



THE FAMOUS GENERAL ELECTRIC

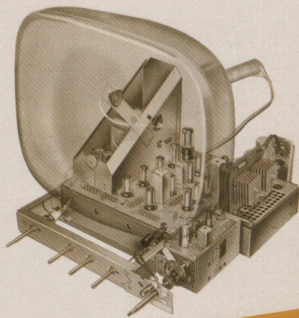
STRATOPower

TELEVISION RECEIVER

TELEVISION COURSE

1952-53

**AN ANALYSIS AND
TROUBLE SHOOTING GUIDE**



PREPARED BY

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GENERAL  ELECTRIC

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CORRECTIONS TO BE NOTED IN
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PAGE 15 - Figures 36 and 37,
shown in reversed polarity.

PAGE 16 - Figure 41, should read
"Discharge Stage Grid Drive Pulse".

PAGE 30 - Photo,
should be same as that shown on page 24.

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THE GENERAL ELECTRIC "STRATOPOWER" RECEIVER

INTRODUCTION

The General Electric STRATOPOWER family of receivers have already received wide acclaim because of their superior performance and their outstanding "eye-appeal".

The following analysis will discuss the many devices of the receiver which are directly responsible for its unprecedented universal acceptance.

A trouble-shooting visual aid section is incorporated in the latter portion of this publication. This section indicates various trouble symptoms and their corresponding corrective measures. This information is compiled in a sequence which follows the sectional circuitry of the receiver.

PHYSICAL FEATURES

This chassis is produced by the application of the dip-solder principle. In this process, the operator places the various components within the chassis with the component leads projecting downward through the dip pins which are fastened to an insulating plate. After all the components are so placed, the entire chassis is then placed into the dip-solder machine. Here the chassis is lowered (top surface down) into a rosin bath and then into a molten solder pool. The component leads thus become soldered to the various pins.

Next, the power supply chassis, r-f tuner chassis and the control apron assemblies are attached and the leads therefrom hand-soldered into the chassis proper. This system has several distinct advantages:-

1. Permits perfect, uniform soldering of the many chassis component leads and other wiring.

2. Eliminates almost all hand-soldering operations. This not only speeds up production of the chassis but also virtually eliminates the possibility of poor solder joints that would otherwise require reworking before final test.

3. Permits a cleaner layout of the components beneath the chassis.

4. Provides convenient points for factory test or alignment jigs.

The picture tube is mounted into the cabinet rather than to the chassis. This was done to satisfy a consumer demand for a better dust seal. By forcing the picture tube forward against the mask

assembly and suitably adjusting the picture tube assembly, an almost perfect dust seal is created. This system is perhaps a bit more costly than a simple chassis-mounted tube arrangement, but the resulting consumer satisfaction more than justifies the use of this method.

Service-wise, this arrangement is far safer since the picture tube remains enclosed in the cabinet when the chassis is removed for service. Also, it is generally much easier to trouble-shoot this chassis without having an attached 21-inch picture tube, when the available extension cables are used.

On the bottom of Stratopower table model cabinets is a removable panel which permits limited service to be performed within the chassis without actually removing the chassis. On Stratopower consoles this panel hinges on one edge and thus provides the same accessibility.

Included in the Stratopower group are the ULTRA-VISION models which use a very dark safety glass, the purpose of which is two-fold:-

1. To assist in the elimination of reflected light or glare. This feature, together with tilting of the safety glass and picture tube virtually eliminates all glare.

2. To increase the contrast range of the picture by darkening the face of the picture tube. (Black objects in a television picture can only be as dark as the tube face. Thus, on a normal screen viewed in a lighted room, dark or black objects actually become light greys and only appear black in contrast with the white portions of the picture).

To compensate for the inserted light output loss due to the tinted safety glass, an aluminized picture tube (21EP4-B) is used. This, together with an exceptionally high final anode voltage provides a much greater picture tube light output. Note that all Stratopower receivers use a substantially large final anode voltage which also results in a smaller spot size. This reduced spot size permits excellent focus to be obtained across the entire screen area.

The Stratopower family of receivers have been designed with UHF in mind. Concurrent with the Stratopower receiver design period was the development of a UHF tuner unit, designated as UHF-103. The Stratopower receiver and the UHF-103 tuner are electrically and mechanically designed to permit simple and rapid installation of the UHF-103 within the receiver.

ELECTRICAL ANALYSIS

Let us now consider the electrical circuits of the Stratopower receiver. In order to better understand the operation and salient circuit features of the receiver, this discussion will be divided into three parts. They are:-

1. Transmitter Fundamentals - A discussion of a few basic facts regarding the nature of the television signal as it emanates from the television transmitter.
2. General Receiver Operation - A brief description of the receiver operation based upon the accompanying block diagram.
3. Circuit Analysis - A detailed description of the various circuits in the receiver, including waveforms where required.

Some of the circuits to be covered are conventional in their design and in many cases bear a great similarity to circuits used in previous General Electric receivers. For the sake of completeness these conventional circuits will be also included in this analysis.

I. TRANSMITTER FUNDAMENTALS

There are several basic facts regarding the nature of the transmitted television signal which must be comprehended before discussing the operation of a television receiver.

Let us consider that a television station broadcasts three basic pieces of information. They are:

1. The sound portion of the program. An FM transmitter operating 4.5 megacycles above the picture carrier frequency is used for this purpose.
2. The picture information.
3. The synchronizing information.

The latter two portions of the transmission (Video and Sync) are combined to modulate the video transmitter. Figure 1 shows the modulation envelope of the transmitted video signal. Note that the maximum carrier level peaks occur at the time of the sync pulses. This carrier peak power level is maintained at a fixed amplitude throughout the television transmission regardless of changes in the camera signal.

The sync pulses are situated on top of the blanking "pedestal" pulse. This blanking pedestal serves the purpose of blanking the picture tube in the television receiver during the period known as the "retrace time" when the scanning beam is returning to the opposite side of the picture tube to start another scanning line.

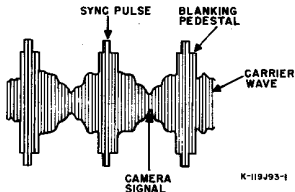


FIG. 1. VIDEO MODULATION ENVELOPE

The actual picture information (video) is that information which exists between the pedestal pulses. Its level varies in accordance with the luminosity of the individual picture elements. The brighter the subject, the lower will be the instantaneous carrier envelope amplitude. The actual limits of video modulation amplitude are such that the darkest picture elements (absolute black) shall not extend upward any further than the top of the pedestal nor should white picture elements extend downward beyond a point approximately equal to 15% of the video carrier. The reason for not permitting the modulation to extend downward beyond the 15% point will be explained in the section discussing the intercarrier sound i-f system. Because the carrier amplitude decreases while traversing from a black or dark picture element to a white one, the system is called a "negative white" transmission.

An important fact regarding the exact carrier frequencies of the existing television channels should be borne out. On each television channel, the sound carrier frequency is exactly 4.5 megacycles higher in frequency than the video carrier. This has been established arbitrarily as a standard for television transmissions in the United States. For example, let us consider channel #3, see figure 2. The video carrier frequency is 61.25 mc and the audio carrier frequency is 65.75 mc. This 4.5 mc "difference" frequency holds true on all channels, including the newly designated UHF channels.

It might be well at this point to also note the bandwidth requirements of a video transmission system.

In a normal AM phone transmitter, the spectrum width of the transmitted signal is a function of the instantaneous audio modulating frequency. If the modulating frequency is, for example, 5 kilocycles, the required channel width would be 10 kilocycles, i.e. five KC above and 5 KC below the carrier frequency.

The situation is quite similar when modulating a transmitter with video program information excepting that the frequencies involved generally extend up to about 4 megacycles. However, sideband information extending beyond approximately 3/4 of a megacycle below the carrier frequency is deliberately attenuated or removed and hence the system is one of a "single-sideband" nature. Figure 2 shows the transmitted signal spectrum. In this case for channel #3. It is obvious that the television receiver must be capable of utilizing this wide band of information if the fine detail picture elements are to be faithfully reproduced.

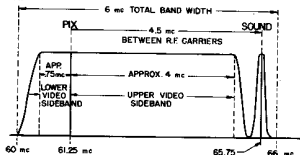


FIG. 2. CHANNEL #3 SPECTRUM

II. GENERAL RECEIVER OPERATION

Let us now briefly discuss the overall receiver operation. Refer to the accompanying block diagram (figure 3).

The incoming signal is amplified by two r-f amplifier stages V101 and V102. The signal is then mixed in the converter V103B, with a signal developed by the local oscillator, V103A. The resulting intermediate frequencies (both sound and picture) are then amplified by V104, V105 and V106. These signals are then rectified or detected by a crystal diode, V151.

Across the diode load circuit appears a 4.5 mc FM signal containing the sound information. This 4.5 mc FM sound i-f carrier is amplified by V109 and then passed to a limiter, V110. The output of the limiter is then detected by the FM ratio detector, V111A. V111B and V112 comprise the remainder of the audio system. The audio signal is then fed to the loudspeaker, 1S201.

Across the diode load also appears the composite sync and video information. This information is then passed to V107A and V107B, the video amplifier and thence to the grid of the picture tube, V108.

A portion of the composite sync and video voltage appearing across the diode load is picked off and amplified by V113A. The noise canceller V113B is tied across the output of the sync amplifier V113A in such a manner that it will remove the deleterious effects of strong impulse noise upon picture stability. This will be more completely described in the circuit analysis section.

The composite video and sync information is then passed to the sync clipper wherein the video information and blanking pedestals are stripped off leaving only the vertical and horizontal sync pulses. Another function of the clipper is to provide an automatic gain control (AGC) voltage for controlling the gain of the r-f and i-f stages.

This is partially accomplished by clipper grid rectification of the sync pulses together with a "minimum" bias developed by the diode detector. Since the sync information is held at a constant level throughout the transmission, these pulses provide an excellent amplitude reference for purposes of AGC operation. The horizontal and vertical sync pulses are separated after the clipper and fed to their respective sweep frequency controlling devices.

First, let us consider the vertical synchronization and sweep system. The many pieces of vertical sync information are grouped or integrated to form the vertical sync pulse. This pulse is applied to one grid of the vertical multivibrator (V114) to control its frequency.

The vertical sweep pulse is properly shaped and then amplified by V115. This amplified voltage is then applied to the vertical windings of the deflection yoke. A portion of the vertical sweep pulse is picked off at the output tube, V115, and after proper shaping, is applied to the cathode of the picture tube. This vertical blanking pulse is used to blank or cut off the picture tube during the vertical retrace time, thus eliminating the annoying diagonal white lines that may appear in the picture should the brightness be turned up too far or if the blanking pedestal pulse from the transmitter is of insufficient amplitude to accomplish vertical blanking. This is a fault in transmission frequently encountered in various areas.

Let us now consider the horizontal synchronization and sweep system. The horizontal pulse information from the clipper tube, V116A, is coupled into the horizontal phase detector V117A wherein a comparison is made between the phase or frequency of the sync pulses and the horizontal sweep pulse. This comparison results in a d-c correction voltage to be applied to the reactance control tube V118A which in turn controls the frequency and/or phase of the horizontal oscillator, V118B.

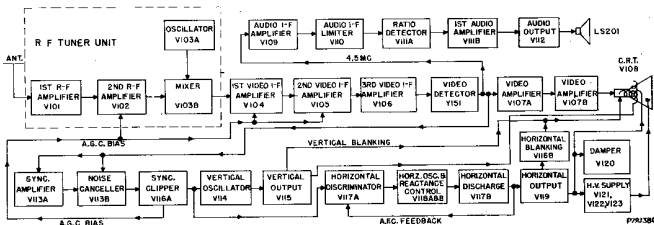


FIG. 3. BLOCK DIAGRAM

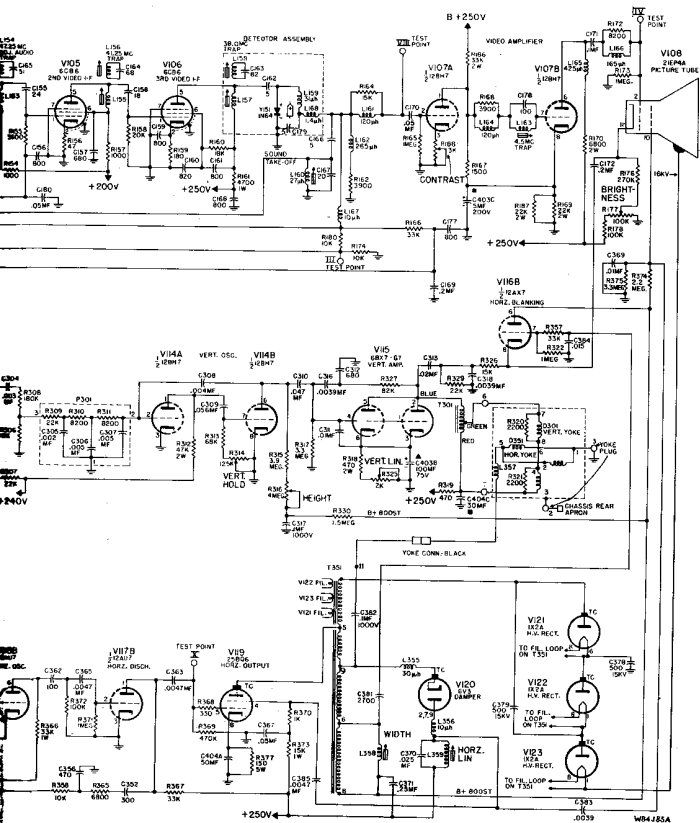


FIG. 4. SCHEMATIC DIAGRAM

The pulse generated by the horizontal oscillator is properly shaped in the horizontal discharge stage, V117B, and applied to the horizontal output amplifier V119. This tube provides the necessary pulses for horizontal sweep and the development of the 15-16 thousand volts required for the final anode of the picture tube. The damper tube V120 is connected in a high-efficiency "flyback" type circuit. Its dual purpose is to dampen out or remove the train of oscillations appearing at the beginning of each sweep pulse and to use these pulses after rectification to provide boosted d-c voltage for the plate of the horizontal output tube, V119.

In the twenty-one inch models, the high voltage is derived from a high-efficiency doubler circuit consisting of V121, V122 and V123. It is the inclusion of V122 as a coupling diode which brings about the higher efficiency and greatly stabilized voltage regulation of the high voltage rectifier system. This will be described in detail in the circuit analysis section. Because of the lower

high voltage requirements of tubes smaller than 21 inches, a straight-forward voltage doubler is used in 17 and 20-inch Stratopower receivers.

A portion of the horizontal scanning pulse, as it appears across the width coil, is picked off and applied to the grid of a cathode follower stage, V116B, from which is derived a horizontal retrace blanking pulse. This pulse removes any possibility of the appearance of horizontal retrace effects. This appears as a vertical white irregular band which might be caused by insufficient transmitted horizontal blanking information or improper fine tuning of the television receiver by the customer.

It is obvious, after having reviewed the general circuit layout, that the new Stratopower models have in their design every necessary circuit or device required for excellent picture reproduction. Now let us closely analyze the individual circuits to better understand their functions.

III. STRATOPOWER CIRCUIT ANALYSIS

1. R-F TUNER UNIT

GENERAL - The r-f tuner is a sub-assembly unit capable of operation on channels #2 to 13. It is fully shielded as a preventative measure against oscillator radiation as well as to prevent stray pickup which might cause picture interference. To further assure low oscillator radiation and to prevent stray coupling, the various leads brought up to the power connection terminal board contain L-C r-f filters.

Mechanically, the tuner unit is similar to tuners used in previous models. Its design includes maximum stability and ease of service. The indivi-

dual switch wafers are easily dismantled for replacement or repair by removing their retaining clip springs and side rails (see figure 5). The oscillator wafer (front wafer) may be removed simply by removing the two front rail clips, the fine tuning capacitor nut and washer and the two self-tapping screws which hold the front detent plate. The detent plate and switch shaft are then removed by pulling the detent plate forward which will leave the oscillator wafer exposed for service.

The various alignment adjustments are conveniently located as shown in figure 6. Note that the adjustment side of the tuner is toward the outside of the receiver, thus permitting complete ease of alignment.

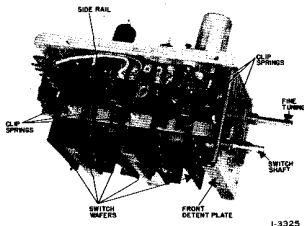


FIG. 5. R-F TUNER

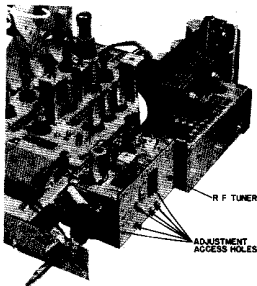


FIG. 6. R-F TUNER (MOUNTED ON CHASSIS)

ELECTRICAL

Refer to figure 7, the r-f tuner schematic diagram.

The input circuits have been designed for efficient antenna coupling as well as to eliminate the transfer of electrical noise or undesirable radio frequency signals which might cause a degradation of the received picture.

