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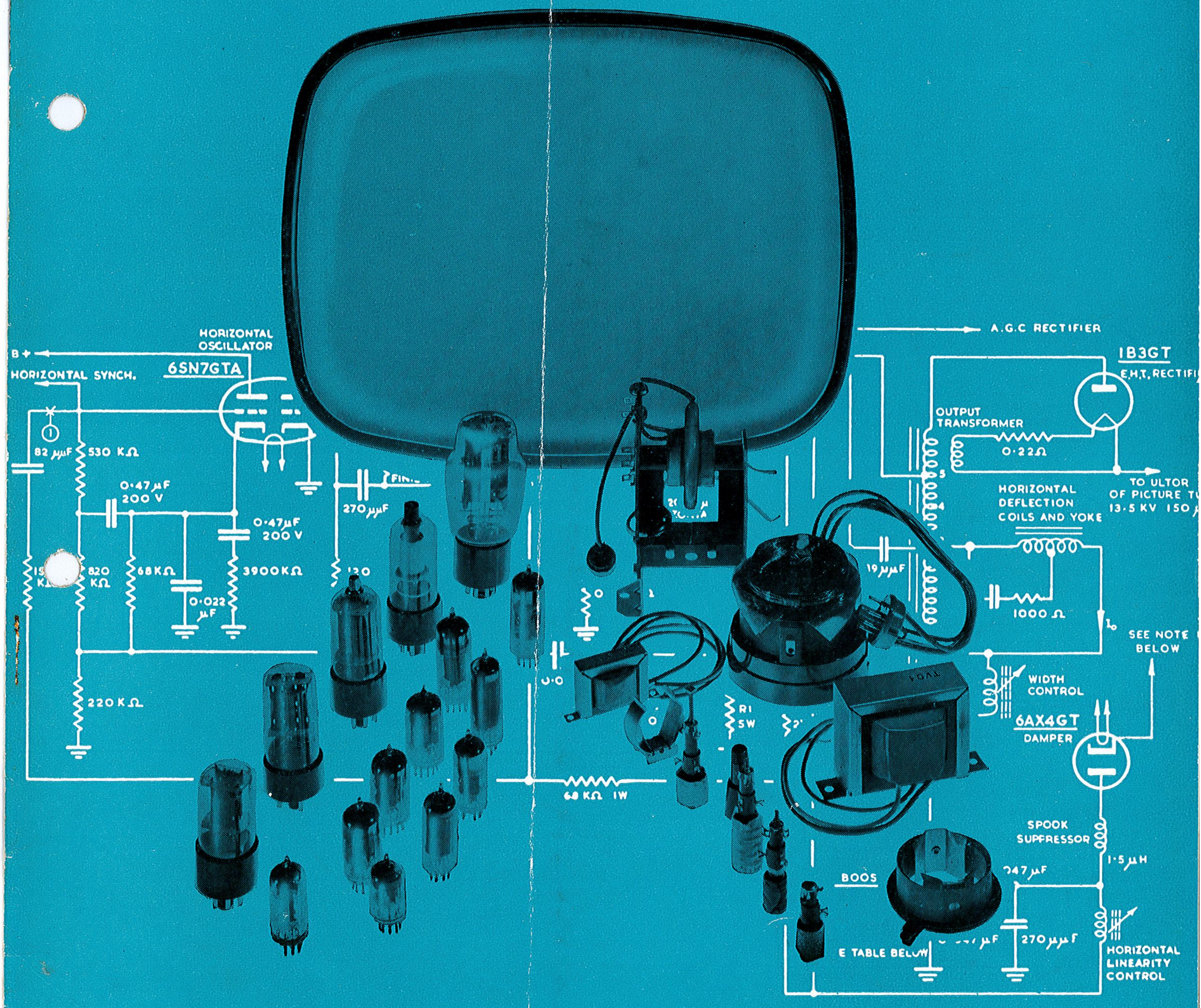

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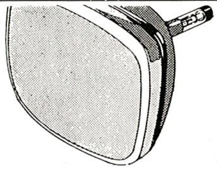

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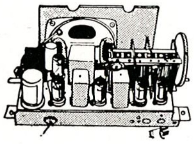

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TV SERVICING

AUDIBLE HUM AND BUZZ

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This article covers the localization of troubles in the receiver that cause audible hum and buzz, without any accompanying visible symptoms. In cases where audible hum is accompanied by visible hum symptoms, it is preferable to concentrate on the visible clues.

The troubles that cause hum are different from the troubles that cause buzz. For trouble-shooting purposes, it is helpful to recognize the difference between these two sounds:

A hum is a "smooth" low-frequency sound.

A buzz is a "raspy" low-frequency sound.

Hum is produced by 50 or 100 cycle voltages that are sine-wave in shape, or that contain only low-frequency harmonics. When audible hum develops in a receiver that has been free from such trouble, it can usually be traced to heater-cathode leakage (50 c/s), or to trouble in the B-filter circuit (100 c/s).

Buzz is produced by square-wave vertical sync, vertical blanking, and low-frequency picture signals, or by saw-tooth vertical-deflection voltage. These square-wave and saw-tooth voltages have a repetition rate of 50 c/s but contain numerous harmonics; the harmonics that are within the frequency range of the audio amplifier and loudspeaker contribute the raspy quality of the buzz. Heater-cathode leakage, however, can also cause a raspy buzz-like output.

SOME TERMS.

When picture signals get into the sound, they produce a buzzing noise that is generally termed "picture buzz".

Any buzz produced by picture signals can be identified easily because the tone and intensity of the buzz change on different televised scenes and on different "commercials". No other type of buzz has this identifying feature. For instance, buzz caused by vertical-deflection voltages (due to undesired coupling between the vertical-deflection section and the audio amplifier) remains unchanged in tone and intensity, regardless of changes in the picture.

The term "picture buzz" identifies the sound of the noise, but does not indicate how the picture signals are getting into the sound. Picture buzz may be caused by a variety of troubles, including: cross-modulation between the picture and sound carriers; coupling between the inner coating of the picture tube and the audio input; coupling between the output of the video amplifier and the input of the audio amplifier; 100% modulation dips at the transmitter (which affect intercarrier sets), and other reasons.

The terms "picture signals" and "video signals" are used inter-changeably in the two different ways. Occasionally they are used to mean only those signals that represent the dark and light areas in the picture, but in most cases they are used to mean the composite signal, which includes picture, sync, and blanking. The latter meaning is always implied in referring to a "picture buzz", because, in a receiver, the picture signals are always accompanied by the blanking and sync signals. It is the effect of the composite signal that produces "picture buzz".

Only the low-frequency components of the composite picture, blanking, and sync signals can get through the audio system and become audible. The audio system in TV receivers may cut off at approximately 5000 c/s or lower. The sound quality of picture buzz is, therefore, due to the 50 c/s vertical blanking and sync signals, and to the low-frequency picture signals, which represent large dark and light areas in the picture.

The term "sync buzz" is often used instead of "picture buzz" but the term "sync buzz" should be restricted to the rare cases where vertical-sync pulses from the sync separator are getting into the sound.

AUDIO HUM.

In cases where there is hum (not buzz) from the speaker and the hum is present on all channels, including blank ones, first determine whether the intensity of the hum varies with adjustment of the volume control:

If the intensity of the hum does not vary with adjustments of the volume control, the trouble is generally in circuits AFTER the control.

If the intensity of the hum can be reduced to the vanishing point by turning the control counter-clock-wise, the trouble is generally in circuits AHEAD of the control. (One exception is mentioned later.)

In cases where the intensity of the hum does vary with adjustment of the volume control, try a new valve in the sound-discriminator circuit. If the hum stops it can be assumed that the original valve had heater-cathode leakage, which introduces 50 c/s heater voltage into the audio-input circuits.

It should be remembered that the discriminator valve and the discriminator-output circuits are a part of the audio-input circuit, and are subject to the same hum troubles, such as heater-cathode leakage, and electrostatic pickup of hum, buzz, and other extraneous signals.

In cases where the intensity of the hum does not vary with adjustment of the volume control, the following "process of elimination" may be used:

1. Try a new valve in each stage of the audio amplifier. If the hum stops, the trouble was probably due to heater-cathode leakage in the original valve.

