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practical TV trouble-shooting

HOW TO
LEARN MORE
FIXING
TOUGH TV SETS

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PRACTICAL TV TROUBLESHOOTING

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contents

introduction

WITHOUT belittling the fact that some repair jobs can cause two gray hairs to grow where only one appeared before, throwing all sets into the canine category implies a certain lack of confidence.

What is this confidence and how do we go about getting our share? You get it with each set you tackle successfully. You lose some of it with every receiver you shove over to the end of the bench with the idea that you'll get to it when you have time. Sooner or later, depending on how loudly the customer screams, that postponed stack will demand attention. But what may have originally been just a set or two, can pile up (a lot faster than most of us realize) into a very respectable mound.

Working on tough jobs brings more than its share of aggravation. There is always the risk that the time you put in will not pay off. There is always the chance that a few hours of troubleshooting will end up with the completely demoralizing discovery that the culprit is just a part worth a few cents. Add to this the confidence-rocking realization that "it was staring me in the face and I didn't see it" and you'll know why such sets get shoved aside.

Even experts can be stumped but the difference between a tube puller and an expert can be reduced to a matter of percentage. A savvy technician may get baffled once in a while, but this represents just a few sets of the large total he works on.

This brings us to the purpose of this book. What we have here is a compilation of articles on television servicing selected from among the best of those that have appeared in RADIO-ELECTRONICS Magazine. Written by practicing service technicians, the articles show how these top echelon technicians learned how to think their way through. In those instances in which theory is given you will find that its function is not to teach you the elements of how a TV set works, but to supply the proper background for explaining the reasons for defects in a particular circuit.

No book on television servicing can ever be complete and this one makes no such pretense. You can be sure that manufacturers will continue to produce new models, each of which will have its own crop of servicing difficulties. However your best servicing tool still continues to be your experience, and, if to your own you can add the experience of others (as described in this book) then you've given yourself a boost up technically. If this book helps you move just one set off the end of your bench, it will have served its purpose. Given a chance (by a thorough reading) it can do much better than that.

The editorial staff of Gernsback Library acknowledges with thanks the use of material supplied by these authors: Jack Darr, William Feingold, Charles Garrett, R. D. Jacques, Wayne E. Lemons, A. V. J. Martin, James McRoberts, Lucian Palmer and Warren J. Smith.

MARTIN CLIFFORD

chapter

1

intermittents

INTERMITTENTS! Please, don't mention that nasty word around the shop. They may make life interesting for the technician but they certainly do not add to his income unless he is equipped to handle them with speed, and too many of such time-consuming toughies can put a technician out of the service business for good.

We cannot delve into a tough electronic mystery with only bare hands and common sense. These things help, but good equipment is also required. Unfortunately, many technicians are limited as to funds for purchase of all the equipment they should have. There are various types of equipment essential for working with intermittents with any degree of success:

Tube checker

While a mutual conductance checker is preferred, a simple emission job is useful and costs less. Since the best tester we can buy will not reveal some tube defects and we must as a last resort try substitution, most any simple checker will do. For field service, its speed of operation, ruggedness and portability are the most important considerations.

Volt-ohm-milliammeter

This instrument should be accurate, portable, rugged and dependable. Many good ones are now available at reasonable prices. And if you're concerned about circuit loading, remember that some vom's have sensitivities as high as 100,000 ohms per volt.

Variable-voltage isolation transformer

This piece of equipment should vary the line voltage between 0–150 volts. The transformer should handle at least 7.5 amperes continuously. If a voltmeter is not built in, provide one externally for monitoring the output.

Vacuum-tube voltmeter

In addition to its very high impedance (much more than that of any volt-ohm-milliammeter) the vtvm permits resistance readings over much wider ranges, from fractions of an ohm up to about 1,000 megohms. The higher resistance ranges are useful for measuring high-value resistors and the leakage of capacitors. The vtvm will help you measure ac and dc voltages, from less than one to several thousand. High-voltage probes extend the dc range to 30,000 volts and more. High-frequency probes push the rf range of the vtvm up into the megacycle region.