The signal as it arrives from the transmission line or built-in antenna is coupled into the cathode of VI01, thru a special broad-band coupling transformer, T100. This transformer consists of a "balanced" primary winding and a "single-ended" secondary winding. Between these two windings is a small copper Faraday shield, the purpose of which is to prevent any voltages picked up in the antenna circuit from being capacitively coupled to the secondary winding. In other words, the only signal to be treated by the secondary winding is the signal picked up by the primary winding. This device may do so only by inductive coupling. This device therefore greatly assists in the reduction of spurious signals and electrical impulse noises picked up by the transmission line.

The "balance" of the primary winding is accomplished by center-tapping the winding and returning this center tap to ground. This further prevents

any signals picked up by the transmission line from getting into the first r-f stage. Refer to Figure 8-A. Suppose that the transmission line were to pick up a signal of a given r-f frequency. This signal, unlike a signal picked up by the antenna will be of equal amplitude and in phase on the two wires of the transmission line, i.e. both leads of the transmission line will appear to be effectively in parallel. Since the two leads of the transmission line are connected to opposite sides of the balanced primary transformer winding, the two in-phase voltages will cancel each other out. Signals of this type are generally referred to as "longitudinal" currents and may consist of anything from spark-pulse noises to shortwave broadcast transmitters etc. Figure 8-B indicates the coupling of signals derived from the antenna into the first r-f stage.

The input circuits are tuned to resonate at the television channel frequencies. This is accomplished by the tank circuits associated with switch S100A. Also, on channels #2-6, a tunable trap L106 is incorporated to reject interfering signals occurring in the 1-f spectrum, the range being approximately 40-50 mc.

V101 is the first r-f amplifier. It is of the "grounded-grid" triode type which is characterized

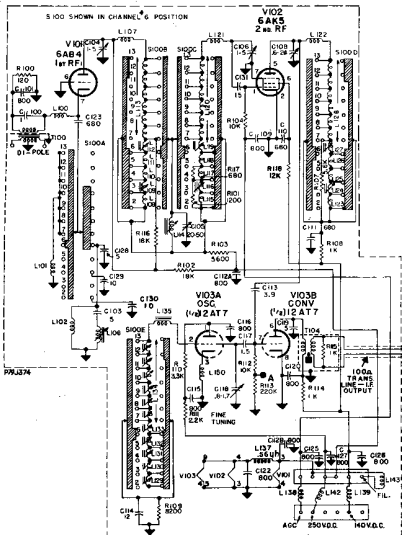


FIG. 7. R-F TUNER SCHEMATIC DIAGRAM

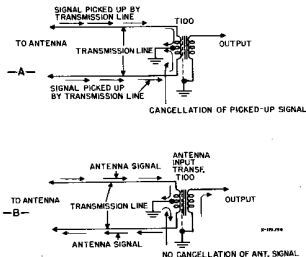


FIG. 8. TRANSMISSION LINE INPUT CIRCUIT

by moderate gain together with an exceptionally low noise figure thus contributing to superior "snow-free" fringe performance. Since the first stage in any high frequency receiver greatly determines the over-all noise figure, a stage which displays a low noise figure and moderate gain is preferable to an input stage displaying high gain with a poor noise figure. Additional gain will be provided by a second r-f stage.

The bias for the first r-f stage is developed across the cathode resistor R100 and is by-passed by C101 which places one side of the input transformer secondary winding effectively at r-f ground potential.

The 1st r-f plate circuit and 2nd r-f grid circuits are tuned by switch-tapped series coils and their associated trimmer capacitors, C104 and C106. These coils are suitably loaded by resistors and are "bottom-coupled" by common impedances represented by C105 and L114.

The second r-f stage is a conventional pentode amplifier (V102) which provides additional gain ahead of the converter and assists in a further improvement of the signal to circuit noise ratio. The 2nd r-f plate circuit is also tuned by tapped series coils and their associated trimmer capacitors, C108.

The signal is then capacitively coupled to the grid of the converter, V103B, thru C113 and is mixed with a signal generated by the high frequency local oscillator, V103A.

This oscillator utilizes grid-to-cathode capacity feedback to sustain oscillation. The coil L150 maintains the cathode above ground. The plate is fed B+ voltage after suitable decoupling and is bypassed directly to ground by C116. The oscillator operates at approximately 41.25 mc above the sound carrier frequency on each channel. The exact frequency of oscillation is determined by the setting of the Fine Tuning control, C118. The Converter, V103B, plate circuit tunes broadly to the desired i-f frequency pass band.

Since the oscillator operates on the high frequency side of each of the television channels, frequency inversion takes place, i.e., the audio i-f carrier assumes a lower frequency than the video i-f carrier. When the receiver is properly tuned, the sound i-f carrier frequency will be at 41.25 mc and the video i-f carrier will be at 45.75 mc. This i-f output signal is then link-coupled to the input grid coil of the i-f amplifier.

The r-f alignment procedure will be found in the applicable service notes. It is important that the published procedures be rigidly adhered to. When using other than General Electric sweep equipment, be sure to properly terminate the sweep output cable in order to prevent standing waves along it which will cause false r-f response curve indications.

2. VIDEO I-F AMPLIFIER (Refer to schematic diagram, figure 4)

The video i-f system consists of three pentode amplifiers, the output of which is detected by a crystal diode. The gain of the first two stages is controlled by an AGC voltage developed by the sync clipper and the crystal diode. The zero-signal or minimum bias for all three stages is developed across their respective cathode resistors. In each case, the amplifiers operate as class "A" stages.

The input signal is delivered from the r-f tuner via link coupling. The grid winding or secondary of T151 is tuned approximately to the center of the desired video pass band. A 38.0 mc parallel-tuned absorption trap, L152, is tied across the input grid circuit. Also, an absorption trap, L151, is inductively coupled to T151 to reject any adjacent channel audio carrier interference. Refer to figures 9-12 to better understand the development of the final i-f response curve.

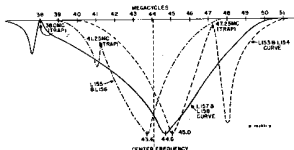


FIG. 9. VIDEO I-F CURVES

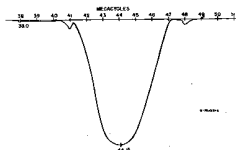


FIG. 10. RESULTANT I-F
(Total Response of Fig. 9 Curves.)

Each curve represents the plate coil and its associated trap. The next two plate coils, L153 and L155, are tuned to opposite sides of the pass band center frequency in such a manner as to provide the desired 45-55% response at 42.5 mc and 45.75 mc. Inductive absorption traps are coupled to each of these coils. L154 is the second 47.25 mc trap. L156 is tuned to the "accompanying" sound frequency of 41.25 mc. It is not the purpose of this trap to eliminate the 41.25 mc carrier since

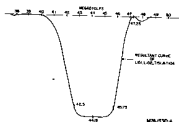


FIG. 11. CONVERTER PLATE & 1ST I-F GRID CURVE

this would remove the sound signal when the receiver is properly tuned. Rather, this trap is incorporated to lower the percentage of audio 1-f carrier present in the i-f system to a point (approximately 30 db down) to prevent excessive 4.5 mc "crystallization" effects in the picture when the receiver is tuned for best picture detail. (The very high gain of the audio 1-f system plus its limiting stage more than compensates for this insertion loss).

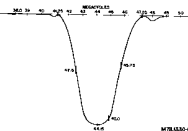


FIG. 12. VIDEO I-F OVERALL RESPONSE CURVE

The coil L157 is tuned to the indicated frequency. Misalignment of this tank circuit will cause a dissymmetry of the i-f system response curve and should therefore be avoided (see figure 13). A 38 mc trap, L158, is inductively coupled to L157.

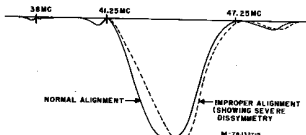


FIG. 13. UNSYMMETRICAL RESPONSE CURVE

Let us stop here for a moment and consider the reason for having 38.0 mc traps. The normal frequency to be used for adjacent channel video trapping would be 39.75 mc when using a video i-f carrier frequency of 45.75 mc. (See figure 14). But supposing, as is the usual case between two television service areas, that there are two weak adjacent channels which may be received. Two conditions must be satisfied:

1. The weak, desired channel video i-f carrier will normally be placed near or at the top of the PAGE 8.

i-f response curve since the operator will tune for maximum picture gain.

2. With the video carrier now at the top of the response curve, the adjacent channel video trap must also be shifted correspondingly lower in frequency - hence, the seemingly odd frequency of 38mc is used for adjacent channel video carrier attenua-

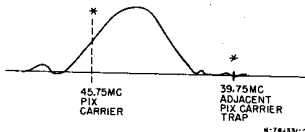


FIG. 14. NORMAL TUNING WITH 39.75 MC TRAP

tion. (See figure 15). It is obvious that adjacent channel attenuation is relatively unimportant in primary service areas since the reception of a strong adjacent channel is unlikely. Also, the inclusion of a 39.75 mc trap might, according to the strength of the received signal, cause the sound output level to fall off, should the Fine Tuning control be adjusted to place the audio i-f carrier in this trap.

The two i-f carrier signals present at the plate of the third i-f (V106) are capacitively coupled

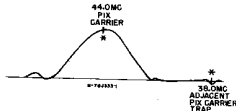


FIG. 15. FRINGE TUNING SHOWING 38.0 MC TRAP

to the crystal diode "shunt-type" detector. L168 is incorporated as a "tweeter" filter and eliminates upper-order harmonics of the i-f frequencies present in the crystal output which would cause tuneable interference patterns on some channels.

The video signal, as it appears at the crystal detector output, is shown in figure 16. Although



FIG. 16. DIODE OUTPUT WAVEFORM

as previously stated, the transmitted signal is of a "negative white" characteristic, the signal is reversed or becomes "positive white" at the crystal detector since the diode is connected so as to pass only the lower half of the modulation envelope, as shown in figure 1. A note should be made at this point that an accidental reversal of the crystal diode will result in a negative picture which will be accompanied by a deterioration or complete loss of the sync stability of the receiver.

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3. VIDEO AMPLIFIER

V107 is a unique video amplifier consisting of two direct-coupled triode stages. There are no coupling time constants between the two stages, thus eliminating the "white flashing" usually caused by ignition interference.

The amplifier displays excellent transient and frequency response, extending upward to approximately 3.75 mc.

Since the sync information is fed to the sync system from the diode detector immediately before video amplification, the video amplifier need not amplify or even pass this information. This permits the full utilization of the video amplifier dynamic amplitude range for the sole purpose of video and blanking amplification, and hence results in a far greater available video output voltage compared to systems wherein the video amplifier must also pass sync information.

As indicated on the accompanying schematic diagram, the plate voltage for the first stage, V107A, is developed essentially from the drop across the cathode resistors (R169, R187) of the second stage V107B. Additional B+ voltage is supplied to the plate of the first stage through R186 which results in a further increase in gain.

A 4.5-mc trap (L163, C178) is incorporated between stages of the amplifier for the purpose of audio carrier attenuation. This trap is parallel resonant and is in series with the input lead to the second stage. This arrangement results in higher gain in the upper frequencies when compared to a series-tuned trap connected between a signal-carrying lead and ground. The series-tuning capacitor (usually a few micro-micro-farads) would tend to partially shunt upper-video frequencies.

The gain of the video amplifier, at the maximum setting of the contrast control, is approximately 60. Since the required amplification is achieved with negligible amplitude distortion, a faithful reproduction may be had of the full tonal values of black through gray and white.

4. AUDIO I-F SYSTEM

The output of the video detector, V151, contains not only composite video information, but also a

4.5-mc signal which is the result of detection of the two i-f carriers (45.75 mc and 41.25 mc). This "difference" frequency is essentially an FM signal which contains the program sound intelligence. It also is amplitude-modulated by video information originating from the video i-f carrier. This video amplitude modulation, unless eliminated, would cause a harsh 60-cycle buzz to be heard in the loudspeaker. Therefore the audio i-f system must amplify the 4.5-mc signal, remove all amplitude modulation and detect the FM signal to recover the program audio information.

A 4.5-mc FM signal is taken off the diode output by the tuned circuit consisting of L160, C166 and C167. This signal is fed to the grid of a high-gain pentode amplifier, V109 (6CB6). This stage operates as a class "A" non-limiting amplifier. The output signal then drives the following stage, V110, into limiting.

V110 operates as an overloaded class "C" amplifier. The plate and screen of V110 are supplied with low voltages, thereby providing a low overload point. The bias for the limiter stage occurs by virtue of grid rectification of the driving signal and consequent charging of C205. R218 is the "grid leak", while R215 provides isolation between the test point and the tuned circuits of T201. The inclusion of this limiter stage permits a constant audio output level over wide variations of signal input level, while also assisting in the removal of impulse noise interference.

At this point we now have a fairly strong FM signal. Much of the video AM has been removed. It is merely necessary now to pass this signal thru a suitable FM detector which will not respond to the small amount of remaining AM. This is accomplished in a conventional ratio detector.

The ratio detector is actually a modified FM discriminator which, additionally, is capable of removing any existing amplitude modulation components of nominal proportions. Notice that unlike a conventional discriminator, the two diodes are series-connected d-c wise. The d-c voltages developed across capacitor C214, an electrolytic, and C215, an r-f bypass, will be proportional to the input 4.5-mc signal level. The audio output terminals of this device are actually terminal "P" of the detector transformer and the theoretical midpoints of R208, C214 and C215 as shown in figure 17. Excursions of the FM carrier above and

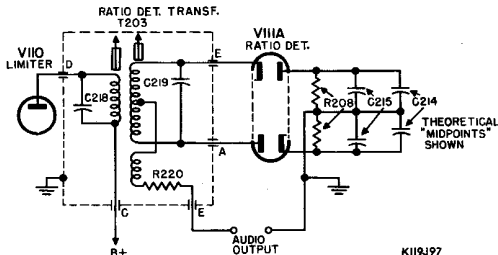


FIG. 17. THEORETICAL RATIO DETECTOR DIAGRAM

below the center frequency will change the ratio of the instantaneous d-c voltages on each side of the above mentioned midpoint, but note that the d-c sum voltage across the entire diode load circuit remains constant. The voltages across each half of the load circuit are equal when the carrier is at "center frequency". Impulse noise or video AM is essentially eliminated by virtue of the very long time constant of the diode load circuit which maintains a constant "total" d-c voltage despite the presence of amplitude modulation. Also AM is rejected because the audio output voltage is a function of the **RATIO** of voltages across each half of the diode load and not a function of the "total" voltage. The audio output voltage is now passed through a conventional de-emphasis filter consisting of C208, C212 and R204. This output voltage is next passed to the audio amplifiers.

At this point let us consider a statement made earlier in the "Transmitter Fundamentals" section of this publication.

It has been pointed out that the video carrier must not be amplitude-modulated beyond certain limits. It is possible that, despite the excellent amplitude-limiting ability of the audio i-f system of this receiver, buzz may be heard in the loud-speaker at times when the picture contains heavy "whites". Recalling the fact that "whites" are actually minimum instantaneous video carrier level components, it becomes obvious that if the instantaneous level of the video carrier is permitted to go too low or even possibly be cut off, a corresponding interruption of the resulting 4.5 mc i-f carrier in the receiver will occur. This interruption will cause a buzz in the receiver audio output which no amount of limiting could possibly correct, since at these times there is simply **NO CARRIER**. For this reason, it has been arbitrarily established that television transmitters shall not be modulated downward beyond the 15% mark so that intercarrier receivers will not buzz on heavy "whites".

5. AUDIO AMPLIFIER

This portion of the receiver is quite conventional in its design. It consists of V11B, a triode voltage amplifier, and V112, a pentode power amplifier which, in turn, drives the loud-speaker.

The volume control, R210, includes a tap for bass compensation in Stratopower consoles. The compensation consists of R209 and C211. This provision is not included in the Stratopower table models.

Between the two audio amplifier stages is a small inductance, L202. This r-f choke is incorporated as a "sweet" filter to suppress the strong harmonics of 4.5 mc. The need for this arises from the fact that the first audio tube is within the same glass envelope as the ratio detector. The plate lead of the first audio stage (V11B) runs back to the extreme rear of the receiver to the output stage. Thus the possibilities of 4.5 mc harmonic radiation must be eliminated by the inclusion of L202.

The cathode of the audio output stage is unbypassed. The resulting negative current feedback enhances the audio quality by reducing the distortion factor to negligible proportions.

6. SYNC. NOISE CANCELLER & AGC

Figure 16 shows the sync amplifier (V113A) input signal waveform which is derived from the diode output. V113A amplifies and inverts the signal, thereby making the sync pulses positive in polarity at its plate, (see figure 18).



FIG. 18. INVERTED SYNC PULSES (V113 PLATE)

The noise canceller is a newly incorporated device designed to combat ignition and similar interference which often is a cause of sync instability. Refer to figures 18, 19 and 20.

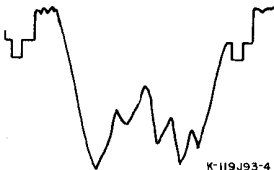


FIG. 19. SIGNAL WITH NOISE (V113B CATHODE INPUT)

The noise inverter or canceller, V113B, is tied across the output of the sync amplifier V113A. The cathode of the canceller has a fixed positive bias applied by virtue of R201, R202. Its grid is maintained at a negative bias level proportional to the peak voltage of the incoming signal. This negative grid bias is obtained from the crystal diode, Y151, and suitably filtered by R166 and C169. These two bias voltages combine to cut off the canceller tube, V113B, so that it will normally not conduct in the presence of a received television signal.

