NEW

H. G. CISIN'S

1955

TV DOCTOR

$1

COMPREHENSIVE REPAIR GUIDE

PICTURE CONDITIONS

Absent all channels ---------- 1
Absent all channels, bright thin horiz. line ---------- 2
Absent all channels, bright thin vert. line ---------- 3
Absent all channels, diagonal horiz. bars ---------- 4
Absent some channels ---------- 5
Background unstable ---------- 6
Bars, horizontal dark and light ------ 7
Blooming (abnormal expansion) -------- 8
Brightness excessive ---------- 9
Brightness insufficient ---------- 10
Brightness non-adjustable ---------- 11
Brown or yellowish spot ---------- 12
Contrast poor (faded) ---------- 13
Contrast strongly black and white (absence of intermediate shading) ---------- 14
Darkened (see Brightness insufficient) ---------- 15
Details absent or poor ---------- 16
Diagonal thin bright lines (about 5) across picture ---------- 17
Diagonal thin lines, shaded dark & light ---------- 18
Dwarfed horizontally ---------- 19
Dwarfed vertically ---------- 20
Dwarfed horiz. & vert. ---------- 21
Enlarged & cannot be focused --------- 22
Focus defective (indistinct picture) ---------- 23
Ghosts (reflections) ---------- 24
Height excessive ---------- 25
Height insufficient ---------- 26
Herringbone effect ---------- 27
Horiz. centering incorrect ---------- 28
Horizontal movement ---------- 29
Horizontally squeezed and/or stretched ---------- 30
Illumination non-uniform ---------- 31
Intermittent ---------- 32
Intermittent dark horiz. streaks ---------- 33
Jittery ---------- 34
Lopsided ---------- 35
Momentary reduction in size (unstable) ---------- 36
Moves up or down (rolling picture) --- 37
Moves up or down & sideways ---------- 38
Moves right or left ---------- 39
Multiple overlap horiz. ---------- 40
Multiple overlap vertically ---------- 41
Negative (as in photographic neg.) certain channels only -------- 42
Negative, all channels ---------- 43
Normal ---------- 44
Off-center horizontally ---------- 45
Off-center vertically ---------- 46
Overlapping horizontally (horiz. foldover left or right) ---------- 47
Overlapping vertically (vertical foldover top or bottom) ---------- 48
Return traces visible ---------- 49
Shaded on right side ---------- 50
Shadow or dark area on one corner ---------- 51
Streaks, intermittent thin light and dark, horiz. ---------- 52
Snow all channels ---------- 53
Snow, certain channel(s) ---------- 54
Tearing horiz., moves to side -------- 55
Tilted ---------- 56
Vertical dark faint line, left side followed by light area ---------- 57
Vertical bars, large number, alternate dark and light ---------- 58
Vertical bars, right side ---------- 59
Vertical centering incorrect --------- 60
Vertically stretched or squeezed ---------- 61
Weak all channels ---------- 62
Weak certain channel(s) ---------- 63
Weaving or pulling horiz. at normal contrast ---------- 64
Width insufficient ---------- 65
Windshield wiper effect ---------- 66
White horiz. bar at bottom ---------- 67
White horiz. bar at top ---------- 68
White diagonal lines throughout ---------- 69

BRIGHT AREA (RASTER) CONDITIONS

Absent all channels ---------- A
Absent all channels, bright horiz. line ---------- AA
Absent all channels, bright vert. line ---------- AB
Blooming (abnormal expansion) -------- B
Brightness excessive ---------- BA
Brightness insufficient ---------- BB
Brightness non-adjustable ---------- BC
Brown or yellowish spot ---------- BD
Darkened (see brightness insufficient) ---------- D
Diagonal thin bright lines (about five) ---------- DA
Dwarfed horizontally ---------- DB
Dwarfed hor. & vert. ---------- DC
Dwarfed vertically ---------- DD
Enlarged & cannot be focused --------- E
Focus defective ---------- F
Foldover left or right ---------- FA
Foldover top or bottom ---------- FB
Height excessive ---------- H
Height insufficient ---------- HA
Herringbone effect ---------- HB
Horizontal centering incorrect -------- HC
Illumination non-uniform ---------- I
Intermittent ---------- IA
Intermittent dark horiz. streaks ---------- IB
Jittery ---------- J
Lopsided ---------- L
Momentary reduction in size (unstable) ---------- M
Normal ---------- N
Off-center horizontally ---------- O
Off-center vertically ---------- OA
Shadow or dark area on one corner ---------- S
Streaks, intermittent thin light & dark horiz. ---------- SA
Tilted ---------- T
Vertical bars, alternate dark and light ---------- V
Vertical bars right side ---------- VA
Vertical centering incorrect --------- VB
Vertical dark faint line followed by light area ---------- VC
Vertically stretched or squeezed ---------- VD
Weak all channels ---------- W
Width insufficient ---------- WA
White diagonal lines throughout ---------- WB
White horiz. bar at bottom ---------- WC
White horiz. bar at top ---------- WD

SOUND CONDITIONS

Absent all channels ---------- 1
Absent some channels ---------- 2
Hum background all channels ---------- 3
Hum certain channel(s) ---------- 4
Intermittent ---------- 5
Noisy ---------- 6
Normal ---------- 7
Not coinciding with picture ---------- 8
Ringing (microphonic) all channels ---------- 9
Unnatural ---------- 10
Weak all channels ---------- 11
Weak certain channel(s) ---------- 12

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TV DOCTOR

By Harry G. Cisin

CHAPTER 1

HOW TO RECOGNIZE & REMEDY TV TROUBLES

FOREWORD

This book is frankly a beginner's book. It has been prepared especially for the novice in TV servicing. Beginners in every skill and trade often encounter a solid wall of opposition from those who have reached the top in their particular field. This of course is only natural, since the highly skilled technician is seldom anxious to impart his hard-earned knowledge to a potential competitor.

The author of this book is not restrained by any such considerations. He is well-known to radio and television men as a recognized electronic engineer, inventor, technical author and educator. He has trained thousands of television technicians, many of them now owning their own prosperous TV service organizations or holding important positions in television. The results of years of experience are embodied in his books on TV servicing. THE TELEVISION DOCTOR provides the novice with a practical, workable start in television servicing eliminating theory, formulas and mathamatics. It also enables the beginner to diagnose television troubles without technical knowledge or training by means of a copyrighted TV trouble shooting method devised by the author.

Heres How it Works

INSPECT THE PICTURE!

1. Inspect the picture and select your particular trouble from an alphabetically listed column of PICTURE CONDITIONS shown on the opposite page. For example, if no picture can be obtained on any channel, you will find this trouble listed under the PICTURE CONDITION heading "Absent All Channels". After each picture condition you will find a CODE NUMBER. Thus, the CODE NUMBER for the condition "Absent All Channels" is "1". The CODE NUMBER for the condition "Weak All Channels" is "62".

OBSERVE THE BRIGHT AREA!

2. Turn the station selector to some channel which you know is not broadcasting. If a picture is still visible on all channels, tune the set to the weakest picture and disconnect the antenna lead-in from the set. The purpose is to remove the picture signal and inspect the screen with the set in this condition. A BRIGHT AREA should then be visible on the face of the picture tube.

Much valuable information about the operating condition of the television set may be obtained by observing the condition of this BRIGHT AREA.

On the opposite page you will find an alphabetically listed column of BRIGHT AREA CONDITIONS. Pick your observed BRIGHT AREA CONDITION from this list. For example the BRIGHT AREA may be entirely absent. You will find this trouble listed under "Absent All Channels". After each listing in this column you will find either one or two CODE LETTERS. The CODE LETTER after "Absent All Channels" is "A".

LISTEN TO THE SOUND!

3. Reconnect the antenna, if it has been disconnected and turn the station selector back to a channel which is providing a picture. Listen to the sound. Observation of the CONDITION OF SOUND provides the third link in the chain which enables you to diagnose television troubles. Pick your particular sound condition from the alphabetically listed CONDITION OF SOUND column. After each condition listed in this column, you will find a CODE NUMBER. For example, if the sound is "Weak All Channels", the CODE NUMBER for this condition is "11".

Now combine the code number obtained from the PICTURE CONDITION column with the code letter(s) obtained from the BRIGHT AREA CONDITION column and

the code number obtained from the SOUND CONDITION column in the order mentioned here. For instance, in the examples given above, the code number for PICTURE CONDITION "Absent all Channels" is "1"; the code letter for BRIGHT AREA CONDITION "Absent all Channels" is "A" and the code number for CONDITION OF SOUND "Weak all Channels" is "11". Hence, the combination of these three gives the CODE COMBINATION for the trouble as "1A11".

Having obtained the CODE COMBINATION, consult the chapter, "TROUBLE LOCATION GUIDE"to ascertain the probable cause(s) of the trouble and its (their) location. The lists on page 1 are restricted to trouble conditions which can be remedied without advanced technical experience. Advanced servicemen and others who require a complete listing of practically all TV trouble conditions, their causes and remedies are advised to obtain a copy of H. G. Cisin's "TV CONSULTANT" which is described in further detail on the inside back cover of this book.

The trouble causes listed in the TROUBLE LOCATION GUIDE deal chiefly with troubles due to defective tubes, misadjustments and other similar troubles which can be remedied without special knowledge or instruments.

THIS TRADE SECRET WILL SAVE TIME

It is a rather closely guarded trade secret that approximately 80 percent of radio and television troubles originate with or are due to defective tubes. Therefore the first thing you should do when called upon to repair a TV set, is to replace certain tubes.

The TROUBLE LOCATION GUIDE makes this information available to you. Therefore, by following the directions given in this book you will be able to locate the defective tubes and replace them and thus save time often lost looking for other faults. However, it must be kept in mind that some television troubles are due to other causes than defective tubes. For example, faulty operation may result from misadjustments, or from troubles outside the set, itself, such as the trouble in the power supply line, antenna lead-in defects, interference from other stations, etc.

Troubles may also result from burnt out or defective parts such as resistors, coils, and condensers. The novice or beginner in TV servicing can remedy many of these troubles with the exception of the last mentioned ones -- that is to say, the burnt out or defective parts.

If you have applied the remedies listed in the TROUBLE LOCATION GUIDE and these do not solve your problem, it is reasonable to assume that the difficulty originates in burnt out or defective parts.

The novice should remember not to experiment indiscriminately with the small screw-driver adjustments which control the so-called "Alignment" of the set. You will recognize these slotted screw heads by the fact that they can be turned only with a small screw driver. They can also be recognized by the fact that the adjustments are made through holes located in the top of the chassis or else in the tops of the aluminum cans which surround the coils. In some instances these alignment screws are at the center of coils which are not shielded by cans. Your rule in regard to these adjusting screws is a simple one -- DO NOT TURN THEM!

TUBE LOCATION GUIDE

In order to apply many of the remedies suggested in the TROUBLE LOCATION GUIDE provided in a later chapter, you must know or be able to find the location of the various tubes mentioned. For example, in order to remedy a certain fault, you may have to replace the low voltage rectifier tube. Therefore, you must know where to find this tube in your set.

The simplest and easiest way for you to find out where any particular tube, such as the low voltage rectifier tube, is located in any set, is to obtain a TUBE LOCATION GUIDE showing the function, type number and location of every tube in that set.

Figure 1B shows a TUBE LOCATION GUIDE which applies to the Magnavox Television Receiver, model CT 214 chassis. You will note from this guide that the low voltage rectifier is a 5U4G tube located at the rear of the chassis on the right side. The R.F. Tuning Unit (Channel Selector) shown at the right front hand corner contains three tubes which have not been labelled. The one nearest the front with the shield around it, is the oscillator tube. The middle tube is a mixer tube and the tube directly to the rear of the mixer is the R.F. tube. All three tubes are 6J6 tubes.

TROUBLE INDICATING TUBE LOCATION GUIDES

A new and more efficient copyrighted type of tube location guide, known as the TROUBLE INDICATING TUBE LOCATION GUIDE has recently been devised by the author, as shown in Figure 1A. TROUBLE INDICATING TUBE LOCATION GUIDES covering over 3000 different TV models are contained in H.G. Cisin's TV TUBE LOCATOR book which sells for $1. Still other similar location guides are available in the 50¢ books, TV TROUBLE TRACER, Volume 1, Volume 2, Volume 3 and Volume 4. Each of these books contains guides of over 500 TV models.

In this improved form of guide all tubes are plainly marked with a letter which indicates the actual effect each tube has on the performance of the television set. The regular type designations are also given to facilitate purchase of replacements. Tubes which affect picture are marked "P"; those which affect sound are marked "S"; those which affect picture and sound are marked "PS". The value of this system is readily apparent where trouble is due to defective or burnt out tubes.

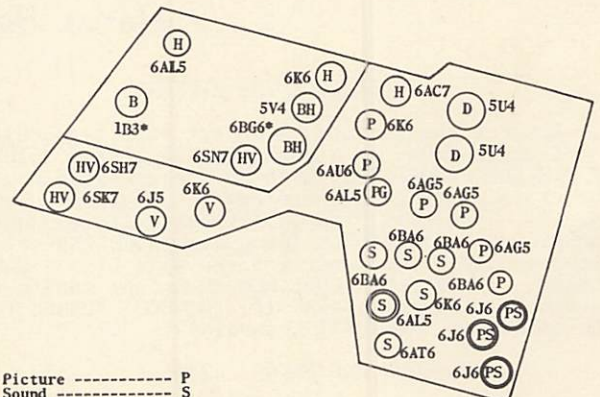


Figure 1A - Typical Trouble Indicating Tube Location Guide. The guide shown refers specifically to the 630-type sets.

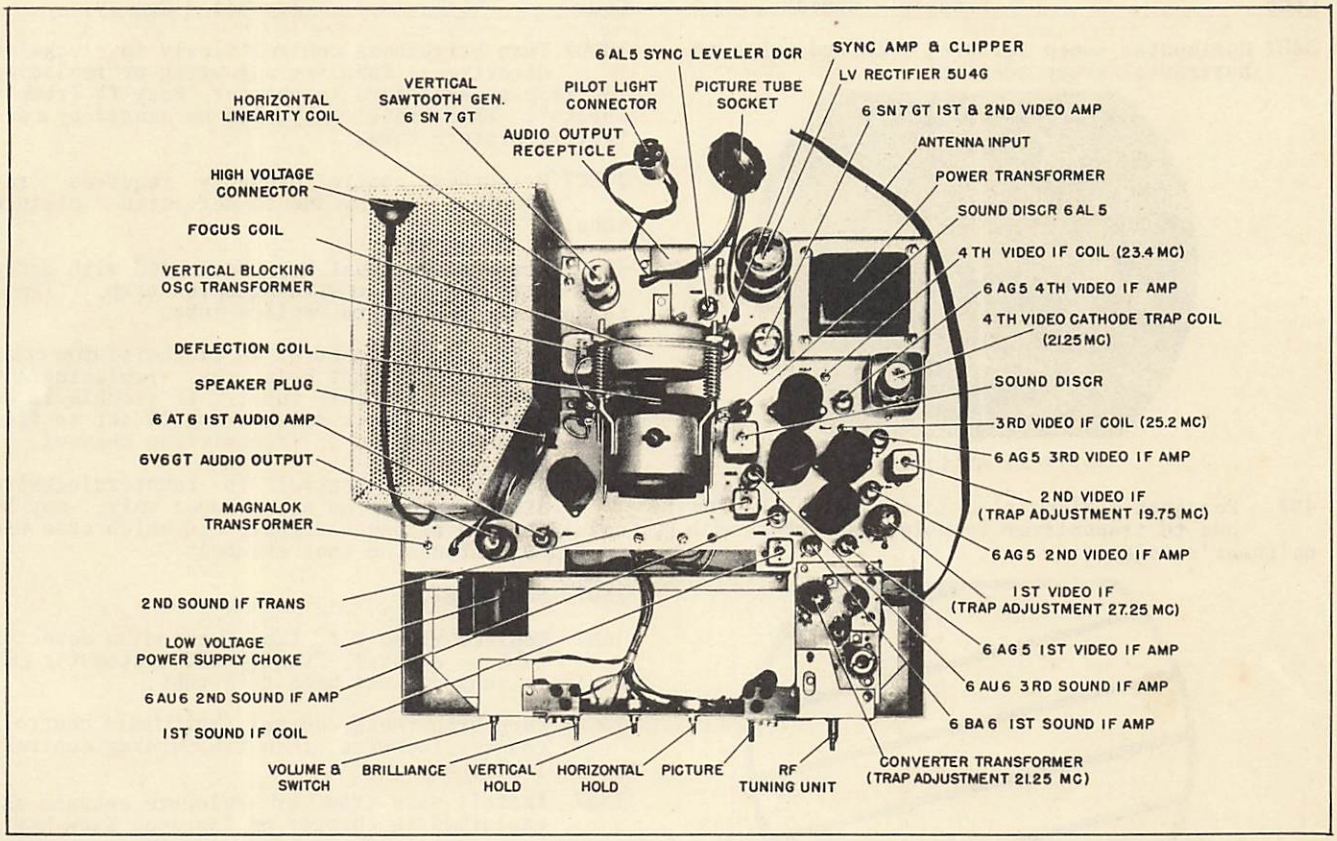


Figure 1B

Top view of Magnavox television set, CT 214 chassis, showing location of tubes and various other parts.

CHAPTER 2

TV TROUBLE LOCATOR

Code	Trouble - Remedy

1A1 Power supply failure. See page 15.

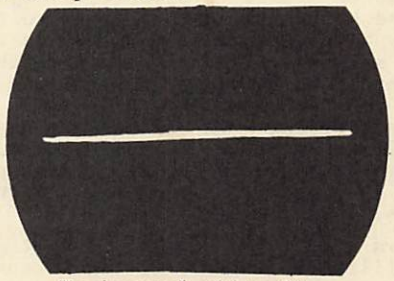
1A7 High voltage failure. See page 15.

1A11 Low voltage power supply still working but weak. First change low voltage rectifier tube. If two tubes are used, change both. If set uses selenium rectifier, this may be defective. Very low line voltage could cause this trouble. If electric lights are unusually dim, this is a definite sign of low line voltage.

1N1 Loss of picture and sound, with bright area unaffected. May be due to non-reception of signal. Check antenna, lead-in, and wiring from antenna terminal strip on set to r.f. coil. Check especially for breaks in wire which may result in open circuit. Next check, by replacement, all tubes which affect both picture and sound signals simultaneously. This includes AGC tubes (contrast) as these affect both picture and sound signals.

1N7 Trouble is in video i.f., video detector or video amplifier. Replace tubes in these sections. Replace d.c. restorer if set uses this tube. In sets using intercarrier circuit (See Fig. 3A) replace only d.c. restorer and video amplifier tube or tubes. Latter need be replaced in such sets, only if sound signal is removed before video amplifier tube. If both sound and picture signals pass through video amplifier, and sound is normal, it is obvious that this tube is not defective. This trouble may also be caused by defective or poorly adjusted ion trap or in rare instances by defective picture tube.

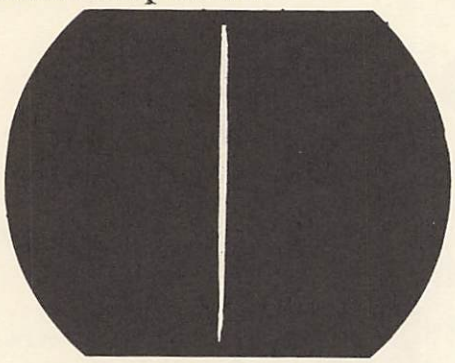
2AA7 Vertical sweep failure. Change tubes in vertical sweep section



Horizontal white line.

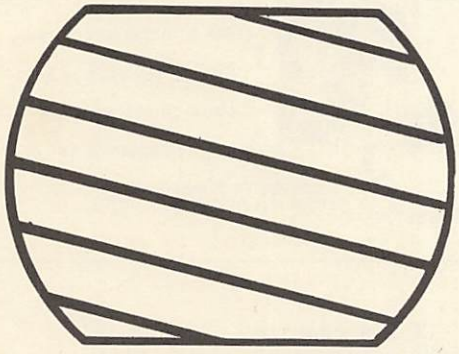
Code — Trouble - Remedy

3AB7 Horizontal sweep failure. Change tubes in horizontal sweep section.



Vertical white line.

4N7 Readjust horizontal hold control. May be due to transmitter trouble, so check with neighbor's television set.



Diagonal bars.

5N2 Poor contact to some channels at station selector drum. Examine drum for weak springs. Clean contacts with carbona or carbon "tet".

5N7 or 5N8 Adjust fine tuning control slightly. If picture can be brought in with fine tuning control, but does not coincide with best position for sound, tune to best sound point by adjusting oscillator trimmer. Exception is case of intercarrier sets, which are tuned to best picture position. Note that in the case of some weak channels, when oscillator is tuned for best sound, picture may be quite weak. This is normal and no readjustment should be made.

6N7 Change d.c. restorer tube.

7N7 Replace oscillator and r.f. tubes. Also pix i.f. tubes. Test these tubes for microphonic action by tapping gently while set is "on". If sound trap is readily available, readjust slightly. These horizontal bars are called sound bars. They vary in brightness and number as volume and pitch of sound signal changes. Also check for microphonic tube in video amplifier.

8B7 Insufficient high voltage. Replace high voltage rectifier tube, damper tube, or if necessary all tubes in horizontal sweep section. Resistor in lead to side of picture tube may be defective.

9BA7 Turn brightness control (sometimes called brilliance control) slowly in counterclockwise direction.

Code — Trouble - Remedy

10BB7 Turn brightness control slowly in clockwise direction. Then try adjusting or replacing ion trap as explained in chapter, "Easy TV Trouble Checks". This trouble may also be caused by a defective picture tube.

