with height control by resistor of lower value. Another possibility is a defective vertical charge-discharge capacitor (connected to plate of vertical multivibrator) usually accompanied by compression at bottom half of pix. If condition is caused by defective vertical yoke, a trapezoidal raster will also be present.

This may also be caused by defective LV rectifier, vertical blocking-oscillator transformer, vertical-output transformer, and deflection yoke. When deflection yoke has a ferrite core in the form of a collar fastened around yoke windings, a loosening of segments can cause loss of height.

If adjustment of size control does not affect pix—replace.

In vertical-amplifier circuit, 6K6-GT may be replaced by 6V6-GT, 6W6-GT, or 6Y6-G, and a 12AU7 can be replaced by a 12BH7. In one-tube vertical circuits insufficient height may be corrected by replacing 6SN7-GT by 6BL7-GT with no change in wiring.

### **Height (shrinking)**

**SYMPTOMS:** Although width is good, adjustment of vertical-height control does not make pix large enough.

**SERVICE:** This may be caused by low line voltage, or misadjustment of vertical size and linearity controls. Check (by substitution) vertical oscillator and output tubes, and LV rectifier.

In some sets condition may be overcome by replacing (in vertical-oscillator discharge circuit) the charge-discharge capacitor or resistor by component of slightly lower value. Should nonlinearity result, increase value of grid resistor in vertical output by not more than one-third.

Other possibilities are defective deflection yoke and vertical-output transformer. An outmoded type of vertical yoke may be the cause and should be replaced by a more up-to-date type. To check a vertical-output transformer, always measure resistance of primary, secondary and between windings with transformer disconnected. Primary and secondary resistance readings should conform to manufacturer's specifications; resistance between windings should be infinite. Check blocking-oscillator transformer in the same way.

Many sets have a resistor connected in series with the vertical-height potentiometer. If the value of this series resistor increases considerably, the pix will be too small (vertically) and the vertical-height control will not be very effective. When making a replacement, use a 1-watt unit.

Other defective components that could cause shrinking are: coupling capacitor between vertical oscillator and output tubes; cathode and grid resistors of the vertical-output tube; charging capacitor connected to the vertical-blocking oscillator.

Some sets utilize the B+ boost voltage to operate the vertical

oscillator. When shrinkage occurs and tubes are not at fault, check boost circuit components, especially the resistor feeding boost voltage to the vertical circuit from the boost capacitor.

## Herringbone pattern

**SYMPTOMS:** Interference in picture on all channels.

**SERVICE:** This usually is the result of an interfering signal which has managed to get through the if stages. Often it is the result of image interference produced by an FM broadcast station when the set is tuned to one of the low-frequency television channels.

Image interference is usually present on only one channel. If the pattern is visible on all channels, it probably is due, not to image, but rather to a different kind of "beat" interference. Its cause and cure may not be obvious, but such interference can be eliminated.

The sound carrier is always 4.5 mc above the picture carrier. In the receiver, these two carriers beat against a local oscillator and produce sound and picture intermediate frequencies which are still 4.5 mc apart. Both signals may travel through a common if stage and then be separated into their respective if channels. After separation, trap circuits in the picture if stages get rid of any sound signal which may remain, and prevent it from reaching the video detector.

Since all detectors are nonlinear, they mix as well as rectify. Thus energy at the sound if gets through to the video detector, the pix and sound if heterodyne and a constant 4.5-mc beat signal is present at the output. This 4.5-mc signal is usually within the passband of the video amplifier and therefore is applied to the grid of the picture tube, along with the picture signals.

There are two methods of correcting the condition. The first is to align properly the sound traps. If they are aligned and the pattern is still present and strong enough to be annoying, the second method (installing a trap) usually serves. See Fig. 2-H.

Since the interfering signal is at a fixed frequency (4.5 mc) after the video detector, the logical step is to install a 4.5-mc resonant trap somewhere in the video amplifier. The best place is in the plate circuit of the first video-amplifier tube, but in any event it must follow, not precede, the sound take-off point. Use a discarded width-control coil as a form.

Remove all the wire from the width control. Close-wind 40 turns of no. 32 enameled wire in a single layer. Connect a 50- $\mu\mu\text{f}$  ceramic capacitor across the winding. Mount the coil close to the

## HIGH-VOLTAGE CHECK LIST

### SYMPTOMS

### SERVICE

Arc when HV anode lead is brought close to the chassis. (Do not touch anode lead to chassis unnecessarily or repeatedly as HV rectifier resistor may break down.)

No arc or weak arc.

Well-insulated screwdriver touched to plate cap of HV rectifier.

a) Arc at tip of screwdriver, but no raster.

b) Weak or no arc.

Screwdriver check at HV filter capacitor. Weak or no arc.

Well-insulated screwdriver touched to plate cap of horizontal-output tube.

a) Slight arc at tip of screwdriver and click in speaker.

b) No arc or click.

Make ohmmeter check between plate cap of horizontal-output tube and plate cap of HV rectifier.

Make ohmmeter check between plate cap of horizontal-output tube and low end of flyback transformer.

HV rectifier or CRT do not light.

Measure voltage between grid and cathode of horizontal-output tube.

HV circuits good.

Defective CRT or brightness control.

Defective HV rectifier. Remove or reduce capacitance across width coil.

a) Defective CRT.

b) Replace rectifier and damper tubes.

Replace defective HV filter capacitor.

a) Horizontal-output stage good.

b) Defective horizontal-output stage. Check for loss of boost voltage. Check horizontal-oscillator stage.

Reading should be 200 to 600 ohms. Open circuit or unusually high resistance readings indicate defective horizontal-output transformer.

Reading should be 15 to 60 ohms. Open circuit or unusually high resistance readings indicate defective transformer.

Make resistance check of filaments.

Less than -20 volts indicates insufficient drive.

plate lead of the first video amplifier and wire it in series with the plate.

If the set has such a trap in the plate circuit (and it probably will have) installing an additional trap in the cathode circuit may help. Similarly, if the set has such a trap in the cathode circuit, try an added trap in series with the plate.

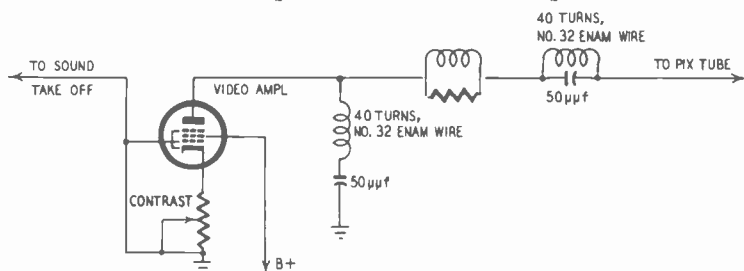


Fig. 2-H. Series trap helps keep 4.5-mc signal out of pix tube.

To adjust the trap, connect a modulated, 4.5-mc AM signal generator to the grid of the first video amplifier. Set the generator output to maximum, producing horizontal black and white bars on the face of the picture tube. Adjust the trap for minimum intensity of the bars. An alternate method is to tune in a signal and adjust the trap for minimum interference.

## High voltage

Satisfactory high voltage is dependent on correct functioning of the horizontal-output tube. Check voltages on grid, cathode, and screen grid. See Fig. 3-H. Refer, also, to the high-voltage check list.

Weak or no high voltage is usually accompanied by low boost voltage. (An exception, affecting only high voltage, is possible, defective capacitor coupling flyback pulse from horizontal yoke to horizontal-output transformer.)

Chief circuits fed from damper tube are horizontal-sweep, vertical-sweep and high-voltage windings of horizontal-output transformer. Defective components in these circuits will affect boost voltage. Check boost voltage. Chief components, when defective, are width coil, horizontal- and vertical-deflection coils, vertical- and horizontal-output transformers.

A hot width coil indicates shorted turns. If not, check for heavy loading in horizontal or vertical circuits. Disconnect load resistor from boost circuit to vertical-output plate circuit. If boost and high voltage become normal, trouble is in vertical yoke or vertical-output transformer.

Disconnect vertical yoke at both ends. If boost and high voltages become normal, trouble is in the vertical yoke. If not, trouble is in horizontal-output transformer. Check that component for overheated condition. Warm and soft wax on secondary winding indicates defective part. Caution—turn power off!

### High voltage (excessive)

**SYMPTOMS:** Picture does not fill screen. Adjustment of width control does not help.

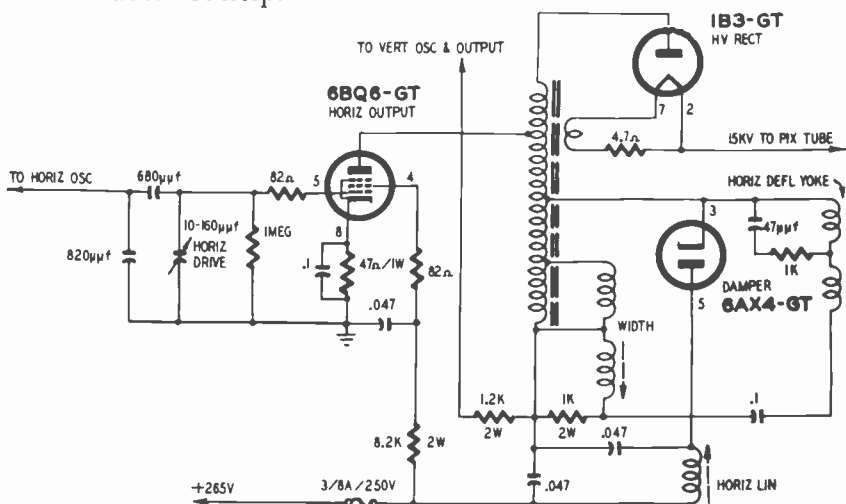


Fig. 3-H. Typical horizontal output and high-voltage circuit.

**SERVICE:** Reduce drive by adjusting horizontal-drive control trimmer. Reduce screen voltage on horizontal-output tube by replacing resistor at screen with one of higher value. Shunt width coil with capacitor of value giving best results. Shunt damper tube with 15K, 10-watt resistor. Reduce B+ voltage to flyback transformer with a series 500-ohm, 10-watt resistor. This condition may also result from a reduced value of cathode resistor in the horizontal-output cathode circuit or a leaky cathode bypass across that resistor. A leaky coupling capacitor to the horizontal-output tube increases the voltage on its grid (less bias) with resultant large output and excessive high voltage.

### High voltage, intermittent

**SYMPTOMS:** Picture blacks out completely for intervals of 5 minutes to an hour, and then comes back.

**SERVICE:** Any intermittent in the entire horizontal-sweep section can cause this trouble. This includes the oscillator and the horizontal afc circuits too. If the screen blacks out completely, there may be an intermittent or partial short in the horizontal-output transformer circuits. Check all wires to the deflection yoke and horizontal-output transformer. Replace the deflection coil, which is the most likely cause of the trouble. The damper tube may also have been affected by failure of the deflection coil. Try replacing it as well. If none of these changes are effective, replace the width coil. Also look for the obvious—a loose connection in horizontal circuits.

### **High voltage, loss of**

**SYMPTOMS:** No raster, sound is good.

**SERVICE:** Complete loss of high voltage usually is caused by a defective high-voltage rectifier or horizontal-output tube. See also preceding comment on intermittent high voltage.

A partial loss of high voltage comes from a defective horizontal oscillator, lowered B+ voltage or defective resistor between high-voltage rectifier and the CRT. A drop or lack of B+ voltage and lack of deflection current in the yoke may cause failure of high voltage. (A lack of high voltage does not always affect B+ boost or deflection current appreciably.)

In cases where the high-voltage rectifier requires frequent replacement, try substituting another resistor of higher value for the filament resistor. In sets where the CRT is mounted to the cabinet and deflection yoke and focus coil leads are connected from chassis by coupling plug, arcing may occur in that component, causing loss of high voltage.

Due to design, some 1B3-GT tubes may have pins 1, 3, 5, 7 and 8 connected internally. If used in a set having voltage doubler where pins 2 and 3 of socket are tied together, or pins 3, 5 and 8 may be used as tie lugs to mount filament dropping or isolating resistors, no high voltage will result. Check tube socket connections on schematic. It may be necessary to clip off pins 3, 5 and/or 8 before using tube in a particular set.

To check high voltage operation, remove 0.25 ampere fuse usually found in this circuit and substitute a Mazda 47 lamp. Adjust horizontal-linearity control to minimum brilliance position of lamp. If lamp still burns brightly set is not operating properly, indicating possible excessive overdrive of horizontal-output tube, partial short of a high-voltage component including horizontal-

output transformer, and/or leaky components in circuit. (In sets using parallel horizontal-output tubes, check should be made with a Mazda 44 lamp.)

### **Hiss**

**SYMPTOMS:** Frying sound noted in vicinity of high-voltage cage.

**SERVICE:** Frequently caused by arcing inside the high-voltage capacitor. To check, disconnect high-voltage leads from capacitor. If hiss stops, capacitor is defective. See also arcing and corona.

### **Horizontal band, black, across screen**

**SYMPTOMS:** Black band, 1" wide, appears horizontally on screen.

**SERVICE:** May be caused by defective selenium rectifier.

### **Horizontal band on screen**

**SYMPTOMS:** Wide horizontal band (about 2 or 3 inches). Band is light in appearance and moves slowly across face of the screen.

**SERVICE:** May be caused by the rf amplifier tube in the tuner going into oscillation. Replace tube. Especially noticeable in sets using a 6BQ7.

### **Horizontal bands, dark, two**

**SYMPTOMS:** Two dark horizontal bands across screen when set is tuned to channels 2, 4 and 5.

**SERVICE:** Probably caused by 117-volt light bulb in same room, apartment, or adjoining house. Neon signs also cause this trouble. Try re-orienting antenna. Use shielded lead-in. Make sure all light bulbs are tight in sockets.

### **Horizontal bars, black, two**

**SYMPTOMS:** Two wide black bars with tapering gray edges appear on screen; intensity varies from channel to channel.

**SERVICE:** Check for defective tube in tuner, video if strip, and low-voltage rectifier. When accompanied by hum, the trouble is probably due to defective low-voltage power-supply filter capacitors.

### **Horizontal bright bar—top or bottom of screen**

**SYMPTOMS:** Bright bar with scanning lines crowded.



**SERVICE:** Usually caused by defective vertical-output tube, especially 6S4, or grid-coupling capacitor of tube. Low line voltage, defective LV rectifier (including selenium rectifiers) could cause trouble as well as other B+ defects.

### **Horizontal bars—top of screen**

**SYMPTOMS:** Similar to sound bar, but usually followed by lower bars of diminishing intensity. Pix has wrinkled appearance.

**SERVICE:** Usually caused by defective shunt resistors across vertical-deflection yoke.

### **Horizontal bars (white and dark, ¼-inch wide)**

**SYMPTOMS:** Usually caused by defective vertical-output tube.

**SERVICE:** Check vertical output tube by substitution.

### **Horizontal circuits—common troubles**

When afc, horizontal multivibrator or horizontal-output stage is suspect, short input grid of horizontal multivibrator to ground. Readjust horizontal-hold control. If condition disappears, trouble is probably prior to input grid of horizontal oscillator. If condition continues, trouble is probably after the grid.

To check if horizontal oscillator is working, measure voltage at grid of tube. Voltage varies, depending upon circuit used, but should not be less than -30 volts.

### **Horizontal foldover (see Foldover)**

### **Horizontal frequency (drift)**

**SYMPTOMS:** Pix begins drifting after warm-up of set; horizontal hold does not function properly, causing poor sync.

**SERVICE:** Generally caused by excessive heating of components in horizontal-oscillator circuit, especially in Synchroguide and multivibrator systems. In many sets, oscillator is in close proximity to the horizontal-output tube and HV section; intense heat generated affects components, particularly the resistors, changing their value. Check these components: horizontal-hold and lock; horizontal oscillator; reactance, and sync discriminator tubes; grid leak capacitor of horizontal oscillator; grid resistor between horizontal oscillator and horizontal hold; screen resistors of reactance tube; screen bypass capacitor of reactance tube; plate capacitor of horizontal oscillator control tube; grid-coupling capacitor. This trouble is sometimes caused by poor ventilation of the cabinet.

# SYNCHROLOCK HORIZONTAL AFC CIRCUIT CHECK LIST

## SYMPTOMS

## SERVICE

Critical hold

Resistor (R10) in series with horizontal-hold control. See Fig. 4-H.

No lock-in

Coupling capacitor (C3) plate of horizontal-oscillator control tube.

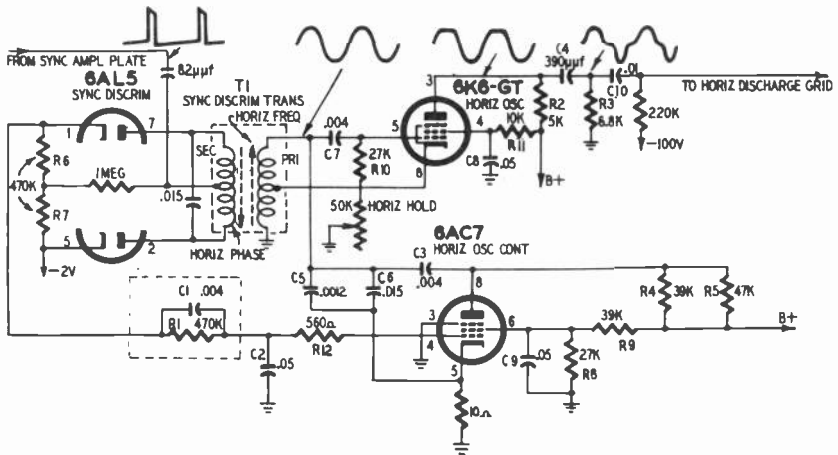


Fig. 4-H. Synchrolock horizontal-oscillator afe circuit.

Poor frequency range

Capacitors at cathode of horizontal-oscillator control tube (C5 and C6) and capacitor (C7) at primary of sync discriminator transformer.

Poor lock-in

Cathode resistors (horizontal-sync discriminator) R6 and R7.

Poor sync

Bypass capacitor (C2) at the grid of horizontal-oscillator control tube.

Screen resistors (R8 and R9) of horizontal-oscillator control.

Plate resistors (R4 and R5) horizontal-oscillator control.

Screen dropping resistor (R11) horizontal oscillator.

Screen bypass capacitor (C8) horizontal oscillator.

Screen bypass capacitor (C9) horizontal-oscillator control tube.

## SYMPTOMS

## SERVICE

Poor sync

Coupling capacitor (C4) at plate of horizontal oscillator.

Differentiating network (R3 and C10) in plate circuit of horizontal oscillator.

Resistors (R1 and R12) between grid of horizontal-oscillator control tube and cathode of horizontal-sync discriminator.

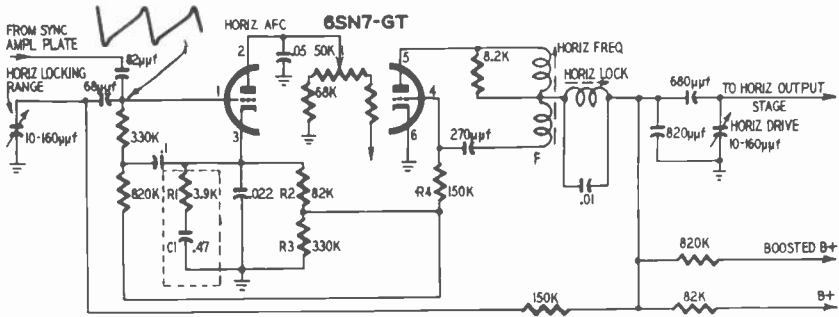


Fig. 5-H. *Synchroguide horizontal-oscillator afc circuit.*

Poor sync

Capacitor (C1) between grid of horizontal-oscillator control tube and cathode of horizontal-sync discriminator.

## SYNCHROGUIDE HORIZONTAL AFC CIRCUIT CHECK LIST

### SYMPTOMS

### SERVICE

Pix jitters, poor sync, pie-crust effect

Cathode capacitor, pin 3.

See Fig. 5-H.

Pix jitters, poor sync, pie-crust effect

Resistors in the cathode circuit, pin 3.

Poor sync

Grid capacitors, pin 1.

Resistors at either end of the horizontal-hold control.

Horizontal-hold control.

Synchroguide coil.

Poor sync, frequency drift

Plate capacitor, pin 2.

Poor sync, frequency drift,

Capacitor between pin 4 and terminal F of oscillator coil.

HV weak

# HORIZONTAL PHASE DETECTOR AND MULTIVIBRATOR CHECK LIST

## SYMPTOMS

## SERVICE

Compression at right, poor width, raster off center, decreased brightness, multiple pix, poor sync  
Same as preceding, vertical bar center of pix

Plate-load resistor at pin 5 of horizontal multivibrator. See Fig. 6-H.

Peaking resistor, plate (pin 5) of horizontal multivibrator.

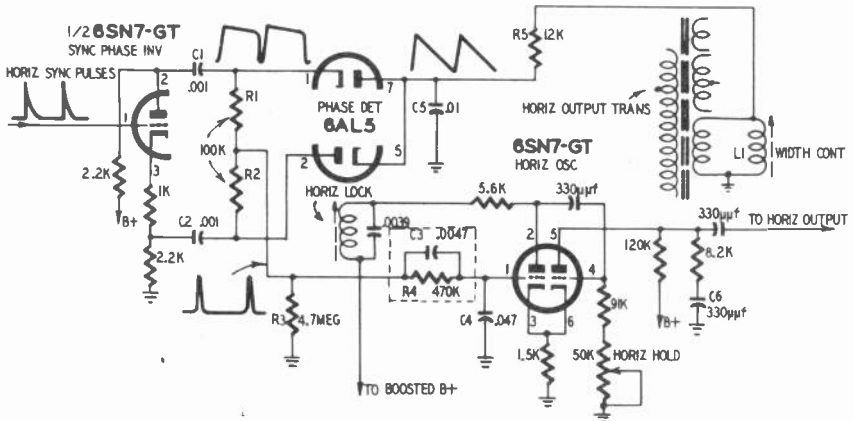


Fig. 6-H. Horizontal phase detector and multivibrator.

Decreased brightness, poor width, nonlinearity, poor sync, no high voltage

Sweep capacitor (C6) at plate (pin 5) of horizontal multivibrator in series with peaking resistor to ground.

Double pix

Resistor between grid pin 4 of horizontal multivibrator and horizontal hold.

Resistor in plate (pin 5) circuit of horizontal multivibrator.

Resistor in plate (pin 2) circuit of horizontal multivibrator to B+ boost.

Double pix, no horizontal hold

Parallel capacitor horizontal frequency coil.

Double pix, poor sync, poor lock-in

Resistor between plate (pin 2) of horizontal multivibrator and horizontal frequency coil.

# HORIZONTAL PHASE DETECTOR AND MULTIVIBRATOR CHECK LIST

(continued)

SYMPTOMS	SERVICE
Foldover	Peaking resistor to plate (pin 5) of horizontal multivibrator.
Foldover	Resistor in plate circuit of horizontal multivibrator.
Horizontal squeal, double pix	Capacitor (C5) between plate and cathode of phase detector and ground.
Low high voltage	Plate-load resistors of horizontal multivibrator.
No high voltage, critical hold, dim raster, critical brightness control, poor width	Cathode resistor, pins 3 and 6, horizontal multivibrator.
No high voltage, double pix, no horizontal sweep, poor sync, critical horizontal hold, raster dim, brightness control ineffective, width insufficient.	Resistor between cathodes of horizontal multivibrator and ground. (Note: Widely varying symptoms such as no pix or double pix can often be traced to the same cause.)
No horizontal hold, double pix	Horizontal frequency (locking) coil.
Pie-crust effect	Capacitor between grid pin 1 of horizontal multivibrator and ground.
Poor brightness, poor sync, multiple pix	Capacitor between pins 2 and 4 of horizontal multivibrator.
Poor sync	Feedback resistor (R5) between plate and cathode of phase detector (pins 5 and 7) and horizontal-output transformer. Plate-load resistor, pin 2, horizontal multivibrator. Resistors (R1 and R2) between plate and cathode of phase detector and ground.
Weak high voltage	Plate-load resistor, pin 5, horizontal multivibrator.

## Horizontal hold (critical)

**SYMPTOMS:** Slight adjustment of horizontal-hold control causes pix to tear. (See also horizontal sync, unstable.)

**SERVICE:** First be sure that the various horizontal controls are correctly adjusted, including agc control, and selector switch (Motorola); DX range finder (Admiral); electronic stabilizer (Arvin); fringe-compensator control (Emerson); fringe-lock control (Zenith); local-distance switch (Crosley-Olympic); noise-gate control (Bendix-Crosley); phasing control (Capehart-Emerson-Sylvania); horizontal-range control (Hallicrafters); picture stabilizer (Emerson-GE); and triple switch (Arvin).

Check by substitution horizontal-oscillator, horizontal-phase detector, afc, agc, sync clipper, and audio-output tubes.

As the proper operation of all horizontal-oscillator circuits depends on other networks, including sync, the oscillator may not always be at fault when trouble develops. Depending on circuits used, a defective 3rd if tube or video-detector crystal could cause poor locking. Another cause could be grid current drawn by one or more tubes in the agc circuit. In sets having an area-selector switch, an if agc overload can be checked by changing the switch from local to suburban position. If overload is eliminated or reduced, it is likely that a defective tube is in the tuner.

Other causes might be excessive screen current drawn by 3rd if tube, insufficient clipping in sync clippers or unbalanced output from the phase detector.

Another source of this trouble could be undesirable video or horizontal sync pulse coupling resulting from improper lead dressing. Check leads from the horizontal-hold control to multivibrator tube, redress leads from contrast or brightness controls away from the horizontal-hold control. Try connecting a .005  $\mu\text{f}$  to .01  $\mu\text{f}$  ceramic disc capacitor from arm of the brightness control to chassis ground (if not already employed) when brightness control is in cathode circuit of pix tube.

If no locking action is obtained when adjusting the horizontal-hold control, then the horizontal sync pulses are not reaching the horizontal oscillator or the afc circuit. The afc circuit may be out of order, or there may be no feedback from the flyback transformer, width coil, etc. Start at the control grid of the horizontal oscillator and work back through the differentiating network. Trouble is usually due to some defect in the horizontal circuit. If set uses phase detector type afc, substitute a new capacitor between the

horizontal-output transformer and phase detector. Check the resistor in series with this capacitor.

If pix locks at center of control but falls out at sides, check horizontal phase-discriminator tube and components in the circuit, especially resistors between the cathode of the diode and the plate of sync inverter tube.

Critical hold may also be caused by a defective phase-detector coupling capacitor between the horizontal phase-detector tube and horizontal-output transformer; or by internally generated spurious horizontal pulses caused by defective high-voltage rectifier tube, cap and/or socket; damper tube; horizontal-output transformer; or plate connection of horizontal-output tube. When damper tube is suspected try connecting 10  $\mu$ h chokes in plate and cathode leads of tube.

### **Horizontal line**

**SYMPTOMS:** Thin white line across width of screen—in center.

**SERVICE:** Indicates lack of vertical sweep. In most instances, replacement of vertical oscillator and output tubes will overcome trouble.

Rotate vertical-size control rapidly. If line fluctuates, plate circuit of vertical-sweep oscillator is satisfactory. Check grid circuit for defective component. If white line wiggles, check vertical winding of deflection yoke for broken wire.

Other defective components that could cause failure of the vertical-sweep circuit include the vertical-size control, the grid capacitor of the vertical-output tube, the vertical blocking oscillator transformer (when such a transformer is used), the capacitor connected between the red lead of the vertical-blocking oscillator and ground, and the vertical-output transformer. Sometimes lack of vertical sweep is caused by B+ failure due to an open B+ resistor.

### **Horizontal line, wavy, center of screen**

**SYMPTOMS:** No vertical deflection due to broken wire in vertical-deflection coil.

**SERVICE:** Check resistance of vertical-deflection coil. Replace if defective.

### **Horizontal line, white, in pix**

**SYMPTOMS:** Spurious pip on sawtooth wave amplified by vertical-output tube, causing one or more scanning lines to overlap, leaving a white line with no pix content.

**SERVICE:** Replace vertical-amplifier tube. Sometimes feedback of the vertical output to the vertical oscillator will cause this too. The effect is a parasitic shock and is caused by improper lead dress.

### **Horizontal nonlinearity (see also Foldover, horizontal)**

**SYMPTOMS:** In pix, if moving objects grow fat or thin while passing through parts of screen, nonlinearity is indicated.

Poor linearity can take the form of an uneven sweep (Fig. 7-H)



*Fig. 7-H. Photo shows example of horizontal nonlinearity.*

or foldover. The linearity coil itself is usually effective only in the case of slight nonlinearity. In such a case, the slug should be varied. If turns are shorted (this lowers the inductance) all adjustments will either be ineffective or critical and unstable.

**Adjustment procedure:** 1) horizontal-drive control; 2) horizontal-width control (filling screen horizontally); 3) horizontal-linearity control (for best distribution); 4) readjust drive, width and linearity controls if necessary.

**SERVICE:** To check linearity in the absence of a test pattern, adjust brightness and contrast controls until vertical-retrace lines are visible on screen. Reduce width until edges of pix are seen; expand width so edges are just out of sight. If retrace lines are perfectly straight from one side to other, pix is linear. If lines bend up or down, pix is cramped. Adjust width and linearity controls for best linear pix.

Some sets use pincushion magnets rather than a linearity control to obtain good horizontal linearity. In sets using both pin-cushion magnets and linearity control, the magnets should first be removed, or positioned as far from the CRT as possible. Horizontal linearity and width controls may then be adjusted, followed by proper posi-



tioning of magnets. (Stray magnetic fields can cause nonlinearity in glass type tubes, such as from a speaker field magnet. The cones of metal tubes can also become magnetized.)

A very common cause of nonlinearity is a defective boost capacitor or damper tube. These usually cause serious foldover of the picture at the left and white vertical bars, also on the left side of the screen. In severe cases, less pronounced bars can be seen across the entire face of the screen.

Many linearity problems arise as a result of overdriving the horizontal-output tube. Check it! Adjust the drive control to eliminate the white vertical drive bar from the picture. Overdriving will shorten the life of the horizontal-output tube.

In general, when the picture is stretched over the right side of the screen, invariably the trouble will be before the linearity coil. Check all voltages and components in the horizontal output circuit. An open screen bypass capacitor is a frequent troublemaker, as are the cathode resistor and capacitor. Also, check all components in the horizontal discharge and drive circuits.

However, when picture stretch is on the left side, the trouble will usually be at or after the linearity coil. Check for a defective linearity coil, damper tube, deflection yoke, and components in these circuits. See Fig. 3-H. Also check ion trap or focus magnet for metal particles.

### **Horizontal output transformer (flyback type)**

This component has several jobs, namely; to match impedance of horizontal-deflection coil to that of the horizontal-output tube; as a stepup transformer to provide adequate high voltage for the pix tube; and to supply voltage pulses for keyed agc circuits and afc circuits; and width control.

A short in the windings of the horizontal-output transformer will cause the pix to be squeezed or compressed on left side.

To check for shorts between windings (disconnect B+ boost leads) in conventional horizontal-output transformer circuit, measure resistance between plate and cathode of damper tube. A low resistance indicates improper connection internally in transformer or linearity capacitor is defective.

A shorted *primary* coil in transformer will cause insufficient width, plate of horizontal-output tube glows very red, low high voltage and raster with jagged edges, a white vertical bar 1/4-inch wide on left side of screen (similar to overdrive line) with compression of pix. Shorted condition usually causes wax to melt.

Shorted *secondary* coil causes low high voltage, blooming and poor focus condition, and often overheating.

When HV fuse blows, examine transformer for HV arcing. If burned or charred spots are observed on any of the windings, replace unit. When flyback transformer arcs or smokes, check horizontal-output tube, damper tube, and other components in horizontal-output circuit before applying power to new transformer. Replacement preferable by transformer conforming identically with original in set.

### **Horizontal-output transformer—whistle**

**SYMPTOMS:** Horizontal-output transformer produces very high-pitched sharp whistle. Whistle cannot be reduced by volume control.