The cathode of the canceller, V113B, is fed a signal consisting of video and negative-going sync as well as impulse noise, if any (figure 19). Since the canceller is biased off and will not pass any signals less than the sync-tip level, nothing happens until a noise burst of greater-than-sync-tip level occurs. When this happens, the canceller tube, V113B, will conduct heavily, and virtually short-circuit the output of the sync amplifier. Of course, during the time interval of the noise burst, neither sync nor noise will be present in the output of the sync clipper (figure 21). At these times, the inertia of the sweep circuits or "fly-wheel" effect is relied upon to maintain proper frequency. After the noise burst ends, the canceller tube, V113B, ceases to conduct and the circuits return to normal operation. (For maximum efficiency, however, the canceller is normally biased in such a manner as to slightly wipe sync. This is mentioned here instead of earlier, to prevent confusion.)

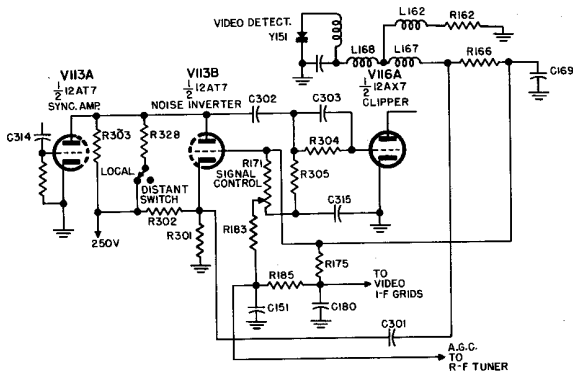


FIG. 20. NOISE INVERTER CIRCUIT

The composite video waveform from the plate of V113 A & B (depending on noise conditions, if any) is next impressed upon the grid of the clipper tube, V116A, through capacitor C302 and the network consisting of C303 and R304. Since the sync information is of positive polarity at this point, it will cause the grid of the clipper to draw grid

current, and consequently charge C302 and C303. This negative charge sets the operating bias for the clipper. This bias voltage is such that the tube is biased beyond cut-off and hence passes only the most positive portions of the driving signal, i.e., the sync information. The only signals to be found at the clipper plate, therefore, will be horizontal and vertical sync pulses which have been stripped free of video and blanking information (figure 22). The inclusion of the network

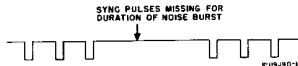


FIG. 21. RESULTANT SYNC OUTPUT (HOLE PUNCHING)

consisting of C303 and R304 permits rapid recovery of sync after impulse noise interference by the introduction of a "double" time constant. C303 discharges rapidly after a noise pulse, while the charging time constant of C303 and R304 is made quite long. The charge on capacitors C302 and C303 is permitted to slowly leak off through R305, R171 and R166 toward a minimum reference bias voltage developed by the crystal diode, Y151.

This bias voltage is also used for controlling the r-f and i-f gain of the receiver, since it remains constant throughout the transmission and becomes directly a function of the received signal strength. C315 serves to filter out pulse information so that it will not appear on the long lead going up to the AGC control. C151 and C180 are AGC bypass capacitors.

The AGC voltage applied to the first two i-f amplifiers is equal to the r-f tuner bias at the fully clockwise setting of the signal control, R171 (maximum gain). However, at settings of R171 other than fully clockwise the i-f bias is divided down to some voltage between the clipper grid voltage and the diode output voltage. This proportioning of the AGC voltage to the r-f amplifier and to the i-f amplifiers permits a more satisfactory range of AGC operation, particularly with respect to eliminating receiver overload on very strong signals.

The extreme clockwise "switch" position of R171 removes R238 from the circuit to increase the sync amplifier gain for fringe area operation.

The composite sync signal found at the plate of the sync clipper (figure 22) is now fed to two devices in order to synchronize both the vertical and horizontal oscillators in the sweep system. First, let us consider the vertical synchronization.

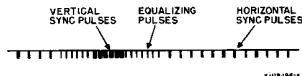


FIG. 22. COMPOSITE SYNC AT CLIPPER PLATE

7. VERTICAL SYNCHRONIZATION

Situated atop the vertical blanking pedestal will be found a series of pulses, the purpose of which is to provide one single pulse for vertical oscillator synchronization. This chain of information is shown in figure 26.

The required vertical pulse is formed in the vertical integrator, a low pass filter (F301), by grouping the pulses to form the single theoretical vertical sync shown. The actual pulse formed in the Stratopower receiver is shown in figure 23.

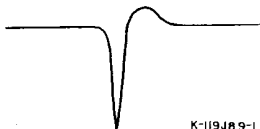


FIG. 23. ACTUAL VERTICAL SYNC PULSE

The vertical oscillator (a multivibrator) locks in on the leading edge of the sync pulse as shown in figures 24 and 25.

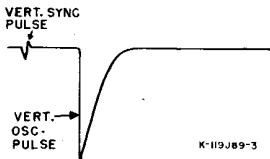


FIG. 24. VERT. SYNC & OSC. PULSE (NOT IN SYNC)

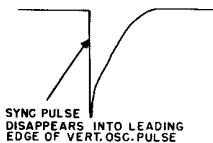


FIG. 25. VERT. SYNC & OSC. PULSE (IN SYNC)

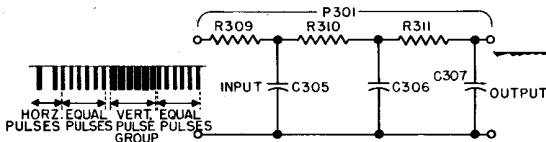


FIG. 26. INTEGRATOR INPUT & OUTPUT

8. HORIZONTAL SYNCHRONIZATION

As previously mentioned, horizontal synchronization is accomplished by comparing the phase and frequency of the incoming horizontal sync pulses with the scanning pulses which are generated in the horizontal sweep system of the receiver. The result of this phase or frequency comparison will be a direct current voltage whose amplitude and polarity will depend upon any difference that may exist between the phase or frequency of the sync pulses and the sweep pulses generated in the horizontal sweep system. This direct-current voltage is then applied to a device (the reactance tube) which in turn advances or retards the timing of the horizontal sweep oscillator in the receiver so that it will remain accurately in step with the sync pulses. This system represents one type of Automatic Frequency Control (AFC).

The composite sync pulses as shown in figure 22 are coupled through C363 and then through the "high-pass" network consisting of R360 and C354. These pulses are then applied to the phase detector tube, V117A. Figure 27 shows the

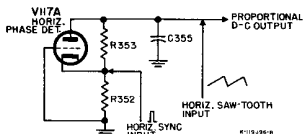


FIG. 27. BASIC HORIZ. PHASE DETECTOR

basic circuit of V117A, redrawn with those components missing which do not directly take part in the phase and frequency comparison. (The grid resistor R354 and its bypass capacitor C351 are only required to insert a small fixed bias voltage which is necessary for the operation of the reactance tube and not the phase detector).

In order to better understand the functioning of this phase detector, we must first recall a few facts regarding the dynamic plate current and "positive region" grid current characteristic curves of a typical triode tube. Generally speaking, the application of an identical small positive voltage to both the grid and plate of a triode tube will

cause almost identical currents to flow in each element. Figure 28 shows an average triode plate and grid current series of curves. As an example, let us see what happens when we apply +20 volts to each element. (The numbered arrows on the chart correspond to the step numbers below).

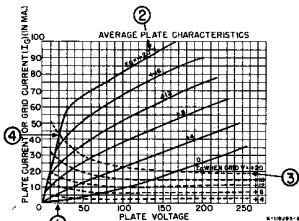


FIG. 28. TRIODE PLATE & GRID CURVES

1. Choose plate voltage = +20 volts
2. Choose plate current line along which $E_g = +20v$.
3. Choose grid current line along which $E_g = +20v$.
4. NOTE RESULT - The grid current curve and the plate current curve cross at approximately 45 milliamperes and are equal. (Note that this condition holds true for other small values of equal applied positive voltage on both elements).

Let us now look at the circuit itself. For purposes of simplified discussion let us again redraw the circuit as shown in figure 29.

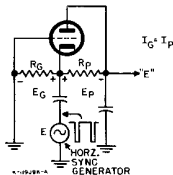


FIG. 29. SIMPLIFIED PHASE DETECTOR (SYNC & SAW-TOOTH INPUT)

Between the cathode and ground is shown, for purposes of discussion, a generator which supplies horizontal sync pulses. These pulses, as supplied by the sync clipper, and in this case by the generator, are of negative polarity, thus causing the plate and grid to draw current. (This being the same as grounding the cathode and applying equal positive voltages to each element). Since the pulse voltages applied to the grid and plate are equal, the currents which flow through R_g and R_p will be equal and hence so will be the voltages developed across them. Consequently, the output voltage between ground and point "E" will be zero volts because of the indicated voltage polarity relationships across the resistors R_p and R_g .

Up to this point, we have not indicated any applied waveform, except sync. Now let us insert the saw-tooth reference voltage which is supplied by the output circuits of the horizontal discharge tube, V11/B. Again, as shown in figure 30, this saw-tooth voltage will be supplied by a generator

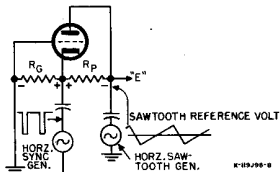


FIG. 30. SIMPLIFIED PHASE DETECTOR (SYNC INPUT ONLY)

for simplicity. This saw-tooth voltage, as here applied, amplitude-modulates the plate current.

As shown in figure 31, condition 1, if the horizontal oscillator in the receiver is properly timed, the developed saw-tooth voltage will be so positioned that the sync pulse will occur exactly at the center of its retraces slope. Therefore, the grid and plate currents will be equal, thus producing zero volts output and hence no phase correction will be applied to the oscillator.

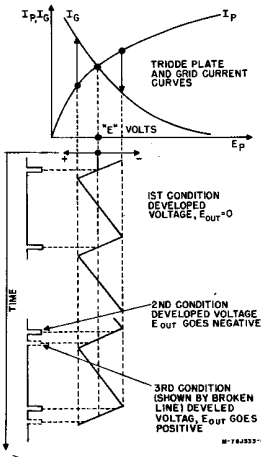


FIG. 31. PHASE DETECTOR OPERATION

Conditions 2 and 3 show the effect of either a leading or lagging sync pulse. In either case, a current unbalance will exist which will cause a positive or negative d-c voltage to be developed which in turn will correct the oscillator timing. If the horizontal oscillator of the receiver fires too late (i.e. the sync pulse is "leading") as shown in condition 2, the plate current increases, causing a negative output voltage. This will cause a speeding up of the horizontal oscillator by virtue of the reactance tube (to be discussed below). If the sync pulse "lags", as shown in condition 3, the negative developed voltage at the plate will be less than the positive voltage appearing at the cathode, thus resulting in a positive output voltage which in turn will retard the oscillator firing time.

The reactance tube, as shown in figure 32, acts as a variable resistance which is connected in series with C358 across the oscillator tank circuit to vary its frequency. As the d-c output from the phase detector changes amplitude or polarity, the reactance tube plate resistance will change accordingly. A positive voltage on the grid will cause the tube to conduct more heavily, thereby lowering the resistance between the capacitor C358 and ground. This increases the effective capacitive reactance of C358 across the oscillator tank circuit and causes a consequent lowering of its natural resonant frequency. Conversely, the application of a negative grid-correcting voltage will result in a higher natural resonant frequency of the oscillator tank circuit. It should be noted that along with the applied correcting voltage will also be found a small value of fixed negative bias which centers the operating grid voltage about the midpoint of the reactance tube linear plate current characteristic, i.e., the tube appears as a simple class "A" amplifier. This negative bias is obtained from the oscillator grid circuit for convenience, and is dropped to the desired voltage by resistors R356 and R354 and then filtered by C351 to remove all traces of the oscillator grid waveform. (See figure 4).

Between the phase detector output and the grid of the reactance tube will be found a circuit consisting of R355, R359, C357 and C375.

The purpose of this special network is to provide a filtered d-c output from the phase detector to the reactance tube grid. The time constant of this circuit is long enough to remove sync and saw-tooth feed-back pulses but yet fast enough to permit rapid frequency correction. Such correc-

tion may be required in case of horizontal oscillator drift or changing from station to station.

In summary, it may be said that automatic frequency control (AFC) systems, of which this is one example, provides a large degree of immunity from horizontal instability arising from various types of noise, signal level changes and horizontal oscillator drift.

9. VERTICAL SWEEP SYSTEM

The vertical sweep system consists of a multivibrator and a class "A" parallel triode power amplifier which in turn drives the vertical windings of the deflection yoke. This provides the vertical deflection of the electron beam in the picture tube.

The tube V114 acts as an "unbalanced" vertical multivibrator. That is, the "mark-space" ratio of its output waveform is not equal. This may be observed by temporarily disconnecting capacitor C310 and noting the oscillographic waveform shown in figure 34. The multivibrator is "unbalanced" by virtue of the large difference between the time constants (RXC) in the two grid circuits.

The free-running frequency of the multivibrator is determined by the time constant of C309 and the total grid resistance determined by R313 and the setting of R314. The amplitude of the output pulse is controlled by varying the plate voltage on V114B by the setting of the height control. The multivibrator is synchronized by applying the negative polarity sync pulse formed in the integrator circuit of P301 to the grid of V114A, as previously mentioned. The square wave output of the multivibrator is transformed into a saw-tooth voltage by the process of integration and the external "Miller effect" introduced by the network consisting of R327 and C316. This waveform may be observed by connecting an oscilloscope to the grid of V115 and noting the waveform of figure 35. The linearity of the sweep amplifier output waveform is controlled by varying the bias on the amplifier cathode. The plates of the vertical amplifier are coupled to the deflection yoke by an auto-transformer, T301. The "tap" point on the winding is chosen to provide a proper impedance match for the vertical yoke windings and thus insures maximum

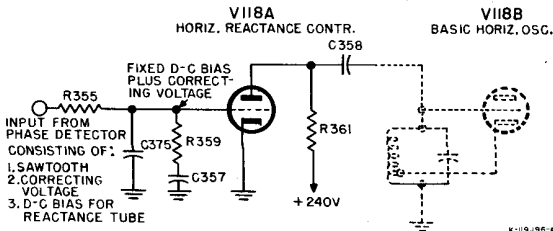
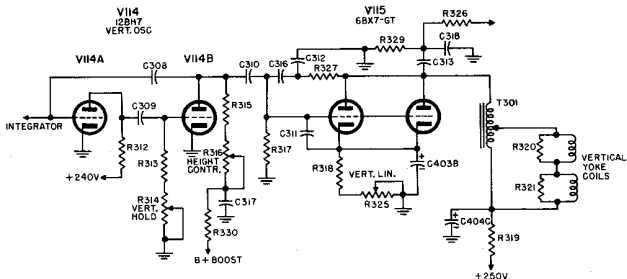


FIG. 32. REACTANCE TUBE CIRCUIT



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FIG. 33. VERTICAL SWEEP CIRCUIT

power transfer. The series network, C316 and R327 also provides a feedback voltage which "stiffens" or shortens the retrace time of the saw-tooth output wave. This waveform is shown in figure 36.

Two resistors, R320 and R321, are connected

A portion of the output voltage is applied to the picture tube for the purpose of vertical retrace time blanking. The coupling network, consisting of C313 and R329, differentiates the sawtooth wave as shown in figure 37. This positive polarity voltage is then coupled to the cathode of

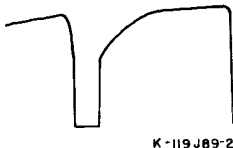


FIG. 34. VERTICAL OSCILLATOR OUTPUT PLATE WAVEFORM.

across each section of the vertical deflection coil. These resistors perform the function of dampening the oscillations which would occur at the beginning of each horizontal saw-tooth sweep trace due to shock excitation of the vertical coils by the horizontal sweep.

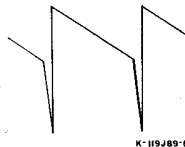


FIG. 36. VERT. AMPLIFIER PLATE WAVEFORM

the picture tube and hence cuts the tube off during the retrace period. (R326 and C318 are a part of the horizontal blanking system and have little effect upon the shape and amplitude of the vertical blanking pulse. These components will be discussed under "Horizontal Blanking").

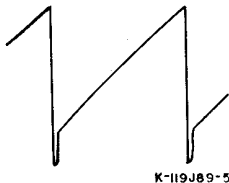
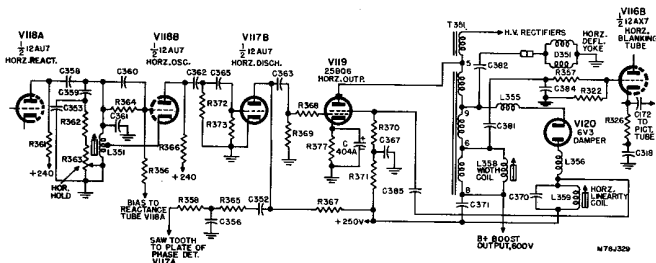


FIG. 35. VERTICAL AMPLIFIER GRID WAVEFORM



FIG. 37. VERT. BLANKING PULSER

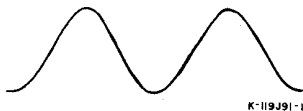


10. HORIZONTAL SWEEP SYSTEM

The horizontal sweep system consists of the following circuits, refer to figure 38.