11BC7 Brightness control probably requires replacing. May be due to defective picture tube.

12BD7 Picture tube must have been used with defective ion trap or without an ion trap. There is no remedy except to replace tube.

13N5 Turn contrast control in clockwise direction. If this does not help, try replacing AGC (automatic gain control) tube. If trouble is on one channel only check neighboring TV set to find out if trouble is due to transmitting channel.

14N7 Turn contrast control in counterclockwise direction. If on one channel only, may be caused by too strong a signal, in which case use an indoor antenna on that channel.

15D7 See 10BB7.

16N7 Replace video i.f. tube; next video detector tube or crystal; finally AGC (automatic gain control) tube, if set uses this tube.

17DA7 Turn brightness control (brilliance control) counterclockwise, then try turning contrast control clockwise.

18N7 Install wave trap or relocate antenna as explained in chapter on "Antenna Know-How".

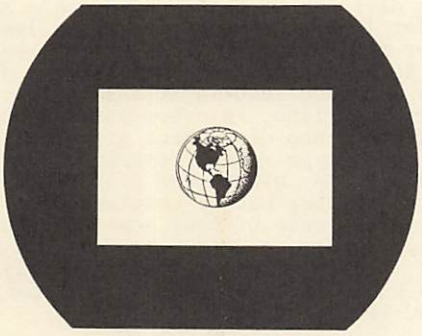
19DB7 Readjust width control. Slightly readjust drive control. If necessary adjust horizontal linearity control. Alternate readjustments of drive and linearity controls may be required. If ineffective, replace horizontal oscillator tube, discharge tube or horizontal output tube.

Dwarfed horizontally.

20DD7 Readjust height control so as to just fill the picture mask. At the same time readjust vertical linearity control for symmetry of picture. Alternate readjustments of these two controls are generally desirable for best results.

21DC7 High voltage to picture tube excessive. Try moving (deflection) yoke forward and nearer flare of picture tube. Try replacing high voltage rectifier and/or damper. (See illustration on page 6)

21DC11 Replace low voltage rectifier tubes or selenium rectifiers. In sets which use oscillator high voltage supply, replace high voltage

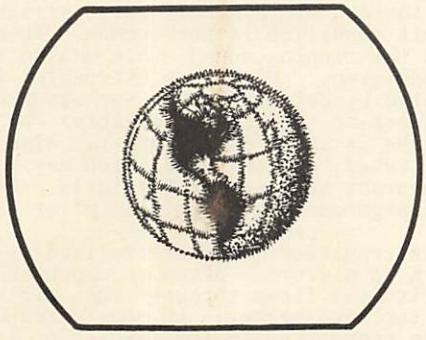


Dwarfed horiz. and vert.

21DC11 (Continued)
oscillator tube.

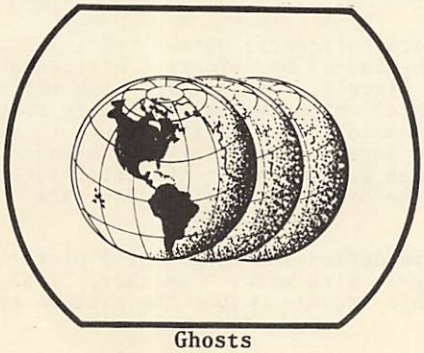
22E11 High voltage to picture tube must be increased. Replace high voltage rectifier tube(s) and/or damper tube. Also try replacing horizontal output tube and all other horizontal sweep circuit tubes.

23N7 Readjust focus control, turning it to setting which gives clearest picture. With set working properly, it will go out of focus either side of this setting. If set uses electrostatic focus picture tube try replacing focus rectifier tube.



Out of focus.

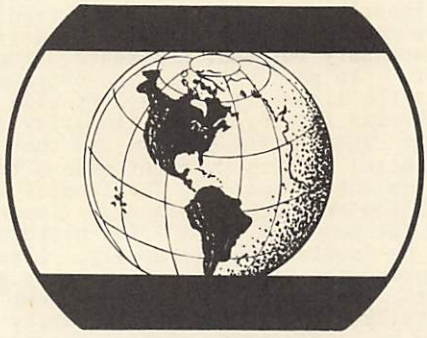
24N7 Rotate antenna to a new position or try relocating it or elevating it. Substitute a more highly directive antenna. If ghost is very close to desired signal, it may be due to reflection in the lead-in (called a transmission line), in which case this indicates that a wrong type of lead-in is being used. If antenna consists of two straight arms (dipole), use a 75-ohm lead-in. If arms of antenna are folded, use a 300-ohm trans-- mission line (lead-in).



Ghosts

25H7 Turn height control (sometimes called "vertical size control") slowly in a counterclockwise direction until correct height is obtained.

26HA7 Turn height control (vertical size) slowly in a clockwise direction.

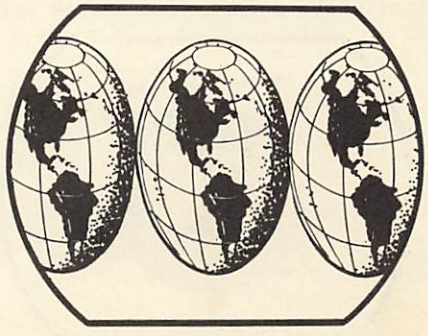


Insufficient Height

27HB7 Since this trouble is due to diathermy or similar interference, best remedy is to shield the offending apparatus. In many cases, therefore, this trouble cannot be remedied.

28HC7 Readjust horizontal centering control if set is equipped with this control. If none is used, readjust position of focus coil. Various manufacturers employ slightly different methods of centering. In some GE sets centering is obtained by adjustment of the amplitude and linearity controls combined with correct positioning of the focus coil on the neck of the picture tube. Some sets employ centering "rings" at the front and back of the focus coil. Certain sets accomplish centering by a special adjustment on the focus coil assembly and also to a slight degree by the positioning of the ion trap. A wing nut on the focus coil assembly holds a solid metallic shield in place. Loosening of this nut permits the shield to be adjusted either along the arc of a circle or along an axis at right angles to the neck of the picture tube and these two adjustments help to center the picture.

29N7 Carefully readjust horizontal hold control. Assuming that the vertical hold control is correctly set, if the horizontal hold control is correctly adjusted, the picture will stop moving horizontally in either direction. If the horizontal hold control is far out of adjustment, many



Moves Horizontally

horizontal pictures may be seen, each one abnormally narrow. As the adjustment of this control approaches correct setting, small horizontal portions

Code Trouble - Remedy

29N7 (Continued)

of the picture appear to be torn away. If readjustment of the horizontal hold control fails to "stop" the picture and the receiver uses a horizontal sync lock, this may require adjustment.

30N7 Readjust horizontal drive control for best linearity. If necessary also readjust horizontal linearity control. Alternate readjustments of drive control and horizontal linearity control may be necessary for best horizontal linearity adjustment. In many TV sets the horizontal drive controls the linearity on the left side of the picture, whereas the horizontal linearity control affects the center of the picture and the horizontal width control affects the right side of the picture. To explain what is meant by "horizontal linearity", a television set lacks horizontal linearity if it make a fat man look thin. The picture is then said to be "squeezed" horizontally. Likewise, it lacks horizontal linearity if it makes a thin man look fat. The picture is said then to be "stretched" horizontally. If horizontal linearity cannot be obtained by readjustment of the controls, try replacing horizontal output tubes and damper tube.

31I7 Turn brightness control (also called brilliance control) in a clockwise direction. Also refer to 10BB7.

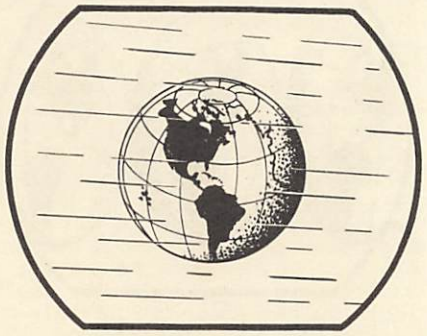
32IA5 An intermittent low voltage power supply will cause picture, brightness area and sound to be intermittent. Intermittents of this nature may be caused by poorly soldered joints and can sometimes be located by inspection. They may also be caused by defective low voltage. In some cases a defective power supply is the cause of this trouble. If the latter is suspected connect an incandescent lamp to the outlet and note if lamp flickers. If so trouble may be due to a loose connection in the power supply line or even to a defective fuse or a loose fuse not tightly screwed into its socket.

32IA7 This type of intermittent is due to high voltage trouble. See next chapter.

32N5 Replace tubes in front end. Examine tuner (channel selector) for defective or dirty contacts. Clean latter with carbon tetrachloride (Carbona).

32N7 Replace video amplifier tubes. This trouble could also be due to defective picture tube. Intermittent of this type may result from defective video amplifier tube sockets.

33IB6 Generally caused by automobile ignition interference but could also be due to sparking or arcing appliances such as brush-type motors or



Automobile Interference

Code Trouble-Remedy

33IB6 (Continued)

vibrating devices, or "make-and-break" switches. Fluorescent lamps and old style carbon lamps cause trouble of this nature. In case of automobile ignition interference, relocate antenna if possible and use a shielded lead-in (transmission line). Ask for coaxial line. In other cases, trace source of interference and disconnect it. In case of a sparking brush-type motor, resurface commutator or replace brushes or use a line filter at the offending device. Filter can be obtained from TV parts jobber. In the case of many home appliances such as electric razors, mixers, etc. it is possible to reduce interference materially, merely by connecting a 0.025 mfd. condenser across the two wires which lead to the device.

33IB7 Caused by same types of interference as 33IB6 and remedied in the same way. In this case, the noise does not reach the speaker, due principally to the fact that the FM circuit prevents this. Some sets have superior design as regards the unwanted sound signals.

33IB9 This is known as "microphonic" trouble. Gently tap each of the tubes closest to the station selector. If the streaks in the picture and the ringing sound in the speaker increase, replace offending tube or tubes. Usually the tube nearest the front -- the oscillator -- is the one which gives this trouble. Hence this is the tube which should be replaced first. Several oscillator tubes should be tried, as the first tube substituted may not function satisfactorily. In some instances, horizontal bars will be seen in the picture, instead of thin horizontal streaks, although this condition is not common. When associated with the ringing sound, this is also a microphonic condition. Microphonic trouble is sometimes caused by defective tube sockets so check the sockets close to the station selector by noting whether tube is loose in its socket. Also examine miniature tubes for bent pins which may cause imperfect contact with socket terminals. Bent pins can be straightened by using thin pliers.

34N6 This condition is characterized by a jumpy erratic picture, often accompanied by thin white horizontal lines through the picture and noise in the loudspeaker. In some cases it is due to a loose connection in the lead-in or it may be caused by swinging lead-in shorting against the building at some point. Remedy is to check lead-in and tighten any loose connections. In some cases when lead-in is badly frayed or in poor condition, a replacement should be made. A poor contact at the tuning drum of the set may cause same symptoms and can be distinguished from lead-in trouble if the trouble persists when an indoor antenna is substituted for the outdoor one. Check channel selector (tuner) for poor contacts. A defective tube or tubes in the front end can also cause this trouble. Try replacing front end tubes.

34N7 Replace horizontal output tube. This trouble may be caused by defective horizontal drive control or circuit. If the grid leak resistor at the horizontal output tube is greatly reduced in value this could cause the trouble. If edges of picture are jagged, check for open by-pass condenser at screen grid of horizontal oscillator. In this case the bright area will also show jagged edges.

35L7 Rotate deflection coil until picture lines properly with mask. Another, less common cause of this trouble is that the picture tube has

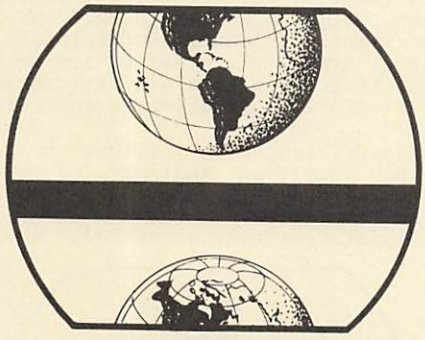
35L7 (Continued)

been rotated somewhat from its normal position. See 56T7.

Tilted

36M6 Due to variations in power supply voltage. Call service department of electric utility company or remedy yourself by the installation of an automatic voltage regulator.

37N7 Readjust vertical hold control. If movement cannot be stopped by hold control try replacing vertical oscillator tube and discharge tube (if separate tube is used). Also try replacing vertical sync clipper. If fault cannot be remedied by above, check vertical sync circuits and vertical oscillator circuit.



Moves Vertically

38N7 Replace all tubes in sync separator circuit. These generally include sync separator tubes, sync inverter tube and/or sync amplifier tube(s).

39N7 See 29N7.

40N7 See 29N7.

41N7 See 37N7

42N7 This condition may be caused by too strong a signal in which case the usual remedy is to readjust the contrast control, turning it in a clockwise direction. When incoming signal is strong enough to cause black parts of the picture to appear white and vice-versa, this condition is usually accompanied by movement of the picture. If the strength of signal cannot be reduced sufficiently with contrast control, try substitution of indoor antenna for outdoor one.

43N7 Replace following tubes: video detector tube, first video amplifier tube, second video amplifier tube. This trouble may also be caused by excessive interference picked up by video amplifier in which case more adequate shielding is indicated. If due to defective peaking coils in video amplifier circuit, these must be replaced. If a normal picture is obtained with low contrast setting and dark areas become silvery in appearance as contrast control is turned in a clockwise direction, this is an indication of a defective picture tube.

Negative

44N1 This trouble might result from one or more defective tubes any place in the sound circuit. The tubes most likely to give trouble, however, are the audio output tube and the discriminator or ratio detector. Therefore these should be replaced first.

44N2 Usually due to misadjustment of oscillator on defective channels. Adjust in accordance with manufacturer's instruction for that particular model.

44N3 Replace audio output tube. If there is a preceding first audio tube try replacing this. This trouble may also result from a defective discriminator tube or ratio detector tube or from misalignment of sound i.f. or discriminator.

44N4 This trouble may be caused by misalignment.

44N5 Any defective tubes or poorly soldered connection in the sound section may be responsible for this trouble. Try replacing one tube after another in sound section until trouble maker is located.

44N6 Apply same checks as for 44N5.

44N8 This condition is usually due to an incorrectly tuned (aligned) oscillator, misaligned front end, or both. See 5N7.

44N9 Look for the microphonic tube or defective socket in the sound section. Locate the trouble by gently tapping each tube in this section and noting if there is an increase in the ringing sound. When the microphonic tube is located, replace it.

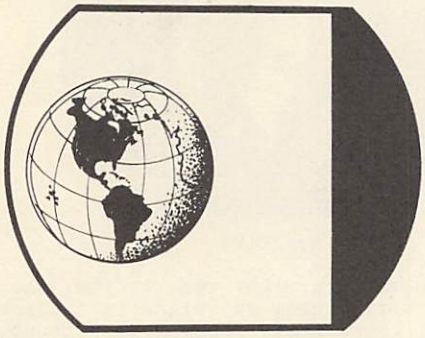
44N10 This trouble shows up as distorted voice and music. The voices of speakers sound harsh and unnatural and music is unpleasant. The first check is to replace audio output tube. Sometimes a defective speaker must be replaced by one which is OK. However, this trouble may also be due to defective resistors and condensers or incorrect alignment of the sound section. A slight realignment of the discriminator stage may help.

Code Trouble - Remedy

44N11 This trouble is generally caused by one or more weak tubes in the sound section. Replace audio output tube first, then audio amplifier tubes, then discriminator or ratio detector tube, finally all sound i.f. tubes. Weak sound may also be caused by incorrect alignment of sound section, defective speaker, incorrect operating voltages and faulty components.

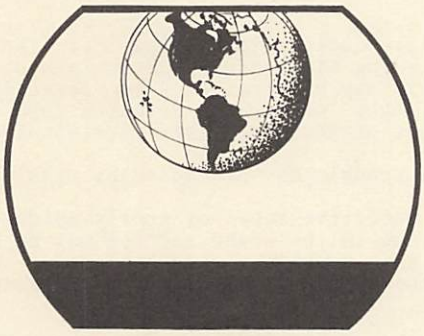
44N12 Weak sound on certain channels may be due to incorrect front end alignment. Try slight adjustment of fine tuning control. If due to incorrect oscillator alignment, this can be remedied if location of oscillator adjustment slug for that channel is known.

4507 See 28HC7.



Off-center Horizontally

460A7 Readjust vertical centering control. If no vertical centering control is provided read instructions for centering picture given under heading 28HC7.



Off-center Vertically

47FA7 Replace damper tube. May also be caused by troubles in damper tube circuits.

48FB7 Replace vertical oscillator tube since vertical foldover may result from leakage in this tube.

49DA7 Readjust contrast and brightness controls.

50N7 Mismatch between lead-in and antenna or between lead-in and TV set. Remedy is to use correct lead-in or install matching device. If antenna consists of two straight arms (dipole) use a 75-ohm lead-in. If arms of antenna are folded, use a 300-ohm transmission line (lead-in).

Code Trouble - Remedy

51S7 Readjust ion trap as per directions in Chapter 5.

Darkened Corner

52SA7 See 33IB6.

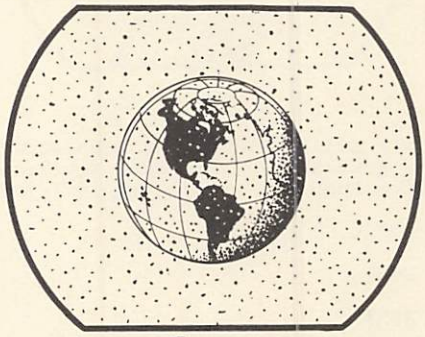
53N7 Defective video i.f. tubes, automatic gain control tube, video detector tube, video amplifier tube or video output tube. In other words, any weak or defective tubes in the picture section of the TV set may be the cause of this trouble. If replacement of tubes fails to remedy trouble, an alignment job may be needed.

53N11 When picture is snowy and weak on all stations, sound is weak and muffled on all stations, but bright area is normal, first look for the trouble in the antenna system. One of the antenna arms may be broken or moisture may have affected the lead-in. Rain, snow, salt air deposits and other inclement weather conditions have been known to affect the lead-in sufficiently to weaken all channel signals. Remedies are self-evident. However, if trouble persists, try replacement of tubes close to the channel selector (front end of tuner).

53W7 Insufficient high voltage.

53W11 This condition indicates a defective low voltage power supply. Replace low voltage rectifier tube(s).

54N7 Adjust fine tuning control. Check other sets.



Snow

54N12 First adjust fine tuning control to make sure trouble is "outside" set. Then try turning antenna so that cross arms directly face the weak station's transmitter (ends of antenna arms point in a direction at right angles to station). Use a director and a reflector to further strengthen desired signal. If in a fringe reception area (50 miles or more distant from the weak station) install a stacked antenna. Read chapter on antennas.

55N7 Readjust horizontal hold control. Replace

Code — Trouble - Remedy

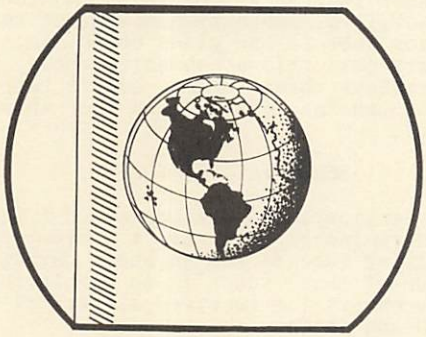
55N7 (Continued)

horizontal automatic frequency control tube or sync discriminator tube; replace reactance tube and horizontal sync amplifier tube.

55N12 When tearing of picture is observed following sound impulses, this trouble is generally caused by incorrect adjustment of associated sound traps and remedy is to realign sound traps.

56T7 Reset deflection yoke. This should be positioned against the flare of the picture tube. This may be done by loosening the adjustment and pushing the yoke forward as far as possible. Then rotate yoke until picture is square in the mask. The neck of the picture tube should be parallel with chassis. This is usually accomplished by raising or lowering the yoke. See 35L7.

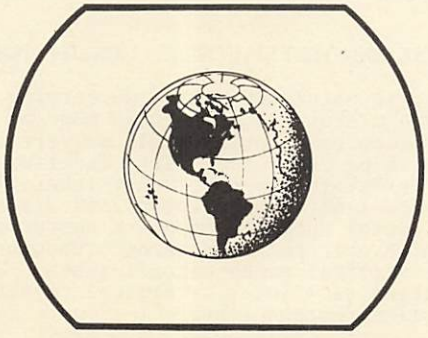
57VC7 Replace horizontal output tube. It may be necessary to try several tubes before obtaining one which does not cause these so-called "Barkhausen" oscillations. In some cases this trouble may be due to misadjustment of horizontal drive control. To remedy, turn this control slowly in counterclockwise direction.



Vertical Line & Light Area at Left

58V7 When accompanied by stippled background, this trouble is caused by interference pick-up. The higher the frequency of the interfering signal, the greater the number of dark and light bars. See chapter on antennas for method of reducing or eliminating this trouble.

59VA7 Replace horizontal oscillator tube.

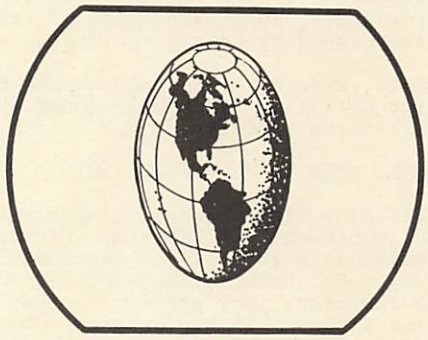


Normal Picture

Code — Trouble - Remedy

60VB7 See 460A7.