**SERVICE:** A steady or intermittent squeal is caused by mechanical vibration in horizontal-output transformer. This is similar to hum produced by a loose lamination in a power transformer or audio signals (even with speaker disconnected) caused by lamination vibration in the audio transformer. As frequency of horizontal-output transformer whistle is high (15,750 cps) it cannot be heard by everyone.

Carefully tighten all bolts, clamps and screws on transformer. Tighten all mounting screws. Reverse procedure (loosening bolts) sometimes helps. Try spraying transformer with high voltage dope, acrylic resin, or paint with Glyptal. Coat all loose turns and leads.

Move leads going to horizontal-output transformer while listening carefully to squeal. If moving a particular lead reduces squeal, fasten lead by means of cement in the position producing minimum whistle. If set has horizontal-drive control, reduce amount of drive. If condition cannot be cured, replace the horizontal-output transformer.

### **Horizontal-output tube, excessive current flow**

**SYMPTOMS:** Horizontal-output tube overheats. Poor horizontal linearity.

**SERVICE:** The drive to the grid of the horizontal-output tube can have considerable effect on performance. Insufficient drive will decrease high voltage as well as width. It will also increase the dc idling current through the tube by reducing the bias. Overdrive will cause excessive signal currents through the tube. Either condition may overheat the tube and associated parts. Overdrive

may stretch the left side of the picture and compress the center. The correct setting for the drive control is just below the point where left-hand stretch starts. A slightly gassy horizontal-output tube will also cause overheating. See sections on foldover and also horizontal nonlinearity.

### **Horizontal-output tube, repeated failure**

**SYMPTOMS:** Horizontal-output tube must be replaced fairly often. Tubes do not burn out, but emission decreases considerably, resulting in loss of high voltage and width.

**SERVICE:**Constant failure of the horizontal-output tube is caused by an excessive amount of current flow. Check for proper screen voltage as well as correct bias between the cathode and grid of the output tube. Do not, however, attempt to measure the B-voltage at the plate cap of the horizontal-output tube because high pulse potentials are present here. Incorrect bias can be caused by improper or defective components in the cathode circuit or improper B-potentials, or underdriving. See also preceding section.

If the horizontal-output tube has insufficient (or occasionally, excessive) grid drive it would also cause abnormal currents to flow which would result in repeated tube failure. Check the peak-to-peak voltages of the grid signal with a calibrated oscilloscope or peak-to-peak voltmeter to ascertain that they conform to those given in the service notes for the receiver. Excessive drive will, of course, manifest itself by the presence of "overdrive lines" on the screen.

### **Horizontal-phase detector (plate or cathode input—grid output)**

This circuit, in which an input signal is applied to the plate or cathode, and the output taken from the grid, has been used by a number of set manufacturers.

If the grid voltage of the oscillator is incorrect, a defective phase detector tube may be cause.

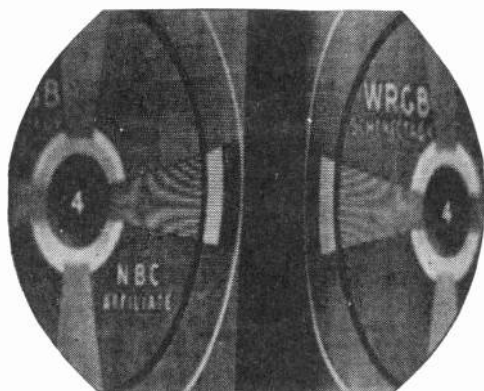
Rotate the horizontal-hold control so that an upright pix is obtained without extreme limits of range necessary. If not possible, check oscillator circuit, namely; tube, coupling capacitors, bypass capacitors.

If pix syncs momentarily, then drifts, oscillator circuit is probably good. Rotate the horizontal-hold control and measure dc voltage between input grid and ground. If no variation in voltage, replace phase-detector tube. If still no variation, measure voltage

at each point on line to phase-detector grids. Voltage variation at any point, but none at oscillator grid, indicates possible defect in filter components. No voltage variation through phase-detector grid, indicates trouble in that circuit, or sync circuit.

### Horizontal phasing

**SYMPTOMS:** Out-of-phase condition usually evidenced by a split pix, blanking bar in center, right half on left and left half on right.



*Photo courtesy G-E Techni-talk*

**Fig. 8-H.** Blanking bar is indication of incorrect horizontal phasing.

Blanking bar may appear at any position on screen. See Fig. 8-H.

**SERVICE:** Frequency is correct when one pix is observed, with or without blanking bar; pix syncs when channel is changed and is stable. If pix has no bend, trouble is usually in afc circuit. Occasionally happens in sync or horizontal-sweep circuits. May be caused by reversed agc winding of horizontal-output transformer; insufficient agc voltage or reversed polarity.

In Synchrolock circuit readjust phasing control. In sets having no phasing adjustments, check point where horizontal-sweep voltage is fed back to afc circuit for comparison with incoming sync pulses. See previous section on horizontal circuits.

### Horizontal pull with white smear

**SYMPTOMS:** Condition appears on left side of pix and usually is found in Synchrolock type sets.

**SERVICE:** Usually caused by defective Synchrolock transformer.

### Horizontal ripple

**SYMPTOMS:** Ripple, moving up or down in the picture.

**SERVICE:** Usually due to a power source frequency difference between the transmitter and the TV set. It is caused by some of the 60-cycle power source voltage feeding into the horizontal oscillator. This ac voltage can come from the B+ supply, through the horizontal-sync discriminator, and thus be applied to the control grid of the oscillator, or from flux leakage around the power transformer. In some sets the most common cause of horizontal ripple is flux leakage around the power transformer to the horizontal-lock coil. Tighten mounting screws on covers. Put grounded shield can over transformer. Punch holes in shield for ventilation.

### **Horizontal squegging**

**SYMPTOMS:** Variegated pattern of fine lines with uneven edges. When observed, turn off set to prevent damage to horizontal-output tube, and/or, horizontal-output transformer. Condition may be intermittent, occurring when tuning from channel to channel. Flashes and high pitched noise may be noticed.

**SERVICE:** Generally due to Barkhausen oscillations. (Refer to that section for procedure). Check, by substitution, horizontal oscillator and horizontal-output tubes. Be sure horizontal drive, width, and linearity controls are properly adjusted. Trouble may also be caused by unbalanced afc network. Check resistors and capacitors connected to plates of afc discriminator.

### **Horizontal sync, loss of**

**SYMPTOMS:** Picture runs horizontally. Horizontal-hold control ineffective.

**SERVICE:** Loss of horizontal sync can be caused by an open primary in the agc pulse coil. This coil is connected across a section of the secondary of the flyback transformer. Disconnect one side of this coil from the flyback transformer before checking continuity.

Fig. 4-D in earlier section shows a simple R-C network with the output taken across R. The input consists of pulses or square waves. The leading edge of a square wave has the effect of a high-frequency voltage. As a result, the reactance of C is extremely low during this time, and for all practical purposes, a short circuit. Thus, the leading edge of the input waveform produces a large and immediate voltage drop across R and appears in the output waveform as a sharp pulse.

If C opens, no voltage appears across R and all horizontal sync is lost. If either R or C decreases in value, shortening the time constant, the pips lose amplitude, causing the horizontal-hold control to become unstable and very critical.

Should R open, the output will be fed into a floating grid and horizontal sync will be lost. However, if there is some other high resistance in the circuit, or should R greatly increase in value, the time constant and the width of the pips will increase. This will reduce the noise immunity of the circuit, permitting noise pulses to produce broader pips.

The output of a differentiator circuit depends upon the rate of change of the input waveform rather than upon its duration. This we see in Fig. 4-D, where the output waveform is independent of the pulse width, containing sharp pulses only at the leading and trailing edges of the pulse.

If horizontal sync is lost when channel is changed, but is stable when set is turned on, this indicates a trouble common in sets using a horizontal-output circuit where a voltage is fed back to grid of horizontal-output tube from the secondary of the horizontal-output transformer. Instability is usually caused by excessive feedback, resulting in oscillation in output stage. To check, remove horizontal-oscillator tube. If sweep and high voltage are unaffected, oscillation is indicated. Replace feedback capacitor by 1,500-volt mica capacitor.

### Horizontal sync, unstable

**SYMPTOMS:** Pix tears.

**SERVICE:** To check horizontal instability, rotate both horizontal- and vertical-hold controls. If hold-in range on both is low and pix is too light and/or dark, the trouble is probably in the video-amplifier strip or in the incoming signal. If hold-in range of both controls is abnormal but pix is good, trouble is probably in sync section. If vertical hold is good and pix is normal, but horizontal hold is abnormal, trouble is probably in horizontal afc or sweep circuits.

To check horizontal-oscillator circuit, remove sync separator or amplifier tube or disable by placing capacitor from grid to chassis. Adjust horizontal and vertical holds so pix will stand still. Examine sides of pix which should be straight though possibly sloping diagonally across CRT. If not straight, trouble is in oscillator circuit. If coupling capacitor between sync and oscillator is leaking sides will be bent.

In many instances, misadjustment of controls causes poor sync; therefore be sure all controls designated by manufacturer as affecting sync, are checked.

This condition can also be caused by faulty tubes in several

sections. Check by substitution afc, agc, and dc restorer tubes. Also tubes in tuner, video if, video detector, video amplifier, horizontal oscillator and reactance circuits, and all tubes in sync circuit.

To overcome instability, particularly after set operates for a period of time, try replacing capacitor connected between tap on horizontal-output transformer and plate of keyer agc tube.

### Horizontal wiggle

**SYMPTOMS:** Pix has S shape appearance.

**SERVICE:** Ascertain if raster also wiggles, by removing 1st video amplifier tube. If sides are straight, pix is affected by sync circuits. Check afc detector tube by substitution. Also horizontal oscillator and control tube, and reactance tube. Be sure that Synchrolock is properly adjusted. Condition usually caused by defective capacitor between plates of afc tube, or cathode capacitors of afc tube. See also various hum in pix classifications.

### Hum, audio

**SYMPTOMS:** Hum in sound.

**SERVICE:** If hum is present on all channels, including blank ones, (no visible symptoms) determine if intensity of hum can be varied by volume control. If intensity does not vary, hum is in circuits after the control. Try new tube in sound-detector circuit. Try new tubes in each stage of audio amplifier. If hum remains, try new audio-output tube. If hum continues, trouble is in audio-output transformer or speaker circuit.

If hum stops with removal of audio-output tube, replace and remove first audio tube. If hum remains, trouble is probably due to faulty capacitors. If hum stops with removal of first audio tube, trouble probably is in audio input circuit.

Ground grid of audio amplifier to chassis. If hum is gone, trouble is probably due to coupling capacitor and grid-leak resistor. If grounding grid does not remove hum, trouble is probably caused by electrolytics in B+ filtering.

Check lead dress in the audio-input circuits with particular attention to the ac leads such as to the *on-off* switch. These leads should be kept well away from the audio-amplifier grid circuit. In sets with tone control, dress the lead between the control and the audio amplifier plate away from ac leads. Check filter capacitors. If none of these are the source of hum, the speaker is probably at fault. This can be checked by substituting a PM speaker.

In audio-output amplifier, hum can be reduced greatly by in-

serting an 8  $\mu\text{f}$  electrolytic capacitor and 50K resistor at B+ terminal of output transformer.

Sometimes audible hum is caused by mechanical vibration of the power-transformer core. This vibration is amplified by the chassis and cabinet; sometimes by the room itself. Shock-mount the transformer on sponge-rubber or rubber grommets, and attach ground strap to transformer.

If no apparent circuit defects are found (i.e., open filter capacitors, cathode-heater short in one of the audio or sound if amplifier tubes), try: 1) reversing the coupling capacitor from the volume control to the 1st audio grid, 2) dressing the ac leads to the power switch away from the 1st audio grid, and 3) checking the cold-side connection of the volume control. If this goes to the grounded heater terminal on the 1st audio amplifier tube socket, remove and reconnect to the grounded cathode terminal on the same socket.

### **Hum bar, horizontal floating**

**SYMPTOMS:** Dark horizontal bar, generally moving upward, similar in appearance to normal hum bar, but grayish and not so wide. Sometimes accompanied by horizontal weaving. (See also following section on hum, modulation.) The rf and oscillator tubes in cascade tuners are the worst offenders and may cause this trouble on blank channel also.

**SERVICE:** Usually appears in sets made prior to advent of color TV. Caused by operation of color TV transmitter injecting 3.58-mc color burst frequency into signals plus out of step relationship between sweep of color transmitter and power-supply frequency.

To eliminate, try adding capacitance across input and output filters of low-voltage power supply, or connect 2 to 10  $\mu\text{f}$  electrolytic capacitor across filter choke (plus of capacitor connected to input of choke). If bar does not disappear try connecting a half-henry choke in series with filter inductance.

Check lead dress in vertical stages, keeping leads to vertical hold and linearity controls away from ac wiring.

If bar darkens or fades sporadically, the trouble is probably due to a defective capacitor in the low-voltage power supply. If tuner tubes are good, check vertical-output tubes, then sync, other vertical tubes, if tubes and video amplifiers.

If condition appears as a faint, narrow horizontal hum bar, floating from bottom to top of pix, distorting vertical linearity and pulling and stretching pix, trouble usually is vertical-output tube.



If pix has slight horizontal weaving, check lead dress in horizontal-sweep stages. In sets having vertical chassis, filter choke may be positioned too close to CRT. This causes horizontal weaving, especially when CRT has deflection angle of 72 degrees or less. Same condition may be caused by low-voltage power transformer which affects even 90-degree angle CRT. May be necessary to shield transformer. Be sure to ground the shield. (Note: Power transformers get hot. Shield must permit ventilation.) Check selenium rectifiers.

If hum is heard on one or several channels only, temporarily connect a .01  $\mu$ f ceramic or mica capacitor across antenna terminals. If hum is reduced, check agc tube and components in circuit.

### **Hum, modulation**

**SYMPTOMS:** All channels have a bad ac hum at all volume control settings. Hum bar on pix when tuned to a channel, but no such symptoms when on a blank channel.

**SERVICE:** Modulation hum caused by heater-to-cathode leakage can be checked simply by opening the cathode return of the suspected stage. If the tube is good, the cathode potential will approach the supply voltage and the set will be inoperative. However, if there is leakage between heater and cathode, the tube will continue to conduct and the hum will grow louder or remain at its previous level. The high cathode voltage will probably cause the heater and cathode to short if the tube is leaky.

This method may not work too well in sets having the filament transformer isolated from ground. It should do the trick in cases where the center tap or one side of the filament winding is grounded. It is always best, of course, to try tube substitution first. Ordinarily the local oscillator in the front end is the offender. Cases arise where the sound 2nd if (intercarrier) may have a leaky tube or an FM detector will produce hum in sound only when on a station. Similarly, hum bar occurs in pix when there is a leaky video tube after the intercarrier if takeoff, producing symptom in pix only.

### **Hum in pix**

**SYMPTOMS:** Hum bars; present only when channel is tuned in.

**SERVICE:** Heater-cathode short in the oscillator tube. This is fairly common in types like the 6C4, 6J6, and the 12AT7. This defect can also cause spurious oscillation, with resultant interference to

other TV receivers Substitute a new oscillator tube. (See also previous section on hum, modulation.)

Other causes are a defective tube (cathode-to-filament short) in any of the following stages: tuner, video if, video detector and amplifier, dc restorer or agc. The edge of the picture bends because the sweep circuits are also affected by the defective tube.

Replace any filter capacitors which are not providing good hum filtering since a ripple from the power supply can contribute to hum bar effects. Check the tubes in the stages mentioned, or replace one at a time until condition is corrected. Hum introduced into the picture signal affects bias at a 60-cycle rate and thus produces the horizontally shaded area.

### **Hum in uhf converters**

Sets having a separate sound channel frequently produce excessive hum when used for uhf reception, usually caused by ac hum in uhf converter (not heard in intercarrier sets). Condition can usually be remedied by adding a 40-40  $\mu$ f capacitor in parallel with each filter capacitor in set.

### **Hum, vertical**

Rotate vertical-hold control. If any variation, change vertical oscillator and output tubes. Replace capacitor in plate circuit of the vertical-output tube and bypass capacitor at vertical-size control.

### **Hum, 60-cycle**

Usually evidenced by one wide dark bar across the CRT. See Fig. 9-H. Kill pix by removing a tube from last pix if amplifier. If bar continues, trouble is probably in video amplifier which includes second detector, the dc restorer and pix tube. Replace and check for single bar on all channels, including off channels. If not seen on blank channels, trouble is in the tuner or video if section. If bar is seen on off channels, trouble is in the video detector or video-amplifier stages.

If bar disappears when pix signal is killed, trouble is in the rf or pix if amplifiers, including rf oscillator and converter. When indicated by white and black herringbone weave covering entire pix, check for cathode-to-heater short in the video if amplifier.

To make quick check for 60-cycle hum, short cathode of tube to ground with screwdriver (make test rapidly to avoid damaging

tube). Hum, due to heater-cathode short, will disappear if tube is faulty.

When pix pulls without hum bar, trouble is in the horizontal afc and oscillator circuits, or in the sync separator. Trouble in the horizontal afc circuit will show on off channels as bend along side of the raster, if raster is moved by centering control. Remove afc tube and see if trouble clears. If there is pulling and hum bars together, trouble is probably in rf, if or video amplifiers and video detector.

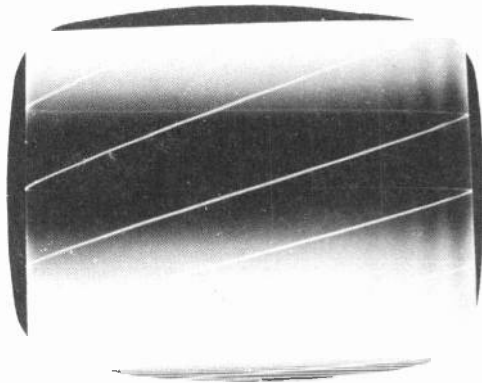


Fig. 9-H. 60-cycle hum in pix.

Hum that develops after set has been operating for a period usually is caused by a defective tube. Hum may be evidenced in speaker, as interference in pix, or both at the same time. In sets having a 6AL7-GT magic eye (electron-ray tube), a shorted condition in it can cause 60-cycle hum.

### Hum, 120-cycle

Hum can appear on the screen by way of the deflection circuits, picture circuits, or both. When hum affects the raster, either as a horizontal bar (variation in brightness) or as a ripple along the edges, it will similarly affect the picture. However, it can appear in the picture without affecting the raster.

Hum in horizontal-deflection circuits causes waviness or pulling in pix without bars, due to defective tube. See Fig. 10-H. The waving or buckling of vertical objects as pix changes is often due to defective .01- $\mu$ f capacitor (C5 in Fig. 6-H) in horizontal-phase detector circuit. In some instances, replacing .001- $\mu$ f capacitors in

this circuit (C1 and C2 in Fig. 6-H) by .0005- $\mu$ f units will overcome hum condition.

Check filter choke and LV rectifier, horizontal-hold control and plate-load resistor of horizontal-oscillator tube. In split-sound sets, rotate the fine-tuning control to maximum and minimum positions. If hum in pix is eliminated, trouble is probably prior to the video detector.

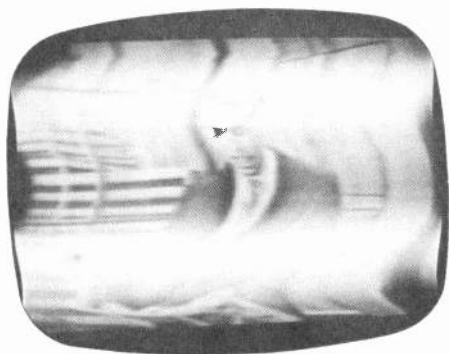


Fig. 10-H. 120-cycle hum in pix.

### Hunting in horizontal circuit

**SYMPTOMS:** Horizontal oscillator operates above and below correct frequency. Pattern may be cogwheel or pie-crust effect. Momentary shaking and shimmering of entire pix.

**SERVICE:** Usually caused by breakdown of components in anti-hunting network in afc circuit or associated components. See also gear tooth effect on screen. Anti-hunting networks are enclosed in dashed lines in Figs. 4-H, 5-H, and 6-H.

## Ignition noise

**SYMPTOMS:** Bright streaks across picture.

**SERVICE:** Ignition noise can be reduced by any one or all of these steps: 1) Relocate the antenna lead-in away from the street side of the house. 2) Connect two 50- $\mu$ f capacitors in series with the antenna line. Shunt a center-tapped coil across the line, either before or after the capacitors. The coil should have about 10 turns of No. 20 enamelled wire on a 1/2-inch form. Connect center tap of coil to chassis. 3) Unbalanced input to the rf tuner results in greater noise factor. Exchanging the antenna coil or the entire tuner for a new one may help to clear up this trouble.

## Individual channel coming in on wrong number

**SYMPTOMS:** Individual channels may come in on wrong number, i.e.; channel 13 on channel 12, channel 11 on channel 10, etc.

**SERVICE:** First check all tubes in tuner; then replace capacitor and resistor constituting grid leak circuit connected to grid of oscillator tube, as defective components would adversely affect frequency.

## Integrator network

**SYMPTOMS:** Poor vertical hold.

**SERVICE:** Trouble sometimes exists in the integrator circuit, a low-pass filter circuit connecting the sync separator and vertical-

oscillator tubes. A typical network consists of three resistors, 22K, 8.2K, and 8.2K in series; parallel capacitors .002  $\mu$ f, .005  $\mu$ f, and .005  $\mu$ f at junctions of these resistors; all capacitors connected to ground. See Fig. 1-I for typical circuit .

A defect in the integrator network can cause poor interlace,

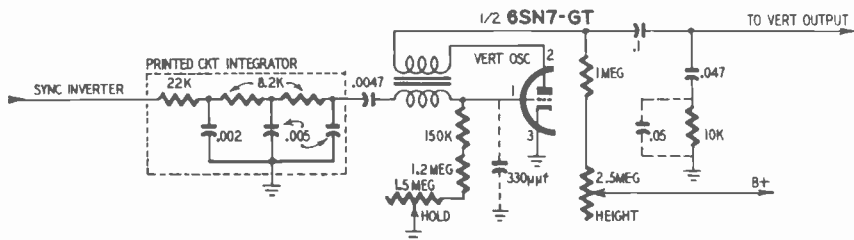


Fig. 1-I. Three-section sync integrator and its location with reference to the vertical oscillator.

critical vertical hold, vertical roll, and unstable vertical sync. An increasing number of sets use a printed circuit as an integrator.

### Inoperative set

**SYMPTOMS:** No sound, no pix.

**SERVICE:** A number of things can cause a set to become completely inoperative. A line plug and/or cord may be defective; no line voltage at input of set is possible; faulty on-off switch, or burned-out fuse are common troubles.

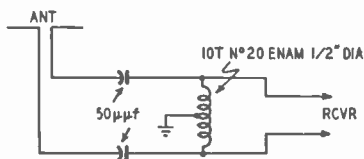


Fig. 2-I. A high-pass filter can be used to cut down interference streaks in the picture.

If tube filaments are lit, line voltage is present at input of set. Check for a defective LV rectifier, filter choke, dropping resistors. LV filter electrolytics, when faulty, cause rectifier plates to glow, transformer and filter choke overheat, hum is heard in speaker, and pix has horizontal bars. Check B+ line for short circuit.

A filter choke may be considered defective if it becomes too hot to hold the hand on it. Selenium rectifiers in transformerless sets should be checked; also fuse-resistor combination. (Series limiting resistor to protect selenium rectifiers, and as fuse, should short occur in power supply.)

In series string, if some tubes are dark and others burn brightly, heater-cathode short may be indicated. (Video-amplifier tube frequently becomes defective.) Check the audio-output tube when it is used as a voltage divider.

## Interference

**SYMPTOMS:** Streaks in picture. Jumpy picture.

**SERVICE:** Whether or not a high-pass filter will eliminate the interference depends on the type of equipment causing it. Interference produced by industrial heating equipment or modern diathermy machines can be prevented from entering the set via the

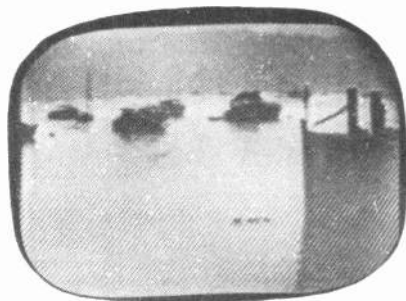


Fig. 3-I. *Strong interference produces diagonal lines on screen.*

antenna by connecting a high-pass filter between the set and the lead-in. As additional precautions, try a good line filter and a shield around the receiver chassis. High-pass filters can be purchased at most radio supply houses. You can construct your own using the diagram in Fig. 2-I.

If the interference is from arc welders, electric motors, or other devices which generate damped waves, it may be partially suppressed by installing power-line filters at the source of the trouble. This is a job for the owner of the offending device.

## Interference, adjacent-channel

**SYMPTOMS:** Diagonal lines across screen.

**SERVICE:** When a strong local station is in the area, it may be very difficult to receive a more distant adjacent channel. Solutions consist of careful adjustment of the adjacent-channel traps of the receiver, plus realignment of the tuner and video if stages so the bandpass characteristics are not too broad. An additional lower-adjacent-channel trap can also be installed in the video if stages. These measures will block the local station sufficiently to permit reception, though the diagonal line interference shown in Fig. 3-I will probably still appear in the picture.

## **Interference, pix**

**SYMPTOMS:** (A) Deflection circuit radiation causing interference in tuner. (B) Video-detector radiation causing interference in tuner.

**SERVICE:** (A) Move antenna lead away from horizontal-deflection circuit. Shield deflection circuit. Filter voltage-supply leads from horizontal-deflection circuit. (B) Move antenna lead away from vicinity of video detector. Shield video detector. Depending on channels in use in a specific area it may be possible to realign video-if amplifiers to a slightly different frequency to overcome the interference.

## **Interference, sound if**

**SYMPTOMS:** Crosshatched interference pattern which varies with modulation.

**SERVICE:** A herringbone or crosshatched interference pattern which varies with modulation may be caused by harmonics of the sound if radiating from the sound discriminator or ratio-detector circuit and entering the rf stage.

Check this by pulling the first sound if tube. If this cures the trouble; carefully check the sound if and detector shield cans and wiring, and make a more positive connection between the shield cans and the chassis. You may find it desirable to place some solder on the chassis where the can contacts it. The can is then pulled into the solder when clamping it in place.

Also check the lead dress in the sound-detector circuit, particularly the leads connected to the discriminator or ratio-detector transformer. Make sure that they conform to all lead dress information contained in the manufacturer's service data.

## **Interlace, lost**

**SYMPTOMS:** Improper sync pulse limiting, which does not maintain sync pulse level low enough for the equalizing pulses to be properly integrated.

**SERVICE:** If scope is available, check sync-pulse wave shapes and compare with service information. Condition may be produced by video in sync circuits which appears as extra equalizing pulses, thus causing the output of the vertical pulse integrator to be incorrect. Check operation of sync separator with scope.

Improper equalizing pulse integration due to insufficient in-



tegration. Check value of parts in the vertical pulse integrating circuits. Sufficient integration will usually be obtained in a three stage integrator, in which each stage reduces the sync pulse level by about  $1/3$ .

### Interlace, poor

**SYMPTOMS:** Poor interlace indicated on screen by moire effect of horizontal wedge in test pattern. White horizontal sweep lines not equally spaced but close together, or both light and dark. Pairing of lines with black space between is especially noticeable on large screens. Horizontal lines look coarse. See Fig. 4-I.

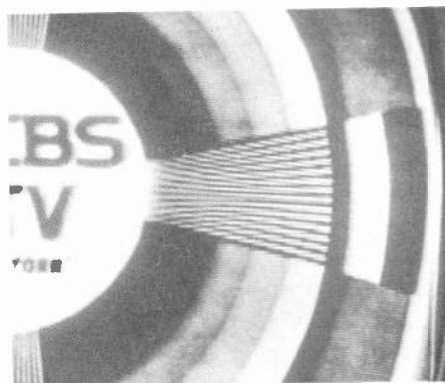


Fig. 4-I. *Poor interlace as indicated by moire effect on horizontal wedge.*

**SERVICE:** To get best interlacing, adjust brightness control until retrace lines can be seen. Turn vertical-hold control until the retrace lines are equally spaced. This usually happens with the vertical-hold control set close to the point where the pix breaks out of vertical sync and starts rolling upward. If this adjustment of the vertical-hold control does not eliminate pairing of retrace lines (that is, if all the retrace lines cannot be spaced evenly) then there may be trouble in the integrator network (input to the vertical oscillator). Defective capacitors in the integrating network are the most common cause. The action of a simple integrating network is shown in Fig. 5-I.

Interlace may be impaired by too much or too little amplification of the vertical-sync system prior to the integration network, or stray pickup from the horizontal-sweep system of horizontal pulses, or (rare) from improper sync clipping of the video information. These are usually shop jobs.

Poor interlace can be due to faulty set design or to transmission troubles. If poor interlacing exists on one channel only but others are good, trouble is not in the set. Replace vertical oscillator and output tubes; also video-amplifier and sync tubes. To improve interlace, try reducing the size of the peaking resistor in the vertical-discharge circuit. Make sure leads of horizontal-deflection circuit are not close to vertical-oscillator grid leads.

Other possible causes of this condition are defective coupling capacitor between vertical oscillator and output tubes, vertical-deflection yoke, and vertical-output transformer. In some sets poor interlace may be observed despite proper components. In sets using a blocking-oscillator type circuit, try connecting a 330  $\mu\mu\text{f}$  capacitor between control grid of vertical oscillator and ground.

### **Intermittent pix**

**SYMPTOMS:** Pix contrast changes. Pix may also disappear entirely.

**SERVICE:** Arcing at the base of the high-voltage rectifier tube socket can produce this trouble. This is the highest voltage point in the set. Arcing may be difficult to see except in darkened room. If arcing exists, coat base and wiring with Duco, or equivalent cement. If this does not cure, replace socket.

Generally, an intermittent pix is caused by loose tube socket contacts, dirty or loose coil contacts, loose or cold-solder joints, and loose or vibrating parts on underneath tuner chassis. Rock tubes in sockets and check for improved condition. Look for loose grid or plate caps and carbon discoloration of tube prongs due to arcing.

Make voltage tests in intermittent cases to pins of socket contacts and not to socket lugs, if possible, to locate poor contacts in socket. Same applies to the terminals of if transformers and other components. Many cases of bad soldering or intermittent contacts will turn up by this procedure.

In video if strip this condition may be caused by a microphonic tube, a defective crystal diode, loose connections, cold-solder joints, defective resistors and/or capacitors, if coils and transformers. Intermittents are often caused by opening of capacitors in rf and if stages.

May also be caused by loose antenna or lead-in at terminals of set. A break in 300-ohm lead-in would produce an intermittent condition.

Check by substitution all tubes through which video signal passes (rock tubes in socket while checking); also sync-discrimina-

tor tube and tubes in horizontal circuit; and damper tube. Occasionally the horizontal tubes, and HV rectifier may develop a faint crack in the glass envelope (discernible only through a magnifying glass) or a tube base becomes cracked; this could cause an intermittent condition.

Check horizontal-drive control trimmer and brightness control, also agc potentiometer or control. May also be caused by defective agc tube or circuit component.

Gently wiggle the base of the CRT. If this affects the pix, there is a loose connection in the tube pins, or in the wires coming to the socket. Examine the filament light inside the pix tube. If it

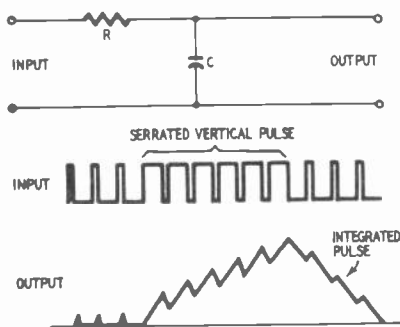


Fig. 5-I. Integrator circuit showing input and output waveforms.

changes when tube socket is moved, this is definite indication of loose connection. Spot solder all connections to CRT socket by applying a hot iron to all socket wires.

### Intermittent pix and sound

**SYMPTOMS:** Erratic pix and sound.

**SERVICE:** When intermittent operation occurs only at specific times during the day, check for power line fluctuations.

