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TV REPAIR

QUESTIONS
and
ANSWERS
on

DEFLECTION & H-V CIRCUITS

by SIDNEY PLATT

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PREFACE

This is the fourth in a series of *Question* and *Answer* books on practical television servicing. This volume should fulfill the need for a book which answers the specific questions that are in the mind of the technician as he troubleshoots and repairs television receivers.

Because this material is intended for the practicing tv technician and the tv servicing student, servicing techniques and procedures are given full coverage, while the electronic theory is kept to a minimum. Following each *Question* is an *Answer* giving specific step-by-step procedures, and a *Discussion* which contains further servicing information and useful hints.

This volume covers the servicing aspects of horizontal and vertical deflection systems, high-voltage circuits, keyed-agc systems (which are associated with horizontal output systems), and deflection yokes. Volume 1 of this series covered front ends, Volume 2 covered video volume has been organized so that it can be read as a complete cover-circuits, and Volume 3 covered sync and sweep circuits. The present age on the servicing of deflection systems and high-voltage circuits and so that it can be used as a handy reference source to answer specific questions as they arise on the servicing bench.

In order to simplify locating the answers to any problem, the book is divided into chapters, generally based upon the direction of flow of the sweep voltages. Chapter 1 covers general horizontal deflection circuit servicing techniques and adjustments. This is followed by separate chapters devoted in turn to horizontal output circuits, high-voltage systems, damper-boost circuits, keyed-age circuits, vertical-output stages, and deflection yokes.

Although specific servicing problems are covered in this book, the author has attempted to furnish answers that can be used as a guide in troubleshooting and repairing receivers of all makes and manufacture.

The author wishes to express his appreciation to Mr. Seymour D. Uslan for his advice and assistance in the preparation of this volume.

Malverne, New York
January 1956

Sidney Platt

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Chapter 1

QUESTIONS AND ANSWERS ON HORIZONTAL DEFLECTION CIRCUIT SERVICING TECHNIQUES AND ADJUSTMENTS

QUES. 1-1. A receiver exhibits symptoms, such as little or no high voltage, caused by troubles in the horizontal output or high-voltage circuits. What major circuits points should be checked and observed?

ANS. The major checks to follow and observations to make when servicing the horizontal-output and highvoltage circuits of a receiver are:

a. Check for a high-voltage arc at the picture tube anode.
b. Check for a high-voltage arc at the plate of the high-voltage rectifier.
c. Check whether the filament of the high-voltage rectifier is lighted.
d. Check for a high-voltage arc at the plate of the horizontal output stage.
e. Check the boost voltage.

DISCUSSION. The proper interpretation of the checks and observations mentioned above greatly simplifies the approach to servicing problems in the horizontal output and high-voltage sections of the receiver. A discussion of servicing by arcing is given in the answer to *QUES. 1-2.*

QUES. 1-2. No raster is present on the picture tube. The horizontal deflection and high-voltage tubes are checked and found to be good. How may the use of high-voltage arcing localize the faulty stage to the horizontal output, damper, or high-voltage section of the receiver?

ANS. If properly interpreted high-voltage arcing will localize the faulty stage that causes a "no raster" condition. To signal trace by means of arcs, observe the following procedure:

a. Turn the receiver off.
b. Disconnect the high-voltage lead from the picture tube.
c. Turn the receiver on and hold the high-voltage lead close to chassis ground, in an attempt to cause a high-voltage arc to form. (Maintain the arc for only a very short time, to avoid damaging components in the receiver.)
    1. If an arc of proper length appears (proper length can be judged only on the basis of experience and comparison), the lack of raster is probably caused by either an improperly adjusted ion trap magnet, a defective picture tube, or incorrect grid, cathode, or first-anode voltages applied to the picture tube.
    2. If no arc appears, turn the receiver off, reconnect the high-voltage lead to the picture tube, and proceed to the next step.
d. Turn the receiver on. While holding a screwdriver by its insulated handle, attempt to draw an arc between the metallic portion of the screwdriver and the cap of the high-voltage rectifier tube.
    1. If an arc now appears, the lack of raster is probably caused by a defective high-voltage rectifier tube, a defective high-voltage filter capacitor, or a defective high-voltage filter resistor.
    2. If no arc appears, turn the receiver off, disconnect the high-voltage cap from the rectifier, turn the receiver on, and attempt to draw an arc from the cap itself. If an arc can now be drawn from the cap, a defective high-voltage rectifier tube is indicated. If no arc can be drawn from the cap, a defective high-voltage rectifier tube is indicated. If no arc can be drawn, turn the re-

ceiver off, reconnect the high-voltage cap to the rectifier, and proceed to the next step.

e. Turn the receiver on. While holding a screwdriver by its insulated handle, attempt to draw an arc between the metallic portion of the screwdriver and the plate cap of the horizontal outpct tube. (This, of course, can only be attempted for those horizontal output tubes that have plate caps, such as the 6BG6 or 6BQ6.)
   1. If an arc of proper size appears, the lack of raster indicates that trouble may be present in tht horizontal output transformer or in the damper circuit. Check the damper tube before proceeding to voltage and resistance checks of tht damper stage and output transformer.
   2. If no arc (or too small an arc) appears, check to see if a high-voltage fuse is open. If no fuse is open, trouble is indicated in the horizontal oscillator or output stage. Voltage and resistance checks and waveform observation can then be used to locate the source of difficulty.

DISCUSSION. When checking for high-voltage arcs in a voltage doubler type of high-voltage supply (using two 1B3-GT's or two 1X2's, for example), the size of the arcs encountered during the test will, of course, be smaller than in the single rectifier type of supply. Allowance must be made for this distinction when signal tracing by arcing in the doubler circuit.

It should also be noted that the servicing procedure outlined above is based upon trouble in a receiver that uses the conventional flyback type of high-voltage supply, rather than the less common r-f type of high-voltage power supply. For a discussion of the latter type, refer to the answer to *QUES. 3-29.*

QUES. 1-3. The picture and raster are intermittent, but the sound is normal. Changing the horizontal output tubes, the damper and high-voltage tubes, and the picture tube does not eliminate the intermittency. If a scope and vtvm are available for checking, where should these instruments be connected as an aid in locating the cause of intermittent trouble?

ANS. To locate the cause of an intermittent pictcre and raster, connect the scope, set to 7875 cps, to the grid of the horizontal output stage, and connect the (d-c) vtvm between the cathode and grid of the picture tube (Fig. 1-3). When the picture and raster disappear, check for the indications on the test equipment. If the scope waveform is absent or distorted, the trouble is probably present in the horizontal deflection oscillator or in the input circuit of the horizontal output stage. If the scope waveform and the vtvm reading are both

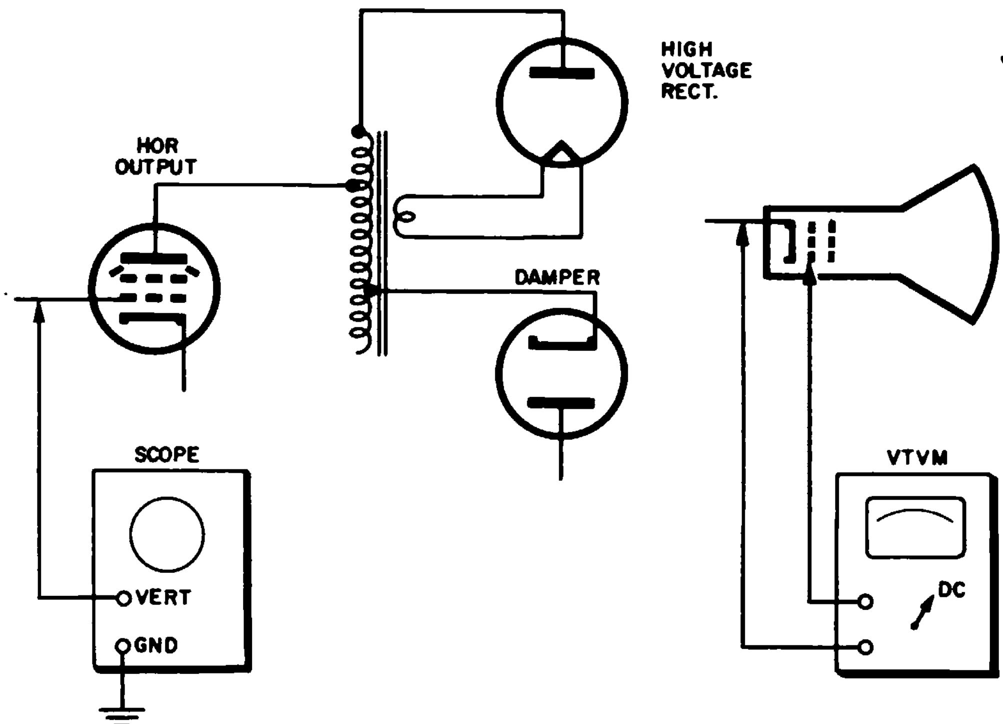


Fig. 1-3. Using a scope and a vtvm to locate the cause of an intermittent raster.

unchanged, then the trouble exists in the horizontal output, damper, or high-voltage rectifier stages, or in the first anode circuit of the picture tube. If the scope waveform is unchanged, but the vtvm reading is changed, the trouble lies in the biasing network of the picture tube.

DISCUSSION. If the trouble has been isolated to the horizontal output, damper, or high-voltage rectifier stages, connect the scope to the cathode or plate of the damper tube (whichever element is at a lower d-c potential), and connect the vtvm to the screen grid of the horizontal output stage. If, when the intermittent condition now appears, the vtvm indication is unchanged, but the scope waveform is abnormal, a faulty horizontal output transformer should be suspected. If the vtvm indication changes abruptly, the trouble is probably located in the horizontal output or damper stages. If neither the vtvm nor the scope indications change, the trouble is probably in the high-voltage rectifier.

QUES. 1-4. When servicing the horizontal deflection section of the receiver, the *circuit patching* technique is often resorted to. To what servicing method does circuit patching refer?
ANS. Circuit patching is a method whereby sections of a properly operating receiver are used to substitute for similar sections of an improperly functioning receiver in an attempt to localize, or sectionalize, the defective portion of the improperly functioning receiver.

DISCUSSION. To explain the technique of servicing by circuit patching, assume that no arc can be drawn from the plate of the horizontal output stage in a faulty receiver, No. 1. To localize the source of trouble, the grid drive at the control grid of the horizontal output stage of a properly operating receiver, No. 2, is applied to the control grid of the horizontal output stage of the faulty receiver. If a raster now appears, the horizontal output and damper sections of the improperly functioning receiver are operating normally, and the source of trouble is in the horizontal oscillator. If, however, no raster now appears, the source of trouble is in the horizontal output or damper sections of the receiver. Thus circuit patching is used to isolate the trouble by sections.

In circuit patching, two leads are connected between the two chassis. One lead joins the B— or ground connections of the two receivers; the second lead is connected between the two hot points of the two circuits. (In the case described above, this would mean that the second lead would be connected between the control grids of the horizontal output stages of both receivers.)

Although only one example of this servicing technique has been described, it should be evident that there are many other applications. Thus the booster section of a properly operating receiver can be patched into the boost circuit of an improperly operating receiver; yokes can be substituted for one another; and many other such applications can be devised and used successfully.

QUES. 1-5. The picture width is not sufficient to cover the picture tube, and the picture itself is dim and out of focus, indicating a decreased horizontal drive. The horizontal deflection and damper tubes are checked and found to be good. A scope is used to check the amplitude and waveshape of the waveform at the grid of the horizontal output stage, and the waveform is found to be normal. What voltage checks should now be made in a typical horizontal output section?

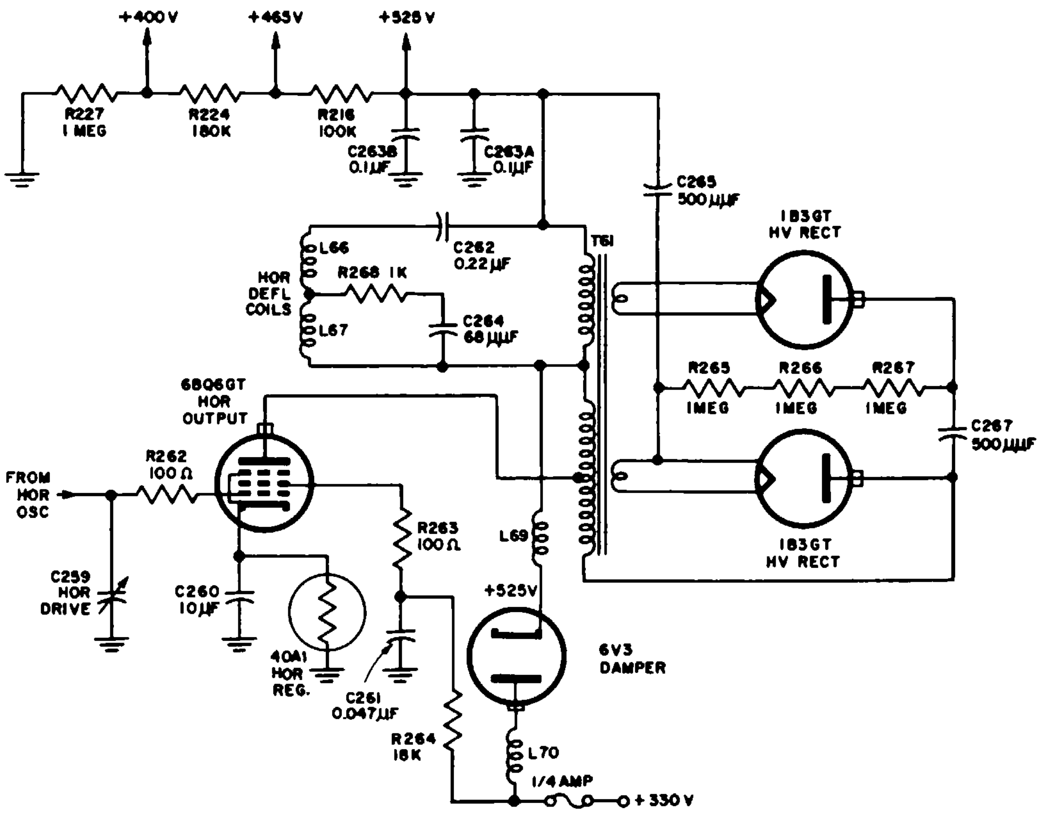


Fig. 1-5. Schematic of a horizontal-output section that uses a voltage doubler.
After Sylvania Electric Products Co.

ANS. Check the B+ voltage at the plate of the damper tube (this voltage is supplied by the low-voltage rectifier in the typical horizontal output section illustrated in Fig. 1-5), and the boost voltage at the cathode of the damper. (The cap of the 6V3 damper tube is connected to the cathode of this tube.) If normal readings are obtained, the above symptoms may be caused by a defective horizontal output transformer. However, if the voltage measured at the plate of the damper tube is low, the low-voltage rectifier supply should be checked as the probable cause of trouble. If the voltage measured at the plate of the damper is normal, but that at the cathode is abnormal, check the components associated with the boost network (*C262, C263A, C263B*) as the probable cause of trouble.

DISCUSSION. As an example of these techniques, voltage checks were made in a receiver that exhibited the symptoms cited above. The damper plate voltage was normal, but the boost voltage, instead of measuring the expected +525 volts measured +430 volts. Capacitors *C262, C263A,* and *C263B* checked normally, but a resistance check of resistor *R216* indicated that this resistor had decreased in value to 5000 ohms. Because of the decrease in value, a greater load was placed on the damper boost circuit, causing a subsequent drop in boost voltage. Replacing this resistor with one of correct value restored normal operation to the receiver.

QUES. 1-6. Light and dark horizontal or vertical bars are observed in the picture and in the raster when no picture is present. What are some of the possible causes of this symptom?

ANS. Alternate light and dark bars in the picture and raster may be caused by:

a. Improper interlace (fine horizontal bars).
b. Crosstalk in the deflection yoke (vertical bars).
c. Crosstalk at the grid of the picture tube (horizontal or vertical bars).
d. Ringing in the horizontal deflection coil sawtooth current (vertical bars).
e. High-voltage ripple (vertical bars).

DISCUSSION.

a. Improper interlace may be caused by an incorrect setting of the vertical hold control. Check the setting of the control and also check the adjustment of the height and linearity controls. If improper control adjustment is not the cause of improper interlace, check for circuit defects. Quite frequently a defective vertical intergrating network will produce this symptom.

b. Crosstalk between coils in the yoke is indicated if a waviness is observed as light and dark vertical bars (Fig. 1-6). (The condition shown in Fig. 1-6 represents an extreme condition that would rarely be seen in practice.) Check the balancing capacitor connected across one-half of the horizontal deflection coil, and replace it if necessary.

c. To check for crosstalk at the grid of the picture tube, shunt the grid with a 0.1-μf capacitor connected between grid and ground. If the bars disappear, the ripple is being picked up by the grid.

d. Inspect the current waveform in the horizontal deflection coil. If sweep ringing is occurring, ringing will be observed in the waveform. (See the answer to *QUES. 4-2.*)

e. Check the high-voltage filtering by means of a high-voltage capacitance divider and a scope. Improper filtering will be evident as high-amplitude a-c ripple in the observed waveform. It should be mentioned that the a-c ripple will not be sinusoidal in form, but will contain a high pulse content. In addition, a certain amount of this ripple will appear even in the normal high-voltage supply without producing any picture symptoms; only when this ripple greatly increases in amplitude do vertical bars appear in the picture.

Fig. 1-6. Picture showing cross-talk of the horizontal-sweep frequency components into the vertical-deflection coils. ***Courtesy General Electric Co.***

QUES. 1-7. What are some of the receiver controls and adjustments that, when improperly adjusted, produce a narrow picture (Fig. 1-7)?

ANS. A narrow picture may be produced by improper adjustment of the following controls and adjustments:

a. Width control.
b. Drive control.
c. Horizontal linearity control.
d. Centering control.
e. Ion trap magnet.

DISCUSSION. Check the above items and readjust them properly. (It should be noted that improper adjustment of the centering control or ion trap magnet does not produce a true narrow picture. It does, however, produce a picture with neck shadow, which is occasionally misinterpreted as a narrow picture by the technician.)

Although readjustment of one or more of the above items may increase the width of the picture to its normal size, it is recommended that the technician strive to discover the basic cause of the picture shrinkage. For example, if the width of the picture is diminishing because of decreasing emission in the horizontal output tube, restoring normal width by means of the horizontal width control is merely a temporary measure. As the emission of the output tube continues to diminish, the width will continue to decrease until no receiver adjustment can compensate for it. Therefore, to prevent continued trouble in the same circuit, attempt to locate the cause of trouble initially, rather than compensating for the cause of trouble by readjustment of controls.

Fig. 1-7. Lack of adequate width in picture. Courtesy Crosley Corp.

QUES. 1-8. When servicing the horizontal deflection section of the receiver, it is noted that the width coil overheats. The

width coil itself does not appear to be defective. What is the probable cause of trouble?

ANS. The slug of the width coil is extended too far out. Readjust the slug while maintaining proper width.

DISCUSSION. The width coil, when connected across the secondary of the horizontal output transformer, acts as a load into which the transformer works. When the slug is extended out of the width coil, the inductance and inductive reactance of the width coil decrease so that a larger current flows in the width coil. As a natural result, the coil overheats.

QUES. 1-9. After a short period of normal operation, the width of the picture decreases until a sizable border appears on either side of the picture tube (Fig. 1-7). The horizontal deflection and damper tubes are checked and found to be good. Although the sweep voltages measure somewhat below normal, no defective component can be located. What is a possible cause of trouble?

ANS. The low-voltage rectifiers, tubes or seleniums, are probably defective. Check them and replace if necessary.

DISCUSSION. A slight decrease in the B+ obtained from the low-voltage supply does not generally reflect in the performance of other circuits as rapidly as it does in the horizontal sweep circuit. This is true primarily because of the critical voltages required to produce the normal, proper amount of horizontal deflection.

When defective, selenium rectifiers, even more than vacuum tube rectifiers, tend to act normally for a short period of time, and then gradually decrease their output voltage. When the rectifier characteristics of a tube or selenium rectifier decrease, the internal resistance of the component increases, as does the voltage drop across the component. As a result, the rectifier output voltage decreases. Because of the difficulty in checking the selenium rectifiers accurately, the best procedure to follow when defective rectifiers are suspected is replacement.

QUES. 1-10. The picture decreases in width at specific times during the day or night. During one of the times when the picture is narrow, the horizontal deflection and damper tubes are checked and found to be good. What is the probable cause of trouble?

ANS. The line voltage probably is varying as a result of the heavy loads placed on the line at various times of the day or night. If the line regulation is poor, and this is more likely in rural than in urban areas, heavy loads lead to a decreased line voltage, which in turn produces a narrow picture.

DISCUSSION. There are several devices on the market that may be used to compensate for line voltage fluctuations and their resultant effect upon the picture. One of these voltage regulator devices is a *voltage booster,* which is usually provided with a rotary tap switch to permit selecting the desired output voltage. (The line voltage becomes the input to the voltage booster; the output of the voltage booster becomes the input to the receiver.) Such a voltage booster is generally used when the line voltage is at a low level for long periods of time.

A second type of voltage regulator provides for automatic adjustment of the input voltage to the receiver when there is continual fluctuation of the line voltage. When this regulator is used, no manual adjustment of the device is required to maintain the required output.

QUES. 1-11. The receiver picture lacks normal width (Fig. 1-7). All tubes are checked and found to be good, as are all adjustments. Voltage and resistance measurements are made, and are found to be normal. How as a last resort may the picture width be increased?

ANS. To increase the picture width, if the cause of a narrow picture cannot be found, shunt a 0.5-μf capacitor across the width coil. (Shunting a capacitor in this manner may produce the undesired effect of horizontal foldover; check the picture for horizontal foldover after adding the capacitor.) A second method is to remove the width coil from the circuit by disconnecting one end of it. (This method can only be used if the width coil is shunted across a secondary of the horizontal output transformer.) A third method is to insert a resistor in series with the high-voltage line going to the crt second anode, or to increase the value of the resistor if one is already in the circuit.

DISCUSSION. On occasion, the cure for a narrow picture may be located in the manufacturer's service notes. Circuit changes that improve on early models of a receiver are placed in the service notes to aid in servicing these early models. Always check the service notes in the case of a particularly difficult servicing problem.

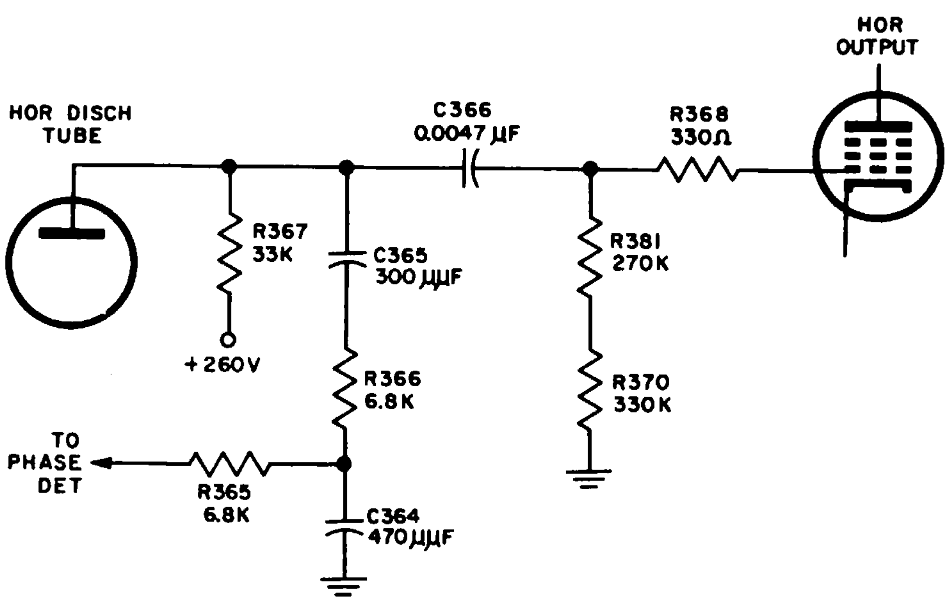


Fig. 1-12. Schematic of the drive circuit in a receiver that does not have a variable-drive control. *After General Electric Co.*

QUES. 1-12. While attempting to adjust the horizontal width and linearity of the picture, the width and linearity controls are located and adjusted, but no drive control can be located. Do any of the major commercial receivers lack a drive control?

ANS. Yes, certain commercial receivers, such as the one shown partially in Fig. 1-12, do not contain a drive control.

DISCUSSION. In the receiver of Fig. 1-12, the drive circuit consists of components located between the plate of the horizontal discharge tube and the grid of the horizontal output tube. If a receiver of this type produces a picture that exhibits center compression that cannot be eliminated by the use of the horizontal linearity and width controls, one of the components in the drive circuit is probably defective.

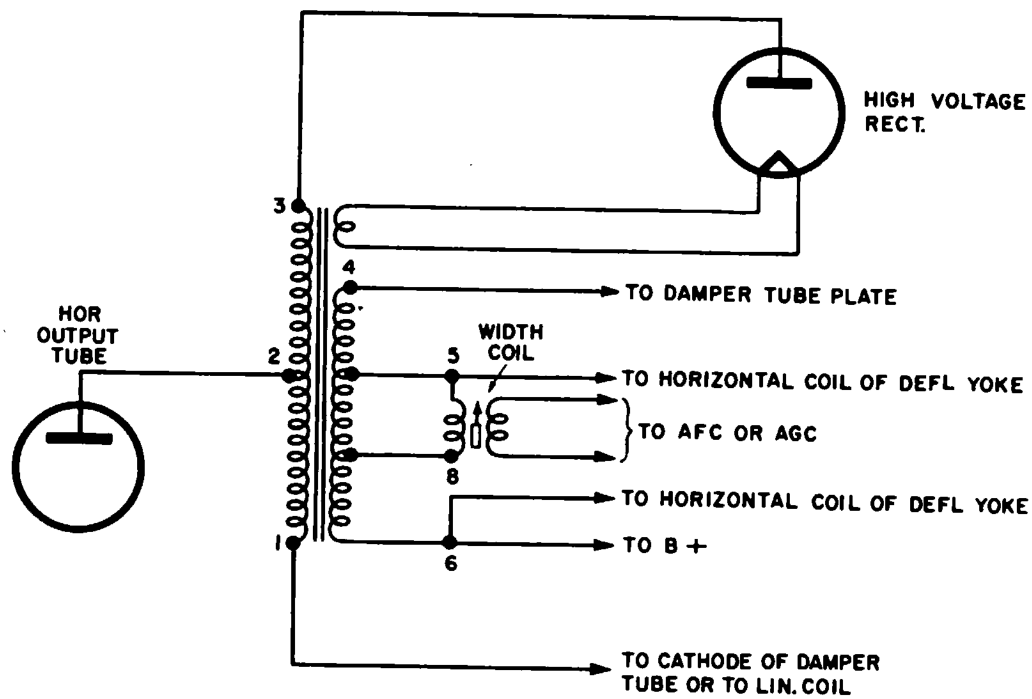
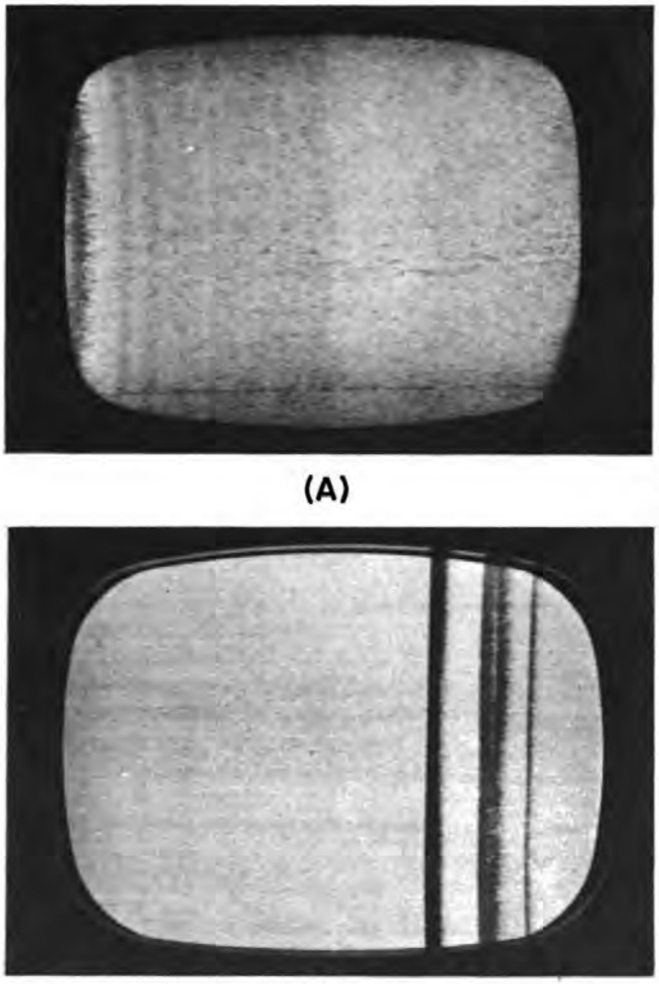


Fig. 1-13. Schematic of typical replacement horizontal-output transformer and width coil.

QUES. 1-13. A defective width coil is replaced by another (Fig. 1-13), and the receiver is turned on. A raster and picture are obtained, but the picture appears to be split down the center, with the right and left sides of the picture transposed and with the horizontal blanking bar appearing in the center of the screen. What is the cause of trouble?

ANS. The primary winding of the width coil is connected backwards. Reverse the two primary connections (those that connect to terminals *5* and *8* in Fig. 1-13) and reconnect. If it is more convenient, reverse the secondary windings of the width coil, rather than the primary windings, to eliminate the trouble.

DISCUSSION. The secondary winding of the width coil of Fig. 1-13 is usually connected either to the horizontal afc circuit or to a keyed agc circuit. If the primary of the width coil is reversed in the case of the latter circuit, no agc voltage is produced, and picture overloading will occur.



(A)

(B)

Fig. 1-14. (A) Raster showing location of "spook." (B) Raster showing location of "snivet." Courtesy General Electric Co.

QUES. 1-14. When servicing receivers that have width or linearity troubles, what general method for localization may be followed?

ANS. As a rule, faults that show up at the left side of the picture are produced by the damper tube and its associated circuits. Thus, nonlinearity of the left-hand portion of the picture and foldover or horizontal shrinkage at the left edge of the picture are generally caused by a faulty damper tube or its components. However, if the faulty symptoms are at the right side or edge of the picture, the horizontal oscillator and output stages generally are the cause of trouble.

DISCUSSION. Examples of the above rules are indicated by the pictures in Fig. 1-14(A) and (B). In Fig. 1-14(A), the dark vertical line, called a *spook* is caused by radiation from the damper stage to the front end. Damper troubles such as this one generally show up on the left side or edge of the picture because the damper tube is conducting and supplying current to the deflection coils for slightly more than the initial one-third of the horizontal trace. During this interval, the horizontal output stage is cut off. As a result, troubles in the damper generally show up while the damper is conducting, i.e., in the left portion of the picture.

