Pin Point TV TROUBLES IN 10 MINUTES

Check Charts

New TV Trouble-Shooting Technique . . .
The World's Fastest!

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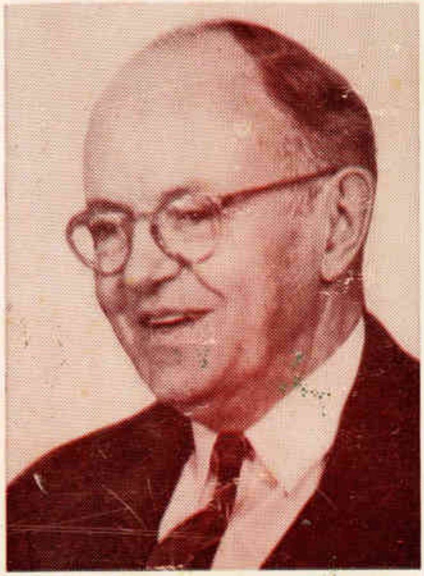
PIN-POINT TV TROUBLES IN 10 MINUTES

ABOUT THE AUTHOR



MR. HAROLD P. MANLY

Mr. Harold P. Manly has been one of our authors for over 25 years. He has a rare quality of being able to explain in words of one syllable the most complicated of electronics subjects.

Since 1925 Mr. Manly has written eleven home study courses for private schools; three on radio and television, one on industrial electronics and others on practical electricity, automotive, refrigeration and aircraft instruments.

He has written dozens of technical books on all types of electronics subjects. Among the outstanding he has written for Coyne have been the CYCLOPEDIA OF TELEVISION SERVICING, APPLIED PRACTICAL TELEVISION-RADIO (a 5 volume set of reference books), INDUSTRIAL ELECTRONICS, TV-RADIO HANDBOOK, and the COYNE TECHNICAL DICTIONARY.

With privately owned laboratory facilities in which he makes actual tests on every circuit used in any book he writes Mr. Manly has acted as a Consultant for many leading radio and TV companies.

The system outlined in this book Pin-Point TV Troubles in 10 Minutes represents one of Mr. Manly's greatest contributions to the TV field. The methods he recommends have been the basis for material he has developed for some of the outstanding radio and TV books and courses in the country.

We feel it would be indeed difficult to find a man better qualified than Harold P. Manly to prepare a book on television trouble shooting. An examination of this book would be the best evidence of the reason for such outstanding confidence in an author.

RAY SNYDER, *General Manager*
Educational Book Publishing Co.
Coyne Electrical School
Chicago 12, Illinois

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PIN - POINT TV TROUBLES in 10 MINUTES

PIN-POINT

TV TROUBLES

in

10 MINUTES

A Practical, Quick answer, REFERENCE book

on TV Trouble Shooting for Servicemen.

Published by

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COYNE ELECTRICAL SCHOOL

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A SYSTEM FOR LOCATING TELEVISION RECEIVER TROUBLES

THIS BOOK is based on seventy kinds of faulty pictures. It covers approximately 700 troubles which may cause the faulty pictures. Cross references, whose use is explained on a following page, allow rapid location of the most probable reasons for each picture symptom.

Accompanying the tables of symptoms and causes are explanations of circuits and designs used in the majority of all television receivers produced since 1953. These explanations clarify the use of the tables. Illustrated and described are methods for checking performance of various parts or components. Also included are precautions to be observed when making tests and replacements, and, in general, the bits of practical information needed while locating and correcting receiver troubles.

The book deals only with trouble location and correction, not with principles and theory. It is assumed that the user understands proper adjustment of all the usual operator's controls and chassis controls, also the use of common service instruments. Instructions are included for some of the more troublesome service adjustments.

Obviously, it is impossible in any book to deal with every intricate trouble which may occur. However, this system will care for the great majority of difficulties, both simple and complex which daily confront the service technician.

CONTENTS

HOW TO USE THIS SYSTEM

1. In the following list of picture symptoms find the one that is marring picture reproduction.

2. Opposite that symptom are numbers of all pages on which are listed probable causes for the existing picture symptom. Numbers in heavy type refer to the page or pages listing most of the probable faults. Refer to these pages first. Use the other tables later, if necessary.

3. At the top of the table on a selected page find the name of the existing picture symptom. Underneath that symptom are reference dots. Opposite the dots, in the left-hand column, are receiver faults which may cause the trouble.

4. The faults listed in each table are numbered, beginning at 1 for each section of the book. Methods of correcting most of the faults need no explanation. For instance, if a capacitor is leaky or shorted it should be replaced, if a voltage is too high it should be lowered, etc.

There are, however, certain faults which require specialized methods for correction or whose location is made easier by additional checks and tests. For faults of this class there are explanations and suggested procedures in numbered paragraphs which precede or follow the tables in the same section of the book. The numbers of these paragraphs correspond to numbers of the faults in the tables. Numbered paragraphs are included *only* for faults requiring special instructions, *not for all of the faults listed in the tables.*

At the beginning of each section in this book are diagrams, illustrations and brief descriptions of designs and components considered in that section. Should you be in doubt as to the part of a circuit in which will be found some fault listed in a table, refer to these preliminary explanations.

Here also, will be found information on circuit peculiarities, on methods for improving performance, making service adjustments, connecting test instruments, checking various components and making many more or less routine tests. The best way to show you how this book will cut your TV trouble shooting time is to take you through an actual case step by step checking out the trouble with this system.

For this example turn to page headed "Picture Symptoms —Trouble Tables." Let's take the very first picture symptom — BAND or BAR Bright, bottom. This describes a problem of a bright band at the bottom of the viewing tube. You will note that the Trouble Tables at right, show that trouble shooting tables for this trouble are to be found on pages 157-158 and 159. On page 157 you will find a check chart with a reference to "bright bar, bottom," in the first column. Glancing down this column you note a dot at "Cathode heater, leak" in the output tube. This tells you that such a condition can cause a bright bar at the bottom of the tube. On the bottom line of page 157 you note that a grid resistor which is "too small" can also cause this trouble.

Continuing on page 158 you will note that a peaking resistor that is "too great" could cause this trouble. On Chart 159, page 159, it is indicated that this condition could be also caused by "too little resistance" in the Linearity control.

Any of the aforementioned conditions, which you can easily check, could cause a bright bar at the bottom of the picture.

With that sample procedure it is easy to understand how much time can be saved through this new system of TV troubles location. Over 70 picture symptoms can be checked in exactly the same way we have taken you through the sample case. As an added aid to the serviceman we include several dozen actual picture patterns. You will find these in a section following picture symptoms. We do this in every case where we feel the *Picture Symptom* as described may not be quite clear to the serviceman unless he *sees an actual photo of the picture trouble.* There are many of the Picture Symptoms such as Band, dark, bottom, Width lacking, etc. that require no picture illustration. *We only include picture patterns on troubles that we feel require them.*

The last section of the book covers sound problems in TV receivers. We confidently feel that when you acquaint yourself with the system covered in this book you can Pin-Point TV Troubles in 10 minutes as the name of the book implies.

Ray Snyder, General Manager
Educational Book Publishing Division
Coyne Electrical School
Chicago 12, Ill.

VOLTAGE SYMPTOMS

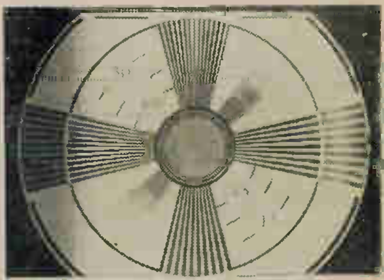
PICTURE PATTERN SECTION

This section illustrates most of the TV troubles covered in this book. The caption under the picture pattern correspond to the description given in the previous section "Picture Symptoms". This section is arranged alphabetically by name of the TV trouble.

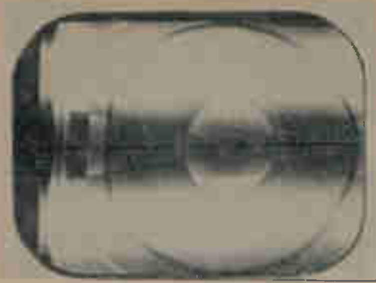
Band or bar, bright, bottom.
157-158-159

Band or bar, dark, top.
79-80

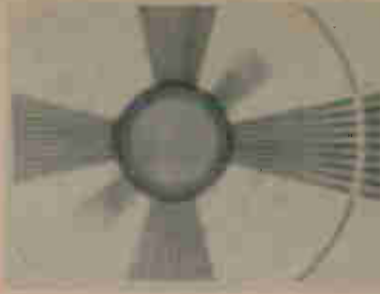
Band or bar, bright, top.
80, **158**, 273-274



Band or bar, dark vertical.
251

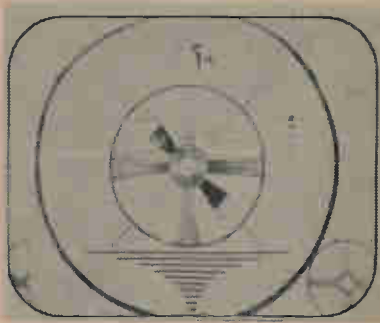


Bars, hum.
28, 39, 49, 57, **292**



Blooming.
85, **261-262**, 290

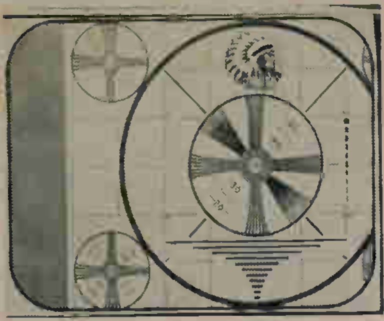
Bars, sound.
15, **28**, 57, 292



Brightness excessive.
28, 77, **79-80,** 85, 197, 206, 251

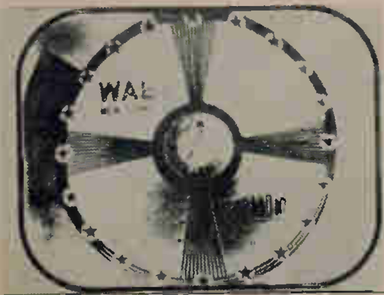
Bending, top.
28, 57, **59**, 124, 194,
196-197, 199

Brightness lacking
15, 28, 77, 81, 85, 97, 194-195,
197, 200, 202-204, 205-106,
225, 251, **261-262**, 273, 290,
292

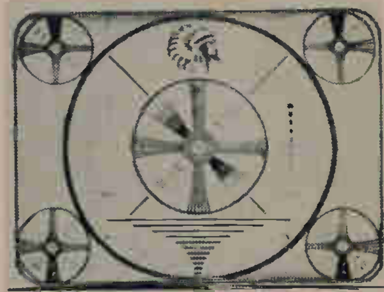


Centering difficult.
97, 225, 276

Dark, no raster or pictures.
77, 81, 85, 97, 194-195, 196-197, 199-201, **202-204**, 205-206, 225, 235, 244-245, 251, 260, 261, 262, 264, 273, **290-291**



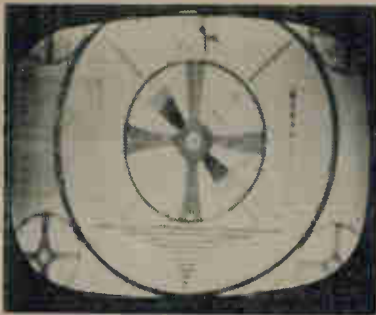
Contrast excessive.
8, 28, 49, 57-58, **59**, 81



Definition poor.
8, 15, 28, 39, 49, **57-58**, **59-60**, 81, 85, 97

Contrast lacking.
8, 15, 28, 39, 49, 57, **59-60**, 77, 81, 85, 292

Flashes.
15, 260, **264**



Focus poor.
85, 97, 251, **261-262**, 276, 292

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154-155, 156-157, 158

Fold, horizontal, center.
124, 194-195, **196-197**, **199-201**, 202, 204, 205, 225, 235, 244, 251

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195, 196-197, 200-201, 204, 205-206, 273-274

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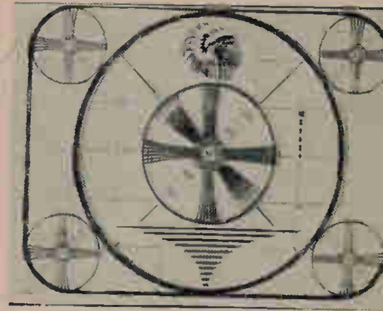
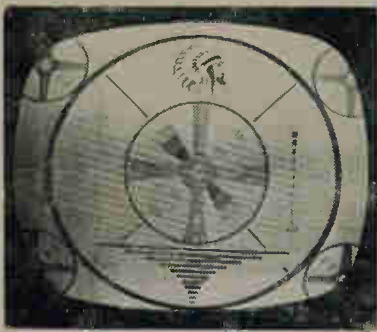
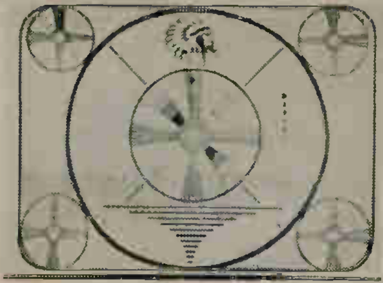
194-195, 196-197, 199, 202-204



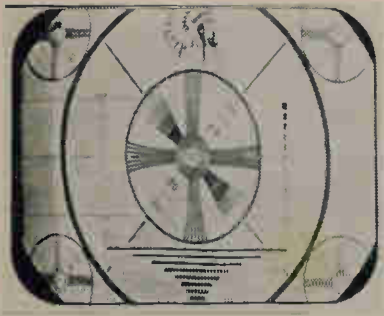
Ghosts.
8



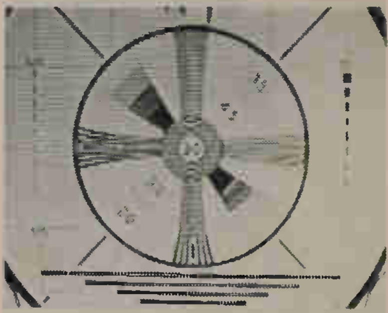
Grainy pictures.
39, **58**



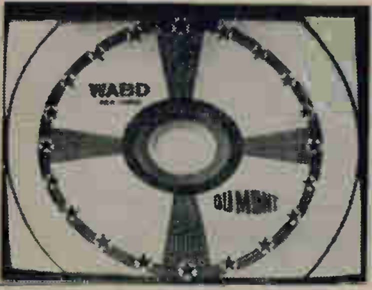
Interference pattern.
28, 39



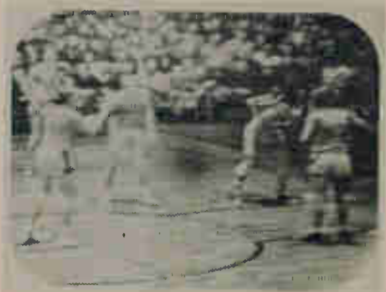
Height excessive
154-155, 156-157, 158-159,



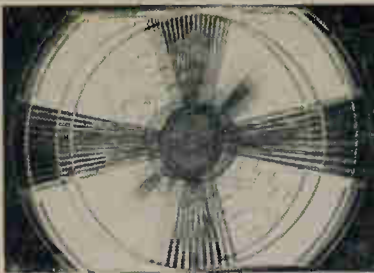
Interlace poor.
154



Height lacking.
154-155, 156-157, 158-159,
251, 273

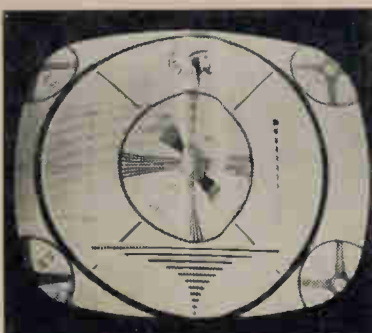


Ion burn.
97

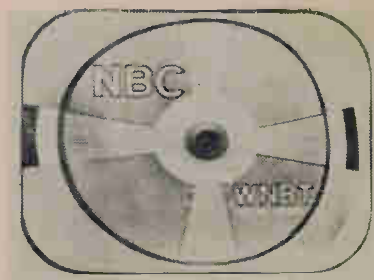


Jitter, horizontal.
15, 57, 194-195, 196, 199, 202, 235, **264**

Line, horizontal, one.
154-155, 156-157, 158, 159, 251, 273-274



Line, bright, vertical.
197, **205-206,** 225, 235, 244-245, 205, 206, 235

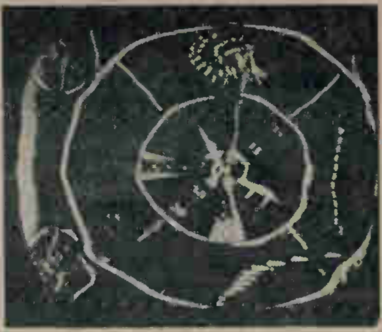


Linearity poor, horizontal.
205-206, 225, 235, 244

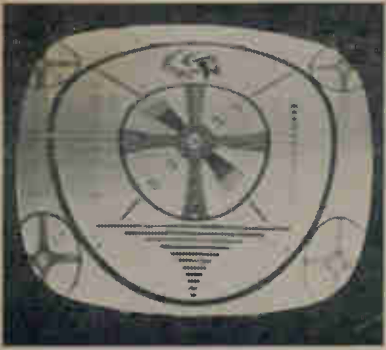
Line, dark, vertical.
205-206, 235

Linearity poor, horizontal and vertical.
85

Linearity poor, vertical, bottom.
155, 156, **158**

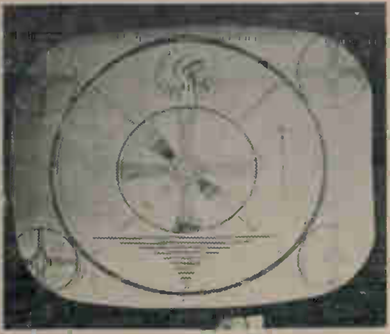


Negative pictures.
57, 59

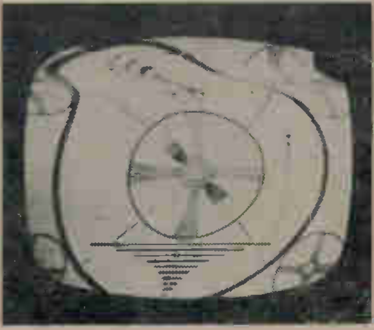


Linearity poor, vertical, top.
155-156, 157, **158-159**, 251, 273-274

Noise in pictures.
15



Multiple images.
15, 28, 39, **57**, **59**

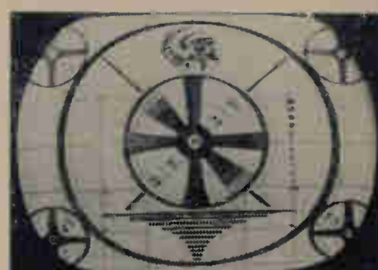


Pulling.
124

Raster only, no pictures.
8, 15, 28, 39, 49, **57-58, 59-60,** 77, 81, 85, 273, 292

Reversed, top-bottom.
273, 276

Retrace lines appear.
77, **79-80, 81,** 273-274



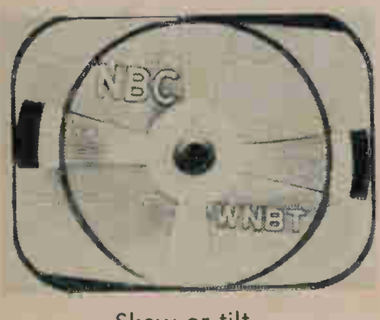
Ringing.
225, **235**, 244

Reversed, left-right.
244, 276

Shadowing
97

Size excessive, height-width.
260, 235, 262

Size lacking, height-width
85, 235, **290**



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97, 276

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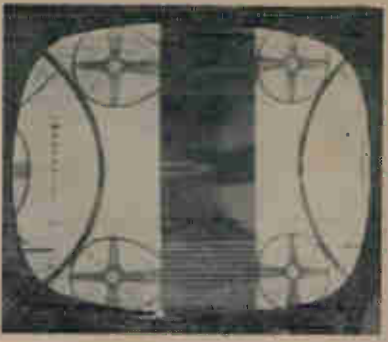
15, 28, 39, 49, 57, **59-60**, 124

Snow
8, 15, 49, 264

Speckling.
28, 225, 260, **264**

Spot only, bright.
276



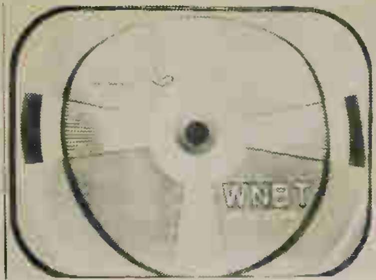
Sync, horizontal, split left-right.
124, 194-195, 196, 199, 202-203

Sync, horizontal, absent.
15, 28, 39, 49, 57, 59, 60, 81, 124, 251, 264

Sync, vertical, absent or critical.
154-155, 156-157, 158-159, 251, 292

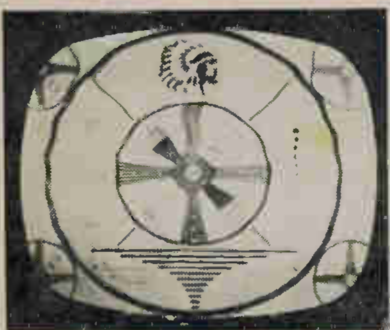
Sync, horizontal, critical.
194-195, 196-197, 199-201, 202, 203, 225, **235, 251**

Sync, vertical, split top-bottom.
156-157, 158-159

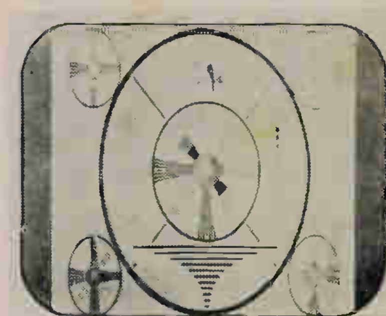


Tear out.
57, 124, 264

Width excessive.
201-202, 204, 206, **225**



Wavy, vertical.
124, 196-197, 199, 202, 205, 274, 276, 292



Width lacking.
194, 196, 200, 203, **205-206**, 225, 235, 244-245, 251

Wedge shaped.
244-245, 273-274, 276

SECTION A

SYSTEMATIC TROUBLE SHOOTING

Locating TV troubles could be almost a pleasure if some single test or observation would eliminate half the possibilities, if a second test could eliminate half of those remaining, and so on until you spotted one small section as containing the culprit. Then simple checks on a few parts and connections would pin point the needed adjustment or replacement. It would be as easy as pictured by Fig. 1.

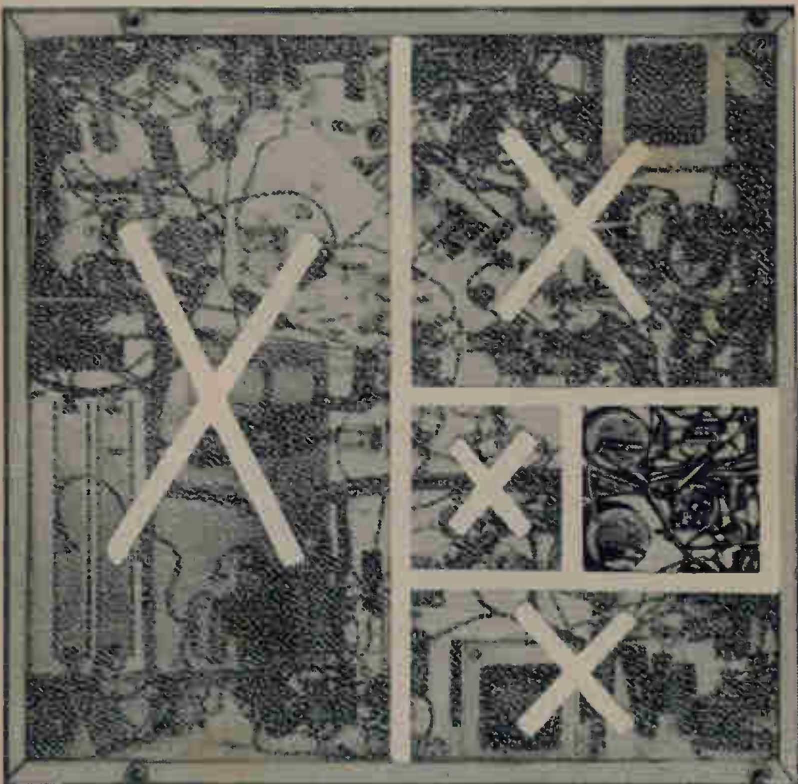


Fig. 1. For fast trouble location we eliminate from suspicion one section after another until only a small group of parts remains for final checking.

We cannot make such mathematical divisions as halves, quarters and eighths of all the parts and circuits in which trouble might exist, but we can do what amounts to the same thing. The basis of such systematic trouble location is in thinking of every receiver as consisting of the sections shown by blocks in Fig. 2, and thinking of signals and other voltages as following the lines.

Video signals follow the heavy solid lines. Sound signals follow the long dashes. Sync, sweep, and deflection voltages follow the light lines. Voltages and currents from the low-voltage power supply go directly or indirectly along dotted lines.

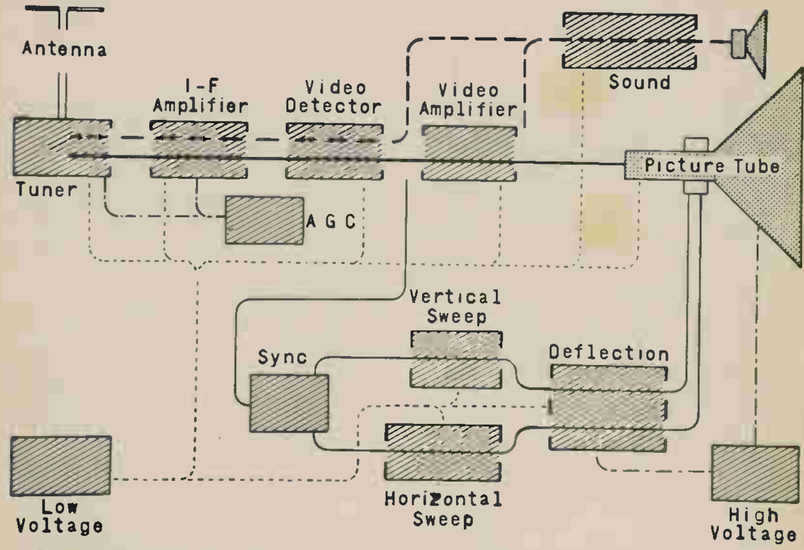


Fig. 2. The technician thinks of every receiver as consisting of these sections.

Merely by observing whether pictures, a raster, and sound are present or absent we may go a long ways toward determining which sections cannot contain the existing trouble, which sections most probably are in difficulty and which ones may only possibly be at fault. We eliminate anywhere from two-thirds to nine-tenths of the sections from further consideration.

Note: To observe a raster place the channel selector where there are no programs or transmissions in your locality. If necessary, advance the brightness control to cause illumination of the viewing screen of the picture tube. The raster consists of luminous horizontal trace lines which cover the screen as in Fig. 3. Each line is produced by action of the horizontal sweep and deflection sections. The lines are spread from top to bottom of the screen by the vertical sweep and deflection sections.

Fig. 3. A raster is made up of horizontal luminous traces.

The first steps in trouble location are outlined by the table *Preliminary Observations.* Supposing, as an example, there are no pictures and no raster, but sound is present. These are the conditions listed as case *B*. We look first for trouble in the high-voltage section. If high voltage is satisfactory at the picture tube anode we check the picture tube itself, then the horizontal sweep, and finally certain parts of the deflection section. Why the tests are made as outlined, and what they signify, are explained briefly for each of the cases in paragraphs which follow.

PRELIMINARY OBSERVATIONS

No Picture, Raster or Sound (A)

The set is dead. Looking at Fig. 2 we note that the low-voltage section furnishes power through dotted line paths to all other sections except the one for high voltage, and indirectly to the high-voltage section. Consequently, performance of all other sections is dependent on the low-voltage power supply, and there we commence looking for trouble.

No Pictures or Raster—Sound Present (B)

The fact that sound is present eliminates from suspicion all the sections along the long-dash line of Fig. 2, also the low-voltage section which is supplying power for sound. No raster means that the electron beam is not being deflected across the picture tube face. Maybe there is no beam, so we begin by checking the high-voltage section.

	PRELIMINARY OBSERVATIONS				
	SYMPTOMS			SECTIONS IN TROUBLE	
	Picture	Raster	Sound	Most Probable	Possible
A	No	No	No	Low-voltage	
B	No	No	Yes	High-voltage	Picture tube Horizontal sweep Deflection
C	No	Yes	No	I-f amplifier	Video detector Tuner Agc Antenna
D	No	Yes	Yes	Video amplifier Picture tube	I-f amplifier Tuner
E	Yes	Yes	No	Sound	Tuner I-f amplifier

If high voltage is satisfactory at the anode of the picture tube it is in order to measure voltages at the second grid, the control grid and the cathode. Having cleared the picture tube, thus determining that a beam may be formed, we proceed to check the horizontal sweep section wherein originate voltages which directly or indirectly affect both horizontal and vertical deflections of the electron beam. The final step would be a check of the deflection section.

No Picture Or Sound — Raster Present (C)

Presence of a raster proves that vertical sweep, horizontal sweep, deflection, high-voltage and low-voltage sections are working. Picture signals and sound signals, which are lacking, would have to come through antenna, tuner, i-f amplifier, video dectector, and video amplifier sections. I-f amplifier trouble is most probable, but if this section is operative we check, in order, the video detector, tuner, automatic gain control (agc) and antenna.

No Picture — Raster And Sound OK (D)

A raster always indicates that vertical and horizontal sweep, deflection, high-voltage and low-voltage sections are working. Sound signals, which here are present, must be coming through antenna, tuner, i-f amplifier, video detector, and often through at least part of the video amplifier section. Accordingly, there can be nothing radically wrong from antenna to the sound takeoff.

It remains to investigate, first, any portion of the video amplifier section that does not carry sound signals, also the control grid-cathode circuits for the picture tube. The i-f amplifier or tuner may pass sound signals even though so far out of adjustment as to prevent formation of pictures, so these latter two sections are possibilities for trouble.

Picture And Raster OK — No Sound (E)

Sound signals should come through antenna, tuner, i-f amplifier, video detector, and part or all of the video amplifier section on their way to the sound section. All these sections that precede the sound takeoff carry picture signals, and pictures are present. Then, naturally, we look first to the sound section as containing the fault.

Incorrect adjustments in the tuner, and possibly in the i-f amplifier, might prevent picture formation while allowing sound to come through, so these two sections should be examined in case the sound section is cleared.

Symptoms And Their Causes

Up to this point we have talked only about pictures, raster and sound which are good or else entirely absent. There will, however, be many cases with which pictures, raster and sound may be present, but poor. By considering poor performance, as distinct from no performance whatever, we may more quickly eliminate groups of parts with minimum effort and time.

As an example, we might have pictures with bad smears or trailers, as in Fig. 4. Such faults might result from any one or more of about twenty-five kinds of trouble. At least half of all these troubles may be in the video amplifier, but a considerable number of possible causes are in the tuner, and an equal number in the video detector. Less common are faults in automatic gain control, picture tube input, and sync sections. Smearing might even result from wrong dressing of conductors and circuit components. Due to all these possibilities we cannot say that smearing (or any other single defect) indicates trouble in only one certain section.

Fig. 4. Smearing may result from trouble in any of several sections.

Neither is it true that troubles in one certain section will cause only one kind of picture fault. For instance, although smearing may result from trouble in the video detector section, various faults in this section may also cause multiple images, lack of contrast, poor definition, snow, loss of synchronization, tear out, or absence of pictures and sound.

To allow more definite tieups between symptoms and causes we may divide most of the major sections into subdivisions. One of the biggest major sections, that for the picture tube, contains everything shown by Fig. 5. In addition to the tube itself we have control grid-cathode signal input circuits, the brightness control, sometimes a contrast control, and the retrace blanking system. We have also an ion trap magnet and focusing and centering controls which may be separate or combined. Other major sections may be similarly broken down.