2. If new valves do not eliminate the hum, remove the audio-output valve: If the hum is still present, there is something radically wrong in the audio-output transformer or speaker circuit, which should be checked in order to locate the fault.

3. If the hum stops when the audio-output valve is removed, put the valve back in its socket, and remove the first audio valve.

4. If the hum is still present with the first audio valve removed, it indicates that there is excessive hum-voltage ripple on the B-supply bus to the audio amplifier, or on the grid-bias bus to the output stage. Check the electrolytic capacitors in the supply circuits.

5. If the hum disappears when the first audio valve is removed, put the valve back in its socket. The hum should reappear. If the grid resistor of the first audio stage is returned to chassis, temporarily short-circuit the resistor. The hum should disappear, providing the previous checks have been made properly. If the grid resistor of the first audio stage is returned to B-point, check the electrolytic capacitor in this circuit.

6. If the above steps have been followed correctly, the trouble will be localized to the audio-input circuits, which should be carefully traced and checked. See that all unshielded audio-input wiring, components, controls, and switches are kept away from the a.c. power supply leads, the power-rectifier circuit, the filter choke, and the heater wiring.

It must be stressed that the above procedure is based on hum trouble, not buzz trouble. If there is any question on this point, remove the following valves: The horizontal oscillator, the horizontal-output valve, the vertical oscillator, the last picture i-f amplifier, and the last sound i-f amplifier. Removal of these valves disables the horizontal oscillator and high voltage, the vertical deflection, the picture and the sound thus eliminating virtually all possible sources of buzz in the receiver. Removal of the horizontal output valve is necessary because removal of the horizontal oscillator valve alone would result in excessive dissipation in the horizontal output valve and possible valve failure. If the hum is still present it is undoubtedly "audio hum" and the above procedure should be effective in locating the trouble.

A minor exception should be noted regarding the rules given above for determining whether the hum trouble is ahead of, or after, the volume control: If hum voltage is being picked up through electrostatic coupling to the lead to the arm of the volume control, or to the lead to the first audio grid (both of these leads occur in the circuit "after" the control), the intensity of the hum will decrease when the control is turned counter-clockwise. This action occurs, when the control is turned counter-clockwise, because the arm is brought to chassis potential for hum voltages, and the first audio coupling capacitor is effectively connected across the first audio grid circuit, thereby bringing the grid closer to the chassis for hum voltages.

MODULATION HUM.

The term "modulation hum" is used to distinguish this trouble from "audio hum". There is a great difference between the two. Audio hum is present at all times, regardless of whether a signal is being received. Modulation hum is present only when a station is being received.

Modulation hum is caused by the presence of undesired hum voltages in the r-f or i-f amplifiers (including the r-f oscillator and converter). The hum voltage modulates the r-f or i-f signal. The modulation is A-M, except in cases where the hum trouble occurs in the r-f oscillator circuit and produces both A-M and F-M.

Modulation hum in TV receivers is usually caused by:

(a) Heater-cathode leakage in any valve through which the r-f or i-f sound signal passes.

(b) Excessive hum-voltage ripple on the plate, grid, or screen supplies for any valve through which the r-f or i-f sound signal passes.

If there is hum trouble in any valve through which both the sound and picture r-f or i-f carriers pass, the effects are always more evident on the picture than in the sound, because the action of the sound i-f limiter and discriminator tend to wipe out amplitude modulation on the sound i-f carrier.

Modulation-hum trouble may not affect all of the TV stations. For instance, if the trouble is caused by heater-cathode leakage in an r-f or i-f valve, and if the particular valve is almost cut off by a.g.c. action on a strong local station, the hum voltage will not modulate the signal of this particular station.

In A-M radio receivers, modulation hum can be easily identified by its tuning action. The hum becomes audible when the receiver is tuned to the station, and it disappears when the set is tuned away from the station. It is for this reason that modulation hum in A-M receivers is often described as "tunable hum".

The tunable action of A-M modulation hum is entirely different in F-M receivers, and on the F-M sound in TV receivers. Because the limiter and discriminator tend to eliminate any amplitude modulation that is present on the signal, the intensity of A-M modulation hum decreases when the receiver is correctly tuned to the station. Correct tuning is the point where the frequency of the sound i-f signal is the same as the centre frequency of the discriminator. The intensity of modulation hum increases when the sound i-f signal is tuned slightly above or below the correct point. This tunable action of modulation hum is evident only on TV receivers that have a separate channel for the sound i-f signal. In inter-carrier receivers, the sound i-f (5.5 Mc/s) is fixed in frequency and it cannot be altered by tuning the tuning control of the receiver. Hence, in inter-carrier receivers, there is no tunable action in cases of modulation hum.

The cause of modulation hum in TV receivers may be determined by:

(a) Trying new valves in all stages through which the r-f or i-f sound signal passes. (Only those stages that have a resistor or 50 c/s impedance in the cathode circuit are likely to show any effect from heater-cathode leakage.)

(b) Using a voltage-calibrated oscilloscope to check for excessive hum-voltage ripple on the plate, screen, and grid supplies for the r-f and i-f amplifiers.

(c) Checking the alignment of the sound i-f amplifier and the sound discriminator with reliable sweep equipment. Incorrect alignment greatly reduces the ability of the limiter and discriminator to wipe out amplitude-modulation hum and buzz.

(d) In inter-carrier receivers, it is important to align the sound i-f amplifier and discriminator exactly at 5.5 Mc/s in order to obtain the greatest reduction of A-M hum and buzz.

In cases where hum is present on only one station, it is always advisable to check another receiver to determine whether the hum is present on the station's sound carrier.

For general background information, it is helpful to consider another cause of modulation hum which occurs under certain conditions, in A-M radio receivers that have a small loop or "hank" antenna. In many locations, considerable signal energy from one or more of the local broadcast stations is picked up by the power line. The strength of such signals at the receiver may be affected by the action of the power rectifier. On positive half-cycles of the power supply voltage, the rectifier and first filter capacitor form an effective r-f short circuit across the line; on negative half-cycles, in the rectifier is affectively an open circuit. This action may produce a variation, at the power-line frequency, in the strength of the line-pickup signal. If some of this hum-modulated signal is coupled into the antenna input circuit, hum will be evident on the sound of the particular station. Remedies for this type of modulation hum trouble in A-M radio receivers include:

(a) Use of line-bypass capacitors, or a line filter, to prevent entry into the receiver of signals that are picked up by the power line.

(b) Use of a grounded electrostatic shield between the primary and the secondary windings of the power transformer to prevent entry of the line-pickup signals.

(c) Use of an electrostatic shield around the loop antenna, to prevent electrostatic pickup of the hum-modulated signal.

(d) Use of an outdoor antenna, to provide "clean" signals of sufficient strength to swamp the effect of the hum-modulated signals.

TV receivers generally have built-in power-line filters that eliminate almost all possibility of this particular variety of modulation hum.

ZERO PICTURE SIGNAL BUZZ.

In inter-carrier receivers, the sound i-f signal 5.5 Mc/s is formed at the second-detector by the difference-frequency beat between the picture and sound i-f carriers. The frequency of this beat depends solely on the difference in frequency between the r-f picture and sound carriers. The specified standard separation between the picture and sound carriers is 5.5 Mc/s, hence the beat is 5.5 Mc/s.

The 5.5 Mc/s beat, which has sound frequency modulation is amplified in the 5.5 Mc/s sound i-f amplifier and fed into the sound discriminator. The audio output of the discriminator is amplified by the audio amplifier, and fed into the speaker. Obviously, if there is no 5.5 Mc/s beat, there will be no sound output.

In order to obtain a 5.5 Mc/s beat signal at the output of the second detector, it is necessary that both the sound and the picture signals be present in the input to the second detector. If either the picture or sound signal is missing for any reason, there will not be a 5.5 Mc/s beat, and, consequently, there will be no sound output from the speaker. If the station shuts off its picture carrier so that there is no picture signal at the receiver, there will also be an absence of sound, despite the fact that the station is transmitting its normal frequency-modulated sound carrier.