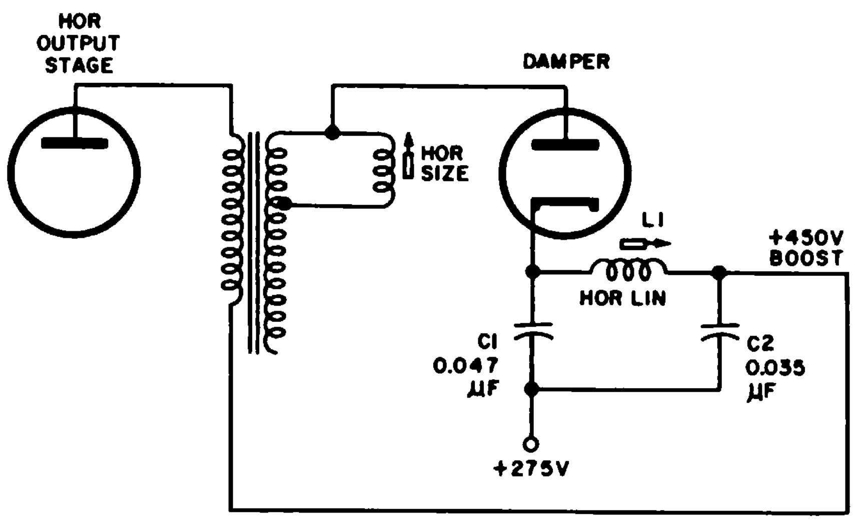
In Fig. 1-14(B), the dark vertical lines at the right side of the picture, called *snivets,* are also a radiation problem, but are caused by the horizontal output stage. Because the horizontal output stage starts to conduct after about one-third of the trace has been completed and continues until the trace is fully completed, trouble in this stage will normally show up on the right side of the picture.

QUES. 1-15. The horizontal linearity of the picture is poor, and has been poor since the initial installation of the receiver. Varying the horizontal linearity control has little effect upon the linearity. What may be done to increase the range of the horizontal linearity control?

ANS. To increase the range of the horizontal linearity control of Fig. 1-15, decrease the value of capacitor *C1* by a small amount, each time checking the range of the linearity control. Substitute the capacitor that gives proper linearity range without causing any adverse effects.

DISCUSSION. The linearity network, consisting of *L1, C1,* and *C2* in the typical circuit illustrated in Fig. 1-15, acts to filter the boost voltage produced by damper pulse conduction. The filtered voltage is applied back to the plate of the horizontal output stage through part of the primary of the horizontal output transformer. Varying the inductance of the linearity coil by adjusting the coil will, of course, vary the degree of filtering, and thereby vary the amount of ripple applied back to the plate of the output stage. This ripple alters the linearity of the horizontal sweep.

Changing the value of capacitor *C1* will also change the degree of ripple applied to the plate, and thus affect the sweep linearity. When changing this capacitor to extend the range of the linearity



1-15. Partial schematic of damper stage showing horizontal-linearity network.

control, decrease its value in small steps only, and do not decrease the value of this input capacitor below the point at which any adverse effects are noted.

QUES. 1-16. When experiencing great difficulty in setting the horizontal linearity of a receiver in the shop, what method can be used?

ANS. To set the horizontal linearity of a receiver in the shop, observe the following procedure:

a. Disconnect one side of the horizontal deflection coil from the horizontal output transformer.
b. Connect a resistor of from 1 to 10 ohms to complete the circuit between the horizontal deflection coil and the horizontal output transformer.

c. Connect the vertical input terminals of the scope, through .05-μf capacitors, across the ends of the 1-ohm resistor. Set the scope to 7875 cps.

d. Turn the receiver on. Two linear sawteeth of current should be observed on the scope screen. If not, adjust the horizontal linearity, drive, and width controls until the waveshapes observed are linear. The picture on the screen will then be linear. (See Fig. 1-16.)

DISCUSSION. Inserting a small resistor in series with either the vertical or horizontal deflection coil will permit the use of a scope to check the current waveform in the coil. for whatever reason this

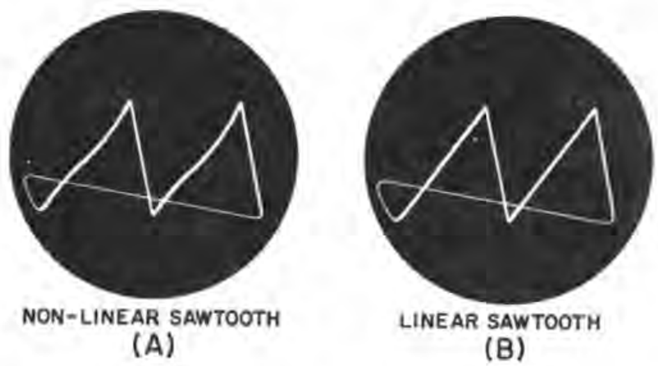


Fig. 1-16. Current waveforms in the deflection coil. (A) Non-linear sawtooth. (B) Linear sawtooth.

may be necessary. If the scope is placed directly across the coils. the deflection coil voltage (not the current) is observed. The voltage waveform is of course unlike that of a sawtooth, because a deflection coil is composed of resistance and inductance. To force a desired sawtooth of current through an *R-L* circuit, a voltage waveform of trapezoidal form is required.

Since the current in the vertical deflection coils is smaller than that in the horizontal deflection coils, use a larger resistor when observing the current in the vertical coils. A resistor between 10 and 20 ohms is satisfactory in the vertical circuit.

QUES. 1-17. The width of the raster is not sufficient to cover the picture tube in the horizontal direction. (The width is insufficient on each side of the raster.) The picture brightness and horizontal linearity appear normal. The horizontal deflection damper tubes are checked and found to be

good. Adjusting the width coil does not eliminate the width problem. In a receiver of the type illustrated in Fig. 1-17, what is a probable cause of trouble?

ANS. The horizontal linearity coil in Fig. 1-17 is probably shorted. Check and replace if necessary.

DISCUSSION. If, in a receiver such as that shown in Fig. 1-17, the voltages at the grid, cathode, and screen grid of the horizontal stage are normal, check the linearity coil immediately, as it is a likely

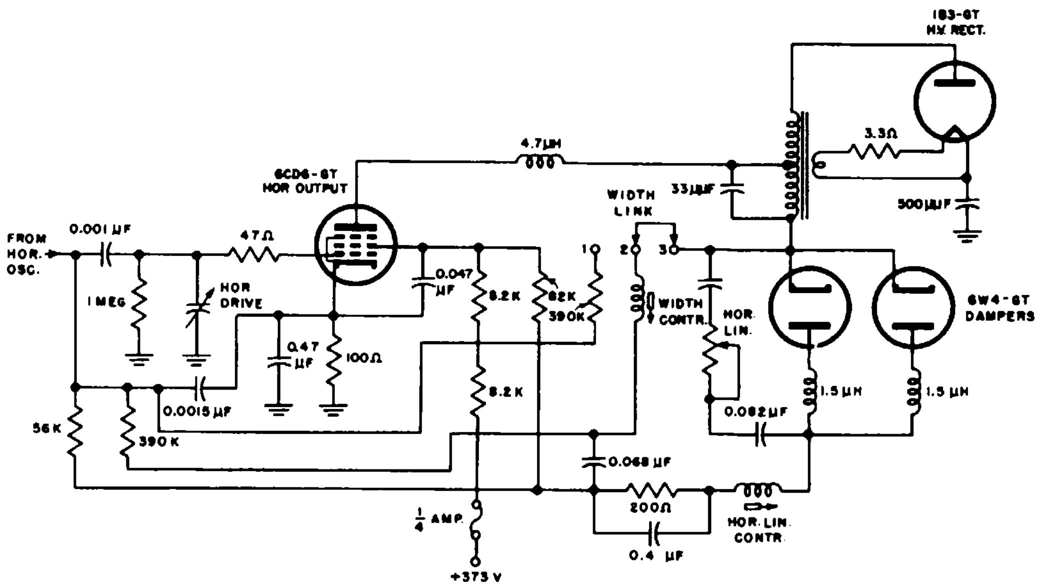


Fig. 1-17. Typical horizontal-output section that uses a horizontal autotransformer. *After RCA Service Co.*

cause of trouble. The horizontal output transformer is of the autotransformer variety and, since the width but not the high voltage is affected, it is unlikely that the horizontal output transformer is defective. It is also improbable that the yoke is the cause of trouble, because the raster does not exhibit any trapezoidal effect.

QUES. 1-18. When adjusting a horizontal linearity control, it is discovered that good linearity can be obtained with the slug of the linearity coil adjusted far into the coil or far out of the coil. Which position should be selected?

ANS. When adjusting a horizontal linearity coil, if two positions of the slug appear to give the proper results, select that position in which the slug is further out of the coil.

DISCUSSION. Adjusting the horizontal linearity of a receiver generally changes the phase of the a-c ripple voltage superimposed on the d-c boost voltage that is applied back to the plate of the horizontal output stage. In some cases, where two positions of the linearity coil slug appear to give proper linearity, choosing that position with the slug further in the coil form may lead to blooming. This may occur because of the phase relationships set up between the a-c ripple on the boost voltage and the horizontal output signal.

QUES. 1-19. Will the normal operation of a tv receiver produce interference in an a-m broadcast receiver?

ANS. Yes. Chirping, squeals, or birdies at intervals of 15 to 75 kc across the a-m band will be caused by radiation from the horizontal deflection section of the tv receiver to the a-m broadcast receiver. High harmonics of the 15,750-cps horizontal deflection signal fall within the a-m carrier or receiver i-f bands.

DISCUSSION. To prevent or minimize the interference in a broadcast receiver caused by a tv set, some of the following cures may be attempted:

a. Use an external antenna in conjunction with the built-in loop antenna of the radio receiver.
b. Shield the deflection section of the tv receiver.
c. Connect the chassis of the tv receiver to an earth ground. (This procedure should only be used with tv receivers that use an a-c transformer in the low-voltage power supply.)
d. Install line filters in both the radio and tv receivers.

QUES. 1-20. When converting a receiver from a small picture tube to a large picture tube, what are the specific points to keep in mind?

ANS. When converting a receiver to a larger picture tube, the sweep deflection must be increased. This is required because the smaller picture tubes have deflection angles in the neighborhood of 50 or 55 degrees, while the larger pictures have deflection angles that range fom 70 to 90 degrees. To obtain the greater sweep deflection, a new yoke and horizontal output transformer are required. In addition, the ion trap magnet on the picture tube neck must be of the proper type as determined by the picture tube characteristics. If it is not, a new magnet is required.

Because conversion to a large picture tube and the use of a new horizontal output transformer mean that the high voltage is going to be increased, the high-voltage filter capacitor in the output circuit of the high-voltage rectifier must be of sufficient rating to withstand the new high voltage without breaking down. This is usually accomplished by using a filter capacitor with a 20-kv rating.

As a rule, after picture conversion, the picture will appear out of focus because of the different characteristics of the new picture tube. To eliminate the focus problems, any resistors that are in series or parallel with the focus coil should be removed (generally the series resistors) or increased in value (generally the parallel resistors). If this does not help, a new focus coil is required.

DISCUSSION. In many cases, conversion to a larger picture tube brings on height or width problems. If the width is not sufficient, slightly decreasing the value of the screen dropping resistor of the horizontal output stage often increases the width by the required amount. If this is not sufficient, increasing the value of the blocking capacitor (in series with the horizontal winding of the deflection coil) will increase the width.

Tube substitution in the vertical circuit will often clear up the height problem. A 6BL7 may be used in place of a 6SN7, a 6W6 may be used in place of a 6K6, or a 12BH7 may be used in place of a 12AU7. If this does not help, increase the B+ applied to the vertical output stage by decreasing the size of the plate decoupling resistor.

QUES. 1-21. A tv receiver is to be converted from a small picture tube to a larger picture tube. Briefly, what are the general procedures to follow to accomplish this?

ANS. To convert a receiver to a larger picture tube, observe the following procedure:

a. Select a horizontal output transformer that will operate in conjunction with the horizontal output tube presently in the receiver to produce the amount of high voltage required by the new picture tube. Install this output transformer.
b. Select a deflection yoke that will operate in conjunction with the new horizontal output transformer to produce the deflection required by the new picture tube. Install the yoke.
c. Turn the receiver on. If the picture is out of focus, replace the focus coil with one for which the picture tube is designed. (See *QUES. 1-20.*)
d. To increase the height, if necessary, decrease the plate decoupling resistor (by trial and error) in the vertical output stage. Change the vertical output tube from a 6K6 to a 6V6, or from a 6SN7 to a 6BL7. (See *QUES. 1-20.*)
e. To increase the width, connect the width coil across different combinations of secondary taps of the horizontol output transformer. Try different width coils.

QUES. 1-22. After a receiver conversion, and while the receiver is still on the bench, it is discovered that the width is insufficient to cover the picture tube horizontally. If the tubes are checked and found to be good, and the horizontal drive and width cannot be adjusted to give the necessary width, what circuit modifications may be used to increase the width?

ANS. To increase the horizontal width of a converted receiver, the following modifications may be attempted:

a. Disconnect the horizontal oscillator from its normal B+ connection, and connect it to the boosted B+ at the damper.
b. Decrease the size of the screen resistor of the horizontal output stage. (This may be done by shunting the screen resistor with another resistor.) Do not, however, decrease the resistance too greatly, as the increased screen voltage and plate current may cause the horizontal output tube or associated components to burn out frequently.

c. Disconnect the width coil, if it is connected across part of the horizontal output transformer.

DISCUSSION. When any of the above modifications are attempted, several thin white vertical lines may appear at the left side of the picture. This is an indication that the horizontal output transformer is being driven too hard, and its core is being magnetically saturated. In this case, decrease the drive to the output transformer by modifying the circuit.

Another circuit modification that is occasionally attempted to increase width is the removal of the cathode resistor of the horizontal output stage. As a rule this is not recommended, since the cathode resistor provides safety bias for the horizontal output tube in the event of grid drive failure. It is advisable to attempt reducing the value of the cathode resistor before eliminating it completely.

QUES. 1-23. After a receiver conversion to a larger picture tube, it is noticed that the picture just misses filling the picture tube horizontally. The horizontal drive and width controls are not able to cause the raster to expand sufficiently to fill the screen. The horizontal deflection tubes are checked and found to be good. In this case, what may be done to add a slight amount of width to the raster without removing the receiver from the cabinet?

ANS. To increase the picture width, connect a capacitor across the width coil. (The receiver will not have to be removed from the cabinet, unless the width coil is mounted on the top side of the chassis.) Start by shunting the width coil with a .001-μf capacitor; if this does not add sufficient width to the picture, increase the size of the shunt capacitor until the proper size is reached.

DISCUSSION. When using the above method to increase the width of the picture, do not place a larger capacitor across the width coil than is absolutely necessary. Too large a shunt capacitance will cause the ringing frequency to decrease far below its normal 75 kc, and will lead to horizontal foldover at the left side of the picture.

QUES. 1-24. After the receiver has been converted to a larger picture tube by using a new horizontal output transformer and deflection yoke, foldover at the left side of the picture is observed. What is the probable cause of trouble?

ANS. Foldover that is evident at the left side of the picture after a receiver conversion is probably caused by a mismatch between the yoke and the output transformer. This cause of foldover can be eliminated by choosing components that are matched.

DISCUSSION. Horizontal foldover frequently appears as a wavy, filmy vertical bar at the left side of the picture When the yoke is not matched to the output transformer, the frequency of oscillation in the secondary of the output transformer is different from the 75-kc ringing frequency normally present in this circuit. As a result, horizontal retrace time may be too short, thereby producing the foldover.

Chapter 2

QUESTIONS AND ANSWERS ON HORIZONTAL OUTPUT CIRCUITS

QUES. 2-1. What are some of the effects of faulty components in the typical horizontal output circuit illustrated in Fig. 2-1(A)?

ANS. The picture symptoms produced by defective components in a receiver similar to that shown in Fig. 2-1(A) are listed in Table 2-1.

TABLE 2-1

Component	Function	Defect	Symptom
R437	Grid return	Increased value	Reduced width, compressed left side (Fig. 2-1B).
		Open	No raster.
		Decreased value	Reduced width, foldover at right (Fig. 2-1C).
		Shorted	No raster.
R440	Cathode bias	Increased value	Reduced width, compressed right side (Fig. 2-1D).
		Radical increase in value	No raster.
		Decreased value or shorted	Reduced width, compressed left side (Fig. 2-1B).
C424	Cathode bypass	Leaky or shorted	Reduced width, compressed left side (Fig. 2-1B).
		Open	Reduced width.

TABLE 2-1 (Continued)

Component	Function	Defect	Symptom
R442	Screen dropping	Increased value	Decreased width, poor horizontal linearity.
		Open	No raster.
		Decreased value or shorted	Increased width, poor horizontal linearity.
C425	Screen bypass	Open or leaky	Reduced width or no raster.
		Shorted	No raster. *R442* will probably burn.
L402	Width coil	Open	Increased width (greatest effect on left side).
		Shorted	Decreased width (possibly no raster).
C427	Input boost capacitor	Open	Decreased width, dim picture.
		Shorted or leaky	No raster.
L403	Linearity coil	Open	No raster.
		Shorted	Poor horizontal linearity (greatest effect on right side).
C428	Output boost capacitor	Open	Decreased width, dim picture.
		Shorted or leaky	No raster.
R443	Filament dropping resistor	Shorted or decreased value	Shortened life of high-voltage rectifier.
		Open or increased value	No raster.
R44	Filter resistor	Open	No raster.
		Increased value	Picture blooming (Fig. 3-18).
C429	Filter capacitor	Open	No raster.
		Shorted	Picture blooming (Fig. 3-18).

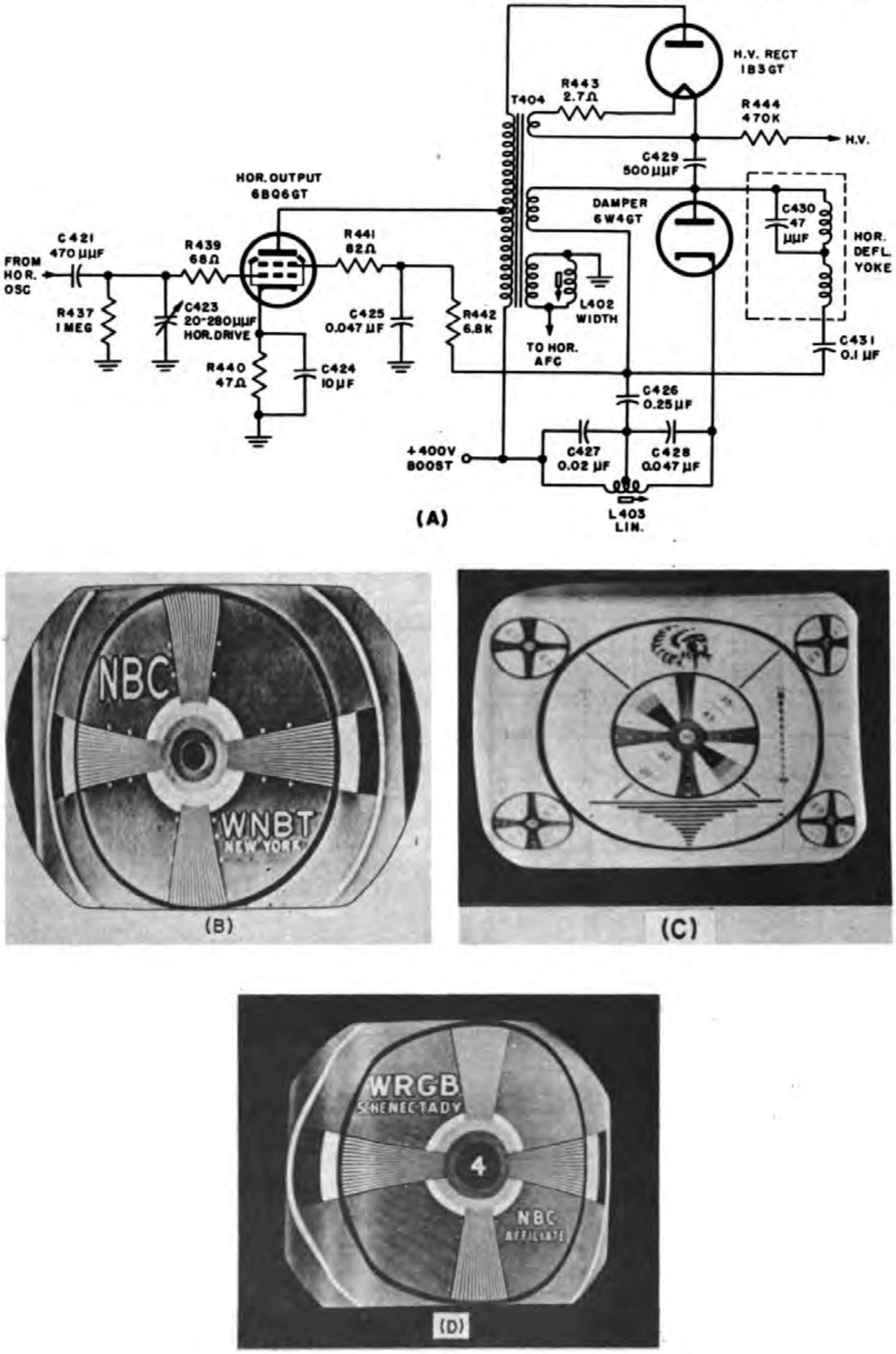


Fig. 2-1. (A) Typical horizontal-output section of a tv receiver. ***After Admiral Corp.*** **(B) Reduced width, compressed left side.** ***Courtesy RCA Service*** **Co. (C) Reduced width, foldover at right. (D) Reduced width, compressed right side.** ***Courtesy General Electric*** **Co.**

DISCUSSION. In many cases, careful analysis of the picture symptoms will aid in quick location of the faulty component. In this section of the receiver, as in other sections, voltage and resistance checks and replacement tests are the primary methods for locating the actual defective component.

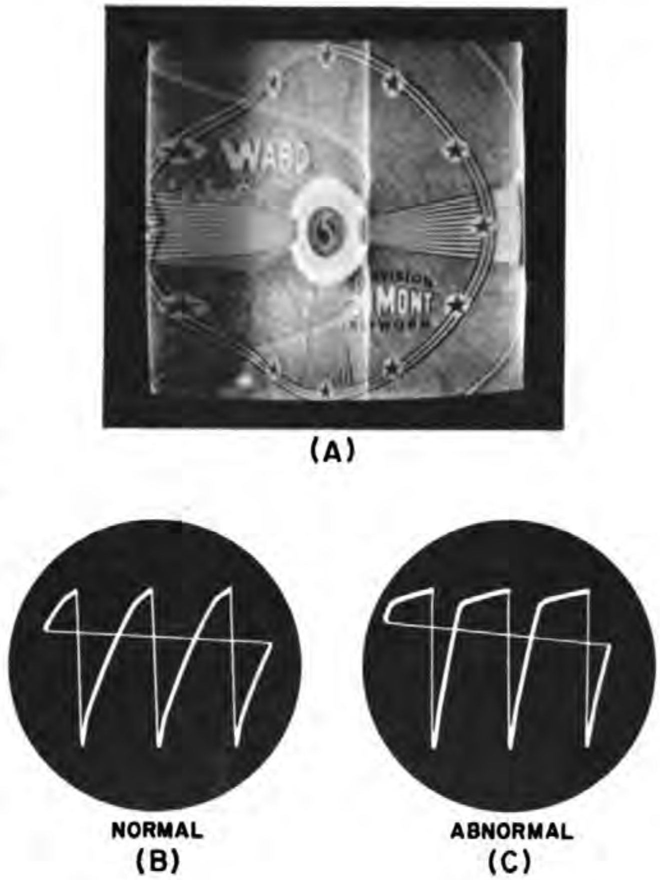


Fig. 2-2. (A) Horizontal foldover. *Courtesy Allen B. Dumont Labs.* (B) Normal horizontal grid-drive voltage waveforms. (C) Abnormal horizontal grid-drive voltage waveform.

QUES. 2-2. Horizontal foldover (Fig. 2-2A) is observed on the picture tube. The horizontal tubes, and the horizontal control settings, are checked and found to be good. What is the first check to be made after the chassis is removed from the cabinet?

ANS. When checking for horizontal distortion (horizontal foldover is caused by a distorted horizontal deflection waveform), set the scope to a frequency of 7875 cps and connect it to the grid of the horizontal output stage. A waveform such as that illustrated in Fig. 2-2(B) should be observed at this point.

DISCUSSION. The control grid of the horizontal output stage is considered to be the logical point for the initial waveform check if horizontal linearity or width problems are encountered. If a normal waveform (Fig. 2-2B) is present at this point, the horizontal oscillator stage is, of course normal and the cause of trouble is somewhere in or after the output stage of the receiver. However, if a waveform such as Fig. 2-2(C) is observed, the horizontal oscillator stage is the source of trouble.

Fig. 2-3. Barkhausen oscillations. *Courtesy General Electric Co.*

QUES. 2-3. Several black vertical lines appear at the left side of the picture (Fig. 2-3), and are very noticeable during the reception of weak signals. What is the cause of these lines?

ANS. Thin black lines at the left of the picture are called Barkhausen oscillations. They occur as a result of oscillation of the horizontal output stage, radiated back to the front end of the receiver. Generally, Barkhausen oscillations may be eliminated by selecting (by trial and error) a horizontal output tube that does not oscillate.

DISCUSSION. In the event of a stubborn case of Barkhausen oscillation, which is not eliminated by replacement of the horizontal output tube, some of the following procedures should be attempted.

a. Tape a small bar magnet to the horizontal output tube. To select the point at which the magnet is to be taped, move the magnet around the envelope of the output tube until the position is reached at which the Barkhausen oscillations are eliminated. (Extreme care must be taken, of course, to avoid contracting the high voltages present in the circuit.)

b. In place of a bar magnet, use an ion trap magnet mounted on the horizontal output tube. Move the magnet around until the point is reached at which the oscillations are eliminated.

c. Connect 100-ohm, 1/2-watt resistors in series with the control grid and screen grid leads of the horizontal output stage. Wire these resistors as close to the tube elements as possible.

d. Shield the front end tubes (if they are not already shielded, and if placing a shield over them does not produce any adverse effects.

QUES. 2-4. Often, in servicing the horizontal output section of the receiver, the waveforms at the plate of the horizontal output stage must be observed. What type of probe must be used to observe these waveforms without damaging the scope?

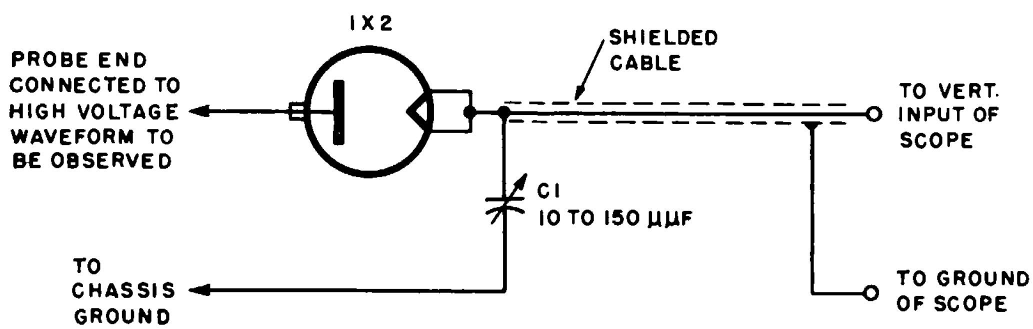


Fig. 2-4. Schematic of high-voltage scope probe.

ANS. When using the scope to check high-voltage waveforms, use a high-voltage probe such as that illustrated in Fig. 2-4, to permit the waveform observation.

DISCUSSION. The probe of Fig. 2-4 is a capacitance voltage-divider probe; it will reduce the amplitude of the high-voltage pulse in the ratio of about 100-to-1. Thus, if the pulse at the plate of the horizontal output tube is 5000 volts, the probe will decrease the voltage to 50 volts for safe application to the vertical input terminals of the scope.

Capacitor *C1* is variable to permit the voltage division to be calibrated accurately, should it be necessary to measure the peak voltage of the high-voltage pulse with any degree of accuracy. The calibration procedure is described in the answer to *QUES. 3- 32.*

Another method of observing high-voltage waveforms makes use of a *gimmick*. In this method, the free end of the test lead that is connected to the vertical input of the scope is formed into a loop. The loop (or gimmick) is placed close to (but not touching) the point at which the waveform is to be observed. The capacitance between the gimmick and the test point is sufficient to couple signal into the loop, and thereby into the scope. With this method, of course, the peak voltage of the observed waveform cannot be measured with any degree of accuracy, since this method does not lend itself to calibration.

QUES. 2-5. After a short period of operation, the raster decreases in width and then disappears completely. The horizontal deflection tubes are checked and found to be good. What is a probable cause of trouble?

ANS. A raster that narrows and disappears after a short period of operation may be caused by an open, or otherwise defective grid resistor in the horizontal output stage. Check and replace, if necessary.

DISCUSSION. In some cases a (narrow) raster will continue to appear in the presence of an open grid resistor in the output stage. This will be true if the coupling capacitor between the horizontal oscillator and horizontal output stages has a slight leakage. In the event of severe leakage of this capacitor, horizontal foldover will be observed.

QUES. 2-6. When using a vtvm to check the cathode voltage of an inoperative horizontal output stage (Fig. 2-1A illustrates a typical stage), a cathode-to-ground voltage of 90 volts is measured. What is the probable cause of trouble?

ANS. Resistor *R440,* the cathode biasing resistor, is open. Check and replace, if necessary.

DISCUSSION. When the cathode resistor opens, or increases to a very high value, leakage current flowing through the cathode bypass capacitor will produce a large d-c potential between cathode and ground.

QUES. 2-7. One or more thin white vertical lines and a certain amount of horizontal nonlinearity are observed in the picture (Fig. 2-7). What is the probable cause of trouble?

ANS. The horizontal drive control is improperly adjusted. Check the setting of this control, and readjust if necessary.

Fig. 2-7. Horizontal-drive lines in picture. *Courtesy General Electric Co.*

DISCUSSION. The horizontal drive control is generally connected in the input circuit of the horizontal output stage. This control is used to adjust the amount of signal applied to the grid, and hence drives the output tube. Improper adjustment of the control affects the waveshape of the signal applied to the output grid, frequently leading to the appearance of the vertical white drive lines.

QUES. 2-8. No raster is observed on the picture tube. No high-voltage arc can be drawn from the plate caps of the high-voltage rectifier and the horizontal output stage. The horizontal deflection and damper tubes and the high-voltage fuse are checked and found to be good. A scope set to 7875

cps shows a normal waveform when connected to the plate of the horizontal oscillator, but shows nothing when connected to the grid of the horizontal output stage. What is the probable cause of trouble?

ANS. The horizontal drive trimmer, *C1* in the typical output stage illustrated in Fig. 2-8, is shorted. Check and replace, if necessary.