61VD7 Readjust vertical linearity control. This may necessitate readjustment of height control since alternate adjustments of these two controls are usually necessary for obtaining best linearity. Replace all vertical sweep circuit tubes. A picture is said to lack vertical linearity if it makes a tall man look short, or a short man look tall.



Stretched Vertically

62N7 See 53N7.

62N11 See 53N11.

62W7 See 53W7.

62W11 See 53W11.

63N7 See 54N7.

63N12 See 54N12.

64N7 Try replacing d.c. restorer tube if set uses such a tube, and video amplifier tubes. If these replacements fail to remedy trouble, check bias on video amplifier tubes, checking for excessive bias.

65WA7 See 19DB7.

66N7 Interference from another channel. Turn antenna in a different direction in order to weaken signal of offending station. For additional information on suppression of interference see antenna chapter. Windshield wiper effect may be either vertical or horizontal or both.

67WC7 Replace vertical output tube.

68WD7 This is due to heater-cathode leakage in vertical output tube. Replace this tube.

69WB7 In this type of trouble, picture is well defined, but contrast control is ineffective. Replace video amplifier tube. Other possible causes of this trouble are leaky by-pass condensers in the grid circuit of the picture tube or a defective picture tube.

CHAPTER 3

VALUABLE INFO. ABOUT TV RECEIVERS

From a practical standpoint, you don't have to know the intricate theory which explains "how" a television set works in order to find out "why" it does not work.

To remedy a fault in a TV set, you must first determine what defect is causing the trouble, next you must find the exact location of this defect and finally you must replace the defective component with one which is in good working order. As explained previously, about 80 percent of television troubles are caused by defective tubes.

Therefore, it is obvious that you will be benefited if you obtain knowledge about the tubes used in television receivers.

TUBES USED IN TELEVISION SETS

The following list contains nearly all the tubes used in present-day TV sets. Picture tubes are not included in this list. Instead of listing the tubes by type numbers, they are listed according to the functions they perform. Not all the tubes listed are used in any one set, but in the list you will probably find most of the important tubes used in the average TV set. The list follows:

audio frequency amplifier tube or tubes
audio output tube or tubes
automatic frequency control tube (AFC)
automatic gain control (AGC) keying tube or tubes
automatic gain control cathode follower
automatic gain control clamper tube
automatic gain control rectifier
blocking oscillator tube
converter tube
damper tube or tubes
d.c. restorer tube or tubes -- also called d.c. reinserter tube or tubes
high voltage rectifier tube or tubes
high voltage oscillator tube
horizontal a.f.c. tube
horizontal blanking tube
horizontal discharge tube
horizontal output tube
horizontal oscillator or multivibrator tube or tubes
horizontal phase detector tube
horizontal sync discriminator tube
horizontal sweep circuit tubes
limiter tube
low voltage rectifier tube or tubes
mixer tube
noise inverter tube
oscillator tube or tubes
reactance tube
r.f. amplifier tube or tubes
sound discriminator tube
sound i.f. amplifier tube or tubes
sound output tube or tubes
sound ratio detector tube
sound section tubes
sync amplifier or sync output tube
sync circuit tubes
sync clamper tube
sync clipper tube
sync leveller tube
sync lock discriminator tube
sync phase inverter tube
sync separator tube or tubes
ultra high frequency (UHF) oscillator
vertical discharge tube
vertical oscillator or multivibrator tube or tubes
vertical sweep circuit tubes
vertical output tube
video amplifier tubes
video detector or second detector tube
video i.f. amplifier tubes
video output tube

Before explaining how to locate the various tubes, a non-technical explanation of the action of the television receiver will be helpful. The television set actually consists of a picture receiver combined with a sound receiver. The latter is quite similar to an ordinary (FM) radio set. The picture receiver, however, employs a number of special circuits, each having its own particular function.

THE FRONT END

Both the sound and the picture signals are tuned in simultaneously by means of a "channel selector." This is included in the "front end" of the receiver, which may have one, two or three tubes. Where only one tube is used in the front end, this is a dual function mixer-oscillator tube. If the front end uses two tubes, one is an r.f. tube, the other is usually a combination of a mixer tube and an oscillator tube in one glass enclosure. Some manufacturers call this a converter tube. If the front end employs three tubes, one is an "r.f. tube", one is an "oscillator" and the third tube is a "mixer".

SOUND SECTION TUBES

Sound section tubes include sound i.f. tubes, a sound discriminator tube or a ratio detector, audio amplifier tube(s) and an audio output tube. The function of these tubes is to enable the loud speaker to convert the received electrical signals into speech and music.

PICTURE SECTION TUBES

These consist of video i.f. tubes, video detector (sometimes called the second detector), video amplifier tube(s) and a video output tube. Many sets, but not all, employ a d.c. restorer tube which can be considered as a part of the picture section. The function of these tubes is to bring electrical signals of suitable nature to the picture tube, so that the latter tube can convert these signals into dots of light having varying degrees of light intensity.

HORIZONTAL AND VERTICAL SWEEP CIRCUIT TUBES

In order to obtain a picture, the varying dots provided by the picture section tubes must be swept across the screen both horizontally and vertically. The tubes which perform the first function are known as the horizontal sweep circuit tubes. These consist of a horizontal oscillator and discharge tube, a horizontal output tube and a damper tube. The tubes which perform the second function are known as the vertical sweep circuit tubes. These are the vertical oscillator, vertical discharge tube and vertical output tube.

SYNCHRONIZING SYSTEM

The word "synchronizing" in effect means "Timing". In order to keep the picture at the

receiver in step with the scene being televised at the studio, every TV set must have a "synchronizing system". This system separates certain portions of the received signal from the picture information portions. The separated signals are called pulses. The pulses are used to make each horizontal line of picture dots at the receiver start and stop at exactly the same time as in the case of the line televised and sent out at the transmitter. The pulses which perform this duty are called horizontal sync pulses.

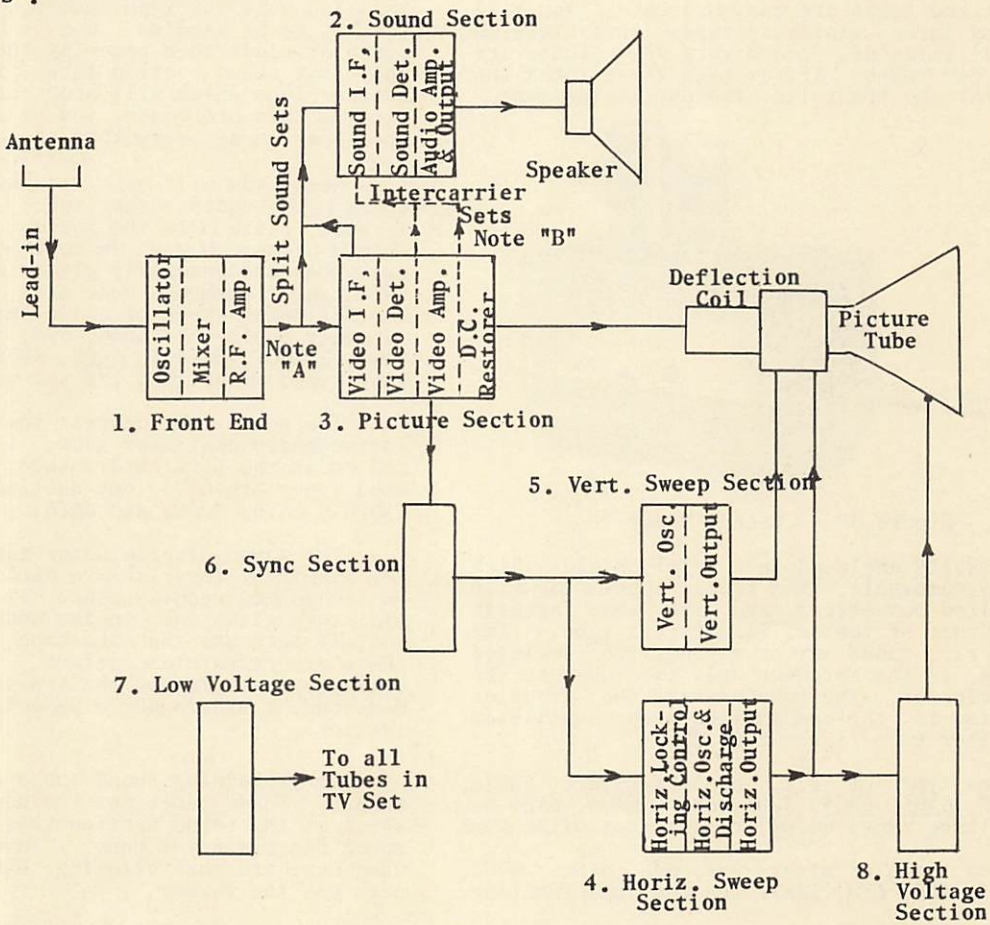
Other somewhat similar pulses keep the vertical movement of the lines at the receiver in time with that at the transmitter. To fully accomplish this purpose, synchronizing systems in some sets use sync separator tubes (to separate the timing pulses from the picture signal), sync amplifier tubes to increase the efficiency of the separated pulses, a sync lock discriminator tube or horizontal phase detector and a reactance tube to make sure that the entire system remains in step. In some sync lock systems, a dual function tube such as a 6SN7 serves as a combination horizontal oscillator control and horizontal oscillator. Most of the tubes in the sync system have been lumped together for simplicity and referred to as "sync circuit tubes".

LOW VOLTAGE POWER SUPPLY

The tubes used in a television receiver must be supplied with d.c. voltages in order to operate correctly. For this reason every TV set has a "Low Voltage Power Supply". This uses either one or two low voltage rectifier tubes. In some sets, selenium (metal plate) rectifiers take the place of the low voltage rectifier tubes.

HIGH VOLTAGE POWER SUPPLY

The picture tube needs very high voltages, ranging from 10,000 volts to 20,000 volts or even higher in the case of projection type TV sets. Therefore, all television sets have a "high voltage power supply". In some early sets the high voltage power supply uses a high voltage oscillator tube and a high voltage rectifier tube. As a matter of fact, all TV sets use at least one high voltage rectifier tube, some sets using two or even three of these tubes. Some types of high voltage power supplies employ the following tubes to enable them to furnish high voltage to the picture tube: a horizontal oscillator, horizontal discharge tube, horizontal output tube, high voltage rectifier.



NOTE "A": In "split-sound" sets, the sound signal is separated from the picture signal either at the output of the front end or after one of the video i.f. stages.

NOTE "B": In "intercarrier" sets, the sound signal is separated from the picture signal either at the output of the video amplifier or at the output of the video detector.

Figure 3A - Eight Basic Sections of Every TV Set

EIGHT BASIC SECTIONS TO EVERY TV SET

You can see that every television set consists basically of the following eight sections. (See Figure 3A.)

1. Front end
2. Sound section
3. Picture section
4. Horizontal sweep section
5. Vertical sweep section
6. Synchronizing section
7. Low voltage power supply
8. High voltage power supply

Note that Figure 3A shows by arrows the path taken by picture, sound and sync signals. Also note that there are two methods whereby sound signals are separated from picture signals. In one system called the "split-sound" system, the sound signal is taken off either at the output of the front end or after one of the video i.f. stages. In the other more commonly used system, the sound signal is removed either at the output of the video amplifier or at the output of the video detector. This method is known as the "intercarrier system.

1 - Front End

Front end tubes are easy to locate. You will find two or three miniature tubes very close to the channel selector. See Figure 3B. These are the front end tubes. If set uses three tubes, the tube nearest the front is the oscillator tube.

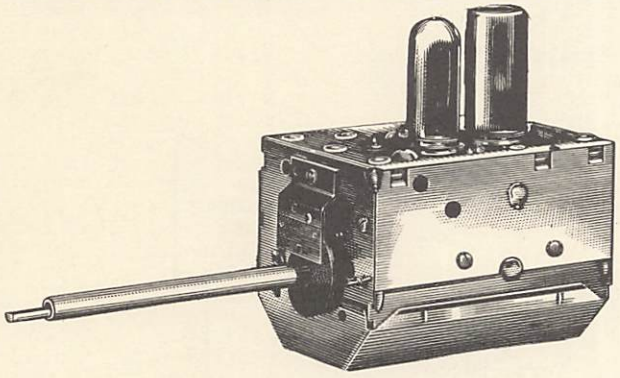


Figure 3B - Cascode Tuner

This is usually enclosed in a metal shield which is readily removable. The middle tube is the mixer (or so-called converter) and the tube farthest from the front of the set is the r.f. tube. The mixer and r.f. tubes may or may not be enclosed in shields. If the set uses only two tubes at the channel selector, the tube nearest the front of the chassis is the combination mixer-oscillator and the other tube is the r.f. tube.

Common types of r.f. amplifiers are: 6BQ7A, 6BQ7, 6BZ7, 6AG5, 6BC5, 6CB6, 6BJ6, 6AU6, 6AB4 and 6J6. The tube types underlined are most often used.

Common types of mixers are: 6J6, 6AG6, 6BC5, 6CB6, 6AK5, 6U8, 6X8, 12AV7 (half of dual function type).

2- Sound Section

If you are unable to obtain a Tube Location Guide of the set being tested it is still possible to locate nearly all the tubes in the TV set by means of a simple method devised by the author.

The method consists of removing tubes, one at a time, and carefully noticing the results on the sound, the picture or the bright area. It is advisable to remove tubes only with the set turned "off" and the power plug removed from the receptacle. This takes a little more time than working with the set "on", but it is far safer. Even when the set is turned "off", work with one hand behind your back as explained in the Safety Rules given below.

Under no circumstances should the cover be removed from the perforated high voltage compartment, except when checking the high voltage system, and even then, not before you have carefully read the directions for making such a check.

The tubes in the sound section may be located by the following method provided any type of sound can be obtained from the speaker.

The procedure in locating the sound section tubes is to tune in a station, then to remove a tube and determine whether this stops the sound from the loud speaker. If it does, you have located a tube in the sound section. It is assumed that you have already located the front end tubes Removal of these would eliminate both picture and sound. Make a note of the location of the tube and also note its type number. If the tubes are too hot to be handled, use a handkerchief or a piece of cloth when removing them. Having found the first sound section tube, replace it and try another tube which will stop the sound. By continuing this procedure, you will be able to obtain the location of every tube in the sound section.

Next, you will want to know which of these tubes is the audio output tube. This tube is easily located, since it is the hottest of the sound tubes. This is because it uses the most power. Audio output tubes are generally glass tubes of the "G" or "GT" types, although some sets use metal tubes. The following types of audio output tubes are most commonly employed: 6U6G, 6V6, 6V6GT, 6K6GT, 6K6, 6SA5, 25L6GT, 50L6GT, 6AQ5, 6BN5 and 6BF5. The tube types underlined are the most commonly used.

The sound tube nearest the audio output tube is the audio amplifier tube. This is often referred to as the first audio tube. The most commonly used types are 6AT6, one section of the 6T8, 6SQ7, 6SQ7GT, 6AV6, 6J5GT and 6AT6.

The sound discriminator tube or ratio detector is almost invariably a 6AL5 tube. This can be recognized readily since it is the smallest miniature glass tube in the sound section. While most TV sets use the 6AL5 tube for this purpose, there are certain exceptions. For example, some sets use a portion of the 6T8 tube as the ratio detector. Others use a 6BN6 tube for sound detection.

The remaining sound tubes are the sound i.f. tubes. These sometimes include a limiter tube which is the sound section tube just before the sound discriminator tube. Tubes most commonly used here are the following: 6AU6 and 6AG5. Most sets use the former.

3- Picture Section

The procedure in locating the tubes in the picture section is identical with that described above for the sound section, except that tubes are removed one at a time to determine which tubes eliminate the picture. Naturally this method cannot be

used if no picture can be obtained on any channel. However, if a picture can be obtained on even a single channel, regardless of how weak or distorted the picture may be, the method described can be used. As mentioned previously, the tubes in the picture section, aside from the picture tube itself, include the video i.f. tubes, video detector, video amplifier and also video output tube . Many sets employ but a single tube after the video detector which is then usually referred to as a video amplifier.

The removal of any one of these tubes will eliminate the picture, but will not interfere with the sound except in the case of intercarrier sets which must be excluded from this method.

The following tubes are most frequently used as video amplifier or video output tubes: 6AC7, 6AH6, 6BA6, 6AQ5, 12AT7 (half for first video amplifier and half for second video amplifier), 6CB6, 12BY7, 12AU7 (half for first video amplifier and half for second video amplifier), 12BH7 (half for first video amplifier and half for second video amplifier), 6SN7 (half for first video amplifier and half for second video amplifier).

The tube used in practically all modern TV sets as a video or second video detector is the 6AL5 (or 12AL5). One half of this tube performs the video detector function, while the other half serves as an automatic gain control tube, a d.c. restorer, or a sync limiter. In some TV sets one half the 6AL5 is not used. Incidentally, the 12AU7 tube is often used as a d.c. restorer. The chief exception to the use of the 6AL5 as a video detector is in the case of sets which employ a crystal detector.

Video i.f. tubes commonly used are 6AU6, 6AG5, 6CB6, 6BC5 and 6BA6.

4 - Horizontal Sweep Section

In most sets, removal of the horizontal sweep section tubes results in complete loss of bright area as well as of the picture. Sound remains normal. The bright area in these sets is lost because the high voltage is eliminated. While the horizontal oscillator may be removed without any special precautions after the set has been turned "off" (provided it is not in the high voltage compartment) other horizontal sweep section tubes inside the high voltage cage must not be handled, even with the power "off", unless special safety rules are followed. The precautions to be taken before removing these and other high voltage tubes are clearly explained below under the heading "8 - High Voltage Section".

Removal of the horizontal oscillator tube(s) (in some sets these are called horizontal multivibrator tubes or horizontal output tubes) in sets which employ an r.f. power supply will eliminate the picture and reduce the bright area to a single bright thin vertical line. In this case also, sound will not be affected.

Tubes generally used as horizontal oscillator tubes include the following: 6K6GT, 6SN7 or 6SN7GT, (in some cases one half the tube is used as the oscillator, the other half as a horizontal discharge tube; in other cases the two halves are used as the two multivibrator tubes) 6AK7, 12AU7 and 12SN7. Sometimes the second half of the 6SN7, 12SN7 or other double function tube is used as an automatic frequency control tube. Typical tubes used as horizontal output tubes and damper tubes will be mentioned under the high voltage section heading.

5 - Vertical Sweep Section

The tubes in the vertical sweep section can be located very rapidly if the set has a bright area or shows a picture. Removal of a tube in the vertical sweep section will eliminate the picture or the bright area leaving only a very bright thin horizontal line. Usually, the vertical oscillator and the vertical discharge tubes are combined in a single double function tube. This tube is usually a 6SN7, a 6SN7GT tube or a 6SN7GTA tube. In some cases one half the 6SN7 is the vertical oscillator and the other half is the vertical output tube and no discharge tube is used. Other vertical oscillator tubes sometimes encountered are the 6C4 tube, 12AU7 and 12SN7 (half as vertical oscillator and half as vertical discharge tube), and the 6J5GT.

The tubes most often used as vertical output tubes are the 6V6 and 6V6GT, 6AH4GT, 6AV5GT, 6AQ5, 6K6GT, 6W6, 6S4 and 12AU7. In general, the vertical output tube will be much warmer than the vertical oscillator.

6 - Synchronizing System.

When the sync separator, sync damper, sync clipper, sync phase inverter or sync amplifier tubes are removed, the picture will move both vertically and horizontally. Hence, these tubes are readily located.

The many different names given to the tubes in the synchronizing system by various manufacturers are apt to be confusing. However, even though the function of each and every sync tube is not clearly understood, this will not prevent you from locating the tubes in the synchronizing system. As explained above, the picture signal carries along with it, at definite time intervals, sync pulses. The purpose of the tubes in the synchronizing section is to separate these pulses from the picture signal, to shape them into certain definite forms, to amplify or strengthen them and then to apply them to the vertical and horizontal oscillators in such a manner that they will be able to control the timing of these oscillators and in this way keep the spots of light going back and forth and up and down across the face of the picture tube in the TV receiver in step with the action at the transmitter.

If the sync pulses through any of the tubes in the synchronizing system are interrupted by removing a tube it follows that the picture will go out of control and move from side to side as well as up and down. It should be understood that the number of tubes employed in the synchronizing system varies with various TV receivers. Some sets employ either two or three sync tubes, while others may employ quite a few more.

Some television receivers use double function tubes (actually two tubes in a single glass envelope) in the sync circuits. For example, the 12AU7 is often used as sync amplifier. One section of the 6SL7 is also used for this purpose. The 6AL5 tube (one section) is sometimes used as a sync leveler. The 6BE6 tube is also used as a sync separator.

Most modern television sets employ an automatic frequency control (AFC) sync circuit. The chief purpose of this circuit is to keep the picture from shifting its position horizontally and moving from side to side. In other words, it is a automatic stabilizing circuit. The tubes usually used in one type of circuit are a sync (lock) discriminator and a so-called reactance tube. The horizontal oscillator tube also forms a part of this circuit.

In some sets the sync discriminator is a 6AL5, readily recognized because of its extremely small size. The 6AC7 tube is also quite generally used as a reactance tube. In another type of AFC sync circuit, a 6AQ7GT performs the dual function of horizontal phase detector and horizontal AFC. In still another AFC system a 6SN7GT serves as a combination horizontal AFC control and a horizontal oscillator. The horizontal oscillator tubes are discussed under the heading "Horizontal Sweep Section".