Suppose that the station transmits a normal F-M sound carrier but that it reduces the picture carrier to zero amplitude for a short period every 1/50th of a second, or at a rate of 50 times per second. During these short periods when the picture carrier is cut off, there can be no 5.5 Mc/s beat and no sound output from the speaker. The resulting 50-cycle interruption in the sound produces the effect of 50-cycle buzz. The tone of the buzz will change with the different scenes.

Before inter-carrier receivers were introduced it was general practice in TV stations to operate the transmitter in such a way that the amplitude of the picture carrier was reduced to zero, for the whitest portions in the picture. Such reductions to zero amplitude repeated at the field frequency of 50 c/s produce picture buzz in the sound of inter-carrier receivers. Consequently, ever since the inter-carrier receivers have come into common use, the operators at TV stations maintain the amplitude of the picture carrier so that it does not fall below approximately 10%. (Note: The Australian standards specify:—White level: In the modulation of the picture transmitter the radio frequency signal amplitude for the maximum white shall not exceed 15% nor be less than 10% of the maximum carrier amplitude.) In this way, there is never any complete interruption in the picture carrier and, therefore, no interruption in the 5.5 Mc/s beat and no buzz.

Occassionally, in the process of making adjustments at the station the carrier may be unintentionally modulated down to zero amplitude for short periods, thereby producing picture buzz in the sound of inter-carrier receivers. This trouble, which was fairly common at one time, is now seldom evident.

On a complaint of picture buzz in an inter-carrier set, it is advisable to check the same station on other inter-carrier receivers to determine whether the same buzz occurs at the same time on all receivers. If the buzz is not present on the other sets, the trouble is not caused by the station. The faulty receiver should then be checked for other causes of picture buzz as described in this article.

CROSS-MODULATION BUZZ.

When two r-f or i-f signals of different frequencies are amplified in the same stage, there is a possibility that the modulation on one signal may appear on the other signal, and vice versa. When this trouble occurs, it is termed "cross modulation".

Operation on a non-linear portion of the grid-voltage v. plate-current curve may produce cross modulation in an amplifier valve.

When cross modulation occurs in a stage that is used to amplify both the picture and sound carriers (r-f and i-f), the F-M sound signal acquires amplitude modulation from the A-M picture signal. If this amplitude modulation is not eliminated by the subsequent action of the sound i-f limiter and sound discriminator, the characteristic noise of picture buzz will be heard in the sound output from the speaker. The tone and intensity of the buzz change on different televised scenes.

In modern receivers, the first stage or the first and second stages of the picture i-f amplifier are used to amplify both the sound i-f and picture i-f signals. Cross modulation can occur in these stages if the input signal to the stage has excessive amplitude, or if the bias is incorrect, or if the valve has a restricted linear operating range.

In inter-carrier receivers, the entire i-f amplifier is used to amplify both the picture i-f and sound i-f signals. Also, in some inter-carrier receivers, one or two stages in the video amplifier are used to amplify both the video signals and the 5.5 Mc/s sound i-f signals. Cross modulation can occur in any of these stages, for the reason given in the previous paragraphs.

Cross-modulation buzz can be demonstrated on strong stations, by temporarily short-circuiting the a.g.c. bias-voltages for the r-f and i-f amplifiers. The lack of bias will cause excessive gain and signal over-load, with cross modulation and buzz. The same effect can be obtained by incorrect setting of the agc threshold adjustment (or switch) which is used in some receivers.

The following suggestions may be helpful in cases of cross modulation:

(a) Check the frequency response and the gain of the sound i-f amplifier and limiter. Check the response of the sound discriminator which should be linear, and centred at the correct frequency. In inter-carrier receivers it is especially important to align the sound i-f amplifier and discriminator exactly at 5.5 Mc/s. Correct alignment and gain is essential to obtain the greatest possible reduction of any A-M picture signals that are present on the F-M sound i-f carrier. Use dependable and accurate alignment equipment.

(b) Check the overall frequency response of the r-f and picture i-f amplifiers. Realign if the response is appreciably different from that recommended by the manufacturer of the receiver.

(c) Check the a.g.c. voltages on the r-f and i-f bias bus and also at the grids of the a.g.c.-controlled valves. Use a good vacuum-tube voltmeter, to prevent loading these circuits.

(d) Try new valves in all stages that pass both sound and picture signals. If the buzz is diminished when a new valve is used in a particular stage, try several new valves in this stage, picking out the one that gives the best results.

(e) If cross modulation is present on only the strongest station, try increasing the bias on the r-f amplifier.

(f) In inter-carrier receivers that use one or two stages in the video amplifier to amplify the 5.5 Mc/s sound i-f signal, determine whether the cross modulation is occurring in the video stages: temporarily substitute a carbon potentiometer in place of the second-detector load resistor, to permit reducing the amplitude of the signal input to the video amplifier. The "pot" should have approximately the same value as the load resistor. Connect the video-input lead to the arm of the pot. Reduce the video-input signal, by means of the pot, to about one-half of normal. If the buzz ceases, it indicates that the cross modulation is occurring in the video amplifier. In this case, remove the pot, restore the original connections, try new valves in the video amplifier, check the voltages on the video valves, and try changing the bias slightly on each stage. Excessive change in bias may affect the video signals.

To avoid unnecessary waste of time on cases of cross modulation, it is always good practice to find out whether the trouble is chronic in the particular model, and whether the manufacturer has recommended any changes to correct the trouble.

HIGH VOLTAGE BUZZ.

Due to the regulation characteristics of the high-voltage supply, there is considerable low-frequency variation in the high-voltage for the picture tube. The voltage is highest at times when the beam current is cut off by long-duration black signals, such as vertical blanking. The voltage is lowest at times when the average beam current is highest, which occurs during large, wide, white areas in the picture. Any variations in high voltage are repeated at the field frequency of 50 c/s.

If there is stray capacitive coupling, even a few micromicrofarads, between the high voltage circuit and the audio input circuits, the variations in high voltage are likely to produce a buzz in the sound output from the speaker. The intensity and tone of the buzz change on different televised scenes and on "commercials".

This type of buzz, which will be referred to as high-voltage buzz, can be identified as follows:—

(a) The intensity of the buzz decreases when the brightness control is turned down.

(b) The intensity of the buzz decreases when the contrast control is turned down.

(c) The buzz ceases when the high-voltage lead is disconnected from the picture tube, or when the socket is removed from the rear of the picture tube.

High-voltage buzz is generally found only in receivers where the audio-input circuits, such as the sound discriminator, volume-control wiring, or first-audio valve circuit, are within a few inches of the high-voltage-electrode connector, and where there is no electrostatic shielding between this electrode and the audio circuits. In receivers, where all of the audio circuits are underneath the chassis, the chassis acts as an electrostatic shield. In receivers with picture tubes having an external conductive coating, the external coating acts as an electrostatic shield, provided the coating is connected to the chassis. The coating serves no purpose unless it is connected to the chassis.

Frequently, high-voltage buzz can be corrected by simply making a good connection between the chassis and the external coating on the picture tube.

VERTICAL DEFLECTION BUZZ.

If there is coupling of any type between the vertical-deflection section and the audio amplifier, the high-amplitude saw-tooth voltages that are present in the vertical-oscillator and vertical-amplifier sections may cause a buzz in the sound output from the speaker.

Vertical-deflection buzz can be identified as follows:—

(a) The tone of the buzz varies when the frequency of the vertical oscillator is changed by turning the vertical-hold control.

(b) The buzz disappears when the vertical oscillator is removed. (N.B.: Before removing this valve, turn the brightness control to a minimum. Without the vertical oscillator a very bright line forms across the picture tube.)

(c) The buzz is present on all channels, including unused ones, and it continues if a valve in the sound i-f amplifier is removed.

Checks (a) and (b) show that the buzz is due to vertical deflection voltages. Check (c) shows that the pulses are being coupled into the audio amplifier, and also that the buzz is not due to cross-modulation of any kind.

If the checks show that the buzz is due to vertical-deflection voltages, inspect the chassis to determine whether the wiring, transformers, valves or other components in the vertical oscillator and vertical amplifier sections are close to the sound-discriminator or audio input circuits. If some of these parts are close to the discriminator or audio-input circuits, try electrostatic shielding to decrease the coupling. A piece of tinfoil, wrapped in paper or plastic sheet to prevent accidental short circuits, may be used while these checks are made. The shield must be connected to the chassis.