Getting Down To Business

Our plan of attack will be this: First we shall examine all the major sections and their subdivisions solely with reference to their probable and possible troubles, the resulting symptoms, various tests for quickly isolating the seat of trouble, and suitable remedies.

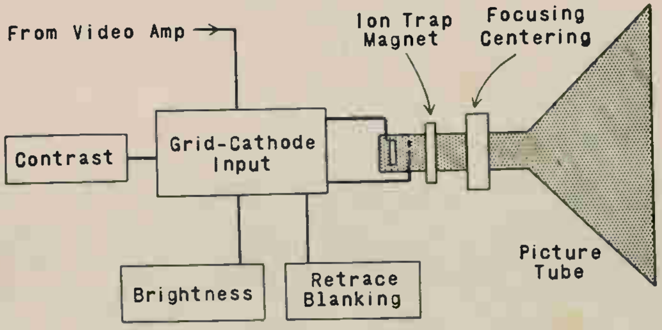


Fig. 5. The picture tube section contains these subdivisions.

Second, we shall apply the same procedure to circuit components such as capacitors, resistors, inductors, all the small tubes, and so on.

How to Begin

No matter what details of tests and measurements we get into later on it is wise to commence every job of trouble shooting with these steps.

1. Tune in each locally active channel and observe performance. Trouble on only one channel may indicate temporary difficulty at the transmitter, or the fault may be in the receiver tuner.

2. Try to get best possible pictures and sound by careful adjustment of the operator's controls. If one control makes performance better or worse you have a clue to the section or circuit at fault — it might be the control itself.

3. Check the effect of any service adjustments which are definitely related to existing faults. As one example, horizontal sync difficulties point to adjustments for frequency and for hold in the horizontal oscillator circuits.

4. When symptoms or tests indicate one section as the probable or possible seat of trouble, try new tubes or tubes known to be good before checking other components in that section.

SECTION 1

ANTENNA

The antenna section or group includes the antenna itself and the transmission line connecting the antenna to the tuner of the receiver. The accompanying table lists common faults and picture symptoms most often resulting from each fault.

Table 1 ANTENNA	Snow	Ghosts	Contrast lacking	Definition poor	Raster only, no pictures	Contrast excessive
ANTENNA FAULTS						
1 Wrong orientation, height or location	•	•	•			
2 Built-in or indoor type	•	•	•			
3 Non-directional		•				
4 Excessive pickup						•
LINE FAULTS						
5 Connections poor or open	•				•	
6 Mismatch	•	•		•		
7 Routing wrong	•					

1. Wrong Orientation, Height Or Location

As illustrated by Fig. 1-1, orienting an antenna means to rotate the dipole and parasitic elements around the mast to a position that allows most satisfactory pickup of desired signals, or least interference, or the most acceptable compromise of these factors. Orientation can be made only while receiving broadcast signals. Relative strengths of signals from different directions are compared by observing pictures, by measuring output from the video detector, or by using a field strength meter.

Although additional height of the antenna almost always improves reception, there may be unusual conditions with which better pickup is secured with less height. The best location among those which are accessible may be found only by moving the antenna from place to place before final erection. Movement of only a few feet to one side or the other may make great improvement, especially on high-band vhf channels and on uhf channels.

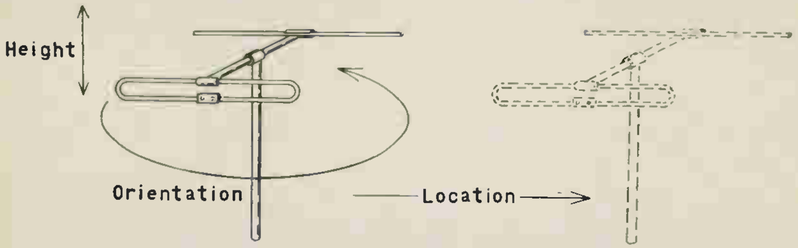


Fig. 1-1. Factors which affect signal pickup by the antenna.

2. Built-in Or Indoor Antenna

Such antennas can be oriented to only a limited extent, they cannot be raised or lowered, and choice of location is limited. These shortcomings account for the troubles which may be expected. The remedy is a good outdoor antenna.

3. Non-directional Antenna

Ghosts, which are due to signal reflections, often may be reduced or eliminated by an antenna of the Yagi type or some other which has marked directional properties. A reflector on any antenna provides a certain amount of directivity, but this property is greatly increased by the addition of one or more directors.

4. Excessive Pickup

An efficient antenna close to a transmitter may deliver to the receiver signals so strong as to overload tubes in the tuner or i-f amplifier. Signal strength may be reduced by changing the orientation or by use of an attenuation pad at the receiver end of the transmission line. A resistance pad reduces signals from all channels. A quarter-wave open resonant line, a tuned stub, sometimes is used to reduce signals from one channel.

5. Connections Poor Or Open

Loose or corroded terminal connections, shorted terminals, or broken transmission line conductors will reduce signal strength to the receiver and leave noise impulses so relatively strong as to cause snow in pictures. In extreme cases or in fringe areas there may be no pictures or sound.

6. Mismatch

A mismatch occurs when impedance of the transmission line differs from that of the antenna or the receiver input. Mismatch as great as two-to-one causes signal loss of 10 to 12 per cent, which should not be a serious loss except in extreme fringe areas. Loss increases rapidly with greater impedance differences.

Wave reflections due to bad mismatching may cause picture effects quite similar to wave reflection ghosts. Splicing the line anywhere between antenna and receiver may cause reflection. Close matching, when required, usually is obtained with any of various kinds of matching transformers or line sections designed for the purpose.

7. Transmission Line Routing

Rules for avoiding excessive signal loss when installing unshielded transmission line are as follows. Some are illustrated by Fig. 1-2.

Make the line as short as possible.

Use standoff insulators for all supports.

Make no sharp turns or twists, and don't squeeze the two conductors toward each other.

Clear all large bodies of exposed or concealed metal by at least 20 inches, when possible, and do not run the line parallel to such metal.

Stay as far as possible from power lines.

Never run the line through metal tubing.

Don't paint the line.

Avoid long horizontal runs if possible, keep such runs above snow level and try to place them where protected from rain and sleet.

Make sure that tubular line is sealed at both ends or is drained at all low points.

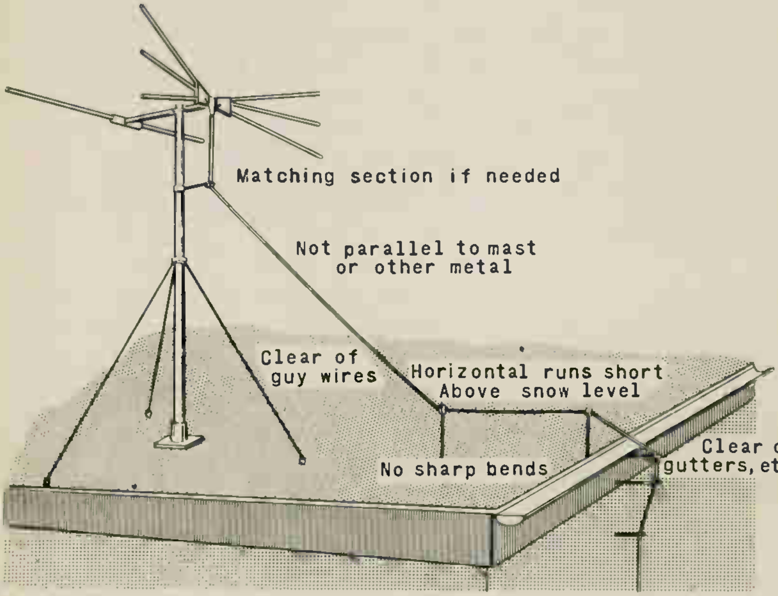


Fig. 1-2. Much signal energy may be lost in the transmission line unless it is properly installed.

SECTION 2

TUNER

The tuner group or section includes the subdivisions shown by Fig. 2-1. There are couplings for signal transfer between antenna and r-f amplifier, between r-f amplifier and mixer, and between oscillator and mixer. Coupling from oscillator to mixer often is referred to as oscillator injection; it may be a small capacitor, sometimes adjustable.

Tuning for channel selection varies the antenna to r-f coupling and the r-f to mixer coupling for resonance at carrier frequencies, and varies the oscillator frequency at the same time. There are service adjustments which allow correct alignment of tuned circuits for carrier and oscillator frequencies at one or more channels, commonly for channels 13 and 6. In addition there may be service adjustments for the degree or amount of coupling and for oscillator injection.

Types Of Tuners

Tuners in present receivers are of two general types, turret and incremental. Principal circuit elements of a typical turret tuner are shown in Fig. 2-2. Tuning is by means of inductors for each channel, mounted on a tuner strip or strips. All the couplings are inductive, between coils on the strip.

The oscillator inductor for each strip or each channel has an adjustable core for alignment. R-f to mixer alignment is by means of adjustable capacitors *Cm* on the mixer grid and

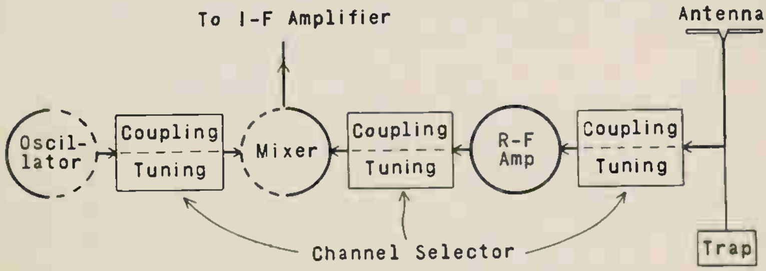


Fig. 2-1. Every tuner section contains these subdivisions in one form or another.

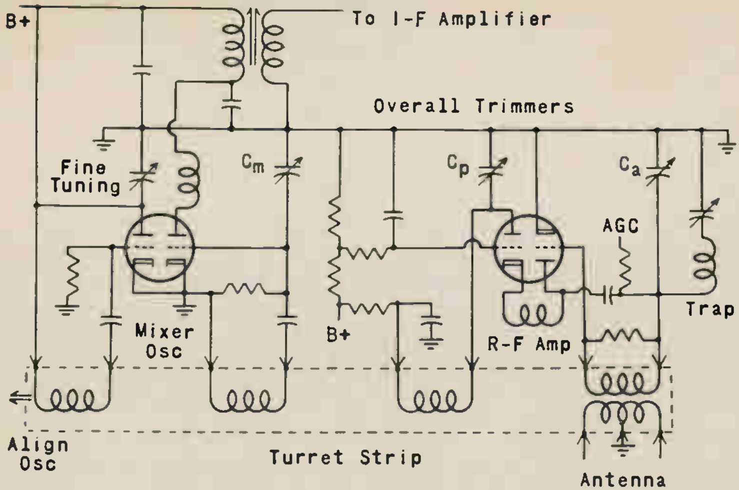


Fig. 2-2. Principal circuit connections in a typical turret tuner.

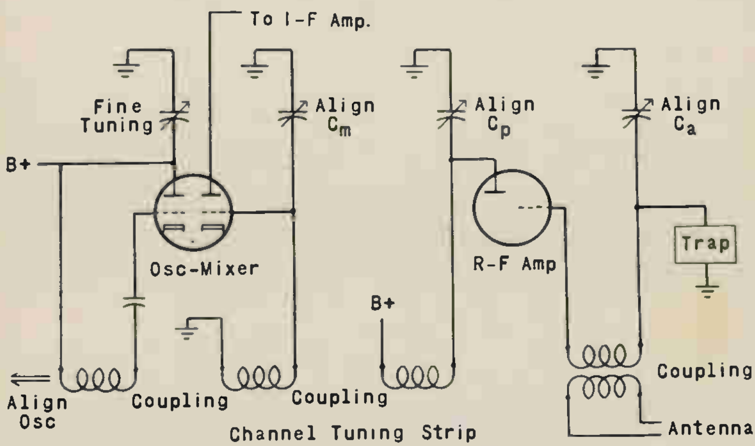


Fig. 2-3. Elements for channel selection and for alignment in a turret tuner.

Cp on the r-f amplifier plate. These two capacitors are the principal adjustments for bandwidth and for bringing video carrier and sound carrier frequencies to correct positions on the frequency response. Antenna to r-f alignment is by means of capacitor *Ca,* which has principal effect on tilt of the response.

The mixer-oscillator tube of Fig. 2-2 is shown as a twin triode. It might be a triode-pentode with the pentode section for mixer. The r-f amplifier is shown as a cascode type, but might be a pentode.

Couplings and service adjustments for the turret tuner are shown in Fig. 2-3 without connections from the low-voltage power supply to plates, grids and cathodes. This diagram includes components in which we are most interested during trouble shooting other than checks for voltages and resistances, and helps bring out the fact that any tuner consists essentially of the elements in Fig. 2-1.

Fig. 2-4 shows principal components and connections in a rather simple type of incremental or switch type tuner. Channel tuning is by means of switching more or less inductance into the antenna or r-f coupling by means of rotary switch *S1*, into the r-f to mixer coupling by switch *S2*, and for oscillator tuning by switch *S3*. The diagram shows front and back connections and inductors for each switch wafer.

Fig. 2-5 is a simplified diagram for parts of the incremental tuner with which we are most concerned during trouble location other than voltage and resistance checks.

Overall alignment for antenna to r-f coupling is by means of adjustable inductor *La*. High-band alignment for r-f to

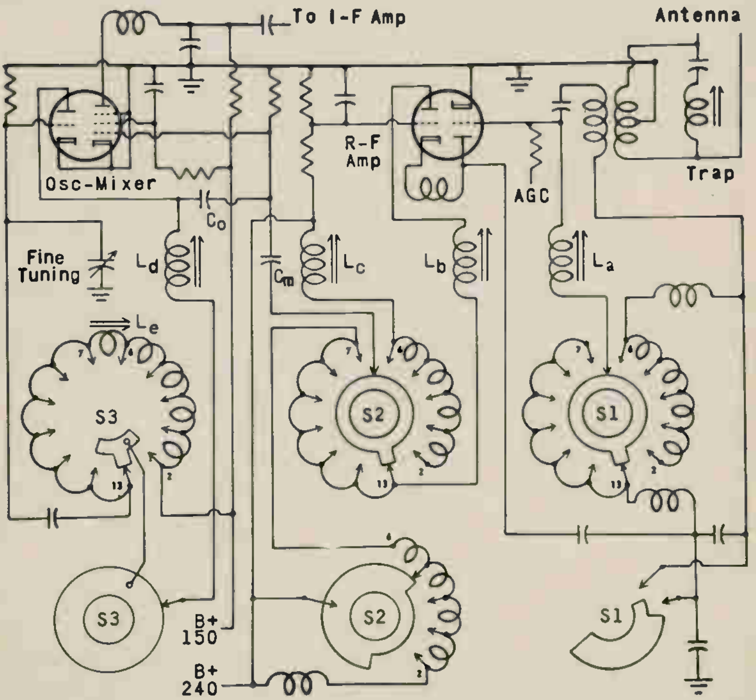


Fig. 2-4. Circuit connections for a simple type of incremental or switch type tuner.

Table 2 TUNER	Brightness Lacking	Contrast Lacking	Definition Poor	Flashes	Jitter, Horizontal	Multiple Images	Noise in Pictures	Raster, No Pictures	Smearing	Snow in Pictures	Sound Bars	Sync Critical
TUBES FAULTY OR TUBE VOLTAGE WRONG												
1 Any tube. R-f amp. mixer or oscillator		•					•	•		•		
2 R-f amplifier gassy			•						•			
3 No oscillation, or none on high band								•				
4 Oscillator microphonic											•	
WRONG ALIGNMENT												
5 Bandwidth too narrow			•									
6 Bandwidth too great, lack of gain		•								•		•
7 Excessive tilt		•										
8 Excessive peaking						•						
9 Video carrier too low		•								•		•
10 Video carrier too high									•			
11 Sound carrier too high											•	
12 High frequencies far down on response			•									
MECHANICAL FAULTS												
Described in text	•			•	•		•	•				

mixer coupling is by adjustable inductor *Ld*, and low-band alignment by means of inductor *Lc*. Hight-band alignment for the oscillator is cared for by adjustable inductor *Ld*, while low-band oscillator alignment is by means of inductor *Le* which is mounted on a switch wafer.

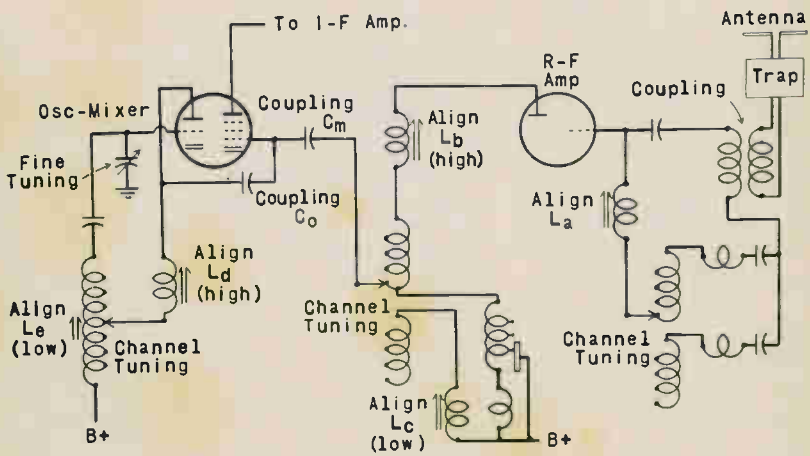
In this incremental tuner there is transformer coupling from antenna to the grid of the r-f amplifier. From r-f amplifier to mixer the coupling is by tuning inductor impedance, which is common to the plate circuit of the r-f amplifier and the grid circuit of the mixer, with blocking and coupling capacitor *Cm* keeping B-voltage from the mixer grid. Oscillator injection to the mixer is through capacitor *Co*.

If we omit from the fairly complete diagram of Fig. 2-4 all B-voltage and biasing connections to plates, screens, grids and cathodes we have the simplified diagram of Fig. 2:5. Considering only the functions of the elements in this latter diagram, and neglecting details of circuit connections, we have Fig. 2-1. Again we find that any tuner consists basically of the elements shown in Fig. 2-1 so far as principles of trouble location are concerned.

Tuner Troubles And Their Symptoms

The accompanying table lists the more common tuner troubles and their probable symptoms as observed on the picture tube or on a tuner frequency response.

With reference to classification *3*, the r-f oscillator some-



Fi.g 2-5. Elements for channel selection and for alignment in the incremental tuner.

times will operate satisfactorily on the low band of the vhf range but not at frequencies required for high-band reception.

With reference to classification *4,* a microphonic oscillator tube will cause horizontal bars or "sound bars" corresponding to the rate of vibration of tube elements, which may be quite different from frequencies in an accompanying sound program.

Classifications *5* through *12* under *Wrong Alignment* in the table require observation of tuner frequency response with an oscilloscope, a sweep generator and a marker generator. Sweep voltage should be fed through a properly terminated cable to the antenna terminals of the receiver or tuner. Vertical input of the scope preferably should be connected, through a plain probe, to the grid return resistor of the mixer. If there is a test point on this resistor, part way from grid to ground, make the connection there. Otherwise use a 10K fixed composition resistor between scope lead and mixer grid.

Should the oscilloscope lack sensitivity to give a good response trace when connected to the mixer grid circuit the connection may be made through a detector probe to the mixer plate, thus obtaining additional gain due to conversion transconductance of the mixer tube.

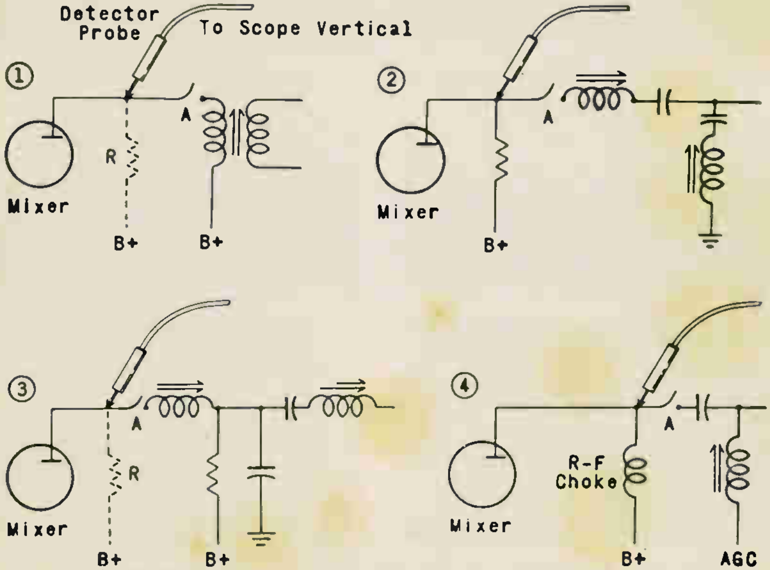


Fig. 2-6. Taking a tuner response curve from the mixer plate.

For scope connection to the mixer output the mixer plate must be disconnected from all following tuned circuits, as in Fig. 2-6, but B-voltage of normal or nearly normal strength must be applied from the regular mixer plate supply line to the plate.

In diagram *1* there is transformer coupling to the i-f amplifier, with mixer plate voltage applied through the transformer primary. The circuit is to be opened at *A* and a fixed

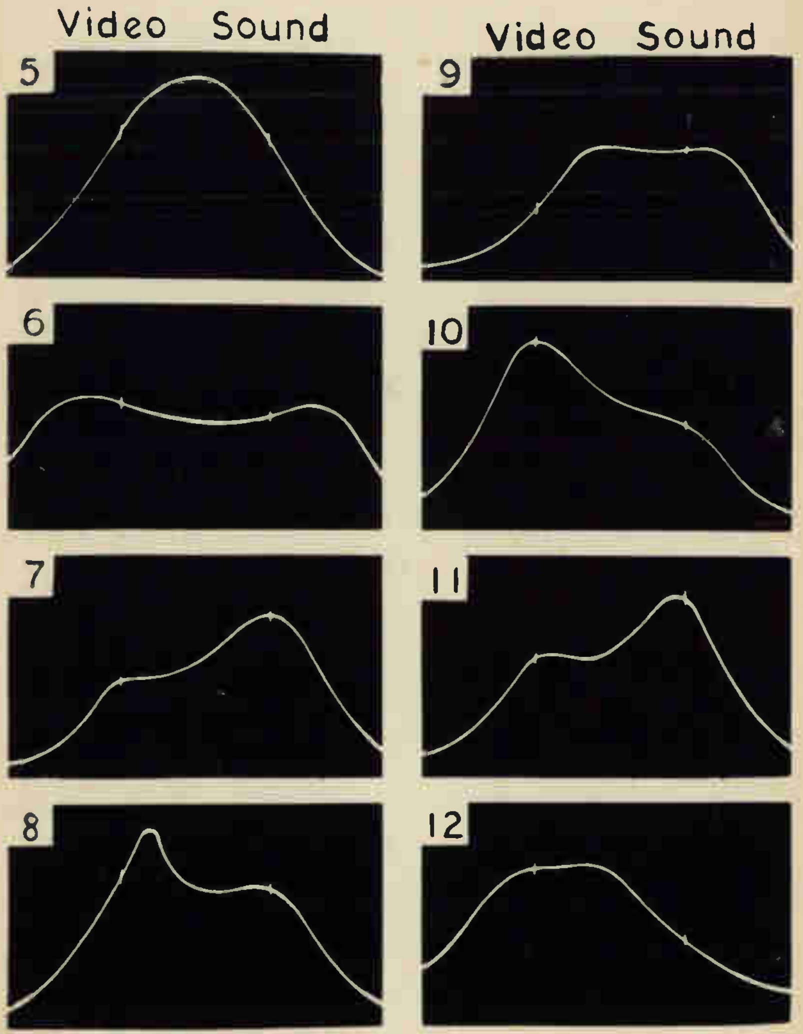


Fig. 2-7. Here are incorrect tuner responses which are likely to cause symptoms listed in the table.

resistor of abount 1,000 ohms or more connected temporarily from plate to B+.

Mixer plate voltage in diagram *2* is applied through a resistor ahead of the first tuned inductor, so it is necessary only to open the circuit at *A* and connnect the detector probe.

Diagram *3* shows a fairly common output coupling with which mixer plate voltage is applied through the first tuned inductor. This inductor is to be disconnected at *A* and a temporary resistor of 1,000 or more ohms connected at *R*, from mixer plate to B+.

In diagram *4* the r-f choke carrying mixer plate voltage remains connected while the circuit to following tuned elements is opened at *A*. Various other couplings may be handled in any way that leaves B-voltage on the mixer plate while cutting off all tuned elements which might upset the response.

Response traces taken from the mixer plate through a detector probe may not be so truly representative of actual performance as those from the mixer grid, but they serve the purposes of trouble location.

Fig. 2-7 illustrates typical response traces for conditions numbered *5* through *12* in the table of tuner troubles and symptoms. Marker pips on the traces indicate video carrier and sound carrier frequencies. All of the faults may be corrected by proper alignment of the various adjustments and couplings.

Mechanical Faults

In case of symptoms listed for mechanical faults in the table look for loose cover plates and tube shields, and for shields not securely grounded to clean metal.

Remove the tuner tubes and examine their base pins. Removal and replacement may clean the socket contacts sufficiently to cure the trouble.

Examine all leads and terminal connections between tuner and other parts of the chassis for looseness or defective joints. Be sure to check all ground connections.

Switch contacts or turret strip contacts which are dirty may cause trouble. Use a liquid contact cleaner made for the purpose, brushing or spraying it onto the contacts and rotating the switch or turret through several turns. Dirty insulation may be cleaned with carbon tetrachloride on a lint free cloth.

Contact surfaces or detent mechanisms which feel rough in action may be lubricated with a little vaseline or with switch contact oil made for such uses. A missing detent ball may be replaced with a bicycle ball bearing obtainable from a bike repair shop. The long bolts or screws holding switch wafers and spacers sometimes need tightening.

Stationary contact members which have become bent or twisted, reducing their pressure on movable members, or such parts which have loose rivets usually cause trouble. Contact pressure sometimes may be improved by working carefully with a pointed tool. It is difficult or impossible to tighten loose rivets without disassembling the switch wafers or terminal strips from the tuner frame.

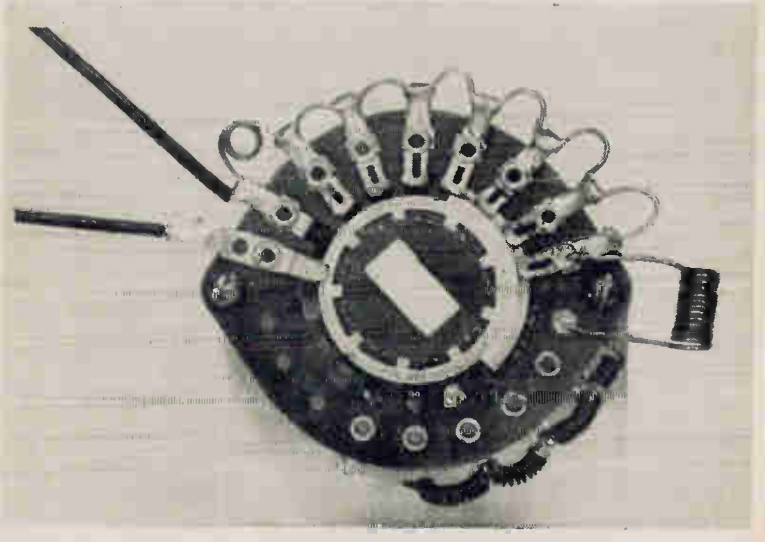


Fig. 2-8. Inductors on a switch wafer for an incremental tuner.

Many tuners have small inductors, as in Fig. 2-8, consisting of coiled enameled wire whose turns may be spread to raise the operating frequency or squeezed together to lower the frequency. When adjustment range is insufficient, a coil may be replaced with one wound from wire of the same or nearly the same gage size, using more turns to reach lower frequencies or fewer turns for higher frequencies. Use no more solder than on the original joints. Remove any remaining film of rosin flux with denatured alcohol on a cloth.

Capacitors and Resistors

Fixed capacitors for coupling, blocking and bypassing in tuners usually are ceramic or mica types rated for working voltages well in excess of any normally applied, so there is little likelihood of puncture. These capacitors may become shorted or open, but it seldoms happens. The fixed resistors are called upon to dissipate much less than their wattage ratings, so run cool unless overloaded due to accidental shorts or grounds in connected circuits.

Most capacitors and resistors may be tested without disconnecting them provided you have a service diagram showing all connections in the tuner. Fig. 2-9 is such a diagram; it will be used for explaining the method. Resistors are marked *R* with subscript letters for identification. Capacitors are marked *C* with subscript identifications. Values of resistance and capacitance vary with the make and model of tuner.

The idea is to locate pairs of terminal points having between them only one capacitor or only one resistor, or not more than two such elements in series with each other. An ohmmeter or a capacitor tester may be connected to these terminal points for readings.

Easily accessible terminal points include the following: The terminals for wiring to chassis. Socket openings for base pins while the tubes are removed. Stationary contacts for a turret drum while the drum is held midway between channels or while the strip or strips for one channel are temporarily removed. A switch or incremental tuner will have selector positions at which certain circuit connections and terminals are opened. The tuner frame, acting as ground, serves for many test connections.

Remember that capacitors, if not shorted or leaky, act as open circuits for resistor checking. Inductors in good condition have negligible resistance and may be considered as a continuous circuit during tests. A capacitor may be checked for opens, shorts or leakage while connected in series with one or more resistors.

Here are a few examples of terminal points for capacitor tests on the tuner of Fig. 2-9.

Ca: Output i-f to mixer pin *2*.

Cb: Mixer pin *2* to oscillator pin *6*. *Rb* is in series.

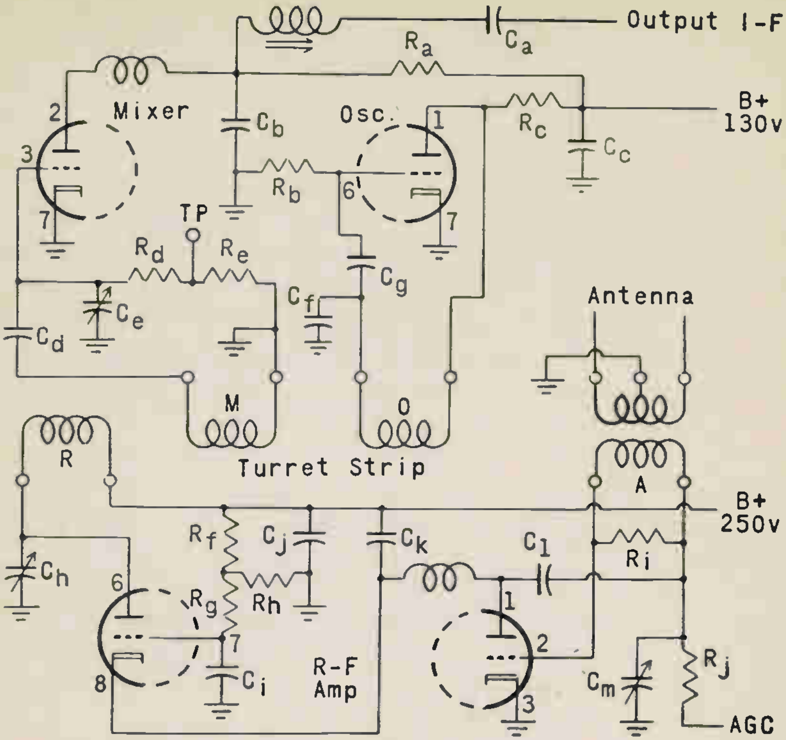


Fig. 2-9. A complete service diagram for a tuner.

Cd: Mixer pin *3* to turret inductor *M*, with strip opened.