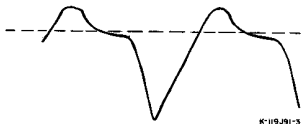
1. The oscillator, which initiates the chain of events resulting in the generation of the sweep waveform.
2. The discharge tube, which together with a charging (storage) capacitor forms the saw-tooth driving pulse.
3. The sweep output stage which controls the delivery of power to the deflection yokes and high voltage system.
4. The damper, which dampens out the train of oscillations that occur at the beginning of each horizontal line caused by shock excitation of the yoke inductance. The damper adds this rectified power of the collapsing horizontal deflection coil field to the original B+ supply and delivers this as "boosted" supply voltage to the sweep amplifier vertical oscillator and the picture tube first anode.

The oscillator, V18B, is a Hartley-type, class "C" oscillator (i.e., plate current is drawn for period of less than one-half cycle). Feedback is accomplished by returning the cathode to a tap on the grid tank coil. The waveform on the grid closely approximates a perfect sine wave as shown in figure 90.



The negative pulses at the oscillator plate are shown in figure 40. These pulses are of short duration since they represent only the uppermost positive portion of the grid voltage.

The combination of C362 and R372 forms a differentiating coupling and produces the waveform of figure 41 which is then coupled through C365 to the grid of V117B.



V117B, the discharge tube, may be considered similar to a switch between chassis ground and the junction of C352 and R367. This stage produces the waveform of figure 42 as follows:-

The positive portions of figure 41 cause the grid of V117B to draw current and thus charge C365 negatively which cuts off V117B plate current. R371 slowly discharges C365, but just enough to allow only the most positive excursions of the driving voltage (figure 41) to cause plate current to flow. During the interval when V117B is out off, C352 and C356 charge up (in series) toward the B+ voltage through R367. When V117B momentarily conducts, the d-c voltage built up on C352 and C356 immediately drops to near zero, thus producing the waveform of figure 42. This "peaked" saw-tooth voltage is fed to the grid of the output stage, V119.



FIG. 42. HORIZ. OUTPUT STAGE GRID DRIVE

This stage also develops grid lead bias, while R377 provides protective bias in the event of oscillator or discharge stage failure. Capacitor C404A provides a low-impedance path to ground for the 15,750 cps horizontal output stage current.

The plate of V119 is connected to a tap on the transformer, T351. This is an auto-transformer which permits a great degree of coupling between the various circuit elements (i.e., V119 plate, the horizontal deflection coils and the damper tube V120). This improved coupling results in extremely high power transfer efficiency and reduced tendency toward Barkhausen oscillation. The V119 plate pulse is of positive polarity as shown in figure 43. CAUTION: Do not check this waveform with conventional oscillographic equipment since severe equipment damage may result!

The screen grid of V119 is supplied with a positive d-c voltage through R370 and R373. A pulse voltage is also applied to the screen through C385 for linearization purposes. This accomplishes a



FIG. 43. HORIZ. OUTPUT STAGE PLATE PULSE

lengthening of the dynamic plate characteristic linear region, and thus prevents cramping of the right side of the raster as viewed from the front of the receiver.

Steadily increasing V119 plate current will result in a drop of potential at terminal 5 below that of terminal 9 of transformer T351. Terminal 9 is essentially at B+ (255 volts approximately) at the start of the first cycle. This voltage drop between terminals 5 and 9 partially energizes the transformer core and also the horizontal deflection coils which are connected (a-c wise) across terminals 9 and 8. (C382 is essentially a d-c blocking capacitor). As peak plate current is produced by the maximum positive excursion of the grid-driving pulse, the transformer and yoke reach a temporary limit of voltage



FIG. 44. UNDAMPED DEFLECTION COIL CURRENT

swing. Following this, the grid of V119 is driven down beyond plate current cut-off by the negative portion of the driving waveform (figure 42), causing the yoke and transformer magnetic fields to collapse. These fields do not cease by collapsing to a level of zero magnetic flux, but continue downward and become negative fields due to oscillation of the current which flows into and from the yoke and transformer inductances and their respective distributed capacitances.

The condition in the yoke corresponding to negative peak flux is such that the cathode-ray beam is forced to the left side of the screen. If no further control or influence of this negative peak energy were to appear, this negative peak magnetic flux would return to zero with the cathode-ray beam correspondingly returning to "screen-center", but only after a considerable irregularity in the spot movement. (This irregularity in spot motion would correspond to the oscillatory nature of the negative flux due to shock excitation of the coils as shown in figure 44).

This oscillatory decay toward screen-center is avoided by the action of the damper tube, V120. This tube conducts as soon as its cathode is drawn negative with respect to its plate, a condition which exists at the end of the "retrace" time when the cathode-ray beam is at the left edge of the raster. It is at this time, that the cathode of the damper would otherwise follow the voltage oscillation of the yoke and transformer negatively on terminal 9 with respect to the applied B+, but because of its clamping action, V120 now conducts and partially charges capacitor C371.

Several following "cycles" of this operation gradually charge C371 up to approximately 350 volts above the applied B+ voltage. This charge on C371 is added to the existing B+ voltage supply and becomes B+ boost, the true source of supply voltage applied to the plate of V119 through its

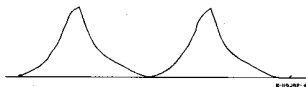


FIG. 45. DAMPER PLATE PULSE

transformer winding. Increasing sweep will occur until capacitor C371 becomes fully charged. Full sweep occurs when the losses (in watts) in the system (determined by the overall "Q" of the output stage) are fully satisfied by the steady-state plate current of V119 multiplied by the B+ supply voltage.

Control of the picture width is achieved by adjustment of the inductance of L358. Since this inductance is "reflected" into the other windings of the transformer, a decrease in its inductance will decrease the effective inductance of the other windings, thereby reducing the voltage swing across them. Conversely, an increase of L358 inductance will permit a larger voltage to build up across the plate and yoke windings, thereby increasing the width.

Linearity control is affected by varying the momentary bias on the damper tube, V120. This momentary bias therefore will modify the damping action across the deflection coils.

This bias is obtained by the use of a tank circuit consisting of C370 and the linearity coil L359. Each time V120 conducts, this tank circuit is shock-excited and forms the waveform of figure 45. Variation of the inductance of L359 varies this waveform and hence modifies the current pulse through the horizontal deflection coils.

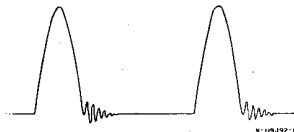


FIG. 46. DIVIDED-DOWN WIDTH COIL PULSE

11. HORIZONTAL BLANKING

Horizontal blanking is accomplished by the application of a suitable positive pulse to the cathode of the picture tube. This pulse drives the picture tube to cut-off during the horizontal retrace time.

Capacitors C381 and C384 form a capacity voltage divider which permits a portion of the positive pulse voltage across the width control to be used to develop a blanking pulse. This positive pulse, figure 46, could be applied across a large value of unbypassed resistance in the picture tube cathode, but would result in a correspondingly high loss of video information. It is necessary therefore, to use a very low-impedance source of blanking voltage to prevent this loss. Thus, V116B a cathode follower, is used to obtain a low-impedance source of horizontal blanking.

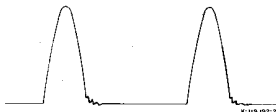


FIG. 47. INTEGRATED PULSE

The plate of V116B is fed positive d-c voltage. The divided-down positive pulse is applied to the grid of V116B through R357, the purpose of which is to integrate, or slightly lengthen its duration as shown in figure 47. This integration will also filter out the train of oscillations at the end of each pulse which would otherwise cause striations.

The actual blanking pulse appears across resistor R326, the bottom end of which is bypassed to ground by C318. This capacitor serves two purposes:-

1. To return the bottom of R326 to ground as far as 15,750 cps is concerned. (This has a negligible effect upon the 60-cycle vertical blanking pulse).
2. To prevent horizontal blanking pulses from appearing in the vertical output circuits which might cause a loss of vertical interlace.

These blanking pulses, shown in figure 48, are next coupled into the cathode of the picture tube through C172, along with the vertical blanking pulses.

As shown in figure 48, the trailing edge of the horizontal blanking pulse does not fall off sharply but rather tends to slope off gradually. This

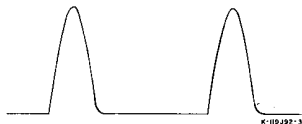


FIG. 48. FINAL HORIZONTAL BLANKING PULSE

would cause a gray shading at the left edge of the picture, and is corrected for by the application of a compensating parabolic waveform to the picture tube first anode. This pulse, shown in figure 45, offsets the shading by introducing a "brightening" effect at the left edge of the picture.

The combination of these two pulses thus provides excellent horizontal blanking action.

12. HIGH VOLTAGE SUPPLY

Two high-voltage systems are currently used in the STRATOPOWER group of receivers. Models 170125 and 200107 use a simple voltage doubler which delivers approximately 14 kv. The 21-inch Stratopower models use a three-rectifier high-voltage supply. This latter supply is actually a voltage doubler whose voltage regulation and efficiency are improved by the inclusion of a third "coupling" rectifier. This version delivers approximately 15.5 to 16.0 kv to the picture tube.

Let us first consider the operation of the simpler doubler circuits. For the sake of simplicity, the bottom of the transformer windings are shown tied to ground as indicated in figure 49.

For the moment, let us neglect the existence of the bottom diode, V123, and C7.

Positive pulses from horizontal sweep output transformer, T551, closes the diode V121 and ultimately charges capacitor C378 to approximately the peak voltage of 7 kv, d-c. Between positive pulses V121 opens and hence passes no current. At such times, the charge existing on C378 will flow into C379 through R378 and eventually charges C379 so that a potential of 7 kv d-c average will exist between its plates.

The "between-cycle" discharging of C378 and consequent charging of C379 will result in a slight power loss in the system since this "charging" current must flow through R378. This resistor actually is responsible for other efficiency losses which are to be discussed below.

A d-c potential of 7 kv exists across C379. Subsequent transformer output positive pulses carry the voltage across C379 upward an additional 7 kv on each terminal thus producing a total of 14 kv at the junction R378 and C379 during such peaks.

Now let us connect rectifier V123 to this junction and connect its cathode to a capacitor (Cp) of approximately 500 mmf. This capacitor is actually formed by the capacity existing between the inner and outer coatings of the picture tube.

This capacitor will gradually become charged to 14 kv, d-c, in consideration of the steady charge on C379 and the lifting of this potential by the applied positive pulses from T351. Continued operation of the above - described mechanism will maintain C_T at 14 kv, d-c, while supplying the normal picture tube load current.

As mentioned above, resistor R378 inserts various losses into the system which result in a slight falling-off of the total supply output voltage. However, this is of no importance in the 17- and 20-inch models since these tubes need not be supplied with voltages in excess of 14 kv.

There is a need, however, for a slightly greater output voltage when using a 21-inch picture tube. Of equal importance is the matter of voltage regulation, since a large drop-off in high voltage under changing picture tube load conditions would cause a de-focusing of the "high-white" picture elements.

In order to achieve a larger output voltage and improved voltage regulation, the effects of R378 must be dispensed with for the following reasons:-

1. R378 introduces a power loss during the period when C378 charges C379, as mentioned previously.

2. R378 introduces an additional power loss since it is in series with the output load current. This results in inadequate voltage regulation and generally reduced output voltage.

If we substitute a diode for R378, the above efficiency limitations are virtually eliminated.

Figure 50 shows the simplified circuit diagram of the three-rectifier system which is frequently referred to as the "Triple Pipper". It functions in a manner almost identical to the simpler version except that:-

1. The charging of C379 by C378, between applied pulses, results in almost zero power loss since the plate-to-cathode resistance of V122, during conduction, is negligible.

2. An additional power loss is eliminated since this now negligible resistance, which is in series with the load current, will not reduce the output

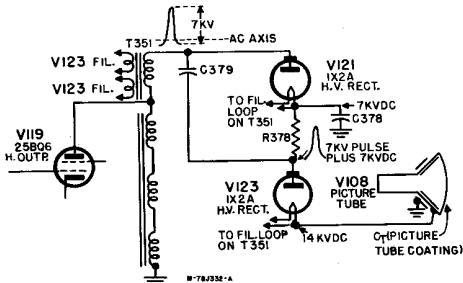


FIG. 49. SIMPLE HIGH-VOLTAGE DOUBLER

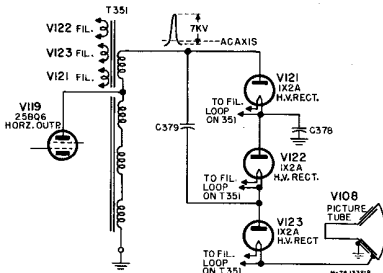


FIG. 50. 21-INCH HIGH-VOLTAGE CIRCUIT

voltage under load. Because of this lower supply impedance, an improvement in the voltage regulation of the system will result.

3. A bonus of 1 kv output is achieved which is added to the total output voltage. It should be noted that the applied pulse from T351 also contains a negative component below the a-c axis as shown on the diagram. VI22 utilizes this inverse voltage to charge capacitor C379 1 kv additionally. (The resistor R378 in the simpler doubler does not take advantage of this inverse voltage, but rather acts as an a-c load upon T351).

The improved efficiency of the three-tube system provides an additional 2 kv d-c output. The B-boost voltage is added in series with the high-voltage output of either system.

In conclusion, it may be said that the addition of the extra rectifier enhances the 21-inch receiver performance to such a degree that its additional cost is more than justified. The over-all results of its inclusion are:-

1. Increased picture brightness.
2. Virtually no de-focusing of "high-white" picture elements.
3. Smaller spot size which not only provides better overall focus but also reduces the annoying effects of snow or other noise bursts in the picture.

13. LOW VOLTAGE POWER SUPPLY

GENERAL:-

The power supply consists of three sections (see figure 51):-

1. The B+ supply
2. A series heater string and its GLOBAR resistor.
3. Filament transformer, T401.

The power supply is doubly interlocked as a precautionary measure. The cabinet back contains the usual safety interlock and the yoke plug contains two jumpers which prevent receiver operation should this plug not be connected.

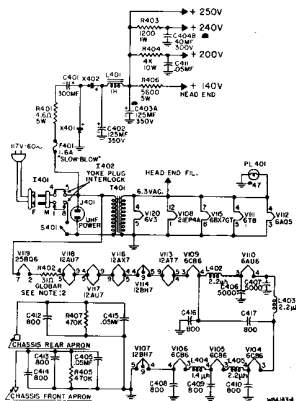


FIG. 51. POWER SUPPLY CIRCUIT

The B+ supply is protected by the use of a 1.6 ampere slow-blow fuse. This type of fuse is required to handle the momentarily large current surge which exists until the power supply electrolytic capacitors become charged after turning the receiver on.

B+ SUPPLY:-

This power supply is a half-wave voltage doubler using selenium rectifiers and a capacitor input filter. The ripple frequency at the output of the second rectifier is 60 cycles. Resistor R401 limits the peak a-c current flow through C401 to a safe value. The voltage doubler operates as follows:

Negative portions of the applied sine wave through capacitor C401 are passed to ground through rectifier X401. Positive halves of the applied sine wave are not conducted by X401. The positive pulses eventually charge C401 in the polarity shown in figure 51. Thus, at the junction of C401 and X401, we find approximately 130 volts d-c upon which is superimposed the original sine wave as shown in figure 52-B.

Rectifier X402 passes this positive 130 volts as well as the positive halves of the superimposed sine wave. The combination of these two voltages charges C402 to approximately 260 volts d-c. This voltage across C402 (figure 52-C) is not pure d-c but contains the ripple frequency which is removed by the smoothing choke L401 and capacitor C403A. Resistors R403, R404 and R406 drop the output to the voltages required by various portions of the receiver. The positive 240 volts output is bypassed by electrolytic capacitor C404B, since this voltage is supplied to circuits which contain sweep, sync and audio frequency components. The 140 volt, and 200 volt outputs do not require such heavy bypassing since these voltages supply circuits which amplify only r-f or i-f signals.

HEATER CIRCUITS:-

Those tubes which do not have 300 ma. heaters are operated from transformer T401. The remaining tubes are connected in series and include in their circuit a protective Globar resistor. This resistor R402 is so designed that its "cold" resistance is quite high - in the order of 200 or 300 ohms. The purpose of this device is to prevent an excessive current surge through the tube heaters when the receiver is turned on. This would occur since the tube heaters have a very low resistance when cold. As the tubes and the Globar resistor reach operating temperature, the tube heater resistances reach their proper values and the Globar resistance falls to approximately 31 ohms.

Possibly the simplest way to check this resistor would be to measure the voltage drop across it with the receiver turned on. The normal drop across R402 is approximately 10 volts. A "cold" check of R402 resistance is almost valueless, since this reading may vary widely between resistors.