In a number of cases of vertical-deflection buzz, it was found that the vertical-output transformer was mounted too close to the audio-input circuits. The buzz was eliminated by wrapping a sheet of insulated tinfoil around the transformer, and by connecting the tinfoil to the chassis.

In cases where vertical-deflection buzz is not caused by electrostatic coupling, check the electrolytic filter capacitors in the supply leads to the vertical section. Open filter capacitors in these supply circuits may permit common-impedance coupling between the vertical section and the audio amplifier or the r-f/i-f amplifier.

SNAPPING OR SIZZLING SOUNDS.

(High Voltage Breakdown)

Intermittent faint snapping or crackling sounds generally indicate high-voltage arc-over. The sound may be accompanied by corresponding noise from the speaker, and also by momentary horizontal tearing of several lines of the picture. Continuous faint sizzling sounds may be accompanied by raggedness in horizontal deflection. Continued arc-over, and also corona, produces the characteristic odor of ozone. When ozone is detected look for corona or arc-over in the high-voltage circuits.

The location of an arc-over can usually be determined by sight or sound, but in some cases the arc-over may occur inside the high-voltage filter capacitor, or in some other component or unit where it cannot be seen. When trying to locate an arc-over by sound, turn the volume control counter-clockwise to eliminate any interfering noise from the speaker. When looking for an arc-over or for corona, darken the room.

In cases of sizzling, accompanied by horizontal raggedness, a common cause is a slight sparking at outer conductive coating on a picture tube. If this trouble exists, the connection should be improved in some convenient and permanent manner.

In cases where there is a snapping or crackling sound of high-voltage arc-over, but where the arc-over cannot be seen, it is advisable to try a new high-voltage filter capacitor.

If a new capacitor is not immediately available, the original capacitor may be checked indirectly as follows:—

Turn off the set, discharge the capacitor, disconnect the capacitor, and turn the set on. Disconnection of the capacitor causes a reduction in the high-voltage and a decrease in brightness. If the arc-over does not occur with the capacitor disconnected, the arc-over probably took place inside the capacitor. In this event install a new capacitor and operate the receiver to make certain that the trouble has been corrected.

Visible arc-over and corona from leads, transformers, or other components can usually be eliminated by shifting the position of the leads or components slightly by eliminating any sharp points on wire and solder, and by use of high-voltage plastic insulating material wherever necessary.

BUZZING TRANSFORMERS.

In tracking down the cause for audible hum and buzz, first determine whether the sound is coming from the speaker or if it is being created by mechanical vibration or buzz in a transformer.

The alternating or pulsating currents that flow through the coils of a transformer set up fluctuating magnetic forces that tend to make the laminations and coils vibrate in step with the changes in current. Precautions are taken in the design of transformers to prevent mechanical vibration. The laminations are tightly clamped together and are usually dipped in varnish to form a non-vibrating block; the coils are thoroughly impregnated in wax or varnish to form a non-vibrating unit; the coil assembly is tightly wedged on the core, and the core-and-coil assembly may be "potted" or buried in an insulating compound which further restricts vibration. Yet, in spite of these measures, a small percentage of transformers develop an objectionable amount of buzz.

Experience has shown that the vertical-output transformer is the chief offender in the production of buzz. The vertical-oscillator transformer may buzz, and there is a possibility of buzz in the vertical section of the deflecting yoke.

An important point to remember in connection with buzz in any vertical transformer, is that the tone of the buzz can be altered by changing the frequency of the vertical oscillator, by adjusting the vertical hold control. Stated oppositely, if the tone of a transformer buzz changes when the vertical-hold control is turned, the buzz originates in a transformer in the vertical section of the receiver.

The power transformer is probably the second chief offender in producing buzz. Any power transformer is likely to buzz if it is greatly overloaded by a short-circuit across a winding or across a portion of a winding. A short circuit, however, usually produces other and more important symptoms, such as failure of operation, overheating, blown fuses, etc.

Vibration of the core or coils in a horizontal-output transformer may produce a high-pitched whistle at the horizontal frequency of 15,625 c/s which is beyond the hearing range of the majority of men, but may be annoyingly audible to women and young persons.

Mechanical vibration in an audio-output transformer produces thin sounds of voice and music, or "singing". Any sound from the audio-output transformer is generally masked by the stronger sound from the speaker.

On rare occasions, sounds may come from a defective tubular capacitor (which has not been properly impregnated, and in which the foil has been wound too loosely) if the amplitude of the voltage fluctuations across the capacitor is in the order of several hundred volts.

Almost all complaints involving buzzing transformers come from installations where the receiver is operated at low volume level in a quiet room. When the receiver is operated at high volume level, or is used in a noisy room, the sound from a buzzing transformer is likely to pass unnoticed. The intensity of the sound is influenced by the acoustics of both the cabinet and the room, which may deaden or reinforce the sound. Listening checks for buzzing transformers should be preferably conducted under quiet conditions. (The same precaution applies when investigating complaints of low-level hum or buzz in the sound output from the speaker.)

To prevent possible confusion when checking for buzzing transformers, it is advisable to kill the audio output of the receiver, either by removing the audio-output valve, or by short-circuiting the primary of the audio-output transformer.

BUZZING POWER TRANSFORMERS.

If the buzz seems to be coming from the power transformer, temporarily remove or disconnect the power rectifier, thus eliminating all other possible sources of hum or buzz in the receiver. The heater load alone is generally sufficient to continue the buzz. If the power transformer is buzzing, try tightening the bolts that clamp the laminations together. Don't draw up too tightly on the bolts, because they have an annoying habit of shearing off.

If tightening of the bolts does not reduce the buzz sufficiently, disconnect the power cord, remove one or both of the end bells (covers), and check to see if the coil assembly is tightly wedged on the core. The transformer may have wedge-shaped pieces of impregnated hardwood or fibre inserted between the core and the inside of the coil form. Tap the wedges tightly into position; drive in new wedges if necessary.

Look for loose laminations on either end of the stack. In some transformers the laminations are bonded into a solid block by means of varnish. If loose laminations have been added, in order to obtain the required core thickness, they may be contributing to the buzz. Apply a coat of varnish to the loose laminations and, while still wet, replace them in the core. Reassemble the transformer, tighten the bolts, and check for buzz. If the buzz has been reduced sufficiently, replace the rectifier and recheck. If the buzz is objectionable it may be necessary to replace the transformer.

A quick check for buzz in the power transformer can be made by listening to the transformer in the few seconds that elapse between the time the set is turned on (from a cold start) and the time the rectifier valve starts operating.

BUZZING VERTICAL TRANSFORMER.

When there is reason to believe that buzz is caused by a transformer in the vertical circuits, kill the audio output of the receiver and rotate the vertical-hold control. If the tone of the buzz changes, it is a definite sign that the buzz is coming from a transformer in the vertical section. In this case, temporarily remove the vertical-output valve. If the buzz stops the vertical-output transformer is at fault. If the buzz continues and if the particular receiver has a transformer in the vertical-oscillator circuit, remove the vertical-oscillator valve. If the buzz ceases, the oscillator transformer is at fault.

Buzz in a vertical-output transformer may be caused by a partial short circuit in the transformer windings or in the circuit. The most prominent symptom in this case is vertical deflection trouble.

Remedies for a buzzing vertical transformer are the same as for power transformers, namely: tighten the bolts (or clamps) that hold the laminations together, and see that the coil assembly is tightly wedged on the core. If these remedies are not successful, it is usually necessary to replace the transformer. Any attempt to repair a "potted" transformer may take too much time.

The writer has never come across a case of buzz in the vertical section of a deflection yoke, but if this trouble should occur, an inspection of the yoke may reveal the cause and suggest a remedy.

In many cases there is no visible reason for buzz in a transformer. The laminations may appear to be securely clamped and varnished into a solid block; the coil assembly may appear to be impregnated into a solid mass; the coil assembly may be wedged tightly on the core; the transformer may pass all electrical tests, including checks that reveal internal short-circuit across turns in any winding; and the transformer may function perfectly in the receiver. The trouble in such cases may be due to vibration in a section of the core or coil that cannot be seen.