Connect AM signal generator through 50  $\mu\text{mf}$  capacitor between grid and ground of any video if stage. Rotate generator to center of video if range and modulate amplitude. Increase output to produce black and white horizontal bars on screen. Tune in station. When intermittent condition appears, pix and bars will disappear if trouble is between CRT and generator; if only pix disappears trouble is between antenna terminals and generator.

### Intermittent sound

**SYMPTOMS:** Picture is good, but sound fades down to a whisper.

## INTERMITTENT OPERATION CHECK LIST

SYMPTOMS	SERVICE
Brightness (poor)	Brightness - control circuit; horizontal sweep; video amplifier.
Flashing	Video if and amplifier; antenna and tuner.
Focus	Focus control; B+ supply (both ends of focus coil); high voltage; 1st anode voltage; focus coil or focalizer.
Height	Vertical sweep (B+ supply to vertical section); vertical oscillator (height and vertical-linearity controls).
Hum	Transformer vibration (mechanical hum); filter capacitors; audio bypass capacitors, discriminator or ratio detector; heater shorts.
Keystoning	Deflection yoke; horizontal sweep; vertical sweep.
Pix	Tuner and video detector; video if and amplifier.
Pix overload	Video if section; agc system; video amplifier; video detector.
Raster	High voltage; horizontal oscillator; brightness control; CRT.
Sound	Audio amplifier; video detector (intercarrier); volume control; sound if amplifiers; take-off coil; sound traps.
Sound distorted	Audio-coupling capacitor; audio B+ and tube pin voltages; audio bypass capacitors; discriminator or ratio detector; resistors in audio.
Sound and raster	B supply; tube heaters.
Sound weak	Audio-output tube; coupling capacitor; tubes in sound if and detector sections.
Sync	Sync section; video if; video amplifier; HV arcing.
Sync—horizontal	Horizontal afc; if alignment; sync section; horizontal oscillator.
Sync—vertical	Sync section; if alignment; integrator network; vertical oscillator.
Width	Horizontal sweep; horizontal oscillator; high voltage.
Width and height	High voltage; B supply; horizontal sweep.

If volume control is turned up, sound is good for a while then suddenly blasts.

**SERVICE:** Intermittent troubles have always plagued service technicians, and they are sometimes the most difficult things to localize. While the set is playing normally, there is no point checking voltages or parts, since nothing appears amiss. However, when the intermittent occurs, it may be of such critical nature that the mere approach of a test instrument probe is enough to cause the part to act normal again.

Try replacing one tube at a time and waiting to see if the trouble still occurs. Repeat, until all tubes in the audio section (from if amplifier to audio output) have been replaced. Also, install a new coupling capacitor in the grid of the audio-output tube, for these are frequent offenders. As a last resort gently push each paper capacitor with an insulated screwdriver while the set is in operation to find which might have loose internal lead contacts.

There are other methods for checking intermittents. Try raising the line voltage or applying shock. In using higher voltages, a Variac or similar autotransformer will be useful. Raise the voltage to about 130, maximum, but don't keep it there too long, and look out for sudden failures.

Open grid resistors, faulty filters, trouble in the output transformer, voice coil, and improper seating in tube sockets are other sources to check.

Sometimes, intermittent sound is traceable to the tuner, caused by loose tube sockets, dirty or loose coil contacts, loose or cold-solder joints, and loose or vibrating parts underneath tuner chassis. Rock tubes in sockets and check for improved condition. All tubes through which audio signal passes should be checked by substitution.

May also be caused by loose antenna or lead-in at terminals of set. Check audio circuit, including speaker, for loose connections.

## **Ion spot**

**SYMPTOMS:** Brownish spot, one-inch or more in diameter, on face of screen, usually near center.

**SERVICE:** This spot is sometimes caused by an incorrectly positioned ion trap. New tubes can be permanently damaged if the ion trap is not adjusted properly as soon as the set is put into operation. With wrong trap adjustment the electron beam strikes the disc aperture of the gun structure and may decompose the metal. This vaporized material will cause brownish spots (which cannot

be eliminated) on the tube face. On new tubes keep brilliancy down and advance it slowly as the ion trap is adjusted in a rotary, forward and back motion. Only when correctly adjusted should the brightness be advanced substantially.

### **Ion trap**

**SYMPTOMS:** Dark picture; picture out of focus. Corner shadows. Sound is good, but pix is missing.

**SERVICE:** Most pix tubes use a bent-gun arrangement requiring a single magnet ion trap with a range of 30 to 50 gauss. Adjust ion trap for maximum pix brightness.

Also check the ion-trap magnet. Too weak a magnet will make it difficult to eliminate corner shadows at the setting which gives maximum brightness. Incorrect ion trap magnet position will cause ion burns eventually—the length of time depending on how far off true position it is. If the magnet is weak it may have to be placed closer to the focus unit. The fields of the latter will influence the ion trap and make it difficult to adjust either one correctly. A new ion-trap magnet is relatively inexpensive and can save costly picture tubes as well as permit you to make proper adjustments for better performance.

If magnet is too strong, this causes adjustment too close to tube base, or brightness peak unobtainable at any point.

If ion trap is too close to, or on tube base, use one of lower field strength. If too close to face end of tube use one of higher field strength. Deterioration from age can cause dim pix. It is sometimes advisable to install an adjustable ion trap.

Correct centering position is indicated by maximum brightness. Frequently two points of maximum brightness are possible. Use that nearest to base of CRT. The second point is caused by ion trap too close to focus coil or magnet. This can damage the CRT. Incorrect positioning of ion trap can not only damage the CRT but prevent proper focusing. If ion trap is coded with dot or arrow, coding should be toward tube face.

## Jitter

**SYMPTOMS:** Pix vibrates, horizontally or vertically. See Fig. 1-J. Focus is poor.

**SERVICE:** If horizontal jitter is observed, CRT and yoke leads may be too close. If vertical sync is affected with horizontal pulling, dress coupling capacitor and leads to sync separator close to chassis and away from agc amplifier output circuit. If vertical jitter is noted, reroute horizontal-deflection coil hot lead away from vertical-oscillator tube. If vertical black lines appear on CRT, reroute transmission line and/or link in set away from deflection yoke cable and assembly. If pix is smeared, reroute cathode and/or grid lead of CRT away from horizontal yoke and/or output tube.

For trouble in the vertical-sweep section, replace the vertical oscillator and amplifier tubes. Check resistors and capacitors in the integrating network. If printed circuit is used, replace entire integrator. Make sure the horizontal-hold control leads are not near the vertical-output transformer. This trouble is sometimes caused by a leaky cathode-bypass capacitor in the vertical-amplifier stage.

For trouble in the horizontal-sweep section, replace horizontal oscillator, afc and output tubes; also the damper. Check sync and agc tubes. Trouble may be caused by defective screen bypass capacitor or sync separator tube; or coupling capacitor between horizontal afc tube and sync clipper tube. Other causes are incomplete video stripping in sync.

Other components to check are the dc blocking capacitor be-

tween the first and second sync clippers; the sync plate load.

Fluctuating line voltage will also cause pix jitter. (Refer to section on line voltage.) This trouble can also be produced by a defective resistor in the cathode circuit of the agc amplifier. Sometimes it is helpful to insert a 1.2-ohm resistor in series with the phase-detector heater. If this resistor is not readily available try paralleling several larger resistors (two 2.2-ohm resistors, three 3.9-ohm resistors).



Fig. 1-J. *Example of horizontal jitter.*

Jitter can sometimes be corrected by reducing signal strength with an attenuator pad. Turn channel selector to station on which very definite jitter appears. Turn contrast control up until pix starts to tear, roll, or become severely distorted. Back off contrast until good pix is obtained. Disconnect antenna and substitute indoor antenna. If jitter stops attenuation pad will be helpful.

Always be sure to check the agc controls at the rear of the set.



### **Keyed agc (see earlier section on Automatic gain control)**

**SYMPTOMS:** The principal enemy of the simple agc circuit is noise, especially in areas where the signal-to-noise ratio is low. Noise usually appears as sharply peaked impulses that are amplified and rectified along with the signal. A prolonged noise condition acts the same to a simple agc circuit as an increase in signal strength and will therefore increase the negative agc bias and further weaken a usually already weak signal. Another troublemaker is airplane flutter, a series of increases and decreases in signal strength caused by signal reflections from an airplane in flight. Since this can occur as a frequency of over 100 cycles, most simple agc circuits cannot smooth out this variation and the result is a continuous overload and fading on the picture screen.

**SERVICE:** The complexity of servicing a keyed agc circuit can be seen from the number of other circuits involved. See Fig. 1-K. Aside from the keyer circuit, there is the video amplifier feeding the grid-cathode circuit, the horizontal-output circuit feeding the keyer plate, and the various rf and if circuits being fed a negative bias from the keyer output.

It might seem that one of the essentials of proper keyed agc action, that of simultaneous positive grid and plate voltages, would be automatic. Refer to Fig. 2-K. Yet, if the horizontal oscillator is out of sync, the horizontal plate pulse will not occur at the right time, and proper agc voltage will not be developed. The same trouble can occur with a poorly operating afc circuit, since this circuit has considerable control over the horizontal oscillator.

As a rule, a poorly operating keyed agc circuit will produce too much or not enough agc voltage. As a result, the following defects are most commonly seen: excessive, insufficient, or varying contrast; snow; airplane flutter; poor horizontal and vertical hold; poor noise immunity, and picture overload.

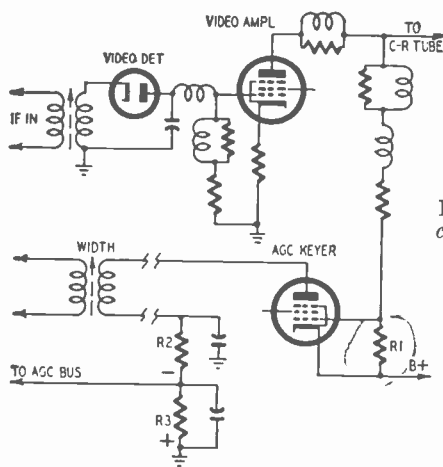


Fig. 1-K. Agc keyer circuit. Width coil is part of horizontal-output transformer.

A common cause of overload is keyer-tube failure. The heater may be open, cathode emission low, the agc winding on the width coil open, or some other defect may lower the agc voltage. This will frequently cause the overloading of an if or video amplifier tube and cause the screen to go blank or a negative picture to appear. If the overload takes place before the sync take-off, it will also result in poor horizontal and vertical sync. When replacing a width coil be careful of the polarity of the windings—incorrect polarity will also cause a negative picture.

Another cause of overload is the improper adjustment of the agc control. If readjustment does not help, place a potentiometer across a 9-volt battery, connect the center arm to the agc line, and use this as the negative agc bias. Some receivers have convenient test points, others require that the agc line be opened and still others that the keyer tube be removed. Set the potentiometer for the manufacturer's recommended bias voltage and observe receiver operation under proper bias voltage. If a scope can be used to observe the keyer grid, plate, and filter waveforms, troubleshooting will be that much quicker. If the trouble is due to a circuit defect in the agc line, setting the proper bias voltage should clear the picture. If trouble persists despite normal agc bias, it is

usually safe to turn your attention to another circuit. Before applying battery bias, be sure the agc line is not short-circuited to ground.

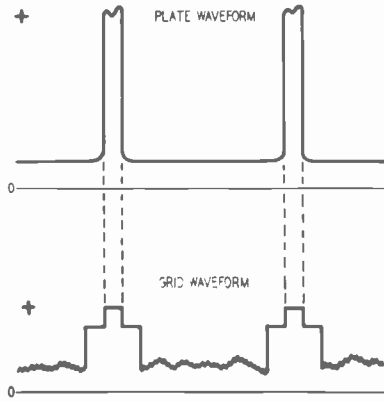


Fig. 2-K. Keyed agc grid and plate waveforms.

Much the same procedure can be used to check excessive bias that causes snow and poor contrast, and poor sync stability. (See Fig. 3-K.) This could be caused by a decrease in the keyer bias causing excessive plate current flow in the keyer. This is often

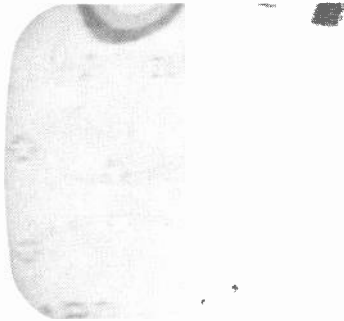


Fig. 3-K. Very poor contrast resulting from defective agc.

caused by a low-emission video amplifier resulting in too small a voltage drop across the keyer input resistor R1 in Fig. 1-K. This resistor is a critical factor in proper agc action. If it varies in value, it will cause considerable changes in bias voltage. Equally critical is the plate current flow through this resistor. Both should be checked carefully.

The keyed agc circuit is a frequent cause of poor interlace. A defective filtering component will allow horizontal sync pulses to appear on the agc line where there should be only dc. This upsets normal vertical sync and destroys proper interlace. Trouble of this nature can usually be checked by placing a scope on the agc line.

In cases of fading, always check for components that are varying in value.

### **Keystoned pix (trapezoidal)**

**SYMPTOMS:** Picture assumes wedge shape. Example: right side of the picture has less height than the left side.

**SERVICE:** This is usually caused by shorted turns in the vertical-deflection coil (or a shorted resistor across one section of the vertical coil).

The particular coil section involved can be identified from the nature of the keystoned picture. The vertical coil sections are on either side of the picture tube neck. When one coil section shorts, the remaining coil section must perform the entire vertical sweep by itself. The beam is influenced less as the horizontal sweep pulls it away from the field of the single coil, and the latter is unable to sweep the beam fully at extreme horizontal deflection. The narrowed section shows on which side of the deflection yoke the shorted coil section is located. Keystoning can occur on either side of the yoke, and also in the horizontal coils.

## **Lead dress**

The difference between a set in good working order and a troublesome job can often be due to such a simple item as the positioning of a small piece of wire. Wires in TV sets carry several different kinds of signal and pulse currents. The magnetic fields surrounding these wires can produce effects symptomatic of broken-down components and tubes.

Proper dress of leads is very important when making replacements of components. Whenever possible, follow original wiring in set, unless it is apparent that by doing so, trouble will be introduced. Do not place components or connecting wires near any spot that runs hot.

## **Audio stages**

Improper lead dress can cause hum, buzz and regeneration. To check, short hot side of volume control to ground. If hum continues, lead dress to first audio stage from volume control may be improper. Keep leads away from filament and line voltage input wiring.

Buzz can result from leads of volume control and 1st audio too close to vertical-oscillator and vertical-output tubes or other components in circuit. Lead of vertical hold too close to volume-control leads or audio tubes will produce buzz.

Dress grid and cathode leads of CRT away from audio tubes;

also leads and coupling capacitor to first sync amplifier; and leads of vertical-retrace blanking circuit, away from audio circuits.

### **Power-supply circuits**

Dress leads away from chassis to prevent breakdown of insulation and arcing. Keep leads in HV section separated as far as possible from each other. Short, direct leads are best, dressed away from horizontal-output transformer windings. HV leads and LV leads must be separated. Leads to caps of HV rectifier and hori-

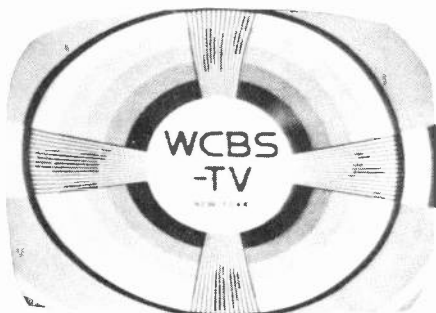


Fig. 1-L. *Test pattern shows left-hand stretch.*

zontal-output tube should be kept away from metal cage. If pix twists, check 6.3-volt filament wires; may be too close to horizontal afc coil. If horizontal-output transformer squeals, reroute leads of horizontal-deflection coil away from vertical- and horizontal-oscillator stages.

### **Rf stage**

Same precautions as for video if amplifiers.

### **Video amplifier**

Capacitors, peaking coils and their wiring must be mounted away from chassis to minimize stray capacitance.

### **Video if amplifiers**

Leads of if coils must be exactly the same length as original and positioned in identical places; otherwise resonant frequency of circuit may be changed. Other troubles that can be created are weak or snowy pix, interference, regeneration, poor sync, bending, improper interlace and a raster with ragged edges. Replace capacitors in identical position as original and with same length of pigtailed, otherwise response of stage may be changed appreciably, requiring realignment.

## Left-hand stretch

**SYMPTOMS:** Picture compressed in center, left side stretched. See Fig. 1-L.

**SERVICE:** Adjust horizontal-drive control. (Some sets do not have this control.) Check all components between the horizontal-discharge circuit and input to the horizontal-output tube.

## Line voltage, variation in

**SYMPTOMS:** Picture size and contrast change when electrical appliances are turned on. See Fig. 2-L.

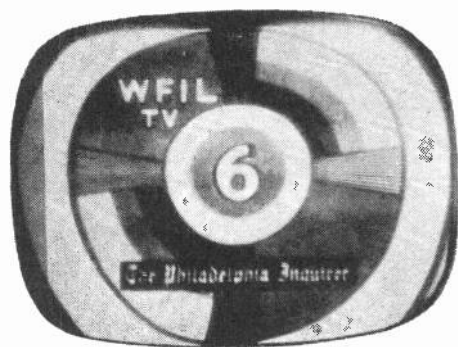


Fig. 2-L. *Effect on pix of line-voltage change.*

**SERVICE:** The trouble is often caused by excessive voltage drop in the power lines when electrical appliances are turned on. This can be checked by measuring the voltage across the line in the various receptacles and lamp sockets when the appliances (refrigerator, toaster, broiler, etc.) are running. If the voltage is low on the receptacles but not on the lighting circuit, the voltage drop is confined to the line feeding the receptacles. The effect is not harmful, but may be annoying. You can eliminate it by having a special heavy line run to the outlet. If the voltage drops on the lighting circuits as well, it may be caused by using too small a wire between the meter and distribution panel or fuse box. Have an electrician check the lines for voltage drop and install heavier lines where necessary.

If it is impractical to change the power lines, install a constant-voltage transformer between the receptacle and the TV set.

Various troubles occur from low line voltage, such as pix jitter, critical horizontal and vertical hold, weak pix, and/or audio, poor focus, contrast, and linearity, insufficient width and height, low brightness and tinny sound.

High line voltage adversely affects focus, causes excessive pix size, tube filament and other breakdowns.

Fluctuating voltage causes pix jitter, loss of sync, variation in pix size, contrast and brightness.

The effect of line voltage on pix size can be seen from the following data based on a 20-inch tube. (All figures given are in inches.)



Fig. 3-L. *Low-voltage B+ causes reduction in height and width.*

	<i>Width</i>	<i>Height</i>
Line voltage at 115	17 $\frac{1}{4}$	14 $\frac{1}{4}$
Using line stabilizer	17 $\frac{3}{4}$	15
Drop to 105 volts on line	16 $\frac{1}{4}$	12 $\frac{3}{4}$
Increase to 120 volts on line	18 $\frac{1}{4}$	15 $\frac{3}{4}$

When the line voltage remains below 110, the use of power-line booster is indicated if the set is to operate at peak efficiency.

### **Low-frequency response, poor (see also Alignment)**

**SYMPTOMS:** Horizontal objects and lines seem smeared. Trailing reversal (white following black).

**SERVICE:** Trouble is due to poor low-frequency response in the video amplifier. Can be caused by open peaking coils and defective video-coupling capacitors. Check video-detector load resistor. Can also be due to video if and tuner misalignment.

### **Low voltage (B+)**

**SYMPTOMS:** The low-voltage power supply is common to all stages of the receiver. Definite indications of trouble are low brightness, weak sound, and undersized raster (both height and width are affected). Pix contrast becomes poor. See Fig. 3-L.

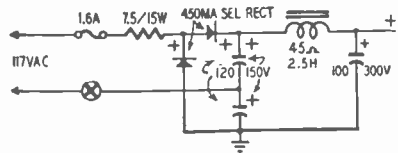
**SERVICE:** Check LV rectifier tube or selenium rectifier and series protective resistor; relay rectifier and associated filament resistor (if any); and B-supply electrolytics.



If the low-voltage rectifier tube is more than one year old and there is trouble in the video-, audio-, vertical-, or horizontal-output stages, replace the rectifier. In some sets, a defect in the audio-output stage, acting as a voltage divider, may affect plate and screen voltages of tubes in the tuner, video if amplifiers, sync tubes, agc tube, and horizontal-output tube. Similarly, trouble in the vertical-output stage can also lower the B+ voltage.

Some sets use a circuit with two selenium rectifiers in a voltage-doubler arrangement. Operating the horizontal-flyback circuit from such a source means that only 240 volts B+ are available.

Fig. 4-L. Selenium-rectifier voltage-doubler power supply.



Special flyback transformers, invariably the ceramic-core type, are used to provide sufficient high voltage and deflection. These modern flyback transformers provide an additional B+ boost of 260 volts or so, and permit about 500 to 525 volts to be applied to several sections of the set.

The circuit in Fig. 4-L shows a typical selenium-rectifier doubler circuit. The output at the filter is 240 volts with 117 volts ac input. If the line voltage is low, the output may drop to 230 or even 210. The B+ boost is affected more seriously. The low line voltage will cause a reduction in width and brightness. Unfortunately, many homes suffer from low line voltage in the evening hours when the load on the power generators is greatest. In some locations the ac line voltage is as low as 95. While most transformer types of receivers have some leeway, the majority of selenium-type TV sets will not perform properly at such low values.

One solution is to install a constant-voltage type of transformer or a suitable variable transformer and run the receiver from that source. The cost of either runs from about \$20 to \$50 and many set owners object to this additional expense. But if you have any old power transformers around, a simple and effective arrangement can be made. Any power transformer having a 117-volt primary and a 5, 6.3-, or 12-volt filament winding can be used.

Connect the ac power line to the 117-volt primary winding as shown in Fig. 5-L. Now make a temporary connection of the filament winding and measure the voltage across 1 and 3. If it is less than the voltage across 1 and 2, reverse the filament connections.

Where 5- and 6.3-volt windings are used, connect them in series, checking to make sure their voltages add. Mount this auxiliary transformer in the TV cabinet away from the picture tube, possibly in some corner or in the bottom section of a console. Solder all leads and tape them securely before mounting the transformer.

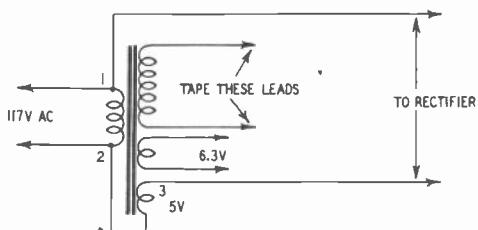


Fig. 5-L. Spare power transformer can be used to give line voltage boost.

If low line voltage occurs only at certain times of the day, a simple toggle switch can be mounted on the back of the cabinet. When the picture gets small and dim, the owner throws the switch to connect his set to the higher tap on this autotransformer. The switch must be returned to the normal position when the set is turned off or when the line voltage rises.

Any transformer designed for several amperes of filament current and about 100-ma (or more) secondary current will be suitable as an autotransformer. Any windings not used should be securely taped.

## LOW-VOLTAGE POWER SUPPLY CHECK LIST

SYMPTOMS	SERVICE
Dim pix; critical pix; low volume; burned-out transformer	LV vacuum-tube or selenium rectifier.
Hum in speaker; hum bars; fuse blows; transformer and filter choke overheat; low B+; rectifier filaments burn brightly; plates in rectifier tube glow	B+ supply electrolytic capacitors.
No B+ voltage	Filter choke (should not run hot); rectifier; line switch, cord, and plug.

## Microphonics

**SYMPTOMS:** A common fault is a continuous whistle, howl, or squeal in speaker, and is present when sound signal is received (and at relatively high volume). Condition stops when volume control is reduced. Most frequent on high channels (7 to 13). Condition may be stopped temporarily by tapping cabinet or by rocking rf oscillator tube in socket. Noticeable during program when volume increases. May produce black or white blotches on pix, and possibly sound bars if tubes in tuner are faulty.

**SERVICE:** To assist in locating offender, tap each tube with rubber-tipped mallet, pencil, etc. Also tap the chassis near components suspected (microphonics can be caused by vibration of loose wires, connections, and components). Cementing a loose component to the chassis may eliminate condition. If part of a tuned circuit (as in a tuner or if strip) some minor realignment may be necessary after cementing.

To locate component causing microphonic whistle, press an insulated probe against each component suspected. If whistle is diminished, faulty component has been located. Also try tapping each component. The one producing the loudest pinging sound indicates trouble spot has been located.

Microphonics produce sound bars on the screen as a result of mechanical vibration of components. Tubes in the tuner, video if or video amplifier are frequently at fault. Vibrations set up by the speaker cause tube elements to move, producing variations in

interelectrode capacitances. Changes in capacitance cause shifts in frequency (FM) which might appear harmless, the video detector being fairly insensitive to variations in frequency. However, in many receivers the response of the video if amplifier and detector is such as to produce slope detection of the FM signal, permitting audio voltages to enter the video amplifier. Because microphonics are the result of mechanical vibration, the intensity of the sound bars in the picture will vary with the setting of the volume control.

A quick check for this trouble is to remove the speaker from the chassis or disconnect the speaker voice coil from the output transformer and substitute a suitable load resistor (5 ohms at 10 watts is about right for most sets). If the speaker vibrations were at fault, the sound bars should disappear even at high volume settings. Tube vibration is not the only cause of this trouble. Others are vibrations between leads, plates of capacitors and changes in spacing between coil turns.

Try substituting less microphonic tubes, strengthen the mechanical layout of loose coils and capacitors (use coil cement), and try rubber damping pieces. Keep all wires in and around the oscillator circuit short and separated. Some manufacturers install a heavy lead shield around the rf oscillator tube (this tube is especially sensitive to microphonics). Supply such a shield if the receiver does not have one.

### **Motorboating and/or siren sound**

**SYMPTOMS:** Loud, motorboating sound.

**SERVICE:** Usually caused by defective oscillator tube in tuner, or old electrolytic filter capacitors in audio section.

### **Narrowing, intermittent pix**

**SYMPTOMS:** Pix changes width. Vertical bars may appear in pix when latter has normal width.

**SERVICE:** Trouble exists in horizontal-sweep section. May be due to excessive horizontal drive, defective horizontal output and damper tubes, or yoke. Open one end of the capacitor shunting one-half of the horizontal scan windings in yoke. If condition is overcome, replace with mica capacitor, about 56  $\mu\text{f}$ . Horizontal-drive trimmer may be shorting or partially leaky.

### **Neck shadow**

**SYMPTOMS:** Pix has rounded, cut off, dark edges.

**SERVICE:** Set ion trap for position producing maximum brilliance, regardless of corner cutting. Do not try to eliminate shadows with ion trap. Yoke must be as far forward as possible (up to flare of pix tube). Adjust focus unit until shadow is removed. The focus unit should be about  $\frac{1}{4}$ -inch away from the yoke. Neck shadow can be caused if gun in CRT is not exactly centered. Rotate tube (length of high-voltage lead will have to be increased) and try to chase shadow behind the mask.

Try reversing the leads to the focus unit. Interaction of the magnetic fields between focus unit and ion trap sometimes creates shadow. If this does not help, it may be necessary to increase the size of the pix, vertically and horizontally. This will sacrifice some pix linearity.

Neck shadow can be caused by partial failure of large capacitors in the power-supply system, resulting in poorer voltage regulation.

The vertical-sweep circuit draws heavy transient currents from the power supply. This will affect the voltage on the CRT electrodes under these conditions.

### **Negative pix (see also Agc, defective)**

**SYMPTOMS:** Turning the contrast control up produces a negative pix (reversal of black and white).

**SERVICE:** Replace the 1B3-GT in the high-voltage supply. Check the high voltage. Replace the pix if amplifier tubes. It is also possible that the pix tube has become weak. Before changing it, try readjusting the ion trap or using a new one.



*Fig. 1-N. Negative pix can be caused by overloading, defective pix tube, outside interference, or circuit defects.*

Fig. 1-N, for example, shows a negative pix, but does this type of pix occur only for the strongest station? If so, it would indicate temporary overloading. Does the pix turn negative only occasionally? If so, it might indicate strong local interference from a shortwave station. Is the pix always negative, even though the antenna lead-in is disconnected and receiver circuits check all right? The pix tube is probably defective. The agc can cause a negative pix on weak stations too. It all depends on the setting of the agc control. Obviously, a correct diagnosis of the trouble can be made only if all symptoms are considered.

### **No pix**

**SYMPTOMS:** Frequent blowing of HV fuse.

**SERVICE:** May be caused by an intermittent short in the damper-tube heater circuit. This can often be cleared up by replacing the leads from the power transformer to the damper-tube heater with heavily insulated, moisture-proof wire. Also try spraying or coating these wires with coil dope.

Other components that might cause this condition are defective peaking coils in the video detector and amplifier circuits; the coupling capacitor between the video amplifier and pix tube (when such a capacitor is used); video-amplifier plate resistor; also the coupling capacitor in the video circuit between detector and output tube; and a possibly defective CRT.

The transmission line may be shorted to the chassis. Transmission line is stranded wire and poor stripping may cause one of the wires to touch the chassis killing pix and sound. Check all tubes up to the point where sound takeoff occurs, including agc. In sets using the audio-output tube as a voltage divider, that tube should be checked. Other components that are suspect would be the agc keyer coil, and the grid capacitor of the oscillator in the tuner. Failure of the local oscillator is a primary cause. A test point is frequently available to check its bias to indicate normal vs. weak or no operation.

Other possible causes of this condition might be incorrect setting of the individual oscillator slugs in the tuner, especially if all channels are not affected, or possible defects in the agc circuit.

### **No pix, normal sound**

**SYMPTOMS:** Raster is observed on screen, sound is good, but pix is missing.

**SERVICE:** Be sure to make a precautionary check of the ion trap on neck of the pix tube. Also check fine tuner, contrast and brightness controls, and focusing magnets, as some owners frequently manipulate these haphazardly. In most instances, trouble will be in video-amplifier stages as sound signal passes through stages operating jointly. Check tubes following sound take off: video detector (in intercarrier sets pix and sound will be missing), video amplifiers, agc tube, and dc restorer. In split-sound sets check the video if tubes.

### **No pix or sound**

**SYMPTOMS:** Raster, but no pix or sound.

**SERVICE:** Detach lead-in and scrape ends across set terminals. If signals are entering set, bursts of noise will be heard in the speaker, and flashes of light will be seen on the CRT.

Turn contrast maximum clockwise. If tube shows some evidence of pix, with snow, check antenna and lead-in connections, tuner and 1st video if stage. This trouble may also be due to an improper setting of the agc control. If the bias setting is too high, pix and sound will be very weak, or cut off.

## **No pix or sound after short period of operation**

**SYMPTOMS:** Pix and sound disappear (raster OK) after set has been operating for 15 to 20 minutes.

**SERVICE:** May be caused by defective audio-output tube; resistor from screen of audio-output tube to B+; capacitor from audio transformer to ground; audio-output tube cathode resistor; and any other components connected to audio-output tube (when used as a voltage divider).

## **No raster or sound**

**SYMPTOMS:** This condition indicates that the trouble is confined to the low-voltage supply.

**SERVICE:** Check the line fuse, usually located on rear apron of set or sometimes built into the line plug. Examine the line cord and connector, the safety interlock; and on-off switch. Ohmmeter test for continuity. Check also the LV rectifier, agc tube, horizontal output and video-amplifier tubes, and, in those sets having a stacked B+ circuit, the audio-output tube.

Other defective components that might cause this condition are the B-supply filter electrolytics, usually located at either side of the filter choke.

## **No raster, sound normal**

**SYMPTOMS:** As the sound circuit is functioning, the low-voltage power supply is providing B+; hence the trouble is associated with the CRT, high voltage and horizontal circuits. Any defects in the HV power supply might be the cause.