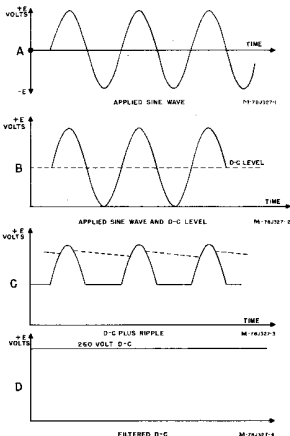


FIG. 52. B+ SUPPLY WAVEFORMS

Note that the front and rear aprons of the chassis are not connected directly to B-. This prevents the danger of the receiver control shafts contacting one side of the power line. These aprons are bypassed to B- by C415 and C405 for sync, sweep and audio. C412, C413 and C414 bypass any radio frequency components on the aprons to B-. R405 and R407 permit any dangerous charge built up on the apron to leak off to B-, the latter being an Underwriters Laboratories requirement.

IV. TROUBLE SHOOTING BY PICTURE ANALYSIS

INTRODUCTION TO TROUBLE SHOOTING

The complexity of a television receiver need not make its trouble-shooting procedure formidably greater than that required for a radio receiver. The picture tube of a television receiver often displays certain picture defects, which by proper interpretation will identify the ailing circuit, and perhaps even the defective component or tube. In this form of electronic sleuthing, the picture tube may perform the function of an oscilloscope and thus help the technician to rapidly locate the trouble. After careful analysis of the symptoms indicated on the picture tube screen, the usual test equipment may be used, when required, to isolate the defective component.

The picture patterns in the following section were taken from a Stratopower receiver and represent typical cases. The pictures were taken with the receiver controls set for optimum reception except where noted in the picture description.

A short analysis of the probable circuit defects together with a sectionalized circuit diagram will help the technician in trouble-shooting Stratopower receivers.

The following analysis is divided according to the major sections of the receiver:

1. R-F and I-F Amplifier
2. Video Amplifier
3. Sync Circuits
4. Vertical Deflection
5. Horizontal Deflection
6. Power Supply
7. Miscellaneous

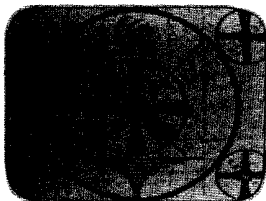
This section closely follows the circuit analysis as described on pages 5 through 21.

It has been established that the greatest percentage of television receiver service calls are required because of vacuum tube failures. It is therefore suggested that the tubes of an ailing receiver be checked or substituted by known good tubes before undertaking the job of circuit trouble-shooting.

Since defective vacuum tubes are easily detected the following trouble-shooting information has been essentially confined to circuit and component failures.



ANALYSIS

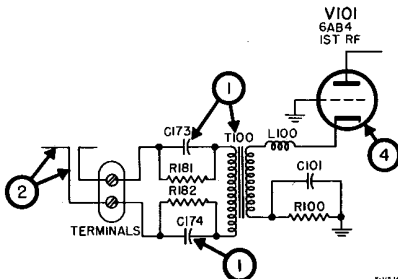


NOISY PICTURE
(Low Signal Strength)

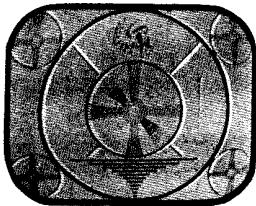
Noise or "snow" in the picture is usually associated with conditions external to the receiver. Although low gain in the r-f amplifier may cause a picture of poor contrast, the "snow" associated with it will decrease proportionately. With the normal receiver gain, a noisy picture will probably be the result of inadequate signal at the input terminals of the receiver and/or station trouble. Inadequate signal to the receiver may be due to the use of a wrong type of antenna for the particular receiving conditions, or due to a defective or improper transmission line, or improper orientation of the antenna. If a built-in or "inside" antenna is used, it may require relocation of the antenna to provide better noise-free reception.

- CHECK FOR:
1. Open input circuit and components of receiver input circuit, such as open capacitors, C173, C174 or open transformer, T100.
 2. Defective antenna, or antenna transmission line.
 3. Antenna orientation.
 4. Open filament, V101

ADDITIONAL NOTES:



K-10249



WIGGLES IN PICTURE BACKGROUND,
TRAILING WHITES, SOUND NORMAL.
(Maladjusted Tuning Control)

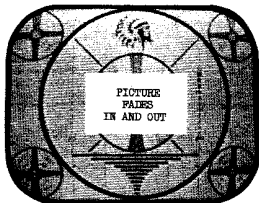
ANALYSIS

This condition results when the sound i-f amplitude is at too high a level at the video detector in reference to the video i-f frequency. It may also be the result of mistuning the receiver or improper i-f alignment.

The "wiggles" which appear like a busy shifting background are caused by the beat frequency which results from the sound i-f carrier and the video i-f modulating frequencies. These beat frequencies pass through the video amplifier and are impressed on the picture tube. The illustration also shows "trailing whites". This results when the receiver is tuned to give the above condition, which raises the sound i-f on the response curve and lowers the video i-f. The lower video i-f response results in an emphasis of the high frequency response in relation to the low frequencies. This sets up a transient response after any black picture element that results in "trailing whites".

CHECK FOR: 1. Proper tuning of receiver.
2. Alignment of i-f amplifier and associated traps.

ADDITIONAL NOTES:



"MOTORBOAT" OR FLUTTER
IN PICTURE AND AUDIO
(Capacitor C151 Disconnected)

ANALYSIS

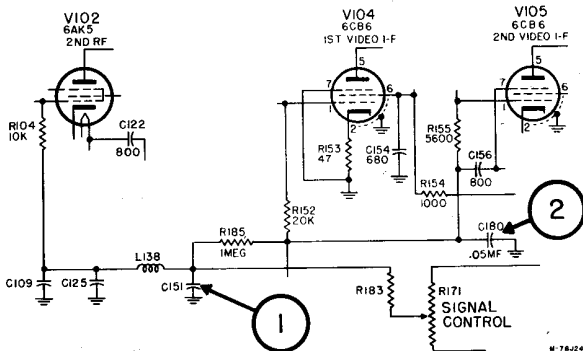
This condition is either caused by the AGC voltage fluctuating at a regular low frequency rate or by oscillation in the video i-f amplifier. The flutter caused by AGC action is usually the result of an open or improper value of capacitor in the AGC circuit. Specially check capacitor, C151 for correct value of capacity.

Next check for r-f and video i-f alignment as incorrect alignment may result in overall instability. Make sure that the response curves conform to published alignment data.

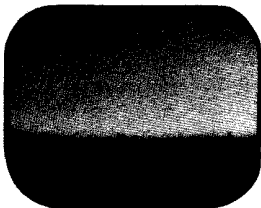
Check all filament by-pass capacitors in r-f and video i-f circuits.

- CHECK FOR:
1. Open by-pass, C151 on AGC bus.
 2. Open AGC filter capacitor C180.
 3. Alignment of r-f and video i-f amplifiers.

ADDITIONAL NOTES:



W-78243



LIGHT AND DARK AREA IN PICTURE, VERT.
SYNC OUT, HUM IN SOUND
(Cathode Of V106 Shorted to Filament)

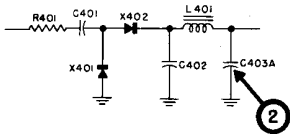
ANALYSIS

The condition illustrated is an extremely severe case of hum modulation in the i-f amplifier. In less severe cases, the condition may permit visibility of complete picture except that it may have dark and light horizontal shadow areas. In severe cases the picture will sync out-of-vertical and usually cannot be brought into sync by readjustment of the control. Since this trouble occurs before the video amplifier, it may also be heard in the audio.

Hum modulation in intercarrier receivers is usually due to heater-to-cathode leakage. If heater cathode leakage occurs in the video amplifier or picture tube, the audio system usually will not be affected.

CHECK FOR: 1. Heater-to-cathode leakage, tubes V101, V104, V105, V106, V107 and V108.
2. Defective B+ filter capacitor, C403A.

ADDITIONAL NOTES:



6-115253

ANALYSIS

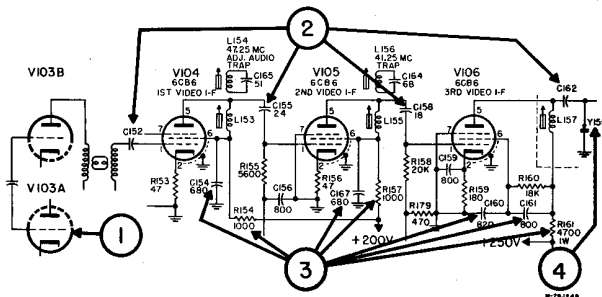
In an intercarrier receiver, as illustrated below, where the sound i-f is taken off immediately after the video detector, the loss of both sound and picture with the raster normal, is probably due to a defect of or prior to the video detector. This may be caused by an inoperative video i-f or r-f stage, local oscillator or converter. A partially operative stage will possibly pass sufficient signal to give weak sound.

First check to see if signal can be passed through the converter stage by applying a video i-f signal to the converter grid. If video i-f and converter circuit is operative, next check for the operation of the local oscillator.

NO SOUND, NO PICTURE, RASTER SATISFACTORY
(DEFECTIVE V103A TUBE)

- CHECK FOR:
1. Inoperative local oscillator, V103A.
 2. Open video i-f coupling capacitors, C152, C155, C158, C162.
 3. Improper or no screen or plate voltage at r-f or i-f tubes due to shorted screen by-pass capacitor or open resistor.
 4. Open video detector crystal, Y151.

ADDITIONAL NOTES:



ANALYSIS

It will be assumed in this case that the lack of picture is due to a defective video amplifier circuit. Since the sound i-f is taken off at the video detector as illustrated, when the sound is normal, it would indicate that probably the r-f, video i-f, and detector circuits are working properly.

With the receiver tuned to an operating station, check with an oscilloscope where the signal is lost between the video detector and picture tube grid. Use the published waveforms for comparison in regards to shape and amplitude of signal at check points.

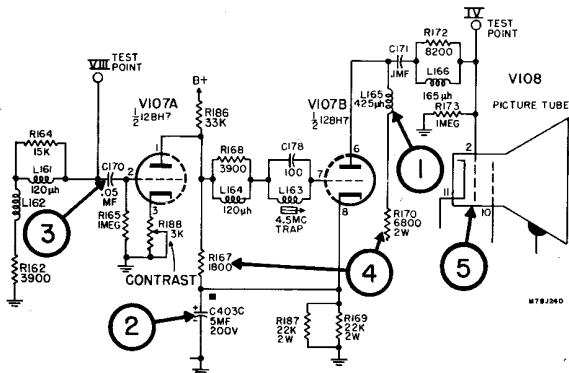
Check B+ voltages at the plates. Since the tubes in the diagram below are connected in cascade, tube V107A is dependent upon proper conduction of tube V107B for operating voltages. Check for shorted capacitor, C403C in cathode of V107B. A short at this point would lower the B+ voltage on the plate of V107A. Check for grid-to-cathode short in picture tube.

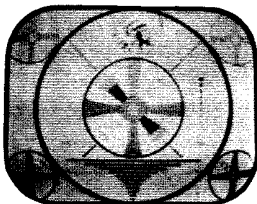
NO PICTURE, SOUND SATISFACTORY, RASTER
SATISFACTORY
(Capacitor C170 Open)

CHECK FOR:

1. Open compensating choke, L165.
2. Shorted capacitor, C403C in cathode V107B.
3. Open input coupling capacitor, C170 to tube V107A.
4. Open plate resistors at tube V107A or V107B. Check plate voltages.
5. Short of grid to cathode in picture tube.

ADDITIONAL NOTES:





LACK OF PICTURE DETAIL,
FOCUS SATISFACTORY

(Resistor R170 Increased To 10,000 Ohms)

ANALYSIS

This condition makes the picture appear out of focus although close examination of the individual line structure of the picture will indicate that the focus is satisfactory. This loss of picture clarity is most noticeable as a blurring of the vertical wedge of the test pattern under normal receiving condition and indicates the loss of high frequencies. The fact that the blacks stand out satisfactorily without trailing whites indicates that the low frequency response is satisfactory.

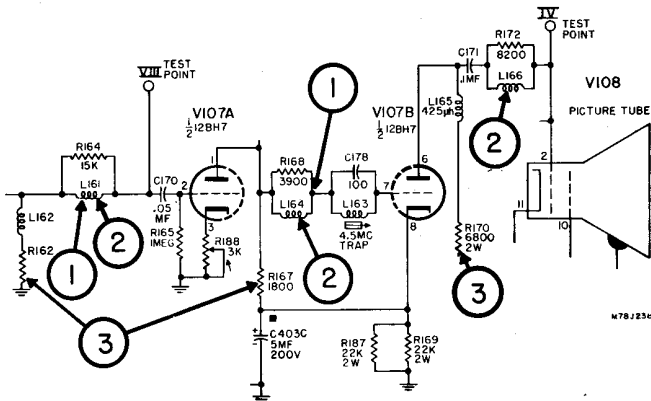
A loss of high frequencies may be due to a defective component (peaking coil, plate load resistor) in the video amplifier or misalignment of the video i-f or r-f circuits.

Since the compensating chokes in the video amplifier are principally used to maintain the high frequencies, they should also be checked for shorts or open circuit. Also check plate resistor values.

Alignment of the video i-f should be checked to make sure that the bandwidth of the response curve coincides with the recommended curves shown in the service notes.

- CHECK FOR:
1. Shorted compensating chokes, L161, and L164.
 2. Open chokes L161, L164 and L166.
 3. Increase in value of resistors, R162, R167 and R170.
 4. Alignment of the video i-f amplifier.

ADDITIONAL NOTES:





ANALYSIS

This condition is the result of a loss of low frequencies in the video amplifier.

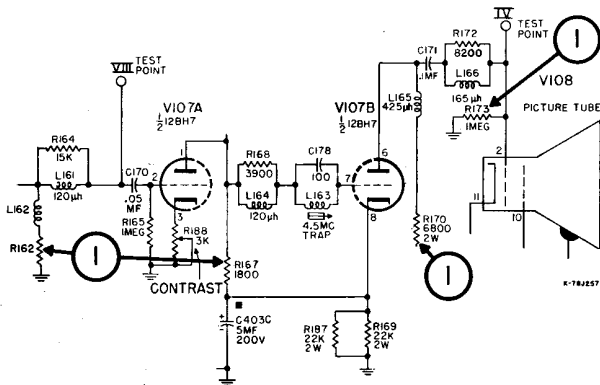
It may be the result of too low a value of plate resistance in either of the video amplifier tube sections. Check the resistance value against published data.

TRAILING WHITES

(Resistor R162 Reduced To 1200 Ohms)

CHECK FOR: 1. Decrease in resistor values of R162, R170, R167 and R173

ADDITIONAL NOTES:



ANALYSIS



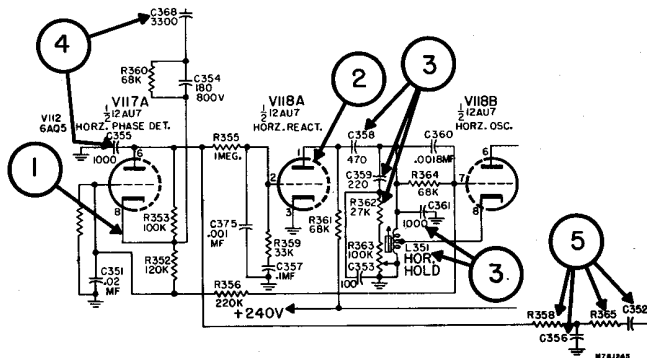
WEAK OR NO HORIZONTAL SYNC; VERT. SYNC,
PICTURE AND SOUND SATISFACTORY
(Open Capacitor C368)

If the Horizontal Hold control will permit a proper horizontal speed condition but the sync is weak or non-existent, it usually indicates that the AFC discriminator speed or control tube circuit is defective. First start checking at the discriminator for proper waveform. If the waveform does not check against published data, it may be due to an open or leaky capacitor or defective resistor. Since the discriminator circuit is a high impedance circuit, it may be caused by a leaky capacitor, C368 or C352 or an off-value in one of the resistors. Improper value of bias applied to the control tube will weaken the sync pull-in capabilities of the system.

If the control will not permit the sweep oscillator to go through a synched position as the control is adjusted, a check should be made that the sweep generator is running at approximately the frequency of 15,750 cps. If it is not, check the frequency-determining components of the sweep generator. Check all d-c voltages at the sweep oscillator tube, then check for correct waveform in the signal circuits.

- CHECK FOR:
1. Sync amplitude at input to discriminator tube, VI17A.
 2. Bias and plate voltage on control tube VI18A.
 3. Sine-wave oscillator components, L351, C361, C358, C359 and R362.
 4. Leaky or shorted capacitors, C368 and C355.
 5. Waveform feedback components, C356, R358, R365 and C352.