Ce: Mixer pin *3* to ground will show up a dead short. However, leakage cannot be detected because *Rd* and *Re* are in parallel with *Ce* to ground, as are also *Cd* and turret inductor *M* unless the strip is opened.

Cf: Turret inductor *O* to ground, with the strip open. Note that *Cg* and *Rb*, in series with each other, are in parallel with *Cf* to ground, so *Cg* should be cleared before checking *Cf*.

Cg: Turret inductor *0* to oscillator pin *6*.

Examples of resistor terminal points on Fig. 2-9 are:

Ra: B+ 130v to mixer pin *2*.

Rb: Oscillator pin *6* to ground, assuming that *Cf* and *Cg* form d-c open circuits so far as resistance tests are concerned.

Rd: Test point *(TP)* to mixer pin *3*.

Rf, Rg, Rh: These three are tested as series pairs. *Rf* and *Rg* are in series from B+ 250v to r-f amplifier pin *7*. *Rf* and *Rh* are in series from B+ 250v to ground. *Rg* and *Rh* are in series from r-f amplifier pin *7* to ground.

Ri: Across turret inductor *A* terminals, with strip opened.

The chief precaution to be observed in all these tests is avoidance of unrecognized parallel paths which may cause erroneous conclusions.

Frequency Drift

Frequency drift of the r-f oscillator in the tuner refers to a change, nearly always to lower frequency, which occurs while the receiver warms up to normal operating temperature or when there is variation of oscillator plate voltage. Drift may be corrected by readjustment of a fine tuning control during or after the warmup period.

Oscillator drift, or adjustment of a fine tuning control, in the tuner will vary the position of video and sound signals on the frequency response of the i-f amplifier, as observed at the video detector output. Fig. 2-10 is a normal i-f response. The sound marker, at the left, is in a dip caused by an accompanying sound trap. The video marker is about half way up the opposite slope.

If adjustment of a fine tuning control moves the video signal higher or to the left on the i-f response, as in Fig. 2-11, the sound signal also will move to the left. This happens when r f oscillator frequency is lowered because of drift, or by adjusting the fine tuning for more capacitance. Higher oscillator frequency, or fine tuning adjusted for less capacitance, would move both the video signal and the sound signal to the right on the i-f response.

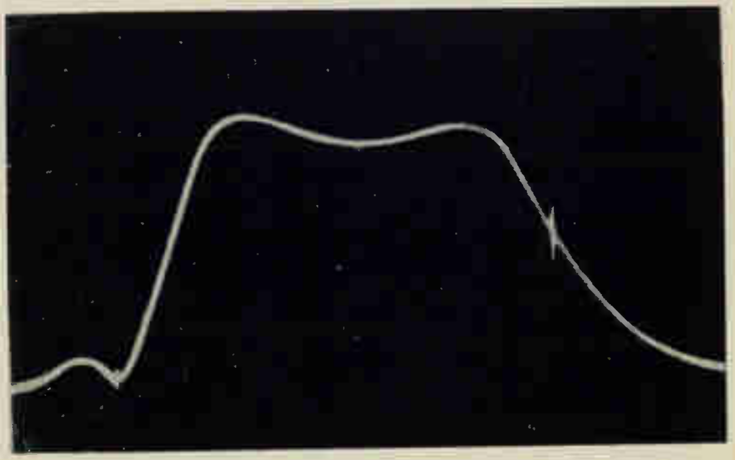


Fig. 2-10. Normal i-f response with sound and video markers.

Since video and sound carriers and the resulting video and sound intermediates always are 4.5 mc apart, oscillator drift or fine tuning adjustment affects both intermediates equally. On a set using intercarrier sound the sound intermediate may move away from a trap dip but it will remain within the pass band of the 4.5-mc sound amplifier.

With dual sound, used in many of the older standard receivers and in a few types at present, frequency drift so small as 0.2 mc throws the sound intermediate outside the pass band of the sound i-f amplifier, and there is little or no reproduction of sound until the fine tuning control is re-adjusted.

Drift to lower frequency is lessened in some tuners by one or more negative temperature coefficient (NTC) capacitors connected in the r-f oscillator circuit and mounted where affected by tuner temperature, usually on tube socket lugs. Capacitors *Cf*, *Cg* or both in Fig. 2-9 might be NTC types. An NTC capacitor may be in parallel with a zero temperature coefficient (NPO) type.

Excessive drift sometimes is corrected, as a service operation, by substituting for an original NTC capacitor another of the same capacitance but greater negative coefficient. That is, a coefficient of 330 might replace 150, or 750 might be substituted for 330. An NTC capacitor may be substituted for an NPO type, commencing with a small coefficient to observe the effect, then using a larger coefficient if needed.

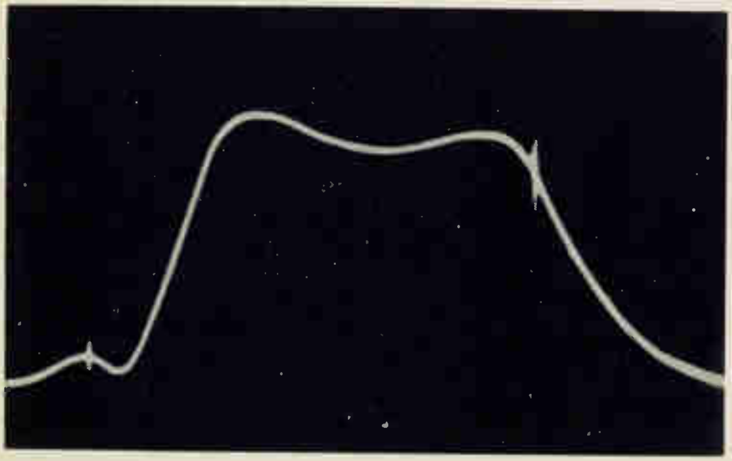


Fig. 2-11. Video too high on the response and sound at frequency below the trap dip.

Increase Of Gain In Tuner

Fig. 2-12 shows a few of the methods for increase of gain in a tuner section. The following three methods are applicable to a tuner having a pentode r-f amplifier.

1. Remove automatic gain control voltage from the r-f amplifier grid return resistor by disconnecting the resistor from the agc line and reconnecting it to ground or B-. Be sure not to remove agc voltage from any i-f amplifier.

2. Substitute an r-f amplifier tube having greater transconductance than the original. This is easy when base pin connections are alike for both tubes, but otherwise requires difficult rewiring at the socket. B-voltages and bias may have to be changed to obtain the greater transconductance.

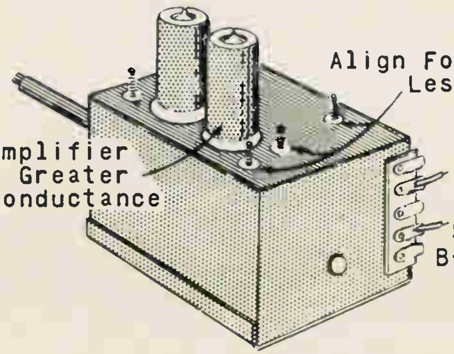


Fig. 2-12. Methods for increasing gain in a tuner.

3. Increase the screen voltage, also plate voltage if both elements are fed from the same line, by not more than 20 to 25 per cent — as from 120 to 150 volts or from 150 to 180 volts. Make the new connection to a higher B-voltage from the chassis rather than reducing internal dropping resistors, which usually are part of a decoupling system. Measure total screen and plate current before and after the change to make sure that tube ratings are not exceeded, especially when agc voltage is removed.

Two additional methods may be used with any type of r-f amplifier, either pentode or triode.

4. Realign for less bandwidth and greater gain. In Fig. 2-2 this would require adjustment of *Ca, Cp* and *Cm*, and in Fig. 2-4 of *La, Lb* and *Lc*. Bring the video carrier as high on the new response as still allows adequate sound. The sound carrier goes down on one side of an r-f response as the video carrier goes up on the opposite side.

5. If broadening resistors are across tuning inductors for r-f grid, r-f plate or mixer grid, substitute greater values of resistance. This will narrow the response, but increase the gain. Resulting peaking of the response may make it necessary to realign the tuner.

SECTION 3

INTERMEDIATE-FREQUENCY (I-F) AMPLIFIER

The i-f amplifier section consists of subdivisions in the block diagram of Fig. 3-1. Uuually there are three amplifier pentodes, although occasionally there are four and sometimes only two. Tuned couplings, adjustable for alignment, are between the tubes and ahead of the video detector.

The second, third and fourth couplings usually are of the same type, commonly two-winding transformers with a single adjustable slug for the two windings. The coupling from mixer to first i-f amplifier may be a series resonant type, a modified bandpass filter, a pair of link coupled inductors, or other type. One adjustable inductor for this coupling may be on the tuner and another on the chassis near the first i-f amplifer.

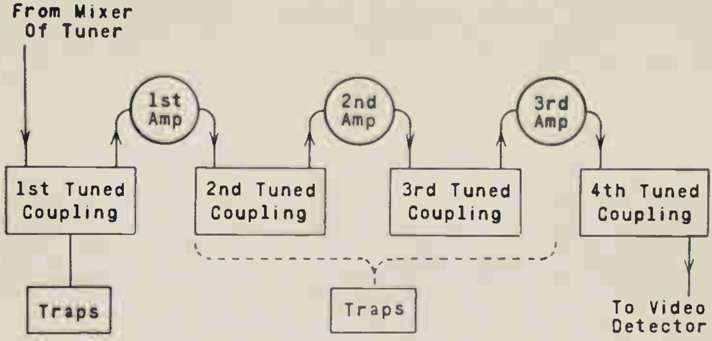


Fig. 3-1. Subdivisions of an i-f amplifier section

The mixer to i-f coupling is more critical in adjustment than others, and may be aligned last during service work. Most of these couplings have marked effect on bandwidth, tilt, and positions of video and sound i-f markers on the frequency response.

Most receivers have from one to three traps in the i-f section. Accompanying and adjacent sound traps are most

Table 3

I-F AMPLIFIER

	Bending At Top	Brightness Excessive	Brightness Lacking	Contrast Excessive	Contrast Lacking	Definition Poor	Hum Bars	Interference Pattern	Multiple Images	Raster, No Picture	Smearing	Sound Bars	Speckling	Sync Critical
TUBES FAULTY														
1 Weak, low Gm					•	•								
2 Cathode-heater short	•						•			•				
3 Microphonic												•		
4 Gassy						•					•			
TUBE VOLTAGES														
5 B-voltages low			•		•									•
ALIGNMENT														
6 Bandwidth narrow						•								
7 Bandwidth too great					•									
8 Video I-F too low	•		•		•								•	•
9 Video I-F too high		•		•					•		•			
10 Sound I-F too high												•		
TRAP ADJUSTMENT WRONG														
11 Accompanying sound												•		
12 Adjacent sound												•		
13 Adjacent video								•						
MISCELLANEOUS														
14 Signal circuit open										•				
15 Transformer shorted or leaky coupling capacitor						•			•					
16 Tube overloaded				•		•			•					•
17 Regeneration		•						•		•				

common, although there are quite a few for adjacent video. All traps may be on the coupling between mixer and first i-f amplifier, or some traps may be on other couplers or on amplifier grid, plate or cathode leads.

The accompanying table lists faults which are fairly common in the i-f amplifier section and shows the most probable picture symptoms for each kind of fault. Notes relating to some of the numbered troubles are in following paragraphs having corresponding numbers.

1. Snow in pictures may result from lack of gain in the first i-f amplifier, but is more likely to result from weak received signals or from tuner trouble. Snow indicates that noise impulses at the picture tube are strong in relation to desired signals. Unless noise enters at the antenna or in the early amplifying stages, desired signals acquire enough early amplification to overcome any noise added in following stages.

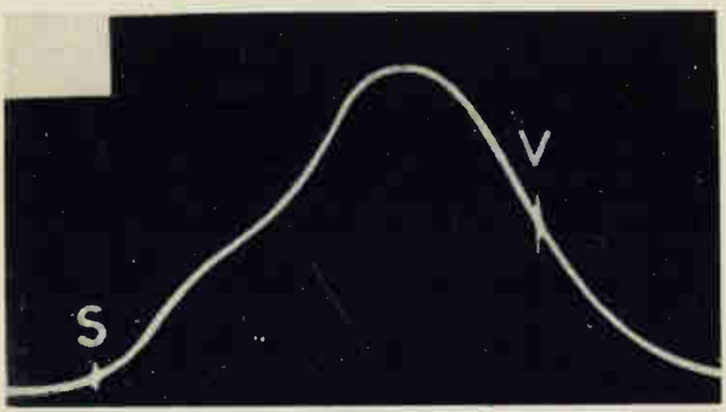


Fig. 3-2 Bandwidth too narrow. The video marker is properly placed on the response.

2. A cathode-heater leak must be of low resistance to cause serious trouble. This is because cathodes of most i-f amplifiers are connected to ground or B- through bias resistors of less than 200 ohms, or sometimes directly.

Alignment (6 to 10 in table)

A satisfactory frequency response is shown by Fig. 2-10. Faulty alignments are illustrated by frequency responses of Figs. 3-2 to 3-5.

The responses are taken with sweep and marker generators connected to the grid or to the grid return of the mixer tube in the tuner, or to an ungrounded metallic coupling sleeve slipped over the glass envelope of the mixer.

The oscilloscope is connected to the video detector load, assuming that the detector is operating properly. If there is any doubt, the video detector section should be checked before working on the i-f amplifier section. It is not practicable to take response traces through a detector probe applied to the output of the last i-f amplifier. Such traces would not show true responses unless all characteristics of the probe were precisely like those of the detector in the receiver.

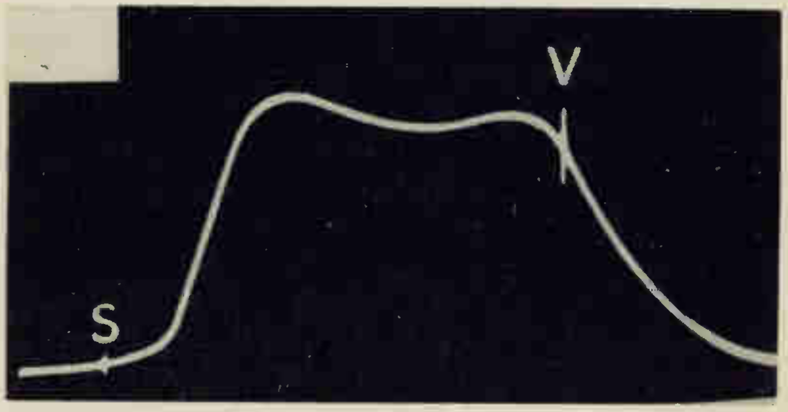


Fig. 3-3. Excessive bandwidth and low gain.

6. Narrow bandwidth (Fig. 3-2) causes poor reproduction of fine details because the higher video frequencies carrying such details are toward the sound side of the i-f response. This side will have little gain because a set operator naturally adjusts the fine tuning for a video intermediate high enough on the gain curve to produce satisfactory picture strength or contrast.

7. Excessive bandwidth (Fig. 3-3) will be accompanied by low gain, because any alignment adjustments which increase bandwidth will reduce overall gain, and vice versa.

8. Video i-f too low on the gain curve (Fig. 3-4) reduces strength of sync pulses, which are of low fundamental frequencies. It reduces picture strength or contrast, and when

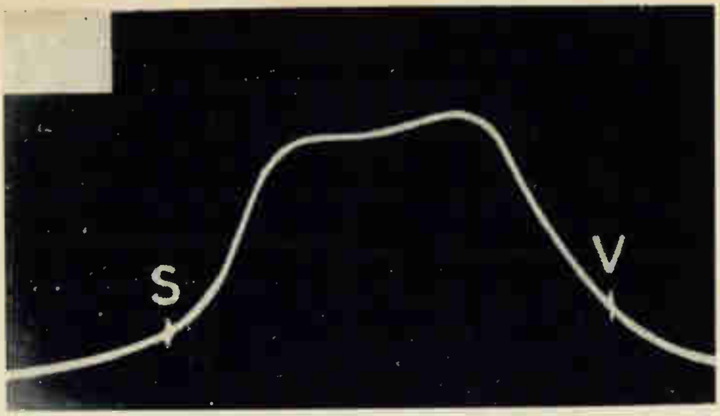


Fig. 3-4. Video marker too low and sound too high.

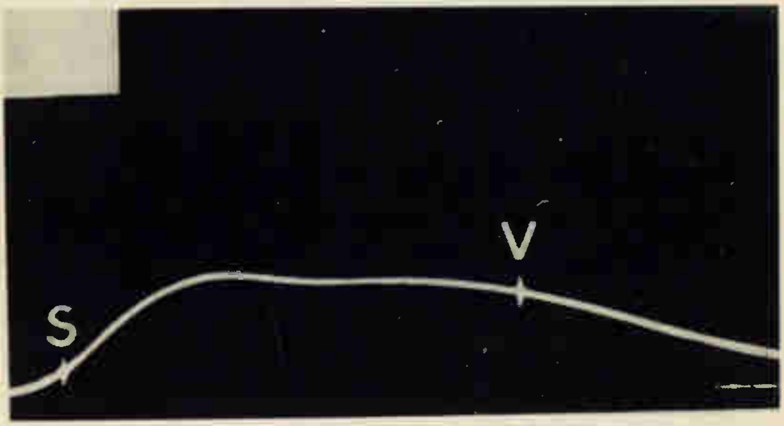


Fig. 3-5. Video marker too high on the response, and sound possibly too low.

bandwidth is normal the low video signal will be accompanied by a high sound signal which is likely to cause sound bars. This would be the condition numbered *10* in the table.

9. Video i-f too high on the gain curve (Fig. 3-5) causes excessive input to the video detector at the lower video frequencies. Then high video frequencies, which carry fine details for pictures, may be weaked unless bandwidth is unusually great. Sound may be weakened due to the sound intermediate going too low on the gain curve when the video intermediate is high.

If, at some certain position of the fine tuning control, adjustment one way causes pictures to have a grainy appearance, while opposite adjustment causes multiple images or slight smearing, it is probable that the video i-f is too high on the response.

Frequency Response With Generator And VTVM

Frequency response or relative gains at various intermediate frequencies may be observed with an r-f signal generator and a vacuum tube voltmeter, using the setup of Fig. 3-6.

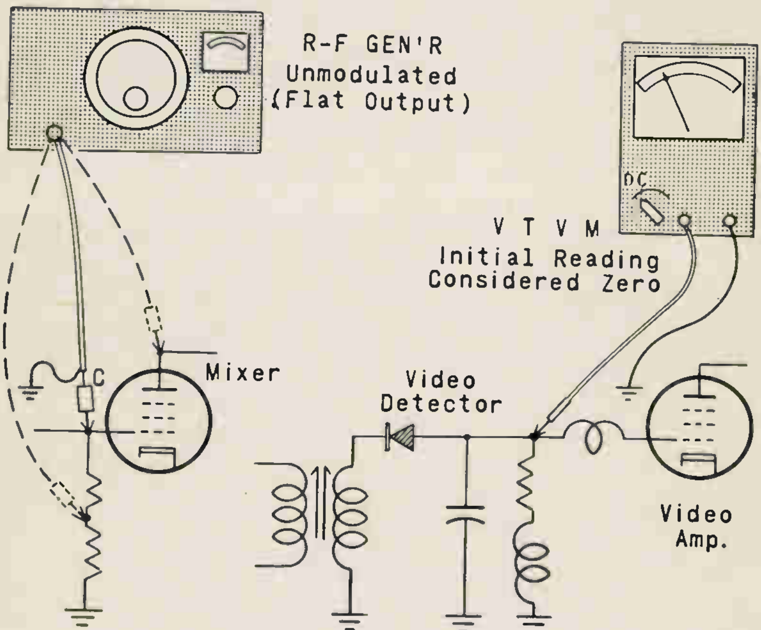


Fig. 3-6. Test setup for observing frequency response of an i-f amplifier by means of a vacumm tube voltmeter.

The generator should have calibrated output or should be flat throughout the i-f range, to allow application of constant signal voltage at all frequencies. Use the generator without modulation. Connect it through about 10 mmf (*C*) to the mixer grid or plate.

Set the VTVM function switch for d-c volts on a low range. Connect the meter through a plain probe to the video detector load. There will be either a positive or negative voltage reading with the receiver turned on and the generator at zero output. Consider this initial voltage as zero so far as response measurements are concerned.

Override the automatic gain control, disconnect the antenna from the receiver, and place the channel selector at any inactive channel.

With everything turned on and well warmed up, vary the generator frequency from well below the sound intermediate to well above the video intermediate frequency. Do this several times while adjusting generator output for maximum net reading of not more than two volts on the VTVM.

Note frequencies for zero net voltage, for video and sound intermediates, and for trap settings. Note relative voltages at any peaks. Readings may be plotted on graph paper.

Trap Adjustments (*11* to *13* in table)

If the portion of the response at which there is high gain is narrow and does not extend close to the sound intermediate there is little likelihood of trouble when traps are slightly misadjusted. But if the response is good enough to cover nearly 4 mc there may be considerable gain at accompanying sound and even at adjacent video frequencies. Furthermore, if the response tapers far out on the video i-f side there may be much gain at adjacent sound frequencies. Then traps must be carefully adjusted.

Signal Continuity (*14* in table)

To check for signal continuity through the i-f amplifier section proceed as follows, referring to Fig. 3-7.

The r-f signal generator should tune to frequencies in the i-f range of the receiver. Use the generator with audio modula-

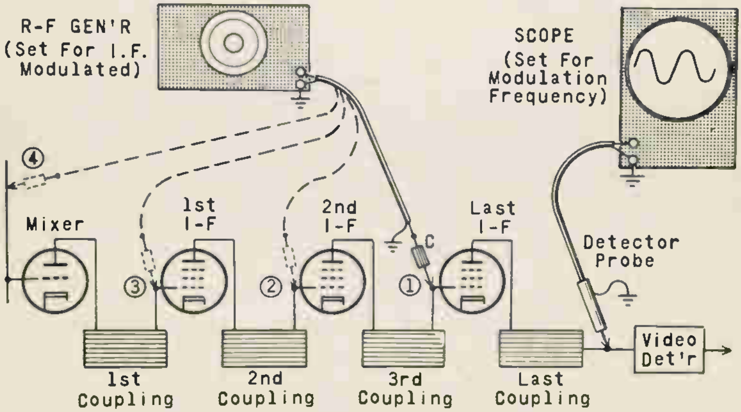


Fig. 3-7. Testing continuity of signal circuits through an i-f amplifier with modulated r-f generator

tion. Make connection through about 10 mmf, *C*, first to the grid of the last i-f amplifier, second to the grid of the preceding amplifier, and so on back to the mixer grid.

Connect the scope through a detector probe to the *input* of the video detector, or, if the detector is known to be operating properly, make connection through a plain probe to the top of the detector load. Adjust internal horizontal sweep of the scope to pick up the modulation frequency of the generator.

Disconnect the antenna line from the receiver and place the channel selector on an inactive channel.

With a connection at test point *1* of Fig. 3-7 the scope should be adjusted for high vertical gain and the generator for enough output to produce a clear modulation trace. Such a trace indicates that the last i-f amplifier and coupler are operative. If the trace is present, and higher, with the generator to point *2* the second i-f amplifier and third coupling are working. Point *3* checks the first amplifier and second coupling, while point *4* checks the mixer and first coupling.

The amount by which scope trace height increases from one test point to the next is a measure of additional gain in the stage last included. Should the trace flatten out or become very weak at any test point check, trouble is indicated between that point and the preceding one yielding a satisfactory trace.

16. Amplifier tube overload may result from low voltages on plate and screen, from bias or agc voltage insufficiently negative, from excessively strong signals from the tuner, or from any combination of these factors.

17. Regeneration usually results from in-phase feedback from the plate circuit of one amplifier to the grid circuit of the preceding amplifier. This may be due to defective shielding or omission of shields on tubes or couplings, or to improper dressing in plate and grid circuits. Regeneration may result also from aligning the couplings on grid and plate sides of the same amplifier to frequencies which are too near alike.

Increase Of Gain In I-f Amplifier

Methods of increasing the gain in i-f amplifiers are quite like those used for tuners.

1. Substitute for one or more tubes others having greater transconductance. As a rule it is fairly easy to rewire i-f amplifier sockets if necessary because of different element connections. Amplifiers with higher gain usually take more plate and screen current, which may require different voltage dropping resistors or connection to leads supplying greater B-voltage. Original bias resistors often will maintain the grids too negative, and must be changed. Consult manufacturers' tube data books for suitable operating voltages and currents on any tubes used as replacements.

2. Increase screen or screen and plate voltages by shifting connections to a lead providing greater B+, rather than by lessening the values of voltage dropping and decoupling resistors. Measure total cathode current to make sure that tube ratings for combined plate and screen voltages are not exceeded. Cathode bias resistors may have to be changed to realize full possible improvement from higher plate and screen voltages. Consult tube manufacturers' data books.

3. Realign for greater gain and less bandwidth, even to the extent of a response with a rounded peak instead of a flat top. Position the video i-f at 60 to 80 per cent of maximum gain rather than at the usual 50 per cent. All this will make for stronger pictures on weak signals, but for poorer definition or detail. There should be no difficulty in obtaining sufficient sound, which ordinarily comes through well even when pictures are weak.

SECTION 4

VIDEO DETECTOR

Typical video detector sections employing crystal diodes are shown by Fig. 4-1. The arrowhead of a crystal diode symbol stands for the anode (equivalent to the plate of a tube)

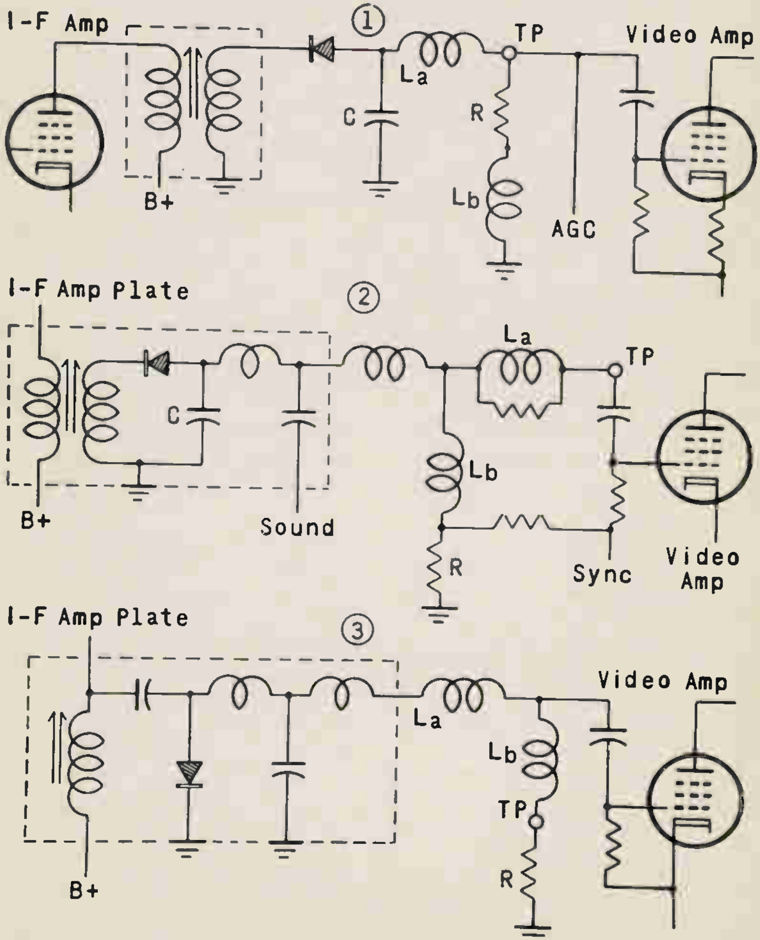


Fig. 4-1. Crystal diode video detector circuits.

and the straight bar stands for the cathode. Electron flow through the crystal is from cathode to anode, against the point of the arrowhead.

Shield enclosures are indicated by broken lines. In many cases the shield can for the transformer or coupler will contain also the crystal and one or more capacitors and inductors.

Fig. 4-2 shows half of a twin diode tube used as a video detector. The other half is an agc rectifier with positive delay bias on its cathode. In Fig. 4-3 the pentode of a pentode-diode tube is the last i-f amplifier and the diode is the video detector. A pentode-triode may have its triode plate and grid tied together to form a diode detector, or the triode grid and cathode may act as a diode detector while plate and cathode act as an agc rectifier.

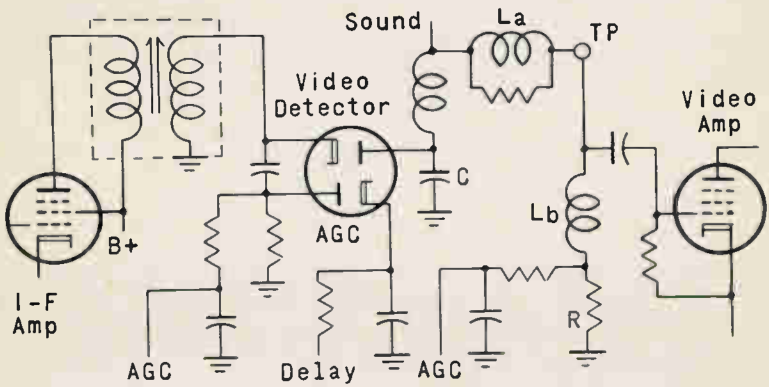


Fig. 4-2. The video detector is half of a twin-diode tube.

Symbols on all the circuit diagrams are marked as follows:

C. Bypass capacitor from detector output to ground or B-. For removing intermediate-frequency voltages which get through the detector and might load the video amplifier.

La. Peaker connected from detector output to grid of the video amplifier, for "splitting the shunting capacitances".

Lb. Peaker in series with the detector load resistor, to maintain satisfactory load impedance at high video frequences.

R. Detector load resistor.

TP. Test point for video dectector output, shown as positioned on various receivers. Output of any video detector may be measured or observed from the high side of the load resistor, whether or not any other test point is provided.

Video detector circuits or sections may be somewhat complicated by takeoffs for agc, sound and sync. A few of these connections are on the diagrams.

Faults in the video detector section and picture symptoms which usually accompany them are listed in the table. Numbered paragraphs which follow refer to faults as numbered in the table.

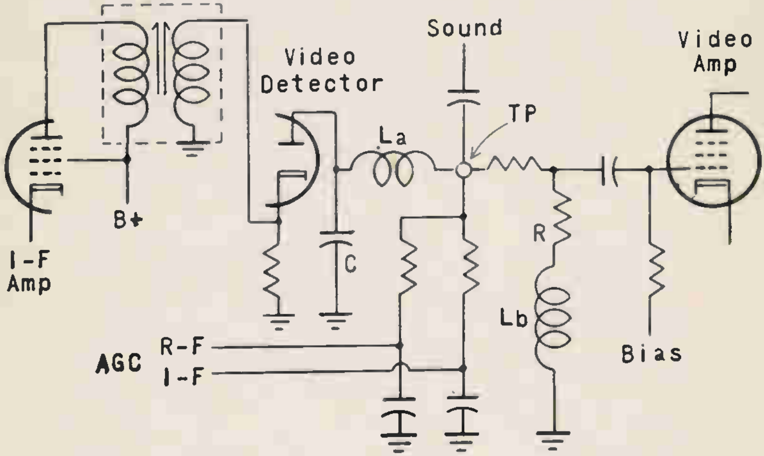


Fig. 4-3. The video detector is one section of a pentode-diode tube.

1. The remedy for a weak crystal is replacement with a type made especially for detector service, not with a general purpose type. Be sure to observe polarity of connections when making a replacement. If the crystal is not held by clips, leave its pigtails as long as will allow firm, vibration-free support. When soldering, hold the pigtails with pliers between the joint and the body of the crystal, to absorb heat. Do not mount an exposed crystal where it is close to hot resistors or tubes.

A crystal may be tested, but not very dependably, with the ohmmeter function of a VTVM or a VOM, measuring the back and forward resistance to determine their ratio. Readings are likely to vary on different ranges of the same meter. It is advisable to select a range having center-scale reading of about 100K ohms, and to stay with it for all measurements.