**SERVICE:** Some service technicians immediately suspect the ion trap adjustment, but in this case it is the source of trouble only infrequently. You can note the layer of dust if it has been moved, or if the back of the cabinet has been taken off. Of more consequence is the B+ at the fuse which supplies the horizontal output. Often this can be checked by simply removing the fuse holder and sticking a voltmeter probe into it. Run a continuity check on the fuse. Check tubes by substitution, beginning with the HV rectifier, horizontal-output, damper, and any other tubes in the horizontal circuit. Some sets have a dc restorer tube or crystal (usually a 6AL5 or a germanium crystal) coupled to the video output and this should also be checked.

Poor low voltage may affect operation of the horizontal oscillator, causing no raster, though sound may be heard. Check the



brightness control, bias on the CRT, video-amplifier tube, screen capacitor of the video amplifier, and coupling capacitor in circuit for vertical-retrace blanking.

Remove the HV lead from the CRT. Connect a vtvm and using a high voltage probe measure high voltage. Voltage lower than 12 kv indicates trouble in high voltage or horizontal-sweep stage. Approximately correct high voltage indicates trouble in brightness circuit, video-output stage, or CRT. Measure voltage at grid of horizontal-output tube. Should be 18 to 35 volts negative and if it is, this indicates that the trouble is between the grid and HV lead to the CRT. Change horizontal-output and damper tubes, and HV rectifier. If condition is not cured, measure B+ voltage at boosted side of damper tube. If fuse is in good condition, trouble may be horizontal-output transformer. No negative voltage at grid of horizontal-output tube indicates trouble in horizontal-oscillator circuit or preceding portion of horizontal sweep. Measure B+ voltages.

Failure of the high voltage, causing loss of raster, can be due to a number of capacitors, such as HV filter, the plate, grid, and screen grid capacitors of the horizontal-output tube; cathode and plate capacitors of the damper tube (the latter usually causing the HV fuse to blow); the capacitor across one-half of winding of horizontal-deflection yoke, which can cause the HV fuse to blow.

Several resistors in the high voltage and associated circuits can result in a loss of raster. These are the HV filter resistor connected between the HV rectifier and CRT; filament resistor of the HV rectifier; grid and screen-grid resistors of the horizontal-output tube; and the cathode resistor of the damper tube.

Other defective components likely to cause loss of raster, are the width coil, the plate caps of the HV rectifier and horizontal-output tube (which may be broken, corroded, or fused) the coupling capacitor connected between the video-output tube and the CRT, and the sawtooth capacitor and resistor connected between the horizontal oscillator and horizontal-output tube.

Some sets have an R-C network across the windings of the horizontal-output transformer to prevent damage should the plate cap of the HV rectifier touch the chassis; this also limits amount of current flow in short circuits, and reduces shock hazard in transformerless sets. If capacitor, about .001  $\mu$ f, becomes defective, raster may be lost.

Other components, if defective, that can cause this condition are the horizontal and vertical windings of the yoke; capacitors at

the plate and grid of the horizontal-oscillator tube; coupling capacitor at plate of the horizontal oscillator; horizontal-output transformer; and cathode bypass capacitor of agc amplifier.

Loss of high voltage can sometimes be caused by arcing at the yoke socket denoting breakdown. Also check positioning of focus unit and deflection yoke on neck of CRT. Improper positioning (components touching) may cause vertical- and horizontal-deflection coils to short to the focus unit.

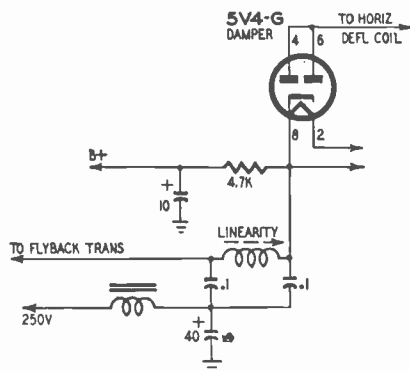


Fig. 2-N. Damper tube and horizontal-linearity circuit.

### No raster when set is turned on, followed by loud noise

**SYMPTOMS:** No high voltage during warm-up period, then a loud noise is heard in the speaker, followed by appearance of raster or pix.

**SERVICE:** Probably caused by defective component in horizontal-output or HV section. Check tubes. Test on tubes should be aimed at slow warmup. Substitution is preferred to see if condition is corrected thereby. Check the cathode of the damper tube or at each end of horizontal-linearity coil. See Fig. 2-N. There may be an intermittent condition in the high-voltage transformer. Be sure socket of HV rectifier has good contact with tube pins, and that there are no loose connections or poorly soldered joints in the horizontal-sweep system.

### No sound, focus poor

**SYMPTOMS:** Sound missing, accompanied by defocusing of pix.

**SERVICE:** In some sets the focus coil feeds the screen and plate circuits of the audio-output tube, and focusing is controlled by a

potentiometer in the cathode circuit. Any defect in the audio stage such as coupling capacitors, screen and plate bypass capacitors, cathode resistor, audio-output transformer and audio tube might cause this condition.

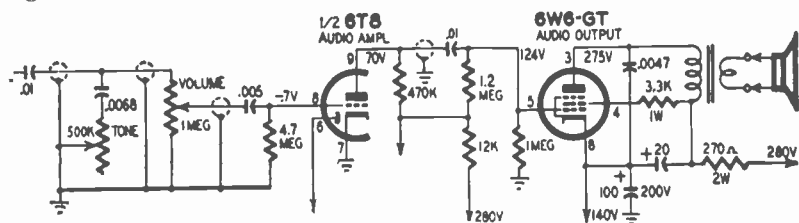


Fig. 3-N. Typical audio amplifier and output circuits.

### No sound, good pix

**SYMPTOMS:** Sound missing, pix good on all channels.

**SERVICE:** Check by substitution, all tubes beginning with the sound take off point, including audio if amplifiers, audio detector and output tubes (Fig. 3-N). Tune in pix. Adjust volume control near maximum position. If no sound, check speaker cable. If hum or buzz are present, speaker and cable are satisfactory. If this condition is noted on only one or several channels, the individual oscillator slugs in the tuner may require adjustment.

To check the audio circuit from take-off point to output, remove and reinsert sound tubes in sockets. If clicks are heard in the speaker, signal is passing. Scratch grid points with tip of screwdriver; spark plate pins of tubes (be careful). If good, bars will flash on screen. Measure negative voltage from top to bottom of the parallel RC combination in the plate circuit of the ratio FM detector. A no voltage reading indicates FM signal is not passing to the ratio detector. A normal negative voltage, as designated by manufacturer's schematic, indicates trouble is in the audio amplifier and output stages. This voltage is varied by switching channels.

Check all 4.5-mc adjustments in sound take-off and amplifier circuits; ratio-detector transformer; screen resistor and capacitor of audio if; grid resistor of second audio if; coupling capacitor between audio amplifier and output tube; plate resistor of audio amplifier; cathode resistor of audio-output tube; capacitors at plate and screen of audio-output tube; audio-output transformer and voice coil of the speaker.

### No sound on some channels

**SYMPTOMS:** Sound comes through on some channels, not on others.

**SERVICE:** Individual oscillator slugs in tuner may be out of adjustment. When there is no sound on high channels, with or without pix, check the oscillator tube.

### **Noisy pix**

**SYMPTOMS:** (A) Weak or noisy tubes in the tuner, video if, or video amplifier. (B) Overall gain too low requiring contrast control to be advanced beyond point where noise in rf tubes begins to show in pix. (C) Video carrier too low on response curve. In considering these symptoms, remember that tubes are the most frequent offenders. However, there are many instances of noisy resistors (particularly in the last if stage) as well as noisy capacitors and even coils (at the connecting points).

**SERVICE:** (A) Replace tubes. (B) Check gain of video amplifiers, video if and tuner. Check voltages, resistors and capacitors in suspected stage. (C) Adjust oscillator frequency in tuner unit. Realign if and rf circuits to provide proper overall frequency response characteristic. Insufficient agc will cause this trouble too.

### **Noisy sound (in fringe areas)**

**SYMPTOMS:** Static-like noises in the sound.

**SERVICE:** In fringe areas the agc is adjusted so that the set operates at maximum sensitivity. In intercarrier type sets the sound is deliberately set far down on the response curve, hence sound signal is attenuated.

Readjust the sound take-off and if transformers. Those if transformers near the sound if carrier are the only ones requiring such adjustment. Adjust the primary of the discriminator transformer or ratio detector for maximum volume. Check sound if and audio tubes for weak condition. Increase size of all audio stage cathode-bypass capacitors. Replace antenna with type having more gain. If the oscillator slug in the front end is not properly adjusted, the sound may be weak or absent.

### **Oscillation in pix**

**SYMPTOMS:** Ghost lines appear after small objects in pix; may be accompanied by horizontal tearing and streaking.

**SERVICE:** Check (by substitution) all tubes in video if stage. Condition may also be caused by defective series or shunt peaking coils (usually, the shunt resistor opens), or by bypass capacitors in video if circuit.

### **Oscillation in pix if**

**SYMPTOMS:** Excessive voltage across the video-detector diode load resistor. Loss of video output.

**SERVICE:** Usually a result of two stages being aligned to the same frequency with consequent regeneration. Check alignment. Increasing the grid bias may stop the oscillation which may also be the result of defective bypass capacitors or defective transformer shunting resistors. The grid leak of the following tube in an if stage has a shunting effect across the coil in the plate of an inter-stage network. Similarly, a resistive plate load can shunt a following coil, as in the case of an if stage feeding a pix detector.

### **Oscillation (parasitic) in tuner**

**SYMPTOMS:** Weak or no pix on some channels, and/or bars on the screen.

**SERVICE:** Can be caused by parasitic oscillation in tuner. Check

by shorting oscillator tank circuit. If grid to ground voltage is present, parasitic oscillation is indicated. This technique does not always work, since it can kill the parasitics too. Try shorter leads, redress grid and plate wiring. Some tuners have neutralizing capacitors. Check these.

### **Oscillator (tuner) drifts**

**SYMPTOMS:** After the set is turned on and fine-tuning control is properly set, sound becomes distorted and pix blurs.

**SERVICE:** Drift in oscillator frequency can be caused by a defective oscillator tube, or a defective capacitor or resistor in this circuit. Sometimes, when the oscillator has been replaced by a new tube, it is necessary to adjust the individual oscillator slugs in the tuner. A fluctuating line voltage can also cause this condition.

Since a slight change in the characteristics of the oscillator tube will often cause drift, it will be necessary to try a few tubes. If this does not help, check the parts in the circuit. Use exact replacements because many components are temperature-compensated to minimize drift warmup. Be especially careful about positioning as distributed capacitances are often important. When replacing parts, always maintain original wiring layout.

### **Overlapping pix**

**SYMPTOMS:** Patterns of pix on screen overlap.

**SERVICE:** Caused by too high frequency of horizontal oscillator or improper adjustment of the horizontal-oscillator tank slug. Can also be produced by defective capacitors and resistors in the horizontal-oscillator tank circuit. Be careful of replacements, as capacitors may be special temperature-compensating type.

Overlapping can be either horizontal or vertical. Too high a vertical oscillator frequency is cause of vertical overlap.

### **Overloading in pix**

**SYMPTOMS:** Contrast excessively dark. Sync may be poor.

**SERVICE:** Condition caused by excessive amplification of video signal. Check for improper (too little) agc voltage and excessive plate or screen voltages on video if tubes. A high gain antenna in a strong signal area will produce this condition. Check for possible misalignment of video if strip.

### **Peaking coils**

When dark scenes become light and light scenes become dark, check peaking coils of video amplifiers. These coils should have a low resistance, ranging from 2 to 10 ohms. Replacement should be identical with original.

Defective shunt and series peaking coils in video amplifiers can cause loss of detail. Too high shunt resistor across the peaking coil can result in ghost lines after small objects or a sharply defined line or edge in pix. A shunt peaking coil (not wound on a resistor) but defective, makes stage inoperative, causing loss of pix. When peaking coil is shunted by a resistor and the coil is defective, pix becomes too bright and detail is lost. A series peaking coil with shunt resistor defective causes dim pix and poor pix quality; also critical sync action.

When replacing the peaking coils, mount them at right angles and space them away from the chassis. A defective shunt peaking coil (wound on a resistor) causes plate voltage of the tube to be partly lost. A series peaking coil is defective (open) if the ohmmeter shows value of parallel resistor, or if the resistance of coil is zero (short).

### **Pie-crust effect on pix**

**SYMPTOMS:** Test pattern evidences jagged edges similar to pie-crust. See Fig. 1-P. Rotating the horizontal-hold control will vary amount of pie-crust in the pix.

**SERVICE:** Usually caused by defective capacitor in grid circuit of horizontal-oscillator tube. A similar effect is produced by faulty horizontal-output tube. May also be caused by defective resistor and/or capacitor in cathode circuit of horizontal-oscillator control tube.

In horizontal afc circuit, check all capacitors between horizontal-discharge tube and reactance tube, and also in grid circuit of reactance tube.

### **Pincushion effect**

**SYMPTOMS:** Sides of the pix are bent to resemble a pincushion.

**SERVICE:** Could be caused by a defective deflection yoke. Often

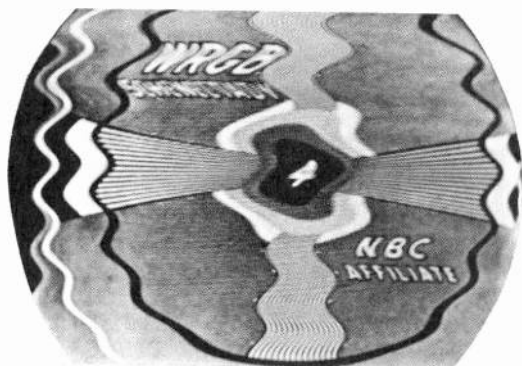


Fig. 1-P. *Pie-crust effect in pix.*

*courtesy G-E Techni-talk*

shorted turns in the yoke will produce this condition. Pincushion and barrel effect can also be produced by a mismatch between the horizontal-output transformer and the yoke. Check to see that there is no magnetic field too close to the pix tube. Make sure the speaker and the transformers are not creating magnetic fields which would cause pix distortion. (A small pincushion effect is a normal characteristic of most high-efficiency 70-degree deflection yokes, especially those with cosine-type windings. The picture size is usually adjusted so that the concave edges are outside the mask.)

Many of the curved-face (or so-called "cylindrical") rectangular tubes are designed to eliminate room glare. These include the 17LP4, 17QP4, 21EP4A, 21FP4A, and 21KP4A. When a cosine-wound yoke is used with these tubes for sharp edge-to-edge focus, pincushion effects are set up. See Fig. 2-P.

To eliminate them, two magnet slugs are placed above and below the tube at the beginning of the flare. These magnets extend slightly beyond the frame of the yoke housing and are suspended by an adjustable wire support.



When replacing defective picture tubes of this type, the magnets may have to be readjusted, particularly if they are accidentally moved from their original position.

Unless a station pattern is on, or a cross-bar generator used, the pincushion effect may not be too noticeable. But when viewing televised scenes with vertical or horizontal sections, the viewer would notice the bending effect and distortion. Adjustments are simplified if the picture size is reduced slightly so the pincushion effect can easily be seen. The magnets should then be adjusted until the picture is perfectly rectangular, after which the size can be increased to fill the mask properly.



Fig. 2-P. *Pincushion effect in pix.*

This adjustment will not correct poor sweep linearity or over-drive conditions. Such defects must still be overcome with the usual controls.

### **Pix appears on channel adjacent to proper channel**

**SYMPTOMS:** When set is turned on, pix appears on channel adjacent to proper channel, then after short time of operation, appears only on correct channel setting.

**SERVICE:** Probably caused by defective component in oscillator-mixer circuit of tuner (such as turret-tuner strip), generally in the grid circuit.

### **Pix blurred**

**SYMPTOMS:** Poor definition and high-frequency response. (A) Blurred pix on strong signals; may be caused by limiting in the video stages. (B) Video carrier too high on response curve. Pix may have tendency to horizontal jitter.

**SERVICE:** Make routine check of focus-control adjustment, and

individual oscillator slugs in tuner; also all tubes, by substitution, through which video signal passes. May be caused by defective capacitor between brightness control and ground. (A) Reduce contrast control setting to obtain less input to the video amplifiers. Check agc circuits for proper operation. Check plate and coupling capacitors in video if and video amplifiers for dc leakage; also peaking coils in video-detector and video-amplifier stages. (B) Realign if or rf circuits to provide proper overall frequency-response characteristics; video carrier 50% below top of response curve.

### **Pix bounce (see also Jitter)**

**SYMPTOMS:** Vertical jitter in pix.

**SERVICE:** Incomplete sync separation is a common cause of trouble in the integrator. If the video information is not completely removed, it will be integrated to produce unwanted vertical sync pulses. This can cause the vertical oscillator to trigger slightly before or after the normal pulse time, making the pix bounce or jitter up and down as each vertical sweep begins sooner or later than it should, by differing amounts.

With the values of the components in integrator circuits becoming so standardized, several components manufacturers are producing printed integrating circuits. They are extremely compact, but should any component in the unit become defective, the entire assembly has to be replaced.

In addition to the integrating network, also check the sync separator tubes and parts, for these could contribute some instability in the vertical circuit. Such trouble is not so readily apparent in the horizontal system due to lock stabilization. Replace any resistors or capacitors in the vertical system that are off by more than 10% of rated value..

This trouble can also be caused by too strong a signal, contrast too high, or a defective vertical-sync tube. It often results from improper sync clipping.

### **Pix compressed at top**

**SYMPTOMS:** Pix crowded at top; people have short heads and long legs. In test pattern, top wedge is shorter than bottom wedge.

**SERVICE:** May be caused by misadjustment of vertical size and linearity controls by set owner. See Fig. 3-P. Check vertical-output tube, components in circuit; also possibility of defective resistor connected to one side of vertical-linearity control.

## Pix compression, right side

**SYMPTOMS:** Pix squeezed on right side.

**SERVICE:** A compressed right side of the pix could very well be caused by a mismatch. For good results in terms of linearity and general performance, both the horizontal-output transformer and horizontal-deflection coils should be matched.

Try adjusting the linearity, drive and width controls, readjusting each one slightly after changing the others. Also try different

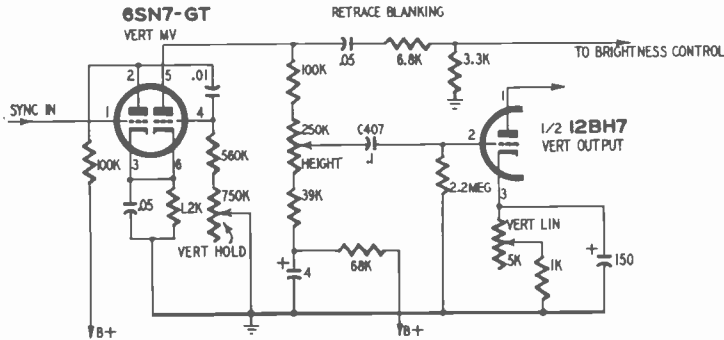


Fig. 3-P. Defective components in vertical oscillator and output can cause pix compression at top.

values of capacitors in the linearity filter of the damper tube. If these measures do not yield satisfactory horizontal linearity, you will have to get a matching output transformer for the yoke, or vice versa.

## Pix contracts severely (horizontally)

**SYMPTOMS:** Pix contracts. Has partial foldover with vertical white line.

**SERVICE:** Check capacitors on either side of the horizontal-linearity coil in the damper circuit. Also refer to foldover, horizontal.

## Pix dark, with buzz

**SYMPTOMS:** Excessive contrast. Usually too much signal output from the video detector, accompanied by buzz. Occurs mostly in strong signal areas.

**SERVICE:** First check tubes, such as agc keyer, amplifier and/or rectifier. Then look for defective agc filter capacitor or resistors in the agc line.

## Pix definition, poor

**SYMPTOMS:** Pix seems washed out.

**SERVICE:** The washed-out pix may be caused by: improperly aligned if system, poor tuner tracking, defective agc system, or video amplifier. Replace the coupling capacitor to the input of the pix tube (if such a capacitor is used). Next, check the agc. Too much agc bias will cut down the gain of the rf and if systems and cause poor pix gain.

All television receivers in use today are not designed for an ideal 4-mc if bandpass. If the video if amplifier consists of only two or three stages, bandwidth is sacrificed to get adequate gain. This poses an impossible problem for the servicing technician when the customer insists on better picture quality. If slight defects in the receiver are contributing to the poor definition, corrective measures can often be taken. Careful checks should be made on the focus-control system, the video if alignment, the rf tracking, and the antenna system. With these working at peak performance, remarkable improvement is often realized. Realign receivers only as a last resort and only if you have the equipment capable of doing a good job.

Checks should be made on the focus-control circuit. See Fig. 4-P. If the focus control requires an extreme setting, or is entirely ineffective, the voltage across the focus coil as well as the current through the resistive network of the control should be tested against manufacturer's data. Changes in resistance values in the focus-control circuit or a defective focus coil can bring about inability to secure good focus. Low or abnormal high voltage can also produce defocusing. (Modern receivers do not have electromagnetic focus units but use permanent magnet units instead. Adjust the screws or slugs of the pm unit to see if a sharper pix can be obtained.)

If the focus control gives best results at around mid-range but the picture is not satisfactory then the trouble, most likely, is elsewhere. This could include improper alignment of the if system or poor tracking in the tuner. Improper if alignment gives poor picture quality on all stations, while improper tracking may affect only *some* stations. This depends on the tuner used:

A contributing cause to poor picture quality would be standing waves on the transmission line. A mismatch between the line and receiver input means that all the energy is not absorbed by the receiver's rf stage. The unabsorbed energy is reflected back to the

antenna and sent back down the line again. Simultaneous reception of the direct signal and the reflected signal of the lead-in can displace (horizontal jitter) picture line structure enough to blur the picture. Matching the transmission line to the receiver impedance will help a great deal on blurry channels.

“Ringing” or a slight “echo” effect which causes repeats to the right of sharp vertical lines due to transient oscillations in the video system can also cause poor picture quality. This calls for a check of the peaking coils in the video amplifier and, in addition,

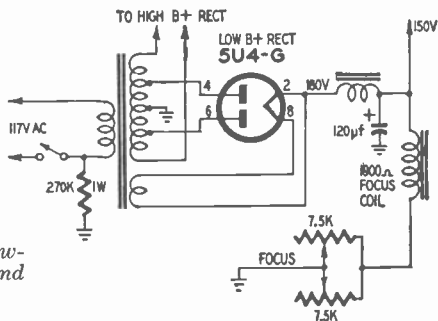


Fig. 4-P. Focus coil is part of low-voltage supply. See also Fig. 2-F and Fig. 3-F.

the rf tracking and if alignment. If the video-response curve favors the high-frequency sideband components, rf or if stages can easily be pulsed into damped oscillations.

An oval beam within the picture tube instead of a perfectly round beam will cause poor definition. This can be ascertained by rotating the picture tube approximately 90 degrees. In such a case, if the horizontal wedge is slightly obscured but the vertical wedge is clear, the opposite would be true after the tube is turned. This immediately gives an indication of an incorrectly formed electron beam which cannot be focused to a circular pin-point on the phosphor screen. Tube replacement is, of course, necessary in correcting this condition. However, check the ion trap adjustment first!

### Pix delayed later than sound

**SYMPTOMS:** Pix appears on screen after sound has been heard.

**SERVICE:** Check horizontal-output tube and B+ boost filter capacitor. May also be caused by defective horizontal-phase coil oscillator transformer. This trouble is sometimes caused by the slow warm-up of the filaments in one or more of the if tubes. Check this by tube substitution.

## **Pix dim**

**SYMPTOMS:** Weak, poor quality picture. See Fig. 5-P.

**SERVICE:** Check the video-amplifier tube (or tubes) and the associated components, particularly series and shunt peaking coils in the video-amplifier circuit.

Is the dim pix the result of poor brightness or contrast? If contrast, then trouble may exist in the if stages, tuner, etc. If brightness, then this may be the result of HV defects, weak pix tube, or trouble in the low-voltage supply.

## **Pix divided horizontally**

**SYMPTOMS:** Split picture with vertical black bar in center.

**SERVICE:** Caused by improper sync phasing, resulting from defective capacitor in tuned circuit of horizontal discriminator. Can also be caused by improper adjustment of slug in horizontal discriminator. Check R-C combination in grid circuit of horizontal oscillator.

## **Pix drift**

**SYMPTOMS:** Picture fades out on high frequency channels. Noise levels increase and snow effect becomes severe. Slight drift also exists on lower channels. Replacing local oscillator tube does not correct the condition.

**SERVICE:** The drift could be due to improper tracking or misalignment of the video if stages. Improper tracking and alignment usually result in more critical performance on the upper channels because normal oscillator drift has a more pronounced effect on the higher frequencies. If the bandwidth is too narrow, normal oscillator drift will not be noticeable on the lower channels, but would be on the higher. This is particularly true if lower channel stations are being received better than the higher. Stations from some distance also fade out on occasion. In either case (oscillator drift or fade-out) the signal-to-noise ratio decreases and the result is increased noise and picture interference. With volume control and contrast up high, the low signal-to-noise ratio becomes serious. Automatic gain-control circuits work in this fashion also. With no signal input, the resultant low bias on the amplifier tubes increases gain and also noise, with little or no signal riding through.

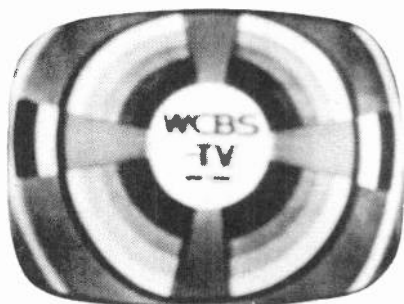
Try adjusting the sound and picture output trimmers on the tuner. These may not be giving a good match between tuner and if stages. Try several different rf tubes also. Some give a better signal-to-noise ratio than others, which means decreased snow effect.

Oscillator drift can be caused by a defective oscillator tube. Try changing the tube. Check the grid resistor and capacitor of the oscillator. See if they have changed value. If so, replace.

### **Pix fading**

**SYMPTOMS:** Pix fades in and out.

**SERVICE:** Often caused by loose transmission line flapping in wind. In the case of uhf channels, antenna vibration can cause fading.



*Fig. 5-P. Defect in video amplifier can produce poor-quality pix.*

### **Pix incomplete vertically**

**SYMPTOMS:** Pix has overlapped appearance with dark space at top or bottom of screen. Vertical hold critical. See Fig. 6-P.

**SERVICE:** Caused by defective resistor in vertical-hold control circuit, rendering vertical-oscillator frequency incorrect. A change in time constant circuit prevents obtaining single complete pix from top to bottom.

### **Pix inverted**

**SYMPTOMS:** Pix is upside-down.

**SERVICE:** Secondary leads of vertical-output transformer may be wired incorrectly to yoke. Reverse the leads. The only other condition causing pix inversion would be a case of extreme foldover.

### **Pix out of shape**

**SYMPTOMS:** Pix pulled out or pushed down, at top.

**SERVICE:** Probably caused by magnetic field of a PM speaker near flare of CRT. Try to relocate speaker in cabinet. See also horizontal nonlinearity.

## Pix overload

**SYMPTOMS:** Picture shifts horizontally when the fine tuning or contrast control is operated. This happens on strong local stations but this difficulty does not appear on distant stations.

**SERVICE:** On local stations the picture is so strong that it overloads the video amplifier. This causes the sync pulses to be clipped, which in turn makes the horizontal sweep unstable. Use a smaller

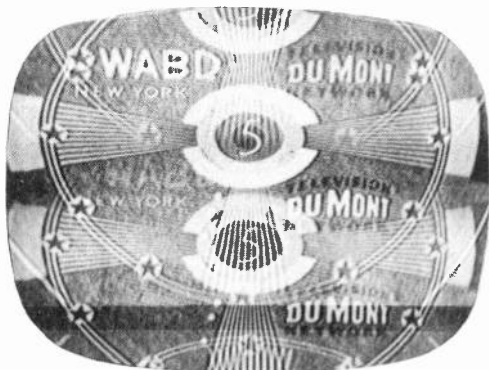


Fig. 6-P. Defect caused by trouble in vertical-hold control circuit.

coupling capacitor from sync to afc, or use a lock-range capacitor.

This last item is simply a trimmer bypass capacitor on the sync feed from the video amplifier. It bypasses part of the sync signal to ground, just as drive controls work on the horizontal-amplifier grid. The trimmer is adjusted for suitable locking range. See Fig. 7-P.

## Pix parts pull out

**SYMPTOMS:** Pieces of pix appear to be plucked out momentarily, usually toward right side of screen.

**SERVICE:** Generally caused by defect in horizontal or sync circuits. Check by substitution all tubes in both stages; also coupling capacitors between video amplifier and sync separator, and between the noise-gate tube and sync-separator tube, and sync to afc or oscillator. See Fig. 8-P.

## Pix pulling, horizontal (see also Bend in pix)

**SYMPTOMS:** Vertical lines tend to weave. Intermittently, on severe pulling, the screen goes black and the picture is lost for a while. Picture bends and weaves.



**SERVICE:**When the picture bends or weaves, the trouble could be caused by any one of the following conditions: improper adjustment of horizontal-lock system; defective tubes or parts in the horizontal-sweep and afc systems; defective tubes or parts in the sync-separator stages; improper sync amplitude caused by poor tuner tracking or video-if alignment; signal overload or defective agc.

Video-amplifier tubes sometimes contribute to pulling by clipping a portion of the sync tip. This can happen even in a tube which checks all right in an emission tube checker. Tube cutoff occurs sooner than it should and clips the highest level of the signal (the sync tips).

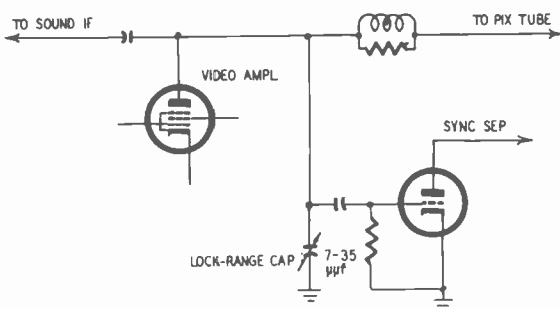


Fig. 7-P. Lock-range capacitor in sync separator circuit.

Intermittent blanking out, however, seems to indicate agc trouble. Insufficient agc voltage can cause overload by allowing excessive gain and sufficient overload can blank out the picture.

The trouble may also be caused by a weak signal. To check, tune to different stations. If pulling disappears, trouble is caused by insufficient signal. Try reorienting antenna.

Can be caused by sync pulse distortion or hum modulation affecting horizontal oscillator. To check, adjust centering control so edge of raster is visible. Tune to off channel. If no pulling is observed, trouble is probably in stage through which video or sync signals pass. Otherwise it will be necessary to make a check on the sync and the afc sections.

In sets where sync take-off is located after stage containing contrast control, rotate contrast. If pulling increases, trouble is before video output tube. If pulling decreases, trouble is in video amplifier, dc restorer or sync stages.

Check the video amplifier and dc restorer tubes, coupling ca-

capacitors in video amplifier and output stages, the plate-load resistors in those circuits, and the contrast control. Condition may be caused by incorrect bias on the video-amplifier tube. This trouble can also be the result of attenuation of sync pulses because of poor low-frequency response. Misalignment of tuner, or more often, video if stages are the cause. Poor low-frequency response can also exist in video-amplifier circuits. Check peaking coils, load resistors, coupling and filter capacitors and decoupling resistors in the video amplifier. Replace video-amplifier tubes.

There may be excessive video-signal input to the video amplifier, produced by a defective agc tube, regeneration in video if amplifiers, increased value of video-detector load resistor. Excessive signal overdrives grids of video-amplifier tubes, resulting in limiting or clipping action, and cutting sync amplitude to a lower level. Clipping may not be due to excessive signal voltage but rather to low B+. Make sure plate voltage on video-amplifier tubes agrees with values stated on manufacturers' schematics. If not, trace B+ bus back to low-voltage power supply. Insufficient B+ is usually caused by filter capacitors having decreased in value; resistors in series with the B+ line having increased in value. Replace LV rectifier.