ADDITIONAL NOTES:





WREAK OR NO VERT. AND HOR. SYNC
OTHERWISE PICTURE AND SOUND NORMAL
(OPENED CAPACITOR C314)

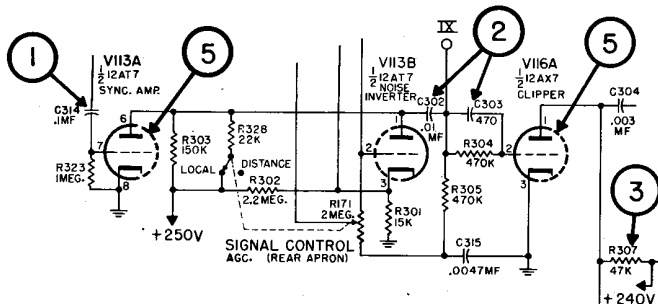
ANALYSIS

Assuming that the picture and sound information is present, it eliminates the signal amplifying circuits such as the r-f, i-f and video amplifier, as a source of trouble. Since the sync for both the vertical and horizontal sweep circuits is unsatisfactory the logical source of trouble is the clipper or sync amplifier stages which are common to both sync circuits. Because AGC voltage is partially derived from the clipper grid circuit, an inoperative sync amplifier tube will result in too little AGC voltage change, possibly causing picture overload on strong signals.

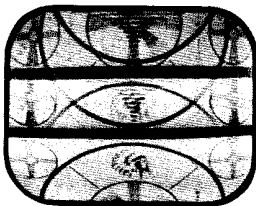
Since weak sync usually indicates that some sync is available, the best procedure is to first check the sync waveform at the input to the sync amplifier for amplitude and shape as compared to published data, check waveform thru sync amplifier and clipper circuits, measure the socket voltages and resistances and then look for defective components.

- CHECK FOR:
1. Open or low capacity of input coupling capacitor, C314.
 2. Defective coupling capacitor C302, or C303, to clipper tube.
 3. Incorrect value of plate resistance, R307, in clipper.
 4. Insufficient amplitude of composite signal applied to sync amplifier from video detector; check video detector circuit.
 5. Defective sync amplifier or clipper tubes.

ADDITIONAL NOTES:



W-78439



ANALYSIS

This condition usually indicates that the vertical sweep generator is not getting sufficient or any sync signal or that the sweep generator is far off-frequency so that it cannot be brought into sync with the signal.

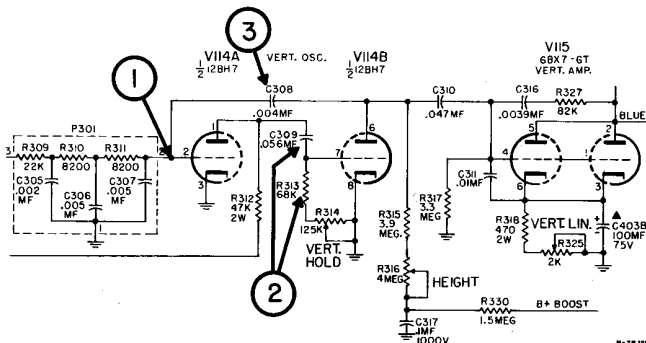
For sync may be the result of either a defective integrating circuit which precedes the sweep generator or a defective component in the sweep generator circuit. The latter usually will show up in other ways as improper height, etc.

The most effective trouble shooting is to check the integrated sync signal against published data by means of an oscilloscope. Also check the socket voltages of the sweep generator. Check the approximate operating frequency of sweep generator by observing the station pattern on the picture tube. Rotate the Vertical Hold control to see if the pattern can momentarily be held in proper position vertically.

NO VERTICAL SYNC,
HORIZONTAL SYNC SATISFACTORY
(VERT. HOLD CONTROL MALADJUSTED)

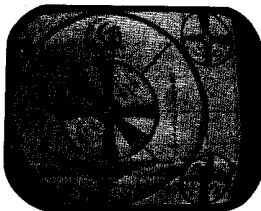
- CHECK FOR:
1. Sync pulse at input to sweep generator.
 2. Sweep generator frequency, if far off from 60 cps, check sweep generator components, such as C309 and R313.
 3. Leakage in feedback capacitor, C308.

ADDITIONAL NOTES:



8-78150

SYNC
TROUBLESHOOTING



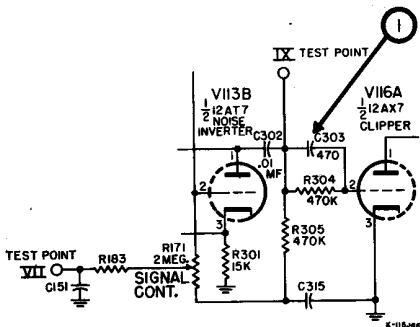
PICTURE DISPLACED TO LEFT
RIGHT EDGE WAVY
(CAPACITOR C303 REMOVED)

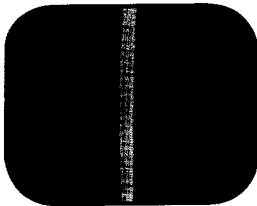
ANALYSIS

This is a specific condition caused by a defective capacitor that couples the sync amplifier to the clipper. Since this capacitor C303 has to pass the horizontal sync pulse, when it is open, the sync pulse will be integrated through the resistor, R304. This integrated pulse causes a delay in the sync which shifts the picture to the left. With the weakened horizontal sync pulse, the sync is influenced by the black transmission of the picture that causes the wavy edge in the picture. It appears as though the "black" picture elements pull the picture out of shape.

CHECK FOR: 1. Open or low value of capacitor, C303.

ADDITIONAL NOTES:





HORIZONTAL SYNC OUT,
BRIGHT BAR OR BARS IN PICTURE
(OPEN CAPACITOR C360)

ANALYSIS

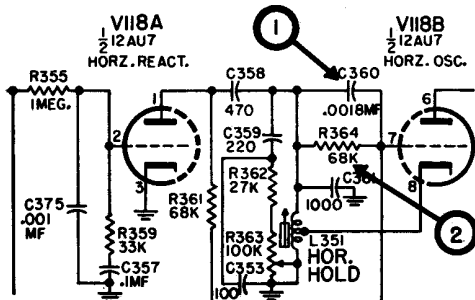
This condition is the result of blocking of the horizontal sweep generator. It usually is brought about by improper operating bias on the horizontal sweep oscillator tube caused by open, leaky, or shorted components in the grid bias circuit.

A ready check to determine whether this is the source of the trouble is to observe the waveshape with an oscilloscope across the sine-wave oscillator tank circuit of tube VI18B.

If the amplitude and waveshape does not check with published data, the components R364 or C360 should be checked.

- CHECK FOR:
1. Shorted, open or leaky capacitor, C360.
 2. Improper value resistor, R364.

ADDITIONAL NOTES:



K-HS/69

ANALYSIS



"GEAR TOOTH" EFFECT
(OPENED CAPACITOR C357)

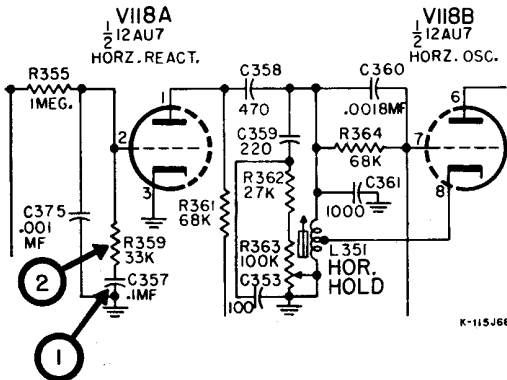
This condition represents a high frequency "hunt" in the horizontal sweep oscillator circuit.

Although it may be the result of the normal variation in transmitting station pulse generators or in the receiver sweep circuit, it is an indication that the receiver AFC circuit is not functioning properly.

The anti-hunt circuit at the AFC control tube, VI18A is shown below and if the resistor R359 or capacitor, C357, were open or considerably off-value, the trouble shown above would result.

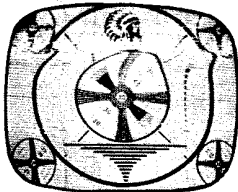
CHECK FOR: 1. Open or low value capacity of C357.
2. Open or high resistance of R359.

ADDITIONAL NOTES:



K-115J68

ANALYSIS

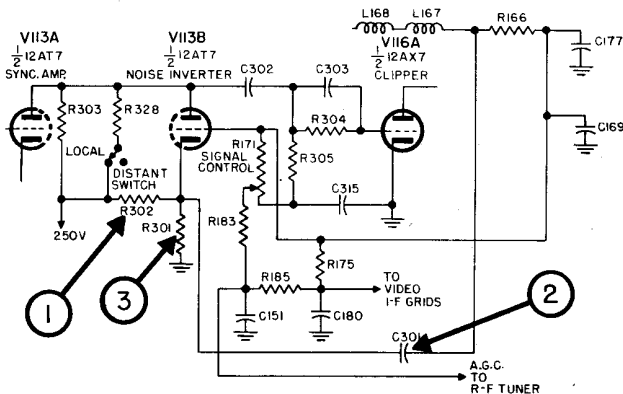


NOISE "TEARING" PICTURE
(See text).

This condition shows a lack of sync system noise immunity due to failure of the noise inverter circuit. This may be caused by excessive inverter cut-off bias or the absence of the required cathode input signal. The picture shown represents a highly exaggerated condition which was done to better demonstrate the effect. This was accomplished by feeding a 1-inch spark signal into the 1-r amplifier, with the noise inverter biased off by shunting R302 with a 100,000-ohm resistor.

- CHECK FOR:
1. Low value, R302
 2. Open C301
 3. Open or high value, R301

ADDITIONAL NOTES:



M-78J334-A

SYNC TROUBLES



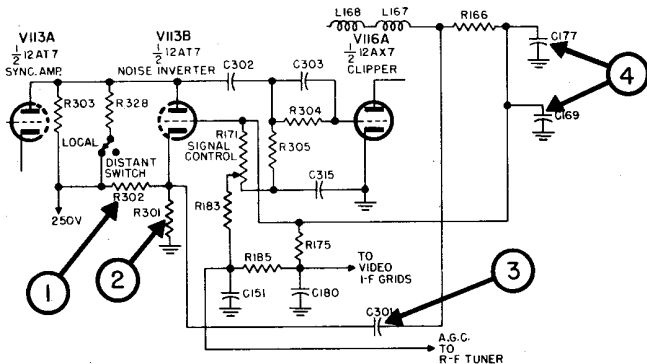
NO HORIZONTAL OR VERTICAL SYNC
(R302 OPENED)

ANALYSIS

This condition, aside from being caused by troubles in the sync amplifier or clipper, may be due to improper noise inverter (canceller) operation. Any component failure which causes an upset of the normal operating bias on this stage will cause it to partially or completely remove the sync pulses from their respective pedestals. The receiver may then lose sync completely or depending upon the degree of difficulty, may attempt to lock on the leading edge of the blanking pedestals. This will cause a shifting or warping of the picture. An oscilloscope connected to test point IX will show the absence of sync pulses which normally would be situated on top of the blanking pedestals.

- CHECK FOR:
1. Open or high value of R302
 2. Low value R301
 3. Leaky or shorted C301
 4. Shorted C169 or C177

ADDITIONAL NOTES:



W-784334

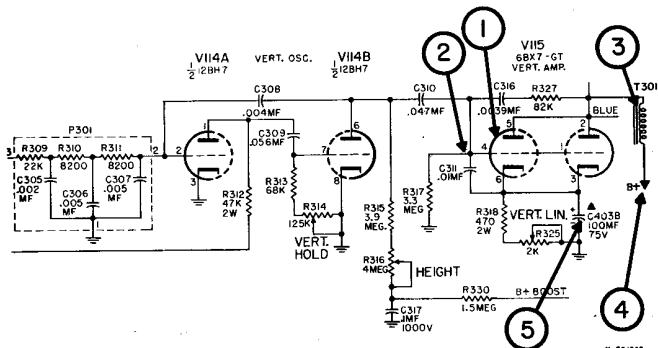
ANALYSIS

When the picture size is reduced considerably by a component or circuit defect, the vertical linearity will probably also be affected. This is particularly true when component failure in the linearity circuit occurs.

Waveshape analysis by oscilloscope will give the most positive isolation of the trouble. Waveshapes should be taken and compared with the published data. Check all components in the sweep output circuit.

- CHECK FOR:
1. Low emission of sweep output tube, V115.
 2. Improper grid input "drive" voltage at V115.
 3. Defective sweep output transformer, T301.
 4. Low B+ voltage to sweep output tube V115.
 5. Low value of cathode capacitor, C403B.

ADDITIONAL NOTES:



VERTICAL
DEFLECTION



INADEQUATE PICTURE HEIGHT
(MALADJUSTED HEIGHT CONTROL)

ANALYSIS

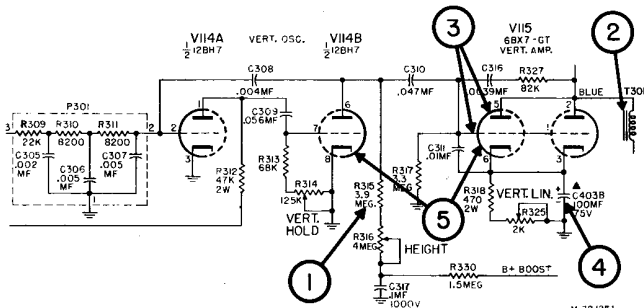
This condition is either due to low power output from the vertical sweep output tube circuit or to inadequate sweep voltage generated by the sweep oscillator.

First measure the amplitude and waveshape of the sweep generator output by an oscilloscope.

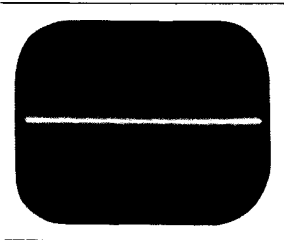
If the drive voltage at this point is normal, then the sweep output stage is probably at fault. This may be due to a defective tube, output transformer or improper operating voltages.

- CHECK FOR:
1. Rise in resistance value of sweep generator plate resistor, R315.
 2. Defective sweep output transformer, T301.
 3. Incorrect value of plate, or grid voltages on output tube, V115.
 4. Low value capacitor in cathode of sweep output tube, C403B. (This usually results in poor linearity.)
 5. Weak vertical deflection tube, V114 or V115.

ADDITIONAL NOTES:



M-78J251



NO VERTICAL DEFLECTION
(OPEN VERTICAL DEFLECTION COIL)

ANALYSIS

A single horizontal white line indicates that no vertical deflection magnetic field is being produced.

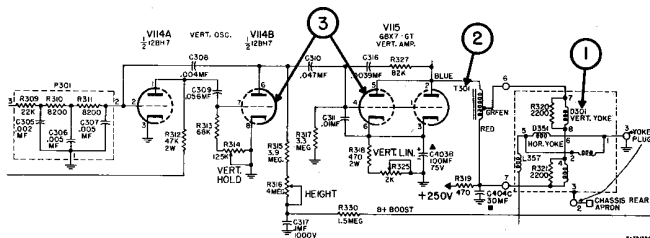
This can be caused by a failure in the vertical deflection system such as the sweep generator, the sweep output tube, or an open sweep output transformer or vertical deflection coils of the yoke.

The quickest method of isolating the trouble is to start checking with an oscilloscope at the vertical sweep generator for the proper waveforms and working back through the vertical sweep output circuit.

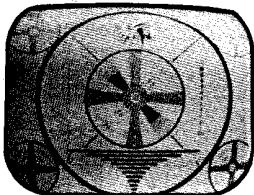
By noting where the waveform is lost, the trouble may be isolated rapidly.

- CHECK FOR:
1. Open vertical deflection coils, D301.
 2. Defective sweep output transformer, T301.
 3. Vertical sweep tubes, VI14 or VI15 not operating.
 4. Poor contacts in yoke plug.

ADDITIONAL NOTES:



P-751224



POOR VERTICAL LINEARITY
HEIGHT SATISFACTORY
(MALADJUSTED VERTICAL LINEARITY CONTROL.)

ANALYSIS

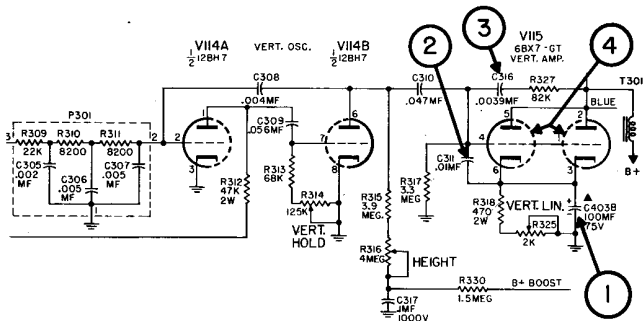
This results in a portion of the picture being elongated vertically out of proportion to the remainder of the pattern. Although this may be caused by improper operation of any part of the vertical deflection system, in most cases it is the result of improper operation of the vertical sweep output stage.

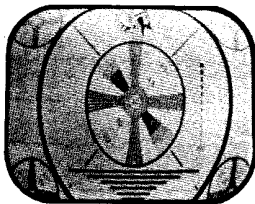
First check that the drive voltage applied to the grid of the vertical output tube has the proper amplitude and shape as compared to a standard receiver. This check may be made with an oscilloscope.

Next check the waveforms and operating voltage at the vertical sweep output stage. Check components in sweep output circuit.

- CHECK FOR:
1. Linearity control components such as cathode capacitor, C403B, for leakage or improper value.
 2. Low value capacitor C311.
 3. Leaky capacitor C316.
 4. Vertical output tube, V115.