SHORT TURNS MAY CAUSE BUZZ.

Many technicians do not fully realize that an ohmmeter will NOT reveal an internal short circuit across a small portion of the turns in a transformer winding, or in any other coil. There is a manufacturing tolerance in the number of turns in the winding. If the tolerance happens to be $\pm$ 10%, the d.c. resistance of the winding also has a $\pm$ 10% tolerance. If 10% of the turns are short-circuited, the windings will still check satisfactorily within the d.c. resistance tolerance. Yet this partial short circuit, in the case of a power transformer, may cause buzz and overheating. In the case of a vertical transformer, the partial short circuit may cause deflection trouble and buzz. A partial short circuit in a winding of a horizontal-output transformer may cause horizontal-deflection trouble and audible 15 Kc/s whistle.

The value of an ohmmeter in checking a transformer winding is restricted to showing whether the winding is open, or completely shorted, or has a short across more than about 20% of the turns.

It is important to remember that d.c. resistance checks do NOT prove that a transformer, or any other coil, is O.K. The best check, in many cases, is to try a new transformer or coil.

A simple check for partial short-circuited winding in a power transformer can be made by operating the transformer with no load on any of the secondary windings. If the transformer becomes excessively warm during the "no-load" check, it indicates the likelihood of a partial short circuit.

15-Kc/s. WHISTLE.

Mechanical vibration in the horizontal-output transformer in some receivers produces a detectable amount of high-pitched whistle at the horizontal frequency of 15,625 c/s. This sound is referred to as "15-Kc/s whistle".

It is generally the lady-of-the-house who mentions the whistle, because the man-of-the-house usually can't detect it and is likely to suspect that his wife is hearing things. The majority of technicians can't hear the whistle either, even if they put their ear against the transformer, which they are unlikely to do. Some technicians handle this question by looking wise and complimenting the lady on her ability to hear sounds that are beyond the hearing range of the majority of men. A hurried exit at this psychological moment, while the lady's eyes are still sparkling, usually ends the matter.

Sometimes it is possible to detect the whistle by throwing the horizontal oscillator out of synchronism with the station, so that several slanting dark bars (horizontal blanking and sync) appear across the screen. When the bars are in motion, not stationary, the whistle has a low-frequency flutter that may be audible.

Little, if anything, can be done in the way of tightening the core or coils in the average horizontal-output transformer. Sometimes, however, loosening the clamps will help. Also, because of the high-voltage insulation requirements, there is need for caution in making any changes or additions in an effort to reduce vibration or to muffle the sound of the whistle. If the whistle is objectionable to the owner, the usual remedy is to replace the transformer.

If high-amplitude horizontal pulses are coupled into the grid of an audio amplifier, they may produce grid current and set up a high negative bias, thereby greatly reducing the sound output. (This trouble may be accompanied by a high-pitched whistle from the speaker. The whistle develops a flutter when the horizontal oscillator is thrown out of sync, as mentioned above. To check for this rare possibility, temporarily remove the horizontal-oscillator and output valves while a station is being received. It is necessary to remove the output valve as well, as in the absence of the oscillator the plate dissipation is considerably exceeded. If the sound output increases greatly when the oscillator valve is removed, revise the lead dress and shielding of the audio circuits in order to reduce coupling from the horizontal-output circuits.

If the electrostatic shielding around the horizontal output circuits is removed, the subsequent radiation of high-voltage horizontal pulses, and of any spurious oscillation in the horizontal-output circuit, can produce a variety of visible and audible symptoms. For this reason it is good practice to keep the high-voltage compartment "buttoned-up".

SIMPLE EXPERIMENTS.

The best way to become acquainted with the causes and effects of hum and buzz in television receivers is to duplicate some of the troubles described in this article. No special equipment is required except a television receiver and an hour of spare time.

The audio amplifier and speaker of the receiver can be used, in conjunction with a simple home-made electrostatic pickup probe, to furnish a convenient means for observing the sound effects of hum and buzz voltages in various sections of the receiver.

Connect a two-foot length of shielded lead to the high-side of the audio volume control, in series with a capacitor of about 0.05 μF. Connect the shield of the lead to the chassis. The shielded lead should have an insulating outer cover.

Remove the shield from about four inches of the lead, at the free end, to afford electrostatic pick-up. The unshielded portion at the end of the lead will be referred to as the "probe".

Tune in a station, and then remove the sound discriminator, or a valve in the sound i-f amplifier, in order to kill the station's sound.

Vertical-Deflection Buzz.

Bring the probe near the vertical-output transformer circuit, and note the sound of vertical-deflection buzz. Turn the vertical-hold control and note that the tone of the buzz changes. Romove the vertical-oscillator valve and note that the buzz stops.

Picture Buzz.

Connect the end of the probe to the cathode of a video-amplifier valve that has a cathode resistor. Note the characteristic buzz produced by picture signals, and note how the tone and intensity of the buzz change on different scenes, especially on "commercials".

Bring the probe near the output of the video-amplifier. The buzz of picture signals will again be heard.

High-Voltage Buzz.

Bring the probe about two inches from the high-voltage electrode of the picture tube, and note the sound of the picture buzz. (If the receiver has a picture tube having an external conductive coating, temporarily disconnect the coating from the chassis.) Turn the brightness control and note that the intensity of the buzz changes. Remove the socket from the rear of the picture tube and note that the buzz stops.

Audio Hum.

Introduce heater-cathode leakage in the audio-output valve, if it has a cathode resistor, by connecting a rheostat of several thousand ohms from the undergrounded heater terminal to the cathode of the audio-output valve. Note the sound of 50 cycle hum.

Bring the probe near the power transformer, the filter choke, and the heater wiring. Note the sound of 50 and 100 c/s hum. (To avoid excessive attenuation of humming sounds, the speaker should be left in the cabinet, or mounted on a baffle.)

Modulation Hum.

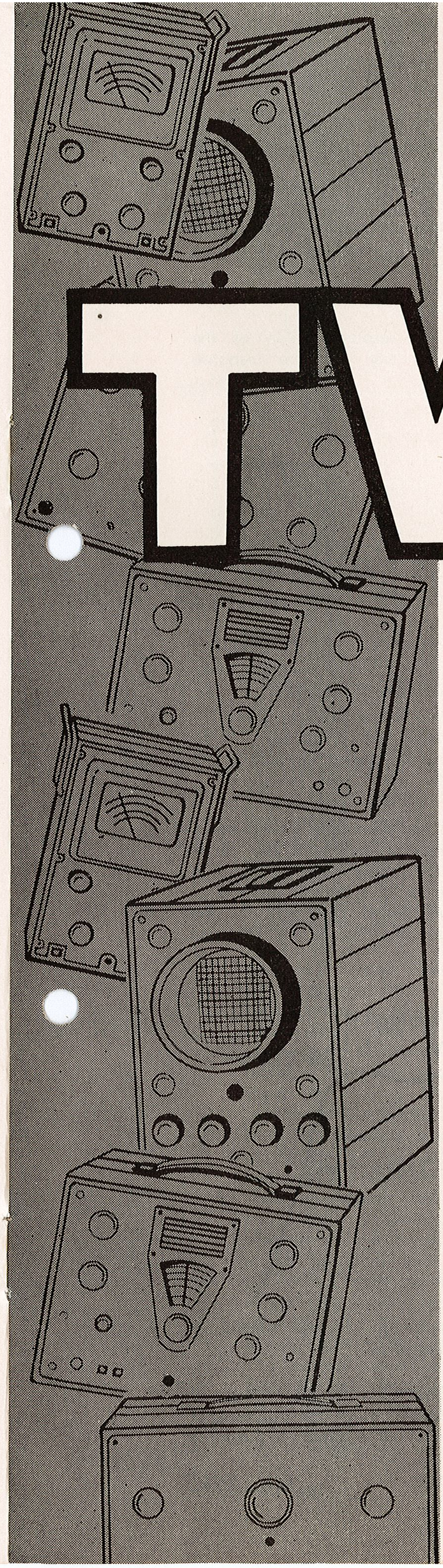
Remove the probe lead from the volume control and replace the sound-discriminator or the sound i-f valve, that had previously been removed. Simulate heater-cathode leakage in valves in the sound i-f amplifier. Note that there is little resulting hum on the station's sound, because the action of the limiter and discriminator tend of eliminate amplitude modulation. Simulate heater-cathode leakage in i-f amplifying valves through which both picture and sound signals pass. Note that the leakage produces pronounced visible symptoms in the picture, but very little audible hum (because of the action of the limiter and discriminator).