7 - Low Voltage Power Supply

If the low voltage power supply rectifier tube is removed, the sound, picture and bright area will go "dead". Sometimes two rectifier tubes are used instead of one. If two similar tubes are located in this section, remove both at once.

Tubes in this section are readily found. They are located close to the power transformer. The low voltage rectifier tube is generally a large glass tube and it is one of the hottest tubes in the TV set. Perhaps the tube most commonly used as a low voltage rectifier is the 5U4G. Other tubes also used are the 5V4G, 5Y3G, 6X5 and similar types. If none of these tubes can be found and you cannot find power transformer, look for selenium rectifiers under the chassis. These are stacks of light gray metal plates about one and one half inches square and separated from each other by about one quarter inch. They take the place of the low voltage rectifier tubes.

8 - High Voltage Section

WARNING!

Special precautions are necessary before removing tubes or when removing or replacing tubes in the high voltage section. In many modern sets the high voltage section is enclosed in a perforated metal protective cage or compartment. This compartment usually has a removable metal cover. Never remove this cover until the set has been turned "off" and the power supply plug has been removed from the receptacle. Before starting work, carefully read safety rules given below.

Safety Rules

(1) Never attempt to replace or even to touch a high voltage tube unless the current is "off" and unless you thoroughly understand and follow the special directions given for this operation.

If you cannot locate the high voltage compartment, use the special high voltage check described in Safety Rule No. 5 to determine the points in the set which are carrying high voltage.

Under all circumstances, it is best to avoid high voltage shock. In modern television sets, such a shock is not necessarily dangerous, although it is decidedly unpleasant. This is because present day TV sets are made in such a way that the high voltage disappears if the high voltage connection is touched. Most servicemen at one time or another, have joined the 10,000 or15,000 volt club (received a high voltage shock from a TV set) without any ill effects. Sometimes an unpleasant shock can be received merely by coming near a poorly insulated wire which carries high voltage. In this case, the high voltage spark jumps from the wire to the hand or elbow and in most cases, this is a good thing, as it thus gives warning not to come any closer. While working, never permit anyone near the television set which is operating with the back or safety cover open. It should also be kept in mind that an electrical shock of any kind may prove fatal to anyone suffering from a heart ailment.

(2) Replace tubes only when set is turned "off" and is disconnected from the houselighting circuit. Regardless of the fact that the set is turned "off" and of the fact that the tubes being replaced are known to be other than high voltage tubes, always use only one hand and keep the other hand behind the back. A shock across a finger or across the hand will have comparatively little effect, as compared with a shock received through the body via both hands and even though the set is "off" there is always a chance of getting a shock because of the discharge of a charged condenser.

(3) While the set is "on" avoid touching the insulated lead which is connected to the snap button on top of the picture tube. It is best to keep several inches away from this lead in order to avoid the possibility of shock from a spark which could jump to the hand from a break in the insulation.

(4) Certain picture tubes such as the 16AP4, 16AP4A, 16GP4 and 16GP4A employ a metal outside cone which is at a potential of from 12,000 to 14,000 volts. KEEP AWAY FROM THIS METAL CONE! The black metal cone may carry a charge (since it is connected to a charged condenser) for some time after the set has been disconnected from the power supply. However, this metal cone should not be confused with the black carbonized coating used on various other picture tubes. This coating is kept at ground potential and is harmless.

(5) By means of the following SPECIAL HIGH VOLTAGE CHECK, you will be able to determine exactly where the high voltage danger points are in the set you are repairing and you will thus be able to avoid them. Obtain a miniature type neon lamp. This can be purchased at very low cost, in sizes as small as 1/16 inch diameter and about half an inch long. The G.E. type NE-2 Neon Lamp (1/25w.) is ideal for this purpose. Insert the neon lamp into the end of a piece of insulated fibre tubing, about ten inches in length. You now have an excellent high voltage indicator. When the lamp is placed near a high voltage point, it will glow brightly. The higher the voltage the brighter the glow. In addition to its use as a safety device, this neon lamp arrangement can also be used to check for high voltage failure.

(6) Before attempting to remove chassis from cabinet pull power plug from wall receptacle and turn "on-off" switch to the "off" position.

(7) Always pull power plug from wall receptacle before making any connections to the set and before doing any soldering on the set.

* * * * * *

Having disconnected the set from the houselighting circuit, wait for ten or fifteen minutes and then remove the metal cover from the high voltage compartment.

Within the compartment are two or more tubes which have metal caps on top. Unless you follow the special directions, you can still get a shock by touching these caps, even though the current has been turned "off". In order to prevent this from happening, obtain a long blade screw driver with an insulated handle and touch each tube cap with the end of the screw driver blade while, at the same time, grounding the blade against the metal chassis or the metal compartment side. Use

only one hand while doing this and hold the screw driver by its insulated handle.

Next, obtain a length of well-insulated wire with the insulation removed at each end and simultaneously touch one end of the wire to the black coating of the picture tube and the other end to the metal chassis, being sure to hold the wire only by the well-insulated portion.

You are now ready to remove tubes from the high voltage section. In many sets you will find the following tubes within the metal compartment: horizontal oscillator tube, horizontal output tube, high voltage rectifier tube(s), damper tube(s). Other sets with the same type of high voltage power supply may have the horizontal oscillator tube outside the compartment. Still other sets which use a different type of high voltage power supply have the high voltage oscillator and high voltage rectifier within the metal enclosure.

You will be able to pick out the high voltage rectifier because of its distinctive shape and appearance. If it is a 1B3GT (formerly called 8016), you will recognize it immediately because this tube is about 3 7/8" high with a diameter of only 1 3/16". It has a metal cap on top.

If the high voltage tube is a miniature tube with a cap on top, it will be a 1V2, a 1X2 or a 1X2A.

The horizontal output tube will also be readily recognized because it is generally the largest tube within the protective enclosure. In many cases the tube is a 6BG6G. However, following tubes are also used for horizontal output tubes: 6BQ6GT, 6CD6G, 25BQ6, 6AU5(miniature), or 6AV5(miniature) 6SN7GT, 12SN7GT. Typical damper tubes are 6AX4GT and 6W4GT.

If a tube in the high voltage section is replaced and the set fails to function correctly when turned "on", perform all safety operations mentioned above before replacing a different tube. In general, if set shows symptoms of a fault in the high voltage section, such as lack of high voltage as indicated by loss of bright area with sound normal, it is better to replace all tubes in the high voltage section at the same time, rather than to replace the tubes one at a time. This eliminates the chance that two or more tubes may be defective in which case replacement of any one tube would naturally fail to remedy the trouble. Note that a defective picture tube or brightness control may prevent appearance of bright area.

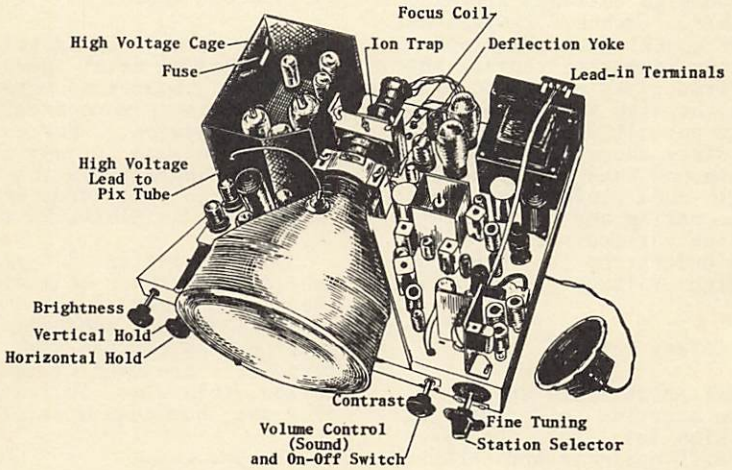


Figure 3C - Top View of Typical TV Set

CHAPTER 4

HOW TO RECOGNIZE & REPLACE DEFECTIVE TUBES

Most television servicemen do not depend on a tube checker to determine whether or not a tube is defective. They employ a method known as the "tube substitution" method. This means that they remove a suspected tube and replace it with a tube which they know is good.

A Trick of the Trade

Tube substitution servicing is a "trick of the trade". It would not be practical to replace all the tubes in the television receiver. Therefore, the first step is to apply the method given in Chapter 1 for diagnosing TV troubles. You can then determine the section in which the trouble is located by means of the "Trouble Location Guide" in Chapter 2.

In this way you would also know whether or not the trouble was due to defective tubes. Your problem is then to locate the troublesome section.

Certain tubes are more likely to give trouble than others. In general, tubes which operate at higher temperatures become defective or burn out sooner than those which operate at lower temperatures. Therefore, replace these tubes, called output tubes, first. For example, suppose that your diagnosis indicates that there is trouble in the vertical sweep circuit. Find the location of this circuit by means of the information given in the third chapter. Assume that this circuit has a vertical oscillator tube, a vertical discharge tube and a vertical output tube. The logical tube to replace first is the output tube.

Tubes which operate at high voltages are also most likely to give trouble. Hence, if symptoms indicate the necessity of checking the high voltage section of a television receiver, replace the high voltage rectifier first. As mentioned previously, if all tubes in the high voltage section are available for replacement it is a good idea to replace all at once, since there is always the possibility that more than one tube may be defective in which case single tube replacement would not be effective. Before making any replacements or other checks on the high voltage section of any television set, read and understand the "WARNING" given in Section 8 -- "High Voltage Section" -- Chapter 3.

A General Safety Rule

The following general safety rule should always be followed: Before starting to do anything whatsoever with a television set, turn the power "on-off" switch to the "off" position and REMOVE THE PLUG which brings current to the set from its outlet. Then wait at least fifteen minutes before starting to remove tubes or doing any other sort of work on the set. If high voltage tubes must be replaced, observe the special precautions given for this type of work.

How to Avoid Placing of New Tubes in Wrong Sockets

A common source of trouble which can be readily avoided is to remove more than one tube and then to forget which replacement tube goes in which socket. Here's a trick of the trade which will save you hours of troublesome experimentation. Before starting to remove tubes, obtain a number of small labels or stickers. If not available use ordinary adhesive tape. If you have five tubes to remove make duplicate stickers numbered from one to five. Place number "1" sticker on one of the tubes and put the second number "1" sticker beside the socket into which the tube is plugged. Do the same thing for the other tubes. In this way, you will be sure to replace the RIGHT tube in the RIGHT socket.

How to Handle Tubes

As you have undoubtedly noticed, different kinds of tubes used in television sets are designated by different combinations of letters and numbers. For example, one tube is labelled 1B3GT; another tube is a 5U4G and still another tube is designated as 6SK7. The picture tube, also referred to as a KINESCOPE or simply as a CATHODE RAY TUBE may, for example, be a 20AP4.

Each such designation is coded in such a way as to convey definite information regarding the use and nature of the tube and also certain information about its physical construction. It is often possible to tell from the type designation whether the tube is a high or a low voltage rectifier, whether it is an amplifier tube and in many cases exactly what purpose it serves in the TV set. Such technical information is not absolutely essential. However, if you remove a defective 1B3GT tube, it is quite clear that this must be replaced with a tube bearing the same type designation. Furthermore, certain precautions must be observed when replacing different types of tubes. For this reason it is necessary to know certain facts about tubes.

The tubes used in television sets are either glass tubes or metal tubes. Metal tubes are more rugged and require no external shielding. Glass tubes, although more fragile, possess certain other advantages. For example, they can be constructed in such a way that they will have more desirable characteristics for television work. This is especially true of the very small glass tubes known as MINIATURE tubes.

If the letter "G" is used at the end of a tube designation, this discloses two facts about the tube. First of all, it shows that the tube is a GLASS tube, secondly it means that the glass envelope has certain size and shape. If the letters "GT" are used at the end of the tube designation, this also indicates that the tube is made of glass, but that it is of a different shape than the "G" type tube and smaller in size. Miniature tubes, although made of glass, do not have special terminating letters to indicate this fact.

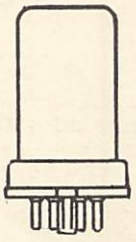


Figure 4A

Figure 4A illustrates a typical metal tube, in this case a 6SK7. The overall height of this tube is about 2 5/8 inches.

Figure 4B shows the appearance of a 5U4G (glass) tube. This tube is about 5 5/16 inches in overall height. It should be noted however that

both metal and glass tubes vary in size according to the function and type of the tube. For example,

Figure 4B

Figure 4C

Figure 4C shows another "G" type tube, the 6BG6G. It will be noted that this tube has an overall height of more than 5 1/2 inches. It also has the "plate" terminal on top, whereas the plate terminals of the 5U4G are at the base. Incidentally, the 5U4G tube is used in many television sets as a low voltage rectifier, whereas the 6BG6G is often used as a horizontal deflection output amplifier.

Figure 4D show a 6SK7GT tube. This tube does exactly the same work as the 6SK7 (metal) tube illustrated in Figure 4A, and in many cases it can be used to replace a metal tube. Note however that it has an overall height of 3 5/16 inches as compared to the 2 5/8 inches height of the metal tube.

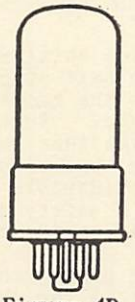


Figure 4D

All of the tubes illustrated in Figures 4A through 4D employ an 8-prong base called an octal base. This type of base requires the use of a matching socket known as an octal socket. The octal base has a bakelite key at the center which fits into a mating keyway in the socket. To remove the octal tube from its socket, merely lift it straight up. To replace a tube in an octal socket, place the tube gently on the socket so that the base just covers the socket. Rotate the tube slowly pressing it gently downward until the key of the tube enters the keyway of the socket.

Then press the tube firmly down into its final position. NEVER FORCE A TUBE INTO A SOCKET. This rule applies to all types of tubes. If the tube has to be forced, this is an indication that the key is not in the correct position over the keyway. However if the bakelite center is accidentally broken off, it usually is still possible to use the tube. In this case, examine the position of the part where the key has been broken off and carefully turn the tube over the socket to the position it would have been forced to occupy if the key had not been broken off. Then press the tube carefully into place in the socket.

Another type of base used in connection with glass tubes is shown in Figure 4E. This is called a LOCTAL or LOCK-IN base. The tube shown is a 7A5 tube. This has an overall height of approximately 3 1/4 inches. In this type of tube, the center key and the base are made of metal. While the loctal tubes can be inserted in matching loktal sockets in much the same way as an octal tube is placed in its socket, loctal tubes cannot be removed as readily. In fact, the particular feature of this type of base is the fact that the tubes will remain locked in position unless purposely removed. To remove a loctal tube from its socket, rock it gently from its upright position to a slanting position. This releases the tube, permitting it to be withdrawn from its socket.

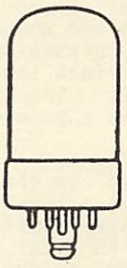


Figure 4E

Figure 4F

Quite often, octal tubes are locked in place by means of a locking ring which is fastened to the chassis above the socket. If you find a tube held firmly in position by a metal locking ring, press the ring down towards the chassis at two points with one hand, removing the tube with the other hand.

Figure 4F shows the outline of a 6AL5 MINIATURE type glass tube. This is one of the smallest tubes used in television receivers. It is only 1 3/4 inches high. The 6AL5 tube has seven pins which project directly from the glass envelope. No bakelite or metal base is used. The tube requires a miniature seven-contact socket. Although the base pins of the tube are sturdy, they can be bent quite readily. It is therefore essential that the pins be straight before the tube is inserted in its socket.

Examine the pins before inserting tube in its socket. This is the time to straighten any bent pins. This operation should be performed with care to avoid breaking off the pin. The manufacturers of these tubes suggest that insertion will be made easier if pins 1 and 7 are first aligned with their respective socket holes. The tube should then be pressed gently into the socket. To remove a miniature tube, lift it straight up trying not to twist or bend it.

Some 7-prong miniature tubes are 2 1/8 inches high, while others are 2 5/8 inches in height. Miniature tubes are also made with nine prongs instead of seven. These tubes are called NOVAL tubes. They are made in three different heights, 2 3/16 inches, 2 5/8 inches and 2 11/16 inches. The highest tube has a miniature cap on top which serves as the plate connection.

Figure 4G

Figure 4G shows a tube of this type, a 1X2A. This tube is a high voltage rectifier which serves a purpose similar to the 1B3GT. Plate connection in this case is at cap on top of the tube.

Crystal Detectors

In discussing the video detector used in the Picture Section (Chapter 3), mention was made of the fact that the chief exception to the use of the 6AL5 as a video detector was in the case of sets which employ a crystal detector. If you are unable to locate a 6AL5 tube in the picture section of the television receiver, it is probable that a

crystal detector, called a germanium detector, is used in place of the small miniature type tube.

This detector is usually, but not always, located beneath the chassis. In some cases it is located above the chassis in a shield can housing a coil or i.f. transformer. If all tubes in the picture section have been replaced and found O.K. it may be desirable to replace the crystal detector. This detector is about 3/4 inch in length and about the diameter of a pencil. The body is usually white or silvered with metal caps over the ends.

A type designation is printed on the white portion. On older sets, the most commonly used crystal detector is a 1N34. On later models, the 1N64 is being used extensively. In order to replace a detector, it is necessary to obtain another one having exactly the same type designation. These detectors usually have a plus sign at one end and a minus sign at the other. When the new detector is put in place, the plus sign must be connected at the same point as the plus sign of the old detector. It is necessary to solder the detector into place, but care should be taken not to use too much heat near the body of the crystal.

Selenium Rectifiers

Some of the less expensive and more compact TV receivers employ selenium rectifiers in place of low voltage rectifier tubes. These rectifiers consist of stacks of metal plates about one and one half inches square. Selenium rectifiers are usually but not always mounted beneath the chassis.

When in use they become quite hot and they often become defective for this reason with the result that low voltage becomes very low or entirely eliminated. Because of this, picture, bright area and sound are lost.

When a selenium rectifier becomes defective, it gives off a characteristic odor of rotten eggs. This will enable you to recognize the source of the trouble at once. Incidentally, these fumes are poisonous and the room should be well ventilated with fresh air at once.

In order to replace a faulty rectifier, merely unsolder it and install a new one having identical size and identical number of plates. The only precaution to be observed is that the positive terminal (marked with a plus sign) must be connected to the same point to which the positive terminal of the damaged rectifier was connected.

How to Replace a Defective Picture Tube

Picture tubes, like all other tubes, finally wear out and must be replaced. The symptoms which enable one to recognize faulty picture tubes have been described in a previous chapter. It is possible to replace a defective picture tube with a new one if you carefully follow the directions given here, but it is most important that you learn and apply the safety rules which must be observed when doing work of this kind.

The new tube must, of course, be identical with the old one in type designation and physical dimensions. If unable to obtain the exact type designation, use a substitute which is recommended by the tube manufacturers for this purpose. In many types of TV sets, it is necessary to remove the chassis from the cabinet in order to replace the picture tube. However in many other TV models, the picture tube may be replaced without the necessity of removing the chassis from the cabinet. In these sets, access to the picture tube is obtained by removing the front panel which holds the safety glass plate. After this has been removed, it should be cleaned with "glass wax" or any similar solution the same as used in cleaning any plate glass.

Before starting any work on any television set, the very first safety step is to turn the set "off" and to pull the plug from the outlet which furnishes power to operate the set. Many TV sets have a protective meshed metal back which provides ventilation for the interior of the set, but prevents one from getting a shock by placing the hand inside of the set while it is in operation. The back is generally equipped with an interlock switch which automatically disconnects the set from the power line when the back is removed. To make assurance double sure remove the plug from the outlet and then wait 15 minutes before starting to work on the set. The purpose of this wait is to permit charged condensers to lose their charge by leakage. Incidentally TV tube changing is something which should be done without the benefit of an audience.

Having obtained free access to the picture tube, the next step is to remove the high voltage lead from the recessed contact on the flared side of the tube. This lead is insulated and held in place on the tube not only by the snap fastener arrangement, but also by a rubber suction cup. Therefore, considerable pressure must be used to remove it. As a safety precaution, work with only one hand, holding the other hand behind your back.

Next ground the metal end of the high voltage lead against the chassis in order to make certain that the high voltage condensers are fully discharged. The black outer coating of the picture tube should also be connected momentarily to the chassis by means of an insulated lead to obviate the possibility that this may act as a condenser to store a charge. Such a charge would, of course, be slight, but it might cause you to drop the tube if received unexpectedly.

You are now ready to prepare the picture tube for removal, but first note the position of the high voltage fastener on the tube in order to be able to place the new tube in the same position. In a number of RCA television sets, this fastener is approximately on top. Also note the position of the ion trap magnets with relation to the ion trap flags.

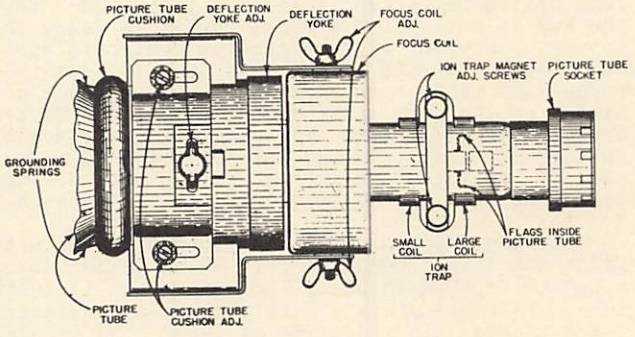


Figure 4H - Typical Arrangement of Focus Coil, Deflection Yoke and Other Parts

Figure 4H shows the arrangement of an ion trap, focus coil, deflection yoke and other parts such as picture tube cushion and grounding springs which

fit over the neck of the picture tube. The various adjustment points are also indicated. This is a typical arrangement used on Motorola, RCA and various other television sets. However some sets use an aluminum-backed screen picture tube in which case no ion trap assembly is required. It is a good idea to make a sketch which shows the positioning of the ion trap before the tube is removed. Another method is to mark the front and top of the trap with appropriate chalk marks which will indicate its proper position on the new tube. Further information on ion trap adjustment will be given in a later chapter.