The oscilloscope

Use it for tracing hum, examining and measuring non-periodic waveforms, signal tracing.

Signal generator

You need one that will cover the operating frequencies of the equipment under test. For most checking on intermittents, tests are made using the regular channels rather than the output from the signal generator.

Source of variable dc voltage

For making surge tests and breakdown tests on capacitors, resistors and transformers.

Resistance–capacitance bridge

This piece of equipment is highly recommended because of the excellent leakage checks provided that will reveal hidden sources of trouble. Since capacitors are among the worst offenders when it comes to causing intermittent operation, checking them accurately is important. And to avoid trouble with repair jobs, *every* replacement should be carefully checked before it is put into use.

Heat lamp

This unit should be portable and have an aluminum reflector.

A heat bulb can be inserted in a photographic reflector equipped with a hand clamp. The lamp is used to raise the working temperature of suspected parts. Always apply heat carefully to avoid damage.

Hot box for cooking a chassis

The box is simply four pieces of plywood $3/8$ inch thick and any reasonable size. It can be assembled over the chassis to form a box with the bottom and front open. The boards can be held together with small pieces of angle iron and some wood screws so that the assembly can be dismantled and folded flat for easy storage when not in use. Cover the plywood on one side with sheet asbestos which may be attached with ordinary wallpaper paste. Cover the front with a piece of canvas or an old blanket. Mount a thermometer through a hole in the top board to show the inside temperature and you are ready for business. Because of fire hazard, a chassis must be watched constantly while cooking. Always keep a fire extinguisher handy.

Other equipment

A bar generator, audio oscillator, grid dip meter, resistance and capacitance substitution boxes, picture-tube reactivator and checker, and a signal tracer are all useful in checking intermittents. Several potentiometers mounted on a board with test leads attached are also useful. Equipment built from kits is adequate for most jobs. The saving in cost is certainly worth while.

Tube troubles

A large percentage of service calls involve only tube replacement. Ordinary tube troubles like shorts, open filaments or heaters, weak emission, gas and breakage show up immediately. The old tubes are thrown away, new ones are installed and the customer is happy. The fun starts when the customer calls 2 hours later to inform us that we did not fix her set, we just made it worse. By the time we get back to look the situation over, everything is working like a charm. We turn the set off and it refuses to come back on again. That's the way it goes!

Often a new rectifier tube will pep up plate voltages enough to cause a coupling capacitor to let go, and once the cycle has started there is no cure short of actually tracking down the defective part and replacing it. Meanwhile, the owner is unhappy about the whole deal and often unwilling to pay for any extra labor or materials. Tact and a lot of careful explaining are necessary at this point, and here is where knowledge, experience and equipment will pay off.

The set is taken to the shop, and the tubes check OK. But are they really all good? No tube checker can give a final answer because there are some defects that do not show up on the best of tube checkers. The applied voltages and loads are different from those in the chassis. Pounding on the tubes (Fig. 101) while they are being checked often indicates loose elements; it can also break good tubes. And we may still overlook an intermittent. The fastest way to eliminate tubes completely as a

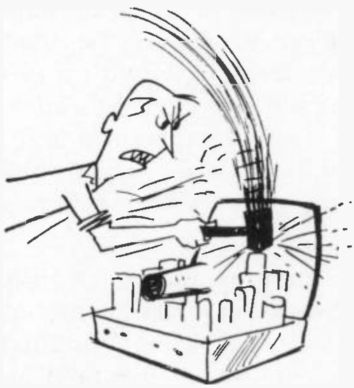

Fig. 101. *Tapping tubes to check for loose elements is a useful servicing technique. It can be overdone.*

source of trouble is to replace the whole set at one time, and then give the equipment a thorough check. If the trouble shows up after the usual waiting time, we can forget about tubes and start looking elsewhere.

Keep a complete set of good used tubes on a rack above the workbench for use in checking doubtful sets. These tubes should be set-tested and all above reproach as far as noise, emission and overall performance can be determined. And don't yield to the temptation to sell one or more of these tubes (when you run out of stock) any more than you would sell your test equipment.