Cross Modulation Buzz.

While a strong station is being received, momentarily short out the a.g.c. bias voltage on the r-f and i-f amplifiers. Lack of bias will produce overloading and cross-modulation, with resulting picture buzz in the sound.

The first of two articles by
C. HAMMER
(Test Instrument Section, A.W.A.)

Article 2 is in Jan.'58 issue, P.3.



TV receiver alignment

GENERAL.

This article has been prepared for all those concerned with the adjustment of television receivers, whether they be professional service men, whose main task is the correction of faults in their customers' euipment, or home constructors faced with the task of setting up their receivers to give the best possible picture.

The alignment and general servicing of television receivers requires the use of techniques which differ from those used in general radio servicing. Although the television receiver is more complex than the conventional radio the servicing of these receivers is greatly simplified by the use of special television test equipment.

To properly service the television receiver the following test instruments are listed as being outstanding facilities for the television service test bench.

(1) Television Sweep Generator

(2) Cathode Ray Oscilloscope

(3) Television Crystal Calibrated Marker Generator

(4) Voltohmyst with High Voltage Probe

(5) Universal Measuring Bridge.

USE AND APPLICATION OF SWEEP GENERATOR.

In conjunction with a suitable cathode ray oscilloscope, the sweep generator is used for the visual checking and alignment of television or f-m receivers, aerials and feeders. The main radio frequency output embraces the television bands in the approximate range 50 Mc/s to 250 Mc/s with fundamental signals on all TV channels.

A block diagram of a typical television receiver omitting sync circuitry is shown in Fig. 1.

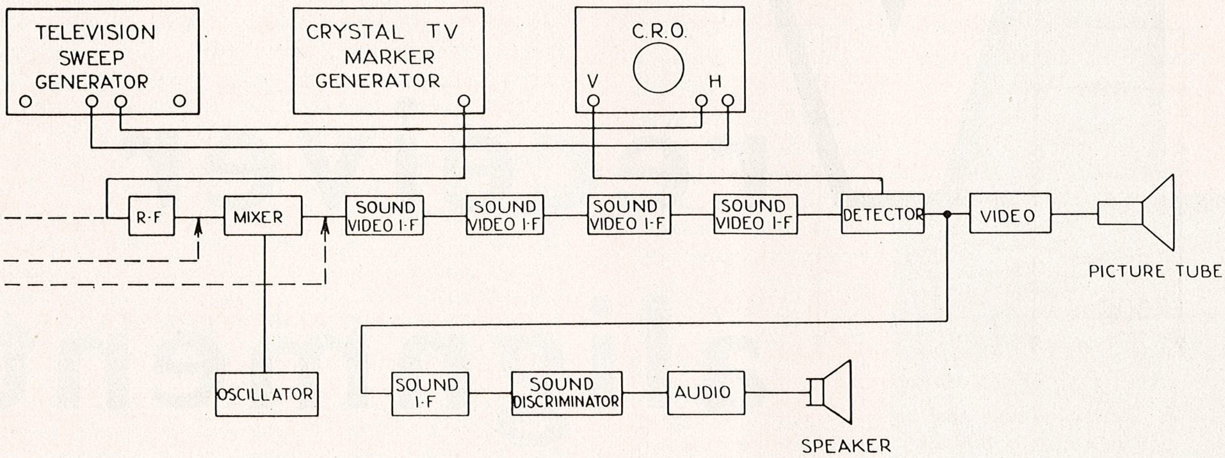


Fig. 1. Block diagram of a typical television receiver.

be achieved with the sweep generator, marker generator and an oscilloscope, and working back from the picture second detector.

The alignment of the sound channel in the television receiver is accomplished in the same manner as in conventional f-m practice, a procedure described below under "Sound I-F and Discriminator Stages".

R-F ALIGNMENT.

By comparing the r-f response curve of the television receiver under test with the response curve illustrated in the manufacturer's service notes, the serviceman can readily determine the circuit adjustments necessary for proper r-f alignment. The procedure outlined below is a typical method of utilizing the television sweep generator to the receiver under test to produce an r-f response curve.

Although most receivers in use can be represented by such a diagram, in practice many different variations will be found. This is particularly true in intercarrier (video i-f) amplifier circuits where the stages may be over coupled, stagger tuned, or combinations of these arrangements. Therefore, when aligning a television receiver, it is necessary to follow closely the manufacturer's service notes. The information below will enable the serviceman to adapt his television sweep generator to the receiver under test. The reader is cautioned that the aligning of any portion of a television receiver should not be attempted unless previous analysis of the difficulty shows alignment to be necessary.

If the television receiver is overloaded with two large an output from the signal generator, the response curves will be distorted. For this reason, the circuits should be aligned with approximately the same signal input and gain control setting that they will receive under normal operating conditions. The average sweep oscillator normally has attenuators in both the r-f and i-f video circuits, features which make it possible to align the receiver at any point from minimum to maximum contrast. The relative gain per stage can be accurately estimated on the screen of the c.r.o.

The initial alignment of stagger tuned i-f systems is generally achieved with an unmodulated Rf source, each circuit being peaked at the frequency recommended by the manufacturer; final alignment can

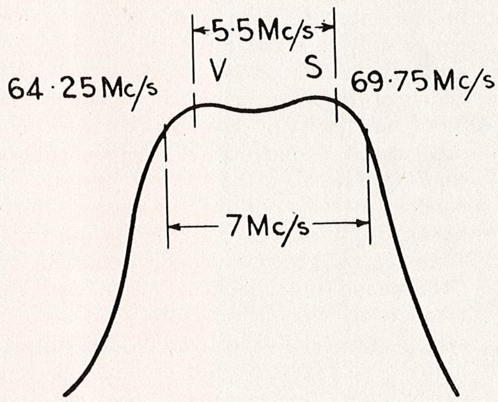


Fig. 2. Response curve of r-f stage (tuned to channel 2).

Fig. 2 shows a response curve for the r-f stage of a typical television receiver which for purposes of illustration is tuned to channel 2. Note the 5.5 Mc/s separation between the sound and video carriers. Since the r-f portion of the receiver must pass both sound and picture signals a channel width of approximately 7 Mc/s is required.

1. Connect the r-f output cable of the sweep generator to the antenna terminals of the receiver via a suitable matching pad where necessary. See Fig. 3.

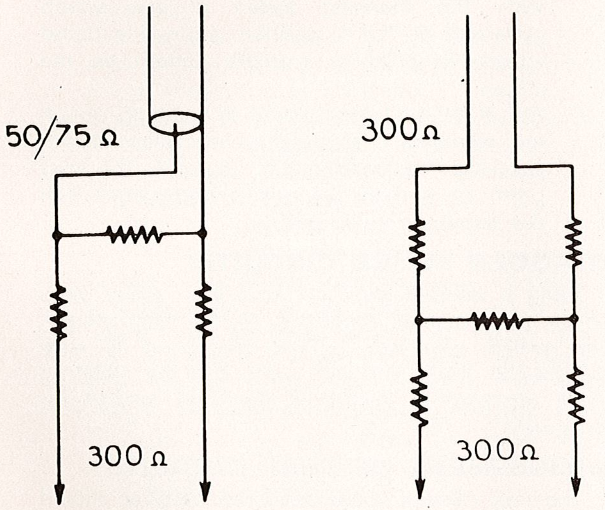


Fig. 3. Sweep attenuator pads.