In preparation for removing the old tube and replacing it with a new one, the next safety step is to put on a sturdy pair of goggles to protect the eyes and a pair of heavy work gloves to protect the hands. Plastic goggles such as used in machine shops will serve the purpose. These precautions are necessary because of the possibility that the tube may be dropped or cracked by means of a deep scratch in which case there would be a terrific "implosion" which would cause pieces of glass to fly in all directions. In an implosion the air rushes with great force into the tube, which had formerly been highly evacuated. The effect and the danger are just as great as in the case of an explosion.

The weakest part of the tube is the neck and for this reason the tube should never be carried or handled by the neck, but always by the large diameter front end. Use great care not to scratch the face of the tube and do not permit tools or other hard objects to knock against it.

You are finally ready to proceed with the removal of the tube. First remove the tube socket and then loosen and remove the flexible strap which holds the other end of the tube in place. In many television sets the deflection and focus coils are integral with the part on which the tube is mounted and hence they remain in position. In any event, if the set uses an ion trap, it will be necessary to loosen and remove this component. It is now possible to slide the defective tube out of the deflection and focus coils. The tube is then temporarily placed face downward on an old blanket or on several layers of felt, cotton, or any soft material. The new tube is carefully removed from its carton. This is done by lifting the tube by its sides, face (screen) upward. It is handled only by its large diameter front end. The neck of the tube is then carefully inserted through the rubber cushion which carried the deflection yoke, and then through the smaller cushion or corrugated paper within the focus coil. While doing this, the neck is gripped for guidance only, most of the weight being supported at the large diameter end.

Both the deflection yoke and the focus coil must be as far up on the neck of the tube as they will go, with the focus coil resting against the deflection yoke cushion. The ion trap assembly is next placed on the neck of the tube in the same position that it formerly occupied on the previous tube.

Then the socket is put in place on the end of the tube. This socket has a keyway into which the key on the base of the tube fits. Turn the socket carefully so that the key and the keyway coincide in position. Never force the socket on the base of the tube. If it is in its proper position it will fit readily. Avoid placing any kind of strain on the neck of the tube. Avoid the use of force when placing the tube in position, when adjusting any of the coils or components and also when tightening holding clamps. The strap which clamps the tube firmly in position at the front end of the tube is next tightened using care not to make it too tight. The high voltage lead is snapped over the contact button on the side of the tube and the replacement operation has now been successfully completed.

Make sure, however, that the black outer coating of the picture tube is again grounded to the mount assembly by the grounding springs, or grounding clamps.

A final safety precaution which is absolutely essential concerns the disposal of the defective picture tube. The simplest method is to seal the tube in the carton which formerly contained the new tube. To make sure that the seals will hold, tie the carton on all four sides with strong rope. Then force a heavy tool, such as a crowbar or a wrecking bar, through the side of the carton, breaking the glass.

CHAPTER 5

EASY TV TROUBLE CHECKS

1. When a TV set goes completely "dead with no sound, no picture and no bright area on any channel, make the following trouble checks in the order given below.

   a. Inspect plug at end of power cord for loose or broken wire.

   b. Check line cord itself by careful inspection for a broken wire.

   c. Turn brilliance and volume controls if they happen to be in full counter-clockwise position.

   d. Make sure plug is fully inserted in outlet receptacle.

   e. Check outlet itself by plugging an electric lamp into it. If lamp does not light up, check fuses which protect this circuit.

   f. Make sure "on-off" switch has been turned "on". Sometimes the knob on this switch becomes defective and turning the knob does not turn the switch.

   g. If repairing a "combination" receiver--that is, a television receiver combined with a radio set, check to see whether the special switch is turned to the "TV" position.

   h. Check back cover of set to see that it is properly fitted and secured in its place. In many TV sets a safety switch is fastened to this back cover and if the back cover is not in its proper place, the switch will remain open and the set will be "dead".

   i. Examine set to note whether tubes remain unlighted. As long as most of the tubes show a dim light, disregard the others which show no light. Some tubes, especially certain miniature tubes, fail to show a light unless examined very closely. However, if all tubes are "cold", this means that the receiver is not being supplied with power. If all the above checks have been made, note whether set itself uses a line fuse and if so replace this fuse.

   j. Examine low voltage rectifier tubes and note if they show a dull red glow. If not, replace them. If these tubes show a violet light replace them.

   k. Replace low voltage rectifier tubes even though they appear to be operating in a normal manner. If the set uses two rectifier tubes, replace both at the same time.

   l. If low voltage rectifier tube checks "inoperative" on a tube checker, <u>do not replace</u> until filter electrolytic condensers have been checked, otherwise defective condenser may cause replaced rectifier tube to burn out.

2. When bright area disappears but sound remains normal on all channels, this may be due to misadjustment, or to HIGH VOLTAGE FAILURE. Make the following trouble checks in the order given below.

   a. Turn up brightness (brilliance) control in a clockwise direction as far as it will turn.

   b. Check adjustment of ion trap. If ion trap is moved away from its correct position, the picture tube may fail to light up.

Adjusting the Ion Trap

When making adjustments of any kind from the back of the television set, place a mirror in front of the receiver so that you readily can observe the results of your work. If the poor positioning of the ion trap is the cause of your trouble, an illuminated area will appear as you slowly move the trap back and forward along the neck of the picture tube, while at the same time turning it slightly clockwise and counterclockwise. This illuminated area will lack brightness and shadows will probably be noticed at the corners.

Having obtained the bright area, continue the adjustment of the ion trap until the illuminated rectangle has become as bright as possible and all four corners are visible without shadows. Adjustment should be made with the brightest picture obtainable, consistent with good line focus and a full rectangular bright area. When adjustment has been completed, make certain that the ion trap is securely fastened or clamped in position.

Ion trap magnets used with magnetically focused picture tubes are classified either as single field (single magnet) or double field (double magnet). The purpose of each type is to remove ions from the electron beam. The double magnet ion trap is used with older type picture tubes; the single magnet ion trap with the newer tubes.

There are four general types of permanent magnet (PM) ion traps and in addition some older ion traps are of the electromagnetic (EM) type.

The electromagnetic type shown in Figure 4A uses a large coil and a small coil connected together, which slip over the neck of the picture tube. Direct current is passed through these coils. The large coil must always be placed nearest the picture tube socket. The current through the coils is regulated by means of a control called a beam bender, located on the chassis of the television receiver. Before adjusting the electromagnetic type of ion trap, turn the beam bender control as far as possible in a clockwise direction. Adjusting screws tighten this trap into place after it is slipped over the neck of the tube. Carefully note the position of this trap with relation to the "flags" shown in the illustration, inside the neck of the picture tube.

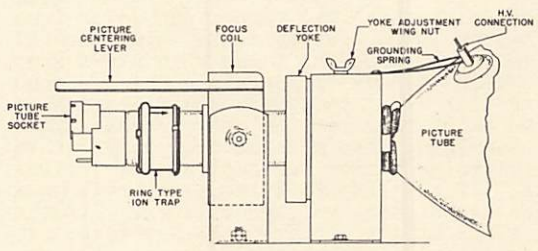


Figure 5A - Ring-type Permanent Magnet Ion Trap

Figure 5A shows a ring type permanent magnet ion trap. The arrow on this trap must be located on the same side as the high voltage connection to the picture tube. The heavier ring magnet is nearest the picture tube socket. This type of ion trap is slipped over the neck of the tube.

Figure 5B illustrates the clamp type permanent magnet ion trap. This trap is held in place with two clamps as shown, which are tightened on to the neck of the tube by means of two locking screws. The clamp nearest the end of the picture tube should always be the black one. The other clamp may be blue or red. Clamp type ion trap magnets must be positioned opposite the high voltage connection.

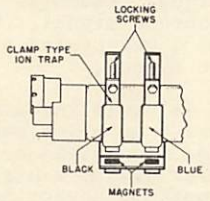


Figure 5B - Clamp type PM Ion Trap

A bar type permanent magnet ion trap is shown in Figure 5C. This type employs two square bar magnets. It is put in place by slipping it over the neck of the picture tube. In this type of ion trap, the arrow on the trap must be positioned on the same side as the high voltage connection on the tube.

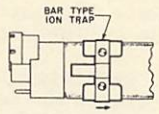


Figure 5C - Bar Type PM Ion Trap

The friction clamp type ion trap shown in Figure 5D is positioned with the magnet opposite the high voltage connection. This type also slips over the neck of the picture tube, being held in place by friction. As in other types of color coded ion traps, the black clamp must always be put furthest away from the picture tube screen.

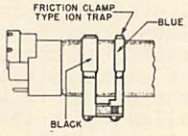


Figure 5D - Friction Clamp Type PM Ion Trap

If you cannot find an ion trap on the set, the set may employ a picture tube having an aluminized screen within the tube structure, in which case no ion trap is needed.

c. If the preceding checks fail to reveal the reason for absence of bright area, turn to "High Voltage Section" in Chapter 3, and read Safety Rule No. 5 which tells you how to make a device consisting of a fibre tube and a small neon lamp, which will enable you to perform a special high voltage check without danger of shock.

First, turn the set off and wait at least fifteen minutes. Then remove the cover from the high voltage compartment being careful not to touch any of the tubes within this area. Next, turn the set "on" again. Put one hand behind your back and grasp the fibre tubing in the other hand at the end furthest from the neon lamp. Then put the neon lamp within the compartment near the caps of the various tubes. If the lamp fails to glow, this is an indication of high voltage failure. If the lamp glows brightly near the high voltage rectifier tube, but not at the high voltage connection at the picture tube, this indicates an open between these two points.

If no high voltage is shown by this test, replace tubes in the high voltage section, carefully following the instructions given under the heading "8 -- High Voltage Section" in Chapter 3.

d. If tube replacement fails to remedy the trouble, replace fuse in high voltage section if set is known to have such a fuse.

3. If the picture greatly increases in size and goes out of focus (becomes fuzzy) while the set is in operation (with sound remaining normal) this fault is known by the descriptive term, "blooming" picture. This trouble is caused by insufficient high voltage. Make the following trouble checks.

a. Replace high voltage rectifier tube or tubes.

b. Check by replacement the high voltage filter resistor.

Preliminary Checks Save Time, Cut Costs

1. If set is "dead" check "on-off" switch; check ballast resistors; check fuses; check power supply; check line cord; check relay.

2. If picture tube raster fails to appear, check ion trap, brightness control, high voltage lead, fuse in high voltage circuit.

3. With set disconnected, examine for charred, discolored, broken resistors, puffed out, broken condensers or for condensers which have lost a considerable amount of wax. Examine for broken pigtails, unsoldered joints, poor connections corroded joints, cold soldered joints, breaks in coils or other components.

4. With set connected, examine for unlighted tubes, for tubes which light up too brightly and for gassy tubes which show a violet glow. Examine for smoke from resistors, transformers, coils or other components. Examine for high voltage sparking or corona discharge. This test is best made in a darkened room.

5. With set connected, feel various components such as low voltage transformer and filter choke, resistors, electrolytic condensers, coils and similar parts which may show undue heating. Such heating, in most cases, is accompanied by smoke. It should be kept in mind, however, that a certain amount of heat is normal. Use extreme care in making this check to avoid shock. KEEP WELL AWAY FROM ALL HIGH VOLTAGE COMPONENTS. In making test, use only one hand, keeping other hand in pocket or behind back.

6. With set connected, check for unusual or suspicious odors. Corona discharge is accompanied by a strong odor of ozone. Overheated transformers and chokes often give off an odor of burnt varnish. Faulty selenium rectifiers give off characteristic odor of rotten eggs. Other unduly overheated components also give off unusual odors. Listen for high voltage hiss which generally accompanies sparking. Listen for high frequency hum at transformer and choke. Listen for frying sounds in components.

7. With set connected, examine glass tubes, neck of picture tube for unlit tubes. Examine high voltage rectifier tube from bottom for soft heater glow. Feel tubes after set has been "on" for ten or fifteen minutes. Cold tubes lack heater voltage. Do not check high voltage rectifier in this way, except after set is "off" and high voltage condenser has been discharged.

CHAPTER 6
COLOR TELEVISION

Color TV in its present form is possible because of the fact that three primary colors: red, blue and green, can be combined to create practically any desired color, even white.

Hence, a partial solution to the problems of transmitting colors as they appear at the scene being televised, is to pick up the red, blue and green information from that scene as well as the brightness information, impress this on suitable high frequency carriers in the form of amplitude modulation and at the receiver get back this impressed information in the form of electrical signals of varying voltages. These must then be applied to a picture tube capable of translating these changes into green, red and blue dots of light of varying brightness, which when properly combined, will be observed as a fairly true reproduction in color of the televised scene.

In order to properly define or describe color, it is necessary to take into consideration the following three variable characteristics: hue, purity or saturation and brightness.

Each particular color sensation is determined by its predominating or dominant wavelength which is called the "hue" of that color.

In order to be able to describe the difference between a faint hue and a very intense hue, the term "purity" or "saturation" is employed. Thus a vivid red or a faint red would have the same hue but nevertheless they would differ in purity or saturation. The most intense hue is obtained when that particular color is undiluted with white light. Such a light is said to have a pure color and has a purity of one or is 100% saturated.

As more and more white light is mixed with the original pure color the percentage of saturation becomes less and less, the purity necessarily becomes a smaller and smaller fraction of the purity rating of one. One of the controls of a typical color TV receiver is called the "chroma" control. This enables the viewer to vary the percentage of saturation. The term "chroma" characterizes the purity or saturation of the color without reference to its hue or brightness.

The third characteristic needed to describe colored light is its brightness. Brightness is also referred to as "brilliance" or "luminance". Degree or amount of luminance is called "Luminosity".

A term often used in connection with color television is "chrominance" or "chromaticity". This term defines two characteristics of colored light — saturation and hue — simultaneously, without taking brightness into consideration.

It is not practical to convert present-day black and white TV sets to receive color broadcasts in color. However, they can be used without the need for any alterations, to receive color broadcasts in black and white. Such use is referred to as "compatibility". Incidentally, TV sets designed for color reception, may also be used for black and white (monochrome) reception.

To obtain compatibility, the transmitted color TV signal resembles quite closely the standard monochrome signal. Color signal channel width remains 6 megacycles as in the case of the black and white signal.

All television picture information, whether color TV or black and white is transmitted by amplitude modulated carrier signals. An unmodulated carrier wave is a high frequency radiated wave having peaks of unvarying voltage. When this wave is modulated or modified so that its peaks of voltage increase or decrease, it is called an amplitude modulated signal.

At the TV transmitter, the unmodulated wave is created by means of vacuum tube oscillators. Light sensitive cameras in the studio pick up the picture information and translate this into voltages which vary as the lighted scene varies. These voltages, after being magnified are used to modify or modulate the carrier changing it from a constant amplitude current to a varying one.

The modulated high frequency currents in the antenna system of the transmitter radiate waves of radiant energy. These are picked up by the antenna system of the TV receiver, and changed into electrical currents having the same characteristics as those flowing in the antenna of the transmitter.

In the case of color TV, three camera tubes are used at the studio to pick up the color information about the scene being televised. These are called the red, green and blue cameras. Special optical systems including color filters separate the colors present and enable the three camera tubes to register the correct proportion of each primary color at each instant. The camera tubes change the light energy into three separate electrical voltages called video information signals. These signals vary constantly in exact proportion to the varying colors of the scene.

The methods used to enable these signals to modulate carriers in order to produce a composite color signal are beyond the scope of this chapter. For present purposes, it is sufficient to state that the red, green and blue signals are mixed in a mixing amplifier called a "matrix" to form a brightness signal known as the "Y" signal and two color signals designated as "I" and "Q" signals. The "Y" signal contains 30% red, 59% green and 11% blue. This is equal to the output signal from an ordinary black and white camera and has all the picture detail elements in terms of gray, black and white. Hence an ordinary black and white TV set can utilize the "Y" signal and translate the color picture into a black and white one. The "Y" signal has a bandpass of 4 mc (megacycles).

"I" and "Q" Signals

The "I" and "Q" signals, called the "chrominance" signals are also referred to as color difference signals, since they are obtained by subtracting definite percentages of the "Y" signal from blue and red signals. Neither of these signals

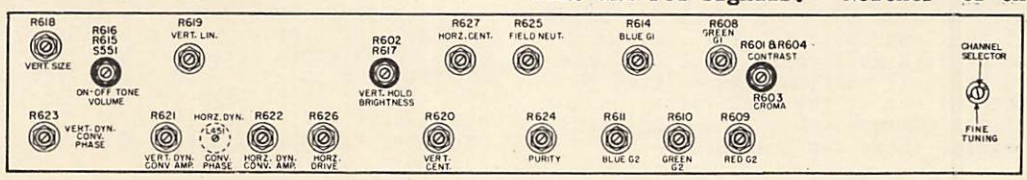


Figure 6A - Front Panel Adjustments of GE Color Television Receiver

contains much picture detail, since this is provided by the "Y" signal. The "I"signal conveys information relating to colors ranging from orange to cyan (blue-green) including therein the flesh tones. It is needed to distinguish these colors in medium to small areas.

The "I" signal requires three times the frequency allotment (band pass) for transmission (1.5 mc) as the "Q" signal which carries the green to purple color information. This information is needed only for the larger areas of the picture as the green to purple colors would not be discernible in the smaller portions. Hence, the bandpass of the "Q" signal is only 0.5 mc.

In the color signal, the "Y" modulated carrier corresponds to the video or picture carrier of the monochrome signal. In order to transmit the additional chrominance "I" and "Q" signals, however, only a single carrier is employed. This is located at approximately 3.58 mc above the picture carrier. As in the monochrome TV set, the sound carrier is frequency modulated and remains at 4.5 mc above the picture carrier.

The 3.58 mc carrier for the chrominance information is referred to as the "sub-carrier". Its ability to convey both "I" and "Q" signal information simultaneously is based on the fact that these two signals are out of phase with each other. This difference of phase or timing in this case means that when the "I" signal is at its maximum amplitude, the "Q" signal is passing through a zero point; when the "I" signal is zero the "Q" signal has maximum amplitude. Such an arrangement represents a 90 degree phase displacement which is one-quarter of the complete electrical cycle of 360 degrees, or a "quadrature" phase displacement. This then accounts for the names given to the two signals.

The "I" signal is the "in-phase" signal; the "Q" signal is the "quadrature" signal. The process of sending signals using only a single carrier frequency is called "multiplexing".

In addition to the "Y", "I" and "Q" signals, the composite color TV signal contains the usual frequency modulated sound information and also includes the usual horizontal and vertical sync signals for keeping the horizontal and vert. oscillators in step with the transmitter. These sync signals occur at essentially the same frequencies as in the monochrome composite signal. A very slight difference is necessary, but this does not affect compatibility.

However, in the color composite signal one new sync signal is necessary. This is known as the "color sync" or "color burst". It occurs shortly after each horizontal sync pulse during the horizontal blanking interval and consists of not less than 8 cycles at a frequency of 2.58 mc. The color burst is the sync signal which controls the action of the color oscillator.

The Color TV Receiver

A block diagram of Figure 6B shows the basic circuit arrangements of the color television receiver. A comparison with Figure 3A shows that many of the circuits of the black and white TV set are incorporated in the color receiver. Actually more than half the circuits are identical. In the color receiver, slight changes from the monochrome set have been made in about 25% of the circuits and about 25% of the circuits are entirely new.

The tuner of the color TV set is almost identical with that of the monochrome set. The i.f. amplifier however usually has more stages and is designed to pass a broader band of frequencies. The sound signal is taken off before the video detector, passed through a first sound detector not found in monochrome TV sets, which changes its frequency to the conventional 4.5 mc intercarrier sound i.f. signal. From this point on the sound system is identical with that of the monochrome receiver.

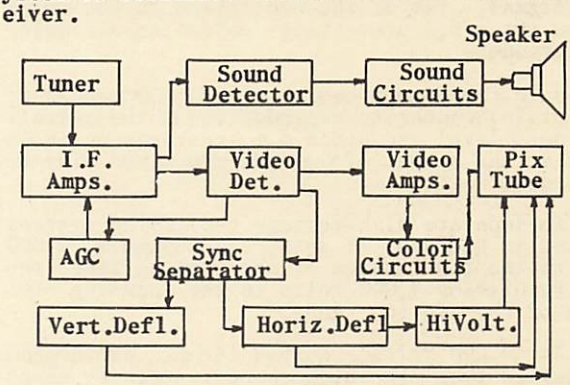


Figure 6B - Simplified Block Diagram of Color TV Receiver

The sync, a.g.c. and horizontal and vertical sweep circuits are practically the same as those of the black and white receiver and hence should be serviced in the same way.

The video amplifier block shown in Figure 6B generally consists of 1st and 2nd amplifier with a delay line between them. The delay line is made in two sections, which are connected in series. Each section consists of 11 coils in series and each section is terminated at both ends by resistors. The delay line serves the purpose of slowing up the "Y" luminance signal 1 millionth of a second. This is just enough to enable it to reach the mixing circuits in correct timing with the chrominance signal (the "I" and "Q" signals).

In the black and white TV receiver the output of the video amplifier goes directly to the picture tube. In the color set, however, the output of the amplifier, that is to say the "Y" signal, goes to the color "matrix" or mixer.