ADDITIONAL NOTES:





EXCESSIVE HEIGHT
SYNC SATISFACTORY
(MALADJUSTED HEIGHT CONTROL, R316)

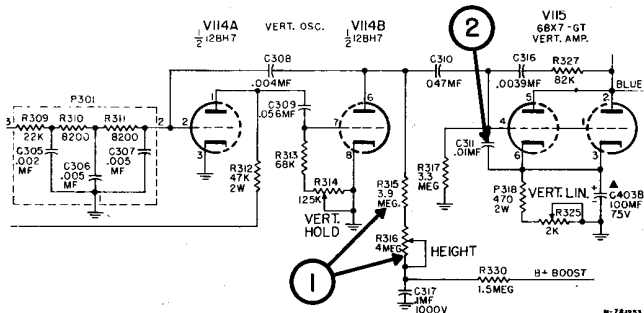
ANALYSIS

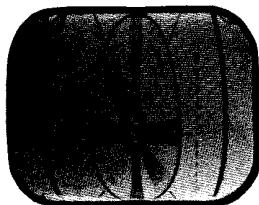
This condition is usually the result of excessive "drive" voltage at the grid of the sweep output tube. Thus any circuit change which results in too great an amplitude of the sweep generator output voltage will cause the trouble.

Check for amplitude of sweep generator waveform at pin 1 of VI15 against normal published data.

- CHECK FOR:
1. Too low value of charging resistance R315 in plate of sweep generator or defective Height Control, R316.
 2. Low capacity value of sweep generator charging capacitor, C311.

ADDITIONAL NOTES:





POOR VERTICAL LINEARITY,
FOLD-OVER AT BOTTOM OF PICTURE,
PICTURE HEIGHT EXCESSIVE
(LEAKY CAPACITOR C310)

ANALYSIS

The condition shown in the picture, results when the coupling capacitor, C310, to the vertical sweep amplifier becomes leaky.

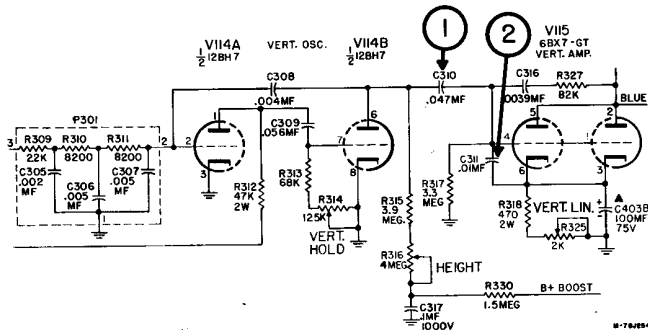
This results in B+ voltage through the plate circuit of the vertical oscillator tube being applied through this capacitor to the grid of V115. This increases the height of the picture the same way as a reduction of the resistance in the plate circuit of V114B would do. With any excessive increase in height, the linearity is affected as well.

A similar condition will result when the capacity value of the charging capacitor, C311, is lower than the recommended value. Check by replacing the capacitor with the correct value.

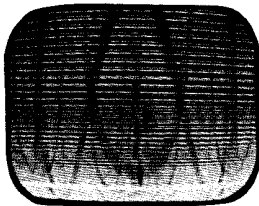
Check socket voltages and waveforms of V114.

- CHECK FOR:
1. Leaky capacitor, C310.
 2. Low value of charging capacitor, C311.

ADDITIONAL NOTES:



4-782854



HEIGHT EXCESSIVE
(Leaky Capacitor C316)

ANALYSIS

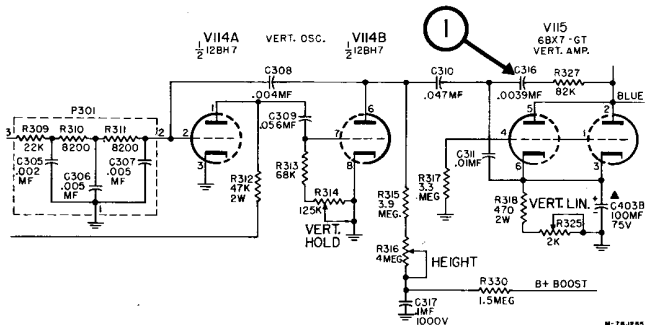
The picture represents excessive vertical sweep amplitude from the vertical sweep circuit.

The sweep is so great that the horizontal sweep lines are pulled apart and it looks as though a small portion of the picture were magnified vertically.

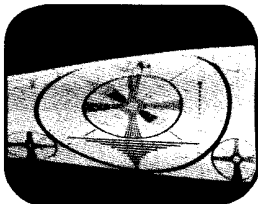
If the capacitor, C316, leaks excessively, the result will be as shown in the accompanying illustration. This condition is similar to that shown on page 44, except to a greater degree. Continued operation under these circumstances will eventually damage the output tube VII5 and/or its plate decoupling resistor, R319.

CHECK FOR: 1. Leaky capacitor C316.

ADDITIONAL NOTES:



M-76J265



VERTICAL KRYSTONING
(SHORTED VERTICAL DEFLECTION COIL)

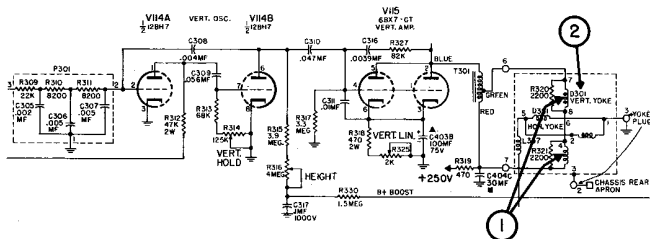
ANALYSIS

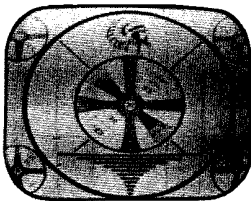
This condition indicates that one of the vertical deflection coils is not producing the same amount of flux as the other series coil. This results in a narrowing of the picture at either the left or right side of the screen.

Since the vertical coils usually have a resistor across each series coil, the first check should be for a defective resistor and then check the coil. Shorted turns in the deflection coil will have the same effect but will probably not show up on a resistance check, so that the proper procedure would be to substitute a new yoke. Narrowing of the picture takes place on the same side that the defective coil occupies in the yoke assembly around the neck of the picture tube.

- CHECK FOR:
1. External short across deflection coils.
 2. Defective vertical deflection coil, D301.

ADDITIONAL NOTES:





TOO GREAT SWEEP WIDTH
RECEPTION NORMAL OTHERWISE
(MALADJUSTED WIDTH CONTROL, L352)

ANALYSIS

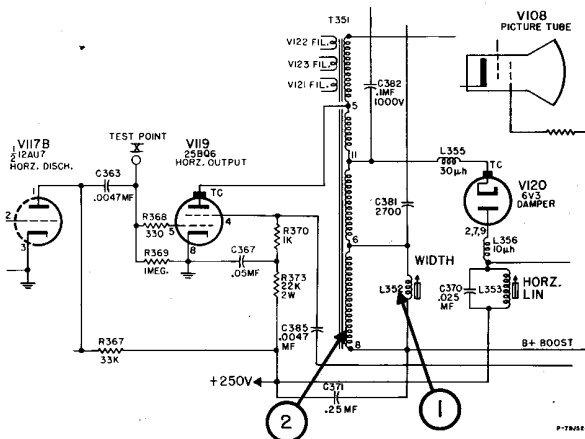
Too great a sweep width may be caused by an inoperative (open) width control or too much drive at output tube.

First check that Width control changes pattern size. Check for "drive" waveform at grid of output tube against published data. Low picture tube anode voltage will result in too great sweep width; however, this condition will also cause the vertical sweep height to be abnormally great.

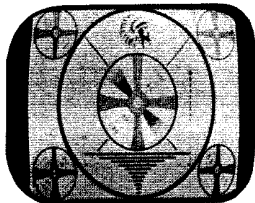
Waveform analysis by an oscilloscope with reference to published data is most helpful in locating the trouble. Check anode voltage of picture tube for proper value.

CHECK FOR: 1. Open Width control, L352.
2. Open winding between lugs 6 and 8 in T351.

ADDITIONAL NOTES:



P-79(51)



INADEQUATE SWEEP WIDTH
(MALADJUSTMENT OF WIDTH CONTROL)

ANALYSIS

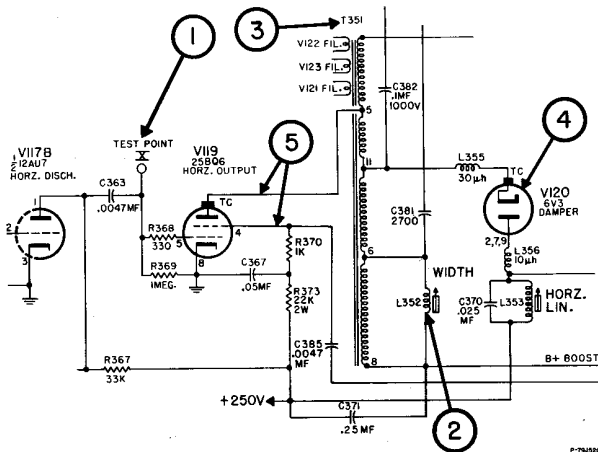
Inadequate sweep width indicates low power output from the horizontal sweep output tube circuit or a defective component associated with this output circuit. Since the power output from the horizontal deflection circuit is dependent upon the sweep "drive" voltage applied to the stage, a waveform measurement of amplitude and wave-shape should be made with an oscilloscope and compared with published values.

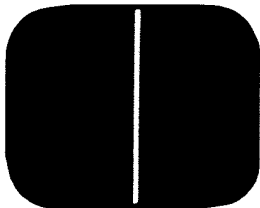
If this checks satisfactory, output circuit components should be checked. Check for resistance changes or defective capacitor values. Waveform analysis at various points of the output circuit will be found most helpful.

Check screen and B+ boost voltages of output tube, V119.

- CHECK FOR:
1. Correct waveshape and amplitude of input "drive" voltage at test point "X".
 2. Shorted Width Control L352 or defective deflection coil, D351.
 3. Defective output transformer T351 - shorted turns or arc-over.
 4. Low emission of damper tube V120.
 5. Low B+ voltage to plate or screen of output tubes V117B, V118B, V119.

ADDITIONAL NOTES:



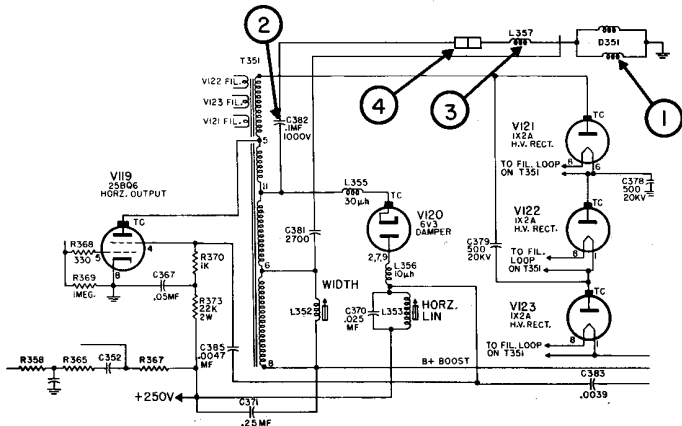


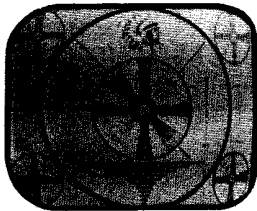
With the picture tube high voltage derived from the horizontal sweep output circuit, practically all sweep output troubles will result in the absence of high voltage on the picture tube, so that no raster is produced. The only exception to this condition is with an open deflection coil when a single white line as shown will be obtained.

Checking for proper waveform at signal points of the horizontal sweep output circuit will provide the quickest isolation of trouble.

- CHECK FOR:
1. Open horizontal deflection coils, D351.
 2. Open capacitor C382.
 3. Open choke, L357.
 4. Open yoke plug connection.

ADDITIONAL NOTES:





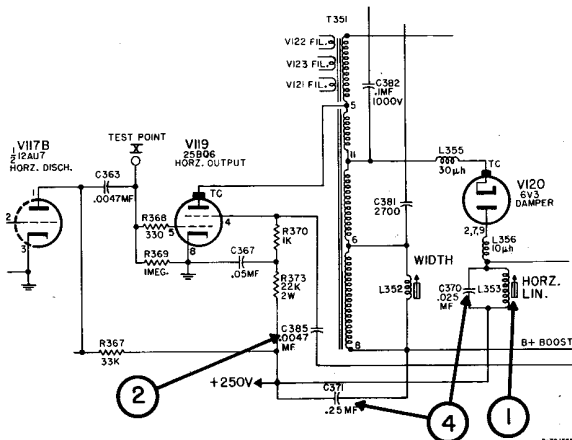
POOR HORIZONTAL LINEARITY
(GRID TO CATHODE RESISTANCE
OF V119 REDUCED TO .2 MEGOHM)

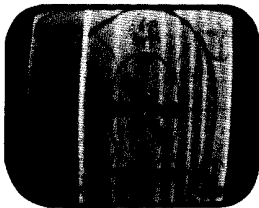
ANALYSIS

An elongation of any portion of a test pattern in relationship to the remainder of the pattern is termed non-linearity. When trouble is experienced, first establish whether the linearity control is operating, i.e., changes linearity of pattern.

- CHECK FOR:
1. Shorted linearity control, L353.
 2. Defective feed back capacitor C385.
 3. Defective yoke, D351.
 4. Defective capacitors C370, C371.

ADDITIONAL NOTES:





HORIZONTAL LINEARITY POOR,
BRIGHT VERTICAL BARS, INADEQUATE WIDTH
(OPEN CAPACITOR C371)

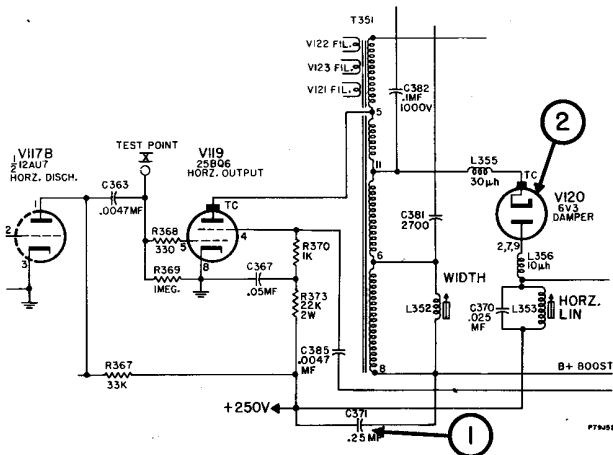
ANALYSIS

This condition is associated with improper horizontal damping. This causes a serious foldover of the picture on the left-hand side which results in elongation of left edge and a distinct white vertical bar appears to the left of center. Less distinct vertical bars may appear across the remainder of the picture.

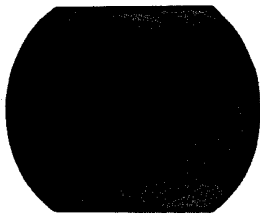
The condition shown is the result of an open capacitor in the cathode of the damper tube. A partially inoperative damper tube may cause a similar condition although when the damper tube is completely inoperative in the circuit shown below no horizontal sweep output or high voltage will result.

- CHECK FOR:
1. Open or low value of capacitor, C371.
 2. Defective damper tube, V120.

ADDITIONAL NOTES:



PT90523



BLACK "READY" VERTICAL LINE
OR LINES, RECEIVER NORMAL
(Defective Hor. Output Tube V119)

ANALYSIS

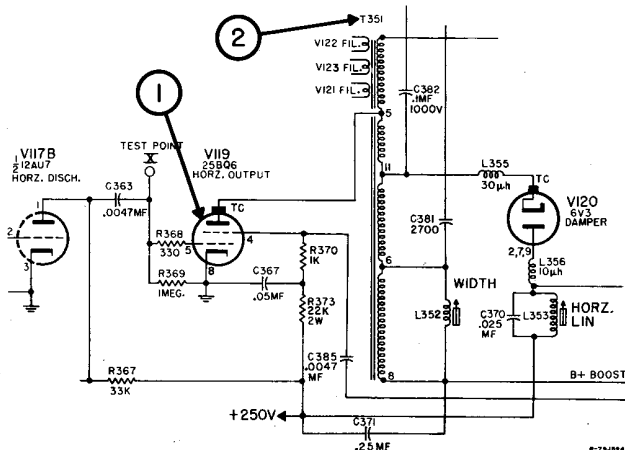
This is an oscillation at r-f frequencies of the horizontal sweep output tube and is commonly referred to as a "Barckhausen" oscillation. It is prevalent in horizontal output circuits where the output tube is supplied by relatively low B+ voltages.

It is most readily seen on a blank raster and sometimes disappears when a strong signal is received.

A good check for this condition is that it shifts in position on the screen between different channel positions and also is influenced or eliminated by a change in output tube. This condition may also occur when the deflection system is run to an excessive sweep width.

- CHECK FOR: 1. Sweep output tube, V119.
2. Sweep output transformer, T351.