A very important point to remember when working with intermittents is: *never do anything haphazardly*. Always keep a record of every move so things can always be returned to the starting point in case the trouble has not been found.

External causes of trouble

Before pulling a chassis make sure that the trouble is not external. Many hours have been wasted slaving over a perfectly good chassis only to find later on that it was the antenna that was bad or the line voltage was way off. This check list will help eliminate the external causes of trouble:

Antenna system

1. Check for loose elements, corrosion, broken or spliced lead-in, broken insulators and leakage due to dampness.
2. Check the ground wire, lightning arrester and the antenna rotor.
3. Always check field strength if possible and, as a last resort when tracing intermittent interference, substitute another set in the same location.
4. Check switches, converters or boosters in the antenna circuit.

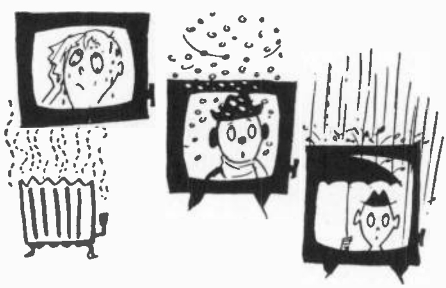

Fig. 102. *Sometimes a balky TV set is simply a victim of its environment.*

5. Check the twin lead where it attaches to the antenna terminals on the receiver. Make sure each lead has the same number of strands and that no stray strand is reaching over to touch the chassis or the opposite antenna terminal. Keep in mind also that an intermittent can be caused somewhere in the external antenna system. This can be checked easily enough by substituting a rabbit-ear antenna. If the intermittent disappears but returns when you replace the lead to the outside antenna, you've eliminated the set as the source of trouble.

Input power

1. Check the line cord, plug and house wiring.
2. Check for low or high voltage. A recording voltmeter (usually supplied by the local power and light company) indicates excessive variations if left on the line for 24 hours. A consistently high or low voltage can be corrected

at the transformer by altering taps; this work must be done by the utility maintenance crew. They are usually very cooperative and glad to be of service in correcting difficulties of this type.

Temperature

1. May be excessive due to inadequate ventilation. Check for heavy drapes which impede air circulation, or chassis located over a heat register (Fig. 102). Check for excessive heat or poor ventilation from any cause.
2. Low temperature can be a factor if the set is operated in an unheated room such as a warehouse in winter.
3. Removing a chassis from its cabinet alters the temperature characteristics and can make location of the intermittent extremely difficult or impossible. Use the hot box for checking to make sure excessive heat is not the cause of trouble.

Humidity

Check for excessive dampness. A laundry or kitchen location may be one of high humidity, and such a condition can produce arcing, leakage and shorts.

Animals and insects

1. If there is a pup around (Fig. 103) make sure it does not chew the lead-in or pull the line cord from the wall socket.

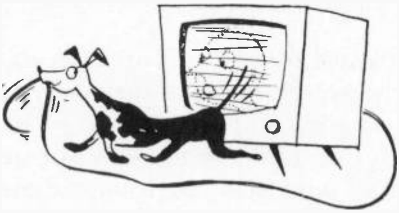

Fig. 103. *TV sets have a number of natural enemies, including dogs and children.*

2. Mice or rats have been known to clip wires and create a bad corrosion problem which can damage tuning capacitors and other parts, creating a miscellaneous assortment of potential trouble spots.
3. Roaches are an annoying source of trouble. They eat the insulation from wiring, remove the labels from parts and have been known literally to fill if transformer cans where they are electrocuted and can cause intermittent arcing.

Put the chassis in a cardboard box and fumigate with a bug bomb. Cover the box for about 30-minutes after a thorough spraying. You can also use a hand-operated sprayer (Fig. 104) keeping a carton handy for enclosing the set after you get finished.