To measure back resistance, which is the higher resistance, connect the ohmmeter leads so positive potential from the meter goes to the crystal cathode. Reverse the leads to measure forward (lower) resistance. Satisfactory crystals usually

Table 4 VIDEO DETECTOR	Contrast Lacking	Definition Poor	Grainy Pictures	Hum Bars	Interference Pattern	Multiple Images	Raster, No Pictures	Smearing	Sync Critical
CRYSTAL OR TUBE									
1 Weak	•						•	•	•
2 Cathode-heater leak				•					
OUTPUT BYPASS									
3 Open. Too little C	•								
4 Too much C		•							
LOAD RESISTOR									
5 Open or disconnected							•		
6 Too little resistance	•								•
7 Too much resistance		•						•	
PEAKER, TO AMPLIFIER									
8 Open or disconnected							•		
9 Too little inductance		•							
10 Too much inductance						•			
11 Short circuited		•							
PEAKER, TO LOAD R									
12 Open or disconnected	•		•		•				
13 Too little inductance		•				•			
14 Too much inductance		•							
15 Short circuited		•							

measure more than 300K ohms back resistance, and should have forward resistance of no more than 1/500 the back value.

2. Cathode-heater leakage resistance as great as 100K ohms or more probably will cause serious trouble, because the video amplifier will amplify the hum frequency.

3. Check the bypass by paralleling it with a fixed capacitor or about 10 mmf. Improved picture strength or contrast indicates that the original capacitance is too small or is open.

5. If pictures appear when a fixed resistor of 5Kto 10K ohms is temporarily connected across the load resistor, the original resistor is open or disconnected.

7. Try paralleling the original resistor with another of about 10K ohms. Improved pictures indicate excessive resistance in the original unit.

8. Check for an open peaker by temporarily jumping it with a short wire fitted with alligator clips. If pictures then appear, or are improved, the peaker is open or disconnected.

9. In order to cause noticeably poor definition the peaker inductance would have to be very small, approaching zero.

10. Try jumping the peaker with a wire. If this prevents the multiple images, while possibly causing poor definition, the peaker probably has too much inductance.

12. Same as for number **8** above.

14. It is improbable that peaker inductance greater than required with cause trouble; it is more likely to add snap to pictures.

Note: If the receiver has operated satisfactorily until the present complaint it is unlikely that peakers, load resistors, or detector bypasses are causing the trouble. Check the detector crystal or tube, then investigate possibilities in other sections before coming back to further checks of the detector section.

SECTION 5

AUTOMATIC GAIN CONTROL (AGC)

Many basic principles employed in automatic gain controls are represented on the simplified diagram of Fig. 5-1. The source of negative voltage for grids of controlled tubes in receivers of recent design may be the video detector output or load circuit, a separate diode rectifier, or a keyed or gated agc system. The source may feed to a single agc bus, or, as shown, to one bus for the r-f amplifier in the tuner and to another bus for any i-f amplifiers which are automatically controlled.

During reception of weak signals it is desirable that the r-f amplifier in the tuner operate with small negative bias or agc voltage to allow maximum gain. On stronger signals the r-f bias should become more negative, to prevent overloading, but

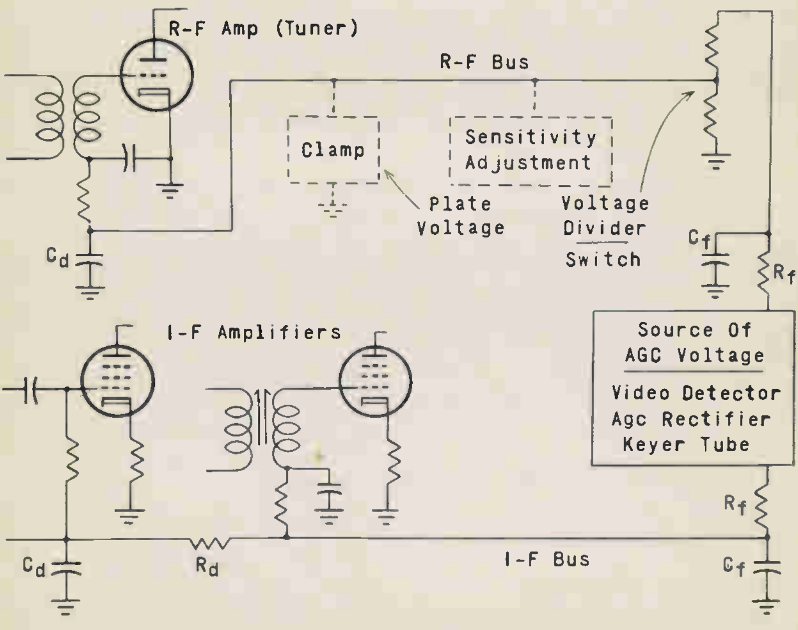


Fig. 5-1. Principal subdivisions of an agc system furnishing two control voltages.

always may be less negative than that applied to i-f amplifiers. Hence the separate buses for r-f and i-f amplifiers. R-f control voltage may be reduced below that for i-f amplifiers by divider resistors as on the diagram, or by opposing the source voltage with a small positive B-voltage, or in various other ways.

There may be a sensitivity adjustment for making r-f bias more negative when a receiver is used in a strong signal area and less negative for fringe localities. Sensitivity may be varied by an adjustable voltage divider, or a switch may alter connections to the r-f bus. Another method applies adjustable positive voltage to the plate of a clamp diode. Sensitivity adjustments may be called by such names as normal, local, fringe, distant or delay.

Filters for smoothing the control voltage from any agc source consist of series resistors marked *Rf* in Fig. 5-1 and of capacitors, *Cf*, to ground or B-minus. Series decoupling resistors, as at *Rd*, are in the agc bus between amplifier stages. Decoupling is completed by capacitors *Cd* to ground or B-minus.

Before taking up faults in the agc section and symptoms which may result it will be well to briefly review operating principles of clamp tubes and of the more generally used sources of agc voltage. Diagrams which follow will help identify various circuits and components referred to in the trouble tables.

Clamp Action

A clamping diode tube usually is connected to the r-f agc bus essentially as in Fig. 5-2. Most often the diode is one of those in a first audio amplifier, but may be part of any other tube.

To the diode plate are connected: *1.* Negative control voltage of the agc source through resistor *Ra*, of about one or two megohms. *2.* Through 5 to 15 megohms at *Rb* to a B+ line carrying something like 125 to 275 volts. *3.* The r-f bus leading to the grid return of the r-f amplifier.

A small positive voltage gets through *Rb* and opposes negative voltage from the agc sources, thus making voltage at the diode plate and r-f bus less negative than control voltage going from the same source to the i-f bus.

On weak signals the entire control voltage from the agc source becomes less negative, and on very weak signals might become so little negative that opposing B+ voltage would tend to make the diode plate, the r-f bus and the r-f grid go positive. The r-f grid is prevented from actually going positive as follows:

Even a slight positive voltage on the diode plate makes the diode conduct. Conduction current must flow in resistance of many megohms at *Rb*. Even though current is only 10 to 20 microamperes, voltage drop in *Rb* becomes practically equal to voltage from the B+ line, and very little positive voltage remains at the diode plate.

Internal resistance of the diode is only 200 to 300 ohms, in which the few microamperes of conduction current cause only negligible voltage drop. Consequently, in spite of positive B-voltage, the diode plate would remain at very nearly the same potential as its cathode and ground. The diode plate and r-f bus could go positive by only a tiny fraction of a volt. Now we shall get rid of this fraction.

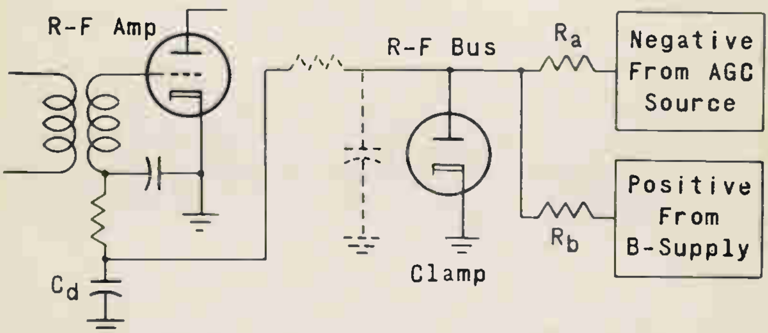


Fig. 5-2. Voltage sources and connections for an agc clamp.

In the diode, as in all tubes, the space charge causes any element near the cathode to acquire a contact potential which is negative with reference to the cathode. Effective negative contact potential at the clamp diode plate is on the order of 0.5 volt. This more than overcomes the slight positive voltage remaining from the B+ connection.

Accordingly, no matter how weakly negative may become control voltage from the agc source, voltage on the r-f bus never can go positive. Always it will remain at least a small fraction of a volt negative, due to contact potential.

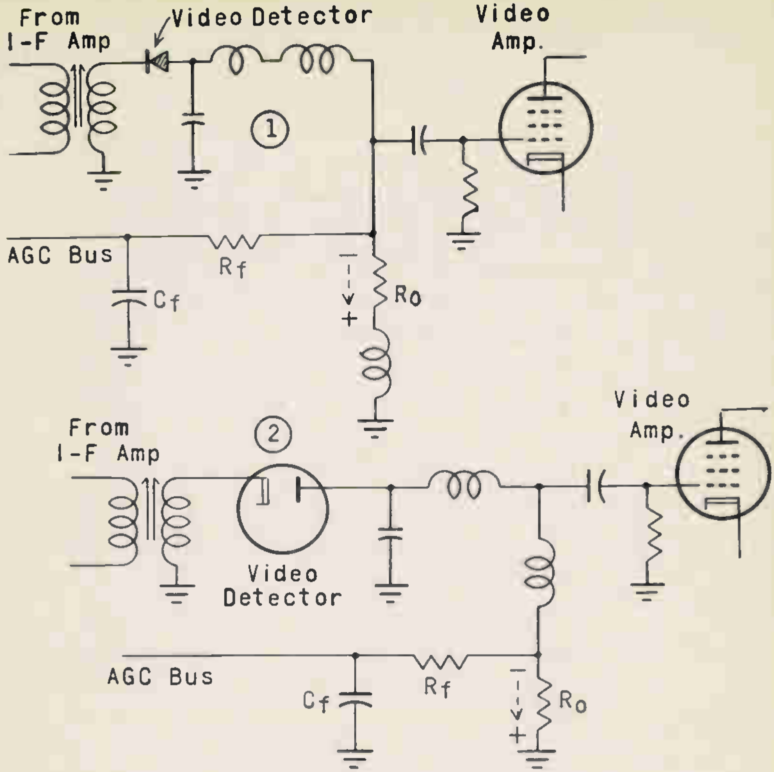


Fig. 5-3. Agc. voltage from video detector load resistors

Agc From Video Detector

Fig. 5-3 illustrates the principle of obtaining negative voltage for automatic gain control from the output of a video detector, always on the high side of the detector load resistor. In diagram *1* the detector is a crystal diode and in diagram *2* it is a diode tube. The type of detector and the exact point in its output circuit from which agc voltage is taken make no difference in operating principles.

D-c electron flow always is away from the anode or plate of the detector. This flow goes through detector load resistor *Ro* in the direction of arrows. Accordingly there is negative potential to ground at the high side of the load resistor, to which is connected the agc bus.

If the video detector section is operating well enough to furnish video or picture signals to the video amplifier, any trouble with agc action will be in the parts shown by Fig. 5-1, not in the detector section.

Agc Rectifiers

Fig. 5-4 shows separate rectifiers for furnishing negative agc voltage. In diagram *1* the rectifier is half of a twin diode tube whose other half is the video detector. The rectifier plate is connected through small capacitance at *Cc* to the output of the last video amplifier. The rectifier conducts positive alternations of i-f signal current to ground, but negative alternations cause d-c electron flow in the direction of the arrow through large resistance of load resistor *Ro,* making the high side of this resistor negative to ground. The negative potential charges capacitor *Cf* through resistor *Rf.*

The rectifier cathode may be connected directly to ground, as shown. Otherwise the cathode may be connected to a small positive B-voltage for delayed agc action. In some cases the rectifier cathode is biased slightly negative.

In diagram *2* of Fig. 5-4 the agc rectifier is a crystal diode so connected that it conducts on negative alternations of i-f signals. Conduction electron flow is through the resistors in the direction of arrows. This makes the top of *Ra,* the high sides of capacitors *Co* and *Cf,* and the agc bus negative to ground.

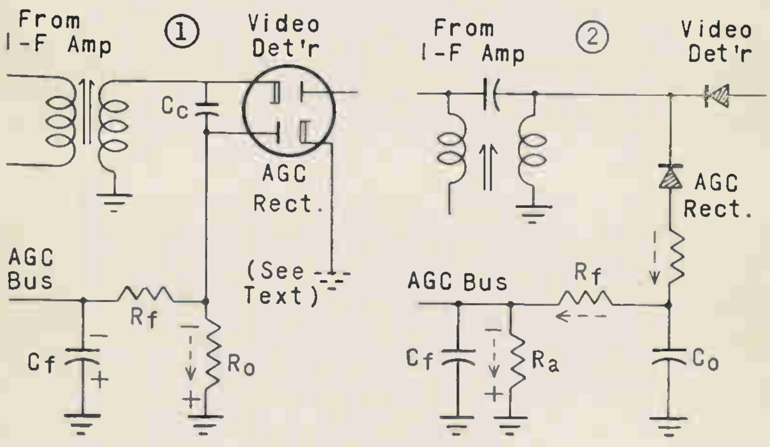


Fig. 5-4. Circuit connections for agc rectifiers.

Keyed Agc

Principles of keyed or gated automatic control are illustrated by Fig. 5-5. The keyer tube usually is a pentode, but in some designs is a triode. The keyer cathode is maintained positive, commonly between 100 and 300 volts. The grid is

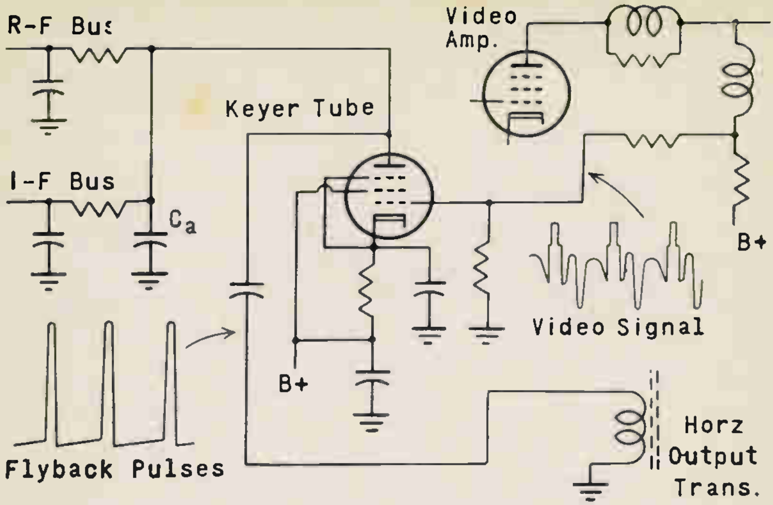


Fig. 5-5. A typical circuit with voltage feeds for a keyed agc system.

connected to a lower positive voltage so that the grid effectively is negative to the cathode by something between 5 and 70 volts. This negative bias holds the keyer tube at cutoff except while positive horizontal sync pulses from a video signal act on the grid to overcome most or all of the bias.

Sync pulses most often are taken to the keyer grid, as a composite video signal, from some point in the output or load circuit of a video amplifier. Sync pulses may be obtained from other sources, such as from a sync amplifier-clipper in which picture portions of the video signal have been reduced.

The keyer plate is connected to no B-voltage. This, considered alone, would leave the plate so negative with reference to the cathode as to prevent conduction even with strong positive sync pulses on the grid. However, the plate is supplied with strong positive pulses at the horizontal line frequency, pulses having peak value of 200 to 900 volts in various receivers.

In the digram of Fig. 5-5 the plate pulses are obtained from a separate insulated winding on the horizontal output transformer. In other designs these pulses may come from a width control inductor, or from a tap on the output transformer winding, and sometimes from the damper circuit.

When positive flyback pulses on the keyer plate coincide in time with positive sync pulses of the video signal on the grid, as they always should, the keyer tube conducts proportionately to strength of horizontal sync pulses. These pulses are proportional to strength of received signals.

Pulses of keyer conduction current, flowing away from its plate, impart a negative charge to the side of capacitor *Ca* that is toward the keyer plate and the agc buses. This negative potential on capacitor *Ca* is the reservoir agc voltage. Capacitor charge and negative voltage increase with stronger received signals, decrease with weaker signals.

In Fig. 5-5 the agc buses are connected to the keyer plate. In many receivers the keyer plate is connected directly, not through a capacitor, to one end of an insulated winding on the horizontal output transformer. Then the agc buses are connected to the other end of that winding, shown grounded in the diagram.

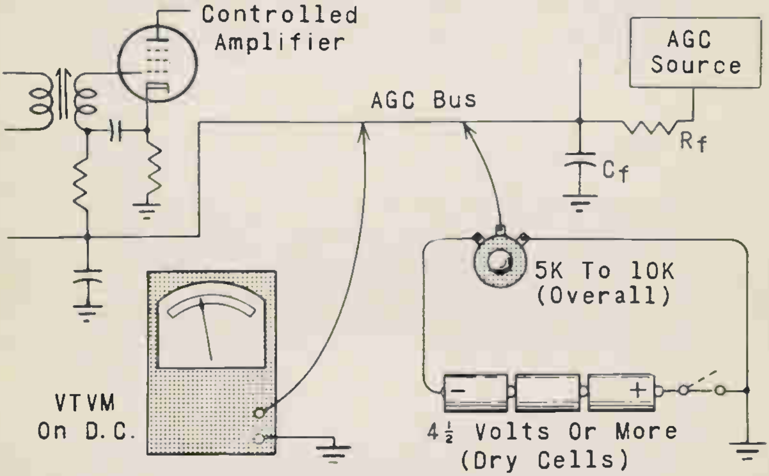


Fig. 5-6. Measuring agc voltage and determining whether voltage is too high or too low.

Agc Voltage Tests

When any trouble symptoms listed at the top of Table 5-A indicate the possibility of wrong agc voltage, shown as faults *1* to *4*, this voltage should be measured as follows:

Connect the negative lead of a vacuum tube voltmeter, set for a low d-c range, to the agc bus anywhere on the side of the filter capacitor away from the agc source. Connect the common or low side of the meter to chassis ground or B-minus. Use only a VTVM. Even though an ordinary voltmeter has sensitivity of 20,000 ohms per volt or better, on a low range it places too much drain on the agc bus to allow correct indications.

Agc voltage should become more negative while pictures are from active channels than on channels not used locally, and should be more negative on strong received signals than on weaker ones. Make note of approximate or average agc voltage on each active channel.

Leaving the VTVM on the agc bus, connect an adjustable battery bias to the bus as in Fig. 5-6. Use dry cells in series, or a single battery, to provide a total of 4½ to 9 volts. Across the battery connect a potentiometer having total resistance of 5K to 10K ohms. Connect the positive side of the battery to chassis ground or B-minus. Use a switch at one end of the battery to prevent discharge while the apparatus is not in use. Connect the potentiometer slider to the agc bus on the side of the filter resistor away from the agc source.

Tune to channels for which agc voltages previously were noted. Vary the battery potentiometer for best picture reproduction on each channel, and note these negative voltages. Unless original agc voltages are fairly close to battery biases for good reproduction the agc voltages may be too great or too little, as will be apparent upon comparison.

If agc voltages are decidedly wrong refer to Table 5-B for probable causes. If agc voltages are close to satisfactory battery biases, but agc trouble still is indicated by Table 5-A, refer to faults number *5* to *14* in this latter table.

Agc Faults

Following numbered paragraphs refer to similiarly numbered faults as listed in Tables 5-A and 5-B.

3. I-f amplifiers usually have cathode bias resistors which furnish some negative bias from grid to cathode even though agc bus voltage is very low or zero. If a cathode is connected to ground or B-minus, as with many r-f amplifiers, grid bias will follow agc voltage and may become so small as to allow severe overloading with normal and weak signals.

6. Where agc voltage is taken from a video detector a shorted filter resistor shorts the detector output and video amplifier input to ground or B-minus through the filter capacitor.

7-8. Excessive filter capacitance lengthens the agc time constant. This may prevent agc voltage from following rapid changes of signal strength or may allow strong noise pulses

Table 5-A AUTOMATIC GAIN CONTROL	Contrast Excessive	Contrast Lacking	Contrast Varies	Dark, Momentarily	Definition Poor	Flicker Or Flutter	Hum Bars	Raster, No Picture	Smearing	Snow In Pictures	Sync Critical
AGC VOLTAGE ON BUS											
1 Too negative		•						•		•	•
2 Not negative enough		•			•				•		•
3 Zero, to ground			•								•
4 Positive	•				•						•
FILTER RESISTOR											
5 Too great, open				•		•					
6 Too small, shorted		•	•					•			
FILTER CAPACITOR											
7 Too small, open			•					•			
8 Too great				•		•					
9 Shorted	•		•								•
DECOUPLING SYSTEM											
10 Resistor shorted					•				•		
11 Capacitor too small, open					•				•		
12 Capacitor leaky					•				•		
CLAMP TUBE CIRCUIT											
13 Resistor to B+ too small			•								
AGC RECTIFIER TUBE											
14 Cathode-heater leak							•				

Table 5-B **AUTOMATIC GAIN CONTROL**	Too Negative	Not Negative Enough	Zero, To Ground	Positive
FILTER SYSTEM				
15 Resistor too great, open		•		
16 Capacitor leaky		•		
17 Capacitor shorted		•	•	
DECOUPLING SYSTEM				
18 Resistor open		•		
19 Capacitor leaky		•		
20 Capacitor shorted			•	
SENSITIVITY CONTROL				
21 Misadjusted, defective	•	•		
CLAMP TUBE AND CIRCUITS				
22 Weak, low emission		•		•
23 Plate too positive		•		
24 Plate not positive enough	•			
25 Cathode open				•
26 Resistor to B+ open, too great	•			
27 Resistor to B+ too small		•		
28 Resistor to source open, too great		•		
29 Resistor to source too small	•			
AGC RECTIFIER AND CIRCUITS				
30 Weak, low emission		•		
31 Cathode-heater leak	•			
32 I-F signal weak or zero		•		

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Table 5-B **AUTOMATIC GAIN CONTROL (Cont)**	Too Negative	Not Negative Enough	Zero, To Ground	Positive
33 Cathode open		•		
34 Cathode too positive		•		
35 Cathode not positive enough	•			
36 Load resistor open, too great	•			
37 Load resistor too small		•		
KEYER TUBE AND CIRCUITS				
38 Tube weak		•		
39 Cathode-heater leak	•			
40 Plate pulses weak or zero		•	•	
41 Capacitor to Pulse source leaky, shorted				•
42 Video signal to grid weak, zero		•	•	
43 Cathode too positive		•	•	
44 Cathode not positive enough	•			
45 Screen voltage too low		•	•	
46 Screen voltage too high	•			

to momentarily cut off the amplifiers. Too little capacitance shortens the time constant and may allow agc voltage and amplification to follow airplane reflections and similar effects.

10-11. A shorted decoupling resistor or open decoupling capacitor may allow spurious interstage coupling to effect picture quality.

13. Too little resistance from a clamper to B+ may lessen changes of agc voltage when there are decided changes of received signal strength. Agc does not follow signals very well.

15. To check condition of a filter resistor use the VTVM to measure negative voltages on opposite sides of the resistor.

The two voltages should be practically equal, although the d-c meter may read slightly lower on the source side because of pulsating rather than smooth d-c voltage on that side.

18. An open decoupling resistor will effect agc voltage only on the portion of the bus which is beyond the open, away from the source.

19-20. If decoupling resistances are on the order of 50K ohms or more a defective decoupling capacitor will chiefly affect that part of the bus connected to the capacitor. With test connections as in Fig. 5-6, temporary disconnection of one end of a faulty capacitor will allow voltage to become more negative. Disconnecting a good capacitor will not affect test voltage.

21. A sensitivity control should be set for best picture reproduction on relatively strong received signals with the contrast fairly well advanced. With correct setting, pictures should appear quickly when switching from one active channel to another. Otherwise the sensitivity may need adjustment.

34-35. The cathode of the agc rectifier tube in some receivers is connected to the contrast control. Then cathode voltage should become more positive when contrast is advanced, less positive when retarded.

40. Observe pulses at the plate of a keyer tube with an oscilloscope set for horizontal line frequency or a submultiple. Unless it is certain that the scope input will not be damaged by high voltage make connection to the keyer plate through a fixed capacitor of no more than 10 mmf, rated for 1,000 volts or more.

41. Capacitors in the lead to the plate pulse source may be of high voltage rating. Check this when making a replacement.

42. Observe the signal at the keyer grid with an oscilloscope. Weak horizontal sync pulses may be due to defects in the keyer circuit, or possibly to an overloaded video amplifier which is limiting the pulses.

SECTION 6

VIDEO AMPLIFIER

The video amplifier receives the composite television signal as demodulated in the video detector and passes the amplified signal to the grid-cathode circuits of the picture tube.

Principal components of a single stage video amplifier section are represented in Fig. 6-1. Fig. 6-2 shows a two-stage video amplifier section. The tube for a single stage nearly always is a pentode or a beam power tube. Tubes in two stages may be two triodes, two pentodes, or other combinations of triode, pentode, and beam power amplifiers.

The video amplifier handles frequencies as low as 60 cycles per second for vertical sync pulses and as high as 4 megacycles for fine details of pictures. Proper amplification of lowest frequencies depends chiefly on (1) large capacitance for coupling or blocking at *Cc,* (2) suitable plate decoupling capacitance at *Cd,* also (3) on grid return resistance *Rg* and (4) plate decoupling resistance *Rd* of correct values in relation to each other and to the capacitances.

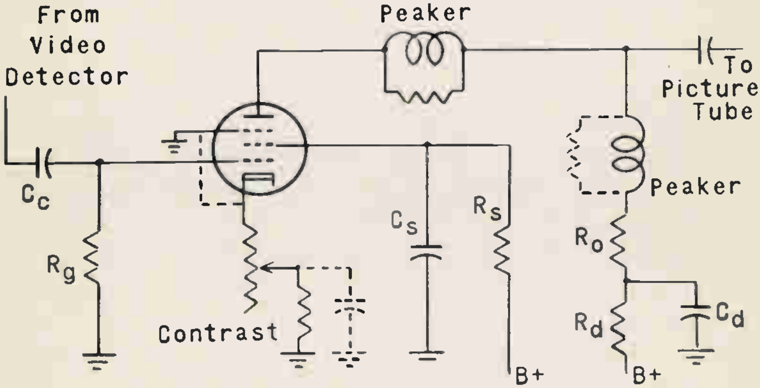

Fig. 6-1. A single stage video amplifier.

Peakers

Amplification is extended to high video frequencies by peaker inductors. The peaker which is in series between the

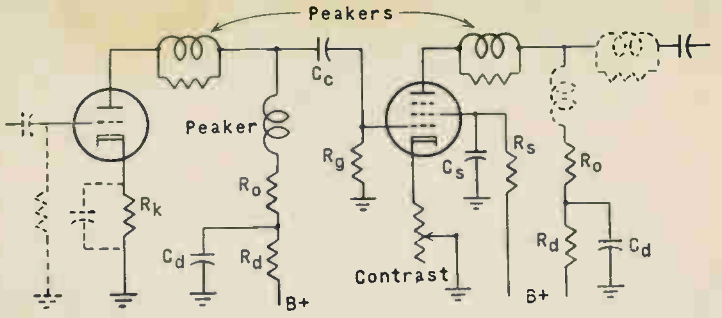

Fig. 6-2. A two-stage video amplifier section.

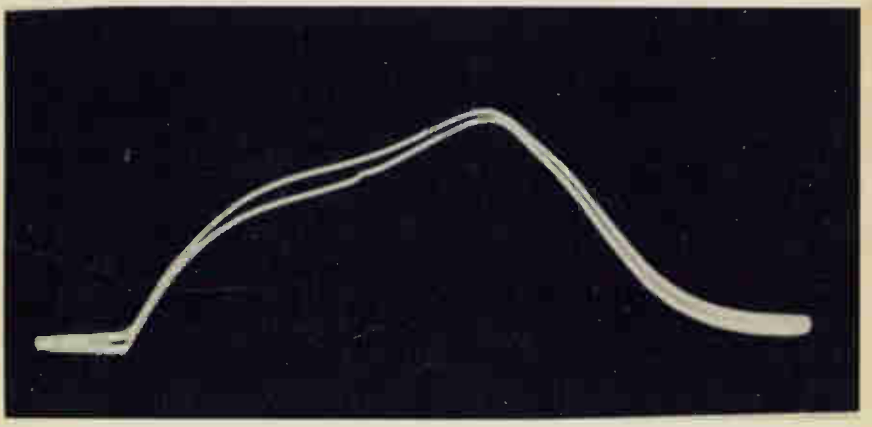

Fig. 6-3. Video amplifier frequency response with gain control at normal setting.

amplifier plate and the output connection to the picture tube or a second stage reduces the effect of stray capacitances and tube capacitances. These capacitances are effectively in parallel with the plate load. They "shunt" the load and tend to reduce load impedance as their reactances drop at high frequencies. We shall call these inductors "plate peakers".

The peaker which is in series with plate load resistor *Ro,* in the lead going to B+, increases its inductive reactance as frequency rises. This maintains or increases plate load impedance at the higher video frequencies. We shall call these units "load peakers".

A plate peaker ordinarily is paralleled with a resistor of a few thousand ohms to broaden the response and prevent excessively sharp peaking. The load peaker to B+ may or may not have a broadening resistor, as in Fig. 6-1, or the peaker may be omitted entirely as indicated by the broken-line symbol in Fig. 6-2.

Fig. 6-3 is a video amplifier frequency response showing the effect of peaker inductors on increasing the gain toward the right, which is the high-frequency side of the curve. This trace was taken with a cathode bias contrast control advanced about half way. Reducing the contrast, and thereby the gain, drops the entire response curve as in Fig. 6-4.

Peakers affect the shape of a video amplifier frequency response much as interstage couplers affect the shape of an i-f amplifier frequency response. Peakers in the detector output and in outputs of first and second video amplifiers may be of such values as to separately peak these outputs at different frequencies. This will make overall gain fairly uniform over a wide range of video frequencies.

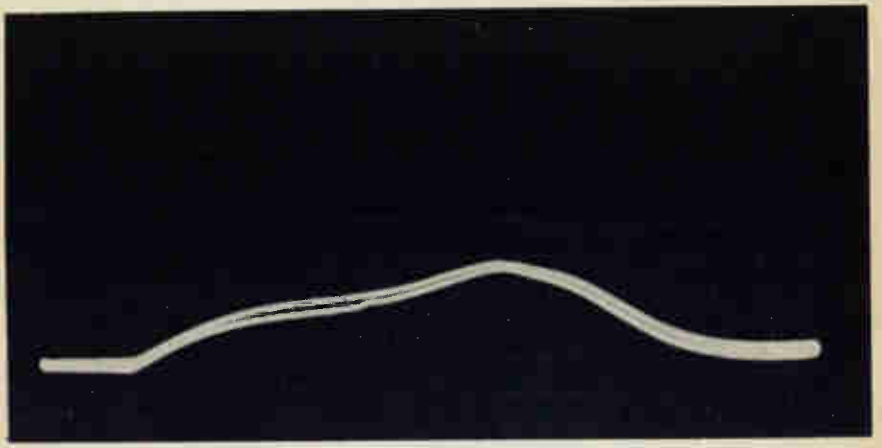

Fig. 6-4. Frequency response with gain control or contrast control retarded.

What we have called the plate peaker has principal effect on shifting the peak of the response to higher or lower frequency. Less inductance shifts the peak to higher frequency, while more inductance shifts the peak downward in frequency.