2. Loosely couple the output from the television calibrator to the input circuit of the receiver. This can usually be done by connecting the ground clip of the calibrator to the receiver chassis and placing the active lead near the antenna circuit of the receiver.
3. Connect the vertical input circuit of the oscilloscope to an appropriate point in the receiver for viewing the r-f response. This connection will vary with different receivers, reference should be made to the manufacturer's service notes. In some sets it may be possible to pick up the signal directly from the converter (or mixer) grid circuit, while in others it may be necessary to modify the converter circuit temporarily in order to obtain the signal.
4. Connect the sinusoidal sweep and earth terminals of the sweep generator to the horizontal input terminals of the oscilloscope. If the oscilloscope employed has a phase controlled sinusoidal sweep of power line frequency, this connection will not be necessary. The line sweep of the oscilloscope may be used.
5. Tune the receiver and sweep generator to an r-f channel, proceeding in the order recommended by the manufacturer and adjust the sweep generator and oscilloscope to obtain a response curve on the oscilloscope screen. Adjust the phase control of the sweep generator (or of the oscilloscope) to obtain a single pattern on the oscilloscope screen.
6. The picture carrier and sound carrier pips from the television calibrator should appear within the flat-topped portion of the response curve of each channel, at points indicated in Fig. 4. (These will vary with every receiver.)

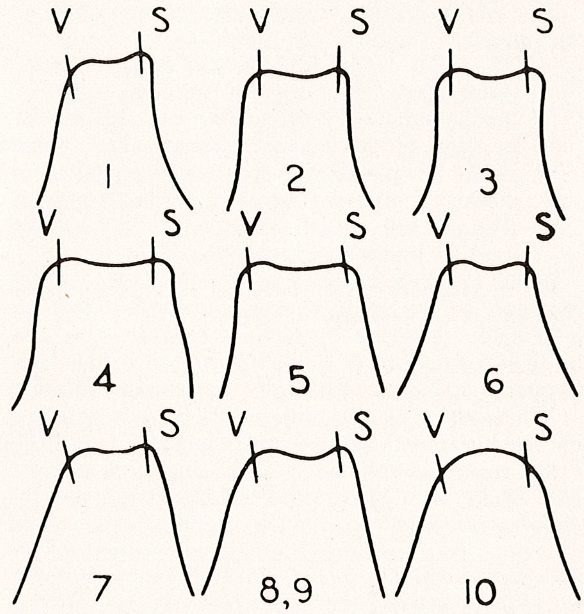


Fig. 4. Response curves for each of the 10 channels.

VIDEO I-F AND AMPLIFIER STAGES.

To provide the proper signal amplification for correct picture definition, the video i-f system of a television receiver must pass a frequency band of 5.5 Mc/s or better in width. Two kinds of video i-f systems are generally used to give the necessary bandwidth. In the over coupled system, both the primary and secondary of the coupling transformers are tuned to the same frequency and the transformers are over coupled to pass the 5.5 Mc/s band. In the stagger tuned system, successive i-f stages are tuned to different frequencies producing a final overall i-f response of the proper bandwidth. Reference to the manufacturer's notes will indicate which system is used in the particular receiver under test.

A hypothetical response curve for the video i-f channel of a typical television receiver is shown in Fig. 5. In this case the receiver employs a video intermediate frequency of 36 Mc/s and is tuned to channel 2.

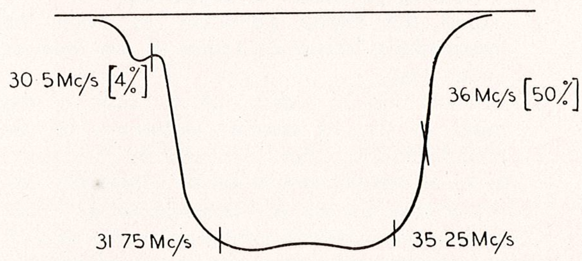


Fig. 5. Video i-f response curve.

VIDEO I-F RESPONSE CURVE.

The frequency relation of sound carrier to picture carrier is reversed in the i-f amplifier since the local oscillator operates at a higher frequency than the carrier.

The following two characteristics of the video i-f response curve should be noted:

(a) The video carrier frequency is set at approximately 50% of maximum response, and

(b) the Sound Carrier frequency must be at 4% or less of maximum response. The video carrier is placed at approximately 50% of maximum response because of the nature of vestigal side band transmission (the system used in transmitting television signals).

If the circuit is adjusted to put the video carrier too high on the response curve, the effect will be a general decrease in picture quality. The low frequency response is increased relative to the high frequency response resulting in an overall reduction in bandwidth. Placing the picture carrier too low on the curve will cause loss in the low frequency video response and result in trailing and reversal with white after black. Loss of blanking and synchronisation may occur. The slope of the video i-f curve is made sharp enough to attenuate to the proper percentage of video carrier amplitude. In order to achieve this selectivity it is conventional to use an absorption circuit (trap) tuned to the sound intermediate frequency. Some receivers include additional traps tuned to the higher adjacent sound channel carrier. These traps, when included in the circuits, will modify the shape of the response curve. Fig. 6 illustrates a typical video i-f response for a receiver using a trap circuit tuned to the adjacent channel frequencies.

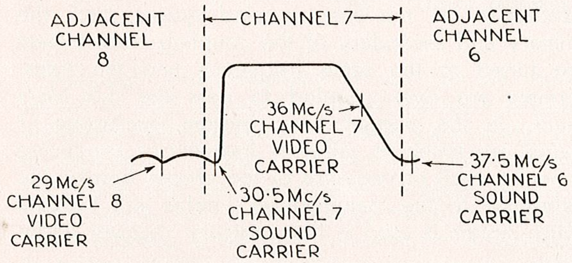


Fig. 6. Video i-f response curve for a receiver using a trap circuit tuned to the adjacent channel frequencies.

OVER-COUPLED VIDEO I-F CIRCUITS.

The following procedure is suggested:

1. Adjust the sweep generator to cover the intermediate frequency range of the receiver under test.
2. Connect the i-f video output Cable to the input of the i-f system. Reference to the manufacturer's notes will indicate the exact point of signal injection for i-f alignment. The signal may be fed to the converter or mixer grid; the recommended feed-point may be shifted progressively from the in put of the last stage back to the converter. The design of some receivers is such that visual alignment of the i-f system is achieved only by feeding into the antenna circuit a signal which has been frequency modulated at the channel frequency.
3. Loosely couple the output of the television calibrator to the input circuit of the receiver.
4. Connect the output of the video second detector to the vertical input terminals of the oscilloscope.
5. Connect the sinusoidal sweep and ground terminals of the sweep generator to the horizontal input terminals of the oscilloscope.
6. Adjust the test equipment to give the i-f response curve on the oscilloscope screen. With the blanking switch of the sweep generator at "OFF" position, adjust the phase control to produce a single pattern on the screen.
7. Adjust the i-f tuned circuits in order to obtain the response characteristics discussed above, checking the band width response, the trap positions, and the i-f carrier frequencies with the television calibrator.

STAGGER TUNED CIRCUITS.

Using a suitable television calibrator, adjust each circuit in the manner suggested by the manufacturer. The sweep generator is then employed to give the overall visual response curve and the response curve analysed to determine the final adjustments necessary.

ADJUSTMENT OF TRAP CIRCUITS.

The trap circuits in the television receiver should be adjusted with an accurately calibrated marker generator to give minimum reading on the oscilloscope at the trap frequency.

An analysis of overall response curve obtained on the oscilloscope by means of the sweep generator will reveal final adjustments to be made.

The final adjustments should be made to conform to an accepted response curve. If, for instance, the response is peaked in the middle of the picture carrier and the picture carrier is low on the response curve, the circuit tuned nearest the picture frequency should be adjusted to bring the carrier up on the curve.

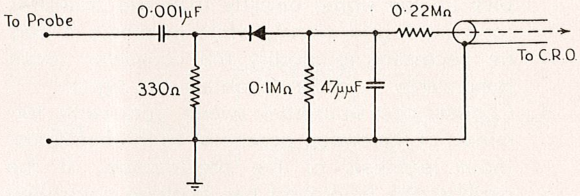


Fig. 7. Crystal rectifier circuit.

VIDEO AMPLIFIER CIRCUITS.

The video amplifier circuits in a television receiver are normally not adjustable. However, the response curve of this circuit may be studied as an aid in locating faulty components.

1. Set the channel selector to the i-f position and the i-f video control to the proper intermediate frequency.
2. Set the blanking control ON.
3. Connect the i-f video output of the video amplifier through a crystal rectifier circuit to the vertical input terminals of an oscilloscope. A suggested crystal rectifier circuit is illustrated in Fig. 7.