The chrominance signal is also obtained from the output of the 1st sound detector and hence this particular detector is called the "chroma" detector. A 4.5 mc trap blocks off the sound signal, permitting only the 3.58 signal to enter the sub-carrier demodulation section. By means of synchronous detectors, the "I" and "Q" signals are separated from the 3.58 carrier and after passing through suitable filters reach the color matrix at the same time as the "Y" signal.

The output of the color matrix consists of three simultaneous color signals, red, green and blue. After amplification these are applied to the three control grids of the color pix tube.

In addition to the above circuits, the color section includes a color burst amplifier which receives the burst signal from the output of the 1st video amp. The circuit also includes a crystal controlled oscillator which supplies the exact frequency needed to provide synchronous detection of the "I" and "Q" signals. To accomplish this, the color oscillator generates two signals of identical frequency but displaced in phase (time) by 90 degrees. The oscillator is kept in step with the chrominance signals from the transmitter by comparison with the color burst signal in a frequency control circuit similar to those used for keeping horizontal sync in step in black and white TV receiver circuits. RCA uses a control circuit similar to that used in the 630TS set.

Another new circuit in the color TV set is the "color killer". This circuit functions to disable the color circuits when the color receiver is being used to reproduce black and white programs. It depends for its action upon the absence of the 3.58 mc color burst. In the absence of the color burst signal, two of the amplifiers in the matrix will be cut off, preventing objectionable color interference.

As in the monochrome receiver, it is necessary to maintain an accurate reproduction of the overall brightness level and hence d.c. restoration is employed at the output of the red, green and blue amplifiers.

Two separate high-voltage rectifying systems are used in GE color TV sets, one supplying 20,000 volts to the final anode of the picture tube, the other furnishing 3,000 volts to the focusing electrodes of the pix tube guns.

The 10,000 volts required for d.c. convergence is obtained from the high anode voltage by means of a voltage divider network. Incidentally a voltage regulator is used to keep the high voltage constant regardless of load conditions.

The low voltage supply, (not indicated in Figure 6B) is a conventional voltage doubler circuit employing selenium rectifiers.

The Tricolor Picture Tube

Two general types of tricolor picture tubes are now available. One uses three electron guns, a phosphor dot viewing screen and a shadow mask. Tubes of this type are made by CBS-Hytron under the trade name of CBS Colortron and by RCA under the trade name of RCA Tri-Color Kinescope.

The second general type is the color tube invented by Dr. E. O. Lawrence, called the Lawrence Chromatron. This tube employs alternate strips of red, green and blue phosphors onto which the beam of electrons from a single electron gun is directed by grids of parallel wires. An electrostatic charge on these grids exerts a lens action on the beam. This tube, available with rectangular glass envelope, requires no masking, thus making a much larger proportion of the swinging electron beam effective. It is claimed that the single gun also improves the reception quality when receiving monochrome pictures as compared to similar reception with the three gun type.

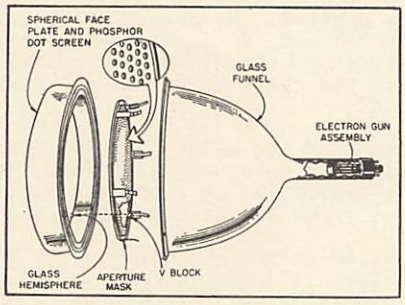


Figure 6C - Exploded View of CBS Colortron Showing its Internal Components

Figure 6C shows an exploded view of the CBS-Colortron tube. The useful screen area of this 19-inch tube is 205 square inches. This tube uses an electromagnetic convergence system which causes the three electron beams to converge correctly at the shadow mask.

The principle of operation of the three-gun Colortron is quite simple. The phosphor screen contains 300,000 phosphor dots of each primary color, making a total of 900,000 dots. These dots are arranged in 300,000 triangular groups, each containing one red, one blue and one green phosphor dot. Less than 1/2 inch away from the screen is the shadow mask, located between the phosphor screen and the electron gun assembly. The shadow mask contains 300,000 uniformly sized round holes, one for each group of three red, blue and green phosphor dots.

Each of the three electron beams is individually modulated by a composite voltage that consists of color and brightness information. By employing a separate composite signal for each beam source, the individual beams are modulated in accordance with the transmitted signal and are of the proper intensities for their respective colors.

The deflection yoke performs the same function as in the black and white picture tube, acting simultaneously on all three beams causing them to move horizontally from left to right and vertically from top to bottom. The shadow mask is positioned so that when viewed from the deflection point of any of the beams, only the dots of a single color can be seen through the perforations in the mask. With the mask in correct position, one beam will strike only the red dots, another beam will strike only the blue dots and the third beam will strike only the green dots. This mask, consequently allows the three beams to reproduce the exact line present in each portion of the televised scene.

As an example of the increased controls needed by the color TV receiver, Figure 6A shows the front panel adjustments of a GE color set. The new controls not found on monochrome sets include vertical and horizontal dynamic convergence amplitude and vertical and horizontal dynamic convergence phase. These four controls are used to create the best converged condition over the entire screen. This is necessary, as the three beams from the separate electron guns must converge at the shadow mask openings for correct operation.

The purity control, also called chroma control, is used to regulate vividness. It is adjusted until acceptable color hues are seen. The field neutralizing control is adjusted for uniform red field at the edges of the raster. Red, green and blue "G1" (also called "background") controls regulate background and overall contrast in conjunction with the red, green and blue "G2" (also called "brightness") controls. These six controls are arranged in a bridge circuit, so that as the master brightness control is turned, correct relationship between red, green and blue light is undisturbed.

Antenna Considerations

Broadband antennas are well suited for color reception. The antenna must be capable of bringing in a clean-cut black and white picture free from snow if it is to be used with a color TV receiver. Narrow band Yagi antennas may reduce the amplitude of the chrominance information enough to spoil the color. Where external signal reflection is a factor a directive antenna is desirable. Such an antenna also helps to minimize interference.

CHAPTER 7

ANTENNA KNOW-HOW

How to Combat Ghosts, Interference, & Snow

The antenna is the most important accessory to a television receiver. Its purpose is to intercept the various programs being telecast by the TV transmitters.

The antenna should be placed as high as possible in order to get distant reception. The antenna will give best results if kept away from metal objects and as great a distance as possible from other antennas.

Television antennas must be turned in a certain direction ("oriented") for best results. Thus if you wish to improve reception from a certain TV station, face the direction of the transmitter of that station and hold your arms out at the sides, parallel to the ground.

This is the exact way in which the arms of your antenna must point. In other words, the arms of the antenna do not point towards the station, but they are at right angles to an imaginary line between you and the station.

Two Basic Types of Antennas

You probably have observed many different types of TV antennas. Some appear to be quite simple, while others seem to be highly complicated. Actually the two basic TV antennas are the "Straight Dipole" as shown in Figure 7A, and the "Folded Dipole" illustrated in Figure 7B.

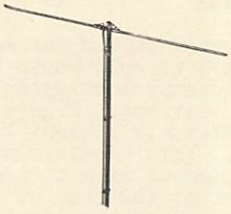


Figure 7A

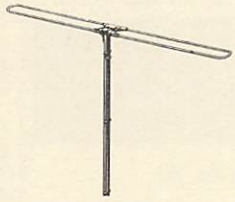


Figure 7B

The straight dipole antenna is divided by a center insulator into two equal length arms. These are connected to the television receiver at the center points by the lead-in which is technically known as the "transmission line".

The insulated ends of the folded dipole are also connected to the receiver by a transmission line. The more complicated antennas are made up of the basic units combined in various ways in order to produce certain desired results, such as better reception in a certain direction, increased distance, etc. These combinations are called "arrays".

TV Antennas are Cut to Definite Lengths

Television antennas have certain definite lengths which enable them to operate with best efficiency. This is because intercepted television carrier waves themselves have definite lengths.

The general rule is that the overall length of the antenna should be about half that of the intercepted wave. The length of each station wave depends upon the frequency assigned to that station by the Federal Communications Commission.

Each assigned channel has a different range of frequencies. The overall approximate antenna length in inches for each channel (approximately half the average channel wave length) is given below.

Channel No.	Overall Antenna Length in Inches
2	97
3	88
4	80
5	70
6	65
7	31
8	30
9	29
10	28.5
11	27.5
12	27
13	26

To illustrate the way in which the above table was obtained, the average wave length of the channel 13 signal is slightly more than 54 inches. Therefore, as the table indicates, a 26 inch (overall) antenna will provide most efficient reception for receiving that channel.

It is impractical and generally unnecessary to have a separate antenna for every operating channel. Therefore it is customary to work out a compromise arrangement. If a single antenna is to be used, it is sometimes cut to a length midway between that necessary for the highest and lowest wave lengths to be intercepted. Such an antenna is called a broad band antenna.

However, in many cases it may be necessary to cut the antenna for the lowest channel to be picked up. This applies particularly to areas which have numerous buildings. In some cases a low band antenna such as a folded dipole, is used to operate on both the low band and the high band. The low bands are channels 2 to 6. The high bands are channels 7 to 13. This is feasible although reception in some directions may be so reduced in strength on the high band that there will be inability to eliminate "ghosts". These are multiple images which appear close to the desired image. They are often caused by reflections from buildings which are in the area between the television transmitting station and the receiver. Except where signals are exceptionally strong, it is not practical to attempt to cut an antenna to the high band and then to try to use this same antenna on the lower band.

The All-Channel (Dual) Antenna

In large cities, located close to numerous television transmitters, a dual antenna is often used. This consists of one antenna to bring in channels 2 to 6 and a second smaller antenna to intercept signals from 7 to 13. Both antennas are mounted

on the same mast as shown in Figure 7C. The shorter antenna may be placed above or below the longer one. This type of antenna is referred to by some manufacturers as an "all channel" antenna.

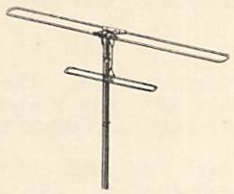


Figure 7C

The antennas shown in Figures 7A, 7B and 7C are generally used only when the receivers are located at a distance from 5 to 10 miles from the TV transmitting stations and then only if no structures intervene between transmitter and receiver to produce reflections or dead spots. Antennas of these types work as well from the back as from the front and therefore are suitable for use where the TV receiver is located at some point between two transmitters.

However, where a range of reception up to 25 or 30 miles is required, it is necessary to use an additional element called a reflector. Everyone knows how a reflector works on a searchlight. It concentrates the light rays, bringing them to a focus with increased strength at the desired point.

The reflector used on a television antenna acts in a similar manner. This element closely resembles the antenna itself, but it has several important points of difference.

First, it is not divided into two separate insulated parts, but instead it consists of a single piece of metal tubing.

Second, it has no connection to the TV receiver as in the case of the antenna and for this reason it is called a "parasitic" element.

Third, it is cut slightly longer than the antenna and it is always positioned behind the antenna, furthest away from the direction of the station to be received.

For best results it is usual to place the reflector about 15/100 wave length in back of the antenna. However, in some instances it is placed as much as 1/4 wave length in back of the antenna.

The combination of the parasitic element (reflector) with the straight or folded dipole constitutes a parasitic array. Such an array may include more than one parasitic element.

Where two parasitic elements are employed the second one is placed in front of the antenna and is known as a director. It is slightly shorter than the antenna and is placed a distance of from 1/10 to 15/100 wavelength in front of the antenna. The purpose of all parasitic arrays is to vary or change the reception characteristics of the antenna.

As mentioned previously, the straight or folded dipole has equally good reception, both front and back. Adding a reflector makes the antenna more sensitive from the front than from the rear. This permits it to be used to concentrate sensitivity in one direction and to face the back or ends towards an interference or reflection source.

Although it is true that TV antennas should be turned broadside towards the transmitting station wherever possible since this is the most sensitive direction, nevertheless when more than one transmitting station is to be received within the area, a compromise may be necessary. Compromises may also be required to get rid of ghosts or of interference. The best way to determine the correct position of the antenna, is to turn it slowly and have someone watch the picture as this is done.

Fringe Area Reception

Distances of 30 miles or more between the television transmitter and the receiver place the receiver in what is known as the "fringe" area. Fringe area reception calls for a special type of antenna called a "high gain stacked array".

Using this type of antenna, excellent TV reception is possible over distances of from 50 to 60 miles and many reports have been received of reception over 100 miles from the transmitter.

However, reception over the latter distance is somewhat uncertain and unquestionably will depend upon various other factors such as type of terrain, strength of signal, intervening mountains, etc.

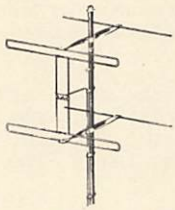


Figure 7D

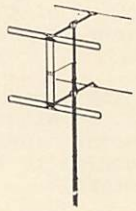


Figure 7E

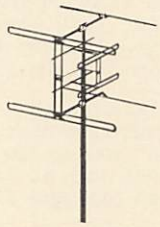


Figure 7F

Figures 7D, 7E and 7F show a low band stacked array, a high band stacked array and a high-low (all channel) stacked array, respectively. The "all channel" array uses only one transmission line to feed both high and low sections. The high-band section operates independently of the low band array and each can be turned separately towards stations that are in different directions.

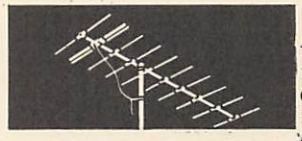


Figure 7G

Another type of antenna, the "Yagi" is well known for its efficiency in bringing in distant stations. Figure 7G illustrates a 10 element Yagi antenna. This consists of an active element with a single reflector at the rear of the element and eight directors ahead of the element. This type of antenna is highly directive, picking up the signal of the transmitters toward which it is pointed and discriminating against those in other directions.

In general, the Yagi is effective only in the reception of a single channel, since it is carefully designed and cut for the reception of a particular desired transmitter. The 10-element Yagi is used for super-fringe areas. At distances of 40 to 50 miles, a 5-element Yagi usually gives excellent results.

A special Yagi type antenna has been placed on the market which includes a high and a low channel driven element and which is claimed to cover channels 2 to 13. A nine-element antenna is used. The five elements of the forward section have been cut to channels 7 to 13; the four rear elements are designed for the reception of channels 2 to 6. Figure 7H shows a system using two of these special antennas stacked for super-fringe area reception.

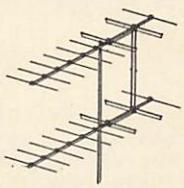


Figure 7H

The Conical Type Antenna

The antenna illustrated in Figure 7I is known by various names such as "conical", "V", "TX-A", "XA", etc. Such antennas are suitable for receiving over distances up to 30 miles. Most of these are trade names, but the most popular designation is simply "conical" antenna.

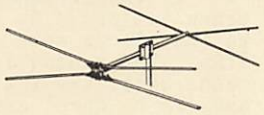


Figure 7I

This type of antenna (while actually a variation of the basic straight dipole) has the advantage of covering a much broader band. In other words, it will receive more channels with greater efficiency. Most antennas of this type have the inherent disadvantage of picking up noise which cannot be reduced by orienting or turning, due to the sensitivity of the antenna in six different directions.

However, several manufacturers claim to have solved this difficulty with a conical antenna having the angles designed to give sensitivity in one direction only. This type of antenna is ideal for use where low and high band stations are transmitting from different directions.

The antenna shown in Figure 7J may be used for reception up to 50 or 60 miles from the transmitter. It is a two-bay conical antenna. By stacking four bays of this same antenna, reception up to 100 miles is possible in some instances.

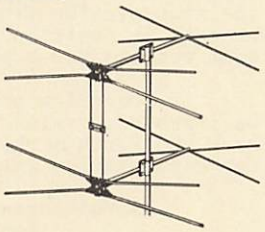


Figure 7J

Another type of antenna known for its high gain is shown in Figure 7K. A feature of this antenna is its rejection of ground reflections. This is an important consideration, especially in UHF reception.

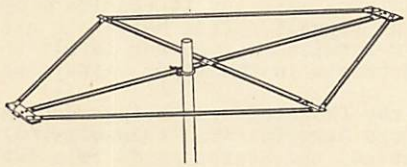


Figure 7K - Rhombic Antenna

A Word About Indoor Antennas

The present day indoor antenna is a makeshift antenna. Unless the receiver is very close to the transmitter, no indoor antenna can take the place of a properly selected and properly installed outdoor antenna.

If forced, through circumstances, to use an indoor antenna, try to locate it on the transmitter side of the building. If the building is constructed of steel, with metal lath beneath plaster, better results will be obtained through the use of a window antenna.

A practical use for an indoor antenna occurs when the signal received via the outdoor antenna is so strong that it overloads the receiver, causing the picture to "tear" and to move horizontally. Very often substitution of the indoor antenna will remedy this trouble by providing a weaker signal. This trouble can also be remedied by use of a pad consisting of resistors between antenna and set.

The Lead-in or "Transmission Line"

Although there are a number of different types of transmission lines which could be used as antenna lead-ins, the two most widely used types are the "twin-lead" transmission line illustrated in Figure 7L and the "co-axial" type (abbreviated and called "co-ax") shown in Figure 7M.

Figure 7L

Figure 7M

The Twin-Lead Transmission Line

As you have probably noticed, the twin-lead type of transmission line is the more popular of the two types. It consists of a solid but flat insulating type of material called "polyethelene" in which two copper conductors are imbedded parallel to each other. It somewhat resembles a ribbon having a width of about 1/2 inch and the brown-colored twin-lead type has demonstrated excellent weather-resistant properties.

Both transmission lines and antennas have an electrical property known as "characteristic impedance" (also sometimes called surge impedance) which is of great importance. Usage has abbreviated this term to "impedance".

All television components have the property of impedance, which merely means the opposition which a component offers to the flow of alternating current such as a signal current. For example the coil connected around the input terminals of the set -- that is at the place where the lead-in is connected to the set -- has a certain definite opposition to signal current flow. The input impedance of such a coil has been standardized in all television receivers at 300 ohms.

Transmission Line Impedance

The impedance of a transmission line (or an antenna), however, has a special meaning. The impedance value of the lead-in is governed solely by the conductor diameter and the spacing distance between the two conductors. The length of the lead-in does not affect its impedance. The chief effect of lead-in length is loss of signal strength. The longer the lead-in, the greater the loss. The amount of loss depends upon the design and insulation material of the lead-in. While Twin-lead transmission lines are available in 72-ohm, 150-ohm, and 300-ohm values, the latter value is the one most generally used, because it "matches" the input impedance of most present-day TV sets.

Transmission Line Matching

A transmission line is said to be matched to a TV input circuit or to an antenna when its impedance is identical with that of these things. Correct matching of the transmission line to the TV set and to the antenna has two beneficial effects. It prevents weakening or loss of the desired signal and it also prevents reflections back and forth between antenna and TV set, which cause multiple images or ghosts.

Mismatch can be compared with the flow of water through a pipe which has a greatly narrowed portion at one point. This slows up the flow, causing a loss of energy due to friction and also causing some water to back up (reflection). Of course this is a very rough analogy.

The impedance of a straight dipole antenna is approximately 72 ohms. That of the folded dipole is 300 ohms. If a 300-ohm transmission line is selected in order to match the input impedance of the TV set and a folded dipole is being used, the match is perfect at both ends. However, if a straight dipole antenna is used under these circumstances, there will be a mismatch between transmission line and antenna.

A mismatch at the receiver is far more serious than one at the antenna, as such a mismatch has a greater tendency to produce ghosts or to blur the picture. A mismatch at either end of the transmission line will weaken the signal, but this loss of signal strength due to mismatch between antenna and transmission line is compensated for since it also serves to broaden the response of the antenna giving it greater sensitivity to stations other than the one to which it is tuned (or cut).

How to Make a Matching Transformer

If such broadening of sensitivity is not desired and best results must be obtained on a particular channel, in circumstances where a straight dipole is being used with a 300 ohm line, you can construct a "matching transformer" which will give a perfect match, by purchasing a length of 150-ohm twin-lead and inserting this between the antenna and the 300-ohm transmission line. The 150 - ohm twin-lead must be cut to one half the overall length of the antenna. For example, if the antenna is 26 inches from end to end (cut for channel 13 reception) then the 150-ohm twin-lead (matching transformer) must be cut to a length of 13 inches.

Co-Ax Type Transmission Line

The coaxial type of line, shown in Figure 7M consists of a copper conductor surrounded by a polyethelene jacket, which in turn is surrounded by a flexible braided copper covering which functions as a shield. This, in turn is protected by a black plastic jacket. The two conductors of this type of transmission line are the inner conductor and the copper-braid sheath.

Certain TV sets are designed for use with coaxial type transmission line. If the set being installed is of this type, it employs what is known as an "unbalanced" type of input. In such receivers, one of the input terminals is grounded (connected directly to the chassis). Always connect the copper-braid sheath (outer conductor) to this grounded terminal. Connect the inner conductor to the other terminal.

Coaxial lines, or cables as they are sometimes called, can be obtained in values of 72 or 73 ohms (type most generally used), and also in values of 50 ohms, 95 ohms, and 300 ohms. The latter two types consist of a two-conductor cable which bears the trade name of "Twin-ax". Other types of transmission lines are discussed in the next chapter.

Comparison Between Twin-Lead and Coaxial Transmission Lines

Twin-lead is more efficient and cheaper than coaxial cable because of lower losses. Co-ax line has the advantage of less interference pickup.

You can reduce interference (often referred to as "noise") if it is picked up by the twin - lead transmission line, by giving the line a complete twist about every 10 or 12 inches. This often reduces noise pickup as much as 20 to 30 percent.

However, where noise pickup is excessive, it may be necessary to install the more expensive co-ax. When this is done, however, signal losses are almost doubled and in a fringe area this may result in the elimination of a picture otherwise obtainable with twin-lead.