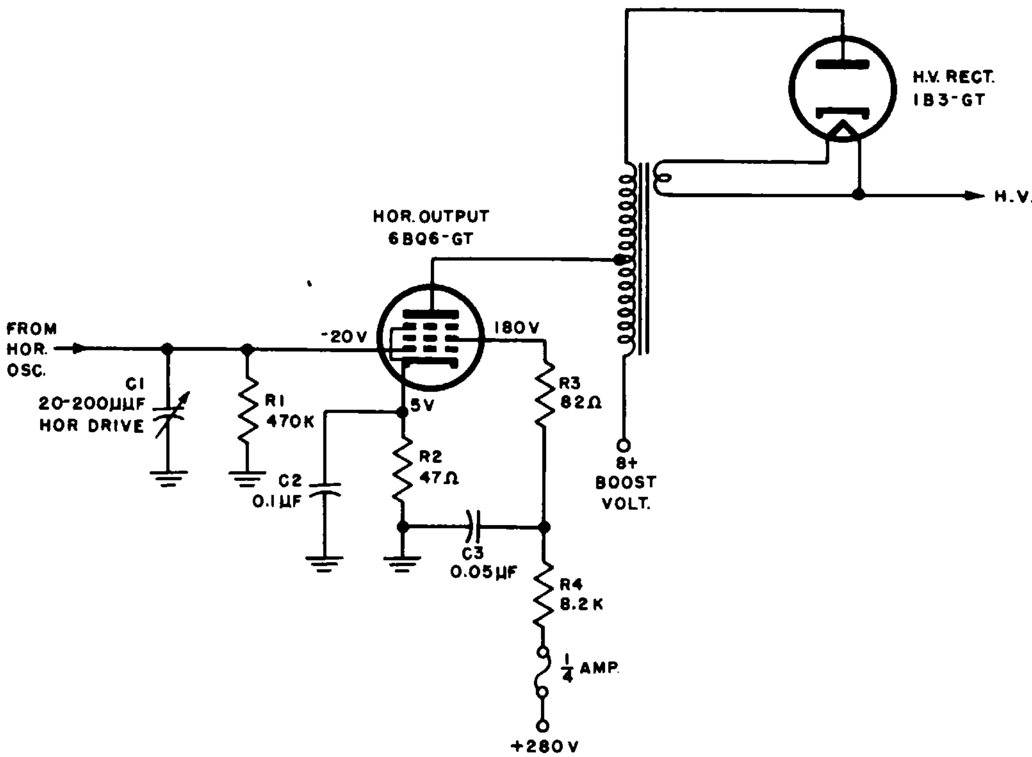


Fig. 2-8. Partial schematic of a horizontal-output stage.

DISCUSSION. If the drive trimmer capacitor shorts, no drive voltage from the horizontal oscillator is applied to the control grid of the output stage. As a result, a voltage check of the control grid will indicate that the grid does not have a negative potential, such as is normally developed by grid-leak bias. Because of the lack of grid-leak bias, plate current rises above its normal value, and the plate of the tube frequently runs red hot. The cathode voltage, instead of the normal 5 volts called for in Fig. 2-8, often doubles. Screen voltage generally remains relatively constant. Thus, if the control grid voltage of the output stage is close to zero, if the cathode voltage is doubled, and if the screen grid voltage is about normal, trouble is indicated in the grid circuit of the horizontal output stage (or at the output of the horizontal oscillator stage).

QUES. 2-9. Sound appears about 10 seconds after the receiver is turned on. No raster appears for approximately 60 seconds, at which time a loud, shrill noise is heard from the speaker, and the raster and picture appear. The horizontal deflection and damper tubes are checked and found to be good. What is the probable cause of trouble?

ANS. The horizontal output transformer may be defective. Check and replace, if necessary.

DISCUSSION. On occasion, an open condition develops (in the horizontal output transformer) that seals itself in the presence of heat. Thus, when the receiver is initially turned on, no high voltage is produced because of the open. As the receiver warms up, however, the heat of operation causes the metal conductors to expand, and the open circuit becomes closed. As the two conductors that make up the open circuit move toward each other, an arc jumps between the two points, and the noise of the arc may be heard in the speaker.

There are, of course, other causes that produce the same symptoms. Intermittent capacitors in the screen circuit of the horizontal output circuit, or in the boost circuit of the damper, can also produce these symptoms.

QUES. 2-10. What methods should be used when checking a horizontal output transformer suspected of being the cause of such receiver trouble as no high voltage, low high voltage, insufficient width, or poor linearity?

ANS. To check a suspected horizontal output transformer, use an ohmmeter to measure the resistance of the windings of the transformer (comparing the values obtained with those specified in the manufacturer's service notes), and check for shorts between adjacent transformer windings and between the windings and the core. If the trouble is still not discovered and the transformer is still suspected as the cause, measure the resonant frequency of the output transformer, as described in the answer to *QUES. 2-11.*

DISCUSSION. Measurement of the resonant frequency of the horizontal output transformer is important, because a departure from the expected resonant frequency indicates that shorted turns or windings exist in the transformer. This type of short is extremely difficult to locate by means of conventional resistance checks because of the low values of resistance present.

QUES. 2-11. What procedure should be followed to measure the resonant frequency of a horizontal output transformer that is suspected of being defective?

ANS. To measure the resonant frequency of the primary-secondary type of horizontal output transformer, observe the following procedure, with the receiver power off.

a. Disconnect all the leads of the secondary windings of the high-voltage transformer, with the exception of the high-voltage rectifier filament leads (see Fig. 2-11A), and remove the high-voltage rectifier tube.
b. Connect a vtvm (low scale ac) or a scope across the set of disconnected secondary windings that normally connect to the deflection yoke.
c. Connect the output of an audio generator through two 47-k ohm resistors across the primary windings of the horizontal output transformer.
d. Rotate the frequency control of the audio generator until a peak indication is obtained on the indicating device. A properly functioning horizontal output transformer will produce a peak indication of between 20 and 50 kc.

To measure the resonant frequency of an autotransformer or direct-drive type of horizontal output transformer, observe the following procedure, with receiver power off.

a. Disconnect the leads that run from the horizontal output transformer to the deflection yoke, width coil, and damper tube (see Fig. 2-11B), and remove the high-voltage rectifier tube.

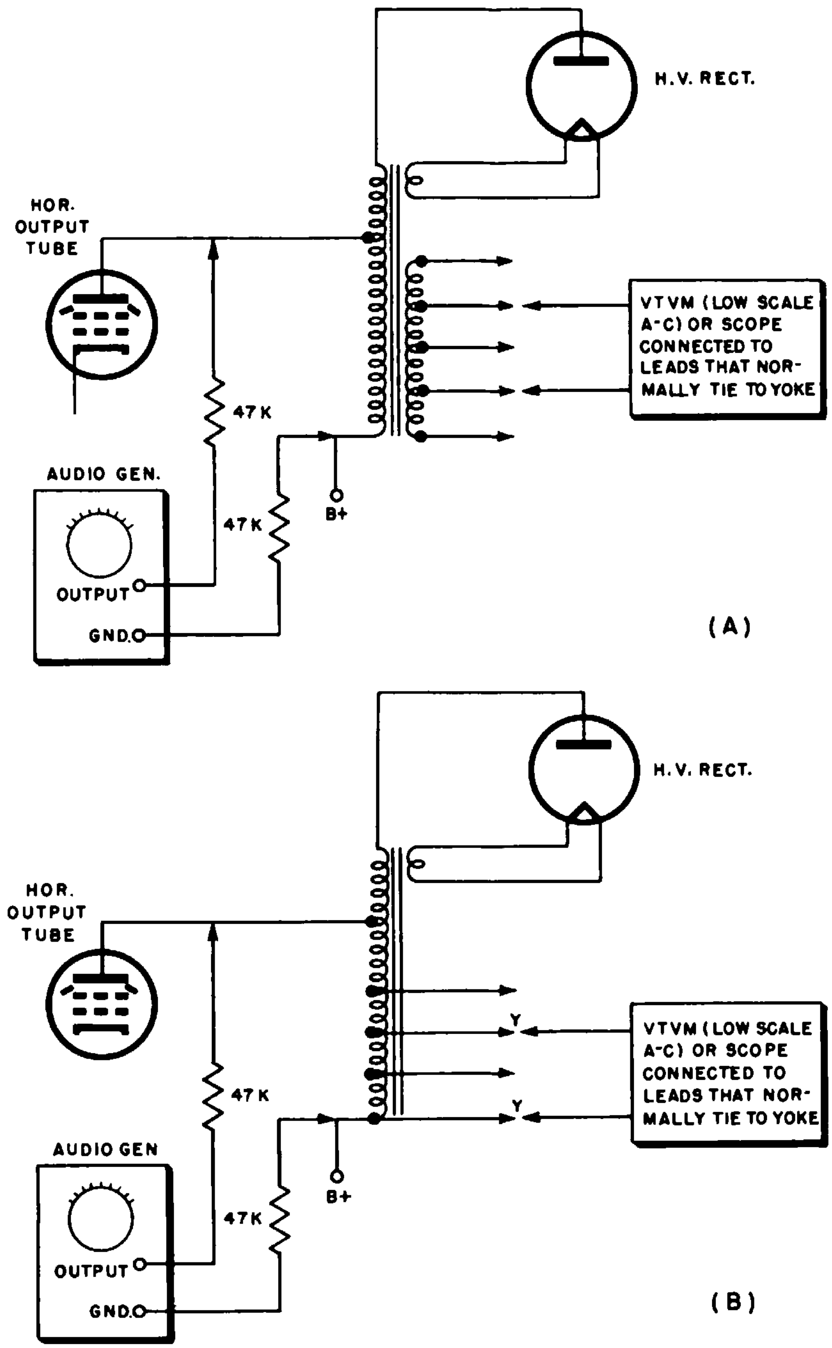


Fig. 2-11. (A) Test set-up for checking the resonant frequency of the primary-secondary type of horizontal-output transformer. (B) Test set-up for checking the resonant frequency of the autotransformer, or direct-drive, type of horizontal-output transformer.

b. Connect a vtvm (low scale ac) or a scope across the disconnected secondary windings that normally connect to the deflection yoke.

c. Connect the output of an audio generator through two 47-k ohm resistors across the full winding of the autotransformer (see Fig. 2-11B).
d. Rotate the frequency control of the audio generator until a peak indication is obtained on the indicating device. A properly functioning autotransformer type of horizontal output transformer will produce a peak indication between 15 and 25 kc.

DISCUSSION. The resonant frequency of a normal horizontal output transformer that is connected into the circuit is approximately 71 kc. (This frequency, of course, is selected to permit the retrace to occur in about 7 microseconds.) When the output transformer is disconnected from the circuit, its resonant frequency is considerably lower than 71 kc. The increase to 71 kc occurs when the yoke and the width coil are connected to the output transformer. The parallel inductances produce a total decreased inductance, thereby raising the resonant frequency.

Note: Commercial units operating on the above principles are available for checking horizontal output transformers.

QUES. 2-12. Severe arcing throughout the horizontal output transformer causes the high voltage to disappear. Close examination of the transformer leads reveals small holes in the insulation covering these leads. Can the horizontal output transformer be repaired?

ANS. In some cases, low grade insulation, which breaks down in the continued presence of high voltage, is used in the construction of the horizontal output transformer. To continue using the transformer, replace the wiring insulation with high quality insulation.

DISCUSSION. When replacing the tubing insulation that covers the wires in a horizontal output transformer, be certain to use new insulation that has at least a 20-kv voltage breakdown rating. In this way, continued normal operation of the output transformer will be guaranteed.

QUES. 2-13. The picture lacks horizontal width which cannot be increased by adjustment of the width control. The horizontal deflection and damper tubes are checked and found to be good. Varying the horizontal drive control causes the picture width to decrease further. What is the probable cause of trouble?

ANS. Parasitic oscillation is probably occurring in the horizontal output stage. Add a parasitic suppression resistor of approximately 50 ohms in series with the control grid of the output stage. If this does not help, check the filament choke and bypass capacitor, and replace if necessary.

DISCUSSION. When parasitic oscillation takes place in the output stage, increasing the drive to the output stage increases the amplitude of the oscillation. As a result, a larger grid current flows (some grid current generally flows in the course of parasitic oscillation) which, in turn, decreases the raster width.

In many cases, parasitic oscillation is responsible for frequent breakdown of the horizontal output tube. If this tube frequently becomes defective in any given receiver, the addition of a parasitic suppression resistor should be attempted in an effort to extend the life of the replacement tube.

Parasitic oscillation in the horizontal output stage may, under different circumstances, produce other symptoms. As an example, the oscillation may cause a vertical column of short horizontal white streaks to be produced. Unstable sync often accompanies this symptom.

QUES. 2-14. When servicing the horizontal deflection section of the receiver to locate the cause of a narrow picture, how can the cathode bypass capicitor of the horizontal output stage be checked for an open?

ANS. To check the cathode bypass capacitor of the horizontal output stage for an open, short the cathode of the input stage to ground. If the capacitor is good, the picture width will increase only slightly. If the capacitor is defective, the picture width will increase appreciably.

DISCUSSION. An open cathode bypass capacitor leads to degeneration in the output stage, thereby lowering the gain of the stage, and causing the width of the picture to shrink. Shorting out the defective capacitor restores the original gain to the stage, so that the width will

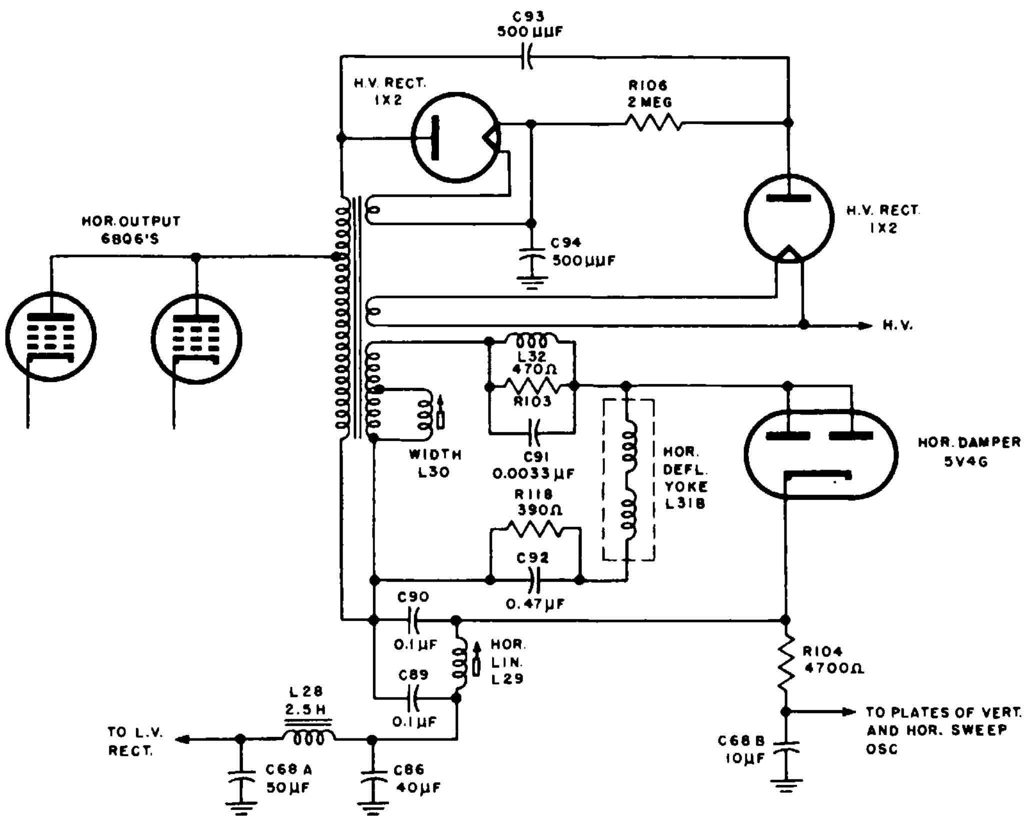


Fig. 2-15. Horizontal-output section showing the effect of an open filter capacitor. *After Philco Corp.*

increase noticeably. On the other hand, if the capacitor is good, shorting it out will produce a negligible change in gain of the output stage, and the picture width will remain relatively stable.

QUES. 2-15. No raster is observed on the picture tube screen. Arcing the high-voltage lead to the chassis indicates that no high voltage is available. Only a small a-c arc can be drawn from the plates of the rectifier (Fig. 2-15). The horizontal output, damper, and rectifier tubes are checked and found to be good. The chassis is placed on the bench, and a visual check shows that the dropping resistor (R104 in Fig.

2-15) connected betwen the cathode of the damper tube and the vertical circuit is overheating. The resistor is replaced but the trouble is still present. What is the probable cause of trouble?

ANS. The low-voltage power supply output filter capacitor (*C86* in Fig. 2-15) is probably open. Check the capacitor and replace if necessary.

DISCUSSION. In the circuit of Fig. 2-15, output filter capacitor *C86* offers a low reactance to the a-c deflection voltages, and consequently places the B+ line at a-c ground potential. Thus the a-c ground return for the 15,750-cycle deflection voltage at the deflection coil is normally through *C92, C89,* and *C86* to ground.

However, when capacitor *C86* opens, the a-c deflection voltages cannot find an easy path to ground through the B+ power supply. As a result, the a-c signal finds a return through *C92, C90, R104,* and *C68B* to ground. Thus a large a-c current flows through *R104,* causing it to overheat and burn out.

Although resistor overheating is gradually produced by the flow of d-c current through the resistor, a-c current can produce the same overheating effect. Consequently, if the cause of an overheating resistor cannot readily be located, try bypassing any associated bypass or filter capacitors, because one of these may be the cause of trouble.

QUES. 2-16. When servicing a receiver that has no high voltage, the plates of the horizontal output stage are observed to be glowing red. What does this symptom generally indicate?

ANS. If the plates of the output stage are red, it indicates that no drive is being applied to the grid of the horizontal output stage. Check the horizontal oscillator tube, and replace if necessary.

DISCUSSION. If, when servicing a receiver with this symptom, the horizontal oscillator tube is found to be good, use a vtvm to check the oscillator grid voltage. If the grid voltage is not of the proper negative value, the trouble lies in the oscillator stage itself. If the negative grid voltage is of proper amplitude, the trouble lies in the output circuit of the horizontal oscillator or the input circuit of the horizontal output stage. In this case, look for such things as defective coupling capacitors or defective sawtooth-forming components.

Sometimes, a gassy horizontal output tube will cause the plate of the tube to glow red. In such a case, the undesired gas in the tube ionizes, the positive ions neutralize the negative charge on the grid of the tube, and high plate current flows. A gassy tube will, of course, have to be replaced.

QUES. 2-17. A loud high-pitched whistle is coming from the receiver. Removing the horizontal oscillator or output tube eliminates the whistle. What is the probable cause of trouble?

ANS. A part of the horizontal output transformer is vibrating at the horizontal deflection frequency, 15,750 cps. To eliminate the whistle if the output trinsformer is at fault, try loosening and then tightening the screws that fasten the transformer to the chassis. Leave the screws in that position in which the whistle is eliminated, or decreased to the point at which it is not objectionable. If positioning the screws does not alleviate the condition, try shock mounting the output transformer by placing rubber grommets between the output transformer and the chassis. As a last resort, before replacing the transformer, pour high-voltage insulation material in the space between the core and the transformer windings.

DISCUSSION. In some cases a mechanically loose width coil may produce the 15,750-cps whistle. If the width coil is suspected, tighten or loosen its mounting screws, or adjust the core of the width coil to minimize the whistle. If the core of the width coil itself is loose, slide a piece of insulating paper between the core and the windings to eliminate mechanical vibration.

QUES. 2-18. When using a screwdriver to draw an arc from the plate of the horizontal output stage, it may be difficult to see the arc. What may be done to aid in checking the presence of an arc at this point?

ANS. When drawing an arc from the plate of the horizontal output stage, keep the volume control adjusted to a high setting. Then, even if the arc is not clearly visible, a crackling sound from the loudspeaker will indicate the presence of an arc.

DISCUSSION. Arcing tests are, of course, of great value when properly performed and their results properly interpreted. For a discussion of these tests, see the answer to *QUES. 1-2.*

QUES. 2-19. A temporary shortage of 6BQ6-GT horizontal output tubes arises. What tube may be used for a substitution?

ANS. A temporary substitute for the 6BQ6-GT is the 6W6-GT. Because the 6BQ6-GT has a plate cap, while the 6W6-GT does not, wire the plate cap connection in the original circuit to pin *3* of the 6W6-GT.

DISCUSSION. It should be emphasized that the above substitution is only recommended in an emergency when a shortage of 6BQ6-GT's exists. Indiscriminate use of this substitution may lead to equipment damage. Care in dressing and insulating leads, particularly the new lead to the plate connection, should be observed.

QUES. 2-20. It is noted that the plate caps of the 6BQ6-GT horizontal output tubes frequently become loose, causing intermittent operation of the horizontal output stage. Can these tubes be repaired so that they will operate normally?

ANS. Because normal solder will soon melt at the high temperatures developed in the horizontal output stage, and because it is too costly to purchase high-temperature solder and too difficult to apply it, it is not recommended that any repair of the plate caps be attempted. Replacement of the 6BQ6-GT with a 6BQ6-GTA or 6BQ6-GA will generally eliminate loosening of the plate cap, and decrease the frequency of horizontal output tube failure. In those receivers that do not have a cathode resistor in the horizontal output stage, a 39-ohm, 1-watt resistor may be inserted in series with the cathode of the output stage.

DISCUSSION. In many receivers, the horizontal output tube is operated at close to the maximum operating characteristics of the tube used in this stage. As a result, high operating temperatures are produced, and subsequent decrease in the life of the tube is not uncommon.

Both the 6BQ6-GA and 6BQ6-GTA horizontal output tubes make use of a larger glass bulb area and an improved internal construction to increase the heat radiation capabilities and to lower the danger of internal breakdowns. Thus these tubes, because of their improved operating characteristics, are recommended when 6BQ6-GT tube replacement is required.

Chapter 3

QUESTIONS AND ANSWERS ON HIGH-VOLTAGE CIRCUITS

QUES. 3-1. When servicing the horizontal deflection high-voltage section of a receiver, it is necessary for the technician to be able to distinguish between the conventional flyback type of high-voltage power supply, and the older r-f type. How can the technician differentiate between these?

ANS. To distinguish between the two major types of high-voltage supply, remove the horizontal oscillator tube and turn the receiver on. If the removal of this tube causes a thin white vertical line to appear on the picture tube, the r-f type of power supply is present. If, however, removal of the horizontal oscillator causes the raster to disappear completely, the flyback type of high voltage supply is present. (When performing this check, do not permit the receiver to operate for long periods of time with the oscillator tube removed. In the case of the flyback supply, continued receiver operation with the oscillator tube removed may damage the horizontal output tube.)

DISCUSSION. In the flyback type supply, the output of the horizontal deflection output stage is fed through the horizontal output transformer to produce both the horizontal deflection and the high voltage. Failure of the horizontal oscillator or the horizontal output stage will thus simcltaneously eliminate the horizontal deflection and the high voltage. A blank picture tube (no raster) will be evident in this case.

In the r-f power supply, the horizontal deflection section of the receiver is independent of the high-voltage section. In this case, failure of the horizontal deflection in the presence of high voltage will cause a white vertical line to be produced on the picture tube, indicating that vertical deflection and high voltage are still present. On the other hand, failure of the high voltage in the presence of an operating deflection section will produce no raster on the screen. High voltage is, of course, always necessary if any picture tube indication is to be produced.

Additional r-f power supply servicing considerations are given in the answer to *QUES. 3-29.*

QUES. 3-2. When replacing defective parts in high-voltage circuits, what general precautions should be observed?

ANS. When replacing parts in high-voltage circuits, check the lead dress of all parts carefully. Improper lead dress can cause corona to appear (see the answer to *QUES. 3-24*), with resultant loss in high voltage. Poor lead dress may also result in high-voltage arcing, which can burn parts and insulation.

When soldering in high-voltage circuits, take care not to leave any sharp points of solder or wire protruding from the soldered connection, as these can also produce corona.

As a general rule, do not attempt to repair the horizontal output transformer by repairing breaks in wires or by splicing wires. In the high-voltage circuit, repairs of this type are generally short lived. Generally speaking, the replacement of a defective horizontal output transformer is recommended.

DISCUSSION. When the replacement of parts and the repairs are completed, turn the receiver on and listen for arcing, look for corona, and sniff for ozone. (Ozone is produced in the presence of corona.) If any of these symptoms are present, they must be corrected at once before they lead to more serious difficulties in the receiver.

QUES. 3-3. When replacing defective 1B3-GT high-voltage rectifier tubes, it is noted that the replacement tubes, all of which check properly on a tube tester, operate correctly in

some receivers but do not work in others. What is the cause of this condition?

ANS. In some of the newer 1B3-GT's, internal connections within the tube exist between pins *3, 5, 7,* and *8,* as shown in Fig. 3-3. Taken alone, this fact is of no importance. However, in some receivers, especially those that use voltage doublers in their high-voltage circuits, pins *2* and *3* are tied together to minimize the possibility

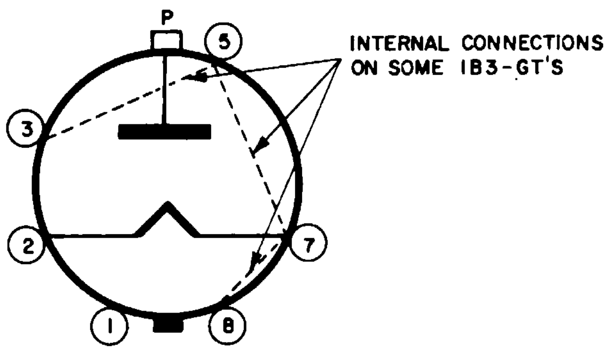


Fig. 3-3. Internal and external connections of some 1B3-GT's.

of arcing or corona. Thus, when a tube is placed in one of these voltage doubler circuits, the connection between pins *2* and *3* shorts out the filament voltage of the rectifier, and the rectifier does not operate.

DISCUSSION. Another problem that is encountered when replacing the newer type of 1B3-GT's in the high-voltage rectifier circuits is produced because in some tv receivers pins *3, 5,* and *8* of the rectifier tube socket are used as tie lugs to which filament dropping resistors are connected. If, for example, a filament dropping resistor is connected between pins *3* and *5* of the tube base, it can be seen from an examination of Fig. 3-3 that the resistor will be shorted out by the insertion of the 1B3-GT.

As a result of the present situation, in the event of trouble encountered when replacing 1B3-GT's, check the high-voltage rectifier tube base to see if a dropping resistor or any other component is connected to pins *3, 5,* and *8.* Also check the 1B3-GT to see if it has internal connections from pins *2* and *7* to other pins. If it has, clip the pin or pins on the rectifier tube that would affect circuit operation.

QUES. 3-4. Because the 5642 high-voltage rectifier tube is designed to be soldered into the circuit, it is difficult to test this tube in a tube tester after it has ben removed from the circuit. What may be done to simplify testing the 5642 tube?

ANS. To simplify testing 5642 high-voltage rectifiers in a tube tester, construct an adapter as illustrated in Fig. 3-4. Take an octal socket, and bolt two Fahnestock clips on the side of the socket. Connect the clips to the pins on the socket which correspond to the pins required by

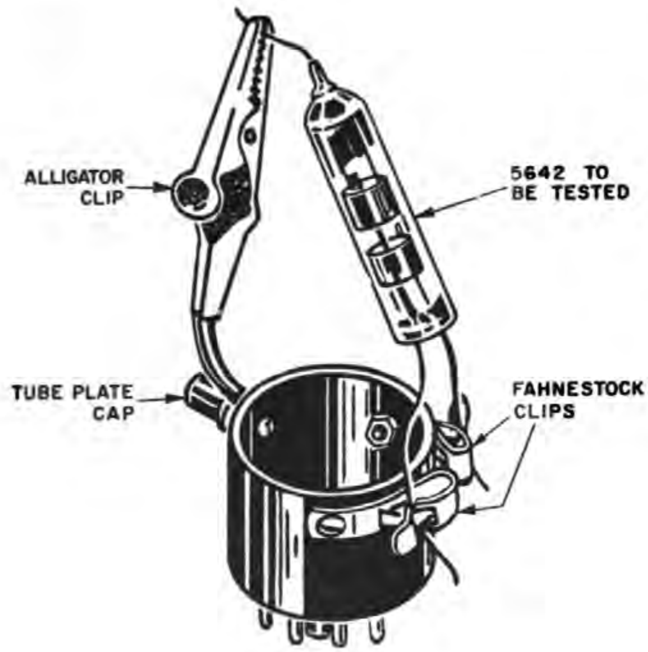


Fig. 3-4. Use of a tube adapter to check a 5642 rectifier in a tube tester. ***After Sylvania.***

the tube tester to be used. Connect a lead and an alligator clip to the other side of the socket. Solder a tube plate cap to the alligator clip connection. Do not connect the alligator clip to the tube base pins.

DISCUSSION. When testing a 5642 with the adapter, connect the filament leads of the tube to the Fahnestock clips, and the plate lead to the alligator clip. If the tube tester requires that a connection be made to the plate of the 5642, connect from the tester to the tube plate cap on the adapter.

QUES. 3-5. When replacing 5642 high-voltage rectifiers, what precautions should be observed?

ANS. When replacing 5642 tubes, center the tube between the terminal lugs so that the lead length between the tube and each terminal lug is equal for all three leads (Fig. 3-5). When proper centering is observed, the possibility of soldering close to the tube itself is decreased, so that the danger of harming the tube with the soldering iron is decreased.

DISCUSSION. All other precautions that are normally observed when soldering in a high-voltage circuit should also be observed in the case of the 5642 tube. Make certain that all solder joints are

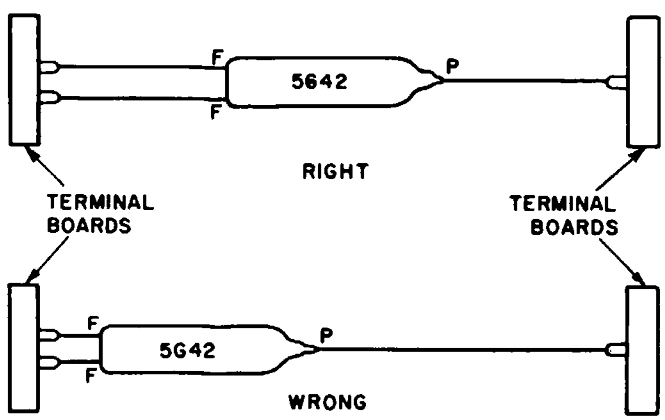


Fig. 3-5. Soldering a 5642 rectifier into the circuit.

rounded rather than pointed, to prevent corona effect. Exercise caution with lead dress to prevent high-voltage arcing.

QUES. 3-6. The picture tube brightness is low. The horizontal deflection, damper, and high-voltage tubes are checked and found to be good. The ion trap adjustment is checked and found to be normal. An arc drawn from the high-voltage lead indicates that the high voltage is not up to standard. Can the high voltage from an operating receiver be used to check the high-voltage supply of the improperly functioning receiver?

ANS. Yes, the high voltage from an operating tv receiver can be substituted for the high voltage of an improperly functioning receiver in an attempt to determine whether a low high-voltage is the cause of trouble. When making this substitution, remember that the value of the voltage used as the substitute should be approximately equal to the normal high voltage of the defective receiver.