Miscellaneous

1. Excessive carbon (soot) in the air from a defective heating plant can cause intermittent arcing in the high-voltage section. The remedy is a thorough cleaning with solvent, and spraying with anticorona dope. Cleansing must be thorough to remove every trace of carbon. Dope must be allowed to dry thoroughly before the set is turned on, otherwise fire may occur. Excessive dust, tobacco smoke, lint or dirt can cause a similar condition.
2. Check for acid fumes in the air. A small radio was ruined because it was installed on a shelf over a battery charger and string of storage batteries. An unusual condition of this type should be noted and called to the attention of the owner before any work is started. Damage from acids may be impossible to correct, so usually the equipment must be junked. Fortunately, such locations are rare.

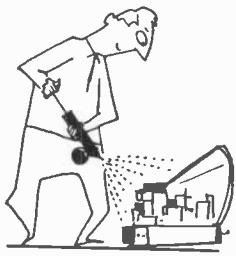

Fig. 104. *Insects often find the inside of a TV set a comfortable and warm place in which to live and breed intensively.*

Internal troubles

Having eliminated tubes and external causes as trouble sources, we can safely assume the trouble is confined to the chassis. Intermittents can be classified according to the type of trouble, nature and duration of the cycle (if a definite time cycle is involved) and can be divided into two general groups:

1. The group in which overall operation continues at approximately the normal level, but there is intermittent interference with picture or sound. The interference originates within the chassis and may consist of hash, noisy sound,

lines in picture, pulling, distortion of either picture or sound, etc.

2. The group in which operation of some portion of the circuit ceases momentarily and may be restored in any one of several ways. This group can be divided into two general classes:
   a. Those in which overall operation ceases.
   b. Those in which only one section goes dead. This can be: picture dead, sound dead, won't hold, etc.

Regardless of the nature of the intermittent, the routine checking procedure is pretty much the same. Obtain a manual covering the specific chassis involved and a wiring diagram. Checking without the circuit diagram is slower and more difficult.

Chassis check list

No one can be expected to remember all the things to look for when inspecting a chassis. Copy this list on a small index card and tack it up on a convenient, eye-level location at your bench.

1. Loose wires, poor insulation, broken wires.
2. Rosin solder joints.
3. Defective tube sockets.
4. Broken or loose controls.
5. Worn-out tuner mechanism.
6. Loose parts.
7. Burned resistors.
8. Overheated transformers or chokes. (Check electrolytics for excessive current drain.)
9. Fluid leakage from capacitors. (Disregard seepage or oil drippings; these are normal.)
10. Signs of overheating, like blistered paint.
11. Bad selenium rectifiers — check by sight and smell, and twist with the fingers to see if plates are loose.

Take a good look at the chassis. Keep your eyes open for poor connections, overheated components, loose hardware. The spacing between uninsulated wires or parts is often no more than the thickness of a sheet of paper. A dental mirror (a small circular mirror mounted on the end of a metal rod) will help you examine connections normally hidden from view. Look for wires going through holes in the chassis. The hole may have a rubber grommet or may be dimpled to keep from abrading the through wires. This isn't always done and the thin insulation of a wire may have been snagged and removed, causing an intermittent short against the chassis.

Go over every inch of the chassis, literally, using a pair of long-nose pliers to move wires and parts around as the checking progresses. Many technicians fail on intermittents because they overlook the obvious. The trouble is probably literally staring you in the face — look in the right place and read the signs of burned paint and blackened resistors.

If a thorough mechanical check reveals nothing, proceed with an electrical check.

Overall electrical check

1. Using the variable-voltage isolation transformer, check the lowest voltage at which operation is possible. Gradually raise the voltage, noting any effect on the intermittent condition. Allow the chassis to operate for some time at high line voltage to see if anything breaks down. During this period connect the scope to the point of greatest suspicion of trouble and look for any changes in waveform as the input is varied.
2. If voltage changes seem to have little effect, assemble the hot box and allow the chassis to cook for an hour or so at a high temperature.
3. Check chassis voltages from the data given in the service manual, using the vacuum-tube voltmeter.

Make overloading and heat checks carefully to avoid damaging good components. Generally speaking, if the chassis is either voltage or temperature sensitive, the effect can be spotted without going to extremes that would damage good parts. This is somewhat like pounding tubes with a screwdriver; they can be broken!