The load peaker has principal effect in raising or lowering the peak, or in increasing or decreasing the gain at higher video frequencies. Less inductance drops the gain, more inductance increases the gain. Of course, both kinds of peakers affect both the frequency of peaking and the gain, but their principal effects are as stated.

Contrast Controls

It is common practice to provide contrast control or video amplifier gain control by means of an adjustable cathode bias resistor. There are, however, many receivers in which the contrast control is in the picture tube grid-cathode circuit rather than on the video amplifier.

To provide a minimum bias there may be a fixed resistor in series with an adjustable cathode resistor, as in Fig. 6-1. The fixed resistor sometimes is bypassed. With no fixed cathode resistor, and while a contrast control is set for zero resistance, there is grid-leak biasing action in capacitor *Cc* and resistor *Rg* of the diagrams.

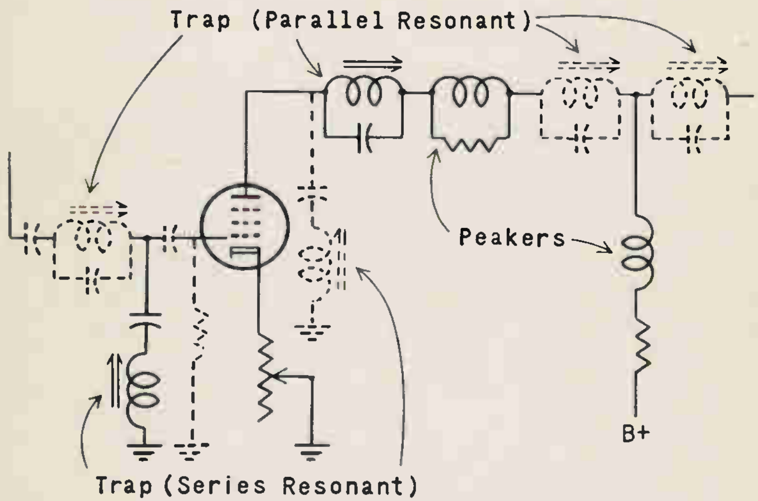

Fig. 6-5. Various positions for 4½-mc traps of parallel resonant and series resonant types

4½ Mc Traps

The video and sound intermediate frequencies, always separated by 4½ mc, combine in the video detector to produce a 4½-mc beat frequency in the detector output. If this beat frequency reaches the picture tube it modulates every horizontal line trace to cause a grainy effect in all pictures.

The 4½-mc beat may be kept from the picture tube by using one trap in any of the positions shown in Fig. 6-5. A parallel resonant trap most often is at the plate of a video amplifier, as shown in full lines, but may be in any of the other positions indicated by broken-line symbols. A series resonant

Table 6-A VIDEO AMPLIFIER Tube, Peakers and Contrast Control	Bending	Contrast Excessive	Contrast Lacking	Definition Poor	Grainy Pictures	Hum Bars	Jitter	Multiple Images	Negative Pictures	Raster, No Picture	Smearing	Sound Bars	Sync Critical	Tear Out
AMPLIFIER TUBE														
1 Weak			•							•			•	
2 Heater-cath leak						•								
3 Microphonic							•					•		•
4 Gassy										•	•			
TUBE VOLTAGES														
5 Plate too low			•	•							•		•	
6 Screen too low			•								•		•	
7 Ripple												•	•	
8 Bias too Negative			•										•	
9 Bias not negative enough		•							•					
PEAKERS														
To 2nd amp. or to picture tube														
10 Open, disconnected			•	•						•				
11 Shorted				•										
12 Too much inductance				•				•			•			
13 Shunt R too great								•						
14 Shunt R too small				•										
To load resistor and B+ line														
15 Open, disconnected			•							•				
16 Shorted or too little inductance				•										
17 Too much inductance	•			•				•						

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Table 6-A

VIDEO AMPLIFIER
Tube, Peakers and Contrast Control

	Bending	Contrast Excessive	Contrast Lacking	Definition Poor	Grainy Pictures	Hum Bars	Jitter	Multiple Images	Negative Pictures	Raster, No Picture	Smearing	Sound Bars	Sync Critical	Tear Out
CONTRAST CONTROL														
18 Open										•				
19 Shorted		•												
4½ Mc TRAP														
20 Misadjusted				•	•									
21 Parallel type open										•				
22 Parallel type shorted					•									
23 Series type open					•									
24 Series type shorted										•				

trap most often connects from the amplifier grid to ground, but may be on the plate side. Most beat frequency traps are adjustable by a movable core in the inductor, although a few have adjustable capacitors.

Troubles And Symptoms

Two tables list video amplifier faults and their symptoms as evident in pictures. Table 6-A covers the video amplifier tube and its voltages, also the peakers, the contrast control, and the 4½-mc trap. Table 6-B deals with capacitors and resistors in the video amplifier section.

Numbered paragraphs which follow refer to faults of similar numbers in the two tables.

1. A weak amplifier tube may cause critical sync where the sync takeoff is from beyond the tube output, but not where the takeoff precedes the faulty tube.

2. Heater-cathode leakage must be of low resistance to cause serious trouble. Leakage resistance must be comparable to resistance of a cathode bias resistor or to maximum resistance of a contrast control on the amplifier cathode.

Table 6-B VIDEO AMPLIFIER Capacitors and resistors	Bending	Contrast Excessive	Contrast Lacking	Definition Poor	Multiple Images	Negative Pictures	Raster, No Picture	Smearing	Sync Critical
CAPACITORS									
Coupling or blocking									
25 Too small	•								•
26 Open							•		
27 Shorted, leaky	•	•	•	•					
28 Capacitance to ground				•				•	
Plate decoupling									
29 Too small	•	•			•				
30 Open	•	•		•	•				
31 Shorted, leaky			•				•		
Screen decoupling, bypass									
32 Too small			•					•	
33 Open			•						
34 Shorted, leaky			•				•		
Cathode bypass									
35 Too small or open			•	•				•	
36 Shorted		•							
RESISTORS									
Plate load									
37 Too small, shorted			•		•	•	•		
38 Open								•	•
39 Too large		•		•					
Decoupling, plate									
40 Too large				•				•	
41 Open							•		
42 Too small, shorted									

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Table 6-B
VIDEO AMPLIFIER
Capacitors and resistors

	Bending	Contrast Excessive	Contrast Lacking	Definition Poor	Multiple Images	Negative Pictures	Raster, No Picture	Smearing	Sync Critical
Decoupling, screen									
43 Too large			•					•	
44 Open							•		
45 Too small, shorted			•				•		
Grid return									
46 Too small			•	•					•
47 Shorted							•		
48 Open			•						

5-6. Abnormally low voltage to the plate, the screen, or both may allow amplifier tube overloading on strong signals, also on any signals for pictures of very light tone or containing a great deal of white. These latter kinds of pictures increase the peak-to-peak signal voltage. Overloading cuts off the sync pulses, and where sync takeoff follows the overloaded tube there may be critical sync.

Plate voltage may be considerably lower than the proper value provided screen voltage is no more than about 20 per cent lower than normal.

7. If plate decoupling and screen decoupling capacitors are in good conditon there is little likelihood of picture trouble due to ripple in the main B-voltage lines to the video amplifier section.

8-9. Incorrect bias refers to fixed bias or bias resistors, not to adjustable bias used for contrast control. Where there is a conductive connection, not a capacitor, from detector output to amplifier input or grid the d-c grid voltage will be the same as at the high side of the detector load resistor.

The amplifier grid sometimes is biased by a negative voltage obtained from somewhere in the B-supply system, or both the amplifier grid and video detector output may be so biased. Watch for such additional fixed biasing voltages when making measurements at the amplifier grid.

10. A peaker winding may be open or disconnected while leaving a paralleled broadening resistor in the circuit. The resistor alone will pass a greatly weakened video signal.

11. A shorted peaker is not likely to cause complaint unless the viewer is critical of picture quality.

12. Slightly too much inductance in the plate peaker lowers the frequency of maximum or peak gain and may impair definition. A great excess of inductance causes multiple images or smearing.

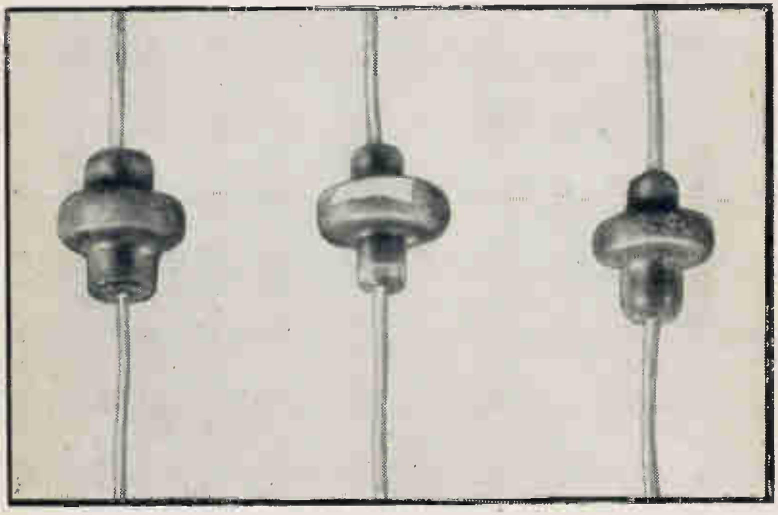

Fig. 6-6. Peaker inductors supported on shunting resistors.

13-14. Non-adjustable peaker inductors as pictured in Fig. 6-6 have the ends of their fine-wire winding soldered to pigtails of the supporting and broadening resistors. Low resistance of the paralleled winding makes it impossible to measure broadening resistance without unsoldering the inductor wire, with great danger of breakage. The best procedure is to try substituting a new peaker-resistor unit.

15. An open or disconnected load peaker winding may leave a broadening resistor in circuit, but plate voltage will be so low as to impair contrast and definition.

18-19. These contrast control troubles exist only when the contrast control is on a video amplifier cathode.

21-24. Keep in mind that a parallel resonant trap is in series with the signal path and, in case of trouble, may act similarly to an open signal circuit. A series resonant trap is between the signal path and ground or B-, and in case of trouble may become a short circuit for signals.

25. A coupling capacitor from detector to first video amplifier, may be of less capacitance than one in the output to the picture tube without causing picture defects.

27. A shorted or very leaky capacitor from video detector to amplifier grid may place an excessively negative biasing voltage on the amplifier, from a negative voltage on the high side of the detector load resistor.

A leaky capacitor from an amplifier plate to a following stage or to a picture tube grid makes the following grid less negative or possibly positive to cause overloading of the following amplifier or picture tube. A leaky capacitor to a picture tube cathode makes the cathode too positive, and the picture tube grid relatively too negative.

28. Coupling or blocking capacitors should be separated from all chassis metal by a quarter-inch or more. Capacitance of less than 100 mmf to ground greatly impairs definition. Capacitors of large physical size are likely to get close to chassis metal. A paper capacitor having considerable internal inductance, due to the foil being in the form of a winding, may cause slight smearing.

29-33. A test for decoupling capacitors too small or open is made by temporarily paralleling them with an electrolytic capacitor of about 10 mf and 450-volt rating. Be sure to make connection on the low side of a plate load resistor, as shown for capacitor *Cd* in Fig. 6-1, and directly to the screen, as for capacitor *Cs* in that diagram.

35-36. A cathode resistor bypass capacitor, when used, increases the gain by lessening degeneration, but makes for narrower frequency response (poor definition) and may allow excessive peaking (slight smearing).

Square Wave Tests

Performance of a video amplifier section at low frequencies is best tested with a square wave generator and an oscilloscope. The scope must have frequency compensating vertical input, and must be used with a frequency compensating probe. The test setup is illustrated by Fig. 6-7.

Before attempting to test the amplifier connect the output of the generator directly to the input probe of the scope and observe waveform traces at fundamental square wave frequencies between 100 and 600 cycles per second, also at generator outputs up to 5 or 6 volts peak-to peak. If traces are other than true square waves it will be necessary to make allowances when checking the amplifier. Then proceed as follows:

1. Disconnect the antenna and place the channel selector on an inactive channel.

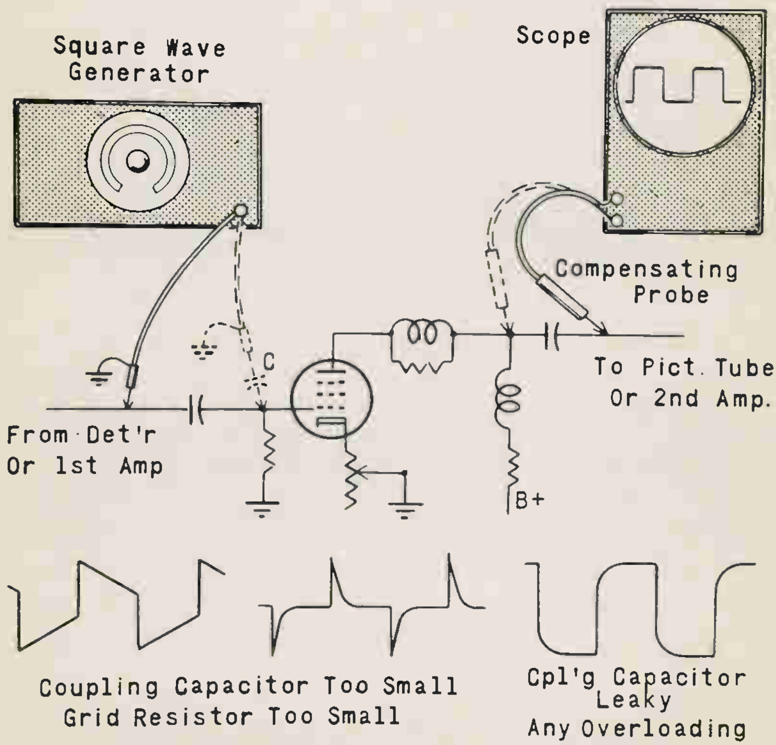

Fig. 6-7. Square wave test setup for a video amplifier and some traces which indicate particular faults.

2. It is best to temporarily disconnect the grid of the amplifier being tested, without disconnecting its d-c grid return.

If the grid is not opened, remove the video detector if it is a tube. Should part of the detector tube be an agc clamper, remove the r-f amplifier tube to prevent its operating with positive bias. If a second video amplifier is being tested, temporarily remove the first video amplifier if it is a separate tube.

3. Connect the output of the square wave generator ahead of any coupling capacitor leading to the amplifier grid, as shown by full lines. If there is no coupling capacitor make the generator connection through a fixed capacitor *(C)* of about 0.1 mf.

4. Connect the scope through a compensating probe to the amplifier output beyond a coupling capacitor, as in full lines, or, as in broken lines, to point following the plate peaker and on the high side of a load peaker.

5. If the contrast control is on the video amplifier cathode advance this control enough to obtain a trace of sufficient height for observation with the vertical gain of the scope at or near maximum.

The form of the trace should be very close to a square wave, or like that observed with generator and scope directly connected, for all fundamental square wave frequencies down to at least 400 cycles per second. This would indicate satisfactory amplification from frequencies of 40 to 4,000 cycles per second. An additional check may be made with the generator set approximately for the horizontal line frequency of 15,750 cycles per second.

As illustrated at the bottom of Fig. 6-7, a traced waveform with decided slope at top, bottom, or both probably indicates a coupling capacitor or a grid resistor which is too small. Sharp peaks indicate very severe faults of this nature. Rounded corners may mean a leaky coupling capacitor or overloading of the amplifier tube due to any cause. Overload may be caused by too strong output from the generator.

Frequency Response Observations

High-frequency performance of a video amplifier section is best observed with a sweep generator, a marker generator and an oscilloscope used as in Fig. 6-8.

The sweep generator must be capable of furnishing a center frequency of about 3 mc with sweep width of 5 to 6 mc. Use a detector probe on the scope vertical input.

Proceed as follows:

1. Disconnect the antenna and place the channel selector on an inactive channel.

2. To prevent small peaks or pips from moving back and forth across the response trace remove the vertical sweep oscillator. General fuzziness all over the trace is caused by horizontal sync pulses. This may be prevented by removing the damper tube or the horizontal output amplifier. Removing either of these latter tubes will raise B-voltages throughout the receiver, but the rise should not be enough to cause trouble.

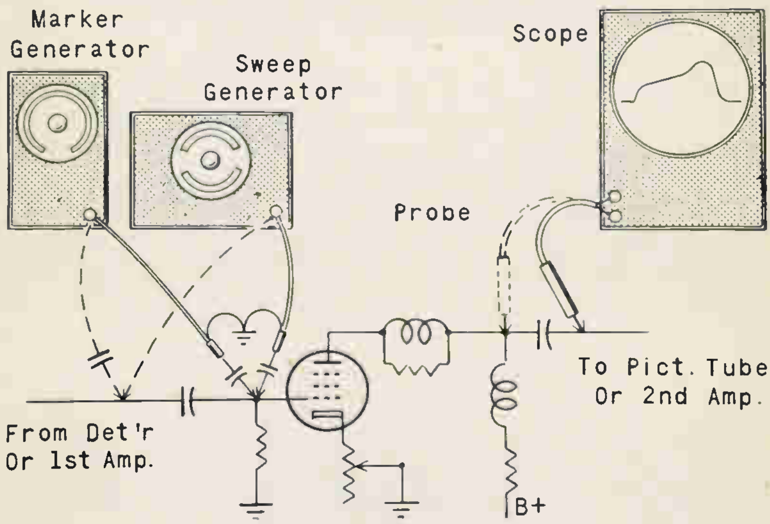

Fig. 6-8. Test setup for measuring frequency response of a video amplifier and noting peaker effectiveness.

3. Temporarily disconnect the grid input of the amplifier being tested, without disconnecting its grid return.

4. Connect the sweep generator through about 1,000 mmf fixed capacitance to the amplifier grid, as in full lines, or directly to a point ahead of a coupling capacitor, as in broken lines.

5. Connect the marker generator through fixed capacitance of 10 or more mmf to the same point as the sweep generator.

6. Connect the scope on the output side of a coupling capacitor, as in full lines, or, as in broken lines, to a point following the plate peaker and on the high side of a load peaker.

7. Adjust the contrast control, when it is on the amplifier cathode, to a position giving the highest trace. This may not be at maximum contrast.

To test a single stage make connections as in Fig. 6-8. For two stages connect the generators to the grid input of the first amplifier and the scope to the output of the second amplifier.

Use the marker generator to measure the frequency at the peak of response. Preferably it should be between 3 and 3½ mc, but not lower than 2½ mc. The response should drop well toward zero at 4½ mc or only slightly higher, and may show a dip due to a 4½ mc trap. These observations will check effectiveness of the peakers in maintaining and peaking the gain at high video frequencies.

SECTION 7

PICTURE TUBE INPUT

When locating trouble in the picture tube input or grid-cathode circuits we are concerned chiefly with (1) the brightness control, (2) the retrace blanking system, (3) voltage at the second grid and (4) whether signals from the video amplifier are applied to the cathode or to the control grid of the picture tube.

Whether signal input, brightness and retrace blanking are on the picture tube cathode or the control grid has much to do with the kinds of symptoms which result from various faults. Following diagrams illustrate circuit combinations most commonly used in present receivers. It is, however,

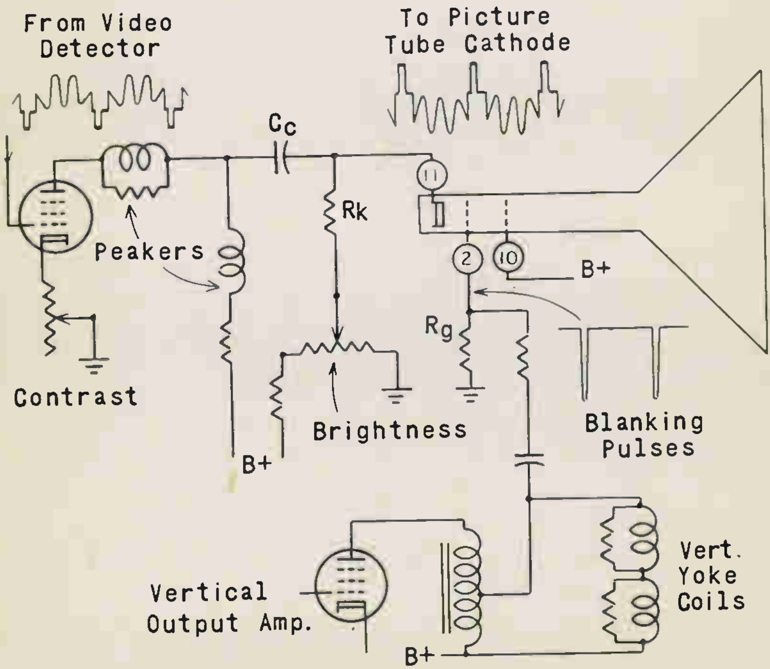

Fig 7-1 These connections are widely used for picture tube input circuits.

possible to combine brightness controls and retrace blanking systems in other ways. Also, almost any of the various sources of blanking pulses may feed to picture tube elements in combinations other than shown without affecting the general procedure of trouble shooting.

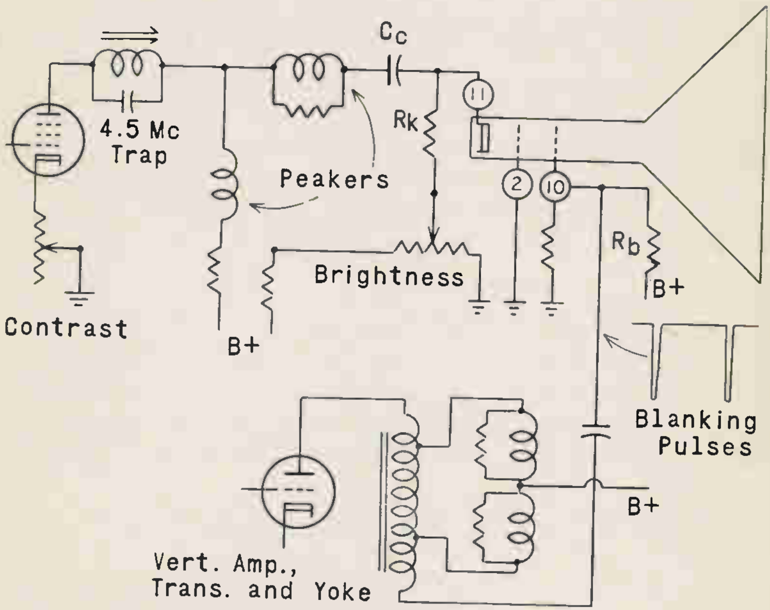

Fig. 7-2. Retrace blanking pulses from an extension on the vertical output transformer are applied to the second grid.

Fig. 7-1

Video signals pass through capacitor *Cc* to the picture tube cathode (pin 11). Picture signals must be negative and sync pulses positive at the cathode. Because there is polarity inversion in the video amplifier, signals from the video detector to this amplifier must have picture signals positive and sync pulses negative.

The brightness control is connected to the picture tube cathode.

Pulses for blanking of vertical retrace lines are taken from the high side of the vertical deflection coils or from the vertical output transformer and carried through a capacitor and resistor to the picture tube control grid (pin 2). Pulses applied to the grid must be negative in order to blank the beam.

The control grid is conductively connected to ground through resistor *Rg*, thence through the brightness control to the cathode. Resistor *Rg* is necessary in order that blanking pulses may not be grounded.

Fig. 7-2

Retrace blanking pulses taken from the vertical output transformer are applied to the second grid (pin 10) of the picture tube. To this grid is applied also a B+ voltage, without which the viewing screen would remain dark. Resistor *Rb* prevents blanking pulses from dissipating themselves in the lines from this resistor to the source of B-voltage.

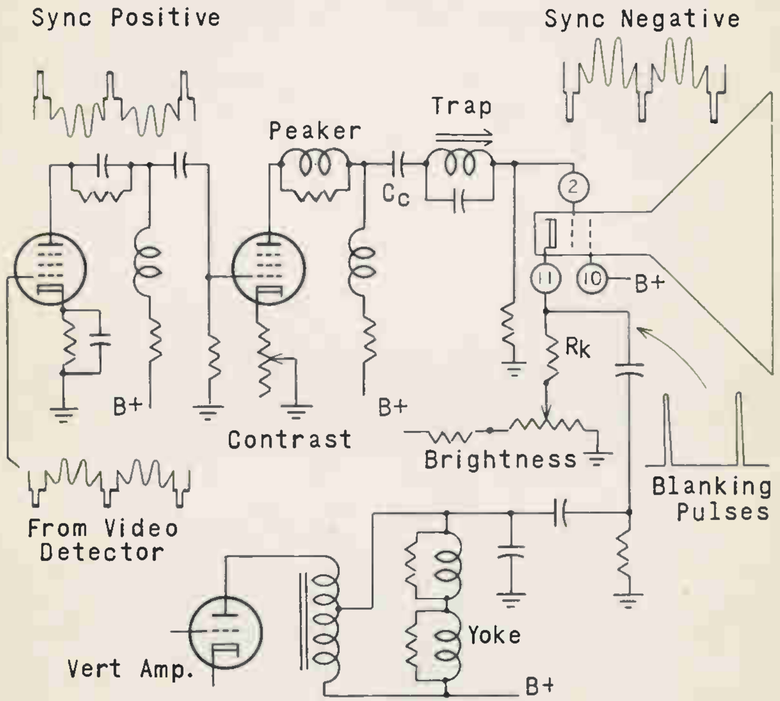

Fig. 7-3. Signal polarities are different when video input is to the picture tube control grid.

Fig. 7-3

A two-stage video amplifier feeds signals to the picture tube control grid (pin 2) at which sync pulses must be negative and picture signals positive. Then, because of polarity inversion in the amplifiers, sync must be positive and pictures negative between the two amplifiers, and sync negative with pictures positive at the output of the video detector.

Retrace blanking pulses are applied to the cathode, and must be of positive polarity because the cathode must be made more positive with reference to the control grid for extinguishing or reducing the electron beam.

A 4½-mc trap is on the side of coupling capacitor *Cc* toward the picture tube. Positions of this trap and of the preceding peaker might be interchanged without affecting trouble shooting.

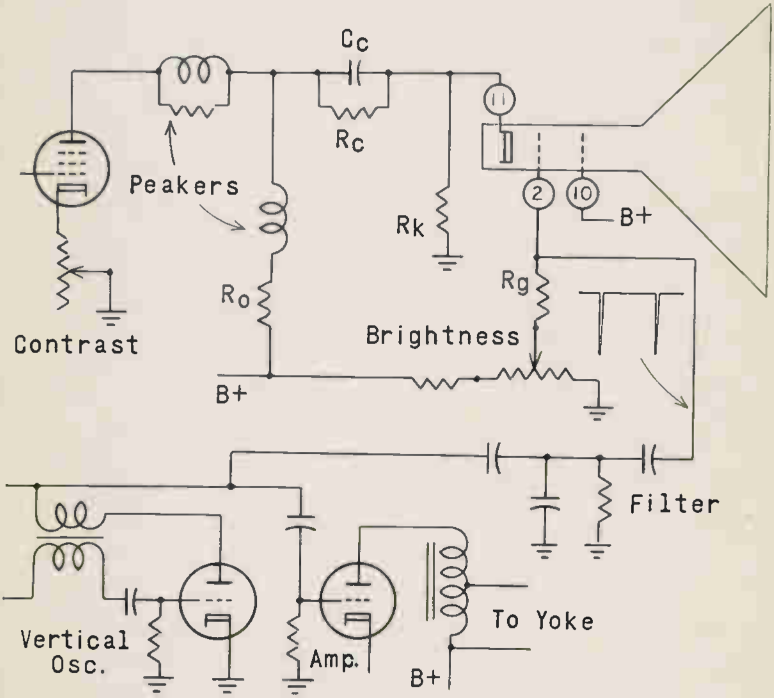

Fig. 7-4. The coupling capacitor from video amplifier to picture tube is paralleled with a resistor.

Fig. 7-4

The brightness control is on the control grid of the picture tube. In parallel with coupling capacitor *Cc* is a resistor *Rc* B+ voltage goes through resistors *Ro, Rc* and *Rk* to ground. Resistors *Rc* and *Rk* act as a voltage divider. The portion of positive B-voltage at the junction of *Rc* and *Rk* is applied to the picture tube cathode.

B-voltage is applied also through the brightness control to the picture tube control grid. Thus both the control grid and the cathode are positive to ground, but their circuit resistances are so proportioned that the grid remains less positive than the cathode, or effectively negative with respect to the cathode. Cathode and grid may be fed from the same B+ voltage, as shown, or from different B-voltages so long as circuit resistances are such as to keep the grid less positive than the cathode.

Retrace blanking pulses are taken from the plate of the vertical oscillator. Pulses may be taken from anywhere in the vertical sweep or deflection sections where there is required pulse polarity and strength. Pulses may be taken from the vertical deflection yoke coil circuit or from the vertical output transformer, from the vertical amplifier plate, the amplifier grid, or the vertical oscillator plate. All these pulse sources are illustrated in our diagrams.

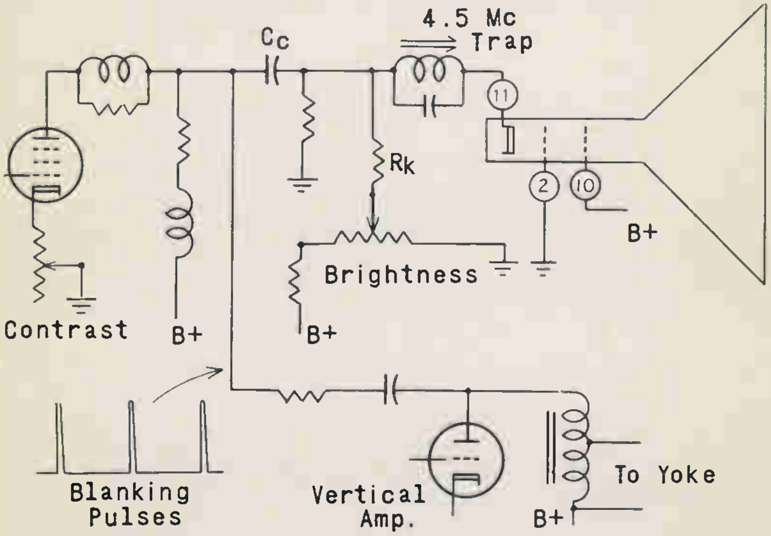

Fig. 7-5. Retrace blanking pulses to the plate circuit of the video amplifier act through the coupling capacitor on the picture tube cathode.

Fig. 7-5

Positive blanking pulses from the vertical amplifier plate are applied to the plate circuit of the video amplifier, and act on the picture tube cathode through capacitor *Cc*. Otherwise this diagram shows no features not illustrated on those preceding.

Fig. 7-6

Negative retrace blanking pulses are taken from the plate of the vertical output amplifier and applied to the picture tube control grid.

The contrast control potentiometer is across the load in the plate circuit of the video amplifier, with the slider of the pot feeding to the picture tube cathode. This allows running the video amplifier at constant gain. Any one or more of the bypass capacitors *Ca* may be used. A peaker may be in either of the positions indicated. Coupling capacitor *Cc* may be in either of the positions shown. The brightness control might be on the picture tube control grid rather than on its cathode.