If interference is being picked up by the antenna instead of by the lead-in, then it is useless to install the more expensive coaxial transmission line. The remedy in this case is to turn the antenna until the interference is reduced. This can usually be done, except in cases where the interference comes from the same direction as the desired TV signal.

How to Improve Reception

In many instances, reception on the higher channels may be improved by the simple expedient of wrapping a piece of tinfoil around the lead-in and sliding this up and down until a position is found which improves the picture. Use a piece of foil about 4 1/2 by 8 1/2 inches, wrapping the smaller dimension loosely in two or three turns around the lead-in.

The 8 1/2 inch length is then moved from the input terminals of the TV set to the point where the transmission line enters the house. It should be left in position at the place which will give best results for a particular station.

If reception on more than one station is to be improved, it will be necessary to slide the foil back and forth in the same way until best position for each station is obtained.

Useful Antenna and Lead-In Hints for Improved Reception

If a co-ax type lead-in is used, seal the ends of the shielded cable in order to prevent the entrance of moisture which will reduce signal strength. Same procedure should be followed with tubular lead-in and several other types.

Avoid the use of tape to fasten the lead-in to the antenna mast, as it results in loss or reduction of signals. It is better to use low-loss stand-off insulators. Do not permit the lead-in to swing freely in the wind. Always anchor it.

If the TV receiver is being used in a fringe area, avoid bargain rate transmission line. In any location, the better grade twin-lead will greatly improve reception over the cheaper grade on the higher channels.

Any mast over nine feet in height should be suitably braced with guy wires. Use low-loss insulation bushings at the point where the lead-in is brought into the house. The use of a good lightning arrestor is recommended in surburban and country antenna installations.

How to Combat FM Interference

If you are troubled with interference from local FM stations connect a piece of 300-ohm twin lead to the input terminals of the TV set and at right angles to the line. Start with a length of about four feet and gradually trim this down until the FM interference disappears or is reduced to the lowest possible point. If the interference is being received from more than one station, connect a second 300-ohm twin-lead in the same way and repeat the above procedure until the second station has been eliminated. These pieces of twin-lead when used for the purpose of eliminating interference are called "stubs" and function as "wave traps".

How to Get Rid of Ghosts

Ghosts are unwanted images visible to the right or left of the desired picture signal. In some cases they are caused because the signal being telecast reaches the receiver by more than one path. In most cases, the desired signal arrives by the most direct path, because the antenna is located in the correct position for this reception. The ghost, however, arrives from the same transmitter, a fraction of a second later, because it travels by an indirect route, first being reflected by one or more structures in its path. Ghosts of this nature are reflected from tall buildings in cities and from hills or mountains in the country.

Ghosts due to the above mentioned type of reflection may often be eliminated by turning the antenna until only one image is received. A second expedient is to increase the height of the antenna. A third method of getting rid of such ghosts is to change the antenna so as to make it more highly directional. For example, if the antenna is a simple folded dipole, try adding a reflector, then add a director. In some cases, a reflector and several directors will be required.

Ghosts are also caused because of mismatch between the transmission line and the TV receiver. The best way to eliminate such ghosts is to provide a transmission line which "matches" the receiver input. Since most receivers employ a 300-ohm input, the use of a 300-ohm lead-in should take care of the difficulty.

The ghosts due to mismatch can be distinguished from those due to reflections from buildings since the former are generally very close to the desired image, whereas the latter are usually considerably separated from the original signal.

Another method of determining whether the "ghost" is due to reflections from buildings or to transmission line mismatch is to view the picture while the antenna is being rotated. If there is no change in the relative intensities of ghost signal while this is being done, then the ghost is definitely due to transmission line mismatch.

How to Get Rid of "Weak-Signal" Snow

In many instances, a "Booster" will prove quite effective in fringe areas in increasing signal strength enough to get rid of snow due to weak incoming signal or at least to bring in a viewable picture.

Most boosters consist essentially of one or more stages of radio frequency amplification added before the signal reaches the TV set. The single tube booster using a 6J6 tube is the one in most general use.

In its most common form the booster is mounted alongside the TV set, has its own power supply and switches which turn its power on and connect or disconnect it from the circuit.

The lead-in is connected to the booster and the output of the booster connects to the antenna terminals of the TV set.

Another method of increasing signal strength in weak signal areas is to use stacked broad-band antenna and rotate this by means of a special electric motor mounted on top of the antenna mast. A dial arrangement near the TV set permits the antenna to be turned at will so that it can be faced in any direction. The rotator illustrated in Figure 7N is an Amphenol "Auto-Dial" rotator. This rotator is said to be so accurate that the best position for each channel can be logged and returned to at any time by a simple setting of the dial. The rotator is sturdily constructed and will support a two-bay stacked antenna.

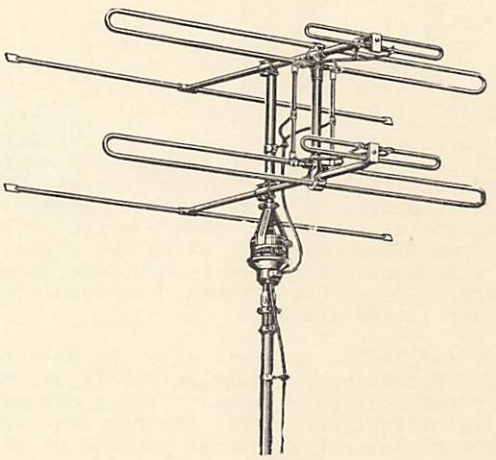


Figure 7N -
Antenna Rotator
Mounted on Top of Mast

CHAPTER 8

ULTRA HIGH FREQUENCY TV

Installation, Servicing, Antennas, Transmission Lines

The novice TV serviceman will be called on to install and service UHF equipment and therefore he will need a basic knowledge of this particular branch of television.

All frequencies between 30 megacycles and 300 are known as VHF (Very High frequency). All frequencies between 300 megacycles and 3000 are designated as UHF (Ultra High Frequency).

Originally, television transmission was radiated over frequencies in the VHF range. The following table shows the channels used.

Channel	Frequency in Megacycles
2	54-60
3	60-66
4	66-72
5	76-82
6	82-88
7	174-180
8	180-186
9	186-192
10	192-198
11	198-204
12	204-210
13	210-216

At the present time, however, TV transmission has been extended to the UHF band and channels now allotted cover the frequencies from 470 megacycles to 890 megacycles. As in the case of VHF each channel is 6 megacycles in width. Channel 14 employs frequencies from 470 to 476 megacycle s channel 15 from 476 to 482, etc. Finally, channel 83 uses the frequencies from 884 to 890 megacycles. In other words, 70 new UHF channels have been added to the earlier 12 VHF channels.

The UHF television set must also be able to receive VHF. Hence the combination UHF TV set essentially consists of an ordinary TV set with means for tuning in the higher (UHF) frequencies and changing them to lower frequencies capable of being handled by the set.

The typical UHF Converter operates on the same basic principle. It differs from the UHF set chiefly in the fact that it is a separate device which can be used with many VHF television sets thus enabling them to receive the UHF signals.

Another way in which VHF sets can be converted to UHF operation is by means of special UHF channel strips, inserted in certain makes of drum or turret-type tuners made with this conversion in view.

The block diagram of Figure 8A shows the circuits employed to reduce UHF to VHF, whether in a UHF Converter, or as a part of the TV tuner.

The principle involved is that of mixing two frequencies together to get a third "difference" frequency. The desired UHF channel is tuned in through a band-pass preselector circuit and applied to a crystal mixer. A local oscillator also applies a certain lower fixed frequency to the same crystal. This fixed frequency is selected so that the difference between the two applied frequencies (i.e. - the output of the crystal mixer) will result in an intermediate frequency (i.f.) of the same value as one of the VHF channels. This output is amplified in a low-noise i.f. amplifier stage and then passed on to the antenna terminals of the VHF receiver, in both the case of the Converter and of the UHF-VHF receiver.

The preselector circuit is designed to tune in the desired UHF channel. It is generally preceded by combinations of coils and condensers which form filters permitting the passage of UHF but greatly weakening VHF signals. No tubes are required for this purpose. The mixer is invariably a crystal. This may be a 1N72 or a 1N82. Very often, where weak signal causes excessive snow, substitution of the 1N82 for the 1N72 will improve reception. In making the change, be sure to connect the new crystal without reversing polarity. The 6AF4 type miniature tube is the one usually used as the local oscillator. In some cases, a 6BQ7 tube is used to provide two stages of UHF i.f. amplification. In others, a 6BK7A tube and a 6AU6 tube are used.

Installation of UHF Converter

The UHF Converter should be installed as close to the VHF television set as possible in order to keep leads and cables at minimum length. Some UHF converters obtain their tube operating voltages from the set to which they are attached. Others have a self-contained power supply and hence must be plugged into a 117 volt a.c. source.

UHF Converters are usually equipped with a switching arrangement for turning power on and off the converter and for changing from VHF antenna to the UHF antenna. Therefore, installation of a converter will include connecting of lead-ins from each antenna to the converter as well as a connection from the balanced output of the converter to the antenna terminals of the TV set. In some instances, the UHF antenna is permanently connected to the Converter and the switch is arranged to connect the antenna posts of the VHF set either to the VHF antenna or to the output of the UHF converter. Figure 8B illustrates this arrangement.

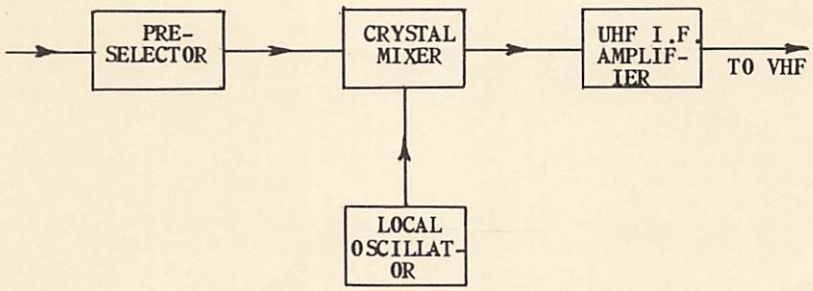
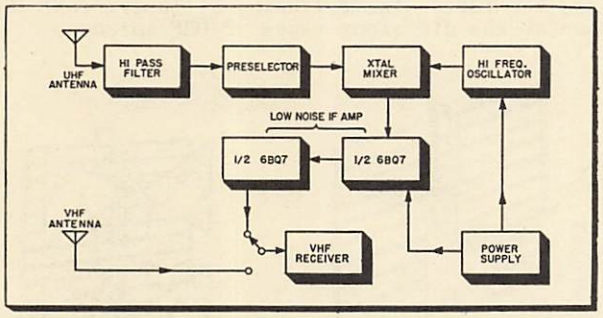


Figure 8A - Block Diagram of Circuits Used to Convert UHF to VHF

After the installation has been completed, the VHF tuner is switched to the channel designated by the maker of the converter as the correct one for use with its unit.



Courtesy Technician and Caldwell-Clements

Figure 8B - Block Diagram of a DuMont UHF Converter

INSTALLATION OF UHF CHANNEL STRIPS

Several makers of turret type tuners, which use removable coil strips have produced units capable of UHF reception without the need for additional tubes. One such device is made by Zenith and is usable with TV sets only of that make. To convert a Zenith set from VHF to UHF, it is merely necessary to remove the VHF channel strips from the tuner drum and replace them with special UHF strips of the channels it is desired to receive. No other changes need be made on the TV set. Since there are 13 channel strips on the Zenith drum, this represents the limit of the number of UHF channels which could be received without changing strips.

The Zenith strip contains two crystals but no tubes. It is housed in a small metal die-casting, having three separate cavity resonators, in the form of hollow metallic cylinders. Small solenoids, wound with flat strips are mounted within the cavities and provide the necessary inductances. Instead of a conventional condenser, the necessary tuning capacity is provided by the capacity between the top of the coil and the cavity plus the capacity between the turns of the coil (distributed capacity) plus the capacity resulting from an adjustable screw which enters the top of the coil.

Another company which manufactures the Standard type turret tuner, has produced several UHF units. The Standard tuner also uses removable coil strips. This company has produced a tubeless converter strip which can be inserted into any Standard turret drum in place of the VHF strips. Tuned strips are available for each UHF channel. The strips are made two in a set. One strip contains pre-selector circuits, crystal mixer, harmonic selector and i.f. grid inductor. The other contains crystal bias network, harmonic generator, loading resistor and i.f. transformer. In converting a VHF set to UHF, it is merely necessary for the serviceman to remove a pair of unwanted strips from the turret drum and insert the desired channel UHF strips. After connecting the UHF antenna, the set is ready for UHF reception.

The same company which makes the Standard turret tuner also produces a complete unit capable of continuously tuning to all existing VHF channels as well as the entire 70 UHF channels. This completely shielded unit includes a preselector, mixer and oscillator in the UHF portion. The VHF portion, located directly in back of the UHF section, resembles the Standard 12-channel Cascode VHF tuner. A unique

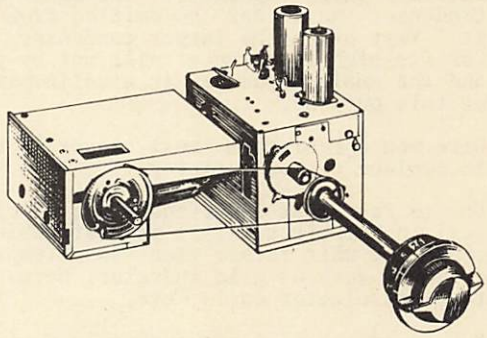


Figure 8C - All Channel UHF-VHF Tuner

feature of this unit is the mechanism which automatically indicates (through small dial opening) the channel to which the device is tuned. Figure 8C shows an all-channel tuner which tunes from channels 2 to 83.

SERVICING UHF UNITS

While UHF units, both converters and complete UHF-VHF sets, present the same trouble symptoms ordinarily associated with VHF front ends, the troubles are more difficult to locate and to remedy for several reasons. These are:

1 -- When working with the higher frequencies certain types of trouble will occur which would cause no difficulty on the VHF bands. For example, a broken connection in a VHF circuit is one of the simplest repairs to make, but special precautions are required for this repair to a UHF circuit. The new connection must be exactly the same length as the original one. No sharp corners or turns are permissible. It must be replaced in exactly the same position relative to other wires and to the chassis. The soldering must be perfect both mechanically and electrically, and in addition must be performed with a minimum amount of solder, without the use of flux and it must present a smooth appearance, as points probably would affect the operation of the circuit.

2 -- When replacing broken sockets, mounting boards or other insulating parts, only low loss parts made especially for UHF work, can be employed.

3 -- When replacing resistors and condensers, special care must be taken to make certain that correct tolerances are observed, that temperature compensating components are replaced with those of exactly the same specifications and that condensers have exactly the same characteristics not only as to tolerance, capacitance and rating, but also as to temperature coefficient, capacitance drift and insulation resistance.

4 -- Positions of coils relative to each other or to chassis must not be changed.

5 -- Several resistors must never be substituted for a single resistor even though they make up the same total value, nor should a single resistor be used to take the place of several resistors in parallel.

6 -- If a condenser having extremely small capacity is used in parallel with one having comparatively large capacity, the small capacity condenser must not be omitted from the circuit. Very often the larger condenser, because of its high inductance will not by-pass UHF, and the small condenser is used in parallel for this purpose.

7 -- Wire wound resistors must never be used to replace carbon resistors.

8 -- Due to fact that inductances are so critical in UHF circuits, it is preferable to replace entire unit rather than to attempt to replace coils such as grid inductor, harmonic selector, preselector coils, etc.

9 -- UHF circuits very often contain entirely new components or new applications of old components insofar as the experience of the TV serviceman is concerned. Therefore, difficulty will be experienced until he has familiarized himself with these features. For example, he will find new types of resonant tuned circuits, quite different from the coil-condenser combination. In this class are the cavity resonator of the Zenith UHF converter and the "tuned line" used in the Kingston converter. Even the use of a crystal as a mixer may not be recognized.

TRACING FAULTS IN UHF CONVERTERS

Faults can readily be localized to the UHF converter, since set can be checked separately on VHF channels. General procedure for faulty operating of converter is to replace tubes if used, and check crystals by replacement with crystal known to be in good operating condition. In replacing crystal, use great care not to overheat crystal while soldering and be sure to observe correct polarity when installing.

Certain types of UHF converters are susceptible to spurious responses. Sometimes such troubles can be eliminated by switching the VHF tuner to another channel and adjusting the i.f. output trimmer according to the channel selected.

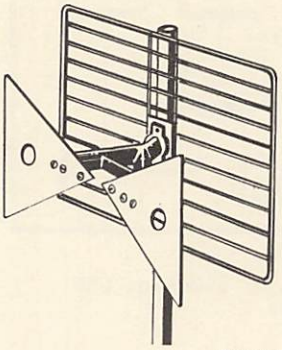
Where trouble developes in a single channel of the UHF tuner of the replaceable strip type, and this is of such a nature that it cannot be rapidly located and repaired, it is probably cheaper from the standpoint of time saving to replace the defective strip with a new one.

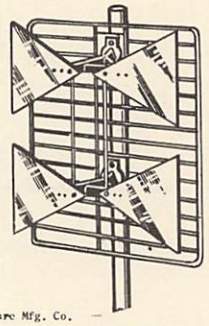
The UHF Antenna

Antenna and lead-in requirements for UHF reception differ considerably from those of VHF.

The UHF antenna is shorter than the VHF antenna because of the shorter wavelengths used in UHF transmission. For example, a half wave length at the frequency of channel 61 is approximately 7 1/2 inches whereas a half wavelength at the frequency of channel 6 is about 65 inches.

Although some manufacturers make antennas stated to be suitable for the reception of both UHF and VHF it is recommended that a separate antenna be provided for UHF in addition to the one used for VHF. The following illustrations show some of the different types of UHF antennas.





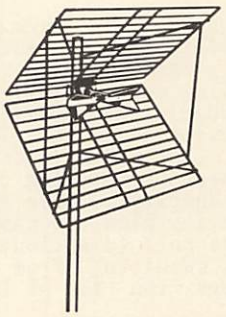
Courtesy Television Hardware Mfg. Co.

Figure 8D - Bow-Tie Antenna with Reflector

Figure 8E - Two Stack Bow-Tie Antenna

Figure 8D shows a typical Bow-Tie UHF antenna designed for local reception in a strong signal area.

Figure 8E illustrates a two-stack UHF antenna with reflector. Stacking the Bow-Ties in this manner increases the reception range up to about 30 miles, provided local conditions are satisfactory. For example it may be necessary to increase the height of the mast in order to get line-of-sight reception.



Courtesy Television Hardware Mfg. Co.

The UHF antenna shown in Figure 8F is known as a corner reflector antenna. It is recommended for troublesome areas or where extra high gain is required.

Figure 8F - UHF Corner Reflector Antenna

Another high-gain UHF antenna is shown in Figure 8G. This is known as a "Conical-V-Beam" broad band dipole. This type of stacked array is said to be very sensitive and suitable for long-distance reception.

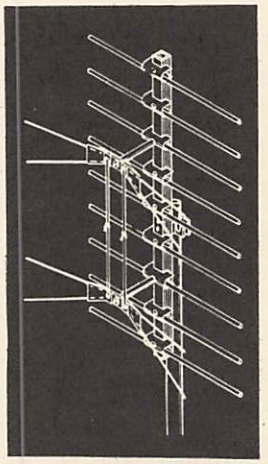


Figure 8G - Conical-V-Beam Broadband Dipole

Other types of UHF antennas include V-Dipole, Yagi, Rhombic, Conical and Fan Dipole.

Location of the UHF antenna is very important. Reception can often be improved greatly merely by moving the antenna to a point at a slight distance from the previous location. The antenna should be carefully turned until best possible reception is attained. As in the case of VHF antennas, it should be located as high as possible and at a point where it is in the "line-of-sight" of the transmitter of the channels to be received.

It is usual to mount the VHF and the UHF antennas on the same mast. In some cases, separate lead-ins are used for UHF and VHF Reception. However a number of very efficient "cross-over" networks are available which permit the use of a single lead-in for both UHF and VHF. These filter or separate the higher UHF from the lower VHF, and have suitably labeled terminals for short connections from each antenna, with a common set of terminals for the lead-in to the set, as shown in Figure 8H.

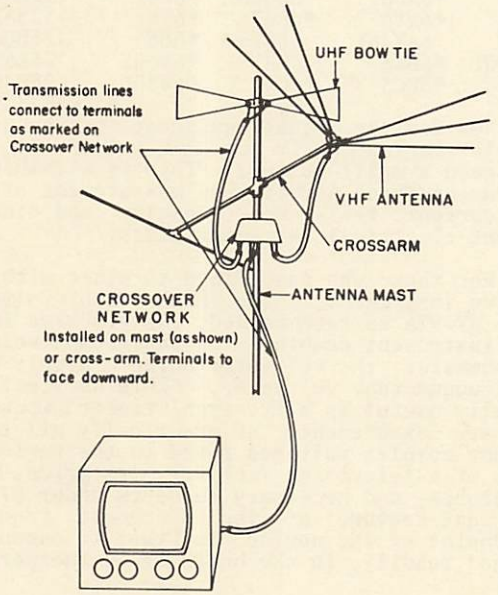


Figure 8H - Cross-Over Network

Incidentally, the lead-in (technically known as the transmission line) must feature low loss with a minimum of stray pickup and there should be only slight increase in loss in wet weather. Open wire transmission line illustrated in Figure 8I has been found to be well suited for UHF use, because of its low loss and high efficiency, even under unfavorable weather conditions. Open wire lead-in is more expensive than other types and due to its higher impedance, requires a matching transformer to bring it down to 300 ohms. A simple matching device can be made by taking out the last three spacers from the open wire lead-in and gradually reducing the distance between the wires to the spacing of the 300 ohm line before soldering the two wires to the latter line.