DISCUSSION. To substitute the high voltage of one receiver for another, observe the following procedure:

a. Remove the high-voltage leads from the picture tubes of both receivers.
b. Connect the high-voltage lead of the normal receiver to the anode connection on the picture tube of the improperly functioning receiver. (Make sure that the high-voltage lead of the improperly functioning receiver is not grounded.)
c. Connect the B— or ground points of both receivers together.
d. Turn both receivers on. If the picture brightness of the defective receiver is now normal, trouble in the high-voltage section of this receiver is indicated, and this section should be investigated. However, if picture brightness is still low, trouble is indicated in the picture tube. Check the voltage at all base pins of the picture tube and, if they are normal, check the picture tube itself, by substitution, as it may be the cause of trouble.

QUES. 3-7. Noise appears in both the sound and the picture. The cause of the noise is immediately diagnosed as high-voltage arcing, but even in a darkened rom no arcing can be seen. It is suspected that internal arcing is occurring in one of the high-voltage capacitors, in the circuit shown in Fig. 3-7. How may the defective one be located without test replacing both capacitors?

ANS. To check for internal arcing in a high-voltage filter capacitor, turn the receiver on for a few minutes. Turn the receiver off, and discharge the high voltage. Feel capacitors *C103* and *C104,* in the circuit of Fig. 3-7. If internal arcing is occurring in one of the capacitors, it will be warmer than the normally functioning capacitor.

DISCUSSION. When internal arcing occurs, a path of leakage resistance is present between the plates of the capacitor. The current flow through this resistance dissipates power, which causes the capacitor to be warmer to the touch than usual.

Of course, the final test of proper diagnosis consists of replacing the defective capacitor with one known to be good. If the arcing ceases with the replacement part in the circuit, the defective part has been eliminated.

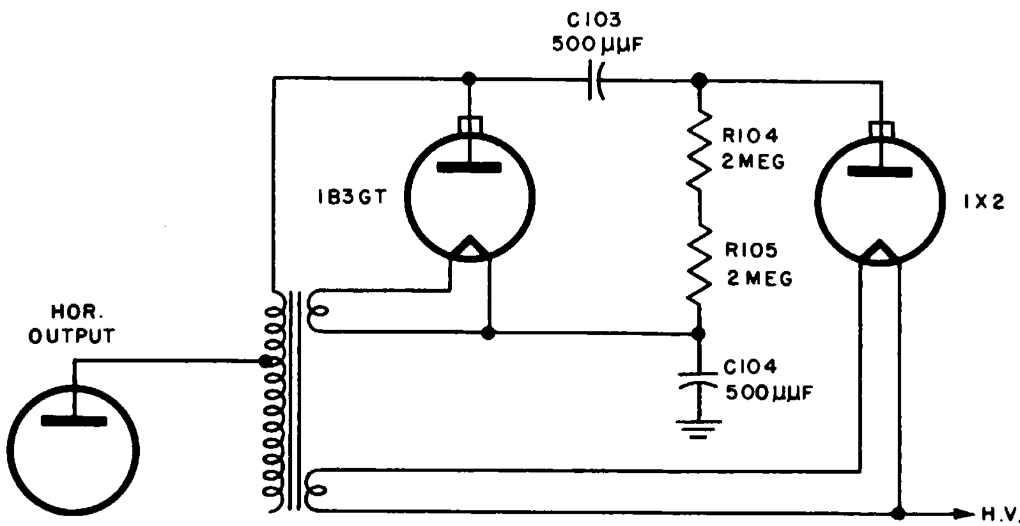


Fig. 3-7. Typical high-voltage doubler circuit. ***After Philco Corp.***

QUES. 3-8. No raster is present on the screen, and severe corona, which covers the entire picture tube, is observed. What is the probable cause of trouble?

ANS. The high-voltage rectifier tube has an internal short from plate to filament. Check the tube and replace if necessary.

DISCUSSION. When a short exists between the plate and filament of the rectifier tube, the high-voltage a-c present at the plate of the rectifier tube is shorted to the filament of the same tube. This a-c voltage is then applied through the high-voltage lead to the inner coating of the picture tube. Some of this a-c voltage is then fed through the capacity that exists between the inner and outer coatings of the picture tube to the outer portion of the picture tube, and severe corona may then result.

QUES. 3-9. When replacing a horizontal output transformer, is it necessary to maintain the high-voltage rectifier filament

leads of the output transformer at their original lengths, or may the leads be cut?

ANS. Once the dress of the filament leads has been determined, the filament leads may be cut to the convenient length.

DISCUSSION. In some output transformers, a filament dropping resistance is part of the transformer leads. When replacing an output transformer of this type. it is necessary to add a series resistor to the filament leads for filament voltage dropping.

QUES. 3-10. When checking for high voltage by arcing the high-voltage anode lead to ground, what precaution must be observed?

ANS. Never continue to draw a high-voltage arc for more than a very short period of time. Arcing for more than a short time overloads the high-voltage circuit, and can cause damage to the horizontal output transformer. high-voltage rectifier tube, and other associated components.

DISCUSSION. Arcing the high-voltage lead to ground is particularly harmful to the high-voltage circuit. if no high-voltage filter resistor is present in the high-voltage circuit. To prevent damage to the circuit when drawing an arc, add a 1-megohm resistor in series with the high-voltage anode lead.

QUES. 3-11. When servicing a high-voltage circuit that is producing no high voltage, an arc can be drawn from the plate of the high-voltage rectifier tube, but the filament of the high-voltage rectifier tube is not lighted. The rectifier tube is checked and found to be good. Checking the resistance of the high-voltage rectifier filament winding does not locate any cause of trouble. How may the filament winding be checked further?

ANS. To check the filament winding of the high-voltage rectifier, disconnect one end of this winding. ~~Coating~~ a 1.5-volt battery directly to the filament circuit of the rectifier tube. If the filament now lights. the high-voltage filament winding of the horizontal winding is probably defective. If the filament still does not light, trouble is indicated in the filament circuit of the high-voltage rectifier itself, exclusive of the winding.

DISCUSSION. For test purposes, the receiver can be operated with the battery connected to the filament leads of the high-voltage rectifier, if it is so desired. If this is done, however, remember that the filament circuit of the rectifier is at a high d-c potential with respect to ground during operation. Consequently, the battery must be well insulated from ground.

QUES. 3-12. Arcing is observed between the picture tube outer coating and the grounding spring clips on a deflection yoke. What can be done to eliminate the fault?

ANS. To eliminate arcing between the picture tube coating and the spring clips:

a. Clean and tighten the spring clips so that they make good contact with the picture tube.
b. Recoat the picture tube with the proper external Aquadag coating. (The coating material can be purchased at any electronics distributor.)

DISCUSSION. In some cases, arcing of this nature is caused by leakage within the picture tube itself. Rather than replace the picture tube, if this is the only symptom of trouble, bend the spring clips away from the picture tube so that they are not making contact. In this way the partially defective picture tube may continue to be used.

QUES. 3-13. Cleaning the grounding springs and increasing the tension, as described in the answer to *QUES. 3-12*, do not eliminate the arcing between the springs and the picture tube Aquadag coating. What procedure may be followed to clear up a stubborn case of arcing at this point in a receiver?

ANS. To insure good contact between the grounding springs and the Aquadag coating of the receiver, observe the following procedure:

a. Take a 2-inch square piece of aluminum foil and cover one side with a glue or paste.
b. Fold a 1/2-inch edge of the foil over the adhesive side of the foil.
c. Insert the aluminum foil between one of the grounding springs and the Aquadag coating on the picture tube, so that the adhesive side is on the picture tube, the grounding spring is resting on the bare aluminum foil, and the non-adhesive side of the folded piece makes contact with the Aquadag coating.

DISCUSSION. To insure good contact, make certain that the folded portion of the foil is directly under the spring. In extreme cases, it may be necessary to observe this procedure on more than one clip.

QUES. 3-14. When servicing a receiver that has been removed from the cabinet without removing the picture tube, the high-voltage lead is a constant source of danger because it is hanging free. What can be done to eliminate this danger point while servicing the chassis?

ANS. To solve the problem of the floating high-voltage lead, take a small rubber ball and cut a narrow opening into it. Place the high-voltage anode cap in the ball while working on the receiver.

DISCUSSION. While some technicians use the above method, others prefer to slip the high voltage anode cap into a small empty soda pop bottle to eliminate the high-voltage danger point.

QUES. 3-15. The receiver operates normally for a short period of time. The raster then alternately blooms and shrinks at a rapid rate. What is the probable cause of trouble?

ANS. The high-voltage filter resistor (or resistors) in the high-voltage doubling network is defective. Check the resistor (or resistors) and replace if necessary.

DISCUSSION. Quite frequently, the filter resistor in a high-voltage doubling network breaks down so that arcing occurs internally in the resistor. When this happens, the production of high voltage fluctuates at the rate of the breakdown within the resistor. This leads to blooming and then shrinking. (Replacement of this resistor is described in the answer to *QUES. 3-16.*)

In a case with the above symptoms, where it is quite obvious that a breakdown is occurring, the use of a common soda straw often aids in locating the source of trouble. Place one end of the straw in the ear, and use the other end of the straw as a probe in the high-voltage circuits. When a loud ticking or clicking is heard that is in step with the symptom on the screen, the defective component has probably been found. Precautions should be observed to prevent body contact with "hot" portions of the circuit.

QUES. 3-16. When replacing defective series high-voltage resistors (such as those used in voltage-doubling circuits), what precautions should be observed?

ANS. When replacing series high-voltage resistors, take care, when splicing the pigtails of the resistors, that the splice is short and kept within the radius of the resistor diameter. In addition, make certain that no sharp points protrude from the splice.

DISCUSSION. Never use standard-type resistors in a voltage-doubling circuit, as they will break down within a short period of time. Use only recommended high-voltage resistors.

QUES. 3-17. Indications of arcing are noted in both the sound (noisy sound) and the picture (flashes through the picture), Fig. 3-17. In checking the receiver, it is discovered that the arcing appears to be originating under the rubber anode cap at the anode button of the picture tube. What should be done to eliminate the arcing?

ANS. Because arcing is often caused by the collection of dirt and dust in the vicinity of the anode button, clean the area around the button thoroughly with carbon tetrachloride, and then with a home kitchen cleanser and water. Dry the area thoroughly after cleaning it. DISCUSSION. On occasion, it may be noticed that the rubber cap on the high-voltage lead is deteriorating. Such deterioration may, by chemical action, cause the rubber to become conductive. This produces a leakage path for high voltage, leading to arcing and corona.

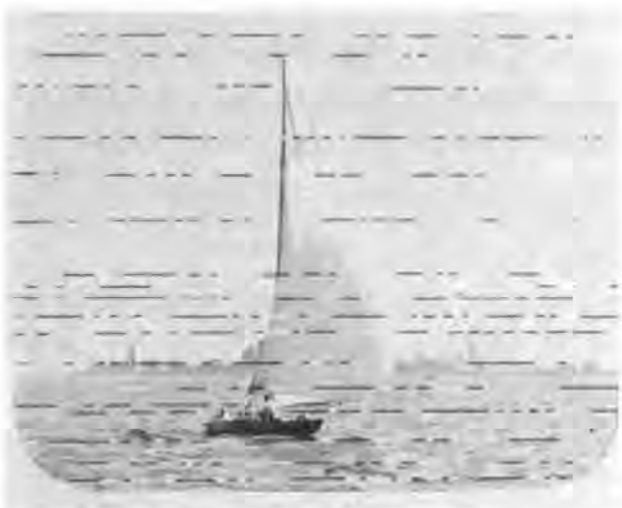


Fig. 3-17. Arcing indications in a picture. Courtesy Zenith Radio Corp.

If this is the case, remove the rubber cap and discard it. As a rule, the normal operation of the receiver will not be affected. If it is, replace the discarded rubber cap with a new one.

High humidity may also lead to arcing at the anode cap. In this case, after cleaning the cap area as described above, spray the area with a clear plastic insulating material. This will generally eliminate cases of high-voltage arcing caused by excessive humidity.

QUES. 3-18. Picture brightness is generally low. The picture blooms and loses brightness (Fig. 3-18) as the brightness control is advanced to the position that normally corresponds to maximum brightness. What is the probable cause of trouble?

ANS. The high-voltage rectifier is probably gassy. Check and replace if necessary.

DISCUSSION. As a rule, picture blooming is caused by poor high-voltage regulation. Thus, as the brightness control is advanced, the resultant increase in second anode current causes the high voltage to decrease, and blooming occurs.

Although a faulty high-voltage rectifier is the usual cause of trouble, the symptom may also be produced by a defective horizontal output tube, or by a high-voltage filter resistor that has increased in value. In addition, an improperly adjusted ion trap magnet may produce a similar symptom.

Fig. 3-18. Picture blooming.

QUES. 3-19. The high-voltage rectifier tube has to be replaced at regular intervals because the filament opens. What is the probable cause of trouble?

ANS. The horizontal-drive control is set to a point at which too much drive voltage is applied to the horizontal-output stage, and thence to the filaments of the high-voltage rectifier. Reduce the drive as much as possible without producing adverse effects on the picture.

DISCUSSION. If reducing the drive to the horizontal output stage does not prevent the rectifier filaments from being burned out periodically, it is necessary to add a resistor in series with the filament leads of the high-voltage rectifier. Choose the resistor by trial and error: it will generally be approximately 2 or 3 ohms.

On occasion, the cause of frequent high-voltage rectifier burn-out is excessive filament voltage, which results from over-efficient coupling between the frequency winding and the main portion of the flyback transformer. In these cases, it is often suggested by the manufacturer that the filament winding be manipulated to reduce the coupling, and hence decrease the heater voltage.

QUES. 3-20. The filament of the high-voltage rectifier consistently opens after several days of normal operation. The setting of the drive control is checked and found to be good. It is noticed that the filaments open only when the receiver is turned on, and never during operation. What is the probable cause of trouble?

ANS. An intermittent arc between the high-voltage lead and the chassis is probably causing the filament to fail. Check high-voltage lead dress, and correct any instances of improper dress.

DISCUSSION. When the receiver is initially turned on, the high voltage produced may be at its greatest magnitude, because the high-voltage circuit is not loaded. As a result, the possibility of high-voltage arcing is greatest at that time. The arcing causes a greater-than-normal current to flow through the high-voltage rectifier tube, which in turn causes the tube filament to open.

QUES. 3-21. Over a period of time, it is noted that the glass envelopes of several receiving tubes located near the high-voltage lead of the receiver have developed white spots on their envelopes and have become useless. What is the cause of this condition?

ANS. A high-voltage arc has developed between the high-voltage lead and the receiving tube, burning a hole in the glass envelope of the tube. Check the lead dress of the high-voltage lead, and move it away from the receiving tubes.

DISCUSSION. Lead dress of the high-voltage wire is important for many reasons. Improper lead dress may also produce Barkhausen oscillation (see the answer to *QUES. 2-3*). Do not allow the high-voltage lead to lie in a random position; use high-voltage tape, if necessary, to secure the high-voltage lead in proper position.

QUES. 3-22. The beginning of a raster appears when the receiver is first turned on, but disappears almost immediately. An arc can be drawn off the plate of the high-voltage rectifier tube, but no high-voltage appears on the high-voltage lead connecting to the picture tube. What is a probable cause of trouble?

ANS. The high-voltage filter capacitor is probably developing leakage at high voltages. Check and replace if necessary.

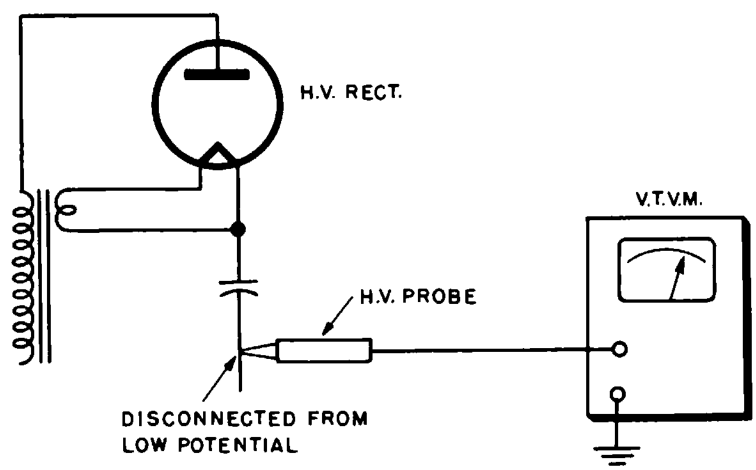


Fig. 3-22. Checking a high-voltage filter capacitor.

DISCUSSION. Although an ohmmeter can be used to determine if a high-voltage capacitor is completely shorted, it cannot be used to check whether the capacitor develops leakage in the presence of high voltage. To check the high-voltage filter capacitor at high voltages, observe the following procedure:

a. Disconnect the end of the capacitor that is tied to low potential (Fig. 3-22).
b. Connect a vtvm through a high-voltage probe to the disconnected end of the capacitor.
c. Turn the receiver on and observe the meter. If a d-c voltage is indicated on the meter, the filter capacitor has leakage,

and should be replaced. (A momentary indication of voltage when the receiver is initially turned on is normal, and does not reflect on the usefulness of the capacitor.

QUES. 3-23. When servicing the high-voltage section of a receiver (Fig. 3-23A), no high-voltage filter capacitor can be found. Is this an indication of faulty factory wiring of the receiver?

ANS. In some receivers, such as the one illustrated in Fig. 3-23(A), no high-voltage filter capacitor is wired into the circuit. Instead, the capacity between the inner and outer conducting surfaces of the picture tube is used as the filter capacitance.

DISCUSSION. Although it is not generally desirable to redesign a receiver by adding components to or subtracting components from it, on occasion a high-voltage capacitor is added to the circuit illustrated in Fig. 3-23(A) to increase the amount of high voltage, and thereby to increase the picture brightness. In this case, the capacitor can be added between the high-voltage rectifier cathode and ground (Fig. 3-23B), or between the high-voltage rectifier cathode and the plate of the damper. If the original high voltage was 10,000 volts, adding the filter capacitor as indicated in Fig. 3-23(B) will increase the high voltage to approximately 11,000 volts; connecting the capacitor to the damper plate will increase the high voltage to approximately 11,750 volts.

QUES. 3-24. What are the symptoms of high-voltage corona?
ANS. Corona (which may be observed as a bluish discharge from a high-voltage point into the air) is characterized by a hissing sound, the odor of ozone, and a decreased high voltage. The reduced high voltage will, of course, cause the picture brightness to decrease and, on some occasions, lead to picture blooming.

DISCUSSION. Since the corona effect is, in most cases, caused by a high-voltage arc originating at a sharp point of solder or wire, the corona can generally be eliminated by soldering a round ball of solder over a sharp point of wire, or by using a soldering iron to round off all sharp points of solder.

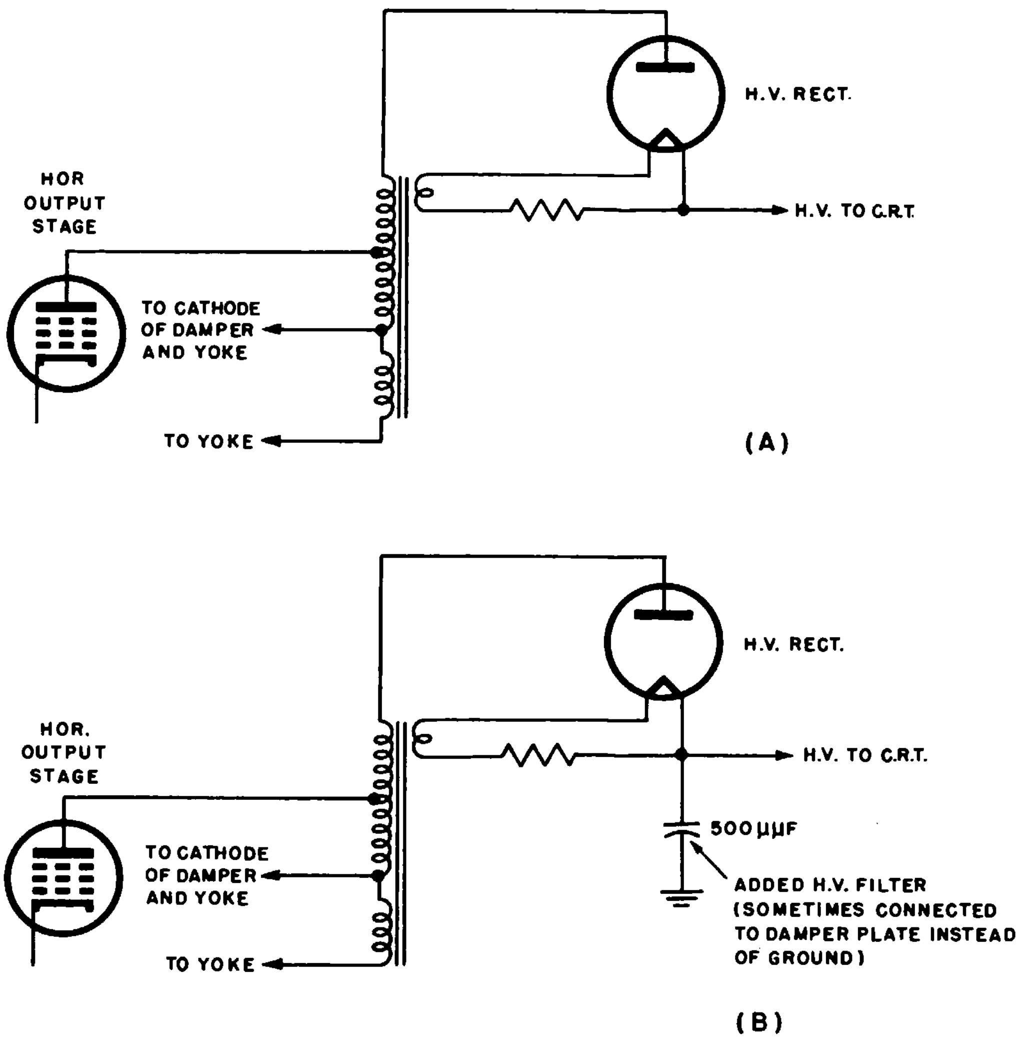


Fig. 3-23. (A) Partial schematic of a high-voltage circuit that has no high-voltage filter capacitor. (B) Adding a high-voltage filter capacitor to a high-voltage circuit.

If the corona cannot be prevented by the above methods, an anti-corona spray or lacquer can be used to cover the point from which the corona is originating. Anti-corona dope is a material of high dielectric strength that will control corona discharge.

To observe the corona during a check, it may be necessary to darken the room in which the inspection is being made. Surrounding light may obscure the blue discharge. See *QUES. 3-25.*

QUES. 3-25. High voltage arcing, as evidenced by noise in the picture and sound, is severe. If the location of the arcing is not readily evident, how may it be located?

ANS. To determine the location of a high-voltage arc, observe the receiver in a dark room. The arc will, in most cases, be more readily visible in this manner.

DISCUSSION. Another method of locating the source of a high-voltage arc is to use a length of plastic or rubber tubing as a sound tube. Place one end of the tubing in the ear, and probe the high-voltage power supply with the other end. The arc location will be characterized by a high noise level as heard through the tubing.

On occasion, the use of the rubber tubing indicates that the source of trouble is within the high-voltage capacitor. Although arcing of this type is not at all visible, it will cause the high-voltage capacitor to become warm to the touch. If this is the case, replacement of the high-voltage capacitor is the next step.

QUES. 3-26. When attempting to locate the source of high-voltage arcing, can the appearance of the picture (Fig. 3-17) aid in localizing the arcing?

ANS. The appearance of the picture tube can be used to sectionalize the trouble; if one or more jagged vertical lines appear in the picture, the arcing is occurring in a section of the receiver where the 15,750-cps signal is present; if the arcing is visible as a series of short black horizontal lines, the arcing is being produced in the presence of the high-voltage dc.

DISCUSSION. As an example of localizing the arcing encountered in modern receivers, jagged vertical lines may be caused by arcing in the horizontal output stage, or transformer, or in the damper circuit. In all these circuits, the 15,750-cps signal from the horizontal deflection oscillator is present. However, if the arcing is caused by faults in the high-voltage output section of the high-voltage rectifier, or at the anode button of the picture tube, short black horizontal lines will be observed on the screen.

QUES. 3-27. Insufficient brightness on the picture tube is diagnosed as being caused by insufficient high voltage (the high voltage is about 1000 volts below normal). The horizon-

tal deflection, damper, and high-voltage rectifier tubes are checked and found to be good, as are the voltages and resistances in the circuits. What may be done to increase the high voltage by approximately 1000 volts?

ANS. To increase the high voltage of the receiver by about 1000 volts:

a. Connect the low-potential side of the high-voltage filter capacitor from ground to the plate of the damper stage.
b. Decrease the size of the screen dropping resistor of the horizontal output tube by slight amounts, taking care that the screen voltage does not exceed the recommended peak operating voltage of the output tube.
c. Decrease the bias on the output tube slightly, by reducing the value of the cathode resistor, and simultaneously increase the drive to the stage.

DISCUSSION. When moving the low-potential side of the high-voltage filter capacitor to the damper stage, it is connected to the plate of the damper stage, in all cases where the horizontal output transformer is of the conventional primary-secondary type. If, however, an autotransformer, or direct-drive transformer, is used in the circuit, the connection will probably have to be made to the cathode of the damper stage. Since no lasting harm can result if the connection is made to the wrong element of the damper tube, try both connections when in doubt.

QUES. 3-28. On occasion, it is recommended that the low potential side of the high-voltage filter capacitor be disconnected from ground and reconnected to the plate of the damper (Fig. 3-28), to increase the high voltage and therefore the brightness of the picture. What precaution should be observed when making this change?

ANS. When reconnecting the high-voltage filter capacitor to the damper plate (Fig. 3-28), observe the left side of the picture to note whether horizontal foldover has been introduced by the new circuit connection. In some cases, the foldover caused in this manner may be eliminated by adjusting the drive and width controls. If the foldover remains, however, the filter capacitor will have to be returned to its original connection.

DISCUSSION. It should be mentioned that the reverse of the situation described above may also be encountered occasionally. In this opposite case, if the high-voltage filter capacitor has, by design, been connected to the plate of the damper, and horizontal foldover at the

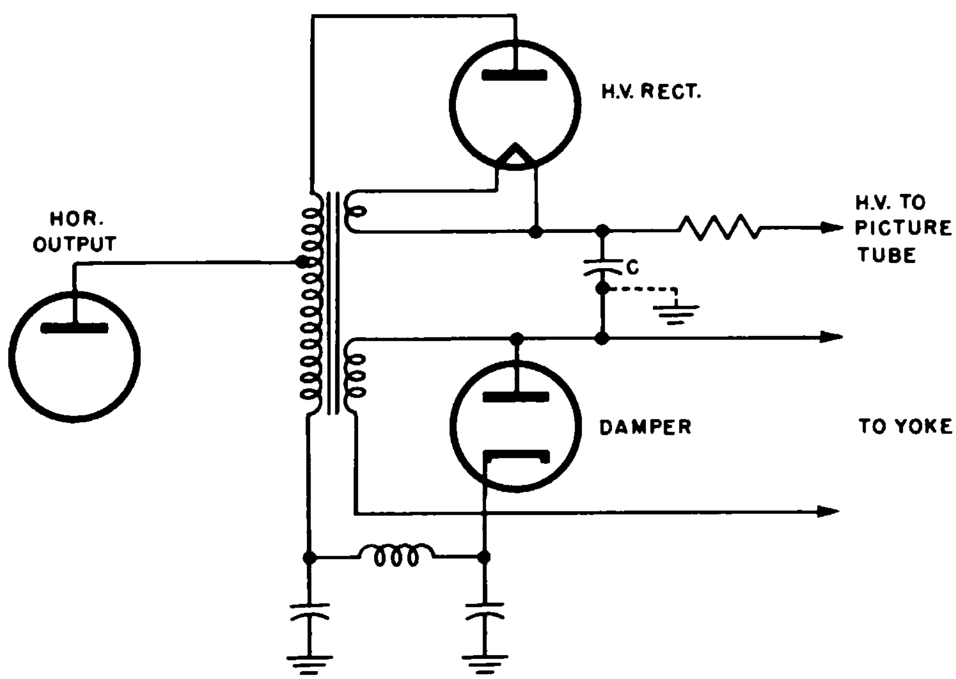


Fig. 3-28. Reconnecting the high-voltage filter capacitor to increase the high voltage.

left side is observed, the foldover may be eliminated by connecting the low-potential side of the filter capacitor to ground. This modification should only be resorted to if the amount of high voltage remaining, after the modification has been made, is sufficient to produce a picture of adequate brightness.

QUES. 3-29. No raster is observed on the picture tube. The high voltage is checked at the picture tube anode and found to be missing. In examining the receiver, it is discovered that an r-f high-voltage power supply, such as that illustrated in Fig. 3-29, produces the high voltage for the receiver. When

servicing this type of supply, what are some of the special servicing considerations to bear in mind?

ANS. When servicing an r-f high-voltage power supply (Fig. 3-29), remember that the supply operates independently of the horizontal section of the receiver. The operation of the supply is not at all dependent upon the reception of any pulse from the horizontal output stage.

The r-f supply generally consists of an r-f oscillator, which operates at a fixed frequency between 200 and 300 kc, and a high-voltage rectifier. The output of the oscillator is stepped up through a transformer and is rectified by the high-voltage rectifier.

When troubleshooting a supply of this nature, the first step, after checking the tubes, is to use a vtvm to measure the grid voltage of the oscillator. As in any oscillator circuit, a negative grid voltage

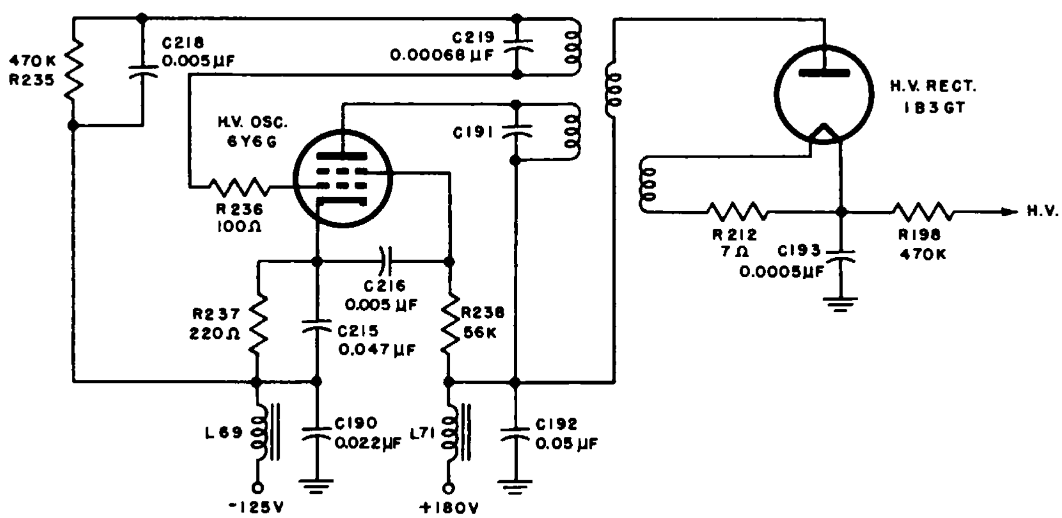


Fig. 3-29. Schematic of typical r-f type of high-voltage power supply. ***After Sylvania Electric Products Co.***

will be present if the oscillator is functioning. After the measurement is taken, conventional voltage and resistance checks should be made, the specific measurements being determined by the presence or absence of oscillator grid voltage.