Video amplifier overloading can sometimes be cured by raising the B+ through connection to a higher voltage source, such as the B+ boost. You may have to change the bias on the tube, and the screen voltage also, if the tube is a pentode.

Agc control is usually an adjustment control on rear apron. This potentiometer may have been tampered with by control-happy set owner.

Heater-cathode leakage in any tube from the tuner to the last video amplifier, sync and horizontal afc can cause pix pulling. This differs from usual pulling action in that pix seems divided into dark and light horizontal sections.

Pulling can be due to magnetic field near cone of metal pix tube. Move speaker to see if pulling disappears. Pulling due to magnetized cone appears in raster as well as in pix.

Condition may be caused by trouble in the yoke, accompanied by other forms of distortion. Pix pulling at top of raster is occasionally caused by poor regulation of the power supply; the vertical-sweep circuit requires heavy surges of current, and these surges cause fluctuation in the B+ supply voltage unless the filter capacitors are sufficiently large and have a satisfactory power factor. The fluctuation in supply voltage affects the operation of the

horizontal oscillator, and the horizontal-sync control circuit. Turn selector to blank channel. Turn down contrast. If raster is distorted at edges trouble probably is in sweep circuits or power supply.

Check tubes in horizontal circuit; damper tube; noise inverter and sync separator tubes; bypass and coupling capacitors in sync circuit; also dc blocking capacitor connected at grid of vertical-sync separator; and cathode resistor of sync amplifier. In sets using

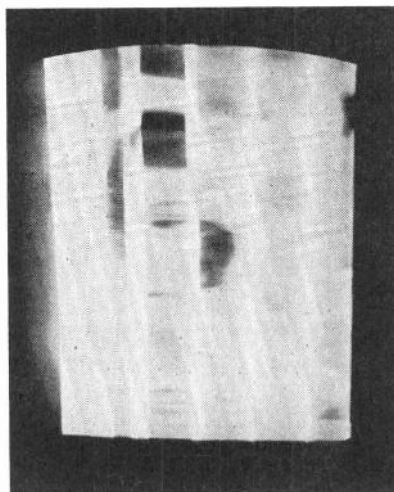


Fig. 8-P. *Pix pullout caused by open coupling capacitor.*

the audio-output tube as a voltage divider, a defect in that circuit, lowering B+ voltages in associated circuits, could cause this condition.

### **Pix reversed horizontally**

**SYMPTOMS:** Pix reversed from left to right on screen; possibly insufficient width.

**SERVICE:** Try reversing leads to the horizontal-deflection coils.

### **Pix shakes (see also Jitter and Microphonics)**

**SYMPTOMS:** Vibration of pix.

**SERVICE:** If shaking is pronounced when volume control is rotated to high level, replace bypass capacitor at screen grid of audio-output tube, or add additional filter capacitor. Check horizontal-output tube; also HV wire from rectifier to CRT, and wire to

caps of horizontal-output tube and HV rectifier. These wires sometimes break under the insulation causing the pix to shake.

### **Pix shimmering**

**SYMPTOMS:** Pix trembles (weak signal areas)

**SERVICE:** May be necessary to install another type antenna or raise height of present antenna. Condition may possibly be relieved by reorienting antenna. Check rf amplifier tube.

### **Pix stretch (see Left-hand stretch)**

### **Pix tearing**

**SYMPTOMS:** Pix tears and rolls on strong signals.

**SERVICE:** Pix tearing and rolling on strong signals may be caused by overloading of the 3rd video if amplifier. The low plate voltage of this tube and higher signal input (compared to preceding stages) can prevent it from properly handling strong signals. (Check bias on this tube.) See Fig. 9-P.

Check rf amplifier, video if tubes, and horizontal-output tube, if tearing is to right; also capacitor in plate circuit of the video amplifier.

### **Pix tilted**

**SYMPTOMS:** Pix is up or down hill.

**SERVICE:** Correct improper positioning of yoke.

### **Pix weak or flat**

**SYMPTOMS:** To check, observe pix at maximum and minimum contrast control settings. If an increase in snow is not observed at maximum control, trouble probably is in video amplifier, video detector, or video if amplifier circuits. If an increase in snow is noted, trouble probably is in tuner or first video if stage. If there is poor contrast, black and white values, and pix is grayish and mushy white, video-amplifier tube may be weak.

**SERVICE:** Make routine check of agc controls at rear of set. Check all tubes by substitution through which video signal passes, including the agc tube. In sets using the audio-output tube as a voltage divider, check that tube. Condition can be caused by an open peaking coil reducing gain of video amplifier; wrong value or partially shorted peaking coil. Check continuity of peaking coils in video-detector and video-amplifier circuits. Substitute peaking coils.

Check coupling capacitor (if used) between video amplifier and CRT; also video-amplifier plate resistors; and video if coils. Even though sound is satisfactory in every respect, pix can still be weak since an antenna usually will pick up sound signals stronger than video signals. If weak pix is accompanied by weak sound, check lead-in dress between tuner and if amplifier. Dress wire away from chassis. (See also pix with snow.)

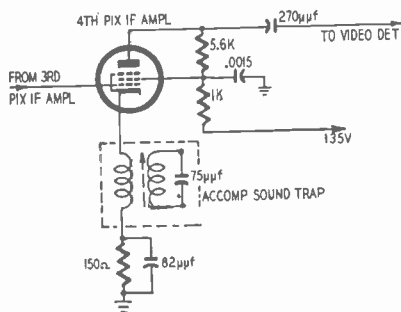


Fig. 9-P. Overloading of last pix if amplifier produces loss of horizontal and vertical sync.

### Pix weak, poor quality. Sound distorted.

**SYMPTOMS:** Picture and sound quality good when set is turned on but gradually become poor in quality. Oscillator shifts frequency or stops oscillating entirely.

**SERVICE:** Often caused by cold-soldered or rosin connections on the tuner terminals or switch contacts. Resolder each connection with a *hot iron* and *fresh solder*. In several cases sweating these connections has saved replacement of the entire tuner. Other common causes of trouble: the oscillator, oscillator control, and low-voltage rectifier tubes, and small ceramic capacitors in the oscillator grid and coupling circuits.

### Pix weave at top

**SYMPTOMS:** Picture bent slightly at the top.

**SERVICE:** Bending at the top of the picture indicates insufficient sync pulse amplitude and possibly a change of sweep-circuit operating characteristics. Try a new sync-limiter tube as well as a new sync amplifier-separator. A change of characteristics in the video amplifier can also clip the sync pulses even though the tube checks OK in an ordinary tester.

Check for proper plate voltages at both sweep oscillators. Improper alignment of video if stages can also cause these symptoms because it can contribute to poor low-frequency response and thus decrease sync amplitude. Check video-amplifier voltages.

### **Pix with smear**

**SYMPTOMS:** Large smear (to the right) following objects. Definition and focus are poor. Can be black streaks trailing from black or white streaks trailing from black.

**SERVICE:** A number of defects can produce this condition. First check controls at rear of set for misadjustment. If fine-tuning control must be rotated to limit to obtain a better pix, adjust individual oscillator slugs in tuner. Smear on one channel only usually indicates slug for that channel needs adjustment.

Rotate fine-tuning control again. If smear is less when control is at one side of best sound point, trouble is probably in rf stage or video if section. In video if stages, defective screen, cathode-bypass, coupling, and decoupling capacitors; defective plate, screen and cathode resistors, can cause smear.

This trouble can be the result of regeneration in rf or video if stages. Best observed through use of sweep generator and scope. Regeneration will show up as a high peak (or peaks) in the signal. Signal on scope screen may seem erratic. (Improper use of test equipment will produce regeneration.)

If set does not use direct coupling in video stages, shunt coupling capacitor with similar unit.

Set may be overpeaking at high frequencies. Make sure damping resistors have not increased in value.

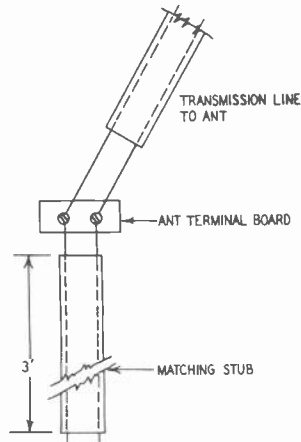
If smear exists on one or two adjacent channels, then trouble is due to an impedance mismatch between transmission line and set. First, check for video overload at antenna. If so, rotation of the contrast control does not affect overloading. Check agc control. Disconnect one of lead-in wires from set. If smear is caused by excessive signal, pix will be weaker but less smeared.

Connect about three feet of line to antenna terminals. See Fig. 10-P. This piece is a matching stub. Starting at end closest to antenna terminals, short the transmission line with a sharp razor blade. Set should be tuned to channel giving worst smear. At point where shorting the line with the blade produces the best pix, cut across with diagonal cutters and join the ends together. The regular antenna line should remain connected in the usual way and not be disturbed during this repair. Stub can be allowed to hang

loosely behind the set. If stub is not used, try connecting attenuator pad between lead-in and antenna terminals.

Excessive low frequency response causes streaking, also loss of vertical wedges in pattern. Check by observing vertical-blanking bar on screen. Turn up brightness. Bar should be darker than darkest part of pix. If not, low frequency response is poor. Check if voltages, capacitors and resistors before aligning.

Fig. 10-P. *Matching stub can be made from scrap piece of transmission line.*



Trouble can be caused by any tube in the tuner, video if amplifiers, video detector, agc, or video amplifiers. Also check LV rectifier tube or selenium rectifier; audio amplifier tube in those sets using that tube as a voltage divider. In sets using a 6BQ7 in the tuner, replace by a 6BQ7-A. If tube and component check does not help, it will be necessary to realign the video if amplifiers. Make sure no one has tampered with the tuner.

Check peaking coils in video detector and video amplifier circuits for opens. When replacing, mount away from, and at right angles, to each other. Dress away from circuit wiring.

Dress horizontal deflection yoke lead away from cathode or grid lead of CRT. Dress both leads away from vertical deflection leads.

Smear may possibly be overcome by connecting a 1500  $\mu\mu\text{f}$  to 4700  $\mu\mu\text{f}$  capacitor across unbypassed cathode resistor of the video amplifier; remove peaking coil in grid circuit of first video amplifier and replace by unit 120  $\mu\text{h}$  to 500  $\mu\text{h}$ ; keep coupling capacitor leads in video-amplifier stage apart; and increase value of coupling capacitors in video amplifier stage by maximum of 0.25  $\mu\text{f}$ .

## Pix with snow

**SYMPTOMS:** Pix covered with white spots or speckles. Not evident on strong signals.

**SERVICE:** Snow can be caused by noise from random voltages in tubes and components. Usually due to trouble in the front end of a TV set. Noise originates from (1) shot effect and (2) thermal agitation. The former occurs in vacuum tubes from the uneven flow of electrons from cathode to plate. Can usually be overcome by substituting a new tube of the same type. Several may have to be tried to obtain satisfactory results.

The mixer-converter stage is a common offender. When no pix and sound (or weak pix and sound) occurs only on some channels, trouble probably is in tuner; if noted on all channels, trouble may include the video if amplifier. In cascade tuners snow develops easily sometimes resulting in noise in speaker. May be caused by defective 6BQ7, 6BK7-A or 6BZ7 tubes.

Check for insufficient agc delay voltage. Increase by replacing the agc resistor with one having a smaller value (10% to 20% less). This will help raise the signal strength at the input to the video if strip and will override tube noise in these stages.

If this trouble shows up after the set has been operating for several minutes, check the agc voltage with a vtvm. If the if agc voltage decreases and the tuner agc increases when the snow appears, one of the video if tubes probably has a grid-cathode leak. Locate the defective if tube by substitution.

Trouble is frequently in antenna and/or lead-in. Check, using indoor antenna. Be sure controls at rear of set are properly adjusted. When the antenna is at fault, re-orientation may be necessary. Also, an impedance mismatch may exist between antenna, transmission line, and set input. In some instances, a booster may be required or installation of another type antenna. To check, rotate contrast and volume controls to maximum position. An increase in snow and audio hiss indicates that all stages from the mixer on are amplifying the noise. In such cases, trouble usually is in antenna, rf amplifier or oscillator. Defective tubes may be responsible. Check rf amplifier, mixer-oscillator, video if, video detector, and video amplifier and agc tubes.

If pix has snow with no reception on some channels, condition may be caused by defective low-voltage rectifier, or other causes of low B+. May also be caused by corona.

In areas where the signal is very weak and snow is considerable,

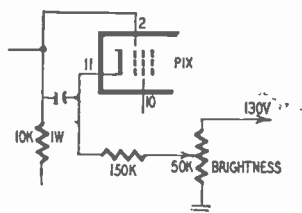


try connecting a 10  $\mu\mu\text{f}$  to 68  $\mu\mu\text{f}$  capacitor between grid and cathode of CRT to alleviate condition. See Fig. 11-P. (Pix may be smeared slightly.)

### Pix with snow during warm-up

**SYMPTOMS:** Pix is weak with considerable snow, which disappears after warm-up period; pix then shows evidence of overloading requiring adjustment of contrast control to obtain normal pix.

Fig. 11-P. Capacitor connected between control grid and cathode of pix tube improves snowy pix.



**SERVICE:** Condition probably due to defective rf amplifier tube or video if tube, as quality of pix is only as good as weakest tube. Since all tubes do not warm up at same rate, one tube probably is weak and should be replaced. Check by substitution.

### Printed circuits

A number of TV sets incorporate considerable printed circuit assembly wiring. Circuit tracing will be easier and location of connections facilitated by placing a 60-watt light bulb underneath the side being traced. The printed-circuit board is translucent.

Resistance or continuity measurements of coils, resistors, and some capacitors can be made from component side of board. In some instances, a magnifying glass will assist in locating very small breaks in wiring. On wiring side of board use needle point probes for circuit checking.

Sockets on some boards mounted upright on wiring side of board; hence tube pin numbers are counted counterclockwise. Clockwise direction usual practice when socket is viewed from bottom. When socket is mounted on component side of board, the key is located when viewing wiring side by absence of lug hole in board at key position.

Be careful when removing components from board; avoid damage to copper foil. Do not apply excessive solder. Do not over-heat terminals or copper foil with soldering iron; 35 watts or less recommended. If leads extending from defective component are not long enough, cut defective component in half and remove each from lead. Keep leads short.

Brush excess solder from lugs of components that are bent. Slip thin blade of knife between terminal and wiring foil while heat is applied. Clean soldering work on foil side of board with denatured alcohol. Spray area worked on with protective coating, avoiding putting any on socket contacts or any part that makes electrical contact. Always clean wiring side of board free of dirt and moisture.

**Pulling (see Bend in pix and also Pix pulling, horizontal)**

## Radiation

**SYMPTOMS:** 15.75-kc radiation from horizontal-sweep circuit. This trouble appears on nearby AM receivers as "birdies" or high pitched whistles every 15.75 kc on the broadcast band.

**SERVICE:** Try a 500- $\mu\text{f}$ , 20,000-volt filter capacitor from the second anode lead to ground *outside the HV compartment*. Also try a .01  $\mu\text{f}$ , 600-volt bypass capacitor from each side of the ac line to water-pipe ground. This line filter should be put on both the TV and the AM receivers.

## Raster brighter at top of pix

**SYMPTOMS:** Upper half of raster brighter than lower half. May be accompanied by insufficient height.

**SERVICE:** Usually caused by defective boost capacitor.

## Raster dim

**SYMPTOMS:** Raster is faint; not easily discernible.

**SERVICE:** May be caused by incorrect positioning of ion trap; defective HV rectifier, horizontal oscillator, horizontal-output transformer, etc.

In sets using an audio-output tube as voltage divider, check that tube. Trouble may also be caused by defective resistor and/or capacitor in the brightness-control circuit; filament resistor of the HV rectifier; or resistor between rectifier and CRT second anode; also check for defective CRT.

**Raster does not appear**

**SYMPTOMS:** No raster with any setting of the brightness control.

**SERVICE:** Measure high voltage (with HV probe) as brightness control is rotated over entire range; should show a decrease of 5 to 10% as brightness is increased, indicating that the CRT is drawing current from HV supply. If HV current is flowing, proper adjustment of good ion trap should provide a raster.

If HV probe is not available, CRT anode current can be checked by carefully holding HV lead near the second anode terminal with an insulated tool. A sustained arc indicates current is being drawn. A single spark, not sustained, indicates no current is being drawn.

If there is no high voltage, check by trying to draw an arc from HV rectifier and horizontal-output tube caps with an insulated screwdriver. Replace high-voltage rectifier, horizontal-output and horizontal-oscillator tubes if necessary. A voltage check in the horizontal-deflection circuit should reveal defective components. Fig. 1-R shows the HV rectifier circuit. (See also high voltage.)

**Raster, left side unlit**

**SYMPTOMS:** Left side of raster does not appear or is dim.

**SERVICE:** Condition is frequently caused by a weak selenium rectifier.

**Raster small (horizontal and vertical)**

**SYMPTOMS:** Raster or pix shrinks on all four sides. Sound volume may be diminished.

**SERVICE:** Most often caused by low B+ such as weak low-voltage rectifier tube or selenium rectifier. If replacing B+ electrolytics does not help, then the high voltage may be too high. This condition can be caused by a gassy horizontal-output tube (most 6BG6-G tubes are slightly gassy) which may be recognized by the small blue glow inside the tube. This is perfectly satisfactory and is troublesome only when gassiness is excessive. The best check is by tube substitution. A gassy horizontal-output tube, combined with above normal horizontal drive, will result in excessive high voltage. Also check damper tube. (See Fig. 3-H on page 76.)

Low line voltage may be the cause, especially when size is small accompanied by improper action of brightness, focus, sync, contrast, and/or sound controls. If condition usually occurs only in evening, line voltage drop should be suspected. When there is

no indication of such condition, in sets using 5Y3-G low voltage rectifier, try replacing by 5V4-G tube. After set has been operating for period of time, condition may be caused by several tubes with low emission. Check tubes by replacing (all of them) noting result of such substitution.

This trouble could result from improper adjustment of horizontal and vertical size and linearity controls.

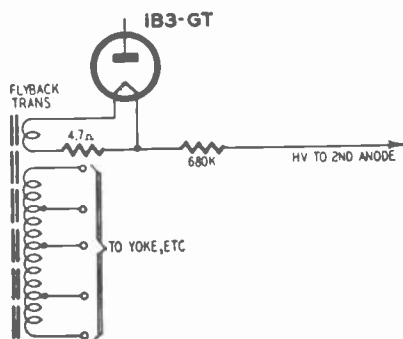


Fig. 1-R. HV rectifier circuit.

When the deflection yoke has a ferrite core in the form of a collar fastened around the yoke windings, a loosening of the segments can cause loss of width and height (if fed by boosted B+). Yoke should be positioned right up against flare of CRT. Check screen-grid bypass capacitor of horizontal-output tube. May be also caused by defective saw capacitor in the horizontal-output stage.

### **Raster, rolled-up (see also Foldover, vertical)**

**SYMPTOMS:** Bottom edge of raster rolls up about  $\frac{5}{8}$ -inch to form a bright band.

**SERVICE:** Replace vertical oscillator, vertical output, and low-voltage rectifier tubes. Another possibility is a faulty capacitor in the vertical section.

### **Raster with curved edge (left and right sides); no pix**

**SYMPTOMS:** (A) 60- or 120-cycle voltage in horizontal-deflection circuits due to heater-cathode leakage, or faulty bypassing. (B) Magnetic fields near the CRT. (C) Pincushion raster resulting from defective yoke.

**SERVICE:** (A) Replace tubes in horizontal-deflection circuit.

Check for excessive ripple on voltage buses and substitute filter and bypass capacitors. (B) Rotate yoke. If shape of raster does not change when rotated, trouble is not due to extraneous magnetic fields. (C) Check yoke resistance and shunt capacitors. Substitute new yoke.

### Raster with shadow in corners (see also Ion trap)

**SYMPTOMS:** One or more corner shadows or dark areas.

**SERVICE:** Improper adjustment of focus unit or ion trap. Adjust

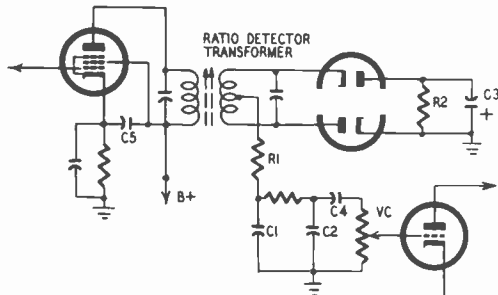


Fig. 2-R. Ratio-detector circuit. See ratio-detector check list.

focus unit or centering magnet to eliminate shadows when ion trap is adjusted for maximum brightness. Be sure deflection yoke is tight against flare of CRT.

### Raster with wavy edges

**SYMPTOMS:** Raster has alternate light and dark areas. Edges are wavy.

**SERVICE:** Caused by hum in horizontal-deflection circuit and in grid circuit of CRT, resulting from open filter capacitors in LV power supply.

### Ratio detector

Trouble in the FM detector stage can produce poor sound sensitivity, noise, distorted sound, and hiss. Circuit can be balanced or unbalanced, and does not require the use of a limiter tube. See Fig. 2-R.

To ascertain if trouble is before or after the FM ratio detector, measure the voltage at the top of parallel R-C combination connected to plate and cathode of the ratio detector. No negative

voltage indicates that the FM signal is not reaching the detector circuit; hence the trouble is somewhere between the video and ratio detectors.

The sound if stages in this circuit can be checked by scratching the grids of the tubes, sparking the plates to chassis, or by rocking the tubes in and out of the sockets. A noise in the speaker indicates these stages are passing the signal.

Check for open resistors and coils; or shorted, leaky, and open capacitors, especially the parallel resistor-capacitor combination in the unbalanced circuit of the ratio detector; and the parallel series resistor-capacitor combination in the balanced circuit. When a strong hiss is present check the de-emphasis network. See Fig. 3-R.

### RATIO-DETECTOR CHECK LIST

SYMPTOMS	SERVICE
No sound	Capacitor (C5) between screen of sound if tube and ground. See Fig. 2-R.
No sound	Resistor (R2) between plate of sound detector tube and ground.
No sound	Ratio-detector transformer. Also check alignment.
No sound or weak sound	Resistor (R1) between tertiary winding of detector transformer and capacitor (C1) in series to ground.
No sound or weak sound	Capacitors (C1, C2, C4)
Weak sound or distortion and buzz	Capacitor (C3) located between plate of sound-detector tube and ground.

### Reception poor on some channels

**SYMPTOMS:** Reception good on some channels, poor on others.

**SERVICE:** May be caused by break on one side of transmission line or bad antenna. Check by substituting indoor antenna. When reception is poor on low channels, but good on high channels, check agc tube. Defective tubes in cascode tuner may cause poor reception on low channels.

### Rectifier-tube failure, high-voltage

**SYMPTOMS:** High-voltage rectifier tube must be replaced fairly

often. Tube arcs if horizontal drive is advanced. Reduction of drive results in loss of brightness and insufficient width.

**SERVICE:** Excessive drive will shorten the life of the high-voltage rectifier tube. The fact that the reduction of drive decreases brightness may be caused by an improperly adjusted ion trap. Move the ion trap with a rotary, back and forth movement for maximum brightness. If this fails to give sufficient brilliance and it is necessary to advance the drive control to the point of arcing, place a 4.7-ohm, 1/2-watt wire-wound insulated resistor in series with one lead going to the filament of the HV rectifier tube. Refer also to high voltage.

### **Regeneration**

**SYMPTOMS:** Indicated on raster by black streaks when tuned to blank channel. Disconnect antenna. If condition remains, regeneration is present. May not be present on strong stations. Sometimes indicated by white horizontal spaces, motorboating in speaker and intermittent pix. Feedback usually occurs in the video if stages and occasionally in the sound if amplifier, producing interference, or a fuzzy, blurred and/or smeary pix.

**SERVICE:** Generally caused by defective bypass capacitors in video if stage, improper lead dress, or incorrect alignment. When the coils in front end circuits are not properly shielded from the ratio detector, harmonics may be picked up by front end circuits or through the agc line, due to poor bypassing. Sometimes caused by improper bias on if tubes.

### **Remote control**

**SYMPTOMS:** Remote control device, such as Zenith Flash-matic system, Emerson model 1158, and units made by Walsco, Sentinel and RCA, do not perform properly.

**SERVICE:** To check, disconnect unit and operate set manually. If set performs, trouble is definitely in remote control unit. Manipulate each dial of unit. The one that does not operate satisfactorily indicates trouble spot. Be sure to check common ground return line, especially if unit does not work properly on any control. The trouble is usually caused by broken wires, poor insulation, contact troubles, poor lubrication of shafts, detents and relays, burned out motors, relays and solenoids, and broken mechanical parts.

In Zenith units, check photocells and sensitivity adjustment. Zenith unit may be indentified by color dots for three types—



yellow-blue, yellow, and red. Circuits are similar. Chief difference is in photocells which are interchangeable. Tubes in unit operate with ac on plates.

When burnout occurs, check voltages during warmup and after several moments of operation.

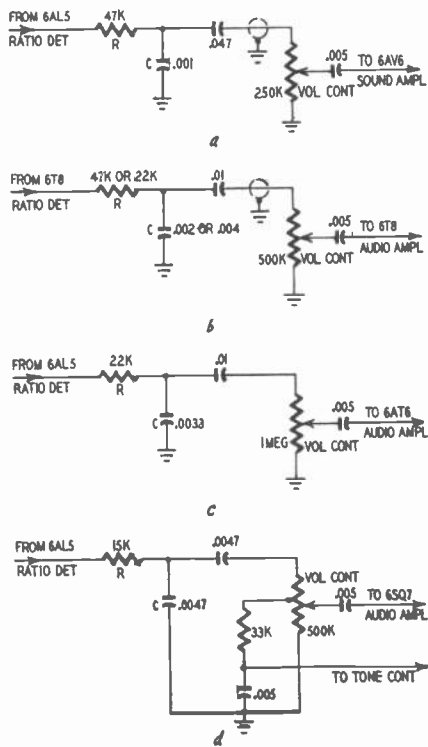


Fig. 3-R. Typical de-emphasis networks.

## Resistors

Replace all discolored or burned resistors. When burned resistor is observed, look for a path of B+ to ground. Any capacitor in the circuit should be replaced.

Composition resistors can generate noise.

For insufficient horizontal sweep and width, check screen and cathode resistors of the horizontal-output circuit. Replace any component that measures 20% higher than listed value or tolerance.

Load resistors in the phase-detector circuit must have matched values. Unbalance can cause horizontal instability.

## **Retrace line bunching**

**SYMPTOMS:** Lines bunch and appear as white band across screen.

**SERVICE:** Check vertical-retrace blanking network (see Fig. 4-R); vertical-output tube; also coupling capacitor between vertical-oscillator and vertical-output tubes.

## **Retrace lines**

**SYMPTOMS:** Vertical-retrace lines visible with low contrast and high brightness-control settings. Vertical-retrace lines appear on screen and cannot be eliminated by rotation of the brightness control.

**SERVICE:** Vertical-retrace lines may not prove objectionable to TV viewers in areas of moderate signal strength when contrast and brightness levels can be properly adjusted. However, in fringe areas the vertical-retrace lines become visible with low contrast and high brightness-control settings. This difficulty may be more noticeable in some of the cheaper receivers where economy is the ruling factor in construction.

If retrace lines are annoying, there may be trouble in the brightness control circuit or in the picture signal amplification. Except in extreme fringe areas, retrace lines should not show if the contrast and brilliancy controls have been properly adjusted. Poor alignment and tracking or a deficient antenna system can contribute to this problem. Also, make sure the ion trap is properly adjusted.

If the receiver is working properly you may see occasional retrace lines during camera changes or station breaks. If this is troublesome or if weak fringe-area reception is to be improved, a retrace-elimination circuit can be added.

Hum on vertical-oscillator grid will cause pix to lock-in out of phase (with retrace lines showing) if transmitter and receiver's vertical-sweep frequency are locked together through a common power source. Check sync amplifier and vertical-oscillator tubes for heater-cathode leakage.

Check capacitors and resistors in vertical-retrace line elimination network and the possibility of a defective brightness control or CRT (gassy).

Check coupling capacitor (when used) at grid of CRT; grid resistor in video-amplifier circuit.

## **Reversed pix**

**SYMPTOMS:** Lettering in televised scene appears backwards.

**SERVICE:** If you get a reversed picture along the horizontal plane it indicates that the two leads to the horizontal coils of the yoke are reversed.

Interchange these leads. When the leads are transposed on the horizontal coils, sweep starts from the right and goes to the left instead of vice versa. If the vertical-coil leads are reversed, the picture will appear upside-down.

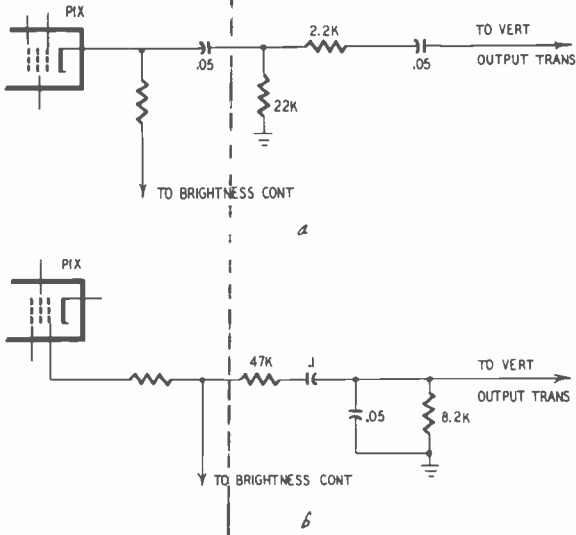


Fig. 4-R. Vertical-retrace blanking networks.

### Rf gain low

**SYMPTOMS:** Fading on channel 13; other high-frequency channels excessively snowy; low-frequency channels lack sufficient gain.

**SERVICE:** Check tubes in tuner consisting of rf amplifier, mixer, and oscillator. Check point B+ is fed to the tuner. If abnormally low, rf and mixer stages will have insufficient gain, affecting oscillator which probably could not work to channel 13 frequency. Also check LV rectifier and agc clamp.

### Ringin g in pix

**SYMPTOMS:** Echo effect. Repeats to the right of sharp vertical lines. Thin white-and-black lines following any vertical picture information. Particularly noticeable during any abrupt change from black to white in the scene, or vice versa.

**SERVICE:** "Ringin g" or a slight "echo" effect which causes repeats

to the right of sharp vertical lines due to transient oscillations in the picture system can also cause poor picture quality.

Echo or ringing usually occurs for *every* station tuned in. Contrast this to ghost reception which will usually show up for only one or two stations, and has more pronounced picture displacement. Echo effect (see Fig. 5-R) is caused by an overpeaked video amplifier or by a misaligned video if section. High-frequency components of the signal pulse the offending stage into transient oscillation which causes the repeat lines to appear as sharply



Fig. 5-R. *Pix of test pattern shows echo.*

defined edges of picture images. If it only occurs on one or two stations it indicates that the if alignment may be out. This symptom will also appear if the level of the video carrier is low with respect to the sound carrier on some channels.

Try a new video-amplifier tube and also make sure that the peaking coils are well separated from other components and dressed away from the chassis. Test the coils to see they are not defective. Try placing a resistor (less than 5K ohms) across the series peaking coil, as shown in Fig. 6-R.

Check the alignment of the video if stages to see that the band-pass is not excessively humped around the high-frequency section of the response curve. Also check for a critical if stage which might be near the oscillation point because of a bad tube or defective part or low bias. Check rf alignment if trouble is confined to one or two channels.

Ringing coils (see Fig. 7-R) found in the multivibrator circuits of horizontal-sweep systems, may be tested without pulling the chassis. Merely tune in a station and rotate the horizontal-hold control toward the low-frequency (greater-resistance) side of synchronization. If the ringing circuit is working properly, the

picture will slip into a number of stationary patterns as the control is rotated.