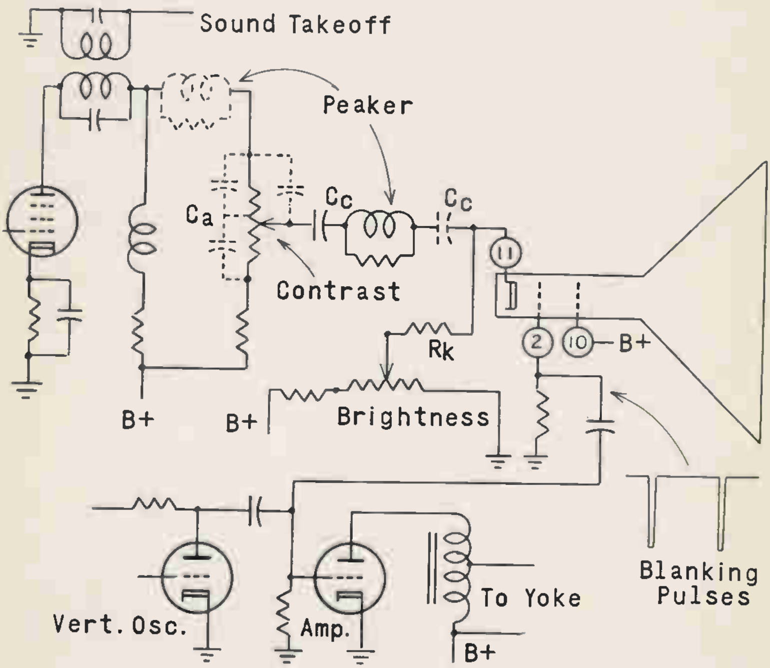

Fig. 7-6. The contrast control is between video amplifier plate and picture tube cathode.

D-c Restoration

D-c restoration by means of a diode is shown at *1* of Fig. 7-7 and by means of a triode at *2*. The cathode and grounded grid of the triode are employed for restoration exactly as are the cathode and grounded plate of the diode. The triode plate is used to obtain sync pulses for use in the sync section. D-c restoration seldom is used in receivers of recent design.

The purpose of restoration is automatic variation of picture tube control grid bias to maintain the black level of video signals close to the voltage of beam cutoff both for pictures of light tone and of dark tone.

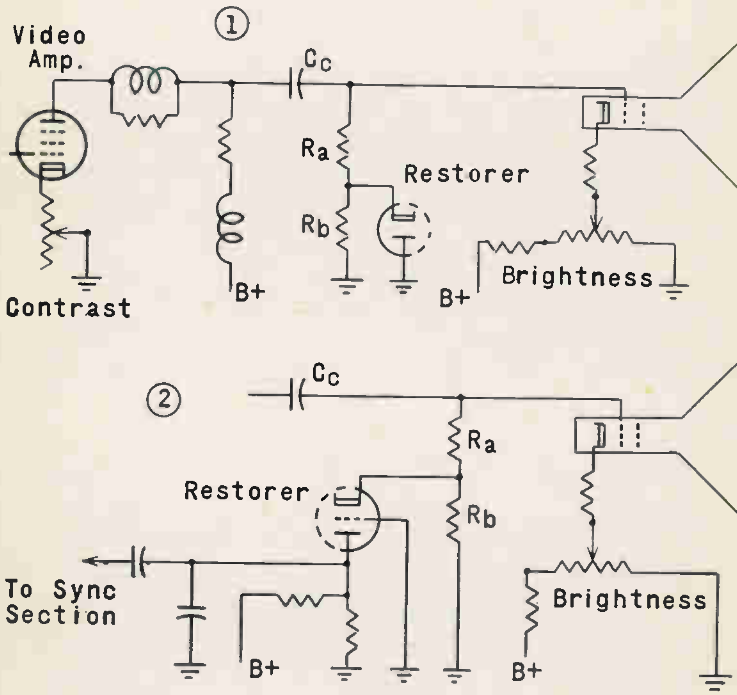

Fig. 7-7. D-c restoration systems which have been commonly used.

Video signals for light-toned pictures have greater peak-to-peak amplitude than those for darker tones. For light-toned pictures the restorer system makes the picture tube control grid slightly less negative to the cathode. This you may observe by connecting a d-c VTVM from control grid to cathode of an operating picture tube and watching the small voltage variations as pictures change between light and dark.

There is little noticeable effect on picture quality with a restorer circuit disconnected provided the conductive grid return through resistors *Ra* and *Rb* of Fig. 7-7 remains complete. Of course, removing or disconnecting a triode restorer tube would cut off pulses from the sync section and there would be neither vertical nor horizontal synchronization.

Retrace Blanking Filters

Both the duration and amplitude or strength of retrace blanking pulses are determined by resistors and capacitors which form a filter of one type or another between the source of pulses and the picture tube element to which the pulses are applied. Fig. 8 shows separately the filters for preceding Figs. 7-1 to 7-6, similarly numbered.

Duration of each pulse is lengthened by either more resistance or more capacitance in the filter, and is shortened by less resistance or capacitance. A pulse which lasts too long blanks the top of pictures as well as the vertical retrace, and tops are darkened. A pulse too short leaves retrace lines at the top of pictures.

Duration of blanking pulses is determined chiefly by these resistors and capacitors:

Diagram 1. *Rp* and *Cp*

Diagrams 2 and 6. *Cp*

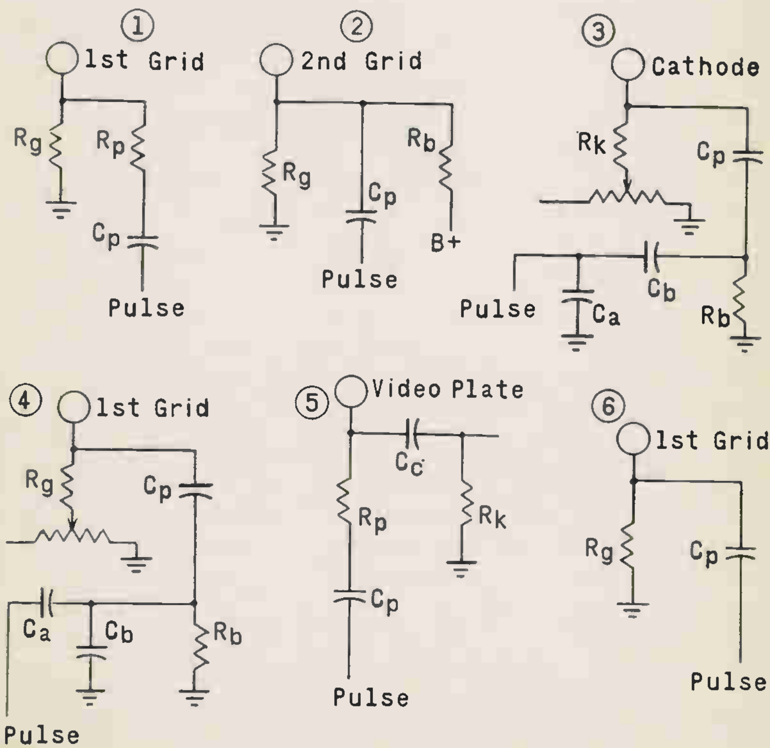

Fig. 7-8. Various forms of retrace blanking pulse filters as used in preceding figures 7-1 to 7-6.

Diagram 3. *Rb, Ca* and *Cb*

Diagram 4. *Rb, Ca* and *Cb*

Diagram 5. *Rp* and *Cp*

Other resistors and capacitors in the blanking circuits affect chiefly the amplitude or strength of pulses, although every resistor and every capacitor affects pulse duration to some extent.

Brightness Control Troubles

There must be a complete conductive path through wiring, resistors or chassis metal from the control grid to the cathode of the picture tube in order that grid biasing potential and control of brightness may be maintained. D-c biasing voltage and brightness control voltage cannot act through a capacitor.

If the picture tube control grid is not conductively connected to chassis ground or B-minus and thence to the cathode, pictures will be excessively bright, there may be blooming, definition will be very bad, and with some circuits the action of the brightness control may be reversed.

With the picture tube cathode not conductively connected to chassis ground or B-minus and thence to the control grid, the viewing screen may remain dark, without even a raster, or pictures will be of very low brightness and the brightness control will have no effect.

With the brightness control on the picture tube cathode (Figs. 7-1, 2, 3, 5 and 6) a resistor *Rk* is in series between the cathode and the brightness control pot. The value of *Rk* usually is 100K to 200K ohms, but may be smaller or larger. Except in the case of Fig. 7-5 all d-c electron flow to the cathode is through resistor *Rk* in a direction such that voltage drop biases the cathode positively. This is equivalent to negative bias on the control grid.

Brighter pictures or stronger signals increase cathode current in resistor *Rk*, increase voltage drop in this resistor, and make the control grid more effectively negative to the cathode. This action tends to limit cathode current and maximum brightness.

In Fig. 7-4 the brightness control is on the control grid of the picture tube. Resistor *Rg* in series between control grid and the brightness control pot prevents grounding of retrace blanking pulses, as would occur were the control grid connected directly to ground. The value of *Rg* usually is about 100K ohms. Since the control grid normally remains negative with respect to the cathode there is no d-c current in *Rg* and no degenerative effect.

Brightness Control Test

Connect the positive of a high-resistance d-c voltmeter or a VTVM to the picture tube socket lug for pin 11, the cathode. Connect the negative side of the meter to the lug for pin 2, the control grid. The socket may remain on the tube or be removed. With the socket removed it is easy to make meter connections to pieces of wire put into the pin openings.

Use a meter range of 100 volts or more, turn on the receiver, and operate the brightness control. Readings should vary from something like 10 volts with the control advanced to 60 volts or more with the control retarded.

Troubles And Symptoms

Three accompanying tables list possible faults in the picture tube input circuits and elements, and show probable symptoms as observed in picture reproduction. Main headings in the left-hand columns of the tables list types of circuits, with subheadings for circuit components. Following paragraphs, number to correspond with numbered faults in the tables, contain information useful in trouble location.

1-3 and **7-9.** Zero voltage would indicate an open connection to the brightness control pot. Too little voltage might result from a series resistor which has been overheated. Too great voltage would indicate a shorted resistor in series with the brightness control pot. The control pot itself may be defective, having poor contact from slider to resistance element, a rough element or an open element. Connections in the brightness control circuits may be loose, open or shorted.

12. Even with an open capacitor some signal will go through the paralleled resistor.

13. A leaky or shorted capacitor allows positive voltage from the plate circuit of the video amplifier to reach the picture tube cathode. This make the cathode too positive and the control grid relatively too negative, thus diminishing the electron beam.

Table 7-A **PICTURE TUBE INPUT** **Grid-Cathode Circuits and Brightness**	Brightness Excessive	Brightness Lacking	Brightness No Control	Dark, No Raster	Definition Poor	Pictures Weak	Raster, No Pictures	Retrace Lines Appear
BRIGHTNESS CONTROL ON CATHODE								
B-voltage To Control Pot.								
1 Zero		•	•					
2 Too little, poor connections		•						
3 Too great	•							
Resistor, Cathode To Pot.								
4 Open				•				
5 Too small						•		
6 Shorted							•	
BRIGHTNESS CONTROL ON GRID								
B-Voltage To Control Pot.								
7 Zero				•				
8 Too little		•						
9 Too great	•							
Resistor, Grid To Pot.								
10 Open	•							
11 Shorted								•
SIGNAL TO PICTURE TUBE CATHODE								
Resistor Paralleling Capacitor								
12 Capacitor open						•		
13 Capacitor leaky, shorted		•		•				
14 Parallel R open, too great	•							
15 Parallel R too small						•		
16 Parallel R shorted				•				

(Continued on next page)

(Continued from preceeding page)

Table 7-A **PICTURE TUBE INPUT** **Grid-Cathode Circuits and Brightness**	Brightness Excessive	Brightness Lacking	Brightness No Control	Dark, No Raster	Definition Poor	Pictures Weak	Raster, No Pictures	Retrace Lines Appear
17 Resistor to ground open		•						
18 Resistor to ground shorted				•				
No Parallel Resistor								
19 Capacitor open							•	
20 Capacitor leaky, shorted		•		•				
21 Resistor to ground open		•						
22 Resistor to ground shorted				•				
SIGNAL TO PICTURE TUBE GRID								
23 Cplg capacitor open							•	
24 Cplg capacitor leaky, shorted	•							
25 Resistor to ground open	•							
26 Resistor to ground shorted							•	
GRID-CATHODE RETURNS								
27 Cathode return open or poor connections		•	•	•		•		
28 Control grid return open or poor connections	•		•		•			

24. A leaky or shorted capacitor allows positive voltage from the video amplifier plate circuit to make the picture tube grid positive with respect to the cathode.

27-28. See the earlier heading, *Brightness Control Troubles.*

29-30 and **44-45.** Blanking pulses may be observed by connecting the vertical input of an oscilloscope to the picture tube cathode or control grid through a frequency compensating probe. Pulses to a cathode or control grid usually have normal amplitudes of less than 100 volts peak-to-peak, but pulses applied to a second grid usually are of greater amplitude.

Table 7-B PICTURE TUBE INPUT Retrace Blanking.	Brightness Excessive	Bright Band At Top	Dark Area At Top	Retrace Lines Appear
RETRACE BLANKING TO CONTROL GRID (C and R references to Fig. 8)				
29 Pulses absent				•
30 Pulses too strong			•	
Series Capacitor, Cp				
31 Open, too small				•
32 Too great			•	
33 Leaky, shorted	•			
Series Resistor, Rp				
34 Open, too great				•
35 Shorted				•
Capacitor To Ground, Cb				
36 Open				•
37 Too small			•	
38 Too great				•
39 Leaky, shorted				•
Resistor To Ground, Rb				
40 Open				•
41 Shorted				•
Resistor, Grid-ground, Rg				
42 Open	•			
43 Shorted				•

(Continued on next page)

Table 7-B (Con't) **PICTURE TUBE INPUT** **Retrace Blanking.**	Brightness Excessive	Bright Band At Top	Dark Area At Top	Retrace Lines Appear
RETRACE BLANKING TO CATHODE (C and R references to Fig. 8)				
44 Pulses absent				•
45 Pulses too strong		•		
Series Capacitor, <u>Cp</u>				
46 Open, too small				•
47 Too great			•	
48 Leaky, shorted	•			
Series Resistor, <u>Rp</u>				
49 Open, too great				•
50 Shorted				•
Capacitor To Ground, <u>Cb</u>				
51 Open				•
52 Too small			•	
53 Too great				•
54 Leaky, shorted	•			
Resistor To Ground, <u>Rb</u>				
55 Open			•	
56 Shorted	•			

31-41 and **46-56.** Refer to the earlier heading, *Retrace Blanking Filters.* As observed on a frequency compensated oscilloscope a satisfactory retrace blanking pulse may be only about one-fifth as wide as a vertical blanking interval. This is illustrated by Fig. 7-9.

Peak or peak-to-peak pulse amplitude, when applied to the picture tube cathode or control grid, need be only about half the peak or peak-to-peak amplitude of the composite video signal from sync pulse tips to maximum white for pictures.

Table 7-C PICTURE TUBE INPUT Retrace Blanking. D-C Restoration	Brightness Excessive	Brightness Lacking	Contrast Excessive	Dark, No Raster	Definition Poor	Pictures Weak	Raster, No Pictures	Retrace Lines Appear	Sync Critical
RETRACE BLANKING TO 2nd GRID (C and R references to Fig. 8)									
Series Capacitor, Cp									
57 Open, too small								•	
58 Leaky, shorted	•							•	
Resistor To B+, Rv									
59 Open				•					
60 Too small, shorted								•	
Resistor To Ground, Rg									
61 Open	•							•	
62 Too Small, shorted		•	•						
D-C RESTORATION (See Fig. 7)									
63 Tube weak									•
64 Tube cathode-heater leak						•			•
65 Resistor Ra open	•								
66 Resistor Ra shorted	•								
67 Resistor Rb open	•								•
68 Resistor Rb shorted					•		•		

Blanking pulses applied to the second grid of the picture tube must have peak amplitudes several times that of the composite signal peak-to-peak voltage.

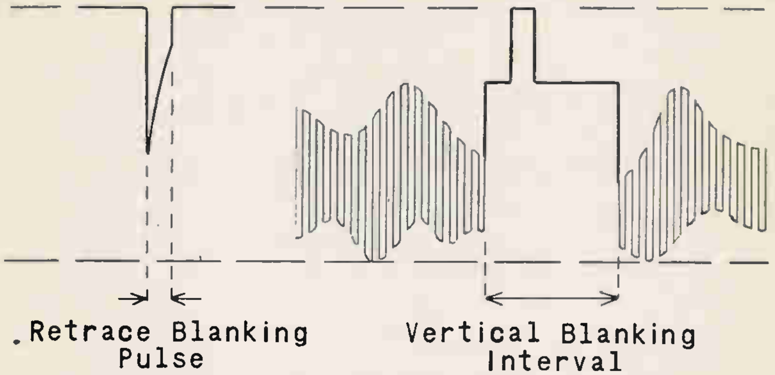

Fig. 7-9. Relations between retrace blanking pulses and vertical blanking intervals.

SECTION 8

THE PICTURE TUBE

Picture tube elements and accessories with which we now are concerned are shown by Fig. 8-1. The cathode (pin 11), the control grid (pin 2) and the second grid, first anode or accelerating grid (pin 10) are found in all tubes.

The widely used method of applying video signals to the picture tube cathode is referred to as cathode drive. The less used method of applying video signals to the control grid is called grid drive.

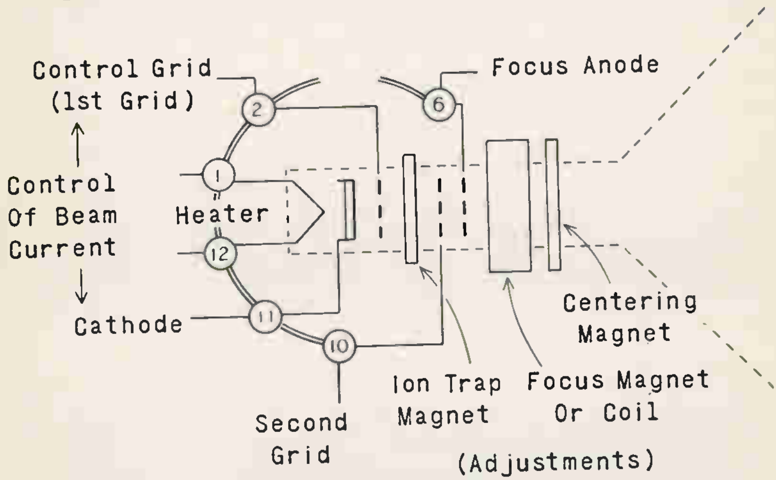

Fig. 8-1. Picture tube elements and accessories considered in this group.

Focusing may be electrostatic or magnetic. For electrostatic focusing there is an additional focusing anode connected to base pin 6. This element is not present in tubes designed for magnetic focusing. With electrostatically focused tubes the centering of pictures is by an adjustable external permanent magnet or magnets.

Magnetic focusing most often is by means of an external device containing permanent magnets with means for adjusting the focusing field. Most permanent magnet focusing devices include the necessary parts and a separate adjustment for centering of pictures. With the few PM focusing devices which do not provide centering there is used a separate adjustable permanent magnet centering unit.

Magnetic focusing sometimes is provided by a wound focusing coil which carries direct current. Focus is adjusted by varying the coil current. The focusing coil may be supported in a mount which allows the coil to be tilted one way or another for centering of pictures. Otherwise there may be a separate adjustable permanent magnet centering device.

The yoke is not considered as part of this group or section because the deflecting coils are in the sweep and deflection system. The second anode or ultor is not included here because it is part of the high-voltage section.

Accompanying tables list faults which may occur with elements and parts of Fig. 8-1. Following the tables are instructions for tests and repairs, also notes helpful during trouble location in this section of the receiver. Instruction paragraphs are numbered to correspond with numbered faults in the tables.

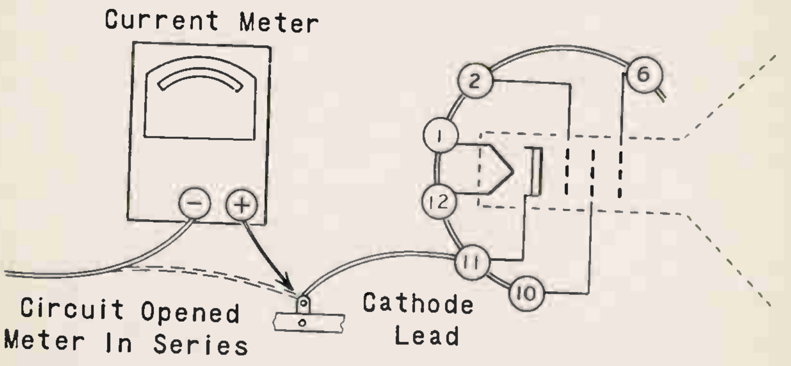

Fig. 8-2. Measuring cathode emission current of a picture tube.

1. Emission Measurements

While a picture tube is in normal operation the cathode current is practically the same as beam current or current for the high-voltage anode. The first grid or control grid is negative to the cathode and carries no current. Current either to or from the second grid and to or from a focusing anode will be negligible or zero in spite of the fact that these elements may be highly positive to the cathode.

Table 8-A PICTURE TUBE	Blooming	Brightness Excessive	Brightness Lacking	Brightness Control Poor	Dark, No Raster	Definition Poor	Focus Poor	Linearity Poor	Pictures Weak	Raster, No Pictures	Size Too Small
PICTURE TUBE											
1 Emission low			•			•			•		
2 Heater voltage low			•		•						
Second Grid Voltage											
3 Zero, or grid grounded					•						
4 Too low		•					•				
Electrostatic Focus Voltage											
5 Too high, too low							•				
Socket Contacts											
6 Dirty, loose			•		•					•	
Leakage											
7 Cathode-heater		•		•	•	•					
Internal Opens											
8 Cathode					•						
9 Control grid				•						•	
10 Second grid					•						
Internal Shorts											
11 Control grid-cathode		•		•						•	
12 Other elements		•			•						
Vacuum											
13 Tube gassy	•						•				•
Magnetized Parts											
14 Cone of metal tube							•	•			
15 Brackets for any tube							•	•			

Cathode current may be measured with a microammeter or with a volt-ohm-milliammeter having a d-c current range of 500 microamperes or 0.5 milliampere, connected as in Fig. 8-2.

Cathode current is increased by any of the following:

A. Received pictures of lighter tone. Tests should be made with the receiver tuned to an inactive channel, so only a raster will show.
B. Advancing the contrast control while receiving pictures. On an inactive channel the contrast control will have little effect or none at all. This control should be set at minimum.
C. Advancing the brightness control, for a brighter raster.
D. Greater heater voltage.
E. Greater voltage on the second grid.
F. Greater voltage on the second anode or ultor.
G. Some types of picture tubes.

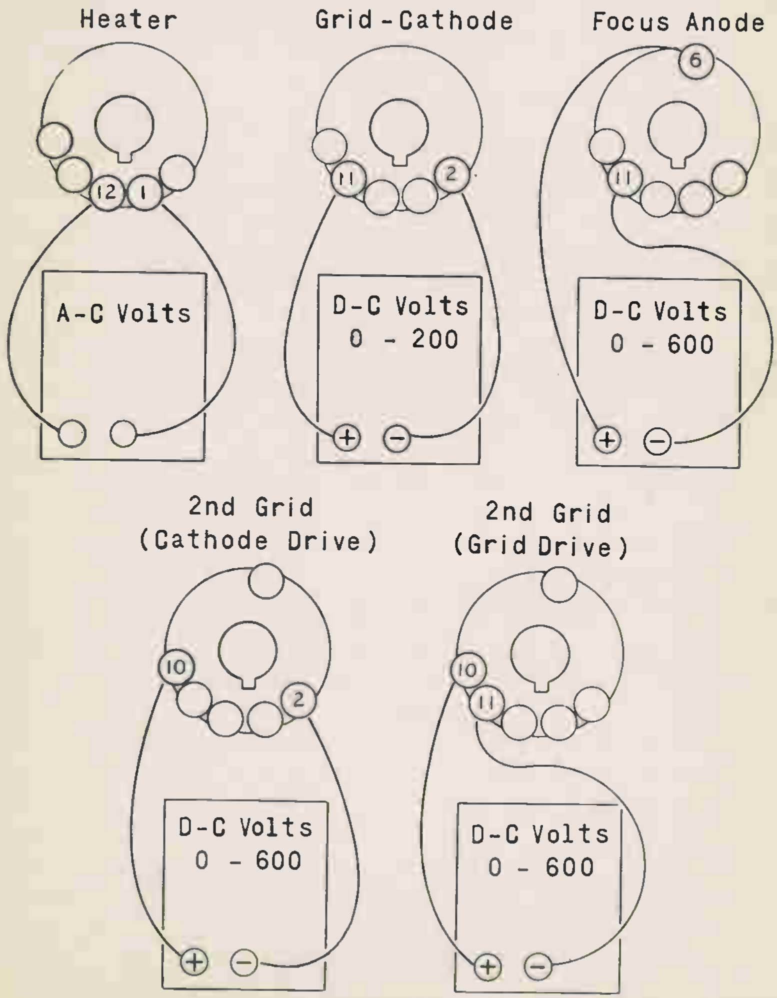

Fig. 8-3. Connections for checking voltages at the various elements of a picture tube.

When emission is low the viewer is likely to advance the contrast control too far, giving the appearance of excessive contrast although the primary trouble is low emission.

2 to 5. Element Voltages

Check element voltages at the picture tube socket as in Fig. 8-3. Use only a VTVM. Even a high-resistance moving coil meter will show incorrect control grid-cathode voltages and second grid voltages with many kinds of receiver circuits. Remove the socket from the tube. Connect the VTVM leads to short pieces of wire inserted in the socket openings.

A-c heater voltage between socket openings for pins 1 and 12 should read no less than 6.0 volts.

3 and 4. Second Grid Tests

Measure second grid voltage with a d-c range of 500 volts or more. Connect positive of the meter to the socket opening for pin 10 and the negative to the opening for pin 2 for a set with cathode drive, or the negative to the opening for pin 11 for a set with grid drive.

Nearly all recent picture tubes are designed for 500 volts maximum positive on the second grid with reference to the cathode with grid drive, and for 625 volts with reference to the control grid with cathode drive. A few older 17-inch tubes are designed for maximum of 410 volts to the cathode. Anything much less than 250 to 350 positive volts on any second grid is likely to mean unsatisfactory performance.

Increasing the voltage on a second grid allows handling stronger video signals or signals with greater peak-to-peak amplitude while preserving a full range of shadings from darkest to lightest. There is increased brightness on the viewing screen, and more cathode current, for any given setting of the brightness control.

The increase of brightness with more voltage on the second grid requires that the control grid be made more negative to the cathode, or the cathode more positive to the grid, in order to have beam cutoff. This is merely another way of saying that more voltage on the second grid allows handling stronger signals or greater signal drive voltage.

Any change of second grid voltage may affect electrostatic focusing. It may be necessary to change the focusing voltage on pin 6 when there is any decided change of second grid voltage.

5. Electrostatic Focus

Measure electrostatic focus voltage with the positive of a d-c meter to the socket opening for pin 6 and negative to the cathode (pin 11) for sets with grid drive, or negative to the control grid (pin 2) for cathode drive.

Focusing voltage may measure almost anything — from negative with respect to the cathode (for grid drive) up to 400 volts or more positive with respect to either the cathode or the control grid. In some sets the focusing anode (pin 6) is connected to chassis ground, usually with a connection at the socket from pin 6 to the grounded pin for the heater. Pin 6 sometimes is connected at the socket to pin 10, thus applying the same voltage to the focusing anode as to the second grid.

During service work it is permissible to connect the focusing anode to some voltage either higher or lower than originally used, provided this improves the focus. The source for focus voltage quite often is a line carrying boosted B-voltage, with a resistor in series to pin 6.

Some receivers have a potentiometer for adjusting the focus voltage. With a pot of 2 megohms resistance connected to a source of 500 volts the pot has to dissipate less than 1/6 watt and should give no trouble.

7. Cathode-heater Leakage

In addition to symptoms listed in the table, cathode-heater leakage of low resistance may cause hum bars, making the upper or lower part of pictures much darker than the remainder.

When video signal input is to the control grid of the picture tube, not to the cathode, ill effects of cathode-heater leakage may be overcome by using a separate heater transformer as in Fig. 8-4. The transformer must have an insulated secondary.

If a separate transformer is used where signal input is to the picture tube cathode, pictures may be of poor quality. Quality will be definitely bad if leakage resistance is less than about 10,000 ohms.

Disconnect the leads for socket openings 1 and 12 from the receiver heater circuit and connect these leads to the transformer secondary. Do not connect either side of the secondary to ground. However, try connecting one side and

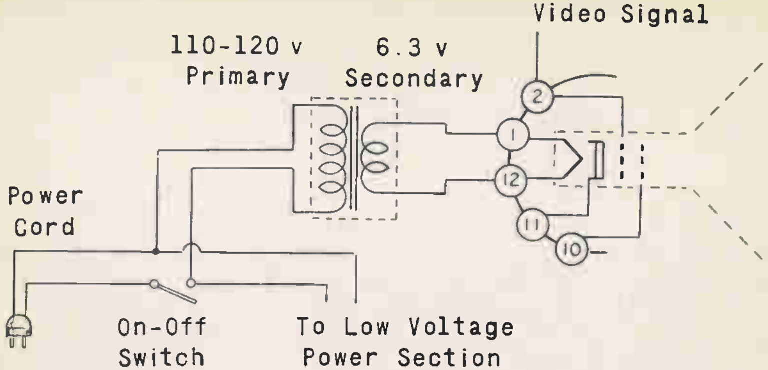

Fig. 8-4. Using a transformer to prevent ill effects of cathode-heater leakage.

then the other of the secondary to the cathode (pin 11) and leave it so connected if picture quality is improved.

When using a transformer designed to reduce a-c power line voltage to 6.3 volts connect the transformer primary to the same receiver leads that go to the power transformer, as illustrated, or to the leads on the receiver side of the off-on switch where there are series heaters.

When using a one-to-one heater transformer connect one side of its primary to the high side of a 6.3 volt parallel heater circuit and the other side of the primary to the other side of the heater circuit, usually ground.

If the receiver has series heaters, disconnecting the picture tube heater as in Fig. 8-4 would leave the receiver heater line open. Continuity must be restored with a resistor connected between points from which leads to heater socket terminals have been disconnected. Resistance should be 10 to 11 ohms. Actual dissipation will be about 3.8 watts, so the resistor should be rated for at least 5 watts and preferably for 10 watts.

Some tube brighteners contain a transformer with insulated secondary and have provisions for a one-to-one voltage ratio. Such a brightener may be installed much more easily than a separate transformer.

8 to 10. Internal Opens

Open circuits at base pins or within the tube envelope to the cathode, control grid and second grid may be checked with the setup of Fig. 8-5. Heater voltage is applied during the tests.

A control grid test is shown at *A*. In series between cathode and control grid connect a single dry cell, a d-c current meter reading to 0.5 ma or more, and a resistor of about 22K ohms.

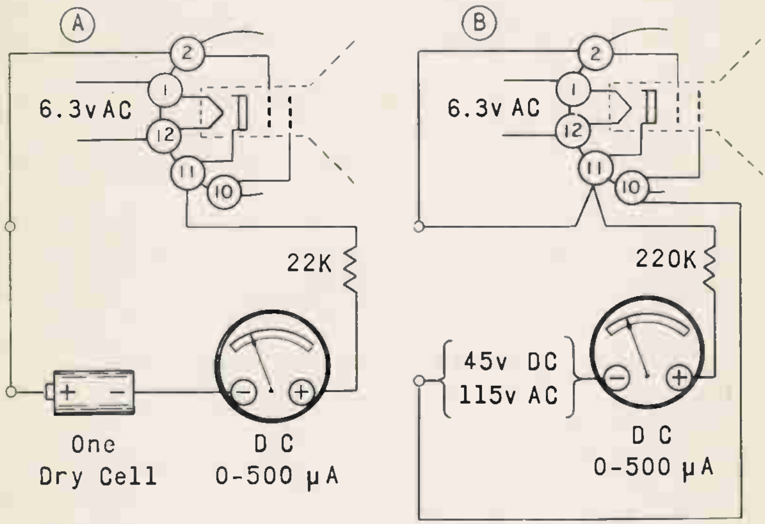

Fig. 8-5. Tests for elements internally open in the picture tube.

Check the second grid as in diagram *B*. Change the resistor to about 220K ohms. Connect the control grid to the cathode. Connect the second grid to the meter through a battery of about 45 volts or else to an a-c power line (110-120 voltage.

Zero reading on *both* tests indicates that the cathode is open.