DISCUSSION. Adjustment of the high-voltage output can be made by varying a trimmer capacitor in the high-voltage oscillator (*C191* in Fig. 3-29). The trimmer setting determines the frequency of the oscillator, which in turn varies the voltage induced into the secondary of the step-up transformer. (This results because the oscillator operates with varying degrees of efficiency at different frequencies, as does the transformer.) The specific procedure for adjusting this trimmer is given in the answer to *QUES. 3-30.*

QUES. 3-30. When adjusting the trimmer tuning capacitor in an r-f high-voltage power supply, what is the recommended procedure?

ANS. When adjusting the trimmer tuning capacitor in an r-f power supply:

a. Adjust the tuning capacitor so that the plates of the capacitor are seperated as far as possible (the capacitor is set for minimum capacity).
b. Adjust the trimmer while observing the picture; select that adjustment of the trimmer that produces the first brightness peak.
c. Varying the trimmer adjustment on either side of the brightness peak should cause the brightness to decrease.

DISCUSSION. Although a second brightness peak may be obtained with the trimmer capacitor set to a higher capacity (the frequency of the supply at a lower point), this peak should not be used, because circuit efficiency is likely to be lower at this point.

QUES. 3-31. When servicing high-voltage circuits, it is often desirable to observe the waveforms present at various points within the circuit. What are some of the probes that may be used with a scope to observe high-voltage waveforms?

ANS. Some of the probes that may be used in conjunction with an oscilloscope to measure high-voltage waveforms are illustrated in Fig. 3-31.

DISCUSSION. The probe of Fig. 3-31(A) consists of two pieces of RG-59/U coaxial cable. To construct this probe, remove the outer shield of a 6-inch piece of coaxial cable. and also remove about 3-1/2

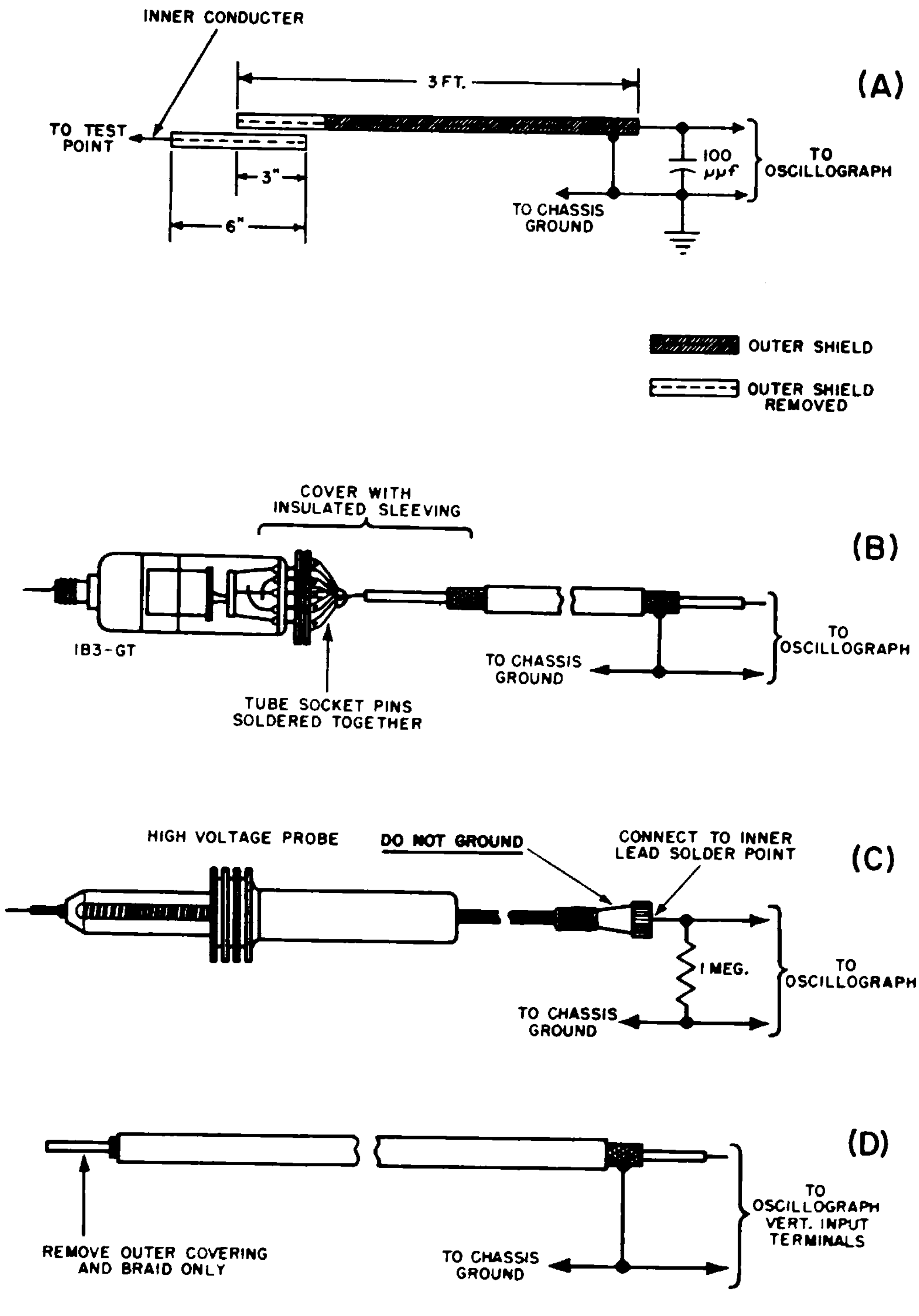


Fig. 3-31. High-voltage probes for use with scope to observe high-voltage waveforms. ***Courtesy DuMont Service News.***

inches of the outer shield of a 3-foot length of cable. Place the cables so that they overlap, as indicated in Fig. 3-31(A), and tape them together. Connect a 100-$\mu\mu$f capacitor between the inner and outer conductors of the longer piece of cable. When this capacitance type of probe is used, it will give a voltage step down of approximately 100:1.

The probe illustrated in Fig. 3-31(B) consists of a 1X2A high-voltage rectifier connected to the inner conductor of a length of RG-59/U coaxial cable.

The probe of Fig. 3-31(C) utilizes a high-voltage probe of the type used with vtvm's to which a 1-megohm resistor is connected. When using this probe to observe waveforms, make certain that the outer shield of the probe jack does not contact chassis ground during an observation of waveforms.

Figure 3-31(D) illustrates a capacitive gimmick that may be used with a scope to check waveforms. To construct it, simply remove the outer shield from approximately 1 inch of a convenient length of RG-59/U coaxial cable. With one of the coaxial cables connected to the scope, and with the scope set to a sweep frequency of 7875 cps, place the free end of the cable in the vicinity of the circuit point at which the waveform is to be observed.

QUES. 3-32. How may the high-voltage scope probe of Fig. 3-31(A) be calibrated to measure peak voltages accurately?

ANS. To calibrate the high-voltage scope probe, observe the following procedures:

a. Replace the 100-$\mu\mu$f capacitor with a 10- to 200-$\mu\mu$f trimmer capacitor.
b. Select a scope with an attenuator switch that will permit attenuating an input signal by a factor of 100.
c. Set the scope coarse attenuator to the least sensitive position (most attenuation).
d. Connect the scope directly to a receiver circuit, such as a sync circuit, and note the deflection on the scope screen. If necessary to frame the waveform properly, adjust the vertical centering control. Note or mark the upper and lower limits of the waveform on the scope screen.

e. Connect the high-voltage probe between the vertical input of the scope and the receiver circuit of step *d* above.
f. Set the scope coarse attenuator to a position 100 times as sensitive as that of step *c* above (100 times less attenuation). Do *not* touch the fine attenuator.
g. Adjust the trimmer capacitor of the probe to obtain the same deflection as noted in step *d* above. The probe is now calibrated as a 100-to-1 divider.

DISCUSSION. The high-voltage scope probe is of great value in measuring and observing voltage in the horizontal and high-voltage sections of the receiver. The probe should not be used in the vertical section of the receiver, because the low frequencies encountered in this section will be distorted by this type of probe.

Chapter 4

QUESTIONS AND ANSWERS ON DAMPER-BOOST CIRCUITS

QUES. 4-1. No raster is present on the screen. An attempt to draw an arc with a screwdriver at the plate of the horizontal output stage indicates a lack of high voltage. The horizontal deflection and damper tubes are checked and found to be good. After a scope connected to the grid of the output stage fails to indicate a sweep waveform, the plate voltage of the horizontal oscillator, obtained from the damper boost supply, is checked and found to be low. How can it be determined whether the trouble is in the horizontal oscillator as opposed to the horizontal output damper section of the receiver?

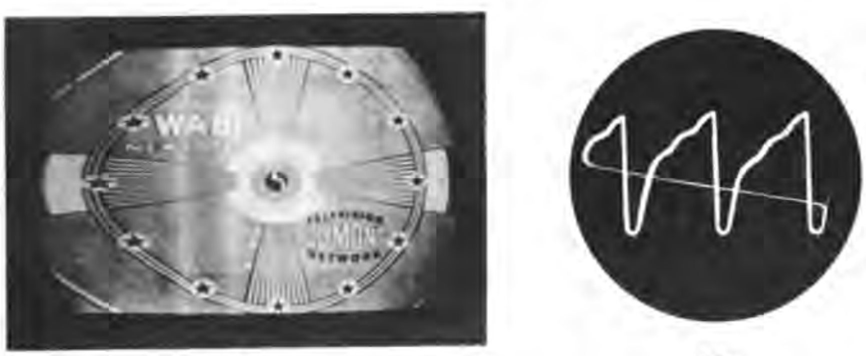
ANS. To check whether low B+ at the horizontal oscillator plate is caused by a defect in the oscillator itself or by the output damper portion of the receiver, connect an external B+ voltage (from an external power supply or from another operating receiver) to the B+ lead of the horizontal oscillator. If the horizontal oscillator then starts to operate, the trouble is located in the horizontal output stage or the damper stage. However, if oscillation does not resume at this time, the horizontal oscillator stage is the source of trouble.

DISCUSSION. When using an external power supply or another operating receiver as a source of B+ to make the test outlined above, simply connect one test lead between the horizontal oscillator plate B+ return and the source of voltage used and connect a second test lead between the B— points (or the grounds) of the two items of equipment. The method of checking a defective receiver with the aid of a functioning receiver is sometimes referred to as circuit patching, and is described in more detail in the answer to *QUES. 1-4.*

QUES. 4-2. Picture ringing (a series of dark and light vertical bars at the left side of the picture) and poor horizontal linearity (Fig. 4-2A) are observed in the picture. The horizontal deflection tubes are checked and found to be good. The horizontal front and rear panel controls are varied but do not affect the picture. What is the probable cause of trouble?

ANS. Picture ringing and poor horizontal linearity may be caused by an open boost capacitor in the damper circuit. Check and replace, if necessary.

DISCUSSION. The boost network, generally consisting of two capacitors and the horizontal linearity coil (see Fig. 4-4), aid in filtering the B+ boost voltage produced in the damper circuit. If one of the capacitors opens or loses capacity, poor filtering occurs and results in picture ringing. At this time, the current waveform in the



(A) (B)

Fig. 4-2. (A) Picture ringing and poor horizontal linearity. *Courtesy Allen B. Dumont Labs.* (B) Current waveform in the horizontal-deflection coil producing picture ringing and poor horizontal linearity.

horizontal deflection coil appears as is shown in Fig. 4-2(B). (The procedure for observing the current waveform is described in the answer to *QUES. 1-16.*)

Another cause of picture ringing and poor linearity may be the core of the horizontal output transformer slipping out of place. When this occurs, the ringing is generally accompanied by low picture brightness. If the core is found to be out of place, return it to its proper position and fasten in place. (Core slipping is *not* a frequent cause of trouble.)

QUES. 4-3. Before replacing 6W4-GT damper tubes that apparently have open filaments, what procedure should be followed?

ANS. Crimp the filament pins (*7* and *8*) with a long-nose pliers or with a diagonal cutter. (When a cutter is used, be careful not to exert too much cutting pressure, as the pins may be cut.) After crimping, check the tube by returning it to its socket.

DISCUSSION. Sometimes damper tubes of the 6W4-GT type are found with filaments that are open in the pins themselves, because of poor solder joints. Such a damper tube acts as if the filament were burned out and the tube in need of replacement. Crimping the filament pins, however, will often cure the apparent trouble.

QUES. 4-4. The raster is small vertically and horizontally, and the picture is dim. The low-voltage rectifier, horizontal deflection, and damper tubes are checked and found to be good. A voltage check of the low-voltage B+ (+280 volts in Fig. 4-4) indicates that this voltage is normal, but a check of the boost voltage (+450 volts in Fig. 4-4) indicates that it is only +300 volts, and is therefore considerably below normal. If a resistance check of the components in the damper circuit does not locate the source of trouble, what is the probable cause?

ANS. Shorted turns in the horizontal or vertical output transformers, yoke, or width coil load the boost circuit by drawing excessive current. The increased circuit load causes the boost voltage to decrease.

DISCUSSION. When attempting to locate the component with shorted turns, disconnect the suspected components one at a time, while measuring the boost voltage each time. When the defective component is disconnected, the boost voltage rises to its normal value.

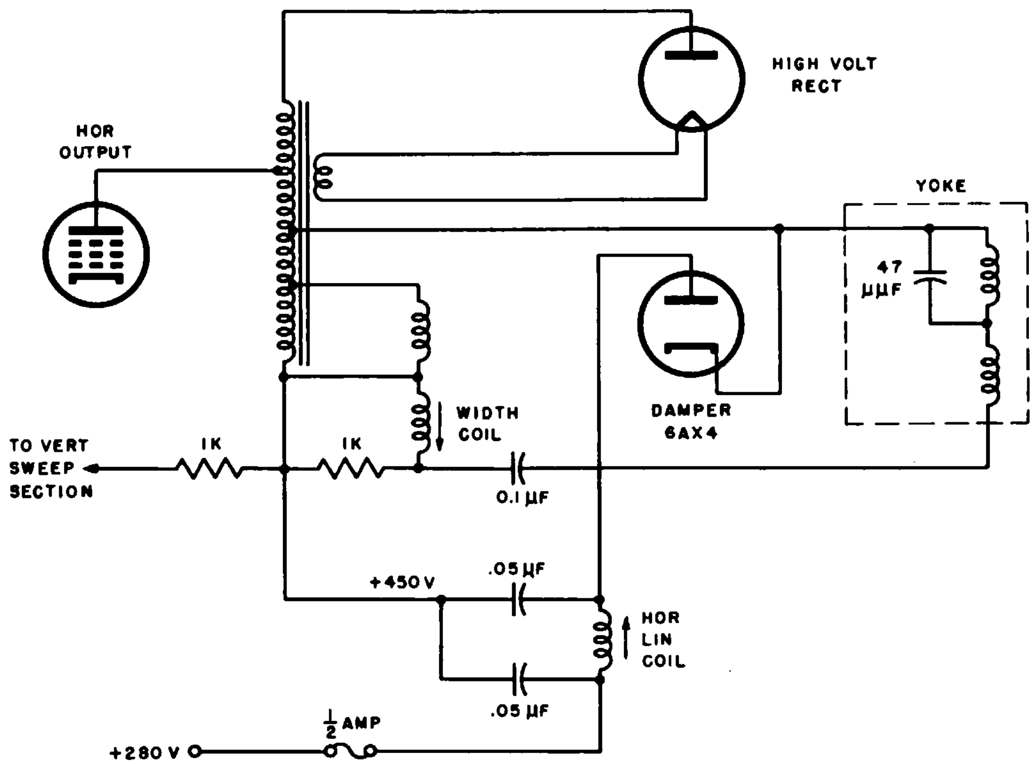


Fig. 4-4. Schematic of typical damper circuit.

QUES. 4-5. No raster is evident on the picture tube, regardless of the setting of the brightness control. The voltage at the picture tube anode is checked by arcing, and is found to be normal. Adjustment of the ion trap magnet is attempted, but to no avail. Voltage checks are made at the picture tube and all voltages appear to be normal, with the exception of the cathode voltage, which measures 550 volts. In the circuit illustrated in Fig. 4-5, what is the probable cause of trouble?

ANS. A cathode-to-heater short probably exists in the damper tube. Check the tube and replace if necessary.

DISCUSSION. In the circuit of Fig. 4-5, it may be noted that the voltage applied to pin *10* of the picture tube is 550 volts, the boost voltage of the damper circuit. If, when servicing the receiver, a

550-volt potential is encountered at a point other than where this high boost is supposed to be, trouble should be suspected in the damper section. Thus, in Fig. 4-5, if a cathode-to-filament short occurs in the 6W4, the boost voltage at the cathode of the damper is applied to the filament and cathode of the picture tube, and will be noted if voltage checks of the picture tube elements are made.

Because the filament circuit of the damper and picture tube is ungrounded for the receiver illustrated in Fig. 4-5, the shorted damper tube would not affect the magnitude of the boost voltage.

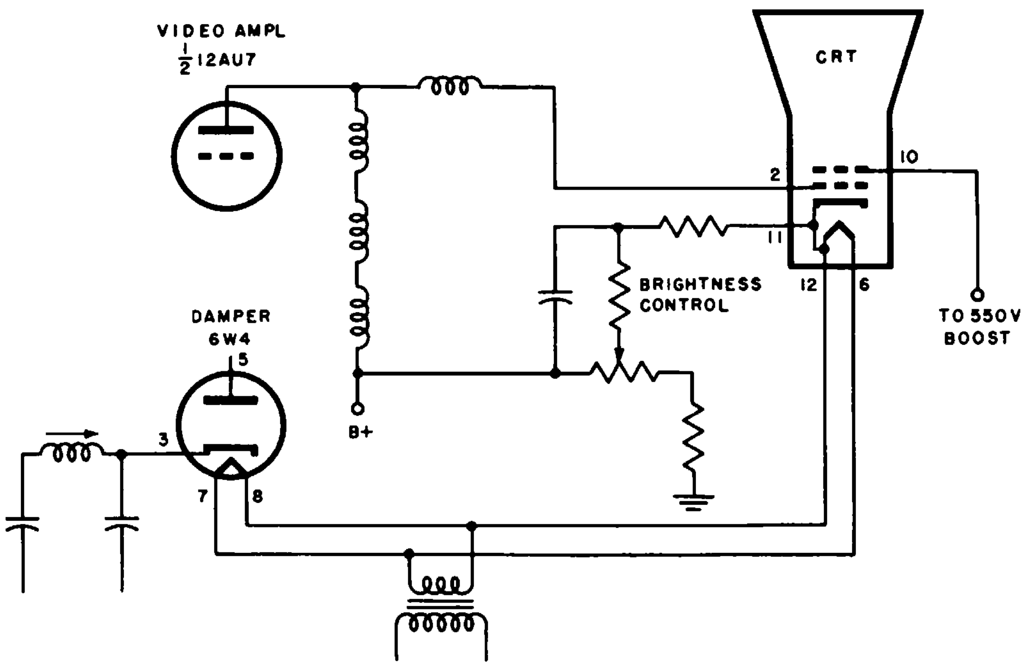


Fig. 4-5. Partial schematic of damper and brightness circuit illustrating the effect of a heater-to-filament short in the damper tube.

QUES. 4-6. A thin vertical black-and-white line (somewhat resembling a barber pole) appears near the left edge of the picture when the receiver is tuned to some channels. The horizontal deflection and damper tubes are checked and found to be good. How can this interference be eliminated?

ANS. To eliminate barber-pole interference, insert small r-f chokes in series with the plate and cathode of the damper tube.

DISCUSSION. Barber-pole interference (sometimes also called spook interference) is a result of harmonic radiation by the damper stage. This radiation, caused by harmonics of the sharp-peaked waveform in the damper circuit, beats against the incoming video signal in the front end of the receiver, producing the undesired symptom mentioned above. The harmonic radiation can be eliminated by inserting r-f chokes in the damper stage.

QUES. 4-7. The horizontal linearity is poor, with the right section of the picture stretched excessively (Fig. 4-7). The horizontal deflection and damper tubes are checked and found to be good. Adjusting the horizontal linearity coil so that the slug is completely within the winding reduces the stretch a great deal, but does not eliminate the trouble completely. What is the probable cause?

Fig. 4-7. Poor horizontal linearity, with right side of picture stretched excessively. *Courtesy General Electric Co.*

ANS. One of the boost capacitors is of incorrect value. Test the capacitors by replacing with ones of properly rated values.

DISCUSSION. On occasion, as the values of circuit elements change within their tolerance, a right hand stretch, as mentioned above, may appear. In some instances, the non-linearity may be removed by test-replacing the boost capacitors with others slightly different in value from the original capacitors in the circuit. If removal of the nonlinearity requires a radical change in the boost capacitor value, however, do not use the new capacitor but recheck the circuit in an attempt to locate a defective component, which is probably the primary cause of trouble.

QUES. 4-8. No raster is observed on the screen. The high-voltage fuse is found to be open, and is replaced. After a short period of normal operation, the plates of the damper stage (*V114* in Fig. 4-8) glow red and the fuse blows again. Replacing the damper tube does not clear up the trouble. What is the probable cause?

ANS. The leads of the damper filament supply are shorting to ground through the core of the power transformer. Unsolder both filament leads from the tube and, using an ohmmeter set to the high-resistance range, check between the filament leads and ground. An infinite resistance reading is normal.

DISCUSSION. Because the cathode of the damper stage is maintained at a high potential with respect to ground (+450 volts in the circuit of Fig. 4-8), the filament of the tube is connected to the cathode. This prevents arcing between the cathode and filament, which would occur in the presence of the large potential difference. However, because the filament leads are now maintained above ground potential, breakdown of the insulation of the filament windings and the grounded core of the power transformer sometimes occurs.

When breakdown occurs, it is not necessary to replace the entire power transformer. Use a 117-volt to 6.3-volt filament transformer, connecting the primary winding across the primary of the power transformer, and the secondary winding to the filaments of the damper. (For further information on this problem, see *QUES. 4-9.*)

QUES. 4-9. High-voltage arcing is discovered between the filament winding for the damper stage and the shell of the power transformer which is grounded to the chassis. Can this arcing be corrected without adding a filament transformer?

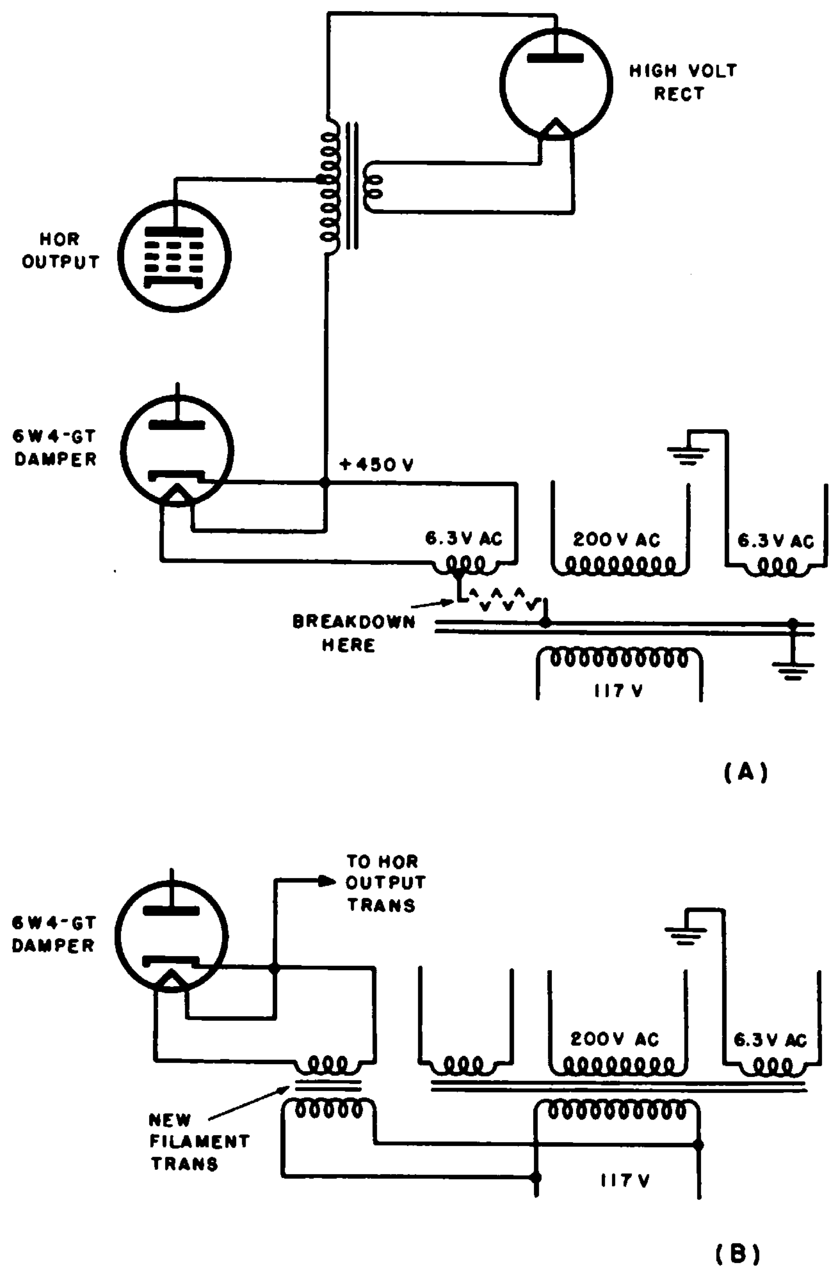


Fig. 4-8. Replacing a defective filament winding of a power transformer with a new filament transformer. (A) Original connection. (B) Replacement connection.

ANS. To eliminate the arcing:

a. Remove the bolts that fasten the power transformer to the chassis.
b. Carefully pry the shells of the transformer away from the transformer winding.
c. Determine the point at which the arc is occurring; this may be observed as a darkened, burnt spot.
d. Cover the point at which the arc has occurred with high-voltage corona dope, or place a layer of insulating material (cambric or the like) so that the point of arc is covered (Fig. 4-9).
e. Reassemble the transformer, and reconnect it to the chassis.

DISCUSSION. Because transformer arcing of this type is often the prelude to a general breakdown of the transformer, it is not recommended that the above procedure be attempted in the customer's home. The repair should be performed in the shop so that the set can be permitted to operate for several hours before returning it.

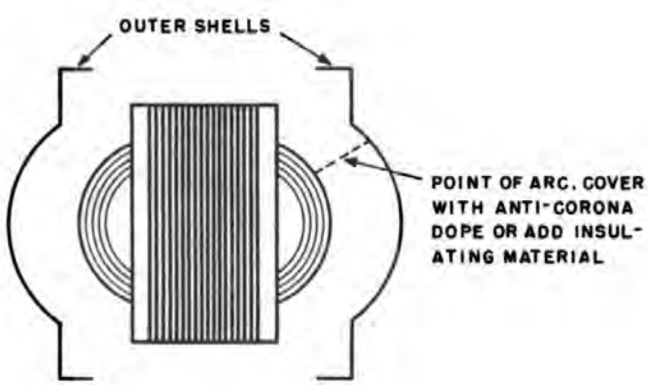


Fig. 4-9. Eliminating arcing between a filament winding and a transformer.

QUES. 4-10. The boost capacitor (*C282* in Fig. 4-10) continually fails after a few weeks of normal operation. Replacement of the shorted capacitor is always made with the exact replacement part, but the failing continues. The tubes are checked and appear to be normal. What is the probable cause of trouble?

ANS. The damper tube (a 6AX4-GT in Fig. 4-10) takes an excessive time to warm up, causing the boost capacitor to break down. Replace the damper tube with a tube of shorter warm-up time.

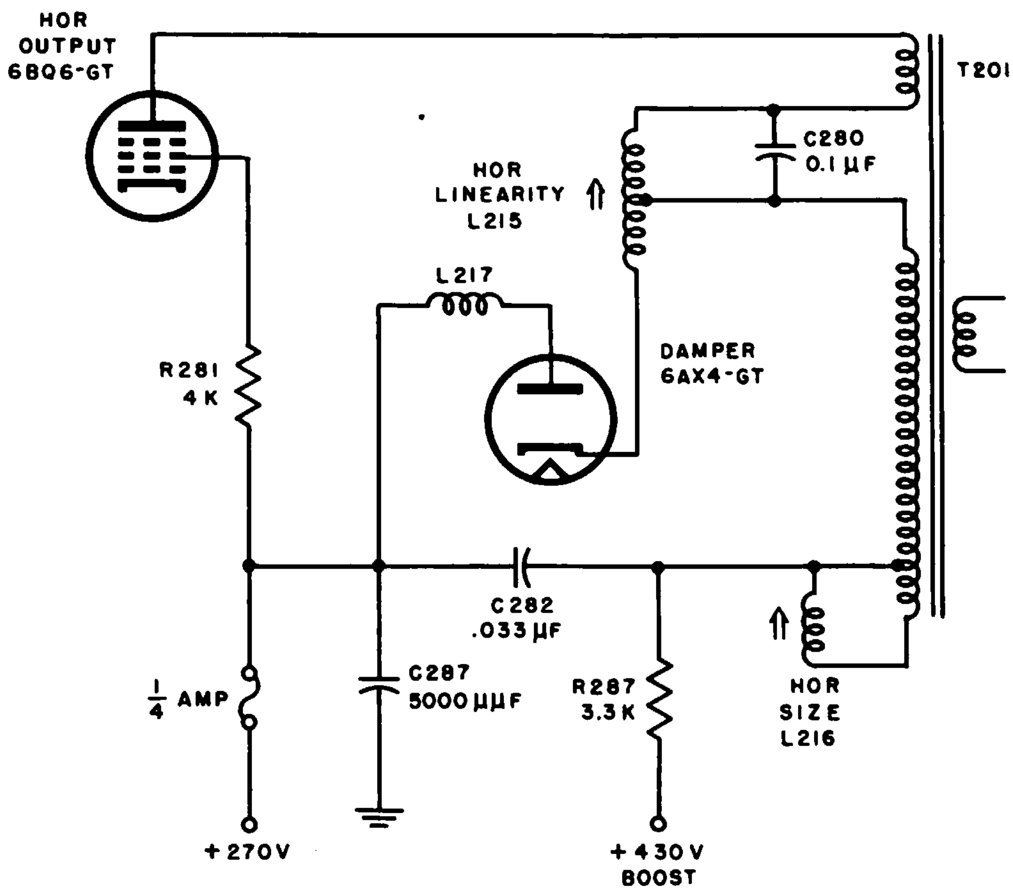


Fig. 4-10. Boost supply using a semi-polarized boost capacitor. ***After Allen B. Du-Mont Labs., Inc.***

DISCUSSION. The boost capacitor, *C282* in Fig. 4-10, is a semi-polarized capacitor. If the damper tube takes a long time for its filament to reach normal operating temperature (20 seconds is a normal time) the +270-volt potential is produced before the +430-volt boost potential, and an electron flow in the wrong direction is forced through the semi-polarized boost capacitor. As a result, the capacitor becomes defective.

Chapter 5

QUESTIONS AND ANSWERS ON KEYED AGC CIRCUITS

QUES. 5-1. When servicing keyed agc circuits, why is it often necessary to resort to waveform observation, and voltage and resistance measurements, in the horizontal deflection section of the receiver?