Each pattern will slip abruptly into the following pattern, re-

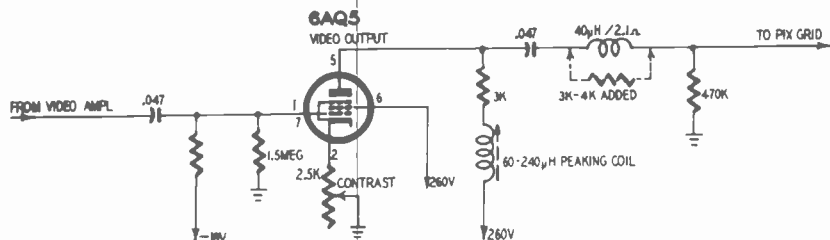


Fig. 6-R. Resistor across peaking coil helps eliminate ringing.

maining for a short time in each position. However, if the ringing circuit is not working properly, there will be no stable patterns. Each pattern will appear briefly and intermittently. Of course, this technique will not work if the hold control is part of the ringing circuit itself, as is the case in some sets.

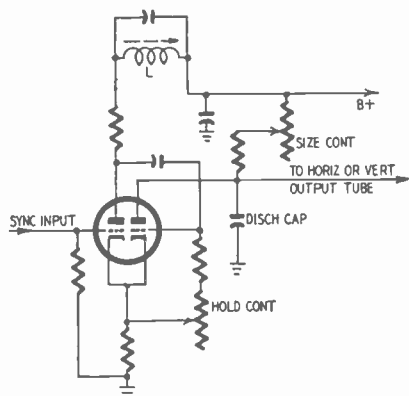


Fig. 7-R. Horizontal multivibrator may have ringing coil, *L*.

## Ringing in raster

**SYMPTOMS:** Alternate light and dark gray bars on the screen even when no pix is present.

**SERVICE:** There are several possible causes of this type of ringing. To check, the height control should be advanced as far as possible to separate the individual scanning lines; if the lines are not straight thru the bars, but wavy, at least one of the troubles is crosstalk between the vertical and the horizontal coils in the yoke. Also, changing the value of the balancing capacitor across half of the horizontal coils will clear up the waviness of the horizontal lines.

The correct value of this capacitor is important (2,000 volt rating). In some instances addition of a 10K ohm resistor in series with the yoke balancing capacitor may overcome this trouble, though width may be reduced. See Fig. 8-R. For high-impedance yokes try connecting a .047  $\mu$ f, 400-volt capacitor across the vertical section of the yoke. Another cure might be connecting a 5,600-ohm resistor across the horizontal-linearity coil.

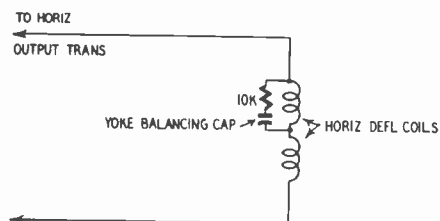


Fig. 8-R. R-C network across horizontal-deflection coil reduces ringing.

The ringing may also be overcome by inserting the circuit shown in Fig. 9-R in series between secondary of the horizontal-output transformer and horizontal-deflection coils. This network consists of a 470-ohm, 1-watt resistor, a width coil, and a capacitor (.01  $\mu$ f to .001  $\mu$ f) in parallel with each other. When connected, the width coil should be tuned for minimum ringing.

If bars are still observed, it is necessary to test for high-voltage ripple, horizontal-velocity modulation, and for crosstalk in the grid circuit of the CRT. To test for grid crosstalk, a .1  $\mu$ f capacitor should be shunted from the grid of the CRT to ground. This will eliminate the bars if the grid circuit is picking up the ripple. Next, inspect the current sawtooth through the horizontal-deflection coils with a scope; a damped sine wave superimposed upon the sawtooth will disclose the presence of velocity modulation due to sweep ringing. A method of doing this is shown in Fig. 10-R. Finally, the ripple on the HV supply to the second anode of the CRT should be checked with the aid of a HV capacitance-divider probe.

### Ripple (see also Microphonics)

**SYMPTOMS:** Sound ripple in pix which changes only with setting of the volume control.

**SERVICE:** Sound ripple that is not tunable but depends on the volume-control setting is usually due to sound feedback to the

B-supply. Because the current changes in the audio-output tubes are relatively large, a decoupling resistor and electrolytic capacitor are usually connected in series with the plate and screen supply of these tubes. If this capacitor opens, ripple is likely to result.

Audio ripple can also be caused by having the audio-output tube plate lead too close to a pix if tube grid or to a video-amplifier grid connection.

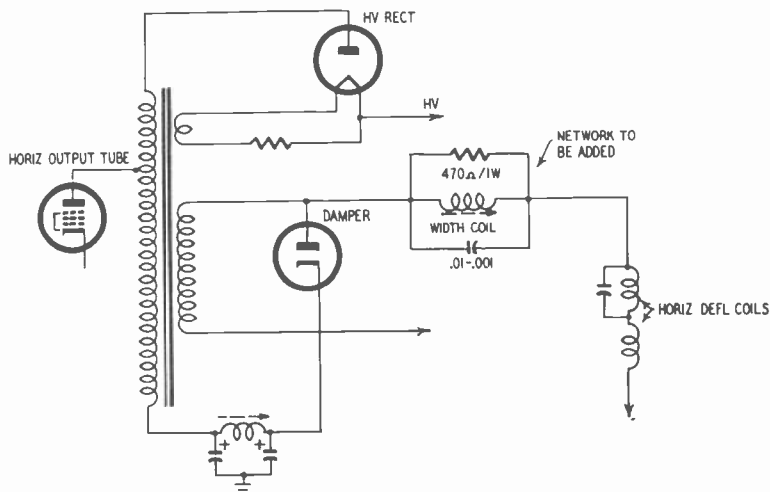


Fig. 9-R. Network to eliminate ringing can be inserted as shown above.

Isolating the audio section both electrically and mechanically will get rid of this trouble. Sometimes the speaker may cause vibrations in a microphonic tube. Tap all picture and if tuner tubes lightly to check for microphonics.

### Ripples, vertical, at left of screen

**SYMPTOMS:** Several ripples at left side of screen, causing pix to appear wrinkled.

**SERVICE:** Indicates oscillation in yoke. Check capacitor shunting half of horizontal-deflection yoke; and resistors across vertical-deflection yoke. Try varying sizes of components.

### Rotators, antenna

Used chiefly in fringe areas utilizing highly directional antennas when multi-channel reception is desired and in cities when reflec-

tions affect reception adversely. A rotator permits optimum reception. The use of a first-class rotator provides the setowner with maximum results from the antenna, i.e., a pix that is clear and free of interference.

Several troubles may develop which can usually be traced to the rotator unit or control box. Rotators have a reversible motor or continuous type, although some have dual motors.

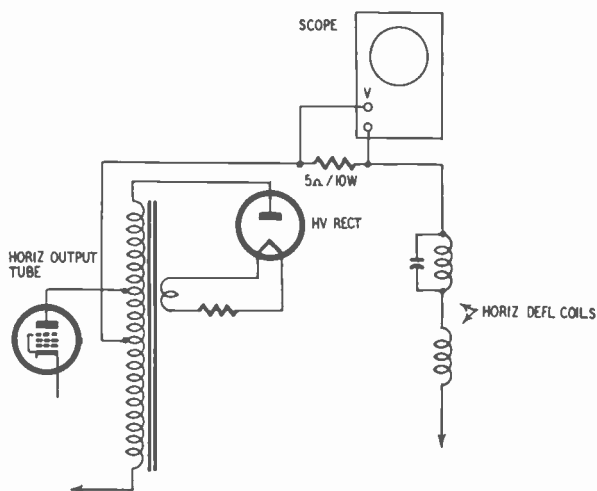


Fig. 10-R. Method of checking horizontal-sweep waveform.

If rotor does not operate, check control box for correct voltage supplied to the motor. Switch frequently breaks down due to burning contacts. If the voltage is satisfactory, but the motor hums and does not run, try substituting another capacitor (located in the control box).

The return springs on the actuating switch frequently break.

If the motor can be heard, but the antenna does not move, check top unit for stripped pinion or slipping pinion, or one of the gears in the train. Control cable wires are small and flexible, hence must be handled carefully. The cable should always be taped firmly to the mast and fastened securely to the roof and eaves by insulated staples. This will prevent whipping in the wind.

In automatic type of rotor, check gap in ring contact when motor does not stop.



### Selenium rectifiers

When replacing use component of same rating or higher (if space permits) but never less. When visual examination indicates discoloration, burned effect, or melting of alloy on cathode side of rectifier, replace component. When soldering or unsoldering leads, do not contact soldering iron to cells of rectifier.

- Crackling sound with blue white sparks indicates unit is receiving considerably higher than rated inverse voltage. Condition will stop when voltage is reduced. Rectifier should not be damaged from surge voltage of several seconds duration.

Excessive black spots on alloy surface, especially completely surrounding washer in center of plate, indicates that unit should be replaced. Replacement should be in original position, firmly fixed, to prevent contact with chassis or other components. Observe polarity.

To check: connect ohmmeter across terminals of rectifier. Reverse leads and re-read.

One low and one high reading—rectifier OK.

Two low readings —rectifier short.

Two high readings —rectifier open.

In event check indicates a drop of 15% in original output voltage, replace unit. When replacing defective line resistor use exact component. If rectifier blows, check capacitors before putting in new rectifier as they may be defective.

### Shock

SYMPTOMS: Shock received when making adjustments on TV set or antenna.

**SERVICE:** Always disconnect a TV receiver from the line by pulling the plug before making any adjustments on the outside antenna. If the set must be turned on while orienting the antenna, be sure that you wear gloves and that you do not permit any exposed part of the body to contact the antenna or mast. Failure to observe these precautions may cause serious injury. Don't rely on the switch. Pull the plug! Sets using selenium rectifiers, with the chassis connected to one side of the power line, should only be serviced after an isolation transformer is inserted between the line cord plug and power receptacle.

The CRT should be discharged after the set has been turned off by a shorting wire from chassis to second-anode cavity. HV filter capacitors should always be discharged by shorting to chassis before working in the HV cage. When two capacitors are used, discharge both simultaneously.

### **Signal tracing**

When servicing away from the bench, the technician usually carries only a minimum of test equipment. He can materially add to this equipment by putting his ears to work.

A surprisingly large portion of a TV receiver can be serviced by audio techniques. Every TV receiver contains an audio amplifier and almost all operate from a 60-cycle test signal for audio-signal tracing. Since it is equal to the vertical-sweep frequency, a voltage from the heater supply can be used to test the vertical-sweep circuits. And do not overlook the fact that the horizontal-sweep frequency is also within the audio range.

Headphones are splendid for audio work. High-impedance units connected in series with a .05- $\mu$ f capacitor are ideal for tracing a signal from the sound-detector output to the speaker voice coil. Thus, when there is no audio output or there is distortion resulting from a defect within the audio section of a receiver, the technician can start at the output of the detector and work toward the speaker, picking up a clear signal and tracing it to a point where it disappears or becomes distorted. This pretty much pinpoints the source of the trouble.

Where no signal is on the air or headphones are not available, the heater supply makes a good audio-signal generator. The strong 60-cycle, 6.3-volt signal can be applied to the audio circuits by tying one end of a test lead to the ungrounded side of the 6.3-volt heater supply through a .05- $\mu$ f capacitor and using the other end as an audio test lead. In series-string heater circuits the 60-cycle

voltage can be taken from the hot side of the first heater at the ground end of the string. Do not use the rectifier heater for this purpose.

From here it becomes a simple matter of signal tracing. You can start either at the plate of the audio-output tube and work toward the detector while listening for the signal at the speaker, or inject the signal at the detector output and trace toward the speaker, using headphones. In either case, the signal will consist of the all-too-familiar 60-cycle hum.

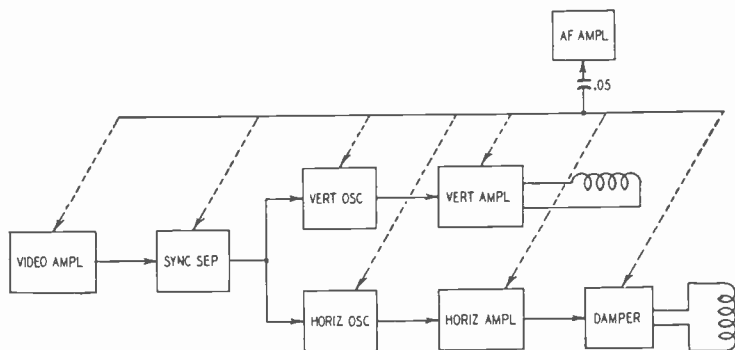


Fig. 1-S. Audio section of TV receiver can be used in testing.

When checking the vertical-sweep circuits, a 60-cycle buzz will be heard if it is operating properly. To make sure that you are not hearing the incoming vertical sync pulses, short the antenna terminals or remove one of the if tubes. Varying the vertical-hold control will cause a slight change in pitch when the signal is from the vertical oscillator. Having isolated the vertical-sweep circuits from the incoming signal, you can check point to point from the output of the integrator to the plate circuit of the vertical-output tube. Watch the blocking-capacitor voltage rating. 1,000-volt (or more) peak-to-peak signals are common in this circuit.

If the audio section of a TV receiver is operating properly, we have a fine audio amplifier for testing (Fig. 1-S) the vertical and horizontal oscillators and output circuits, sync separators and video amplifiers. In each case the test consists of listening for the loud 60-cycle buzz and the shrill 15,750-cycle components of the signals in these circuits.

Should there be no vertical sweep, the heater supply provides an excellent drive voltage for the vertical-output tube. When injected into the grid circuit of this tube, provided the vertical-output circuit and deflection coils are in good order, the screen will show

a vertical sine-wave sweep. The sweep will, of course, be non-linear folded over, and about half height. However it will indicate whether the primary source of trouble is lack of vertical-oscillator output.

The 60-cycle supply also provides a good test voltage for the video amplifier in cases where a raster is present, but there is no video signal. In much the same manner as audio injection, the 60-cycle signal can be applied at the input to the picture tube (grid or cathode). If the input circuit to this tube is in good order, the raster should show a broad horizontal dark bar similar to the effect produced by heater-to-cathode leakage. From this point the test lead can be moved back toward the output of the video detector. Should a point be reached where the bar disappears, the trouble area is pinpointed.

When checking the horizontal-sweep circuit, place the probe at any point between the input to the horizontal oscillator and the screen grid of the horizontal-output tube. The plate of this tube, and the damper cannot be directly touched because of the very high pulse voltages present. However, sufficient pickup through stray capacitance can be obtained by placing the probe lead next to, or wrapping it around, the insulated leads of these circuits.

The horizontal-sweep frequency cannot always be heard. However, by turning the horizontal-hold control to its low-frequency side, the horizontal-sweep frequency can be reduced enough to be fairly audible.

The better the high-frequency response of the amplifier, the easier it is to hear the horizontal-sweep signal. In this case the probe consists of a test lead in series with a .05- $\mu$ f capacitor, one end connected to the input of the audio amplifier and the other used to pick up signals from the various circuits.

A properly operating sync separator will produce a strong 60-cycle buzz at the audio-amplifier output; the same is true for the video amplifier. In either case, the 60-cycle buzz caused by the vertical-sync pluses serves as a rough indication of proper operation.

These tests do not replace standard servicing equipment but, rather, act as temporary substitutes for rapid TV repair in the home.

### **Slow intermittent**

**SYMPTOMS:** Set works well when first turned on, then sound or pix becomes poor after a short time.

**SERVICE:** Many times in TV servicing the complaint is that the set cuts off, or sound or pix are intermittent after a warmup of a half hour or so. In the majority of these cases tubes are at fault. To save valuable waiting time when doing a TV repair job in the home, hasten warmup by placing empty tube cartons over the suspected tubes. This will hold in the heat and will cut down a half-hour wait to five minutes.

### **Smear, white**

**SYMPTOMS:** White smear pulls in from left side of picture.

**SERVICE:** Caused by defects in the damping circuit. Try adjusting linearity and if this does not help, try another damper tube. Try replacing the voltage-boost capacitors (connected to the linearity coil) with others of different value.

### **Snivets (see Blotches)**

### **Snow (see Pix with snow)**

### **Sound bars**

**SYMPTOMS:** Horizontal bars on screen. Number varies with frequency of the audio signal. Intensity changes with strength of audio signal.

**SERVICE:** Tune to blank channel and jar cabinet. If bars disappear, trouble probably is microphonic rf or if tube. (See section on microphonics). If bars remain, vertical-oscillator tube is faulty. Microphonic tube in rf, pix if and video amplifiers may produce bars when set in operated at high volume. Always see if bars disappear when volume is reduced.

Bars may be caused by defective afc tube.

Sound bars can also be produced from the 4.5-mc beat which appears as numerous fine dark lines, vertical or slanting, with a horizontal herringbone pattern. In this case, the intensity is not affected by the volume control. Can be caused by incorrect alignment of pix if amplifier, the 4.5-mc transformer or trap in the video amplifier, or incorrect tuning or alignment of sound if traps in the pix if amplifier.

Excessive sound bars in pix that are not due to fine tuner misadjustment usually indicate that the germanium-crystal video detector is about to fail. Ultimately, complete failure will result in weak pix and loss of sync. See if bars disappear when sound stops. If not, trouble probably is in power supply filtering. If they appear when the volume is turned up, put an electrolytic from the audio-output tube screen grid to chassis.

X

To ascertain if the trouble is caused by a microphonic tube or other component, or inadequate filtering in the audio-output stage, disconnect the speaker. Connect a dummy-load resistance (5 ohms, 5 watts) in place of the speaker. Rotate the volume control. If sound bars continue to occur, especially at high-volume level, trouble is in filtering.

In the audio-output stage, replace the decoupling filter capacitor, or cathode capacitor; and in the preceding audio-amplifier stage, the plate-load decoupling capacitor.

### **Sound, distorted**

**SYMPTOMS:** Sound is rough, unintelligible, and may disappear.

**SERVICE:** Sound if and FM detector alignment are the first consideration. Any unbalance in the detector (including a faulty tube) may be the trouble. Do not overlook the usual causes of distorted sound following the FM detector in the audio portion. Distortion can be caused by loose slugs in sound if and detector transformers. Many cases of distorted or missing sound are due to improper operation of the receiver's controls but some may be traced to excessive oscillator drift. A bad tube is usually at fault when poor front-end design is not evident. Misalignment of the rf and if stages is an obvious cause of the same trouble. (A common mistake is to realign the picture if rather than the sound stages. The sound if bandpass is not as wide as that of the video if; therefore the former is more critical.) Fig. 2-S shows circuits of typical sound if stages.

A mismatch between the antenna system and the tuner can alter the Q of the rf input circuits and distort the response curve. Slight mistuning can eliminate one carrier by causing it to fall outside the passband of the rf circuit. This condition is cured by proper matching between the receiver and antenna.

Other defective components contributing to this condition are the ratio-detector stabilizer capacitor; coupling capacitors in the audio circuit; screen bypass and cathode capacitors of the audio-output tube; the capacitor between plate and cathode (or chassis) of the audio-output tube; plate resistor of the audio-amplifier tube; the B-supply filter electrolytics, and a noisy volume control.

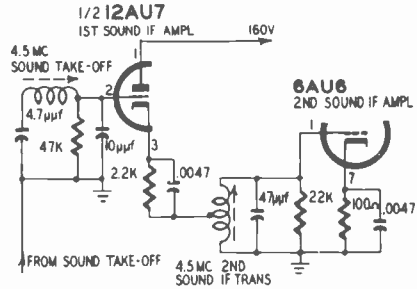
Airplane flutter can also cause distorted sound and changing volume in sets not equipped with keyed agc.

### **Sound, drifting**

**SYMPTOMS:** Sound gradually becomes weak and distorted.

**SERVICE:** Usually a fixed capacitor in one of the sound if transformers changes value. There are two of these in each sound if can; humidity or vibration often causes a terminal to separate from the capacitor plate and open the connection. This may show up during alignment as low gain or inability of the transformer to peak properly. May also be due to a change of detector-tube characteristics on warmup.

Fig. 2-S. Typical sound if stages.



## Sound in pix

**SYMPTOMS:** Dark waves on screen when strong sound signal comes in.

**SERVICE:** These horizontal dark waves traveling vertically across the screen may be due to a number of causes. The trouble may be due to a microphonic tube, or the video if amplifier or second detector may be microphonic and strong sound waves from the speaker cause it to vibrate. The if amplifier (especially the sound traps) may be misaligned. Incorrect agc bias on the if amplifiers may also be the cause.

Another possibility occurs when the audio voltage modulates the B+ supply to the video circuits, causing variations in brightness. This is generally caused by poor filtering of the plate circuits of the receiver's audio stages. Be sure to check all audio-decoupling networks. At high volume there are large swings in the plate current drain from the B+ supply. If the plate supply circuits are not properly filtered, the B+ supply becomes amplitude modulated. Here again the intensity of the bars will vary with volume-control settings. However, with the speaker disconnected and the amplifier working into a dummy load, microphonic troubles will disappear but filter troubles will remain.

## Sound, intermittent

**SYMPTOMS:** Picture is good. Sound fades down to a whisper. When volume control is turned up, sound is good for a while, then blasts.

**SERVICE:** Intermittent troubles have always plagued service technicians, and such troubles are sometimes the most difficult to localize. While the set is playing normally, there is no point in checking voltages or parts, since nothing appears amiss. However, when the intermittent occurs, it may be of such critical nature that the mere approach of a test instrument probe is enough to cause the part to act normal again.

Try replacing one tube at a time and waiting to see if the trouble still occurs. Repeat, until all tubes in the audio section (if amplifier to audio output) have been replaced. Also, install a new coupling capacitor in the grid of the audio-output tube, for these are frequent offenders. As a last resort gently push each paper capacitor with an insulated screwdriver while the set is in operation to find which might have loose internal lead contacts.

There are other methods for checking intermittents. Try raising the line voltage or applying shock. In using higher voltages, a Variac or similar auto-transformer will be useful. Raise the voltage to about 130, maximum, but don't keep it there too long, and look out for sudden failures.

Open grid resistors, faulty filters, trouble in the output transformer, voice coil, and proper seating in tube sockets are other sources to check. Sometimes an intermittent crystal pix detector will provide a reasonably good pix, but no sound.

## Sound traps

**SYMPTOMS:** Sound bars in pix.

**SERVICE:** Misaligned traps in the video if or in the video amplifier (Fig. 3-S) are a common source of sound bars in the pix. Adjacent-channel sound interference is easily recognized since the bars do not follow the sound accompanying the picture on the screen. In addition, adjacent-channel audio will usually cause trouble on only one channel and even then not all the time.

A sound trap can be quickly checked by varying its slug while observing the picture. Try placing a single shorted turn of wire around or over the trap. This raises the trap's resonant frequency. Place your hand near the coil. This adds capacitance to the circuit and lowers the frequency. If all traps are properly aligned, doing this will in each case increase the sound-bar interference. If, however, one of these tests improves picture appearance, that trap should be aligned. In most cases traps can be aligned by varying the slug while observing the picture.



## Sound weak

**SYMPTOMS:** Sound subnormal; pix OK.

**SERVICE:** Generally caused by a weak tube in the sound if or audio amplifier, or misalignment. Check by substitution all tubes

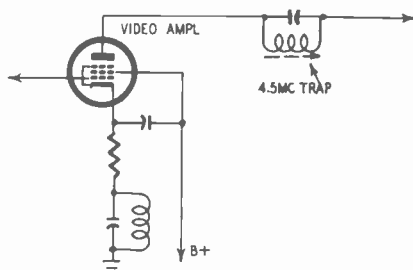


Fig. 3-S. Misaligned sound trap results in sound bars in pix.

in sound circuits after the take-off point (if pix is not 100% normal, check tubes beginning with tuner to sound take-off point); also LV rectifier.

Individual oscillator slugs in tuner may need adjustment, especially if sound is weak on only one or two channels.

Check for proper adjustment of ratio-detector transformer; sound take-off coil; and other 4.5-mc tuned circuits.

Other defective components that can cause this condition are the plate resistor of the audio-amplifier tube; grid and cathode resistors of the audio-output tube; cathode bypass electrolytic of the audio-output tube and the capacitor connected between the cathode and plate of the ratio-detector tube, and screen grid and cathode bypass capacitors of the sound if amplifiers.

## Speaker

To check the voice coil, put a 1½-volt dry cell across the terminals. Make and break connections, and listen for a click. It should be strong. This procedure will burn up the voice coil or will distort it if allowed to remain connected for too long a time. Make the connection a momentary one.

The voice coil may also be checked by removing the audio-output tube slightly from socket and moving it around. A click should result.

To check an electromagnetic speaker, hold a socket wrench close to the center pole piece. A good field coil will cause the wrench to be attracted strongly. (Set must be on.) Make the same test with PM speaker. Set need not be turned on, however.

Rattling in speaker may be caused by a torn paper cone or by loose screws holding the speaker.

## Spooks

**SYMPTOMS:** Thin vertical line at extreme left edge of raster. Not Barkhausen oscillations.

**SERVICE:** This effect, known as spooks, is seldom troublesome because it generally appears beyond the visible portion of the raster and can be ignored. It is the effect of radiation.

Many harmonics are generated in the damper circuit as a result of the rapid rise and fall in deflection current. These are radiated, picked up by the antenna, rf or if circuits, and appear on the screen. Aside from adjusting the deflection circuit for maximum linearity, there are very few remedies. The most effective cure for this radiation consists of inserting rf chokes of 1 to 15  $\mu$ h in the cathode, heater and plate circuits of the damper tube. Small bypass capacitors may also be used. See Fig. 4-S for a typical circuit.

This effect is most noticeable on the low-band channels because the strength of harmonics decreases with increase in frequency. Since the vertical line appears on the extreme left edge of the picture, should you have difficulty eliminating this interference, simply increase the width slightly to move the line behind the mask. Most receivers are capable of a little extra width.

## Spot on pix tube (afterglow)

**SYMPTOMS:** Bright spot about two inches in diameter appears on the picture tube when the set is shut off. The spot then fades out.

**SERVICE:** This spot is not a defect and will not affect the operation of the set. The afterglow is not harmful provided the ion trap is adjusted properly. The appearance of the spot depends on the setting of the brightness control before the set is turned off. To reduce it, turn the brightness control slightly higher than normal before turning off the set.

The afterglow is common with many sets having a permanent-magnet type of ion trap. In coil-type ion traps the magnetic field collapses when the set is shut off, hence the beam does not reach the screen and leave the afterglow caused by charged capacitors and the heated filament of the picture tube. Adjusting the brightness control immediately after shutting off the receiver minimizes this condition. Little can be done when the permanent-magnet type of ion trap is used. If the trap is properly adjusted for maximum picture brightness the danger of a brown spot (ion spot) is minimized.

The afterglow is caused by the charge remaining on the high-

voltage capacitors maintaining the electron stream while the cathode cools. This is no more harmful than any bright televised area during normal reception.

## Squegging (see Ringing in pix)

### Squegging in tuner oscillator

**SYMPTOMS:** Lines or parts of lines ripped out of pix.

**SERVICE:** Frequently occurs in tuner oscillator. To check, bridge

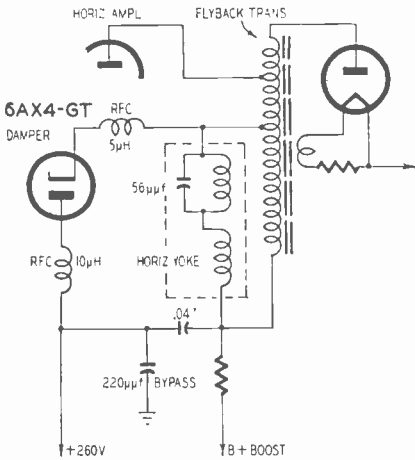


Fig. 4-S. Spooks can be eliminated by rf chokes in the damper-tube circuit.

resistor at grid of oscillator with a resistor of same value. Disappearance of condition indicates oscillator was squegging. Lower oscillator grid resistor should be substituted.

## Streaky pix (see also Microphonics)

**SYMPTOMS:** Flashes of light through pix.

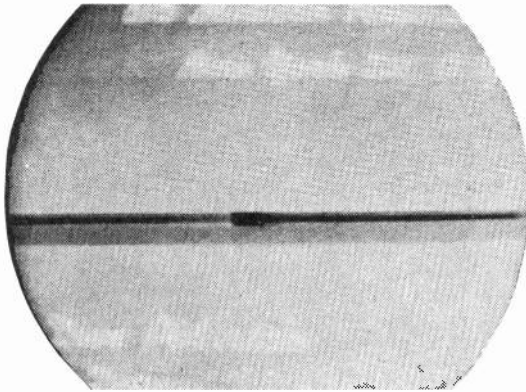
**SERVICE:** May be caused by dirty tuner; tap tuner—if flashes show on CRT, tuner is dirty. May be caused by high-voltage arcing. In sets using ordinary clip on 1B3-GT, 6BG6-G, 6BQ6-GT, etc., substitute clip with ceramic cap. Coating of CRT may not be properly grounded to fingers of yoke housing.

In cascode type tuners this trouble may be due to a defective rf amplifier tube. In some sets a defective converter tube may produce similar conditions. If flashing does not occur on off channel, trouble may be in damper or horizontal-output tubes. Check by substitution tubes in tuner and video amplifier.

## Sweep instability

**SYMPTOMS:** Pix tearing and rolling.

**SERVICE:** Replace vertical and horizontal oscillator and amplifier tubes. If tubes are not at fault, trouble probably is a loss of vertical and horizontal-sync pulses. Check sync separator and sync amplifier tubes and circuits; also afc, integrator and differentiator circuits. The dc restorer often forms part of the sync stripping network and should be checked. It may be possible to obtain a good pix, though tearing and rolling, due to clipping of sync pulses in any stage from tuner to last video amplifier tube.



*Fig. 5-S. Blanking bar showing sync pulse.*

### **Sync bar (vertical) locking in center of pix**

**SYMPTOMS:** Vertical sync bar will lock, dividing pix, usually at low point of contrast control, then locks in some other position, as contrast is advanced.

**SERVICE:** Usually caused by defective coupling capacitors or gassy tube in sync stages.

### **Sync, loss of**

**SYMPTOMS:** Horizontal tearing; vertical rolling of pix.

**SERVICE:** To check normal sync pulses, permit pix to roll slowly down and examine vertical blanking bar. Reduce contrast and increase brightness. This will make the different levels of the bar stand out. There must be a distinct difference in shading between sync pulses, blanking and pix information. Sync pulses should be darker than the blanking bar and the blanking bar should be darker than the pix. See Fig. 5-S.

This indicates trouble is between the video amplifier and deflec-

tion oscillators and probably exists in the sync separator or sync amplifier. If the sync pulses are not darker than the pix information, then the trouble is in the rf amplifier, video if stages, or the video-amplifier circuit.

If the horizontal- and/or vertical-hold controls bring proper synchronization momentarily without going to either extreme, the trouble is in the sync section. See Fig. 6-S. A pix with good quality and contrast, but poor sync also indicates trouble in the sync section. Generally, a weak pix with insufficient contrast will prevent synchronization, and noise interference will also affect the sync. Multiple images (usually ghosts) are sometimes responsible. Sync take-off points are the video detector, video amplifier and dc restorer.

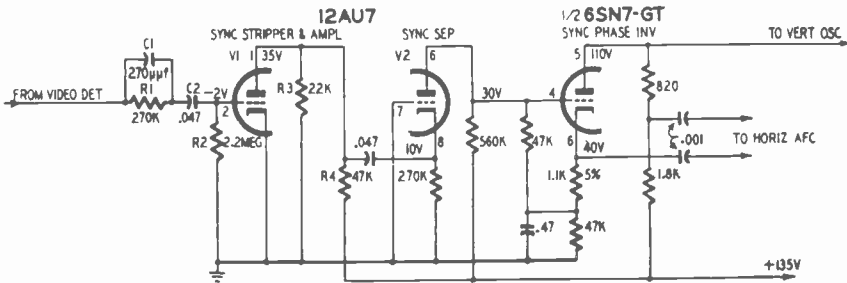


Fig. 6-S. Check sync circuits when pix rolls or tears.

Check these tubes by substitution: agc; dc restorer; rf amplifier and mixer-oscillator in tuner; video if amplifiers; video detector, video amplifier and output; sync; horizontal afc; horizontal and vertical oscillator and LV rectifier.