Zero on test *A*. but not on *B*. shows that the control grid is open.

Zero on test *B* but not on *A* shows that the second grid is open.

An open circuit may be due to poor connection of an internal lead wire into a base pin. Resoldering may cure the fault, and can do not harm since the tube is useless with an open element.

Clean the tip of the pin with a fine sandpaper. Hold a hot soldering iron against the side of the pin near the tip while applying rosin core wire solder to the tip until some solder flows into the tip. An iron not hot enough or continued heating with any iron may loosen the pin in the base.

Some workers slip a piece of number 20 bare tinned hook-up wire into the pin while it is heated, then apply solder. Excess wire is cut off after cooling. If solder gets on the outside of the pin shave it off with a penknife blade.

11 and 12. Internal Shorts

Internal shorts sometimes may be discovered and located by using the highest resistance range of an ohmmeter as in Fig. 8-6. Remove the second anode (high-voltage) connector from the picture tube, cover the connector and place it where there is no chance of shorting to metal or giving you a shock.

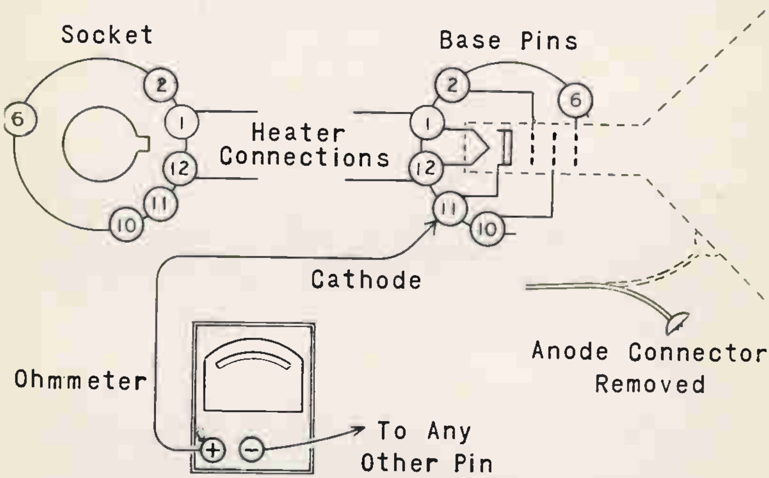

Fig. 8-6. Testing for elements shorted within the picture tube.

Remove the socket from the picture tube and make temporary connections from the heater line, or the line and ground, to pins 1 and 12 in order to light the heater.

Either lead of any ohmmeter may be positive with respect to the other lead. Determine which lead is positive. While checking for shorts to the cathode always connect the positive lead of the ohmmeter to the cathode. Otherwise the ohmmeter will show a low resistance reading which is due to emission current in the tube.

All internal elements may be checked by making the following connections in the order listed.

A. From cathode (pin 11) to control grid, second grid, focusing anode, second anode cap.

B. From control grid (pin 2) to second grid, focusing anode, second anode cap.

C. From second grid (pin 10) to focusing anode, second anode cap.

D. From focusing anode (pin 6) to second anode cap.

Internal shorts sometimes are burned out with high voltage from the high-voltage power supply of the receiver, using the cable that normally goes to the second anode cap on the picture tube. This method is likely to damage the high-voltage section.

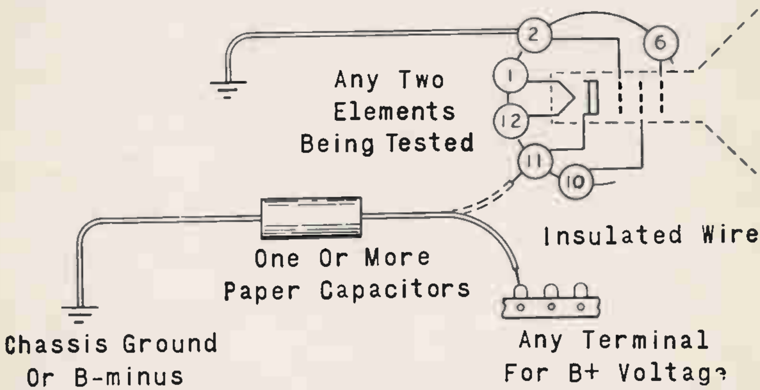

Fig. 8-7. Burning out internal shorts with the charge from a capacitor.

With another method of burning out shorts, illustrated by Fig. 8-7, a capacitor is charged from a d-c source and then discharged through the short. The discharge provides large current but discharge time is too brief to overheat the tube elements. The capacitor should be of at least one microfarad, or several units of less capacitance may be connected in parallel to make up the total. Capacitor voltage rating should at least equal the charging voltage, which may be taken from a B+ line or from a boosted B-voltage line of the receiver.

Remove the socket from the picture tube, also the high-voltage second anode connector. Connect the bared end of an insulated wire to one side of the capacitor. Connect the other side of the capacitor to chassis ground or B-minus. Connect either of the two shorted elements to chassis ground or B-minus.

Touch the other bared end of the insulated wire to the source of B-voltage for a moment, then touch this end of the wire to the pin for the shorted element that has not been grounded. The process may be repeated or a higher charging voltage may be used should the ohmmeter show that the short persists.

Picture Tube Brighteners

When cathode emission has become low due to aging of a picture tube the emission usually may be increased to obtain some further useful life by applying greater than normal voltage to the heater. This is done most conveniently with a tube brightener or booster consisting of a small transformer in a housing on which is a picture tube base with pins. There is a picture tube socket on leads connected into the brightener housing. The regular socket is removed from the picture tube and placed on the brightener while the socket on the brightener leads is put onto the base of the picture tube.

Some brighteners are designed to operate only where heaters are wired in parallel. Others will operate where heaters are wired either in series or in parallel.

A brightener will improve the performance of most old picture tubes. The improvement may last for only a week or so, or for many months.

Reactivation Or Rejuvenation

Picture tubes often are reactivated or rejuvenated by applying greater than normal voltage to the heater for a limited time while no voltages are applied to the second anode, the second grid, a focusing anode or the control grid. To the heater may be applied 9 to 10 a-c volts for about one minute, then about 7 volts for an hour or more. This may be done with a brightener which provides a choice of heater voltages.

Fig. 8-8 shows all connections for rejuvenation employing a step-down transformer which will supply secondary voltage adjustable from 6 to 10 volts. A small toy transformer with a 5-ohm 2-watt resistor in series is satisfactory. A non-adjustable 6.3-volt heater transformer may be tried instead of the adjustable type. The picture tube rectifies the a-c voltage. D-c

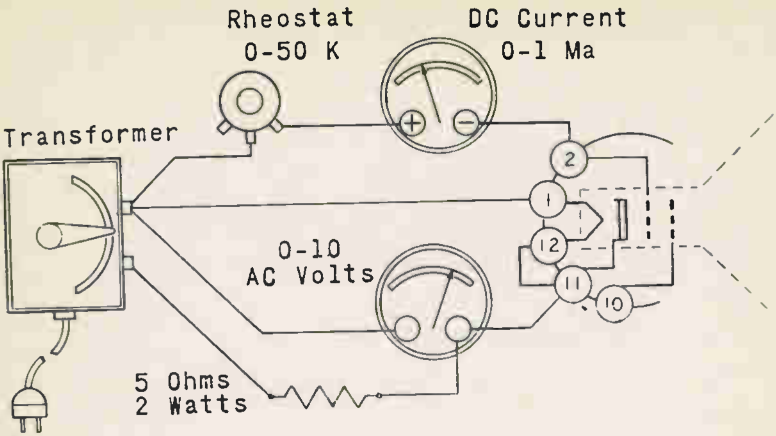

Fig. 8-8. Connections for picture tube rejuvenation from a stepdown transformer.

emission current flows from the control grid through a d-c milliammeter and adjustable rheostat.

With 7 to 8 volts on the heater the rheostat is set to limit emission current to no more than 0.1 to 0.2 ma in the beginning. The process is allowed to continue while emission current increases with the original setting of the rheostat. This current should not be allowed to exceed 0.5 ma.

Rejuvenation may allow improved performance for short or long periods, as is also true when a brightener remains on the picture tube. Often a brightener may be used for a few hours or days, after which the picture tube will continue to perform well for a considerable period without the brightener.

PICTURE TUBE ACCESSORIES

The second table relating to this group lists faults and symptoms for ion trap magnets, focusing magnets or coils, and centering magnets. Following explanatory paragraphs are numbered to correspond with numbers of faults in the table.

Ion Trap Magnets

16. Extreme misadjustment of an ion magnet may allow the viewing screen to show only a faint glow, visible only in a darkened room. Such misadjustment, if continued for more than a few minutes, will permanently damage the picture tube.

Adjust the magnet while tuned to an inactive channel with brightness advanced only enough to allow a dim raster. Rotate the magnet around the tube neck and slide the magnet forward or back to attain the maximum brightness. Retard the brightness control as adjustment proceeds.

Do not attempt shadow elimination by adjustment of the trap magnet if this causes any reduction of brightness. Eliminate shadows by the centering adjustment.

Focus sometimes is improved by slight readjustment of the trap magnet within the range of positions where brightness is not reduced. Check this on a raster of low brightness. Good focus may be impossible if the ion trap magnet has long remained misadjusted.

Any change of adjustment of a focusing magnet or coil, or of a centering device, should be followed by readjustment of the ion trap magnet for maximum brightness.

17. Strength of ion trap magnets is measured in gausses. The gauss is a unit related to concentration or density of magnetic field strength in a given cross sectional area of the field. Strengths of commonly used magnets range from 30 to 50 gausses.

For tubes of recent design the strength of the ion trap magnet is increased by about one gauss for every 1,000-volt increase at the second anode or ultor. There is no direct relation between magnet strength and size of the viewing screen.

A magnet which has to be moved well toward the yoke for maximum brightness probably is too weak. One that has to be moved close to the tube base for maximum brightness probably is too strong. Good brightness may be unobtainable with a weak magnet in any position.

18. As a general rule a single-field ion trap magnet won't work on a picture tube designed for a double-field magnet, nor the other way around. There are a few tubes which operate satisfactorily with either kind of magnet.

19. A double-field magnet turned front for back will cause severe shadowing when moved to the position for maximum brightness. A single-field magnet may be rotated to the position for maximum brightness and good picture reproduction regardless of front and back relations.

Focus Magnet Or Coil

20. If a focusing magnet or coil is moved lengthwise of the picture tube neck to improve focus or prevent shadowing it is necessary to readjust the ion trap magnet.

21. It is important that a focusing magnet or coil be centered around the tube neck, with practically uniform spacing between the outside of the neck and the inside of the magnet or coil at all points. A unit off center may cause generally poor pictures.

22. A focusing coil rotated to the wrong position around the tube neck may make good focusing difficult or impossible. The effects usually are worse with a coil than with a PM focuser.

23. A focusing magnet of wrong strength for the picture tube may allow good focus only at the sides of pictures or only at the center.

26. Reversed leads to a focusing coil may have little effect on focus, but one connection will require more or less coil current than the other connection. If the focus current adjustment cannot provide enough variation of current there will be poor focus.

27. Turning a focusing coil front for back does not have just the same effects as reversing the coil leads, because a magnetic gap on the inside of the coil housing should be toward the yoke, not away from the yoke.

28. Changes anywhere in the B-supply circuits of some receivers, or deterioration of resistors in such circuits may either limit or increase focusing coil current to such an extent that the adjusting pot cannot make compensation. Then good focus can be had only at the center or only at the sides of the viewing screen.

Centering

30-31. In cases where shadowing persists when there is correct centering the trouble sometimes may be overcome by rotating the picture tube on its neck axis to a new position.

Table 8-B PICTURE TUBE ACCESSORIES	Brightness Lacking	Centering Difficult	Dark, No Raster	Definition Poor	Focus Poor	Ion Burn	Shadowing	Skew Or Tilt
ION TRAP MAGNET								
16 Misadjusted	•	•	•	•		•	•	
17 Too weak or too strong	•			•				
18 Wrong style for tube	•				•			
19 Turned front for back		•					•	
FOCUS MAGNET OR COIL								
20 Too far forward or back					•		•	
21 Not centered on tube neck		•			•		•	
22 Rotated to wrong position		•			•			
FOCUS MAGNET								
23 Too weak or too strong					•			
24 Wrong type for tube					•			
FOCUS COIL								
25 Control pot defective					•			
26 Leads reversed	•	•			•			•
27 Turned front for back		•			•			•
28 Current too great or small					•			
29 Internal open or short					•			
CENTERING MAGNET								
30 Wrong position		•					•	
31 Weak		•						

SECTION 9

THE SYNC SECTION

As shown by Fig. 9-1, signal input to the sync section is from the video amplifier or detector. Sync output is to vertical and horizontal sweep oscillators. The input to all sync sections is a composite television signal consisting of horizontal sync pulses, vertical sync pulses, equalizing pulses, blanking intervals, and picture signals.

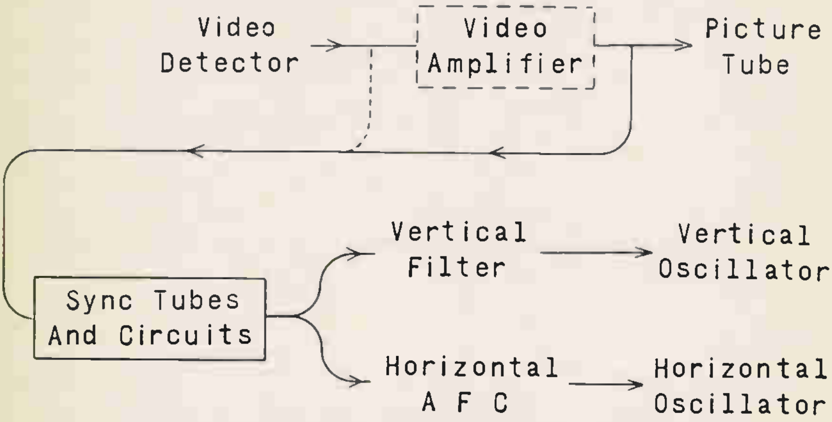

Fig. 9-1. Signal paths through the sync section.

From the composite signal the sync section must form vertical synchronizing pulses which go through a vertical (integrating) filter and trigger the vertical sweep oscillator, also horizontal synchronizing pulses which go to the horizontal afc system for control of the horizontal sweep oscillator.

Oscilloscope For Testing

The function of the sync section is to receive waveforms of a complete video signal and deliver waveforms suitable for synchronizing the sweep oscillators. Since necessary changes of waveform may be observed only with an oscilloscope, the scope is a great time saver when locating faults in any sync section.

The oscilloscope need have only moderate vertical gain, something like 0.05 rms volt per inch or even less being sufficient. The vertical attenuator should be frequency compensated and a compensating probe with shielded cable should be used. This is especially necessary for observing horizontal pulse traces.

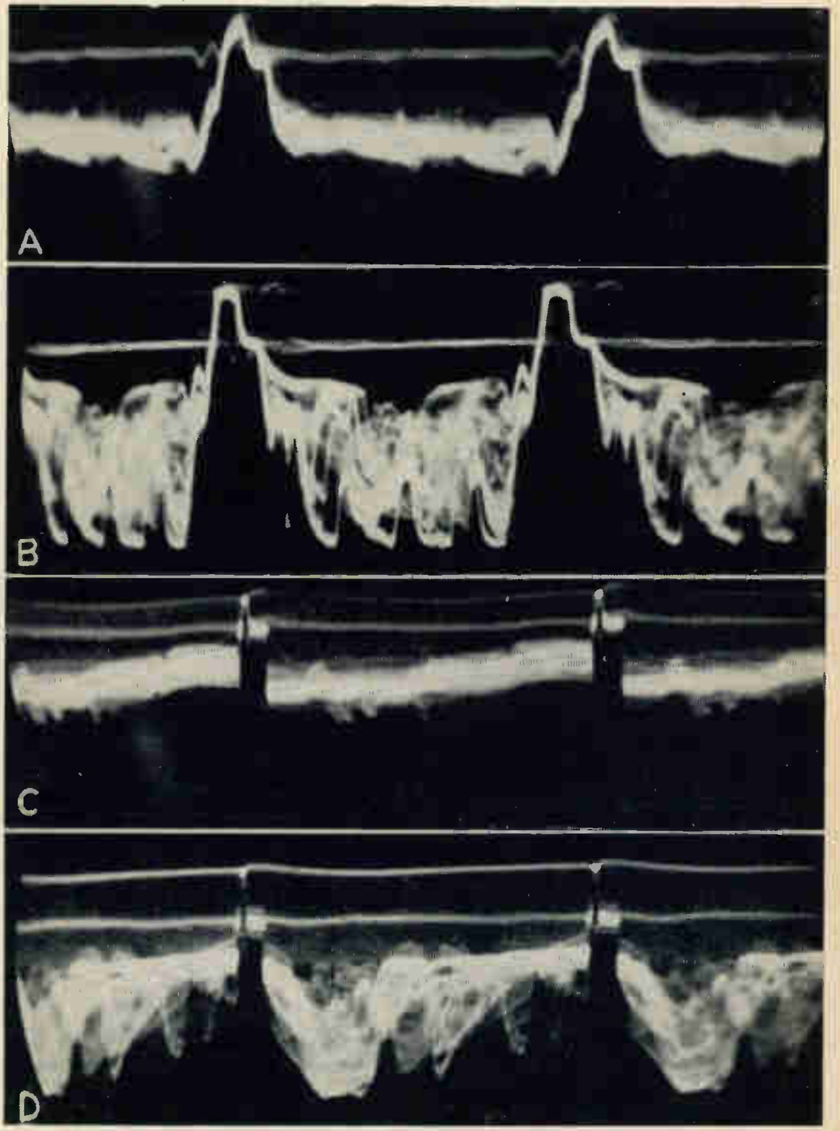

Fig. 9-2. Horizontal trace with poor frequency compensation (A) and with better compensation (B). Vertical trace with poor compensation (C) and with better compensation (D)

At *A* of Fig. 9-2 is a horizontal trace seen with poor compensation, and at *B* is a similar signal with satisfactory compensation. At *C* is a vertical trace with poor compensation, and at *D* with good compensation for similar signals.

Sync Sections With Triodes

In Fig. 9-3 are circuit connections for a widely used sync section employing two triodes which may be in the same envelope or else portions of two separate tubes used also for other purposes.

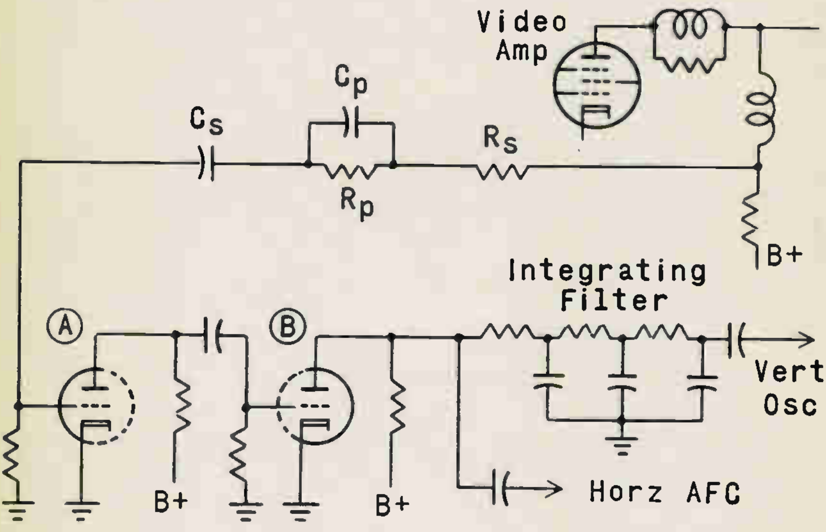

Fig. 9-3. Two triodes in a sync section.

Input for this sync section is taken through resistors and capacitors from the plate load of the video amplifier to the grid of tube *A*. Tube *A* often acts chiefly as a sync amplifier, but is operated with plate voltage low enough to limit or clip the positive peaks of sync pulses that come from the video amplifier.

There is polarity inversion in tube *A* and again in tube *B*, making pulse polarity at the plate of *B* the same as at the plate of the video amplifier. Output from tube *B* goes through an integrating filter to the vertical oscillator and through a capacitor to the horizontal afc system.

At the sync takeoff from the video amplifier the horizontal and vertical waveforms should have, as in Fig. 9-4, reasonably

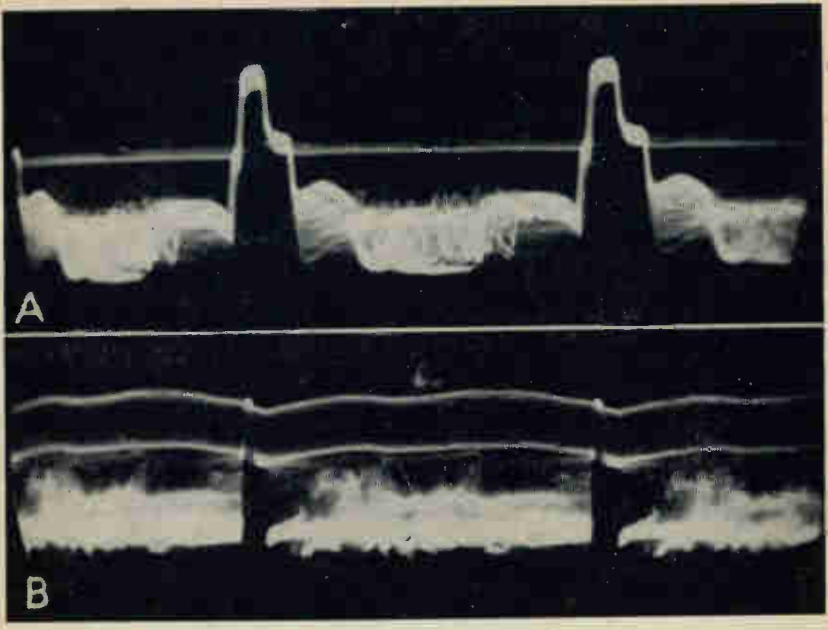

Fig. 9-4. Satisfactory video signals are the first requisite for good synchronization. Horizontal (A) and vertical (B).

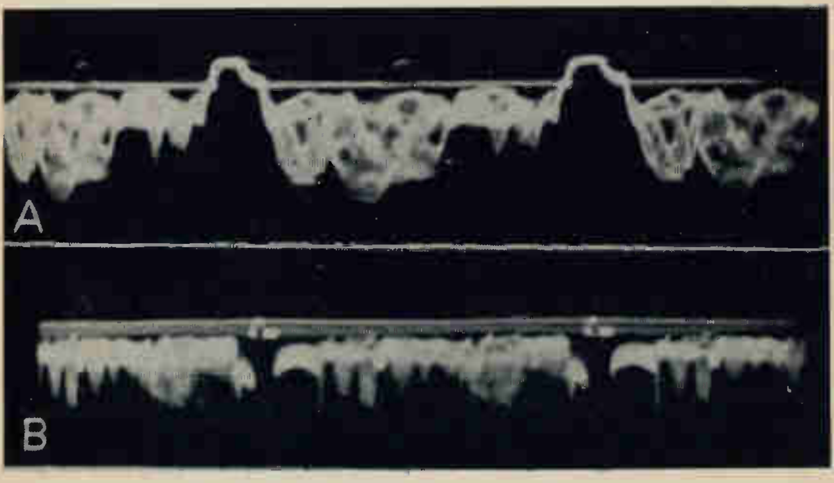

Fig. 9-5. Sync pulses of limited amplitude make synchronization difficult or impossible. Horizontal (A) and vertical (B).

flat topped sync pulses without excessive slope or fuzziness. Height of the pulses alone should be at least one-fourth or total peak-to-peak height of video signals for light-toned pictures.

If sync pulses are low in proportion to the total video signal, as illustrated by Fig. 9-5, it will be nearly impossible to have good synchronization of pictures. Such limiting of sync pulses nearly always is due to overloading in the video amplifier. Overloading may result from insufficient plate or screen voltage, from grid bias not sufficiently negative, or from excessively strong signals from the video detector.

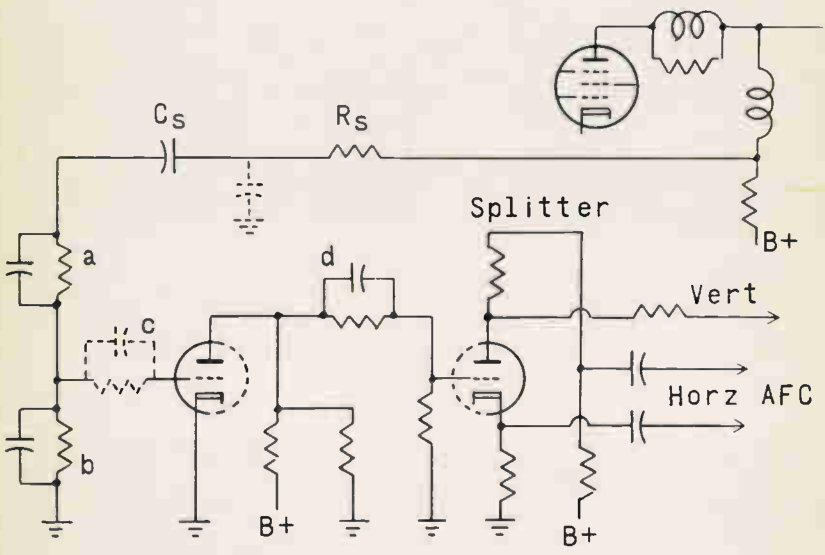

Fig. 9-6. Resistors and capacitors in series or in parallel may be at various points in the sync circuits.

Video Signal Filtering

In Fig. 9-3 video signals on their way to the first sync tube pass through a series resistor *Rs* and series capacitor *Cs,* also through resistor *Rp* and capacitor *Cp* in parallel. A resistor and capacitor paralleled might be at any one or more of the positions marked *a, b, c* and *d* in Fig. 9-6.

A series resistor, *Rs,* prevents the first sync tube from taking too much signal strength away from the video amplifier output, it isolates the sync section from the video amplifier.

Resistance value usually is from 10K to 33K ohms, which reduces strength of signals reaching the sync section. Resistance sometimes is changed to smaller value if more effective sync action is needed, and if the change does not adversely affect signals from video amplifier to picture tube.

A series capacitor, *Cs*, blocks high B+ voltage in the video amplifier plate circuit from the grid of the first sync tube, and thus allows suitable grid biasing for the sync tube. Series capacitors most often range from 0.002 mf to 0.02 mf.

A resistor and capacitor in parallel have the apparent effect, as observed with the scope, of "cleaning up" the pulses

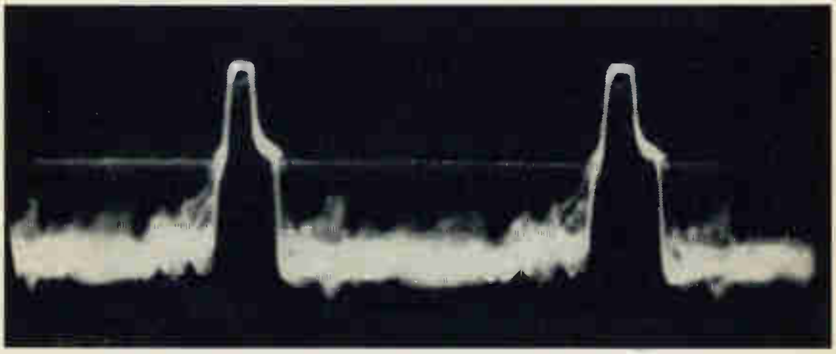

Fig. 9-7. Filter capacitors help improve the waveform of sync pulses. Compare Fig. 9-4-A.

when it is needed. Horizontal pulses of Fig. 9-4 appear as in Fig. 9-7 upon reaching the grid of the first sync tube. Fuzziness is removed and steepness of leading edges is maintained or improved.

Effects of a parallel resistor-capacitor filter are not so apparent in vertical pulse traces, but the effects are there just the same. Paralleled resistors range from 100K to 470K in most sets while paralleled capacitors range from 220 to 470 mmf. Values are chosen for best results in each receiver circuit.

All or most of the series and parallel resistors and capacitors may be in a single printed circuit unit, such as a couplate, enclosed in molded plastic with pigtail leads.

Sync Amplifier

One of the triodes in Fig. 9-3 is an amplifier and the other is a separator or clipper. The first tube might serve either function while the second tube serves the other function. How a tube performs depends on plate and grid voltages.

For example, about 50 volts on a triode plate and 5 or 6 volts negative bias on its grid allows considerable amplifica-

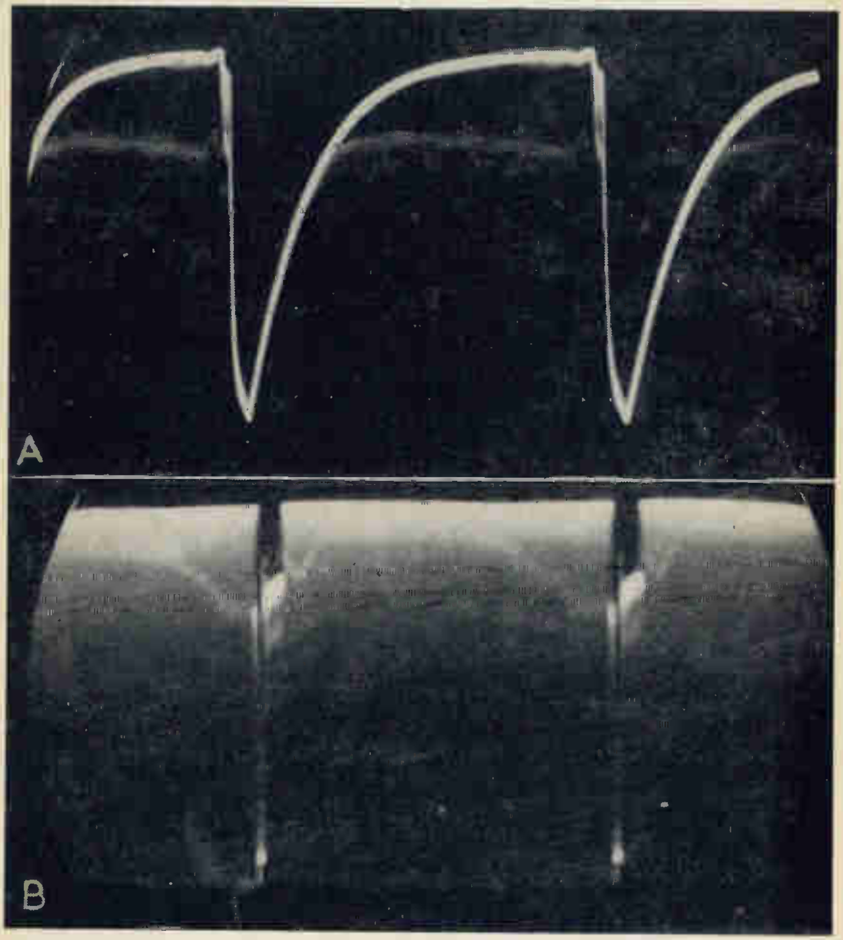

Fig. 9-8. Horizontal waveforms (A) and vertical (B) of these general types should appear after a sync separator triode.

tion. But strongly positive peaks of sync pulses, also noise pulses, exceed the bias and there is plate current limiting of pulse peaks on the plate output.

Sync Separator Or Clipper

With voltage so low as 15 to 30 on a triode plate, and with grid-leak biasing, negative picture signals and often the lower portions of sync pulses drive the grid to plate current cutoff. The result is removal of picture signals and maybe part of the sync pulses. The tube is called a separator or clipper, two names used to describe the same function.

At the separator plate appear horizontal pulses of the general form in Fig. 9-8 at *A* and vertical pulses such as at *B*. Whether polarity of these pulses is negative, as shown, or is positive depends on whether the separator immediately follows a video amplifier whose output has sync pulses positive or negative. Any sync tube between video amplifier and separator will invert the pulses.

These horizontal and vertical pulses accompanied by little or no picture signal are highly important. Something of this kind will appear somewhere in every sync section that is working properly.