ANS. The keyed agc (or keyer) tube is normally biased beyond cutoff, so that this tube does not conduct. Application of the composite video signal to the grid of the agc tube does not alter the nonconduction. However, a large positive-going pulse voltage is applied from the horizontal deflection circuits to the plate of the keyed agc tube, thereby bringing the tube out of cutoff and into conduction. Because the keyed-agc stage requires this horizontal keying pulse for operation, servicing this type of agc requires checking the presence or absence of the keying pulse, thereby requiring checking back to the horizontal deflection section of the receiver.

DISCUSSION. The positive keying pulses from the horizontal deflection section are applied to the keyed-agc tube at the horizontal deflection rate of 15,750 cps. These pulses are applied to the keyer to coincide with the sync pulses of the composite video signal. Beciuse the agc tube does not conduct between sync pulses, any noise voltages that are present on the incoming video signal are not effective during the production of the agc voltage. In addition, the short time constant required by this type of keyed operation permits the system to be sensitive to rapid changes of signal, such as are caused by airplanes.

QUES. 5-2. When servicing keyed agc circuits, what symptoms can be expected when trouble develops in the circuit?

ANS. Defects in keyed agc circuits may cause:

a. Reduction of picture contrast and sound volume (Fig. 5-2A).
b. Loss of picture and sound.
c. Snowy picture in strong signal area (Fig. 5-2B).
d. Horizontal pulling.
e. Extremely dark, contrasting picture (Fig. 5-2C).

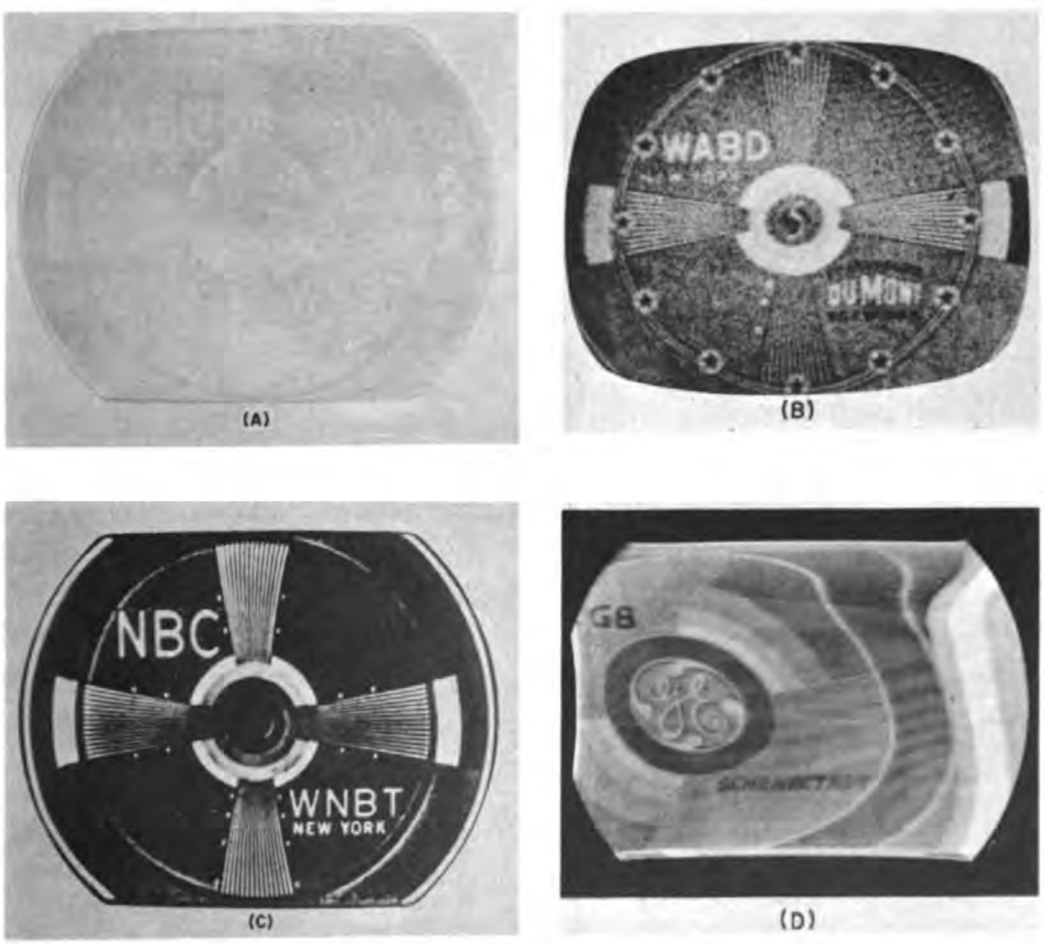


Fig. 5-2. (A) Reduction of picture contrast. *Courtesy RCA Service Co.* (B) Snowy picture. *Courtesy RCA Service Co.* (C) Excessive contrast. *Courtesy RCA Service Co.* (D) Negative picture. *Courtesy General Electric Co.*

f. Negative picture (Fig. 5-2D).
g. Complete lack of sync.
h. Buzz in sound.
i. Poor immunity to noise.

DISCUSSION. Troubles in the keyed agc circuit generally result in either an excessively high agc bias being produced and fed to the grids of the r-f and i-f stages, or an excessively low agc bias. The first three symptoms mentioned above are usually caused by an increase in the agc bias produced in the agc circuit. Thus, if a —3-volt agc bias is the normal bias of a given receiver for a given signal strength, an improper functioning of the circuit to produce —6-volt bias can produce symptoms *a, b,* or *c*. On the other hand, a decrease in agc bias below its normal level can produce any of the symptoms *d* through *i*.

QUES. 5-3. What is the first voltage measurement to make when checking the agc system of a tv receiver?

ANS. To check the operation of a keyed agc network:

a. Connect a vtvm, set to a low d-c scale, to the agc bias as in Fig. 5-3. (Connect the negative lead of the vtvm to the agc bus, and the positive lead to B— of the receiver.)
b. Tune the receiver to a strong channel. Note the meter indication. (The meter may indicate between —3 and —6 volts.)
c. Tune the receiver to a weak channel. (If no weak channels are present in the area, disconnect one side of the antenna from its antenna terminal at the receiver.) Note the meter indication. The meter should now register between 0 and —3 volts. If both readings (step *b* and *c*) are as expected, the keyed agc system is operating normally. If, however, the readings are not normal, trouble may be present in the agc network.

DISCUSSION. When measuring the agc bias, it is recommended that a vtvm, rather than a multimeter, be used for the test. The reason for this is to minimize loading the agc line so that erroneous readings, and subsequent false indications of circuit operation, are not obtained.

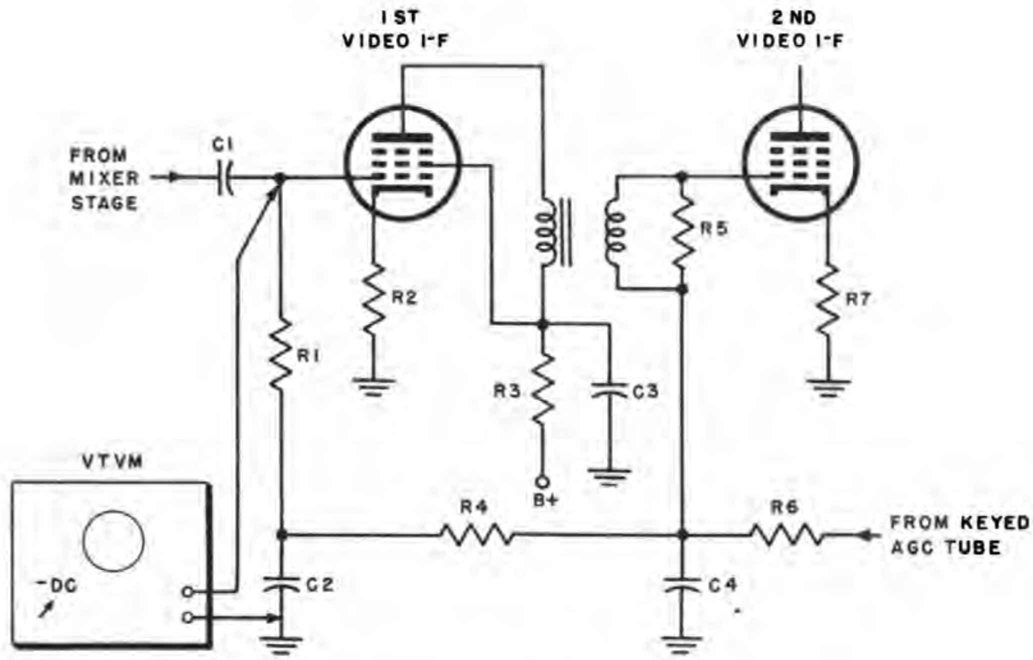


Fig. 5-3. Checking the agc voltage in a receiver.

QUES. 5-4. The cause of picture overload is diagnosed as an improperly functioning keyed agc circuit. In the typical agc circuit illustrated in Fig. 5-4, what general procedure should be followed to determine whether the keyed agc circuit itself is functioning properly?

ANS. When checking a keyed agc circuit, short the cathode and grid of the keyer tube together, then use a vtvm to check the voltage on the agc line.

a. If a normal negative agc voltage is obtained, check the cathode and grid circuits of the agc tube for the cause of trouble. Excessive bias voltage produced by defects in these circuits may prevent keyed tube conduction.

b. If an excessively negative agc voltage is obtained, check for an open resistor in the agc line. The circuit is probably being completed through the vtvm.

c. If no negative voltage is obtained, the keyer tube is not conducting because of any one of the following: no pulse from the agc winding; bad keyer tube; shorted agc capacitor; no screen voltage on keyer tube.

DISCUSSION. If it is suspected that the agc winding on the horizontal output transformer is defective, the winding may be checked as follows: Connect a 100,000-ohm resistor between the plate of the keyer tube and ground. Connect a .005-μf capacitor between the plate of the keyer tube and the high-potential side of the width coil (or any other point in the horizontal output circuit that may be used to supply about a 500-volt pulse). Short the grid and cathode of the keyer tube together and use a vtvm to measure the voltage on the agc line. If a normal negative voltage is now obtained, the winding is defective.

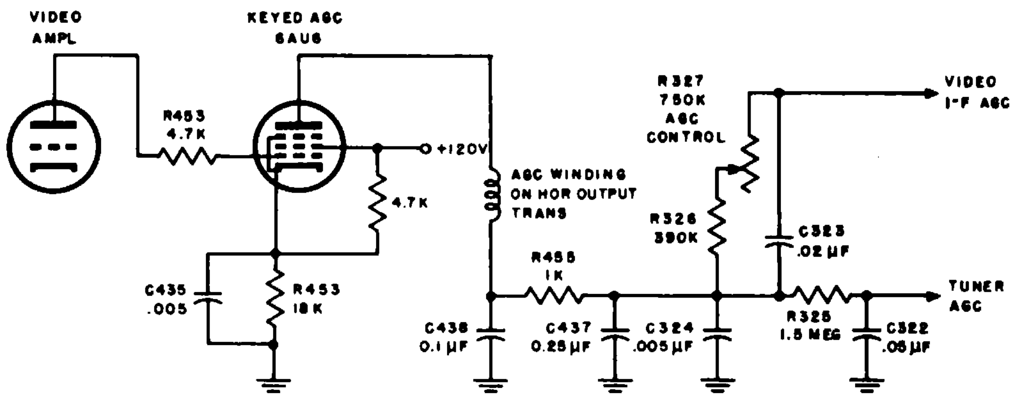


Fig. 5-4. Schematic of a typical keyed-agc circuit. *After Westinghouse Electric Co.*

QUES. 5-5. The picture has excessive contrast, and the sync is poor. The front end, video, and agc tubes are checked and found to be good. Because the picture symptoms can be caused by a defect in the keyed agc circuit, it is decided to check this circuit. How can the keyed agc circuit be checked rapidly with a variable bias box?

ANS. To check the agc circuit, connect the output of an agc bias box to the agc bus of the receiver, after removing the keyer from its socket. Vary the bias box output over its entire range, while observing the picture. If a good picture can be produced at one setting of the agc bias box output, the agc circuit is the probable source of trouble. If, however, the agc bias box cannot cause a good picture to be produced, the trouble lies elsewhere.

DISCUSSION. Because the correct bias voltage applied to the grids of r-f and video i-f stages is always negative, always connect the negative output of the agc bias box to the agc bus of the receiver.

The construction of three simple bias boxes is described in the answer to *QUES. 5-6.*

QUES. 5-6. How may a simple agc bias box be constructed?

ANS. The schematics of three simple agc bias boxes are illustrated in Fig. 5-6(A), (B), and (C).

DISCUSSION. The bias box of Fig. 5-5(A) is simple to construct, and has a low initial cost. Its main disadvantage, of course, is the fact that the battery requires relatively frequent replacement.

The bias box of Fig. 5-6(B) uses a selenium rectifier, rather than a battery, to produce the d-c output. The input to this bias box is 6.3 volts a-c, which may be tapped from a filament of the receiver under test.

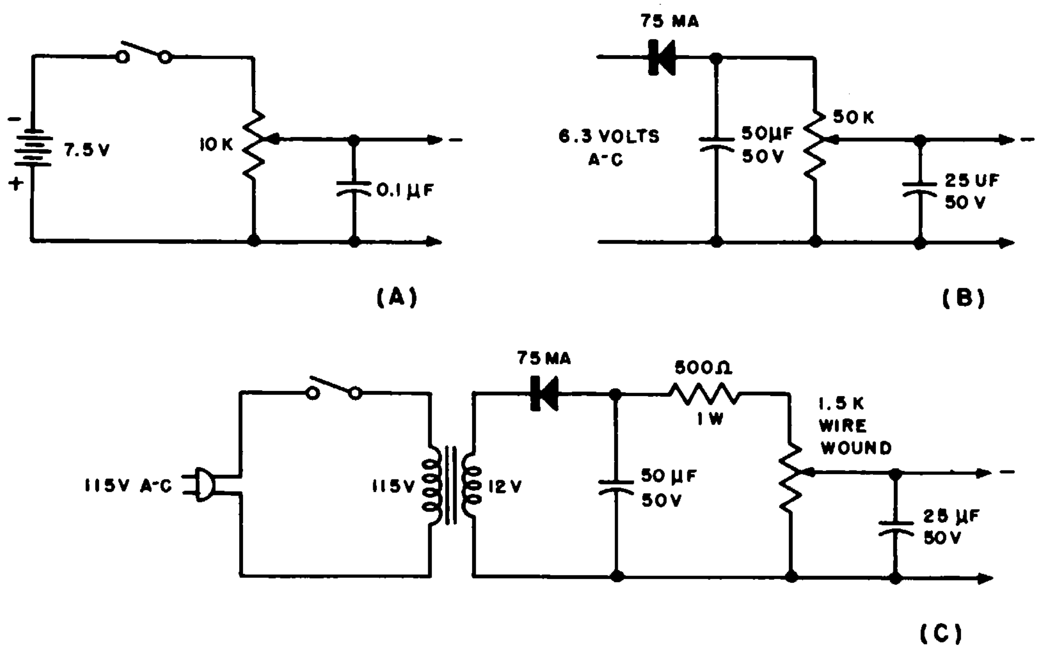


Fig. 5-6. Construction of three simple agc bias boxes. Courtesy DuMont Service News.

The bias box of Fig. 5-6(C) is the most elaborate, but the most convenient in the long run. It uses a filament transformer and a selenium rectifier to produce the desired d-c output. The advantage of this box over that of Fig. 5-6(B) is that its input can be connected to any 115-volt outlet.

QUES. 5-7. After the receiver has been operating normally for a period of time, the picture contrast increases, and the horizontal stability becomes poor. The horizontal deflection and agc tubes are checked and found to be good. In the receiver of Fig. 5-7, what is the probable cause of trouble?

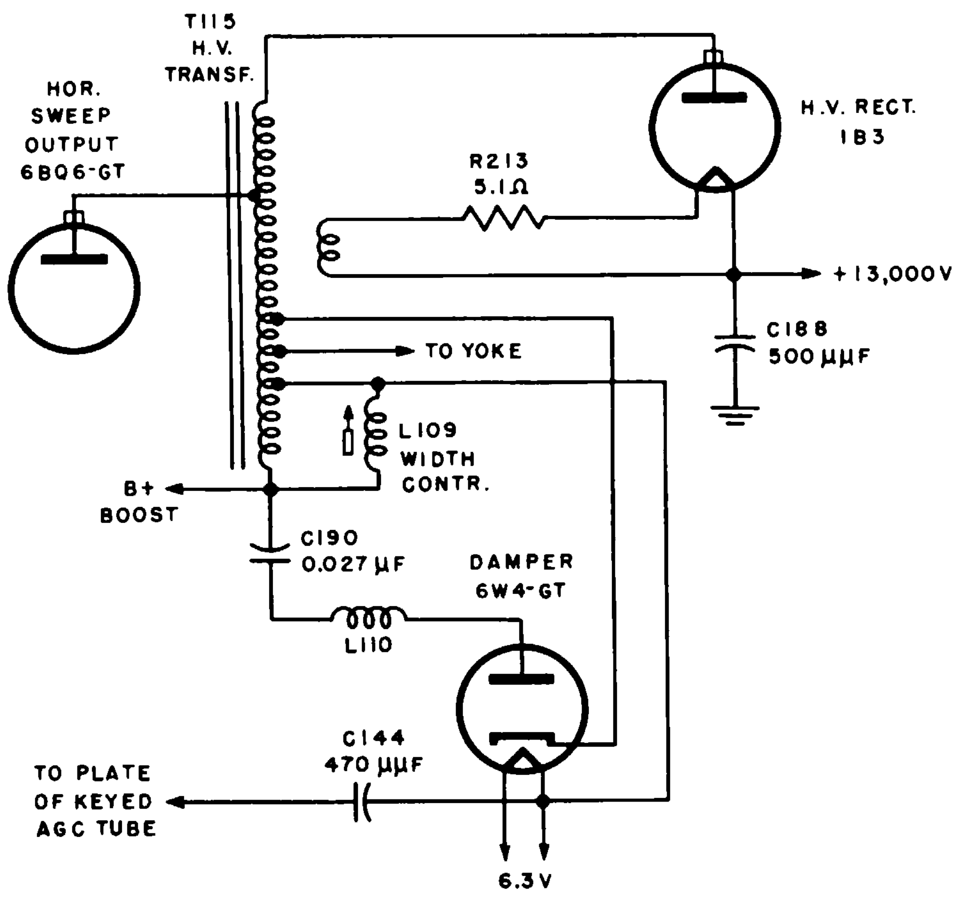


Fig. 5-7. Partial schematic of a horizontal section. *After RCA Service Co.*

ANS. Capacitor *C144*, which couples positive pulses from the horizontal output transformer to the plate of the keyed agc tube, is defective. Check and replace if necessary.

DISCUSSION. As a rule, if the receiver operates normally for a period of time and then starts to function improperly, the trouble is caused by an accumulation of heat in the cabinet. Thus it should be remembered that when a chassis exhibiting this general type of symptom is removed from the cabinet the trouble may not readily appear, because air circulation is better with the chassis out of the cabinet. To increase the ambient temperature at the chassis, a heat lamp focused on the chassis (or a cardboard box placed over the chassis) is frequently used. Another method that proves of great value involves the use of a soldering iron. The tip of the heated iron is placed beneath (or close to) each component in the suspected section of the receiver, and held there for a short time. When the iron is placed near the defective component, the part will generally break down and the symptom of trouble will then be noted.

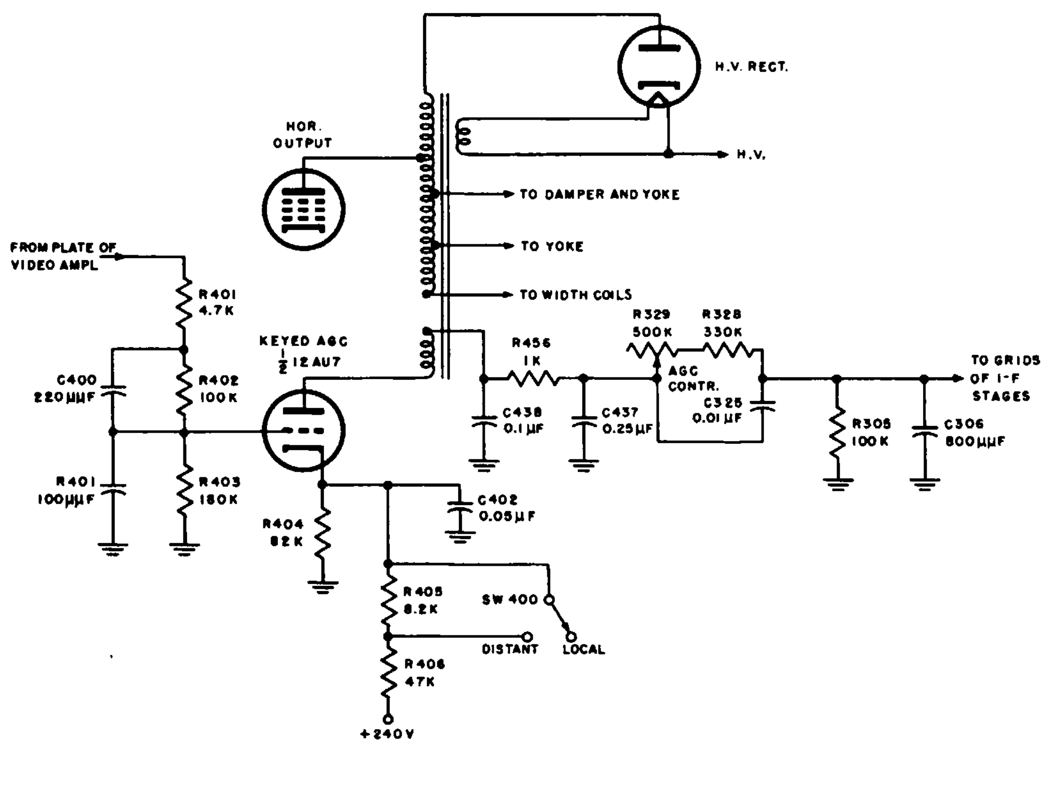


Fig. 5-8. Second example of a keyed-agc circuit. ***After Westinghouse Electric Co.***

QUES. 5-8. The picture is overloaded (excessive contrast and poor sync) on all channels. Adjusting the agc control *(R329* in Fig. 5-8) or the local-distant switch *(SW400* in Fig. 5-8) has no effect. The agc, r-f, and i-f tubes are checked and found

to be good. A voltage check at the grid of the first video i-f stage indicates that —.5 volt, rather than the —3 or —4 volts expected, is present. In a typical keyed agc circuit, such as that shown in Fig. 5-8, what is the next step that might be attempted?

ANS. Because the keyed agc circuit is dependent for its operation on the pulse taken from the horizontal output transformer, this pulse should be checked. Connect the vertical input of a scope, set to a

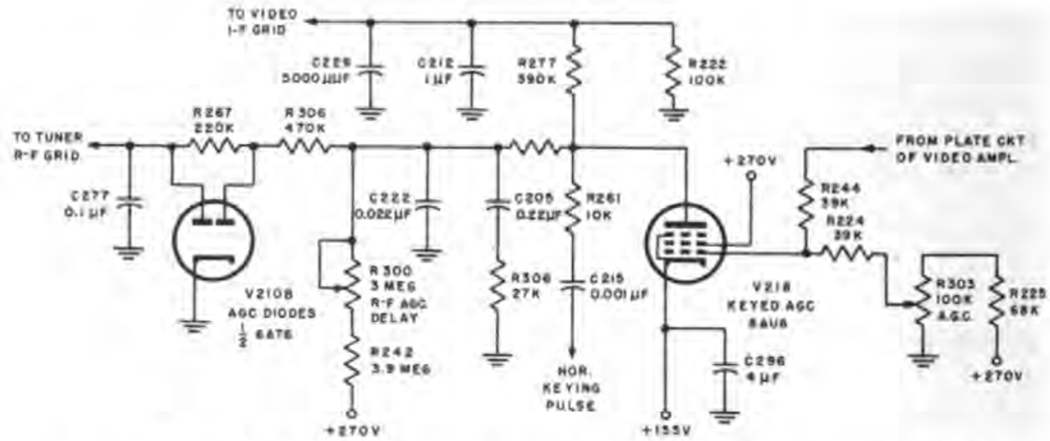


Fig. 5-9. Keyed-agc circuit that feeds r-f and i-f grids. ***After Allen B. DuMont Labs.***

frequency of 7875 cps, to the plate of the keyer tube. If 15-kc pulses of high amplitude are observed, the trouble is in the keyed agc stage itself. If no 15-kc pulses are observed, trouble is indicated in the pulse take-off winding of the output transformer.

DISCUSSION. When trouble is suspected in the pulse take-off winding of the output transformer, be sure to check for cold or poor solder joints at the winding itself, because these have proved to be a constant source of trouble. Do not replace the output transformer before checking the solder joints.

QUES. 5-9. Horizontal black and white bars (approximately 40 of them) appear superimposed over the picture. The bars are not affected by the receiver sound in any manner, and seem to be drifting in a vertical direction. The tuner, video, and agc

tubes are checked and found to be good. What is the probable cause of trouble?

ANS. The agc filter capacitor, *C277* in Fig. 5-9, is open. Check the capacitor and replace if necessary.

DISCUSSION. The above symptom generally occurs when one of the large agc filter capacitors opens. If, in the presence of one of these open capacitors, a scope is used to check the waveform on the agc line, an a-c voltage of rapidly fluctuating amplitude may be observed. Under normal circumstances, any a-c component present on the agc line is bypassed to ground by the filter capacitors.

QUES. 5-10. The picture is overloaded on some channels. The agc tube (*V218* in Fig. 5-9) is checked and is found to be good. The agc control (*R303*) is adjusted but no effect on the picture is noted. In the circuit illustrated in Fig. 5-9, what is a probable cause of trouble?

ANS. Capacitor *C215,* a coupling capacitor, is open. Check and replace if necessary. (This particular capacitor has a voltage breakdown rating of 2000 volts. Do not replace it with a capacitor of lower rating.)

DISCUSSION. In order to permit the keyed agc tube to conduct for only a short period of time (so that noise voltage and video amplitude variations will not have a radical effect on the agc level), the tube normally is biased to cutoff. However, when a positive high-voltage pulse from the horizontal output transformer is applied to the plate of the keyed agc tube, the tube is forced into momentary conduction, and agc bias is produced. Since pulses are fed back from the horizontal output transformer at 15,750 cps, the tube conducts at this frequency.

The pulses from the output transformer are coupled through capacitor *C215* to the plate of the keyed agc tube. If this capacitor opens, no positive pulses are applied to the tube, the tube does not conduct, and no agc voltage is produced. As a result, picture overload occurs.

QUES. 5-11. When servicing keyed agc circuits, what rapid voltage check may be made to determine whether any agc trouble is caused by defects in the filter network or in the i-f stages to which the agc voltage is applied?

ANS. Measure the d-c plate voltage of the keyed agc tube, and the d-c grid voltage of the first i-f stage. The ratio between these voltages should be in the order of 3.5 to 1. If the ratio is lower, trouble should be suspected in the i-f stages to which the agc voltage is being applied. If the ratio is greater than 3.5 to 1, trouble should be suspected in the agc filter network.

DISCUSSION. As an example of how variations in this ratio may arise, if the grid of an i-f tube draws current, the grid voltage may become more negative. As a result, the ratio, as discussed above, will decrease below 3.5 to 1.

QUES. 5-12. When servicing a keyed agc circuit, a peak-to-peak voltage of 330 volts is indicated on the plate of the agc tube. Can an ordinary vtvm be used to measure this voltage?

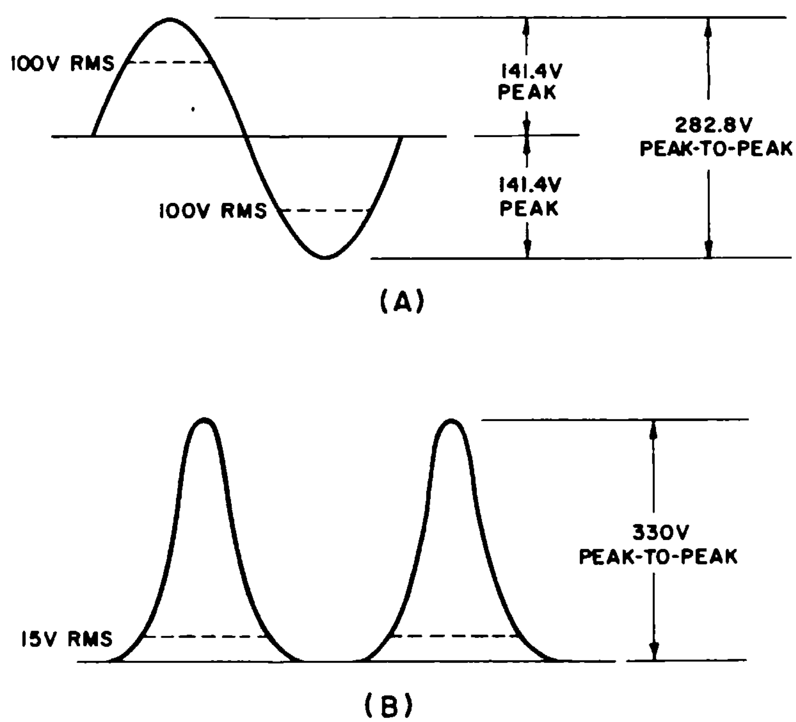


Fig. 5-12. (A) Peak-to-peak value of sine wave voltage. (B) Peak-to-peak value of pulsed waveform.

ANS. No, the peak-to-peak voltage of a complex waveform cannot be measured accurately by means of a vtvm. Measurement of a non-sinusoidal peak-to-peak voltage requires the use of a calibrated scope or a calibrated peak-to-peak vtvm.

DISCUSSION. When measuring a sine wave, such as that illustrated in Fig. 5-12(A), with a conventional vtvm, the a-c indication obtained on the meter is the rms value of the voltage. The rms voltage, multiplied by 1.414 and then doubled, gives the peak-to-peak voltage of the sine wave.

In the case of the pulsed waveform shown in Fig. 5-12(B), however, multiplying the rms voltage by 1.414 and then by two, gives a completely erroneous idea as to the peak-to-peak voltage. Thus the method cannot be used for determining the peak value of this type of waveform.

Chapter 6

QUESTIONS AND ANSWERS ON VERTICAL OUTPUT STAGES

QUES. 6-1. What are some of the effects produced by defective components in the vertical output stage of the receiver?

ANS. Some of the symptoms, and their causes, produced by improper functioning in the vertical output stage (Fig. 6-1) are listed in Table 6-1.