SOUND I-F STAGES.

The alignment of the sound i-f and F-M detector is similar to the procedure adhered to for the conventional F-M receiver.

1. Set the Channel Selector of the television sweep generator to i-f position and the i-f video control to the proper intermediate frequency.
2. Connect the i-f video output cable to the input of the i-f stage which feeds the limiter. (Note: There may be no limiter.)
3. Connect the sinusoidal sweep and ground terminals to the horizontal input terminals of an oscilloscope and adjust the oscilloscope for external horizontal input.
4. Connect the vertical input terminals of the oscilloscope across the resistor in the grid circuit of the limiter tube. In some receivers, the time constant of the grid RC circuit of the limiter may be large enough to distort the pattern obtained when the output is taken from the i-f system at this point. If the pattern is distorted, temporarily remove the capacitor of the RC circuit or shunt the resistor with another resistor of suitable value to produce an undistorted output.
5. Adjust the sweep width for a total deviation of approximately 1 Mc/s.
6. Loosely couple the output from the marker generator to the same point at which the sweep generator is connected and tune the marker generator to the sound i-f.
7. With the blanking set to "off" adjust the phase control to obtain a single pattern as illustrated in Fig. 8.

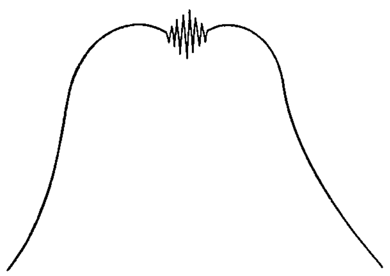


Fig. 8. Marker pattern.

8. Adjust trimmers for maximum amplitude and symmetry of pattern about the marker.
9. Connect the output from the sweep generator to the input of the i-f stage preceding the one just turned and align this circuit according to the above procedure.
10. Continue the alignment working through the i-f system toward the detector valve.

DISCRIMINATOR ALIGNMENT.

After the i-f stages have been properly aligned, the discriminator circuit can be rapidly and efficiently adjusted by the visual method outlined below:—

1. Set the channel selector of the sweep generator to the i-f video control to the sound intermediate frequency.
2. Connect the i-f video output cable to the input of the limiter stage feeding the discriminator.
3. Connect the sinusoidal sweep and ground terminals to the horizontal input terminals of an oscilloscope, and adjust the oscilloscope for external horizontal input.
4. Loosely couple the output cable from a marker generator to the point at which the sweep generator is connected.
5. Connect the vertical input terminals of the oscilloscope to the discriminator circuit at points A and B. Fig. 9.

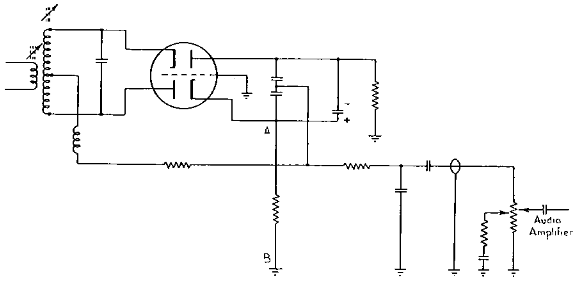


Fig. 9. Typical TV discriminator circuit.

6. Adjust the sweep width control for a total deviation of approximately 1 Mc/s.
7. With the blanking switch "off" adjust the phase control to obtain a single pattern on the oscilloscope screen.
9. Turn the blanking switch to "on" position so that the zero reference line will appear on the screen.

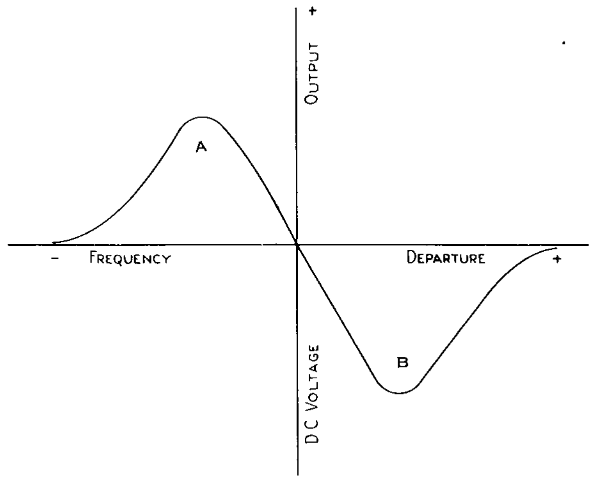


Fig. 10. Ideal response of discriminator.

9. The ideal response of a discriminator which has been properly aligned is illustrated in Fig. 10. The calibrator is used to check the points on the curve at which the various sweep frequencies appear. The sound i-f point should appear at the intersection of the response curve and the zero reference line. Tune primary and secondary of the Discriminator Transformer for maximum linearity between points A and B, Fig. 10, and symmetry about the zero reference line.

NEW RCA RELEASES

RADIOTRON 6198—A
VIDICON

The 6198-A is a small camera tube intended primarily for industrial television applications. Utilizing a photoconductive layer as its light-sensitive element, the 6198-A has a sensitivity which permits televising scenes with 100 to 200 foot-candles of incident illumination on the scene; a resolution capability of about 600 lines; and a spectral response approaching that of the eye.

The design of the 6198-A features a structure without a side-tip and thus allows the use of a longer deflecting yoke than is permitted by a side-tip structure. The longer yoke offers the advantages of less deflecting power, and a narrower deflection angle which effectively reduces deflection distortion and improves centre-to-edge focus of the beam.

Measuring only about 1 inch in diameter and 6¼ inches in length, the 6198-A lends itself to use in lightweight, compact TV cameras. The dimensions of the useful area of the photoconductive layer are such that stock sizes of camera lenses can be employed. The size and location of the layer permit a wide choice of commercially available lenses.

Three New "Pencil" Tubes for U.H.F. Applications

R.C.A. is pleased to announce to equipment manufacturers three new "pencil-type" triodes for military and critical industrial applications—5876-A, 6263-A, and 6264-A.

These new A-versions retain the desirable characteristics of their prototypes and, in addition, are designed to meet special tests for fracture, vibrational acceleration, low-frequency vibration, and one-hour stability life performance.

RADIOTRON 5876—A
HIGH-MU TRIODE

Radiotron 5876-A is a general-purpose hugh-mu triode intended for use in cathode-drive circuits as an r-f power amplifier and oscillator, i-f amplifier, or mixer tube in receivers operating at frequencies up to 1000 Mc/s; as a frequency multiplier up to about 1500 Mc/s; and as an oscillator up to 1700 Mc/s.

As an unmodulated class C r-f amplifier, the 5876-A is capable of giving a useful power output of 5 watts at 500 Mc/s. As an unmodulated class C oscillator, the 5876-A can deliver a useful power output of 3 watts at 500 Mc/s and 750 milliwatts at 1700 Mc/s.

RADIOTRON 6263—A
MEDIUM-MU TRIODE—

Radiotron 6263-A is a medium-mu triode utilizing the "pencil-type" structure with integral plate radiator. It is intended for use particularly as an r-f power amplifier and oscillator in cathode-drive applications in mobile equipment, and in aircraft transmitters operating at altitudes up to 60,000 feet without pressurized equipment. It can be operated at full ratings up to 500 Mc/s and with reduced ratings up to 1700 Mc/s.

The 6263-A has an amplification factor of 27 and when operated under ICAS conditions at 500 Mc/s is capable of giving a useful power output of approximately 10 watts as an unmodulated class C r-f power amplifier or 7 watts as an unmodulated class C oscillator with a plate input of only 14 watts.

RADIOTRON 6264—A
MEDIUM-MU TRIODE

The Radiotron 6264-A is like the 6263-A but has an amplification factor of 40 and is intended for use particularly as a frequency multiplier. It is also useful as an r-f power amplifier and oscillator.

When operated under ICAS conditions, the 6264-A can deliver approximate useful power output as follows: 3.4 watts as a frequency tripler to 510 Mc/s; 10 watts as an unmodulated class C r-f power amplifier at 500 Mc/s; and 6 watts as an unmodulated class C oscillator at 500 Mc/s with a plate input of only 12 watts.