In sets using an audio-output tube as a voltage divider, check that tube, as a defect could cause redistribution of voltages across the LV power supply, upsetting the sync.

Poor sync can also be caused by unsatisfactory transmission line or a weak signal at the antenna. It may be necessary to reorient the latter.

In sets with a dc restorer, leakage between the grid and cathode of the CRT can affect operation of the dc restorer stage, preventing passage of sync pulses to the horizontal and vertical circuits, causing loss of sync.

When another receiver of the same type can be obtained, whole sections of the faulty receiver can be checked out. The entire sync section of an auxiliary receiver (of the same type) can be substi-

tuted for the sync section of a faulty receiver. The video signal from the cathode of the video amplifier is applied to the grid of the sync separator.

To check the entire sync section by substituting the sync section of an auxiliary receiver, the two chassis are grounded together and the signal paths broken at suitable points. Be careful—make sure both chassis are at ground potential. Caution must be used in the case of transformerless receivers in which the line plugs may be “crossed,” resulting in a short circuit. Transformerless receivers should always be powered by a line-isolation transformer. The auto-transformer type of unit is unsuitable and will not isolate the receivers. Separate primary and secondary windings must be provided.

Test leads are then used to patch the section; they should be kept reasonably short. If there is trouble in the sync section of the faulty receiver, normal operation will be resumed when the test leads are connected. Various stages in the sync circuit can be eliminated by similar procedure, thus closing in on the faulty stage or component.

If normal operation is not resumed, it is apparent that the fault does not lie in the sync section, but in some other part of the receiver. The sweep or the video sections of the receiver can be patched in the same manner.

A poorly ventilated set can cause loss of sync. Check by placing an electric fan on the rear of the set, with back removed.

## Tearing

**SYMPTOMS:** Lower half of picture tears, zigzagging back and forth. When the tear is severe, there is buzz in the audio. Tearing is most evident in "live" network shows. It is also difficult to get enough contrast without a distorted picture and buzz in the audio.

**SERVICE:** Severe video overload or defective phase detector, or poor if alignment. Trouble can be due to very strong signal—so strong, that clipping takes place in the last video amplifier.

To overcome this, use an attenuator network in the antenna lead-in. Change the sync-coupling or reduce it to a smaller value. Change the values of the video-amplifier load resistor at the point of sync take-off. As a last resort, try signal-tracing the sync pulses from the second detector to the horizontal oscillator with a scope and watch for sync pulse compression.

## Test Patterns

1. Correct height of pix should equal the diameter of the large black inner circle. Correct width should equal the diameter of the large white outer circle.

2. Adjust circles for roundness on one station. This will indicate proper linearity. Roundness of circles will vary from station to station due to differences in transmission, so do not change adjustments once correct positioning has been obtained.

3. Test pattern should be centered so that both vertical and horizontal wedges are of equal length.

## CHECK LIST

STAGE	PROCEDURE	SYMPTOMS
Agc line (if and tuner)	Connect 3-volt battery; plus side to chassis or B—.	Normal pix indicates agc trouble.
Antenna terminals	Scratch with lead-in ends.	Flashes on raster and clicks in speaker.
Audio amplifier	Scratch grid with screwdriver and spark plate to chassis (or use vtvm). Apply 6.3-volt filament voltage through .5 $\mu$ f capacitor to grid.	Clicks in speaker.
Audio output	Scratch grid with screwdriver and spark plate to chassis, or use vtvm. Apply 6.3-volt filament voltage through .5 $\mu$ f capacitor to grid.	Hum in speaker.
CRT	Tuner defect. Defect in video detector or amplifier stages. Measure dc voltage at pin 10 of CRT socket. Measure ac voltage at pin 12 of CRT socket.	Hum in speaker. Hum in speaker. Hum in speaker. Pix with snow. Pix weak—no snow. 350 to 550 volts. 6.3 volts ac.



## CHECK LIST

STAGE	PROCEDURE	SYMPTOMS
CRT	Measure negative dc voltage between pin 11 and pin 2 of CRT socket and rotate brightness control.	0 volts to -55 volts or more.
Crystal detector (disconnect one end)	Measure forward resistance	Ratio of forward to back resistance 1:25 or more.
Damper tube	Measure reverse resistance (10 ohms or more). Measure dc voltage at cathode.	Normal boost B+ voltage indicates horizontal-deflection system is OK. Boost voltage will not be normal if horizontal output transformer is defective. -30 volts or more.
FM ratio detector (at parallel resistor-capacitor combination connected to plate)	Measure negative dc voltage.	-30 volts or more.
Horizontal oscillator	Measure dc voltage at grid.	Negative voltage. If equal to that shown on manufacturer's schematic, indicates tube is being driven properly by horizontal-oscillator signal.
Horizontal output	Measure dc voltage at grid.	

## CHECK LIST

STAGE	PROCEDURE	SYMPTOMS
Mixer grid	Ground intermittently.	Flashes on raster and clicks in speaker.
Oscillator grid	Measure dc voltage.	At grid —6 volts minimum. At mixer grid —2 volts minimum.
Speaker	Connect ohmmeter.	Click in speaker (trouble may be in transformer).
Sync stages	Scratch grids and plates. Connect .1 $\mu$ f capacitor between grids and/or plates, and top of volume control. Measure dc voltage at grids. Connect .1 $\mu$ f capacitor between grid and/or plate, and top of volume control.	Momentarily upsets deflection. Vertical buzz heard in speaker.
Vertical oscillator		Negative voltage. Vertical buzz indicates stage is operating.
Vertical output	Connect .1 $\mu$ f capacitor between grid and/or plate, and top of volume control. Scratch grid with screwdriver.	Vertical buzz indicates stage is operating.
Video amplifier	Spark plate to chassis.* Apply 6.3-volt filament voltage through .5 $\mu$ f capacitor to grid.	Flashes on raster and clicks in speaker. Flashes on raster. Light and dark bars on raster.

## CHECK LIST

STAGE	PROCEDURE	SYMPTOMS
Video detector (across load resistor)	Measure dc voltage	-2 volts (strong station).
Video if tubes	Scratch grids with screwdriver. Spark plates to chassis.* Measure dc voltage at grids.	Flashes on raster and clicks in speaker. Some video if stages may be at zero bias, while others may have more than -6 volts. In no case should any grid run positive.
Video-output tube	Scratch grid with screwdriver. Spark plate to chassis. Apply 6.3-volt filament voltage through .5 $\mu$ f capacitor to grid. Measure negative voltage.	Flashes on raster and clicks in speaker. Light and dark bars on raster.
4.5 mc sound if grids		-30 volts or more.

\*In this section, and others, the suggestion has been made to spark the plate of a tube to chassis—i.e., ground the plate momentarily. This is good only as an emergency measure, or for rapid TV repair when a vtvm is not at hand. This technique (sparking) can burn out components, so use it with caution. Preferably, make such tests with a voltmeter. Touching the voltmeter probe to the plate is like sparking, and may be used on grids too, so the results are about equal.

4. Adjust contrast so that all small circle sections are sharp and present different shades, from dense black in extreme center to white on last of five circles.

5. Adjust focus for sharpest pix of vertical wedges as near to center of screen as possible. If horizontal wedge is blurred, CRT may be defective. Note that most receivers cannot be adjusted to produce perfect focus over the entire screen.

6. Vertical linearity can be checked when no test pattern is available by rotating vertical-hold control so that pix rolls slowly from top to bottom of screen. Examine the black blanking bar closely. This should be of identical width at all positions on screen if linearity adjustment is correct.

7. The resolution or definition of a set is important. This is indicated by the clearness of small details in the pix or test pattern. If small details of pix are sharp and clear, set has good resolution; if small details of pix are blurred, soft and indistinct, set has poor resolution. Vertical resolution is determined by the horizontal wedges in the test pattern and depends on the size of the CRT spot. The blackness of the lines in the horizontal wedges compared to the lines in the vertical wedges depends upon the low-frequency response of the set. If poor, the horizontal wedges, in relation to the vertical wedges, may be gray.

Horizontal resolution, determined by the vertical wedges in the test pattern, depends on the high-frequency response or bandwidth of the set and the size of the CRT spot. The degree of resolution may be determined by examining the vertical wedges to ascertain how far down toward the center spot the individual lines can be seen. A set that is correctly aligned or has sufficient bandwidth will produce vertical wedges whose individual lines can be distinguished down to the center spot.

When checking horizontal resolution be sure contrast and brightness controls are properly adjusted so blooming will not take place. Ghosts, snow, and a weak signal will adversely affect horizontal resolution.

8. Adjust the vertical-hold control for good interlacing. Look for trouble in the vertical-oscillator circuit if adjustment of the vertical-hold control does not produce satisfactory interlacing.

### **Test points**

To simplify servicing, a quick check is possible, measuring

certain voltages, and/or checking components, to ascertain if various stages are functioning. Consult the check list on pages 182 to 185 inclusive.

### **Three pix appear on screen vertically**

**SYMPTOMS:** Condition usually accompanied by strong flicker and poor interlace.

**SERVICE:** Indicates vertical-oscillator frequency operating at 20 cycles per second, produced by defective resistor and/or capacitor in grid circuit of vertical oscillator.

### **Trailing reversal (see Alignment and also Low-frequency response, poor)**

### **Troubleshooting—see Signal tracing**

### **Tubes, gassy**

**SYMPTOMS:** Generally indicated by a bluish glow. Whitish deposit inside tube, near base.

**SERVICE:** Gassy tubes can cause a number of troubles, such as loss of sync, negative pix and 60-cycle hum. They can upset the proper operation of agc, and put positive voltages on the grids of tubes. Most 6BG6-G tubes have a slight bluish glow near the top of the glass envelope. This is normal. Look for a white deposit near the base of tube; if observed, replace.

### **Tube leakage, heater-cathode**

**SYMPTOMS:** Pix may be broken into two areas, one light and the other dark and which may move up and down. The modulating hum voltage, 60-cycles, is same frequency as the frame rate.

**SERVICE:** Check all tubes (beginning with those in the tuner) by substitution. Replace defective tube.

### **Tuners**

Tuners generally are an individual subchassis and consist of the rf amplifier, mixer and oscillator stages of the set. All signals, pix and sound, are received by the tuner through the rf amplifier, then passing to the mixer-oscillator. Generally, trouble in the tuner affects both pix and sound—one usually missing. Raster will be OK. A weak and snowy pix may be observed. If tuner is suspected,

replace tubes and measure B+, heater and agc voltages. Check for identical condition on all channels. Check antenna by substitution. Defect may also cause hum or sound in pix, loss of pix detail, or no reception on certain channels.

A defect in the rf stage (Fig. 1-T) usually produces trouble on

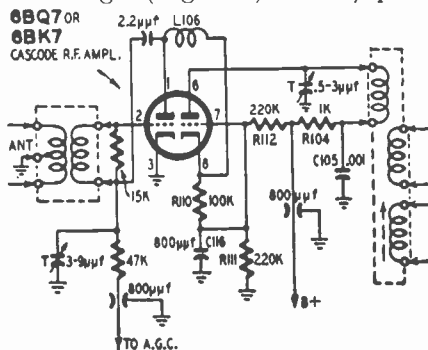


Fig. 1-T. Typical rf amplifier circuit.

one or several channels, while others operate satisfactorily. This includes the antenna and lead-in. To check operation of tuner, remove rf tube. Connect one side of antenna line to 100  $\mu\mu\text{f}$  capacitor and insert other end of capacitor in plate hole of socket. If improved signal is heard, then tuner rf is faulty in some respect.

A defective oscillator can produce a weak pix and/or sound. Inoperative oscillator results in no pix or sound.

One tube tuners frequently fail on high channels. Replace tube. Inspect spacing between tuning plates. If any plates touch adjacent coils, B+ voltage will be shorted to ground. Clean switch contacts and check for cold-solder joints. Condition frequently caused by defective tuning coil in grid circuit.

To check mixer, connect antenna to wire around tube. If normal operation, pix and sound will be heard. Another test is by using an adapter. Ground the mixer grid with a screwdriver intermittently. This should produce flashes and static demonstrating that signals can pass through the entire video and sound systems.

Connect a vtvm to the grid of mixer tube and chassis, or B-, whichever is specified. Reading at the grid of the mixer should be about -2 volts dc. Repeat this check on all channels. To check tuner as source of snow, disconnect antenna. Short antenna terminals of set. Turn contrast control maximum clockwise. Excessive snow indicates trouble is in set.

In uhf sets, always check if condition exists on both uhf and vhf channels. If condition appears on both, trouble probably is located in if amplifier or video-amplifier circuits. If condition appears only on uhf, and vhf pix is normal, check the uhf antenna installation.

In uhf tuners (see Fig. 2-T) if trouble occurs in oscillator, the pix usually disappears; when there is a defect in rf and mixer stages, a decrease in signal will result. To adjust individual oscillator channel slugs always set fine-tuning control at center of range.

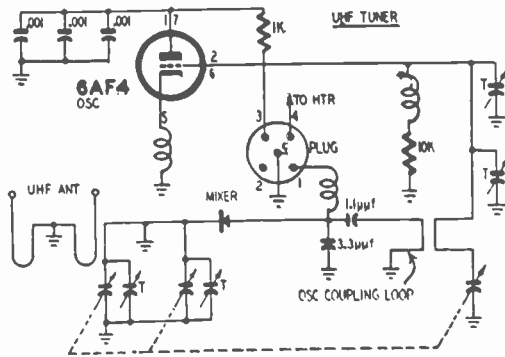


Fig. 2-T. Simplified circuit of uhf tuner.

Common complaints in operation of uhf tuners are drift and low sensitivity. The former is usually caused by defective oscillator tube, and the latter results from improper operation of the crystal in tuner.

## TUNER CHECK LIST

SYMPTOMS	SERVICE
Microphonics (pix or sound)	Tubes, tube shield loose, loose parts, connection, or cold-solder joints.
Reception (fringe) poor	Rf amplifier.
Snow and weak-sound	Antenna and or connections, rf amplifiers.
Sound distorted	Individual oscillator channel slugs misadjusted.
Sound bars	Fine tuner, microphonic tubes, individual oscillator channel slugs misadjusted.
Sound missing on some channels	Individual oscillator channel slugs.

## TVI

**SYMPTOMS:** Diagonal bars across screen.

**SERVICE:** Service shops are often called upon to minimize radio interference caused by nearby television receiver. The best procedure is to shield the receivers. Ordinary aluminum foil (kitchen type) can be used for lining the inside of the television cabinet. It can be stapled to the cabinet or applied with plastic tape (on most cabinets). Attach one section of the foil shield to the chassis.

The short section of transmission line connecting the tuner inside the receiver to the antenna terminals often picks up interference signals and causes their radiation by the antenna system. This section of ribbon lead should be wrapped loosely with aluminum foil and the foil should be grounded to the chassis by a short length of wire. If the foil is wrapped too tightly some signal attenuation for higher-channel stations may occur. The leads which run from the chassis to the picture tube can also be wrapped loosely with aluminum foil and the latter grounded. A tight wrapping here may attenuate some of the higher-frequency video-signal components because of the capacitive effects of the shield. The leads from the chassis to the yoke should also be shielded and grounded to minimize radiation.

Adjust the drive control of the receiver below the point where left-hand stretch or center compression occurs. Excessive drive not only will shorten the life of the tubes in the horizontal and high-voltage sections, but also will increase pulse amplitudes and aggravates interference to radios.

Interference can be external or internal, depending on origin. All frequencies over 60, and less than 15,750 cps, produce one vertical black and one vertical white stripe or one black and two white or one white and two black. At twice the horizontal frequency there would be two black and two white vertical stripes. If the frequency is an exact multiple of 15,750, the lines are vertical; if not, they are slanting. To find the frequency of the signal, count the number of black or white stripes. If bars are horizontal multiply by 60; if vertical or diagonal, multiply by 15,750.

### External interference

**SYMPTOMS:** Ignition and similar noise causing random flashes across screen.



**SERVICE:** Diathermy, rf heater, etc., causing a herringbone pattern through part of pix. Depending on the strength of signal, it can cause horizontal pulling at top and a black and white marble striped pattern covering the entire screen. Also caused by: electric motors, air-conditioning, refrigerators, electric appliances, producing fine horizontal broken lines; other TV sets (producing diagonal bars across screen); local-oscillator interference from neighboring sets, causing narrow vertical or diagonal black and white stripes. Double conversion interference may resemble oscillator radiation from another receiver.

Amateur or other radio transmission will produce a condition similar to local interference (black diagonal lines), but may be on or off, or intermittent. FM interference will result in a wavy, vertical-line pattern.

Adjacent-channel interference (observed mostly in fringe areas) from lower channel produces a herringbone pattern due to the sound carrier which varies according to the adjacent-channel program; also interference from higher channel from video carrier and causing a superimposed pix stationary or slowly moving, or a number of diagonal lines, or a vertical moving bar. Co-channel interference will cause a venetian-blind effect with superimposed pix.

Interference from another TV station is indicated by a windshield wiper type effect. (Vertical bar moving back and forth across the screen or horizontal bar moving up and down.)

Airplane flutter will also cause interference similar to rf type, i.e.; diagonal bars across screen.

In areas having a community TV antenna system, the condition usually is caused by radiation from the system. Signal leakage can be traced generally to loose or corroded splice and/or plugs in the main cable; corroded and/or loose joints in plug or socket on amplifier box; loose lid or cover of amplifier box; defective grounding (loose ground wire from amplifier box, or wire connected to shield of main coaxial cable); or excessively high signal level of amplifier. In latter instance, signal should be reduced to lowest level consistent with good pix quality.

External interference can come by three paths: antenna transmission line; line cord; or directly to chassis.

First, detach the antenna. If interference is still observed, it is coming from the power line or directly to the chassis. Next, attach

a lowpass filter between the set and the power line. If you find that this attenuates the interference, then some part of the TVI is coming through the power line.

Video amplifier pick-up can be determined by removing the last pix if tube. If condition continues, pick-up is in the video amplifier.

Other remedies are: reroute the lead-in; re-position the set; re-orient the antenna; shield affected parts of set; reverse the power plug of offending-equipment.

If detaching the antenna reduces interference, then it is coming from the transmission line. Try a high-pass filter or tuned stub. A channel trap may be effective. Make sure the trap does not fall on some used channel (higher in frequency) and act as an absorber over part of the band. Construct one of 300-ohm transmission line, slightly longer than required length, shorted at one end, the other end connected to antenna terminals of set. Short line with razor blade at  $\frac{1}{8}$ " intervals, working toward set. At critical point, cut line and connect carbon resistor. (20 ohms to 150 ohms), depending on strength of interference, across line. Do not use value lower than necessary to minimize interference. If interference frequently is other than that of another TV station, resistor may not be necessary.

Channel	Channel trap (length in inches)
2	84
3	78
4	70
5	61
6	53
7	25
8	24
9	24
10	23
11	22
12	22
13	21

### Internal interference

Tweets. This appears on the screen as black and white stripes. When the fine-tuning control is not rotated, stripes usually are continuous in motion and vary in number and position. They

change from a diagonal to a vertical position and sometimes are horizontal. Interference can only be seen when station is tuned in and usually on one channel only. Can appear on almost any channel. Pattern is affected considerably by rotating fine-tuning control.

If originating in sound if, can be checked by removing first sound if tube. A possible remedy is to keep the lead-in from the antenna terminals to the front end as far from the if strip as possible. Keep the antenna lead-in away from the power line. Try covering the if and detector tubes with metal shields.

4.5-mc interference consists of very fine black and white stripes, slanting or vertical which have an effect similar to poor focus. (In split-sound sets, the pix is often smeared.) This can be caused by incorrect positioning of the fine-tuning control in intercarrier sets, incorrect tuning of the sound take-off coil, or incorrect tuning of the 4.5-mc trap in the video-amplifier stage.

Arcing in the high-voltage system appears as ignition interference on the screen, is present when the antenna is disconnected from the set, and can be seen and heard in the high-voltage cage.

When two dark bands appear across channels 2, 4, and 5, the trouble may be caused by a loose (or poorly contacting) 117-volt light bulb. Turn lights on one at a time, until offending bulb (or socket) is located.

## **TV interference with AM radio**

**SYMPTOMS:** Whistles and birdies heard in radio come from radiation, or parasitic voltages in power line from TV sets. The interference is usually experienced between 60 to 300 feet from the TV receiver, and is stronger in areas where AM signals are weak. Radios using built-in antennas are especially affected.

**SERVICE:** Rotate the horizontal-hold control of the TV set. The pitch of the whistle as heard in the AM receiver should vary. Turning off the TV set should eliminate the whistle. In portable radios, if the interference is unchanged when operating on batteries, then the TVI is being picked up by the receiver antenna.

To eliminate this problem, wrap tin foil around the deflection cable of the TV set. Ground the foil. Insert a line filter in the power line (if not already in the TV receiver) and bypass capacitors across the ac line to the radio. Use capacitors having a value of less than .04  $\mu\text{f}$ . Insert rf chokes in the filament leads of the horizontal-output and damper tubes. The chokes must be capable of passing the filament current.

## **Two stations (pix) reproduced simultaneously on CRT**

**SYMPTOMS:** Video signals of two different stations, reproduced as separate pix, appear on the CRT at the same time.

**SERVICE:** This is caused by cross modulation in the rf amplifier, due to an excessively stronger signal on one channel, when tuned to a different channel. The trouble may be eliminated by installing an antenna with better selectivity. Try checking rf tube voltages. Substitute a new tube (or tubes) for the rf amplifier even though it may check out on the tube tester.

### Variable controls

When a potentiometer develops a bad spot, and a replacement is not readily available, reverse the two outside connections, changing operation to the other side. This is not a repair, but just a temporary expedient until a replacement control can be obtained. Controls can be cleaned by tilting set and allowing cleaning solution to run into component on shaft from dropper. When replacing controls in cathode circuits (such as the vertical-linearity control) use a wire-wound type.

### Vertical band—center of pix

**SYMPTOMS.** A ragged vertical band of noise pulses in center of pix.

**SERVICE:** May be caused by a defective high-voltage rectifier or corona in high-voltage transformer windings at terminals, plate caps and/or loose strands of wire at plate caps.

### Vertical bands, white, left side of raster

**SYMPTOMS:** Ringing in horizontal-output circuit.

**SERVICE:** Replace damper tube. Insert a parallel-resonant trap, tuned to approximately 250 kc in series with the horizontal-deflection coil. See section on ringing.

### Vertical bar at left

**SYMPTOMS:** Ragged bar, about  $\frac{1}{4}$ -inch wide, inside left edge of screen.

**SERVICE:** Usually caused by damper-tube oscillation. May be cured by inserting rf chokes at plate and cathode of tube. (See also section on spooks.)

### **Vertical bar, single, wide—left of screen**

**SYMPTOMS:** Wide, bright vertical bar, accompanied by several narrow white bars. Narrow raster.

**SERVICE:** Check B+ boost capacitors and also damper tube for weak emission.

### **Vertical bar, white, near center of screen (drive bar)**

**SYMPTOMS:** Thin white bar between center and left side of screen. Pix squeezed together in center.

**SERVICE:** This condition is caused by excessive horizontal drive. Reduce the amount of drive until the overdrive line can no longer be seen. As the horizontal-drive control affects pix linearity, the width and linearity controls must be readjusted. The linearity control may have little or no effect. Correct procedure: 1) Adjust horizontal-size control until pix fills screen horizontally. 2) Adjust linearity control for best distribution. 3) Adjust drive control until bar is observed in pix. 4) Reverse drive control until bar is eliminated, plus additional quarter turn. 5) Rotate brightness control, maximum to minimum. Drive bar should not appear. 6) If necessary readjust width and linearity controls.

This trouble may also come from defective components in the horizontal circuit, such as the damper tube, horizontal oscillator and output tubes, width and linearity coils. Check the plate resistor of the horizontal-oscillator tube; grid resistor, and the screen resistor and capacitor of the horizontal-output tube; the series capacitor connected to the drive control, and parallel capacitors connected across the linearity coil. If the drive bar cannot be eliminated by rotation of the horizontal-drive control, try reducing the value of the coupling capacitor between the horizontal oscillator and horizontal amplifier by addition of another capacitor of equal value in series.

### **Vertical bars**

**SYMPTOMS:** (A) Two white vertical bars at left side of screen. (B) Dark vertical bars at left side of pix or raster.

**SERVICE:** (A) Usually caused by defective plate resistor of horizontal-discharge tube, or capacitor connected between plate of horizontal oscillator and grid of horizontal-discharge tube. (B) Caused by defective filter capacitors in B+ supply to horizontal- and vertical-output circuits.

**Vertical black line (left side of pix)—see Barkhausen oscillation**

### Vertical circuits

Vertical-deflection stage may be checked by connecting each stage to the top of the volume control through a .1  $\mu\text{f}$  capacitor.

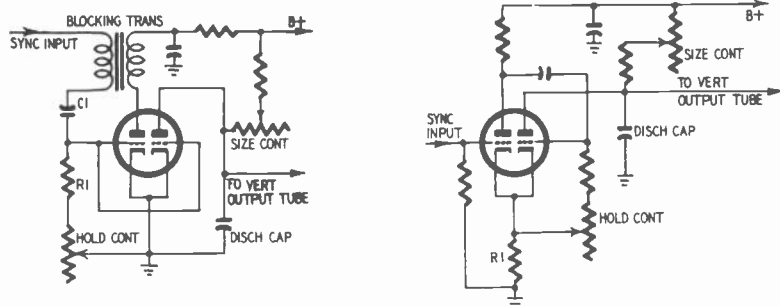


Fig. 1-V. Vertical-blocking oscillator and multivibrator circuits.

A vertical buzz will be heard in the speaker, indicating that the respective stages are functioning.

A weak vertical oscillator causes insufficient height and poor vertical linearity. A vertical oscillator working off frequency results in inability to obtain one complete pix from top to bottom within the range of the vertical-hold control. Fig. 1-V shows vertical-blocking oscillator and multivibrator circuits.

See the check list on page 198 for vertical-sweep troubles.

### Vertical deflection, insufficient

**SYMPTOMS:** Bright horizontal line across face of screen. Increasing the vertical-gain control has no effect.

**SERVICE:** The defect must be in the vertical-sweep section, as there is no vertical deflection at all. Quite often a defective tube or capacitor is the most likely cause, although a defect in the vertical-deflection coil in the yoke or in the leads running to the yoke will also cause this trouble. Replace the vertical oscillator and

## VERTICAL SWEEP CIRCUIT CHECK LIST (BLOCKING OSCILLATOR)

SYMPTOMS	SERVICE
Compression	Capacitor at the grid of the vertical amplifier in series with resistor to ground. See Fig. 1-V.
Compression at top	Peaking resistor.
Compression at top, insufficient height	Vertical-output transformer; vertical yoke.
Compression, nonlinearity, foldover	Coupling capacitor between the vertical-oscillator and the vertical amplifier.
Double half pix superimposed, vertical roll, triple pix	Capacitor (C1) in oscillator grid circuit and resistor (R1) between grid of oscillator and vertical hold.
Foldover, nonlinearity	Cathode resistor and bypass capacitor of vertical-output stage.
No vertical sync	Blocking - oscillator transformer; vertical-hold control; resistor R1 connected to vertical-hold control.
Roll	Vertical-hold control.

## VERTICAL SWEEP CIRCUIT CHECK LIST (MULTIVIBRATOR OSCILLATOR)

SYMPTOMS	SERVICE
Nonlinearity	Grid resistor of the vertical-output amplifier. See Fig. 1-V.
Poor vertical sync	Cathode resistor R1 of the vertical oscillator.
Poor vertical sync, insufficient height	Capacitors and resistors in the retrace blanking circuit; cathode capacitor of the vertical-output amplifier.



output tubes, measure plate voltages, and check the continuity of the windings of the vertical-output transformer.

## Vertical hold, critical

**SYMPTOMS:** Vertical hold does not lock pix.

**SERVICE:** To check, rotate vertical-hold control. If one complete pix cannot be formed, even momentarily, trouble is incorrect frequency of vertical oscillator. Check all components in the vertical oscillator. If the vertical hold stops pix and pix drifts vertically out of hold, then trouble is in the vertical-sync section. Check sync tubes by substitution. See also vertical sync, unstable.

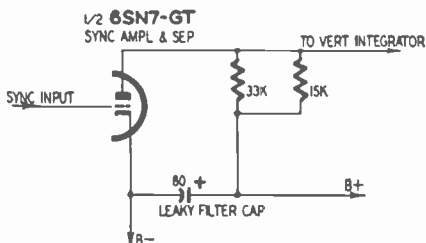


Fig. 2-V. Leaky filter capacitor can produce vertical jitter.

This trouble may also be caused by a defect in the integrator network; in the agc; and by the coupling capacitor between sync stages.

## Vertical hold—no range

**SYMPTOMS:** Vertical hold works only at extreme setting or does not lock in pix at extreme position.

**SERVICE:** A properly operating vertical-hold control should lock the pix in somewhere near the center of travel of the control. If not, then the trouble is usually caused by a defective capacitor and resistor combination at the grid of the vertical-oscillator tube. If the pix drops down slowly, and cannot be stopped by the vertical hold, the value of the resistor between the grid of the oscillator and vertical-hold control can be reasonably increased slightly for better operation.

This condition may sometimes be corrected by replacing the vertical oscillator with a new, good tube. However, this is usually unsatisfactory after a short period of time.

## Vertical jitter

**SYMPTOMS:** Vertical vibration of pix, with left side of screen be-

coming dark before right side, when the brightness is turned down.

**SERVICE:** This trouble is usually caused by defective low-voltage supply filter capacitors. A leaky decoupling capacitor in the sync amplifier and separator could give this trouble. Refer to Fig. 2-V. (See also jitter.)

### **Vertical line**

**SYMPTOMS:** White vertical line down center of screen.

**SERVICE:** Condition can be caused by defective horizontal-deflection coils, horizontal-output transformer, width control, and capacitor connected across one-half of horizontal-deflection windings. See also horizontal nonlinearity.

### **Vertical line pattern, wavy (see TVI)**

### **Vertical lines, left side of screen**

**SYMPTOMS:** Light and dark vertical lines, two or more, at left side of screen (parasitic oscillation).

**SERVICE:** To help locate the source of trouble, remove the video-amplifier tube. If the lines disappear, the trouble is in the video circuit; if the lines remain the trouble is in the horizontal sweep. This difficulty is generally caused by a defective tube such as the horizontal oscillator, horizontal output, damper, or HV rectifier. Be sure horizontal drive, linearity, and width controls are correctly positioned.

May also be caused by defective capacitor in keyed agc circuit. Also check the horizontal-linearity coil and the horizontal-output transformer. If your search narrows down to these components, you will have to substitute new parts.

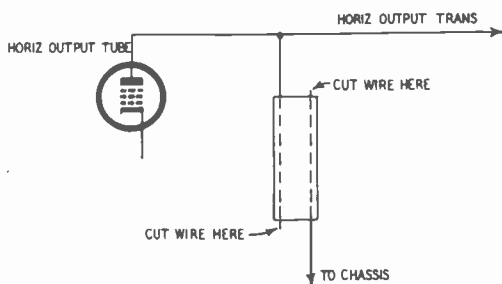
### **Vertical lines, narrow, at left edge of screen**

**SYMPTOMS:** Originates in horizontal-deflection circuits. Always appears at extreme left edge of screen, and is similar to Barkhausen oscillations. When signal is weak, line is very black with ragged edges. When signal is normal line is not so black. Strongest on low-frequency channels, especially channel 2. In severe cases this condition may disturb sync and horizontal-afc circuits. When two sets are sufficiently close, the pix may be disturbed annoyingly, especially if the sets are tuned to different channels. When this happens the black line moves back and forth across the screen.

**SERVICE:** This is a form of radiation generated in the damper

circuit resulting from the rapid rise in deflection current. If the condition is very annoying, it may be possible to increase the width of the raster slightly to move the line beyond the mask. Adjust width control for maximum pix width. If this does not help, connect a high-voltage capacitor from the plate cap of the horizontal-output tube to chassis. You can easily make this capacitor from a small piece of transmission line as shown in Fig. 3-V. Use the smallest amount of line that will give the desired result. Keep the line clear of the chassis.