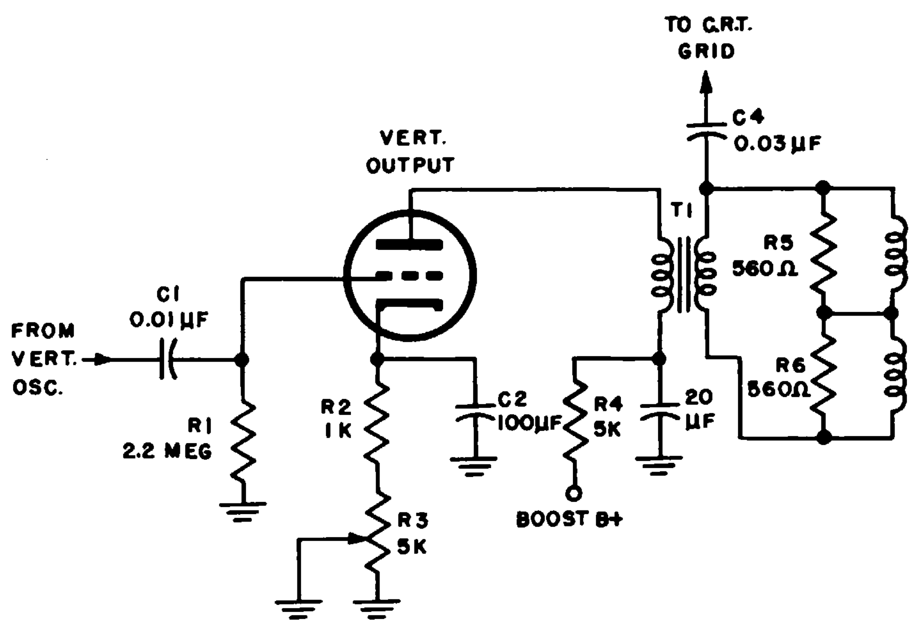


Fig. 6-1. A typical vertical-output stage.

TABLE 6-1

Component	Function	Defect	Symptom
C1	Coupling capacitor	Open	Thin white horizontal line.
		Leaking or shorted	Foldover at bottom of picture.
C2	Cathode bypass capacitor	Open	Decreased height.
		Leaking or shorted	Increased height, foldover
R2	Minimum cathode bias resistor	Increased value	Decreased height, vertical nonlinearity
		Decreased value	Increased height, vertical nonlinearity.
R3	Vertical linearity control	Open	Thin white horizontal line.
T1	Vertical output transformer	Shorted turns	Decreased height.
		Open	Thin white horizontal line.
R5, R6	Damping resistors	Open	Picture ringing.
		Decreased value	Keystoning.
C4	Retrace blanking coupling capacitor	Open	Vertical retrace lines visible.
		Leaky or shorted	Excessively bright or dark picture.

DISCUSSION. Troubles in the vertical deflection circuit are generally not too difficult to locate, because a distinct visual representation of the trouble can be observed on the picture tube. The observed symptom, used in conjunction with conventional voltage and resistance checks, generally leads to rapid location of the defect.

QUES. 6-2. When servicing the vertical section of the receiver, what general deductions may be made based upon the symptoms observed?

ANS. When vertical foldover at the bottom of the picture is observed (Fig. 6-2A), the source of trouble is probably located in the biasing circuit of the vertical output stage. Check for a gassy tube, defective grid or cathode resistors, faulty cathode bypass capacitor, or leaky coupling capacitor connected to the grid of the output stage.

When vertical foldover at the top of the picture is noted (Fig. 6-2B), trouble is indicated in the vertical integrating circuit. Check for defective capacitors or resistors.

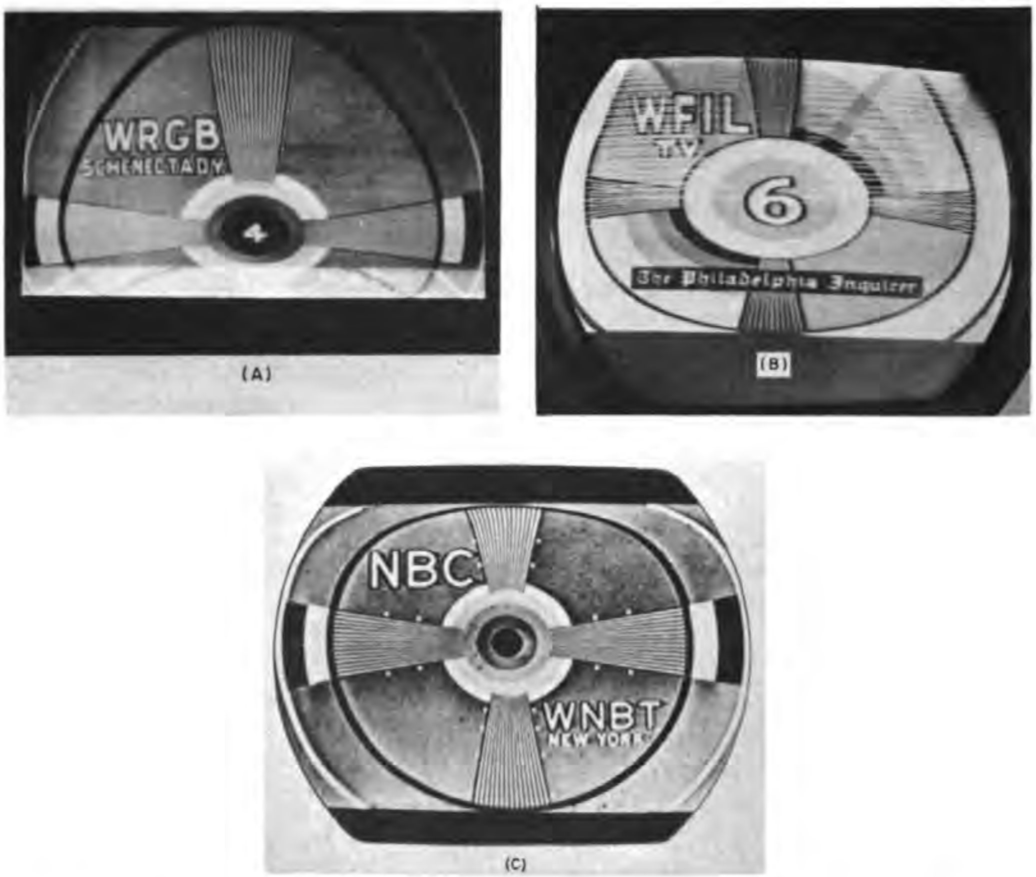


Fig. 6-2. (A) Vertical foldover at the bottom of the picture. *Courtesy General Electric Co.* (B) Vertical foldover at the top of the picture. *Courtesy RCA Service Co.* (C) Insufficient height, poor linearity. *Courtesy RCA Service Co.*

When the height is insufficient and the linearity is poor (Fig. 6-2C), check for defective components in the plate circuit of the vertical oscillator stage. Also check for a defective peaking resistor or sawtooth-forming capacitor.

When the height is insufficient but the linearity is good, check for faulty cmponents in the plate circuit of the vertical output stage.

DISCUSSION. As a rule, trouble in this section of the receiver is not difficult to locate. If the symptoms indicated above do not localize the trouble, conventional scope waveform checks and voltage and resistance measurements will normally disclose the source of the improper functioning.

QUES. 6-3. Vertical foldover is observed at the bottom of the picture. The vertical tube (a single twin triode tube is used for vertical oscillator and output, Fig. 6-3) is checked and found to be good. Because the coupling capacitor between the

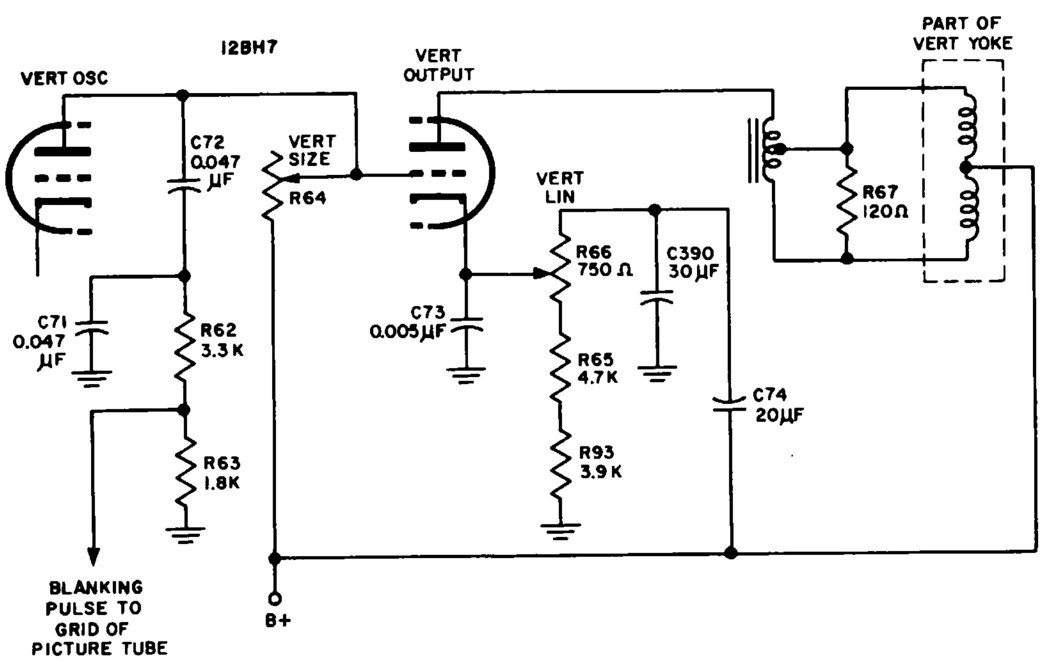


Fig. 6-3. Direct-coupled vertical-sweep section. *After Motorola Inc.*

vertical oscillator plate and the vertical output grid is a frequent offender, the circuit is checked for this capacitor, but the capacitor cannot be found (Fig. 6-3). What is the probable cause of trouble?

ANS. Vertical foldover in a circuit such as that illustrated in Fig. 6-3 can be caused by a shorted vertical size control, *R64*. Check, and replace if necessary.

DISCUSSION. In the direct-coupled circuit of Fig. 6-3, the grid of the output stage is prevented from going positive during normal operation by the vertical size control, which has a 1-megohm stop. However, if an internal short occurs in this control, a B+ voltage is applied to the grid, and foldover occurs.

QUES. 6-4. The vertical stability is poor, as evidenced by vertical jitter and bounce. The vertical tubes are checked and found to be good. A scope check at the grid of the output stage indicates that a stable voltage is present at this point, while the waveform observed at the plate of the output stage jitters and is generally unstable. What is the probable cause of trouble?

ANS. Vertical jitter and instability can be caused by arcing between the primary and secondary of the vertical-output transformer. Since this arcing is internal and cannot be seen, test replacement of the output transformer is recommended as a checking procedure.

DISCUSSION. Another cause of vertical jitter is poor bypassing of the vertical output plate supply. Placing a scope on the plate supply line should produce only a small amount of a-c voltage on the scope. However, if a large a-c voltage is evident, check the bypass capacitors as a probable cause of trouble.

When replacing a defective vertical output transformer, use an identical part, if available, or a replacement part specified by the manufacturer. Replacement of the output transformer with an incorrect one may not produce any immediate symptoms; the receiver may operate in what appears to be a normal fashion, but excessive plate current may flow and cause the vertical output tube or output transformer to become defective within a short period of time.

QUES. 6-5. The picture collapses to a thin white vertical line, intermittently. The vertical deflection tubes (*V216B* and *V212* in Fig. 6-5) are checked and found to be good. In the circuit illustrated in Fig. 6-5, what is the probable cause of trouble?

ANS. Capacitor *C259*, in the plate circuit of the output tube in Fig. 6-5, is shorting intermittently. Check the capacitor, and replace if necessary.

DISCUSSION. In many modern receivers, voltages are fed back from the plate circuit of the vertical output stage or from the secondary of the output transformer (as in the circuit illustrated in Fig. 6-5) to sustain the vertical oscillators. Those capacitors which are directly concerned with the feedback process have transient voltages applied to them of high amplitude. As a result, these capacitors, although of relatively high breakdown ratings (*C263* has a rating of 1000 volts and *C259* of 2000 volts), frequently become defective. Good servicing procedure requires that these capacitors be kept in mind as likely rauses of trouble.

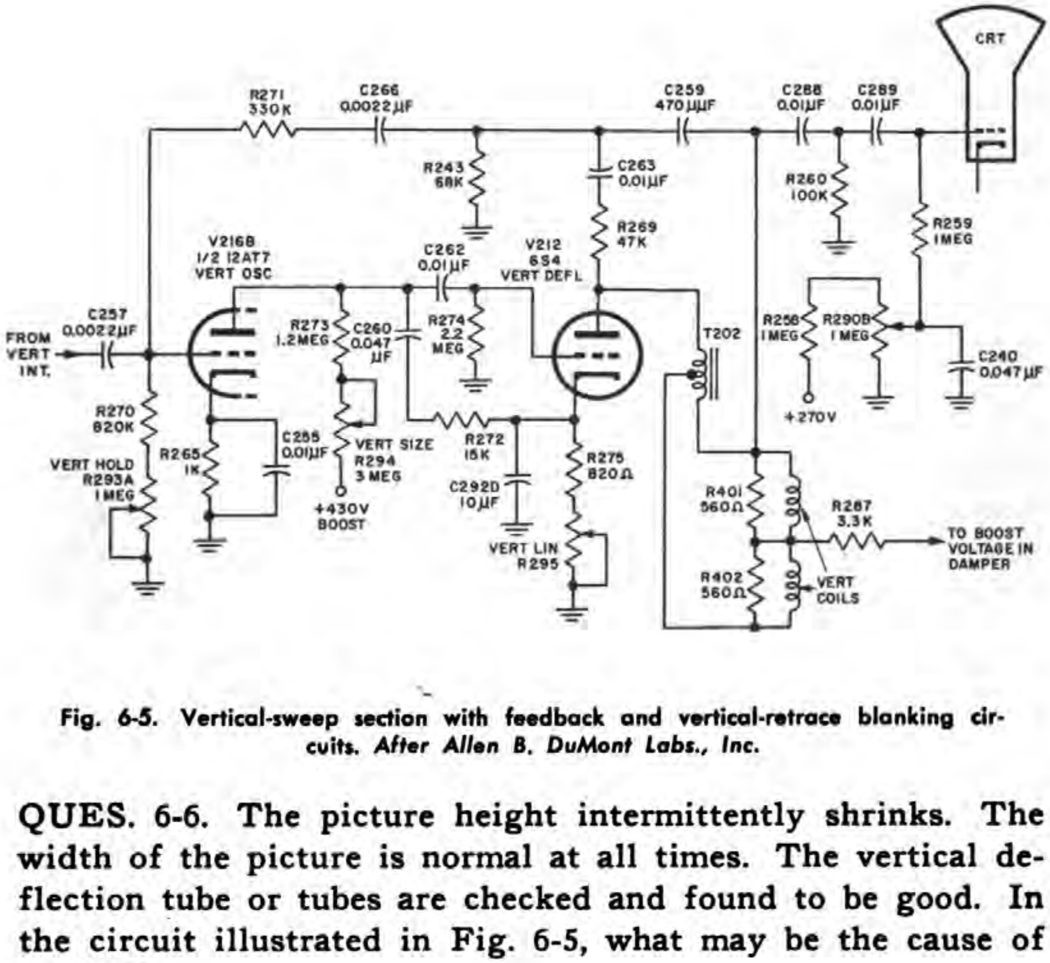


Fig. 6-5. Vertical-sweep section with feedback and vertical-retrace blanking circuits. ***After Allen B. DuMont Labs., Inc.***

QUES. 6-6. The picture height intermittently shrinks. The width of the picture is normal at all times. The vertical deflection tube or tubes are checked and found to be good. In the circuit illustrated in Fig. 6-5, what may be the cause of trouble?

ANS. Check resistor *R287,* connecting to the yokes in Fig. 6-5. Intermittent breakdown of this resistor will affect the vertical height without affecting the width.

DISCUSSION. Since the plate voltage for the vertical output stage is fed from the boost circuit in many receivers, the damper tube and its associated components should not be neglected in the event of height troubles. In the symptoms given above, the damper tube and the boost capacitors (common causes of trouble in this section of the receiver) were eliminated as suspects because the picture width was normal.

QUES. 6-7. Intermittently, no vertical deflection is evident on the picture tube; a thick white horizontal line appears across the center of the picture tube when the set is not operating properly. The vertical deflection tubes are checked and found to be good. Using a scope isolates the trouble to the vertical output stage, but each time a voltmeter is used to check the voltage in the vertical output stage the raster reappears. All resistances appear to be normal. What is the probable cause of trouble?

ANS. The vertical output transformer is probably defective, especially if it has a separate primary and secondary. Check the transformer by test substitution, and replace if necessary.

DISCUSSION. When checking resistances in the vertical deflection circuit in an attempt to locate the cause of trouble, always check the resistance between primary and secondary of the vertical output transformer. Leakage often develops between primary and secondary of the transformer, resulting in a decreased vertical deflection. When leakage is present, it should be noted that the primary and secondary resistances of the transformer will still measure correctly.

QUES. 6-8. The horizontal width is insufficient. The horizontal oscillator and output tubes are checked, found to be weak, and are replaced. It is now observed that the height of the raster, while previously normal, is now insufficient to fill the picture tube in the vertical direction. What is the probable cause of trouble?

ANS. When the horizontal deflection tubes are functioning at peak performance, the amount of high voltage produced may be such as to produce a "stiff" electron beam in the picture tube; i.e., the beam of electrons, moving at a high velocity because of the high voltage, will be difficult to deflect. Thus the vertical size of the raster may be insufficient. In a situation of this type, check the vertical linearity and height control settings, and check the vertical deflection tubes as well. Readjust the control setting and replace tubes, if necessary.

DISCUSSION. Tube replacement in the horizontal deflection section of the receiver should only be made with those tubes for which the set is designed. Clearing up a width problem by substituting a 6CD6 for a 6BG6, for example, is never recommended, because of the additional strain placed on the circuit by a substitution of this nature. It should always be remembered that, in the great majority of receivers, the horizontal deflection signal also is used to produce the high voltage applied to the anode of the picture tube. Thus any circuit modification that affects the sweep signal must also affect the magnitude of high voltage produced.

QUES. 6-9. Vertical retrace lines are visible on the picture tube, in a weak signal area. How can the retrace lines be eliminated?

ANS. A vertical blanking network, such as that illustrated in Fig. 6-9(A) and 6-9(B), should be added to the circuit to eliminate vertical retrace lines. When properly connected, the blanking network blanks out the retrace lines so that they are not visible at any time.

DISCUSSION. When adding a vertical blanking network to a receiver, three components are generally used—two resistors and one capacitor. The capacitor should be about .02μf. One of the resistors should be 100 k ohms, and the second resistor should be selected by trial and error as explained below.

To add vertical blanking to a receiver, proceed as follows:

a. In those receivers where the video signal is fed to the grid of the crt:

1. Connect the .002-μf capacitor to the plate of the vertical output tube.
2. Connect the 100-k ohm resistor between the open end of the capacitor and the cathode of the picture tube.

3. Break into the cathode circuit and connect a 100-k ohm potentiometer in series with the cathode, as shown in Fig. 6-9(A).
4. With the receiver turned on, and the brightness turned up beyond its normal setting, vary the 100-k ohm potentiometer until the retrace lines are no longer visible.
5. Turn the receiver off, and measure the resistance placed in the circuit by the potentiometer. Connect a resistor of this resistance value into the circuit at this point.

b. In those receivers where the video signal is fed to the cathode of the crt:

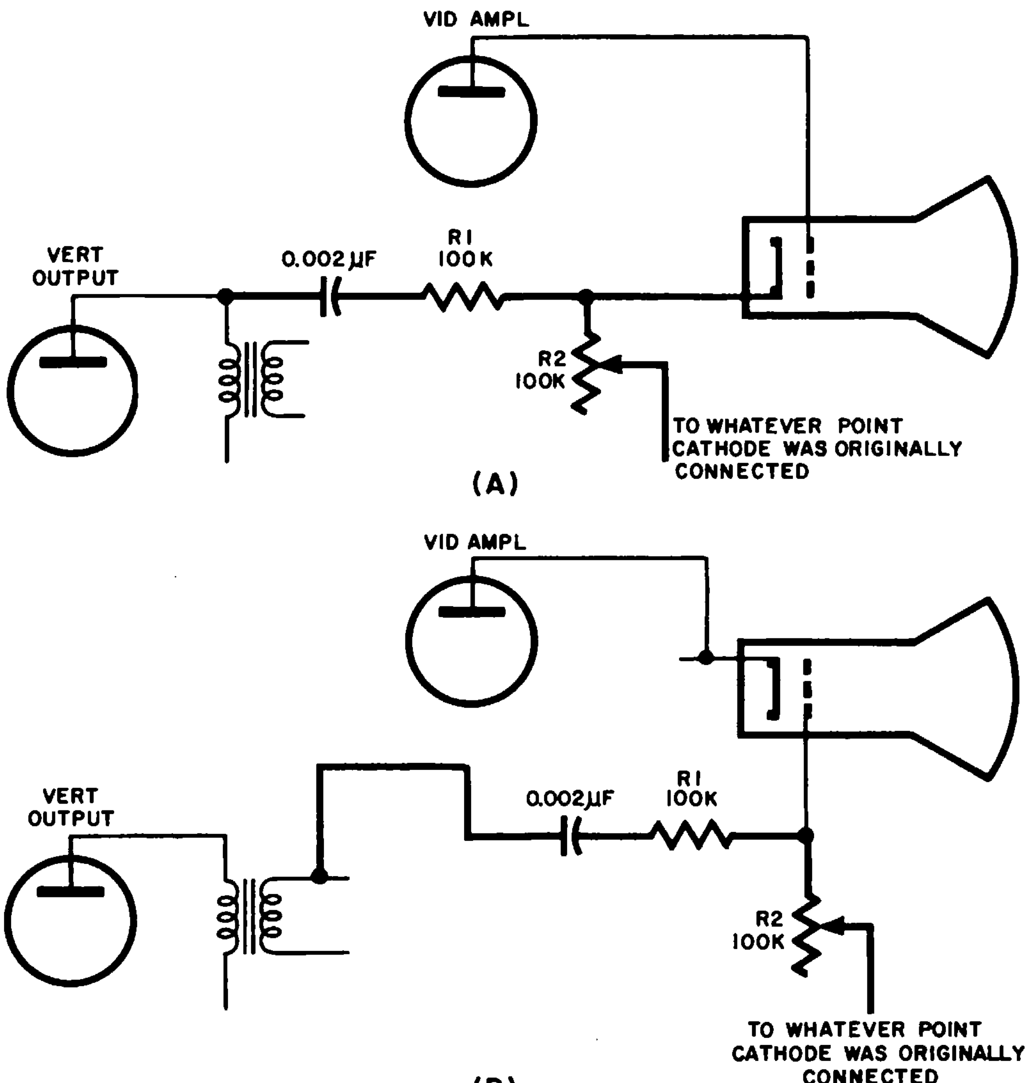


Fig. 6-9. Connecting a vertical-blanking network into a receiver. (A) Connection when video is fed to the grid of the crt. (B) Connection when video is fed to the cathode of the crt.

1. Connect the .002-μf capacitor to the high potential side of the secondary of the vertical output transformer.
2. Connect the 100-k ohm resistor between the open end of the capacitor and the control grid of the picture tube.
3. Break into the grid circuit and connect a 100-k ohm potentiometer in series with the grid, as shown in Fig. 6-9(B).
4. With the receiver turned on, and the brightness control turned up beyond its normal setting, vary the 100-k ohm potentiometer until the retrace lines are no longer visible.
5. Turn the receiver off, and measure the resistance placed in the circuit by the potentiometer. Connect a resistot of this resistance value into the circuit at this point.

Although the above methods will work in a great majority of receivers, on occasion the receiver's circuit constants require that the suggested component values be changed somewhat for proper operation of the blanking network. Furthermore, some experimenting may be necessary to determine the most favorable take-off point at the vertical output transformer for the blanking pulse.

QUES. 6-10. A vertical retrace blanking circuit has been added to a receiver, as described in the answer to *QUES. 6-9.* Although the retrace lines are now blanked, two or more vertical bars appear at the left side of the picture. What is the probable cause of trouble?

ANS. Vertical bars that appear after a vertical-blanking circuit has been added to a receiver indicate that the amplitude of the blanking signal is too large. Increase the value of the series resistor (*R1* in Fig. 6-9) and decrease the value of the return resistor (*R2*).

DISCUSSION. As indicated in the answer to *QUES. 6-9,* it is occasionally necessary to modify the recommended values of circuit components to get the retrace blanking network to function properly. However, it is not recommended that radical changes be made in the circuit components at any time; change the values in small steps, and observe the results each time.

QUES. 6-11. The picture brightness is low. Rotating the brightness control has little effect on the picture. The con-

trast control must be turned to maximum to observe a picture, and retrace lines are clearly visible at this time. The picture tube is checked and found to be good. In the circuit illustrated in Fig. 6-5, what is the probable cause of trouble?

ANS. Capacitor *C289,* in the vertical retrace blanking circuit at the picture tube grid of Fig. 6-5, is shorted or leaking. Check the capacitor and replace, if necessary.

DISCUSSION. Because of the symptoms of lack of brightness, poor contrast, and visibility of retrace lines, servicing the receiver illustrated in Fig. 6-5 would almost of necessity start at the grid of the picture tube, once the technician had satisfied himself that tube trouble could not be the cause of the symptoms. If *C240* in the grid return circuit of the picture tube were checked and found to be good, *C289* would be the next to be checked. It is quite obvious from an examination of the schematic that if *C289* did short, the grid circuit would be grounded through resistor *R260*. Thus no positive potential could be applied from the arm of the brightness control to the crt control grid. Brightness would have to become low, and retrace lines would have to be visible, since *C289* is in the retrace blanking circuit.

QUES. 6-12. Vertical foldover is observed at the bottom of the picture. The vertical deflection tubes are checked and found to be good. Using a vtvm to measure the grid voltage of the output stage indicates that a positive voltage is present at the grid, but clipping the coupling capacitor that connects to the grid does not eliminate the positive voltage. What is the probable cause of trouble?

ANS. Leakage has probably developed between successive lugs on the terminal board to which the grid is connected. Check the terminal board, and replace if necessary.

DISCUSSION. Some of the most difficult troubles to isolate are those in which the insulation between lugs on a terminal board (or base pins on a vacuum tube) break down. The reason for the difficulty usually lies in the fact that the technician too often does not recall that such a possibility exists and may frequently occur. When servicing a receiver, it is desirable to check for the common causes of trouble, but the more obscure causes, such as insulation leakage, should not be overlooked.

Chapter 7

QUESTIONS AND ANSWERS ON DEFLECTION YOKES AND SYSTEMS

QUES. 7-1. What are some of the ways in which deflection yokes may become defective?

ANS. Some of the possible faults that may arise in deflection yokes are:

a. Shorted turns in either the vertical or horizontal deflection coil.
b. Open windings in either the vertical or horizontal deflection coil.
c. Shorts between the horizontal and vertical deflection coils.
d. Shorts between the horizontal and vertical deflection coil and the yoke core.
e. Faulty damping network or balancing components.

DISCUSSION.

a. When shorted turns are present in a deflection coil, a keystone picture will be evident on the screen. The type of keystone effect (Fig. 7-1, A and B) will be determined by whether the vertical or the horizontal deflection coil has the shorted turns. The effect shown in Fig. 7-1(A) indicates shorted turns in the horizontal windings; the type of keystoning shown in Fig. 7-1(B) is the result of shorted turns in the yoke's vertical windings.

b. When an open winding occurs in the vertical deflection coil, a thin white horizontal bar appears on the picture tube (Fig. 7-1C). The visible effect of an open winding in the horizontal deflection coil depends upon the type of high-voltage power supply used in the receiver. If a conventional flyback-type of high-voltage supply is used, an open in the horizontal

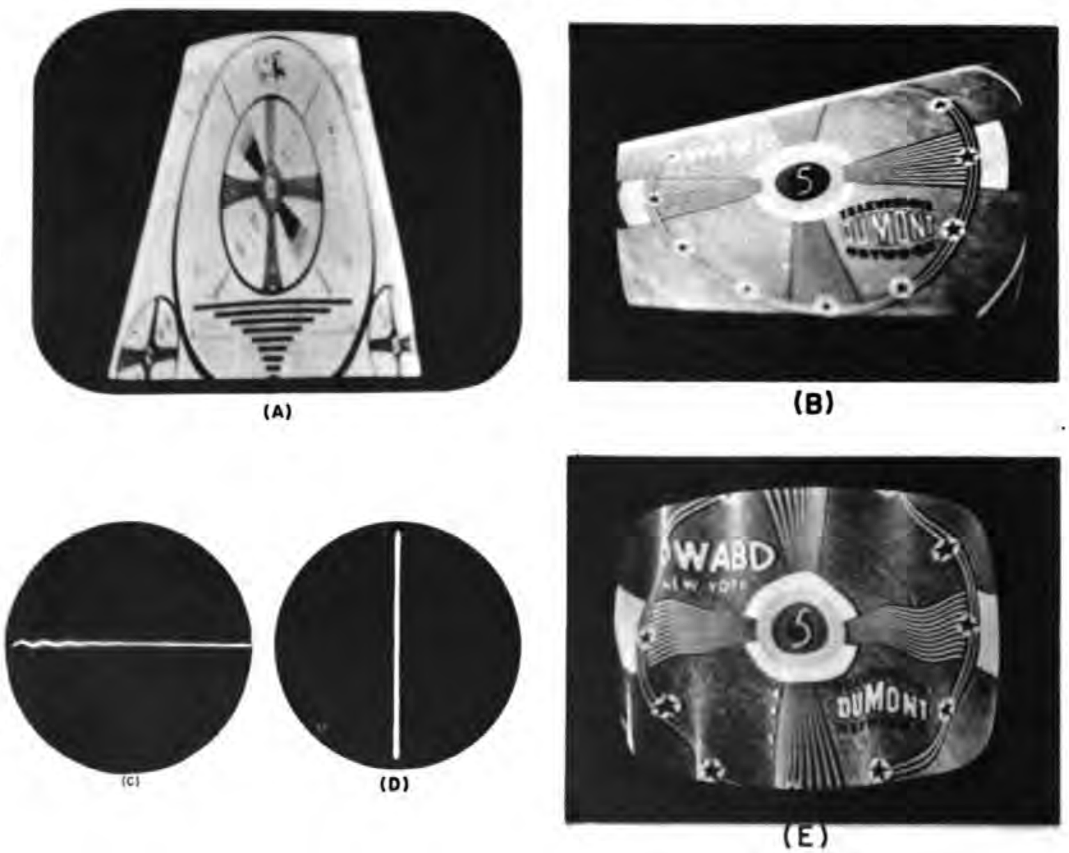


Fig. 7-1. Horizontal keystone effect. *Courtesy General Electric Co.* (B) Vertical keystone effect. *Courtesy Allen B. DuMont Labs.* (C) No vertical deflection. *Courtesy RCA Service Co.* (D) Lack of horizontal deflection in the presence of an r-f high-voltage power supply. (E) Cross-talk in picture. *Courtesy Allen B. DuMont Labs.*

deflection coil may result in a decrease in high voltage, and a subsequent lack of raster on the picture tube. If there is an r-f high-voltage power supply in the receiver, an open in the horizontal deflection-coil is evidenced by a thin white vertical bar on the picture tube (Fig. 7-1D).

c & d. A short circuit in a deflection yoke, regardless of whether it is between the coils or between a coil and the core, causes an excessive current to be drawn from the power supplies.