ADDITIONAL NOTES:



ANALYSIS

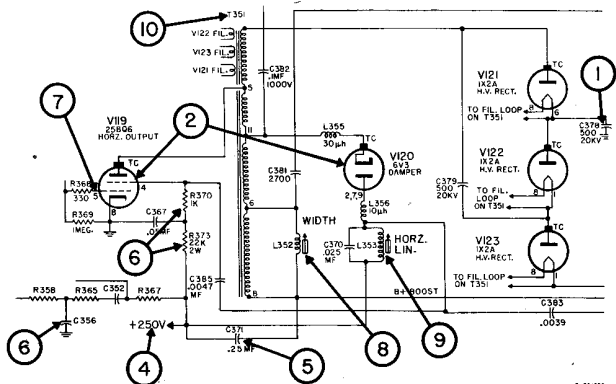
It is assumed that the lack of a raster is due to the absence of high voltage at the picture tube 2nd anode. First check for high voltage at the 2nd anode of the picture tube. Check the H.V. rectifier tubes by substitution. If these checks do not indicate the source of trouble, then additional checks in the horizontal sweep output circuit should be made in the order specified.

In making high voltage measurements use a VTVM with a high voltage probe.

NO RASTER - SOUND SATISFACTORY

- CHECK FOR:
1. Shorted capacitor, C378
 2. Defective sweep output tube, V119 or damper tube, V120.
 3. Defective tubes, V117B, V118B.
 4. No voltage at T351 primary.
 5. Shorted C371.
 6. No screen voltage on V119.
 7. Proper waveform at grid of V119.
 8. Shorted Width control, L352.
 9. Open Linearity control, L353.
 10. Defective sweep output transformer, T351.

ADDITIONAL NOTES:



ANALYSIS

This condition may be due to a defective picture tube, improper voltages applied to any one or more of the picture tube elements, or an improperly adjusted ion trap magnet.

Since the audio is satisfactory, this eliminates a primary power supply failure. However, the trouble may exist in a secondary B+ supply source, such as the B+ boost voltage which is applied to the horizontal sweep output tube and the 1st anode of the picture tube.

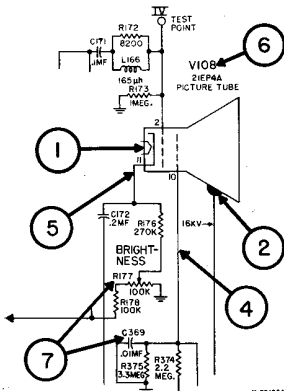
As a first check, visually examine the picture tube heater. If it is glowing, the picture tube can be assumed satisfactory, for the moment at least. Next check the high voltage (2nd anode) of the picture tube. If this voltage is normal, try adjusting the ion trap magnet. If adjustment of the trap magnet produces no raster, then check voltages at the 1st anode, cathode and grid of the picture tube. Check for an open Brightness control or open resistor R176. If after checking no definite reason can be found for the lack of a raster then the trouble probably lies in the picture tube and it should be replaced. If in making the foregoing checks,

NO RASTER - SOUND SATISFACTORY

it is found that there is no, or very little, voltage at the 2nd anode of the picture tube, then considerable checking may be necessary in the horizontal deflection system.

- CHECK FOR:
1. Open or shorted picture tube heater.
 2. No voltage on 2nd anode of picture tube.
 3. Improper adjustment of ion trap magnet.
 4. Improper or no voltage at 1st anode of picture tube.
 5. Improper voltage at cathode of picture tube.
 6. Defective picture tube, check by substitution.
 7. Shorted capacitor, C369, or open Brightness control, R177.

ADDITIONAL NOTES:



M-702004

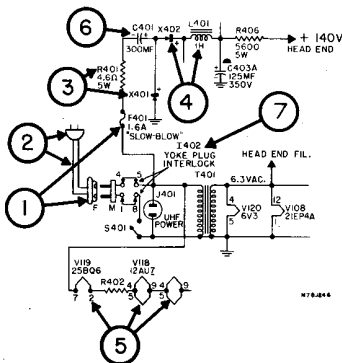
ANALYSIS

This condition usually indicates a power source failure. This may either be in the primary input circuit or due to defective power supply components such as a rectifier unit, filter choke or capacitor. A voltage check will be found most helpful in isolating the trouble; for example check for 115 volt a-c input; check for filament or B+ voltages.

NO RASTER, NO SOUND

- CHECK FOR:
1. Power supply interlocks, fuse, or output.
 2. Power cord plug and cable.
 3. Rectifier components.
 4. Selenium rectifier, filter choke.
 5. Open tube filament in series filament string.
 6. Open input capacitor, C401.
 7. Yoke plug not connected.

ADDITIONAL NOTES:





PICTURE SIZE SMALL,
BRILLIANCE LOW, SOUND NORMAL
(OPEN CAPACITOR C402)

ANALYSIS

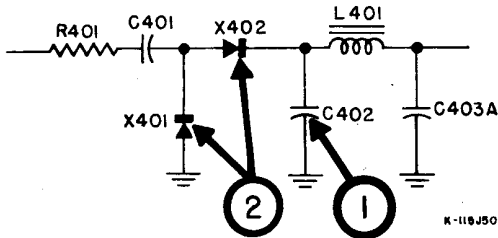
This condition indicates a defective component which reduces the output B+ voltage. This reduced B+ voltage will affect both vertical and horizontal sweep and will also give reduced brilliance to the picture.

Although the sound appears normal at the listening level, the maximum output would be reduced due to the lower B+ voltage applied to the audio output tube.

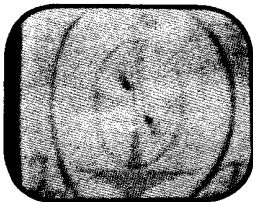
Check for B+ voltage with voltmeter and compare with published voltages. The ripple and shadow through the picture are due to inadequate filtering of the B+ supply.

CHECK FOR: 1. Open or low value of input filter capacitor, C402 of power supply.
2. Defective rectifier, X401 or X402.

ADDITIONAL NOTES:



K-119J50



PICTURE BLOOMS
(PICT. TUBE CATHODE SHORTED TO CHASSIS)

ANALYSIS

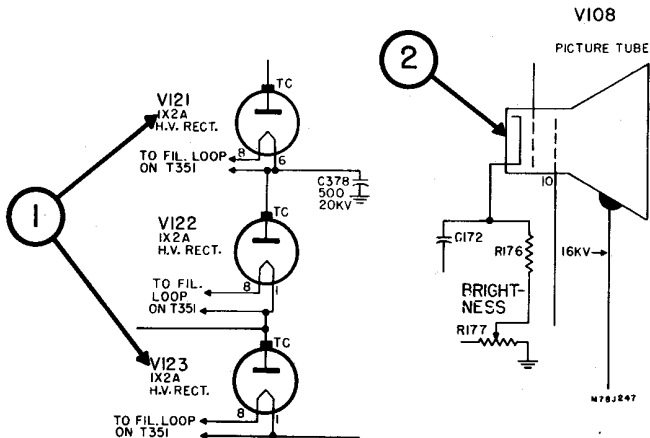
A condition of excessive picture "expansion" when the Brightness control is turned up is an indication that the picture tube anode voltage is dropping to a much lower value, permitting the beam to be more easily deflected.

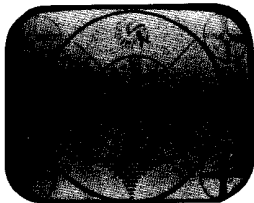
This lowering of the picture tube voltage may be due to an increase in impedance of the high voltage supply, or a defective rectifier tube. Check the high voltage output with normal brightness.

CHECK FOR:

1. Defective H.V. rectifiers, V121, V122, V123.
2. Defective picture tube.

ADDITIONAL NOTES:





HUM BAR IN PICTURE
WAVINESS IN EDGES OF RASTER
("NAE WEST" MOVEMENT)
(Open Capacitor C403A)

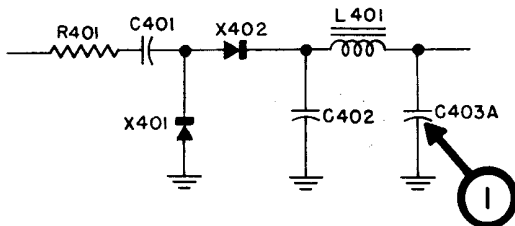
ANALYSIS

Inadequate filtering of the B+ supply which supplies the video amplifier, sync and sweep circuits usually shows up as a shaded or dark horizontal hum bar and possibly a waviness in the left and right edges of the raster.

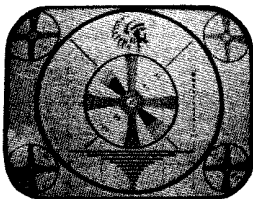
The dark shaded bar is caused by hum in the picture tube grid circuit, while the waviness of the raster edge is the result of hum in the horizontal deflection circuit. This inadequate filtering of the B+ should be clarified to include the output filter capacitors only, as hum caused by an input filter capacitor, will result also in a reduction of B+ voltage and picture size.

CHECK FOR: 1. Open or low value of filter capacitor, C403A.

ADDITIONAL NOTES:



K-115J51



**LOW PICTURE BRILLIANCE,
SOUND SATISFACTORY**
(Brightness Control Near Minimum)

ANALYSIS

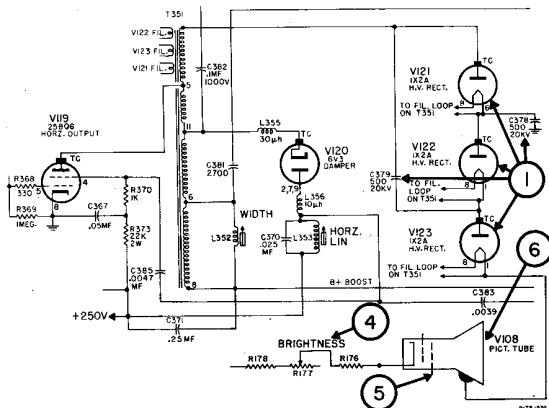
This condition may be caused by low voltage on either the H.V. anode or the accelerating anode (Grid #2) of the picture tube.

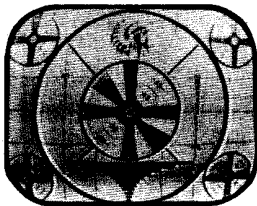
It may also result because the Brightness control does not permit a wide enough variation of bias to the picture tube. Improper adjustment of the ion trap will result in low brilliance.

A leaky capacitor, C369, in the accelerating anode will also cause insufficient brightness, or no light output from the picture tube.

- CHECK FOR:**
1. Low voltage at H.V. anode of picture tube, caused by leaky filter capacitors C378 and C379, defective rectifiers, V121, V122 and V123.
 2. Improper adjustment of ion trap.
 3. Low B+ to sweep output tube, V119.
 4. Defective Brightness control circuit - improper voltage.
 5. Low voltage at 1st anode of picture tube.
 6. Defective picture tube.

ADDITIONAL NOTES:





AGC
CONTROL INEFFECTIVE
(CAPACITOR C180 SHORTED)

ANALYSIS

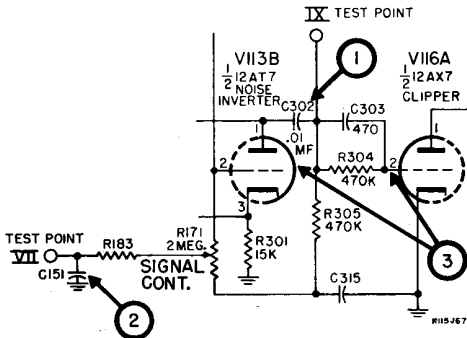
This condition is typical when a component fails in the AGC circuit. It causes a complete failure of control or may result in only partial control.

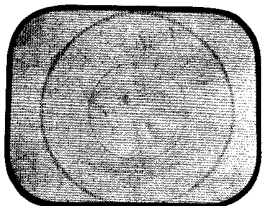
If there is a partial but inadequate change in the contrast as the AGC control is rotated, it may be due to a high leakage in one of the capacitors such as C151 or C180. Since the impedance of the circuit is high, leakage in the order of 1 megohm or less will cause trouble.

Next check for sync voltage at the clipper grid. If this is lower than normal, it will result in too low an AGC voltage which has the effect of insufficient range as the control is varied from one extreme to the other. On strong signals this will cause "Black Squashing" and possible sync instability.

- CHECK FOR:
1. Shorted capacitor, C302. This will result in excessive RF-IF gain and the AGC control will work backwards.
 2. Shorted AGC by-pass C151. This will result in no control and too much contrast.
 3. Insufficient signal at clipper. Check for normal voltages with oscilloscope. Check V113 and V116 and crystal diode.
 4. Leaky capacitor C155 and C131 (R-F Tuner Unit).

ADDITIONAL NOTES:





BRIGHTNESS CONTROL PARTIALLY OR
COMPLETELY INOPERATIVE
(MALADJUSTED BRIGHTNESS CONTROL.)

ANALYSIS

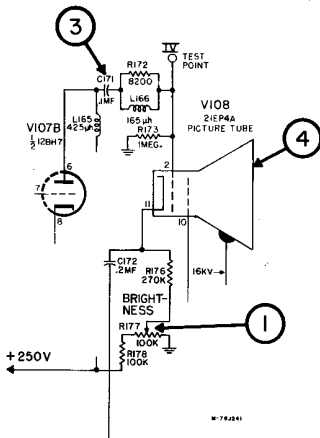
This condition is usually caused by inadequate range of control of the picture tube bias voltage. Since the bias voltage is controlled by the Brightness control, a check should be made of the components in this circuit.

If they are of correct value, check the voltage to the Brightness control circuit. Leakage through the coupling capacitor C171 to the grid of the picture tube will apply B+ to the grid of the picture tube through this capacitor and cause excessive brightness with little or no effect when the Brightness control is turned.

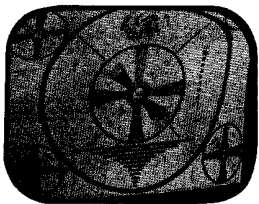
If the above checks do not disclose source of trouble, change picture tube as a "gassy" tube may cause erratic Brightness control operation.

- CHECK FOR:
1. Defective Brightness control, R177, or circuit components.
 2. Low B+ to Brightness control circuit.
 3. Defective (short or leaky) capacitor, C171.
 4. Defective (gassy) picture tube.

ADDITIONAL NOTES:



W-79,281



PICTURE PULLED OUT OF SHAPE
ON ONE SIDE OR CORNER
(Maladjustment Of Picture Straightening
Magnets)

ANALYSIS

When a picture is pulled out of shape in one corner or side, it usually indicates improper orientation of the anti-pincushion magnets, the "Picture Straighteners".

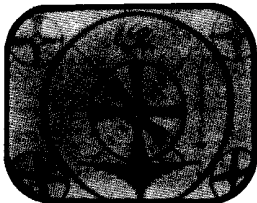
CHECK FOR: 1. Proper orientation of the Picture Straighteners.

ADDITIONAL NOTES:

ANALYSIS

The best point to observe focus is to the right of center in the horizontal wedge. If the raster lines are not clearly defined when the Focus control is varied, this condition is probably due to an improper magnetic field produced by the focus unit.

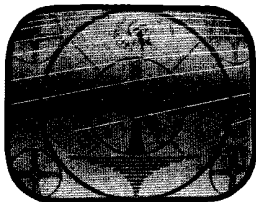
Check by replacing the focus unit. Make sure that what looks like poor focus is not the effect of r-f, i-f or video amplifier troubles which have a similar effect as far as picture detail is concerned, however, these troubles do not affect the clarity of the raster lines while poor focus does.



POOR FOCUS
(Maladjusted Focus Unit)

CHECK FOR: 1. Proper focus unit adjustment and position.
2. Defective picture tube.

ADDITIONAL NOTES:



VERTICAL RETRACE LINES VISIBLE
(CAPACITOR C313 OPEN)

ANALYSIS

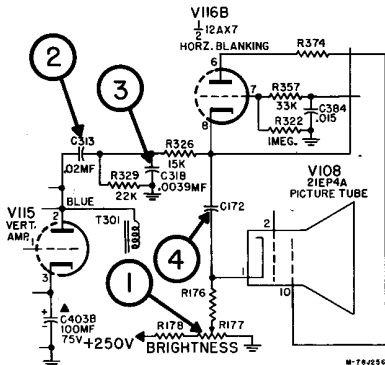
On some competitive receivers, vertical retrace lines are visible when the brilliance is too great and/or the contrast is too low.

This is the result of insufficient blanking voltage applied to the picture tube to cut-off the beam current during retrace. In modern GB receivers retrace blanking circuits are incorporated. The troubles described below are on the basis of the use of this circuit as shown in the illustration.

First check the operating voltages of the picture tube, then check resistor values and capacitors for leakage in the vertical retrace blanking circuit.

- CHECK FOR:
1. Normal operation of contrast and brightness circuits.
 2. Open input capacitor to blanking circuit, C313.
 3. Check for shorted capacitor in blanking circuit, C318.
 4. Open coupling capacitor C172 on picture tube cathode.

ADDITIONAL NOTES:

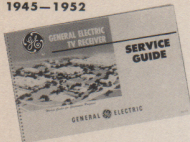


M-78-256

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1945—1952



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