It may be necessary to ground the high-voltage cage at several places. Dress the antenna lead-in away from deflection circuits. Try



*Fig. 3-V. Capacitor made from a small piece of transmission line. Use the minimum amount of transmission line needed to increase pix width. One side of the line can connect directly to the plate cap of the horizontal-output tube. Fasten the other side of the line to the chassis.*

a new damper tube. Insert rf chokes (from  $1 \mu\text{h}$  to  $5 \mu\text{h}$ ) in the plate, cathode, and heater circuits of the damper tube. Small by-pass capacitors (HV types,  $47 \mu\text{mf}$  or less) can also be used.

In sets using autotransformer and direct-drive deflection circuits, the trouble generally originates in the B+ lead connected to the plate of the damper tube. If space permits, insert a  $100\text{-}\mu\text{mf}$  electrolytic in the low-voltage power supply, between the B+ side of the filter choke and the chassis.

### **Vertical lines, three or more**

**SYMPTOMS:** Appearance of three or more vertical lines on left side of screen after replacing yoke.

**SERVICE:** Capacitor across one of the windings of the horizontal-deflection coils may be misplaced. Transfer as shown in Fig. 4-V.

## Vertical lines, white, left side of screen

**SYMPTOMS:** Lines diminish in intensity near the center of the screen. Do not confuse with horizontal-drive bar.

**SERVICE:** This is a type of ringing, usually caused by a defective damper or horizontal-output tube. Additional possibilities are defective components such as the capacitor connected to plate or cathode of the damper tube, and B+ boost capacitors.

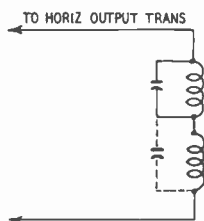


Fig. 4-V. The capacitor across one of the horizontal windings in the yoke may be misplaced, as shown by dashed lines in the drawing.

Watch the vertical lines on the screen and at the same time move the leads to the CRT socket. If this has an effect, dress leads for minimum interference. Shunt the existing mica capacitor across one-half of the yoke winding with a similar unit. The usual value is about 56  $\mu\text{f}$ . Be careful. Improper size can result in a wave on the left side of the pix.

Insert 47-ohm to 100-ohm resistors at grid and screen of horizontal-output tube. See Fig. 5-V. Place a magnet over the horizontal-output tube and adjust. Sometimes, when horizontal-output tubes are used in parallel, parasitic oscillations may occur. Insert 47-ohm to 100-ohm resistors between plates, also grids, as shown in Fig. 6-V.

## Vertical lines, white, right side of screen

**SYMPTOMS:** Several white lines at right side of screen, and possible nonlinearity.

**SERVICE:** Check the horizontal-output tube, preferably by substitution. Also check the coupling capacitor between the horizontal-oscillator and horizontal-output stages. This trouble may also be caused by a defective grid resistor of the horizontal-output tube, or lack of a parasitic suppressor resistor at grid of tube. Try substituting new horizontal oscillator and damper tubes.

## Vertical nonlinearity

**SYMPTOMS:** Pix compressed or elongated.

**SERVICE:** Vertical controls are frequently misadjusted by some set

owners. Make sure that size, linearity, and centering controls are positioned correctly. The vertical-linearity control usually affects the top half of the pix, and height control affects bottom half. In some sets reverse may be true.

To check, rotate vertical hold to allow pix to roll down slowly.

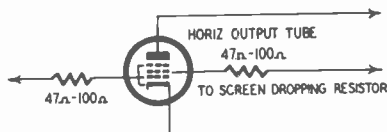


Fig. 5-V. Parasitic oscillation in the horizontal-output tube can be eliminated by inserting 47-ohm to 100-ohm resistors at the control grid and screen grid pins of the tube.

These resistors can have a rating of one-half watt. Also try placing a magnet over the horizontal-output tube. Keep your hand away from the tube cap when adjusting the magnet.

If black bar is same thickness at all positions, linearity is satisfactory. If the linearity control has no effect on the pix, replace the

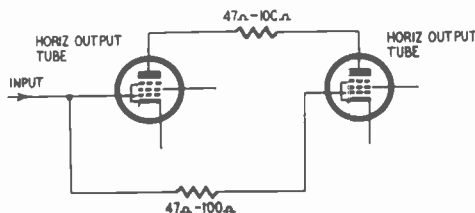


Fig. 6-V. Method of connecting parasitic-suppression resistors to horizontal-output tubes when the tubes are operated in parallel.

control. (Also refer to section on egg-shaped test pattern.)

This condition may be caused by weak vertical-oscillator or amplifier tubes; defective vertical-blocking oscillator or vertical-output transformers, or applied voltages. If the condition is at the bottom of pix, accompanied by decrease in height at top and bottom, check the vertical-output tube. This may also be caused by low B+ to the vertical oscillator. If the entire pix evidences non-linearity, accompanied by stretching of bottom beyond edge of mask, look for low B+ to the vertical-output stage. If the condition exists at the bottom of the pix, accompanied by a decrease in

height at the bottom, the grid resistor in the vertical-output circuit may be defective.

Try using a new vertical-output tube. If this does not help remove the cathode bypass capacitor of the vertical-output tube and note results. If still not improved, shunt cathode resistor of vertical-output tube with new 100- $\mu$ f electrolytic. After the new capacitor is installed, readjust the linearity control. If the control is still ineffective, check the series resistor associated with it, as well as the control itself. Check the vertical-output tube grid resistor and the coupling capacitor (for leakage).

### **Vertical roll**

**SYMPTOMS:** Pix moves up and down; vertical-hold control does not lock pix in place. (See Fig. 1-H on page 71.)

**SERVICE:** Check setting of vertical-size and linearity controls, since these may have been misadjusted. Look for gassy tubes which might cause an unstable pix, including agc and tubes in the front end. Two or more frames rolling vertically may be caused by a defective tube in the sync circuit, vertical oscillator or video-output. Rotate the horizontal-hold control. If this control has less-than-normal range, and the vertical hold is critical, trouble is indicated in video-amplifier or sync circuits.

When the quality of the pix is normal and horizontal hold is good, but vertical hold cannot keep pix locked in, trouble probably is in sync or integrator circuits. Also check resistor-capacitor components in the grid circuit of the vertical oscillator. Examine the resistor in series with the vertical-hold control.

Hum modulation (120 cycles), due to insufficient filtering, can cause vertical rolling. Keep 60-cycle filament leads away from the control grid of the vertical-oscillator tube. Poor lead dress, sometimes produced by necessary servicing, can hum modulate the vertical-oscillator grid.

While the pix rolls, observe the sync signal which should be darker than the blanking bar and pix signals. If sync signal is not darker, then trouble is indicated in the rf amplifier, video if, or video-amplifier stages, including agc. Insufficient agc may cause an overloading condition to prevail, causing sync pulse clipping.

### **Vertical sync, unstable**

**SYMPTOMS:** Pix jumps out of vertical lock. Vertical-hold control

must be readjusted frequently. New tubes in sync separator and vertical-oscillator circuits do not correct the condition. (See also previous section on vertical roll.)

**SERVICE:** Vertical-hold trouble can be caused by a change in one of the parts in the grid circuit of the vertical-blocking oscillator. Take a resistance reading of the grid leak and hold-control potentiometer, and if off value by more than 10%, replace them. If this doesn't help, try a new grid capacitor. If multivibrator oscillator is used, check grid and cathode resistors.

Check for incorrect parts values in the integrator. If integrator is a printed circuit, it may be necessary to replace the entire unit. Misalignment resulting in poor low-frequency response is another cause of poor vertical stability.

Vertical sync instability sometimes occurs for only one station of several that can be received. Picture contrast and quality is usually excellent and there is ample signal strength. Horizontal stability seems good, but for this one channel the vertical-hold is critical and it is difficult to keep the pix from rolling vertically. This trouble is found where signal strength is high, as opposed to sync troubles which usually occur in fringe areas, or it occurs only when the strongest station is tuned in. The agc is either defective or too critically adjusted. This results in sync pulse clipping, affecting vertical sync. Horizontal sync remains fairly stable because most sets use automatic sync lock. If the agc is too far out, both horizontal and vertical instability will occur and pix quality will suffer.

Adjust the agc while the strongest station is tuned in. Advance the control to where the pix starts to bend or pull horizontally, then back off until stability is secured. Even after this, sync instability may occur for peaks of high modulation in the transmitted signal, particularly during film commercials. If too severe, the agc will have to be decreased. This may give poorer contrast for the weaker stations.

In some cases the antenna should be re-oriented. An attenuation pad can be switched across the antenna terminals of the receiver to cut down the signal for the strongest station. This may require some experimentation.

### **Vertical wedges of test pattern with dark streaks**

**SYMPTOMS:** May be accompanied by ringing at right of station letters and circle, observed chiefly on weak signals.

**SERVICE:** This is regeneration, probably resulting from incorrect alignment of video if amplifier. May also be caused by improper lead dress and defective plate and screen resistors. See also regeneration.

## Video amplifier

Most often is a single-tube circuit. In addition to amplifying the video signal, the video amplifier may be the sound take-off point in intercarrier sets, and also furnishes signals for noise-reducing and sync separator circuits. See Fig. 7-V.

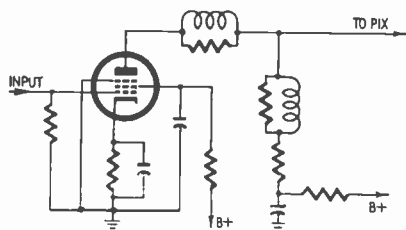


Fig. 7-V. The video amplifier is usually a single-tube circuit. This stage is often directly coupled to pix tube.

Defects in agc, noise, and sound if circuits can affect the video amplifier, lowering pix quality. A defect in the noise circuit can affect the sound take-off signal and also the sync level feeding into the separator stage.

When measuring bias voltages of video amplifiers, the grid is always negative with respect to cathode. If voltage is zero or positive, check the coupling capacitor.

When pix has poor definition, trailing smears, and improper contrast, check coupling capacitors and peaking coils. Examine the horizontal-line trace. If fuzzy, check focus control or focus unit on pix tube. If the line trace is clearly defined, but pix has poor focus, trouble probably is in video amplifier.

## Video amplifier, overpeaking (see Repeat lines)

### Video-detector circuits

Several troubles can arise from defective video detector operation. Some of them are not too evident. For example, good sound with poor or no picture and sync can be due to the video detector.



The video detector performs two functions: as an AM detector it rectifies and filters the modulated if input to deliver a composite video signal to the video amplifier. As a mixer it heterodynes the AM picture carrier with the FM sound carrier to produce the 4.5-mc intercarrier sound. Fig. 8-V shows the course of the signals.

In most sets, the output of the picture detector must be more than 1 volt peak-to-peak to produce a usable picture; a good

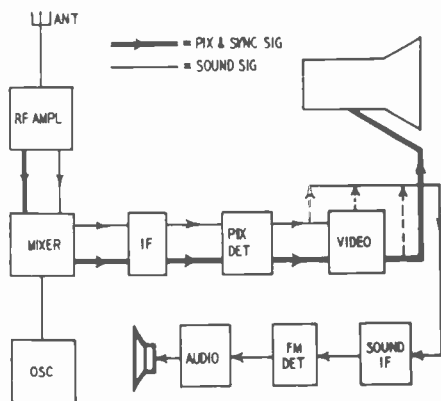


Fig. 8-V. Block diagram shows the paths of the pix, sync, and sound signals in an intercarrier receiver.

picture requires 3 or more volts. If the video detector and preceding sections are performing satisfactorily, we can measure these voltages at the output of the second detector. We can select a weak station to see if more than the minimum of 1 volt peak-to-peak is present and also to see if the output on a strong signal is 3 to 5 volts peak-to-peak. The sound if will be present if both picture and sound signals are sufficiently strong. A very weak picture signal will heterodyne with the sound signal to procure fair sound.

In troubleshooting, check with a scope or vtm across the video detector load to determine whether the output is satisfactory for the station tuned in. If so, the video detector is OK. If not, the input to the video detector must be checked to see if the signal is satisfactory there. If it is, the trouble lies in the video detector or its circuitry.

The video detector may be a tube such as half a 6AL5. See Fig. 9-V. Typical modern crystal detector usage is shown in the schematic of Fig. 10-V; the crystal is in the last if can. The most

accessible place to test is the plate of the last if amplifier tube. Check here with a demodulator or peak-to-peak probe with a vtvm.

To check the output of a video detector, connect a scope across the detector load resistor. The load resistor may be easily identified in other circuits since its value is around 3,000 to 5,000 ohms.

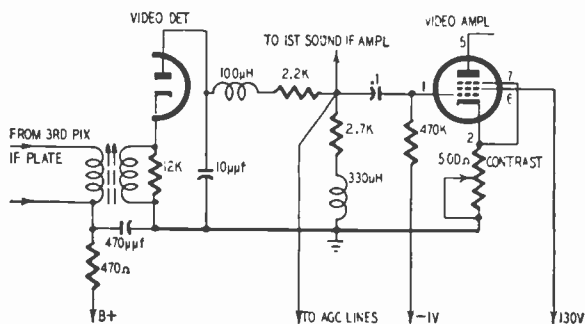


Fig. 9-V. Video detector using one half of vacuum-tube duo-diode. Usually found in older sets. More modern receivers (including color TV) use crystals (1N64). Load for the detector is less than 5,000 ohms.

If the trouble is in the video detector, check for open resistors and coils. Substituting a new rectifier will reveal a bad diode. Substitution or check on a capacitance meter will test the capacitors. The small 5-10- $\mu\text{f}$  filter capacitor may be disconnected for testing since the signal will come through with it out of the circuit. The capacitor may be shunted if it is suspected of being open-circuited.

The if tuning in the detector circuit may be off; it can be checked by turning the slug adjusting screw while monitoring the output or the picture. Make a mark in line with the adjustment screw slot on the chassis prior to turning this screw so that you can return to the same point if there is no change. An ohmmeter check will reveal a short-circuited crystal detector.

Crystal detectors have a bad habit of changing their forward resistance. The forward resistance of a good crystal is about 75-100 ohms and the back resistance 150,000 ohms or more, resulting in a ratio of 2,000 to 1 or so. To obtain a good video signal, the ratio must exceed about 200 to 1. To heterodyne sound, a ratio of 10 to 1 will yield a good signal. This accounts for the phenomenon of good sound with no picture. In such a case, after making the tests mentioned, check the crystal with an ohmmeter or, better yet, replace it.

## Video if stage

TV sets have from two to four if stages, usually with ranges between 21 and 26 megacycles, and between 41 and 46 megacycles. In split-sound sets, video if and sound if signals are amplified separately; in intercarrier sets, both video if and sound signals are amplified through a common if strip. Operation of video if strip depends on rf signal voltage from tuner, B+ voltage, either

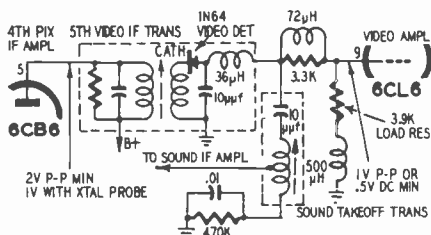


Fig. 10-V. Typical crystal-detector circuit. Crystal is enclosed in can with last if transformer.

from low-voltage power supply or audio-output stage, and agc voltage.

Defective tubes are common, with low emission as a usual trouble. In conventional sets, pix will be lost; in intercarrier sets, pix and sound will be lost. To check whether the pix signal is reaching video-detector stage, connect a vtvm across the diode-load resistor. Refer also to preceding section on video-detector circuits.

Quick check. Touch metal tip of screwdriver to grid of if tubes; then lightly touch metal part of screwdriver with finger. Signal will show on screen.

Voltage at grids should be negative with respect to cathode of tube. A defective coupling capacitor can produce positive voltage at grids, resulting in excessive contrast, poor pix quality, and pix weaving and pulling.

Check agc bias on grids of if tubes. Observe the negative bias from the agc line to ground, varying as fine-tuning control is adjusted. Strong signal increases negative agc bias on grids, and weak signal decreases the bias. If abnormal, check agc tube, agc resistor and/or capacitor.

Distorted video signal and/or diagonal line interference may be caused by defective screen bypass capacitors and voltage dropping resistors. Loose cores in if coils will cause noisy sound; also sharp changes in volume. See also microphonics.

## Video if transformers

Breakdown can cause streaks on pix similar to ignition interference; and static noise in sound channel. In newer sets, check plastic insulation (which may have melted) around terminal lugs, which may be permitting lug to touch can or chassis.

At plate side, usually burns out winding. Dropping resistor may burn out, or affect power-supply components. At secondary (grid) side, set becomes inoperative.

## Voltages

When space permits, use test adapter socket. Caution: In sets using selenium rectifiers with one side of power line connected to chassis (constituting a shock hazard) use an isolation transformer.

Do not measure voltages on caps of horizontal-output tube, HV rectifier, or plate of damper tube; or 2nd anode of CRT, unless proper probe is used.

Generally, when making voltage checks, all controls should be set at half rotation, excepting contrast—maximum clockwise; set station selector on blank channel with antenna disconnected from set with terminal shorted. Measure dc voltages between tube socket terminals and chassis, unless otherwise stated.

Check all plate, screen and cathode voltages in suspected circuit, comparing measurements with values indicated in manufacturer's schematic. Any dc voltage 20% off from rated values usually indicates trouble.

When there is no voltage on the plate of a tube, check each component along line from that point to B+. In sets having a voltage divider in the B+ supply, if positive voltages are too low, and negative voltages are too high, there is a short in the positive side, or an open in the negative side.

### **Warmup, slow**

**SYMPTOMS:** Picture requires almost one-half hour to stabilize.

**SERVICE:** Check the low-voltage power supply. Determine whether there is a change of voltage output during the first half-hour. Low emission from the rectifier during warmup could cause this trouble. If the power-supply voltage is fairly stable and at full rated value during warmup time, the horizontal oscillator and horizontal-output circuits should be checked for slow-heating tubes or other component parts that prevent proper linearity and full picture width.

### **Wavy scan at left**

**SYMPTOMS:** Wavy lines on left side of screen.

**SERVICE:** This is produced by an open or defective capacitor across one-half of the horizontal-deflection coils. This capacitor balances the distributed capacitance of each coil section and prevents the distortion which looks like vertical sections of waviness.

### **Whistle (see also Microphonics)**

**SYMPTOMS:** Set may howl, growl, squeal, or whistle.

**SERVICE:** A high-frequency whistle may be caused by a loose screw in the high-voltage transformer. The terminal board on the high-voltage transformer may be loose. A high-pitched whistle can sometimes be stopped by adjusting the horizontal-width control.

If the set is a table model, remove screws holding speaker in

place, and note if trouble persists with speaker not mounted. If trouble is cured, shock-mount the speaker with small rubber tabs between the speaker frame and cabinet. If the trouble remains, try replacing the oscillator tube. This may throw the set out of alignment, so it may be necessary to try several tubes until one is obtained that is not microphonic, affecting alignment the least. Put a heavy metal shield, made and sold for this purpose, over the oscillator tube.

Howl can also be due to positive feedback in the audio amplifier. This should not happen unless some of the wiring has been replaced and dressed improperly.

### **White line at top of picture (see also Ringing)**

**SYMPTOMS:** Bright white line across top of picture. Adjustment of controls and replacement of tubes does not remove this trouble. Voltage and resistance checks normal.

**SERVICE:** The white line indicates crowding of the initial vertical-sweep trace and possible transient oscillations in the vertical system.

First of all, check the network of resistors and capacitors (the integrator circuit) feeding the vertical oscillator. If these components check OK, use a scope to observe waveform linearity at the input and output of the vertical amplifier. This will help determine where the nonlinearity occurs and so localize the trouble.

Some vertical-oscillator transformers have a relatively high Q and will ring unless the damping resistor across the secondary has the specified value. Ringing produces velocity modulation of the scanning beam, which causes the white line.

### **White vertical line**

**SYMPTOMS:** Trouble is a line that may change or shift when horizontal hold is adjusted. (Same trouble may appear as "vener" effect on side of screen.)

**SERVICE:** Possible cause: Misadjustment of horizontal afc transformer. Readjust transformer; see that horizontal-hold control covers its normal range. If circuit is unstable, check or replace horizontal afc control tube and realign transformer if necessary. If trouble remains, check horizontal-discriminator transformer or coupling capacitor in this circuit. This trouble can also be due to sync clipper misadjustment or a defect at the TV station. Check on two or more stations.

## Width, excessive

**SYMPTOMS:** Pix is too wide.

**SERVICE:** Generally caused by improper manipulation by set owner of horizontal-size and/or horizontal-drive controls. If adjustment of width coil has no effect on pix—replace.

May also be caused by line voltage too high, or insufficient high voltage at second anode of CRT. If line voltage is too high and a capacitor is across width coil, replace with capacitor of lower value. Check width control.

Check (by substitution) HV rectifier, horizontal-output, damper, and horizontal-oscillator tubes. A defective horizontal-output transformer can cause this condition.

Excessive width may also be produced by defective resistors and capacitors, such as filament resistor of HV rectifier, grid and screen resistor and capacitor of horizontal-output tube; and plate resistor of horizontal-oscillator tube.

## Width insufficient

**SYMPTOMS:** Pix too narrow, usually about  $\frac{1}{2}$ -inch on each side. Adjusting width and linearity controls not helpful.

**SERVICE:** Insufficient width can be caused by a number of conditions. Frequently, set owner has misadjusted horizontal size, linearity, and drive controls. A common cause is a defective horizontal-output tube, frequently coupled with poor focus.

Check by substitution, horizontal output and oscillator tubes, HV rectifier, damper, and LV rectifier. In sets using the audio-output tube as a voltage divider, that tube should be checked.

Can also be caused by low line voltage (may not affect height), defective deflection yoke or improper connection to horizontal-output transformer. If a universal or tapped output transformer is used, check connections and try different taps; or focus unit may be too close to deflection yoke. Spacing should be  $\frac{3}{8}$ " minimum. When the deflection yoke has a ferrite core in the form of a collar fastened around yoke windings, a loosening of segments can cause loss of width.

Defective resistors and/or capacitors in horizontal-deflection circuits can produce this condition, such as: cathode, control grid and screen resistors and capacitors of the horizontal-output tube; capacitors and resistors across horizontal- and vertical-deflection coils; cathode and plate capacitors of damper tube; plate resistor of the horizontal-discharge tube; coupling capacitor between

horizontal discharge and output tubes; and, in a circuit employing series filaments, check voltage dropping and bypass resistors.

When the set is first turned on and narrow pix occurs, followed quickly by complete loss of horizontal deflection evidenced by a white vertical line, cause probably is defective grid-return resistor of horizontal-output tube or a very weak tube. A defective cathode bypass capacitor of the horizontal-output tube causes an intermittent loss in width. Bridging capacitor when trouble develops will show if this component is faulty.

Arcing in the width coil can cause an intermittent decrease in width, especially noticeable when slug has been screwed fully in. Readjustment of slug may overcome condition. Check the width coil, the linearity coil and its capacitors. A defective isolating transformer in the damper heater circuit may be at fault. Sometimes the horizontal-output transformer may have a loose core due to a loose bolt (generally indicated by 15,750 cycle squeal).

There are always those few stubborn cases which seem to defy all logical solutions and turn out to be the most time-consuming jobs. If the suggested tests have failed to show up the defect, the following remedies will yield that extra quarter inch or so:

Clip the leads which run from the width-control coil to the horizontal output transformer. This allows maximum sweep. (The action of the width control when it is in the circuit is to reduce the sweep width below maximum.) Width coils are omitted in some sets. In others the width coil is part of a keyer coil (agc) and so should not be removed.

Decrease the size of the resistor in the plate circuit of the horizontal-discharge tube. Increase the plate voltage to the discharge tube by obtaining it from the boosted B-plus.

Connect a mica or paper capacitor across those terminals of the horizontal-output transformer to which the width control was originally connected. Try various values from .001  $\mu\text{f}$  to about 0.1  $\mu\text{f}$ . The capacitor should be rated for at least 600 working volts. It tends to decrease the amount of high voltage produced by the power supply. The larger the capacitance, the lower is the output voltage. A decrease in the picture tube's second-anode voltage reduces the speed of the electron stream; a lower-velocity beam can be more easily deflected, resulting in greater sweep width. The disadvantage of this method is that the brightness is affected. However, the decrease in brightness is very small for a slight increase in width.

Increase the voltage on the screen grid of the horizontal-output tube. When the screen grid voltage of the horizontal-output



tube is increased moderately, it is an effective and safe way to obtain additional width and high voltage. A typical circuit contains a 15,000-ohm 2-watt voltage dropping resistor in the screen circuit. Do not decrease this by more than one-third. Install a 10,000-ohm 2-watt unit. This should increase the picture width and the second-anode voltage. Also, the voltage on the screen of the horizontal-output tube may be increased by tapping it off the boosted B+. (This may result in parasitic oscillation.) Increasing the screen voltage occasionally results in a decrease in width due to an increase in secondary emission.

Many of these modifications may result in a change in linearity as well as width. That usually calls for readjusting the linearity controls and possibly changing the value of some resistors. Variable resistors can be used and the effect of different values noted.

### **Windows, pix**

Some cabinets have pix windows, which may be easily removed from the front, so that the inside of the window, and the face of the pix tube can be cleaned. Look for the removable molding, usually at top of pix window. Windows of plastic frequently are screwed into the front of the cabinet.

The tube and pix windows should be cleaned with damp cloth, and dried carefully with chamois or lint-free cloth. Never use cleansers or solvents to clean plastic pix windows, as damage may result. Wax-type cleaners cut down on light transmission through the plastic.

### **X-Burn (see also Ion spot and Ion trap)**

**SYMPTOMS:** Brown cross consisting of lines running from the diagonally opposite corners of the screen.

**SERVICE:** The brown stain is an ion burn. The cross, called an X-burn, is characteristic of rectangular picture tubes. It corresponds to the round or oval ion spot on round tubes. There is nothing that can be done to remove the burn but you can take steps to prevent it from getting worse and you may be in time to avoid serious damage to the gun structure.

Slip the ion trap over the neck of the tube just in front of the tube base. Rotate it so the magnet is that side opposite to the high-voltage connector. Turn on the receiver with the brightness control set to a low-intensity position. If a raster appears, move the trap slowly forward while twisting it slightly from side to side. Reduce the setting of the brightness control as the intensity of the raster increases. The brightest raster should be obtained with the

ion trap magnet behind the flags on the gun of the tube. Replace the trap with one having a stronger magnet if the brightest raster is obtained with the trap ahead of the flags. (If the raster does not appear when the brightness control is turned slightly above half-way, turn off the set and swing the magnet around.)

Advance the brightness control until the raster is slightly brighter than normal. Adjust the focus control until the line structure is clearly visible in the raster. Touch up the setting of the ion trap with the brightness control set to the maximum position at which good line focus can be maintained.

Always check the setting of the ion trap whenever the chassis has been moved from the cabinet or the set has been moved about. The ion trap should always be checked whenever the focus coil is moved or the focalizer adjusted.

### **X-Ray effect**

**SYMPTOMS:** Background objects can be observed right through performers. Horizontal objects smeared.

**SERVICE:** Trouble is due to poor low-frequency response in video amplifier. Check peaking coils and coupling capacitors. The trouble may exist at the station and is caused by camera photocathode sticking or persistence. Verify by switching channels.

### **Yokes, frozen**

**SYMPTOMS:** Occasionally, during a CRT replacement, the problem of a yoke frozen tight to the tube neck may arise. Breaking the neck of the old tube can be dangerous; not only is implosion a serious consideration, but the job can turn into an ordeal.

**SERVICE:** The solution is to (1) put a light coat of Lubriplate on the tube neck between the yoke and the base, (2) unsolder the yoke loads and hook up the vertical and horizontal windings in series, (3) then, using a Variac transformer, apply about 50 volts across the total windings for approximately five minutes. Touch the yoke, which should now be about as hot as a TV power transformer that has been in use for about an hour. If necessary, the voltage can be increased to meet these heat conditions. When the yoke reaches this heated stage, it will be quite simple to slide it off the CRT neck.

A Variac must be employed because of the variations in the resistance of various yokes. A light bulb might be used in series with a 117-volt supply, but it is advisable to utilize a meter as a check to protect the yoke. Incidentally, the application of ac in the yoke will remove or reduce any residual magnetism in the core, making the picture easier to center.

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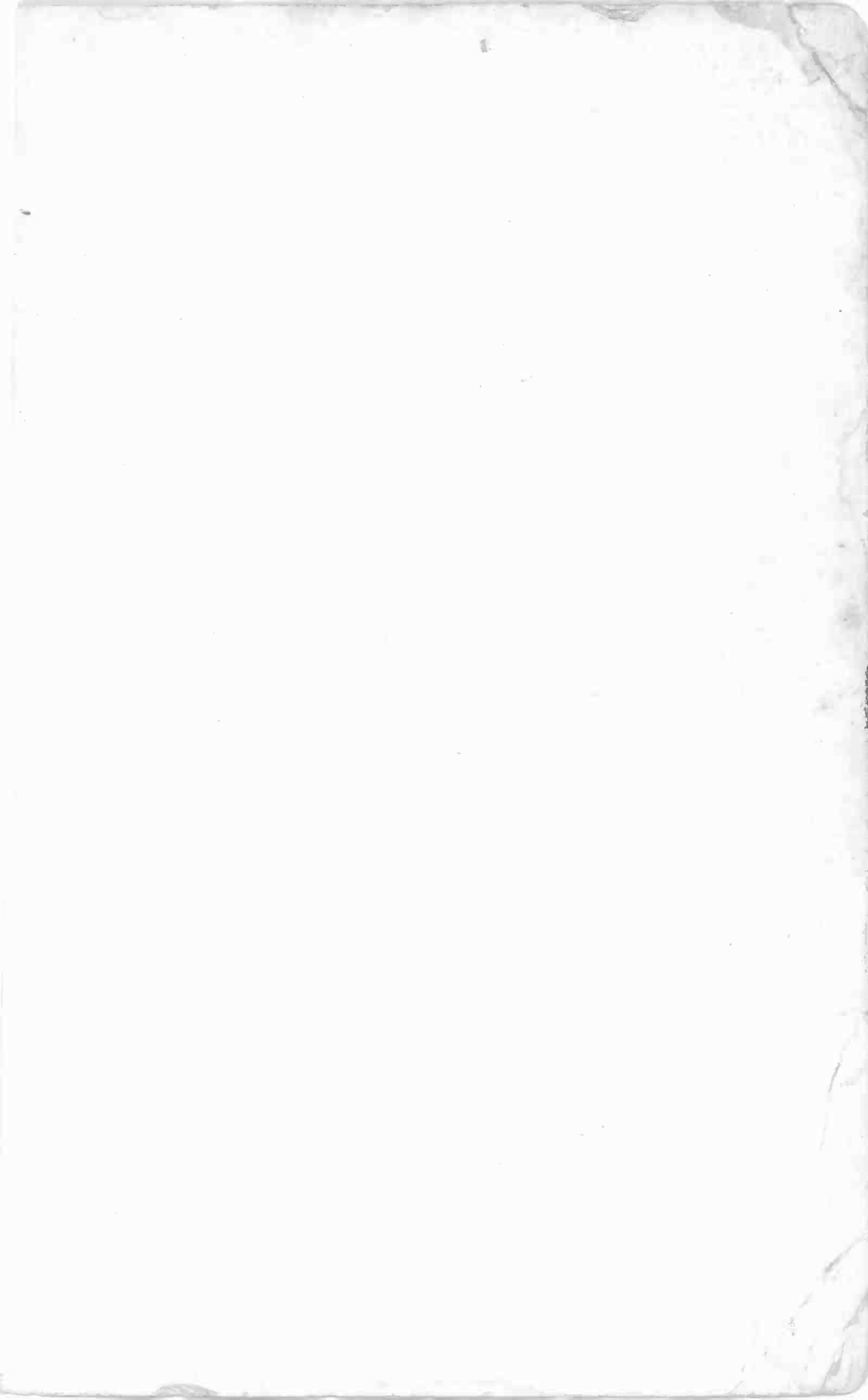
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