As a result, high voltage is generally lost, and the low voltage decreases. Frequently the low-voltage rectifier plates become cherry red, causing the tube to burn out in a short period of time.

e. Faulty damping components (usually damping resistors across the vertical deflection coil) or a faulty balancing component (usually a capacitor across one-half of the horizontal deflection coil) produce ringing or crosstalk in the picture (Fig. 7-1E). To check for these defective components, unsolder one end of the suspected part and check it with an ohmmeter or capacity checker.

QUES. 7-2. When checking deflection yokes with an ohmmeter, are there any typical resistance values that may be expected?

ANS. When using an ohmmeter to check a deflection yoke, there is no such thing as a typical value that will cover all of the yokes used today. Use only those resistance values specified in the manufacturer's service notes. In case of doubt as to the yoke's condition, test replacement is recommended.

DISCUSSION. An idea of why it is difficult to assign a "typical" value to the resistances may be obtained by examining various yokes in use today. Horizontal windings have a d-c resistance ranging from 12 ohms to 45 ohms; the resistances of vertical windings range from 3.5 ohms to 65 ohms. Thus it is obvious that "typical" value has no meaning with respect to the resistances of yoke windings.

Open windings, and the checks for them, are discussed in the answer to *QUES. 7-3.*

QUES. 7-3. When checking for an open winding in a deflection yoke, what procedure should be followed?

ANS. To check for an open winding in a *vertical deflection coil*:

a. Disconnect one end of the vertical windings of the coil.
b. Set an ohmmeter to a low range.

c. Connect the ohmmeter across the vertical deflection coil. The resistance measured will generally be between 35 and 65 ohms. An open vertical winding will be indicated by an infinite resistance reading.

To check for an open winding in a *horizontal deflection coil,* follow a procedure similar to that given above for the vertical windings. The horizontal deflection coil resistances measured will generally be between 12 and 45 ohms. (It should be noted that a capacitor

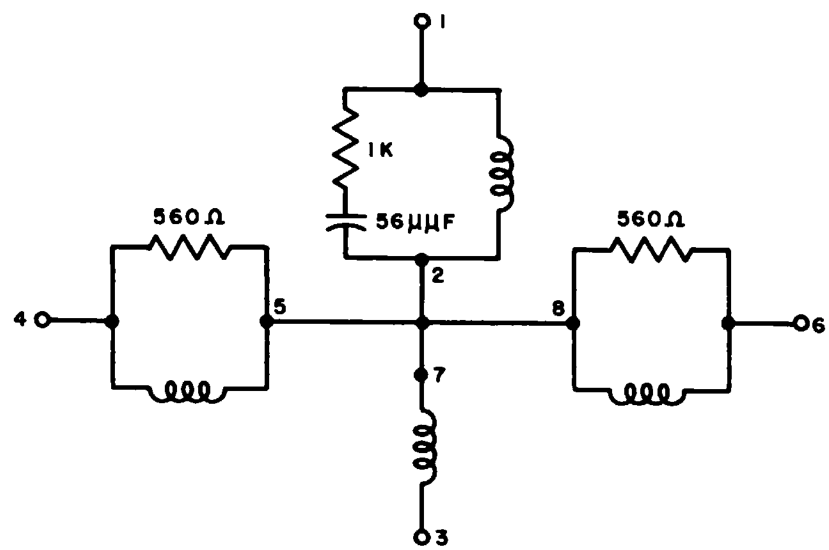


Fig. 7-3. Schematic of a typical deflection yoke used in modern receivers.

is frequently in series with the return lead of the horizontal deflection coil. If this capacitor is present, one end of the horizontal deflection coil need not be opened to check the coil, as the ohmmeter can be placed directly across it.)

DISCUSSION. Figure 7-3 illustrates the schematic of a typical deflection yoke, such as is used in many modern receivers. The 1-k ohm resistor in series with the balancing capacitor is not found in all yokes. When it is present, its function is that of a damping resistor.

QUES. 7-4. When replacing a defective yoke with another, it is discovered that the horizontal damping components (the 56-$\mu\mu$f capacitor and the 1-k ohm resistor in Fig. 7-3) are present

in the yoke but are not soldered into place. How should these components be connected into place?

ANS. To connect the horizontal damping components into place properly, first determine whether the horizontal output transformer is of the conventional transformer type (separate primary and separate secondary windings) or of the autotransformer type (direct drive). If the transformer is conventional, connect the high-potential side of the secondary to terminal *1* of the yoke, and the low-potential side, or return, to terminal *3* of the yoke (Fig. 7-3). Then connect the horizontal damping network between terminals *1* and *2* of the yoke.

If, however, the horizontal output transformer is of the autotransformer variety, connect that portion of the autotransformer which is at the highest sweep potential to terminal *3* of the yoke, and the low potential, or return, side to terminal *1* of the yoke. Then connect the horizontal damping network between terminals *3* and *7*.

DISCUSSION. When connecting the vertical winding of the yoke into the circuit, a trial and error procedure is generally observed for locating the proper polarity. To prevent loss of time by this method, follow the procedures outlined in the answers to *QUES. 7-5* and *7-6*.

QUES. 7-5. When replacing a defective yoke, it is discovered that the lead colors of the replacement yoke do not match the lead colors of the original. If the windings of the defective yoke are not completely open, how may the lead windings be matched to provide a normal picture without any trial and error process?

ANS. To match the leads between original and replacement yoke, some technicians observe the following procedures:

a. Place the yokes next to each other on the work bench, and in the same general position.
b. Place a small piece of cardboard or wood across the yokes, and set a small compass on top of the cardboard (Fig. 7-5).
c. Connect a 1-1/2-volt dry cell (or two 1-1/2-volt cells in series) to the horizontal windings of the original defective yoke. Position the compass over the deflection yoke and observe the direction in which the compass needle points.

d. Connect the 1-1/2-volt dry cell, with the same relative polarity as in step *c* above, to the horizontal windings of the new yoke. Position the compass so that it is over the new yoke. The lead windings of the replacement yoke are chosen in the correct fashion when the direction in which the compass needle now points is the same as observed with the original yoke in step *c* above.
e. Repeat these procedures with the vertical windings of the old and new yokes.

DISCUSSION. As an example of the above procedure, assume that the original horizontal windings are coded with red and yellow leads, and the vertical windings are coded with black and green leads. Also

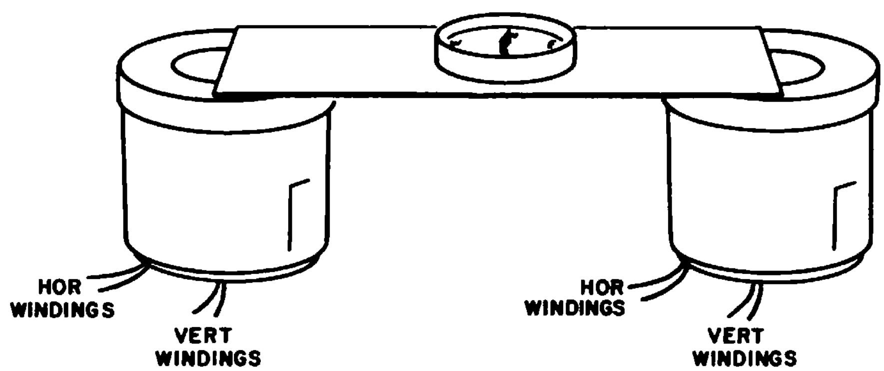


Fig. 7-5. Matching the leads of an original yoke to the leads of a different color-coded replacement yoke.

assume that the new yoke has horizontal leads of blue and blue-red and vertical leads of white and white-red. If, when testing the horizontal windings, connecting the negative side of the battery to the yellow lead of the original yoke and the positive side to the red lead produces the same compass deflection as connecting the negative side of the battery to the blue lead of the replacement yoke, and the positive side to its blue-red lead, the yellow original corresponds to the blue replacement, and the red original corresponds to the blue-red replacement. The same method, of course, may be used for the vertical matching.

QUES. 7-6. A defective yoke (one of the windings open) is replaced by another. After the connections are made and the

receiver turned on, it is not known whether the horizontal connections are reversed, since there is no obvious indication on the observed picture (such as lettering). How can the horizontal connections be checked rapidly for correct or reversed polarities?

ANS. To check the polarity of the horizontal section of a replacement yoke that is connected into the circuit, turn down the contrast and turn up the brightness so that the vertical retrace lines are clearly

Fig. 7-6. Proper slant of vertical-retrace lines.

visible. If the horizontal connections are correct, the vertical retrace lines should be diagonal lines that run from the lower left portion of the picture to the upper right section, as shown in Fig. 7-6.

DISCUSSION. If a picture can be observed on the picture tube, the polarity of the vertical leads can be readily checked—if the picture is right side up, the vertical polarity is correct; if the picture is upside down, the vertical leads should be reversed.

When, however, no picture is present on the screen, check the vertical connections by manipulating the vertical linearity control. Improper adjustment of this control will bunch or expand the retrace lines in the upper half of the picture in most sets. If the improper adjustment of this control affects primarily the lower half, reverse the vertical connections.

Another method of checking for the vertical polarity involves varying the vertical hold control until the vertical blanking bar is visible. When the vertical winding is connected properly, the blanking pulse on the bar will appear toward the top of the bar.

QUES. 7-7. When replacing an ordinary yoke by a replacement cosine deflection yoke, what effect may be observed?

ANS. The use of a cosine-wound yoke in place of an ordinary yoke may produce a noticeable pincushion on the raster (bowing in along the edges of the raster, Fig. 7-7A). Use corrector magnets to compensate for, and to eliminate the pincushion effect.

(A)

(B)

Fig. 7-7. (A) Pincushion effect, with height and width reduced to make effect more noticeable. (B) Location of anti-pincushioning magnets. *Courtesy General Electric Co.*

DISCUSSION. Pincushion effect is frequently produced as the result of an impedance mismatch between the horizontal output transformer and the deflection yoke. Thus, in the case of stubborn pincushioning noticed after the replacement of a defective yoke, check the new yoke to see whether it is the proper yoke for a match with the horizontal output transformer.

In many receivers that use cosine yokes, two anti-pincushioning magnets are mounted on the picture tube mounting brackets (Fig. 7-7B). These magnets are inserted so that they may be moved forward or backward to permit proper adjustment. The adjustment of the magnets is made by moving the raster so that first one edge and then the other is seen.

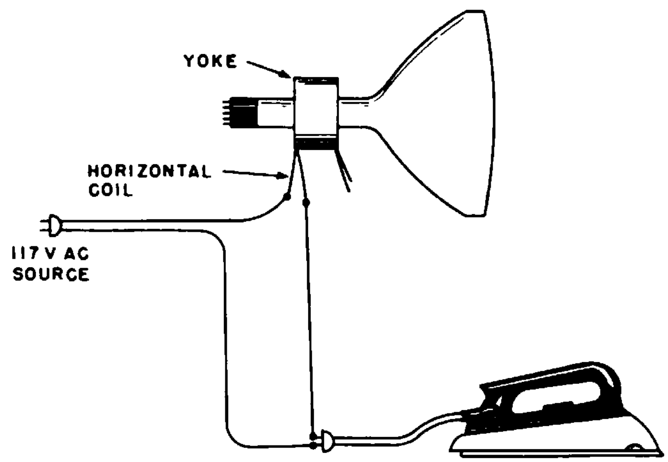


Fig. 7-8. Removing a deflection yoke that is stuck to the neck of a picture tube.

QUES. 7-8. In attempting to remove the deflection yoke from the neck of the picture tube, it is found that the yoke is tightly fastened to it. It is observed that the cause of this is yoke insulation that has melted and flowed on to the neck of the picture tube, and then hardened to form a tight bond between the yoke and the picture tube. How can the yoke be removed without damaging the picture tube?

ANS. To remove a yoke that is stuck to the neck of a picture tube, observe the following procedure:

a. Disconnect all four deflection yoke leads from the receiver.
b. Apply Lubriplate on the tube neck between the yoke and the base.
c. Set a variable-voltage transformer (or any low-voltage a-c source) to supply 35-volt ac, and connect this potential to the horizontal deflection coil.
d. Allow current to flow through the yoke until the insulation begins to soften; then remove the yoke. Do not keep the ac applied to the yoke for longer than necessary, or damage to the yoke may result.

DISCUSSION. If no variable-voltage transformer is available to aid in the removal of the yoke, apply a 117-volt a-c potential to a series circuit composed of the horizontal deflection coils and an electric iron (or electric heater, etc.), as shown in Fig. 7-8. Again the current flowing through the coil will be sufficient to cause the yoke insulation to melt, so that the yoke can be removed in a very short period of time.

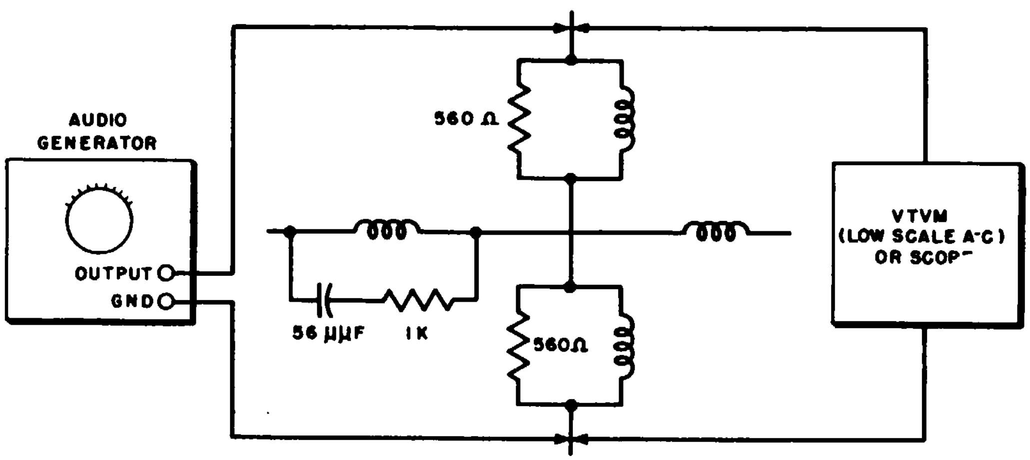


Fig. 7-9. Measuring the resonant frequency of a deflection yoke.

QUES. 7-9. When a deflection yoke is suspected of having a small number of shorted turns that cannot be detected by an ohmmeter check, can a resonant frequency measurement be made to check the soundness of the yoke?

ANS. Yes, checking the resonant frequency can be used to determine whether the yoke is good or bad. In those yokes with vertical coils of inductances between 35 and 50 millihenries, and horizontal coils of inductances between 10 and 20 millihenries, the resonant frequency of the vertical coils is about 8 kc, and the resonant frequency of the horizontal coils is about 85 kc. In those yokes with vertical coils of inductances of 3 millihenries, and horizontal coils of inductances of 30 millihenries, the resonant frequency of the vertical coils is about 50 kc, and that of the horizontal coils is about 75 kc.

DISCUSSION. To check the resonant frequencies of the vertical and horizontal coils of a deflection yoke, observe the following procedure:

a. Disconnect all external leads from the yoke. (Internal damping resistors and crosstalk capacitors need not be removed.)
b. Connect a vtvm (low scale ac) or a scope across the full winding to be checked (Fig. 7-9).
c. Connect the output of an audio generator across the full winding to be checked (Fig. 7-9).
d. Rotate the frequency control of the audio generator to obtain a peak indication on the indicating device. Compare the frequency of the audio generator at this peak with the frequency listed in the answer above for a normally operating yoke. Shorted turns will appreciably alter the self-resonant frequencies of deflection coil windings.

Fig. 7-10. Picture showing neck shadow. ***Courtesy RCA Service Co.***

QUES. 7-10. After placing a receiver chassis, including deflection yoke and focus coil in the tv cabinet (the picture tube is cabinet-mounted), it is noted that neck shadow (Fig. 7-10) is present on the picture. What is the probable cause of trouble?

ANS. The deflection yoke, if not seated snugly against the flare of the picture tube, will cause neck shadow to appear. Check the yoke and readjust it forward if necessary.

DISCUSSION. It is *never* recommended that the ion trap magnet be manipulated primarily to remove neck shadow. Neck shadow can be eliminated by placing the deflection yoke as far forward on the picture tube neck as is possible, and by readjustment of the focus coil. The ion trap magnet is to be adjusted only for maximum picture brightness; adjusting it to produce any other effect may lead to an ion burn on the picture tube.

QUES. 7-11. Picture ringing is observed at the left side of the raster (Fig. 4-2A). The horizontal deflection and damper tubes are checked and found to be good. What is a possible cause of trouble?

ANS. The capacitor across one-half of the horizontal deflection coil in the yoke has changed value. Replace this capacitor by one of correct value.

DISCUSSION. The small capacitor across the deflection coil is used to balance the horizontal deflection coil to ground, and thus prevent crosstalk between the horizontal and vertical coils of the deflection yoke. If crosstalk occurs, picture ringing is observed.

In some rare cases, replacing the balancing capacitor with one of the supposed correct value will not eliminate the crosstalk. In a case such as this, a trial and error process is then recommended to locate the capacitor value that will eliminate the difficulty.

QUES. 7-12. Horizontal jitter at the top of the picture and erratic white streaks in the picture are observed on all channels. The horizontal deflection, damper, and high-voltage tubes are checked and found to be good. What is the probable cause of trouble?

ANS. Internal arcing, or corona, is occurring in the small capacitor connected across one-half of the horizontal deflection coil. Check the capacitor and replace, if necessary.

DISCUSSION. When replacing the anti-ringing capacitor, be sure to select a capacitor with a proper breakdown voltage rating, because this capacitor is subject to high transient voltages.

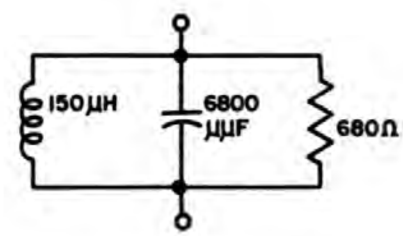
QUES. 7-13. Picture ringing is observed at the left side of the raster. The horizontal deflection and damper tubes and the

horizontal adjustments are checked and found to be good. The current waveform in the horizontal deflection coil is observed with a scope (see the answer to *QUES. 7-16* for method) and a trace such as that illustrated in Fig. 7-13(A) is noted. What may be used to eliminate the ringing?

ANS. To eliminate ringing from the current waveform of a deflection coil, use a ringing filter similar to the one shown in Fig. 7-13(B). Connect this filter in series with the horizontal deflection coil.

DISCUSSION. The ringing filter indicated in Fig. 7-13(B) is resonant to approximately .5 mc. This filter can only be used to eliminate or reduce ringing that is present in the deflection coil current waveform. However, if the picture ringing is caused by improper peaking in the video amplifier section of the receiver, or by any other receiver trouble, this type of filter will be completely ineffective.

(A)



(B)

Fig. 7-13. (A) Ringing in sawtooth-current waveform. (B) Ringing filter.

QUES. 7-14. A picture, such as is shown in Fig. 7-1(A), appears on the picture tube. What is the cause of trouble?

ANS. The picture observed in Fig. 7-1(A) is referred to as the horizontal keystone effect, and is caused by a shorted horizontal coil in the deflection yoke. Check the yoke, and replace if necessary.

DISCUSSION. In many cases, the keystone effect is the result of a short in the balancing capacitor, wired across one of the horizontal deflection coils. In the presence of horizontal keystoning, be sure to check this capacitor by unsoldering one end of it, and making an ohmmeter check. Do not replace a suspected defective yoke until this check has been made.

In the event of a short across one of the vertical deflection coils in the deflection yoke, a vertical keystone effect will be evident. This may be seen in Fig. 7-1(B). Although two damping resistors are connected across the vertical deflection coils, these resistors are rarely the cause of a vertical keystone, as they do not commonly short. However, good servicing procedure dictates that each of these resistors be checked with an ohmmeter in the event of vertical keystoning, before replacement of the yoke is attempted.

QUES. 7-15. Horizontal keystoning is observed in the picture (Fig. 7-1A). Because this symptom indicates the presence of a short across the horizontal deflection coil, the balancing capacitor (generally 47 to 56 $\mu\mu$f) across one of the horizontal deflection coils is checked and found to be shorted. The capacitor is replaced. Instead of keystoning, severe picture ringing is now observed. What is the probable cause of trouble?

ANS. The replacement balancing capacitor has too large a capacitance, and should be replaced by a capacitor identical in value to the original part.

DISCUSSION. The balancing capacitor is used to balance the two portions of the horizontal deflection coil against each other. In this manner crosstalk between coils is held to a minimum. However, if an unbalance arises, such as may be caused by operating with a balancing capacitor of improper size, crosstalk occurs and is observed as picture ringing.

QUES. 7-16. It is desired to observe the current waveform (not the voltage waveform) in the horizontal deflection coil. How should this be done?

ANS. To observe the waveform of the current flowing in the horizontal deflection coil:

a. Connect a .5-ohm to 2-ohm resistor in series with the coil. (To do this, disconnect one end of the deflection coil, and insert the series resistor, as shown in Fig. 7-16A.)

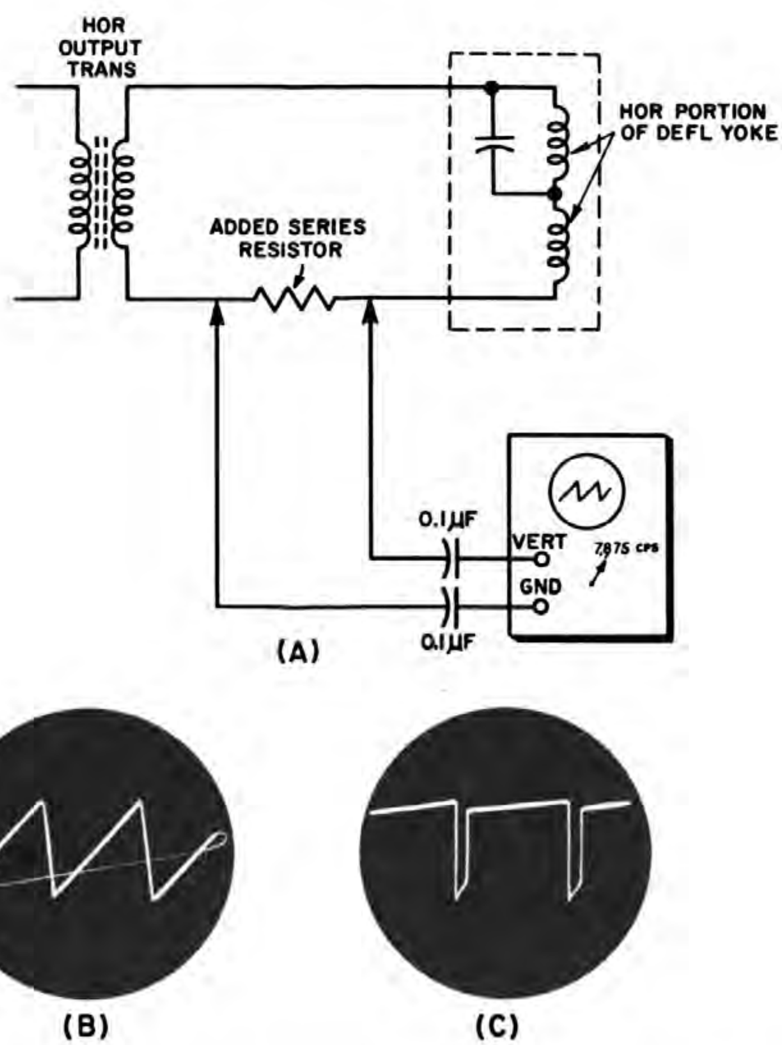


Fig. 7-16. (A) Circuit connection for observing the horizontal-deflection coil current waveform. (B) Current waveform in the horizontal-deflection coil. (C) Voltage waveform across the horizontal-deflection coil.

b. Connect the vertical input of a scope across the series resistor.
c. Set the scope to a sweep frequency of 7875 cps. A waveform similar to that illustrated in Fig. 7-16(B) should be observed on the scope. This waveform is a representation of the current flowing in the horizontal deflection coil.

DISCUSSION. The voltage applied across the deflection coil (Fig. 7-16C) must be rectangular in shape in order to cause a sawtooth current to flow through the inductance of the coil. The sawtooth current is necessary, of course, to produce the linear sweep (and retrace) of electrons across the face of the picture tube.

It should be noted that the scope, as connected in Fig. 7-16(A), has both of the vertical input terminals above ground potential. To prevent equipment damage during this application, in case the scope housing is shorted to an earth ground, always connect two isolating capacitors in series with the vertical input leads of the scope.

Fig. 7-17. Horizontal foldover.

QUES. 7-17. Instead of a full raster, a thin, white horizontal line is observed on the picture tube. After checking the vertical circuit, a defective deflection yoke is found and is replaced. When the receiver is turned on after the yoke replacement, horizontal foldover (Fig. 7-17) is seen on the screen. What is the probable cause of trouble?

ANS. Horizontal foldover that appears in the aftermath of a yoke replacement is caused by a mismatch between the replacement yoke and the horizontal output transformer. Replace a defective yoke only with an identical part or with a factory-authorized replacement.

DISCUSSION. When a mismatch exists between the horizontal output transformer and the deflection yoke, the flyback, or retrace time of the horizontal sweep, can be increased. An increase in this time will produce a foldover which cannot be corrected by adjustment of the horizontal circuit controls.

QUES. 7-18. When replacing a defective yoke, a cosine-wound yoke is chosen as the replacement. After the yoke is connected

into the circuit, the receiver is turned on, and picture compression is observed on the right side of the picture. What is the probable cause of trouble?

ANS. The new yoke does not match the impedance of the horizontal output transformer. When an identical replacement is not going to be used, choose a replacement yoke whose characteristics match the horizontal output transformer in the circuit.

DISCUSSION. On occasion, manipulation of the horizontal drive, width, and horizontal linearity controls may compensate for the mismatch if it is not severe, and eliminate the picture compression described above. In other cases, if another yoke is not readily available, trial-and-error replacement of the values of the boost capacitors in the damper circuit may also compensate for compression. However, the rule that should be followed at all times, if possible, is that a replacement yoke should have characteristics that permit it to work in conjunction with the horizontal output transformer.

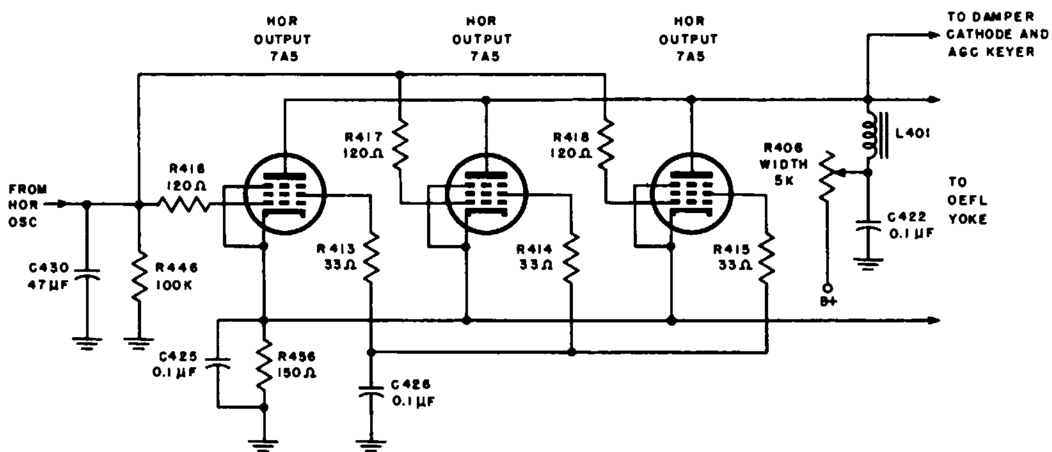


Fig. 7-19. Schematic of horizontal-output circuit. *After Westinghouse Electric Co.*

QUES. 7-19. Instead of a full raster, a thin vertical line is observed on the picture tube. The horizontal deflection tubes are checked and found to be good. In the receiver illustrated in Fig. 7-19, what is the probable cause of trouble?

ANS. In the receiver of Fig. 7-19, lack of horizontal deflection is probably caused by a defective yoke. Check the yoke and replace, if necessary.

DISCUSSION. In the receiver of Fig. 7-19, high voltage is produced by an r-f high-voltage power supply. In a receiver of this type, the high voltage and the horizontal sweep are totally unrelated to each other (see the answer to *QUES. 3-1*), so that high voltage can be present despite the lack of horizontal deflection voltage.

Other possible causes of trouble in the receiver under discussion are shorted or leaking bypass capacitor, *C422*, or an open plate load coil, *L401*.

QUES. 7-20. Can damage result from operating a receiver that has been removed from a cabinet in which the picture tube and the yoke assembly remain in the cabinet?

ANS. In some cases, operating a receiver with the deflection yoke disconnected from the receiver may cause the screen grid resistor of the horizontal output stage to burn out. As a general rule, do not operate a receiver when the deflection yoke is disconnected from the receiver.

DISCUSSION. In those sets in which the yoke must be connected during operation, the plate circuit of the output stage is completed through the yoke circuit. If the yoke is not connected, the screen grid of the output stage will be the only tube element at a high positive potential and will draw excessive current, causing possible damage in the screen circuit.

QUES. 7-21. A picture such as that illustrated in Fig. 7-1(C) is observed. The vertical deflection tubes and adjustments are checked and found to be good. What is a possible cause of trouble?

ANS. Lack of height and a characteristic waviness at the left side of the picture may be caused by an open vertical deflection coil.

DISCUSSION. To check for an open in the vertical deflection coil of the yoke, disconnect one end of the vertical deflection coil from the receiver (in some receivers the yoke plugs into the chassis and should be removed for this check), and make an ohmmeter check across the coil.

In the event of an open in the vertical deflection coil, it should be noted that an infinite resistance will *not* be obtained. This is true because of the vertical damping resistors across the deflection coil. Thus, if one of the coils opens, an ohmmeter reading will still be obtained, as is shown in Fig. 7-21. The resistance in this case will, of course, be considerably higher than the normal reading.

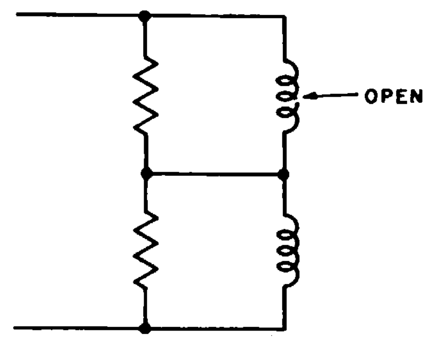


Fig. 7-21. Complete resistance path if the vertical-deflection coil is open.

QUES. 7-22. When using a scope to service the horizontal output section of a receiver, can the scope be used to observe the voltage waveform across the horizontal deflection coil?

ANS. A scope can be used to observe the horizontal deflection coil voltage waveform only if a properly compensated 100-to-1 attenuating probe is used in conjunction with the scope. (The construction of a probe of this type is described in the answer to *QUES. 2-4.*)

DISCUSSION. The voltage pulses in the horizontal deflection coil are often of large enough amplitude to cause the vertical amplifier stage or stages of the scope to overload when these pulses are applied, or to break down capacitors in the scope input network. The attenuation probe, however, safely reduces the amplitude of these pulses without distorting them, if the probe is properly compensated.

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