The perforated open 300-ohm twin lead-in (Figure 8J) is somewhat less efficient than the open line transmission line, but it has the correct impedance match for most TV sets and antennas, costs less than the open line and is easier to install. Loss is apt to increase in wet weather due to collection of water in the perforated spaces.

The tubular 300-ohm lead-in (8K) utilizes polyethelene as its dielectric as in the case of flat ribbon lead-in but is formed like a hollow tube with the leads embedded at the sides of the tube. Due to this type of construction the energy field is concentrated within the tubing and hence is affected very little by bad weather conditions. Tubular lines must be sealed at the ends but this offers no problem, since polyethelene end seal plugs may be purchased from most TV jobbers.

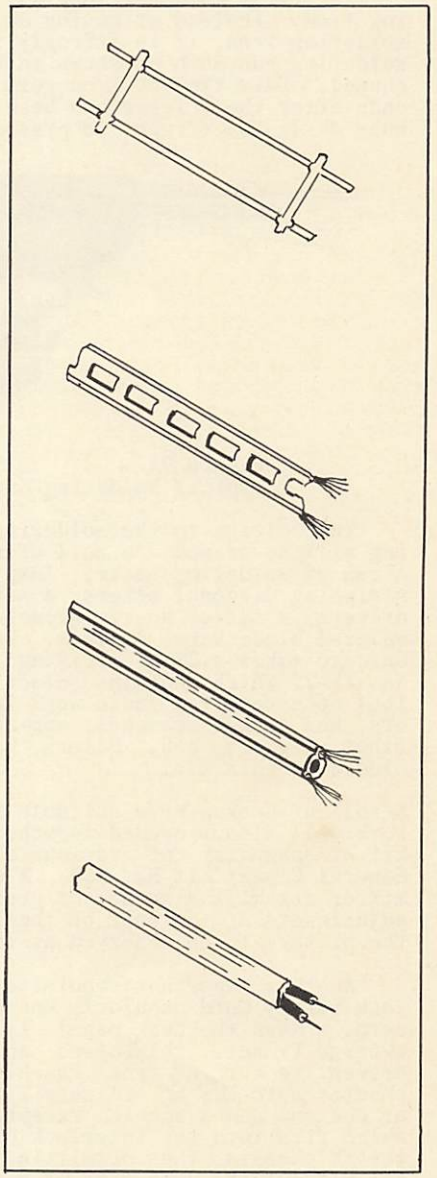


Figure 8I - Open Wire Transmission Line

Figure 8J - Perforated Open 300-ohm Twin Lead-In

Figure 8K - 300-ohm Tubular Twin Lead-In

Figure 8L - Anaconda ATV-270 Lead-In

The Anaconda ATV-270 Lead-In (Figure 8L) has 270-ohm impedance, as its name implies. The copperweld conductors are encased by polyethelene spiral threads which serve to center the wires in their separate polyethelene tubes. The outer polyethelene jacket furnishes excellent protection against inclement weather. This line can be used with 300-ohm antenna and TV set without requiring a matching device. It is recommended that the ends be sealed.

CHAPTER 9

PRACTICAL HINTS FOR PROSPECTIVE SERVICEMEN

The novice TV serviceman is faced with the important problem of equipping his test bench with enough tools and instruments to handle routine trouble shooting and repair jobs.

The first purchase should be a suitable soldering iron. Instead of buying an ordinary electric soldering iron, it is strongly recommended that a soldering gun such as shown in Figure 9A be purchased. This type of iron gets hot in three seconds after the trigger has been pulled and heats only while the trigger is pressed.

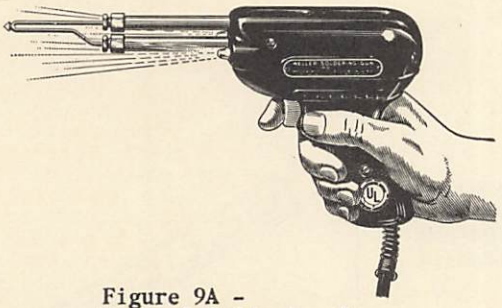


Figure 9A -
Typical Soldering Gun

In addition to the soldering gun, the following will be needed: a roll of rosin core solder, a can of soldering paste, long nose pliers, wire stripping diagonal pliers, a set of Phillips screw drivers, a set of socket wrenches, and a set of insulated blade screw drivers. Vaco Products Co. of Chicago makes a 27 piece TV and radio kit, Model No. TV-27 which contains practically every hand tool necessary for radio work including screw drivers, hex socket wrenches, non-metallic adjusters, fiber aligners, etc. Pliers, however, are not included in this kit.

A roll of hookup wire suitable for TV and radio work will also be needed together with an assorted kit of spaghetti of various sizes, such as the General Cement Kit No. 551. A G-C "Third-Eye" TV mirror set will also be of great help in making adjustments at the rear of the TV set, permitting the picture to be observed at the same time.

Another important requisite is the TV Interlock Safety Cord popularly known as a "cheater" cord. When the back panel is removed from the average TV set, this opens an interlock switch, preventing current from reaching the set. The cheater cord has an ordinary 110-volt molded plug at one end and a special receptacle at the other which fits into the interlock plug on the rear of the TV chassis, thus permitting operation of the set without the necessity of replacing the back panel.

In an emergency, it may be possible to use the line cord from an electric razor in place of a cheater cord. It is also possible to make a connection with the interlock receptacle on the panel and still leave the back of the set open for tube replacement, or other adjustments. This is done by turning the back panel upside down and making the connection between panel receptacle and chassis plug. The panel now extends far below the set leaving the back of the set open.

A most important item is a fairly large assortment of spare tubes. It would be impossible to list all tubes likely to be needed in every set encountered. However, the tubes listed below would make an excellent starting group.

Of the following tubes, those in most common use are marked with an asterisk (*). Hence if it is necessary to start with less than the entire lot, these twenty seven should be purchased first.

*1B3GT	6AK5	6BE6	*6CB6	6W6GT
1X2	*6AL5	*6BG6G	*6CD6G	6X8
1X2A	*6AQ5	6BH6	*6J6	*12AT7
*5U4G	6AQ7GT	6BK5	*6K6GT	*12AU7
5V4G	6AS5	6BK7	*6S4	12AV7
6AB4	6AT6	6BK7A	6SL7GT	12AX4
*6AC7	6AU5GT	6BL7GT	*6SN7GT	12AX7
6AF4	*6AU6	*6BQ6GT	6SQ7	12BH7
*6AG5	*6AV6	*6BQ7	*6T8	12SN7GT
6AG7	6AX4GT	6BQ7A	*6U8	25BQ6GT
6AH4GT	*6BA6	6BZ7	*6V6GT	25L6GT
*6AH6	*6BC5	*6C4	*6W4GT	25W4GT

Now for the actual equipment to be used in trouble tracing the TV set. First of all, you will need a multi-tester. This is a combination instrument which permits the measurement of voltage, current, resistance, capacity and other important electrical characteristics.

For those who can afford to start with an expensive instrument, the RCA Senior Voltohmyst Model WV-97A is recommended. As its name implies, this instrument combines the function of voltmeter and ohmmeter, the voltmeter being a highly efficient vacuum tube voltmeter. This device is especially useful as a TV signal tracer and can give accurate measurements of practically all the important complex voltages found in the various sections of a television receiver. Its price, including probes, and necessary leads is under $70. An important feature of the instrument from the standpoint of the novice is that it cannot be damaged readily, in the hands of an inexperienced user.

For those who wish to start TV servicing on a more modest scale, Model 670-A Super-Meter made by Superior Instruments Company is highly recommended. This handy instrument measures a.c. volts, d.c. volts, output volts to 3000 volts, resistance from lowest readings up to 10 megohms, capacity, inductance, reactance, decibels and will even check the quality of electrolytic condensers on a special "Good-Bad" scale. This model is housed in a rugged crackle-finished steel cabinet complete with test leads and clear operating instructions. These latter are so clearly written that anyone can use the instrument without previous experience or knowledge. The model 670-A sells for $28.40 net.

Another highly efficient but modestly priced volt-ohm milliammeter is the Superior Model 770-A illustrated in Figure 9B. This is a handy pocket-sized instrument capable of measuring a.c. and d.c. voltages, d.c. current, decibels and resistance from low values up to 1 million ohms (1 megohm). The model 770-A measures only 3 1/2 inches by 5 7/8 inches by 2 1/4 inches and is housed in an attractive round cornered molded case. It sells

for $15.85 net, complete with self-contained batteries, test leads and very clearly written operating instructions.

A selection should be made from the above three multi-testers depending upon the available financial resources. With the tools and instruments described above and the special high voltage checker described in Chapter 3 on page 15, a start in servicing is now possible.

Figure 9B

Of course, additional test instruments will be needed and these should be purchased as soon as circumstances permit.

One of the first such instruments to be obtained out of servicing profits should be an a.c. operated Signal Generator such as the Superior 660-A. This is useful for trouble tracing, and alignment and can be purchased complete with coaxial cable, test lead and instructions for $42.95.

The Cathode Ray Oscilloscope is a very desirable instrument for the well-equipped service bench. In the lower priced bracket, the 5-inch Eico Model 425-K kit can be obtained for about $44.95, and the same instrument, Model 425, is available factory wired for $79.95.

Another instrument which adds to the completeness of a TV service outfit is a modern tube tester such as the Superior Model TV-11 selling for $47.50. This device tests all types of tubes including 4, 5, 6, 7, octal, loktal, noval and many other types. It contains a built-in roll chart which provides complete data for all tubes. An important special feature of this instrument permits it to be used as an extremely sensitive condenser leakage checker.

If further information is desired about any of the above instruments, write to the author at Amagansett, N.Y., enclosing stamped self-addressed envelope.

The novice serviceman should now build himself a sturdy test bench. These are available in kit form ready to assemble at a price of around $20.00. A good antenna should also be erected capable of intercepting strong TV signals as explained in Chapter 7, the type of antenna depending upon distance from transmitting stations and on local conditions. In all cases, however, if distance reception is a requisite, use as high an antenna as possible. Great care should also be taken in the installation of an efficient low-loss transmission line.

Checking the Cathode Ray Tube

When the brightness of a picture tube and of the raster (bright area) are extremely slow in reaching a normal level, and the picture cannot be made clear with the focus control or when the picture always remains quite dim, this is generally a sign that the picture tube is defective.

There are a number of Cathode Ray Tube (picture tube) testers on the market, some of them selling for as low as $16.00 or slightly less. However, it is possible to test a picture tube by means of an inexpensive device variously referred to as CRT tube brightener, CRT reactivator, or TV picture tube booster. To use this device, remove the socket from the picture tube to be tested, putting the socket of the brightener on the tube instead. The original picture tube socket is then plugged into a receptacle on the brightener. The device acts on the principle of boosting the heater voltage just enough to increase cathode emission.

If cathode emission was poor, the brightener in many cases will cause the picture tube to regain its lost brightness and ability to focus. If there is a cathode-to-filament short, a transformer type brightener will permit continued use of the picture tube. If the set owner merely wishes to extend the life of his picture tube instead of replacing it, the brightener may be left in place permanently. Cost of this device varies from about $3.00 to $6.00 depending upon the make.

How to Read a Schematic Diagram

The schematic diagram provides a "short-hand" means of showing circuit connections. In schematic diagrams, symbols are substituted for pictures of the actual apparatus. In many cases the symbols resemble the device they represent as in the case of loudspeakers. In others there is only a slight resemblance between the symbol and the device. These latter are the ones which must be carefully studied and memorized.

Perhaps the best point to start learning to read a schematic is at the vacuum tube. Figure 9C is a schematic representation of a typical 7-prong miniature tube. The letters have the following meanings: H - heater; P - plate; K - cathode; G - grid. the numbers after the G's serve the purpose of distinguishing one grid from another. The grids are numbered in accordance with their nearness to the cathode. Thus the nearest grid is G1, etc. The numbers in the circles represent bottom-view socket connections.

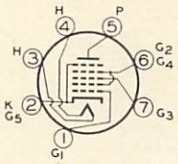


Figure 9C

Figure 9D shows the actual tube. Note the wide space between pins 1 and 7. The numbering starts at the wide space and proceeds in a clockwise direction. Figures 9E, 9F and 9G show bottom views of other types of television tubes and the numbers correspond to the socket terminal numbers when socket is viewed from the underside.

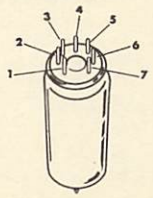


Figure 9D

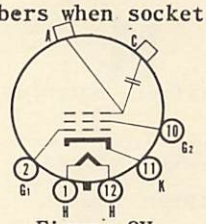
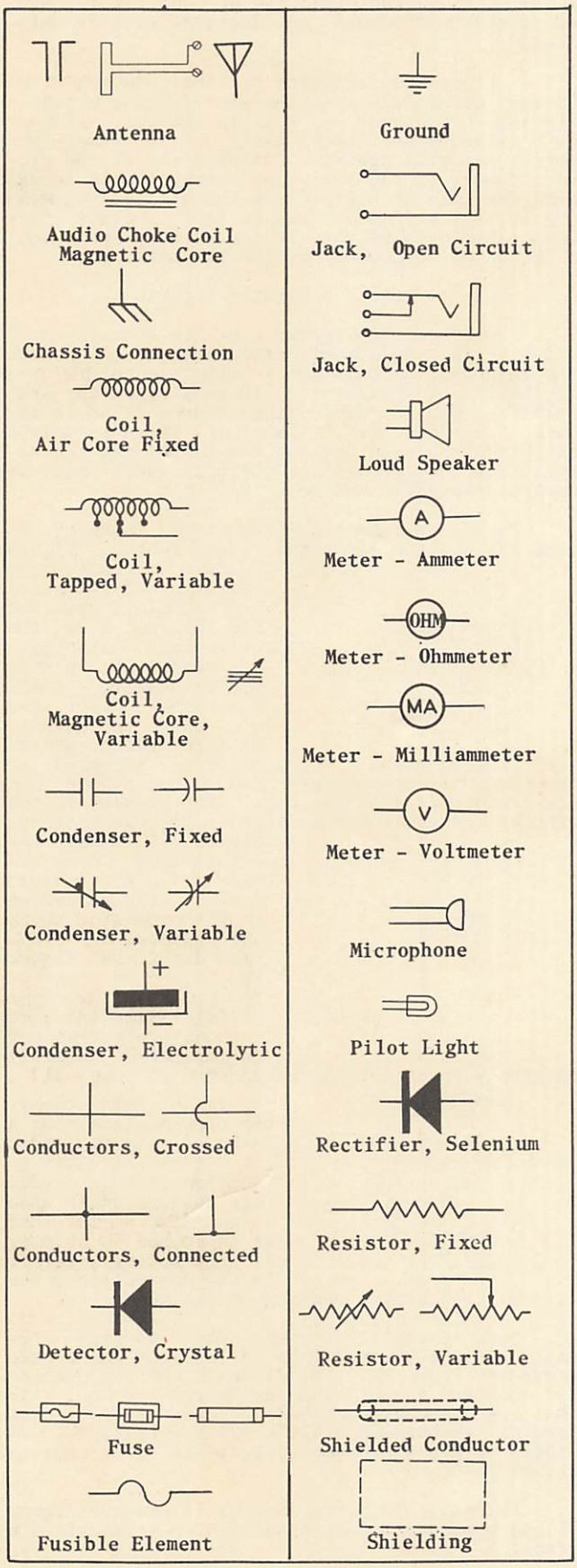


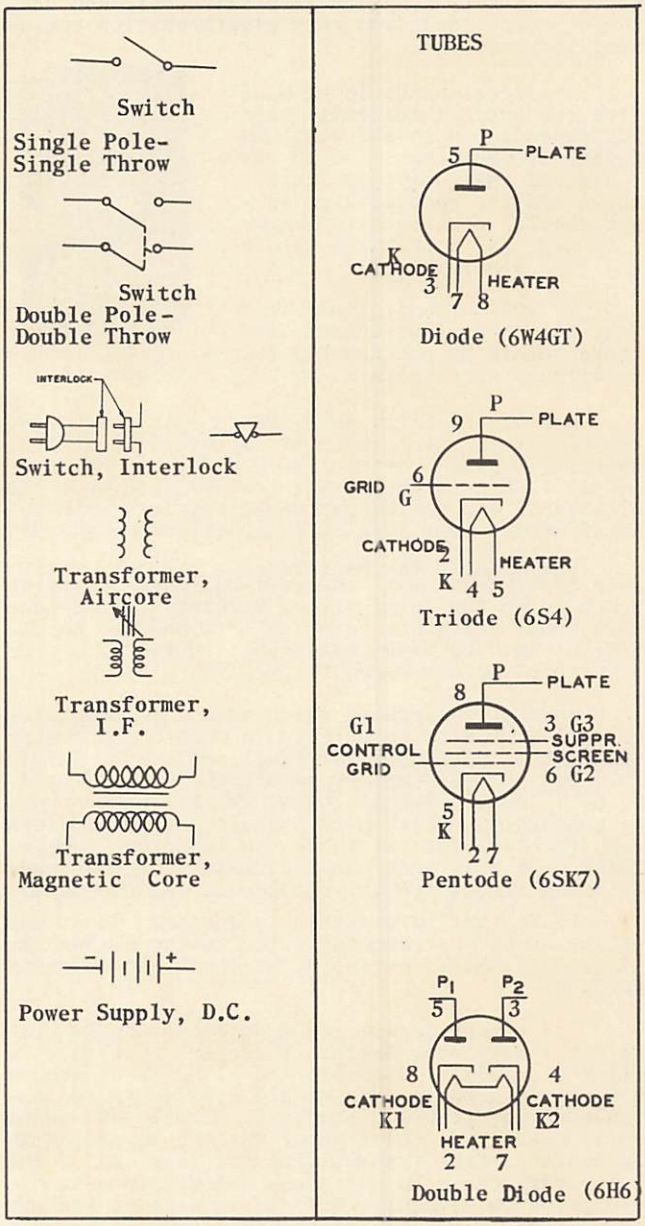
Figure 9H

Figure 9H shows schematic representation of a 16RP4 cathode ray tube. The letter A refers to the high voltage anode. This connection is made at the side of the tube as explained in Chapter 3. The letter C refers to the connection to the external conductive coating of the tube.

Some schematic diagrams show a side view sketch of the picture tube instead of the circle shown in Figure 9H. The elements are represented and numbered in the same way in each method. Note that some schematic symbols of tubes show socket terminal numbers in small circles (Figure 9C) and others merely show numbers beside element connections.

The following list of symbols shown in Figure 9I has been adopted as standard for schematic diagrams.





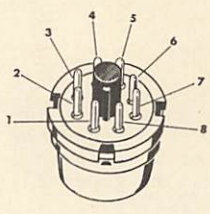


Figure 9E

Bottom view of 8-prong "octal" base tube.

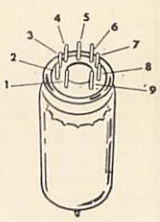


Figure 9F

Bottom view of 9-prong "noval" base tube.

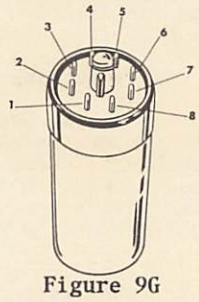


Figure 9G

Bottom view of 8-prong "lock-in" or "loktal" base tube

Figure 9I - Symbols Used in Schematic Diagrams

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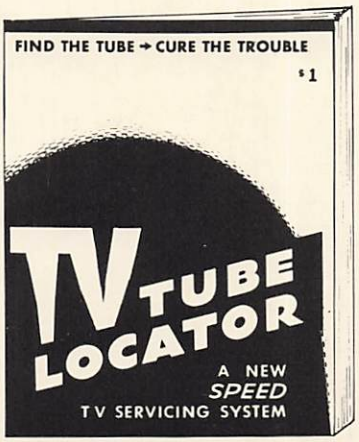

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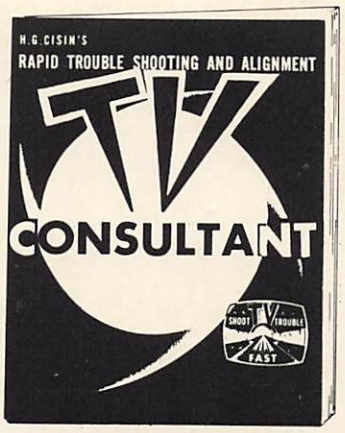

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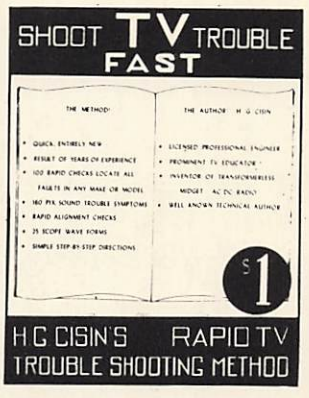

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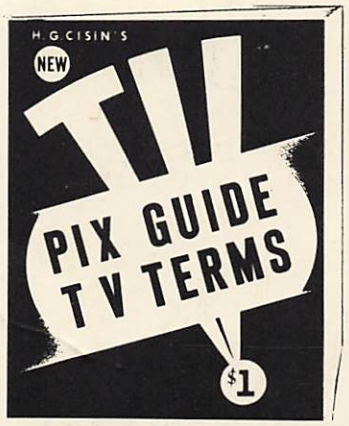

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