The separator or clipper is the essential tube of the sync section. Other tubes may amplify, limit or invert the pulses, but the separator forms the pulses for application to following sweep oscillator circuits.

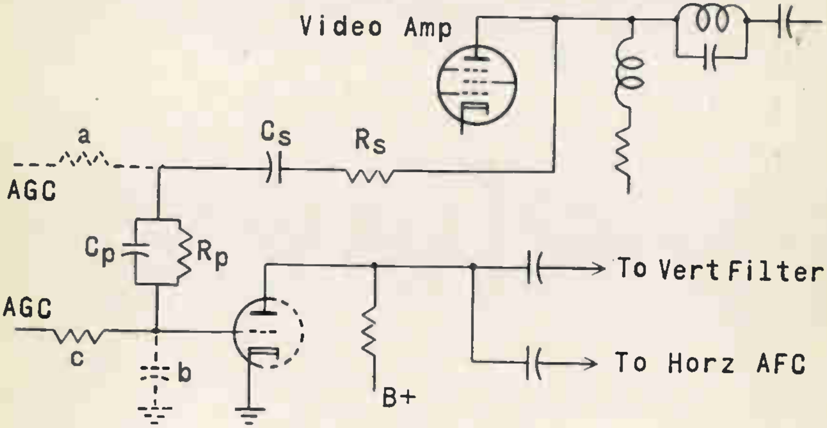

Fig. 9-9. A sync section consisting of one triode acting as a separator or clipper.

In Fig. 9-9 the only sync tube is a separator or clipper with the usual series and paralleled resistors and capacitors in the line from the video amplifier. The separator grid return might be through a high resistance to ground, as in other diagrams, or, as here, to a line carrying agc voltage. The agc connection may be through a resistor at *a*, with a capacitor used at *b*, or the agc connection may be through a resistor at *c*.

A separator grid always is negatively biased to a degree which, acting with low voltage on the plate, causes plate current cutoff of all negative portions of video signals. These are

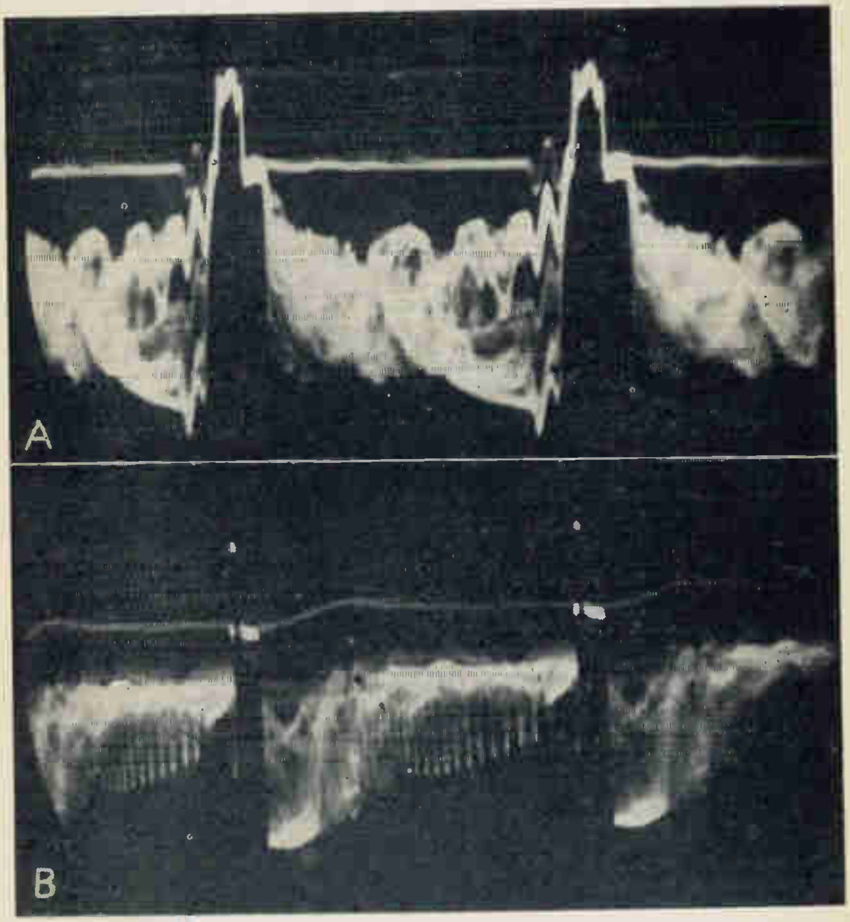

Fig. 9-10. Horizontal signals (A) and vertical (B) at sync takeoff from video amplifier plate circuit.

the portions containing picture signals. The required negative bias may be from the agc system, as in Fig. 9-9 but more often is secured from grid-leak biasing.

The separator amplifies the sync pulses to some extent while cutting off the picture signals. In addition, because of low plate voltage, the separator limits the positive peaks of sync pulses. This limiting occurs at the point where grid current commences to flow for maintaining a charge in the capacitor used for grid-leak biasing.

In a receiver using the sync system of Fig. 9-9 the hori-

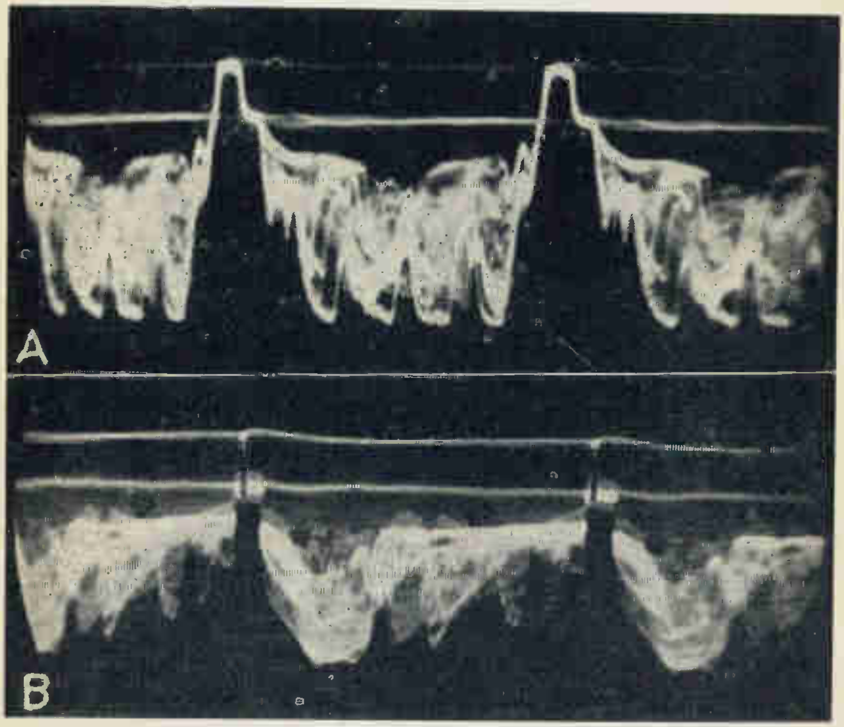

Fig. 9-11. Signal waveforms are improved as they pass through the sync input filter system. Horizontal (A) and vertical (B).

zontal and vertical signals from the video amplifier plate appeared as in Fig. 9-10. After passing through the resistors and capacitors the signals at the separator grid were as in Fig. 9-11. At the separator plate the signals to vertical integrating filter and to horizontal afc appeared as in Fig. 9-12.

Note that separator output waveforms of Fig. 9-12 are essentially equivalent to those of Fig. 9-8. These are the typical separator outputs which always should appear.

Traces of Figs. 9-10, 11 and 12 were taken without altering vertical gain of the oscilloscope. It is apparent that sync pulses at the separator plate (Fig. 9-12) have been amplified in comparison with pulses at the grid (Fig. 9-11).

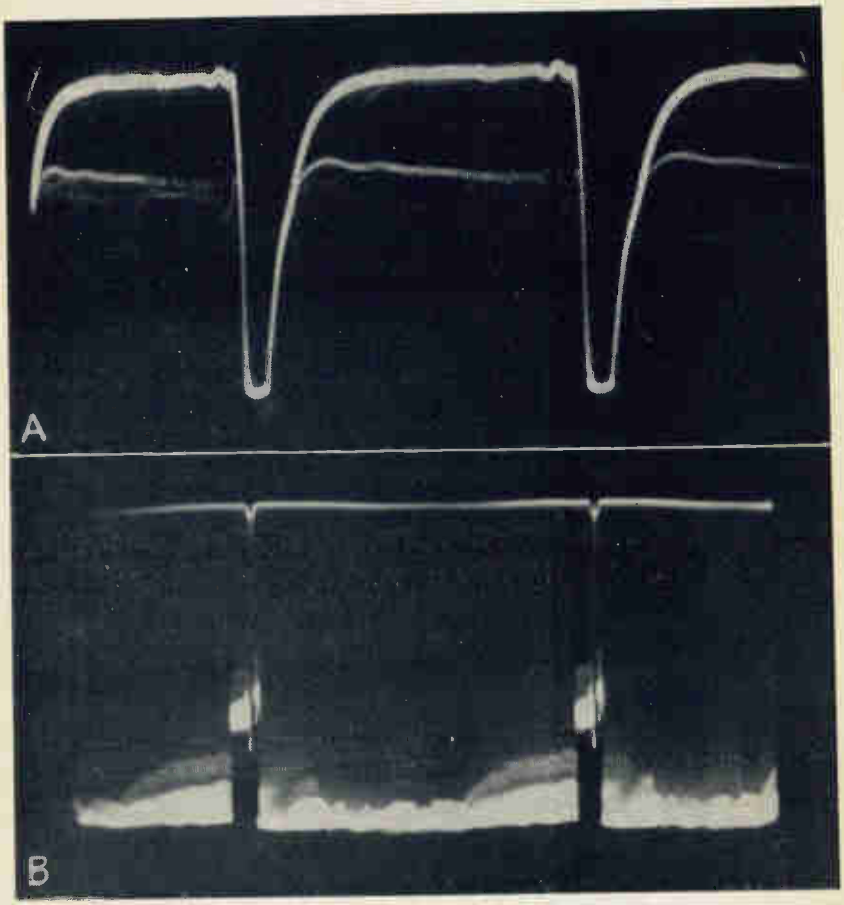

Fig. 9-12. These signals are delivered from the separator plate to horizontal and vertical sweep sections. Both the horizontal (A) and vertical (B) signals go to both sweep sections.

Fig. 9-13 shows another sync section using only a separator. The separator feeds to a phase splitter which is considered part of a following afc system employing a phase detector. Note the direct conductive coupling from separator plate to splitter grid. The separator plate and splitter grid may operate at something like 10 to 15 volts positive. Cathode

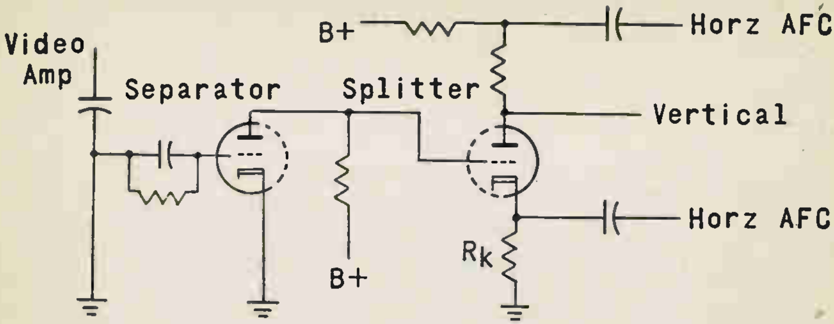

Fig. 9-13. The single sync tube, a triode separator, feeds to a splitter or inverter used with a phase detector for horizontal automatic frequency control.

bias from resistor *Rk* on the splitter is slightly greater than positive voltage on the grid, thus providing a small effective negative bias for this tube.

Two-stage Separator-clipper

In Fig. 9-14 one tube is called a separator, another is called a clipper, and a third is a sync amplifier. The clipper is operated with a grid grounded for signal voltages, input being a direct connection from separator plate to clipper cathode. In a typical case the element voltages are as follows:

	Plate	Grid	Cathode
Separator	+ 80	— 20	0
Clipper	+ 130	+ 50	+ 80
Amplifier	+ 80	— 3	0

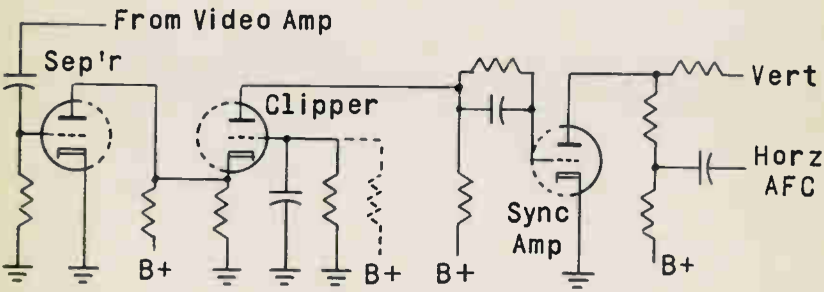

Fig. 9-14. Separate separator and clipper triodes are used for removing picture signals and for clipping or leveling the sync pulses.

Sync pulses are positive and picture signals negative from video amplifier to separator grid. The highly negative grid of the separator causes cutoff of negative picture signals in spite of the rather high plate voltage.

Due to polarity inversion in the separator, sync pulses at its plate and at the clipper cathode are negative. The clipper grid is 30 volts less positive than its cathode, giving an effective 30-volt negative grid bias. Negative pulse peaks are cut off by the clipper to uniform height or amplitude.

Horizontal And Vertical Separators

In Fig. 9-15 there is a horizontal separator, a vertical separator, and a sync output tube. We shall follow signals through

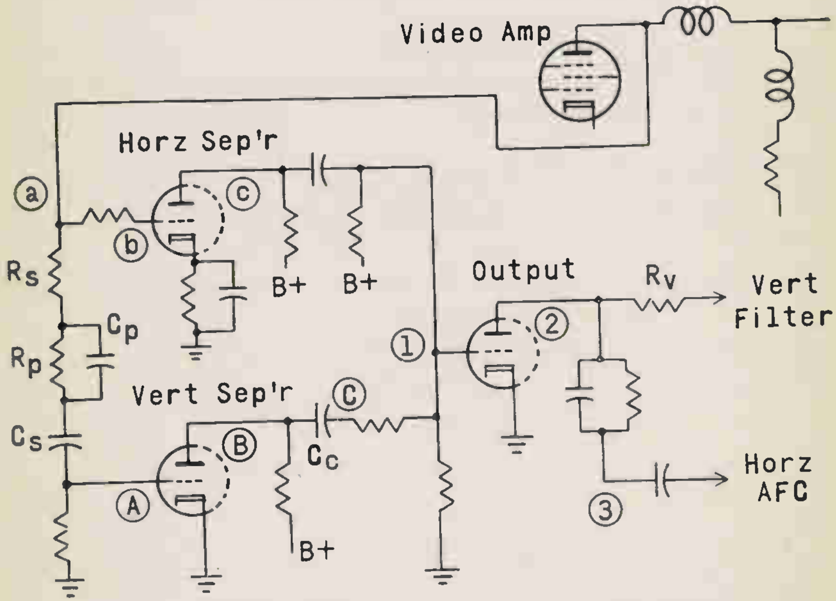

Fig. 9-15. A sync section having individual separators for horizontal and vertical sync pulses, with combined pulses fed to a sync output tube.

this rather elaborate sync section to learn that certain changes of waveform should occur in any sync section, no matter how the tubes are arranged. All traces were made without altering vertical gain of the oscilloscope.

Fig. 9-16-a shows video amplifier output signals observed at *a* of Fig. 9-15. At *b*, the horizontal separator grid, signals are weaker and slightly rounded due to 10K ohms in series with the grid. At *c*, the horizontal separator plate, signals have the familiar forms observed earlier in Figs. 9-8 and 9-12.

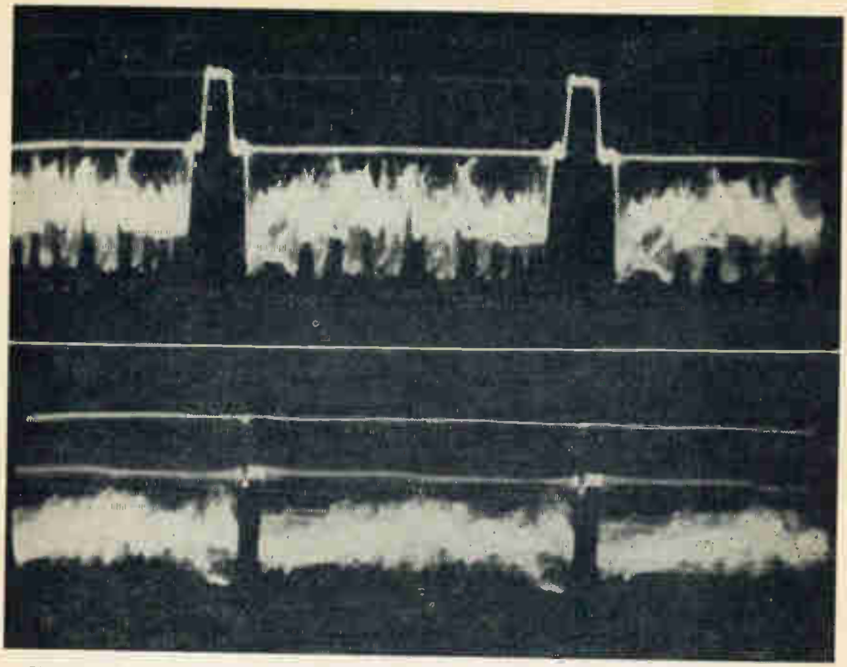

Fig. 9-16-a. Horizontal and vertical signals from the video amplifier as observed at a of Fig. 9-15.

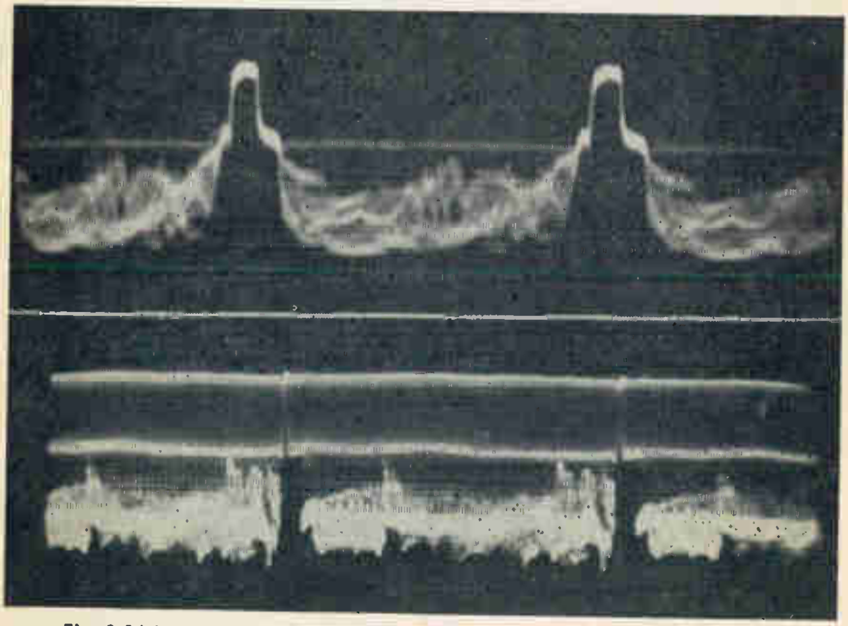

Fig. 9-16-b. Signals at horizontal separator grid, observed at b of Fig. 9-15.

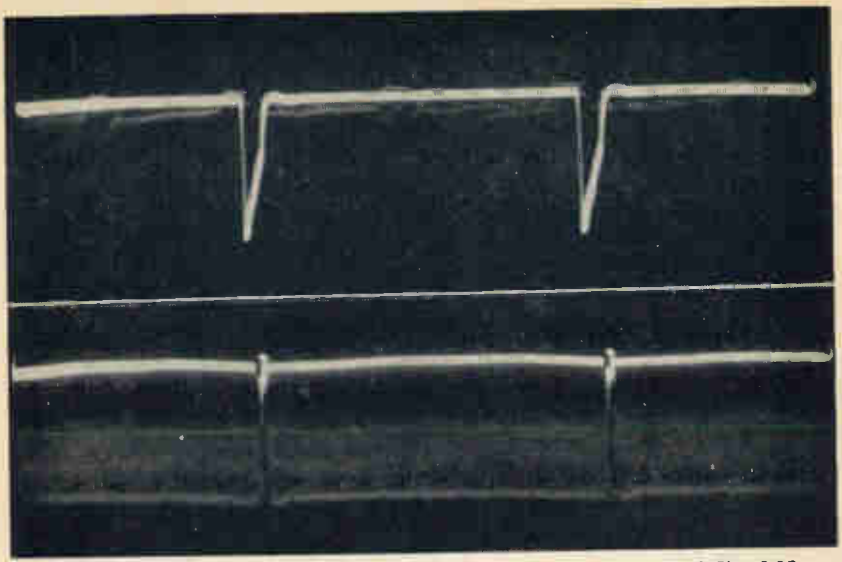

Fig. 9-16-c. Signals at horizontal separator plate, observed at c of Fig. 9-15. Either a horizontal or a vertical waveform may be seen, depending only on the sweep frequency of the oscilloscope.

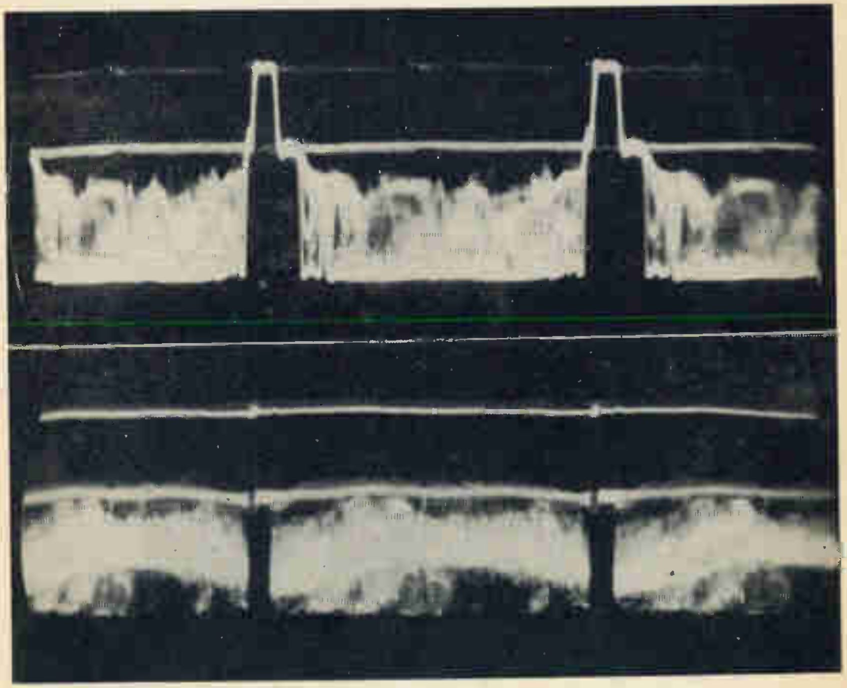

Fig. 9-17-A. Waveforms at the vertical separator grid, A of Fig. 9-15, after passing through sync filter elements.

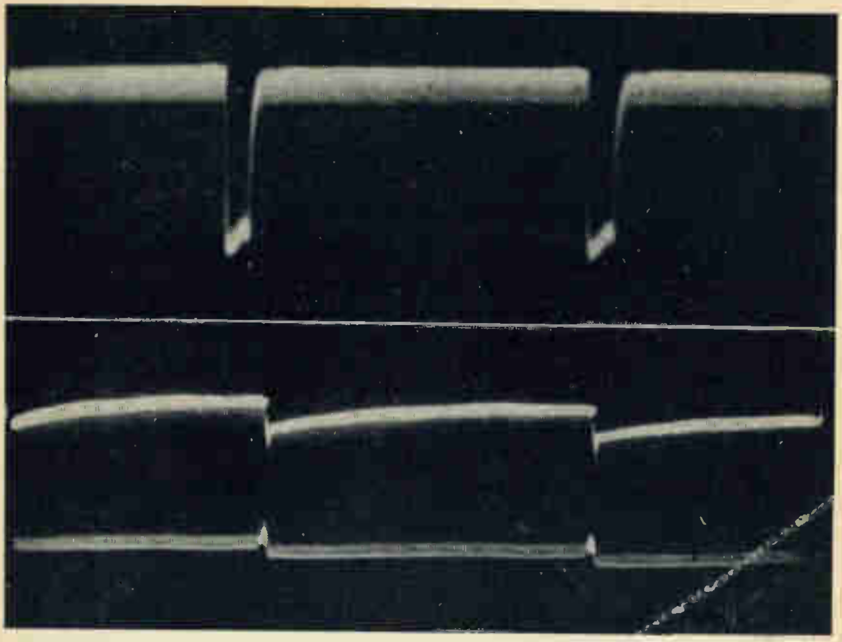

Fig. 9-17-B. At the plate of the vertical separator, B *in Fig. 9-15, these pulses appear with the scope internal sweep timed for horizontal and vertical intervals.*

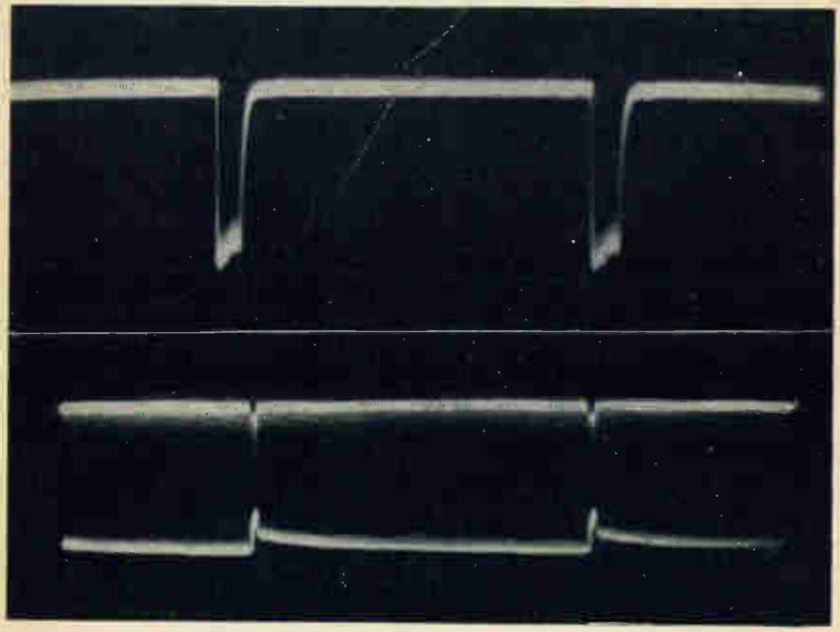

Fig. 9-17-C. At C *of Fig. 15 the pulse waveforms are nearly the same as at* B.

Video amplifier output signals go from *a* of the circuit diagram through series and paralleled resistors and capacitors to *A*, the vertical separator grid, and there are seen to be well formed and sharp as in Fig. 9-17-A. At the vertical separator plate, *B*, we find waveforms of Fig. 9-17-B. These are generally similar to waveforms in Figs. 9-8, 9-12 and 9-16-c. Beyond capacitor *Cc*, at point *C* on the circuit diagram, the pulses appear as in Fig. 9-17-C.

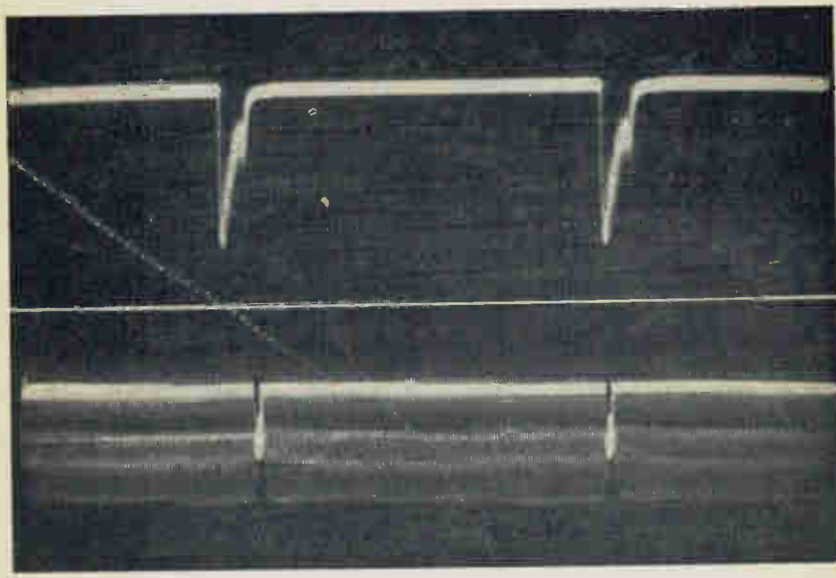

Fig. 9-18-1. Pulses from horizontal and vertical separators combine at the grid of the sync output triode, 1 of Fig. 9-15.

Signals from the horizontal and vertical separators combine at the sync output grid, *1* on the circuit diagram, and appear as in Fig. 9-18-1. Combined signals at the output plate, *2* on the diagram, are as in Fig. 9-18-2. These signals go to the vertical integrating filter through resistor *Rv*, also to the horizontal afc system through a paralleled resistor and capacitor. From this paralleled combination we have, at *3* on the diagram and in Fig. 9-18-3, sharp and well-defined horizontal pulses.

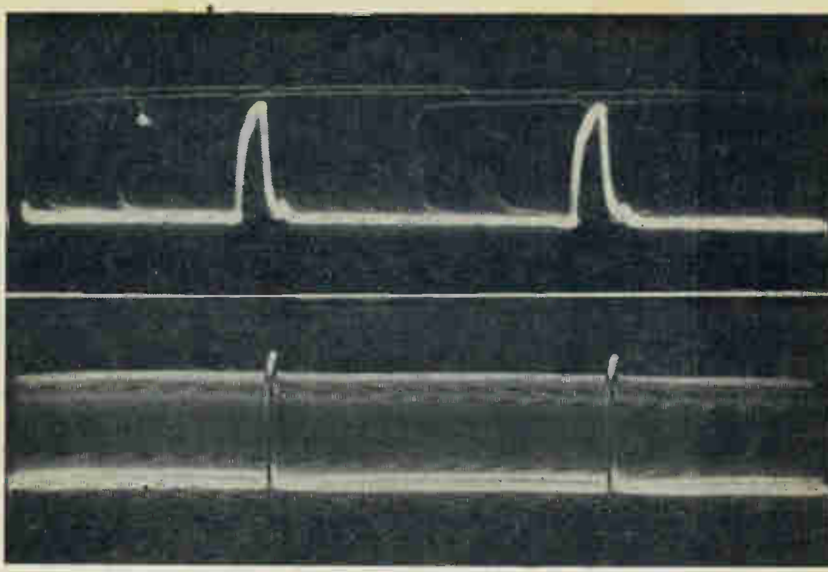

Fig. 9-18-2. These horizontal and vertical waveforms appear at the sync output plate, 2 of Fig. 9-15.

Fig. 9-18-3. These horizontal pulses go to the horizontal afc system, from 3 of Fig. 9-15.

Element voltages for the sync section of Fig. 9-15 were approximately as follows while traces were photographed.

	Voltages Measured To Chassis Ground			Effective Voltages, Measured To Cathode	
	Plate	Grid	Cathode	Plate	Grid
Horz Sep'r	+ 240	+ 80	+ 120	+ 120	— 40
Vert Sep'r	+ 80	— 35	0	+ 80	— 35
Output	+ 50	— 2	0	+ 50	— 2

Note that the separators have rather high effective plate voltages, but also highly negative grid biases. It is relative values of plate voltage and grid bias that determine whether a tube acts as a separator or an amplifier.