If overloading, high-temperature and voltage checks reveal nothing, you must use other means. If we can by this time pinpoint it to specific circuitry, well and good. Usually, this is difficult, and often impossible if the intermittent condition lasts only a few minutes at a time followed by hours of normal operation.

The really rough ones are often the cases where an oscillator refuses to start without an external shock and where the trouble is due to a case of stable circuitry so balanced that the oscillator does not get the initial "push" to start it off. Any disturbance such as touching the chassis, flipping the power switch rapidly, disconnecting the antenna or even flipping on a room light will start things going. No hard and fast rules can be established for repairing such cases and it may be a matter of trial-and-error substitution. Here is where the potentiometers with test leads attached come in handy. Circuit values can be shifted until a point of reliable operation is found, and then the values can be measured and replaced with fixed resistors. *Changing circuit values is not for the beginner.* If you find it necessary to alter circuit values, make a little diagram showing what was changed and why the alterations were made. Attach it permanently to the chassis with tape.

Basic causes of intermittents

Let us now consider those components that have an unsavory reputation as troublemakers.

Tubes

We can easily eliminate by substitution all the tubes at once, as a source of trouble. There are, of course, many reasons why tubes cause an intermittent condition — poor welds, loose elements, parts almost touching internally, loose bases, defective heaters, etc. All these are sources of trouble we may not be able to check on a tube tester. *Substitution is the answer.*

The pins of modern miniature tubes don't have the large surface contact area of the octals. Sometimes a tube needs nothing more than to be wiggled back into a better position. Slide the tube in and out of its socket (without removing the tube completely) to improve contact between tube pins and socket. If the tube has a shield, make sure that it is secure so that it cannot move and knock against the tube.

Capacitors

Capacitors can be either shorted, open or develop internal leakage which will unbalance other circuits. The basic function of a capacitor is to store an electrical charge. If the charge leaks off, the capacitor is like a bucket with a hole in the bottom.

Capacitors are used for filtering, coupling and time-delay networks. All of them show some leakage. If this condition increases with age they must be replaced. These conditions are often hard to check because of other circuit components which make checks for leakage impossible unless the capacitor is removed or special equipment used. Sometimes it is quicker to discard the suspected ones than it is to try to salvage them by removal, checking and replacement. Test new replacements for leakage and capacitance before using. Surge checking often reveals defects that would otherwise never show up.

Resistors

They may be open or they may change in value with age or temperature. They may increase in value rapidly under load. Unless they are temperature-sensitive Globar resistors we want them to remain constant in value. Permanent changes in value can be checked, but the intermittents may check OK cold and open up under load. Some technicians like to check them by temporary overloading. A resistor may be safely overloaded to the point where the paint just starts to blister, but if carried too far such overloading can cause permanent damage. If a resistor is consistently running too warm in a circuit, either its wattage rating is too small or some tube or capacitor is passing an excessive amount of current and this is overloading the resistor.

Transformers, chokes, yoke

The usual troubles are open or shorted windings. Turns may be intermittently shorted, and this condition is hard to detect. There is an obvious tendency to replace a transformer only as a last resort. Substitution is often the only final answer, but surge checking will frequently show up defects impossible to locate otherwise. To apply a voltage surge, we need only a charged capacitor which is discharged through the transformer winding. Capacitor size and charging voltage depend on the size and type of coil being tested, and the amount of overload that can be safely applied. For small outputs — if, and rf coils — about 2 μf provides a sufficient surge to detect intermittents without danger of damage to the windings. For power transformers, chokes and deflection coils, use a 16-μf capacitor or larger and charge to 300 volts or more.

A final hint for quick and accurate circuit tracing: Using the wiring diagram, take a red or blue pencil and draw a line through each circuit as it is checked or make a check mark at the symbol of each component as it is tested on the chassis. Get a bottle of colored lacquer and a small brush. A nail polish bottle is convenient. Mark each part as it is tested with a little daub of paint. You can tell when the job is finished, and you will not only save time involved in haphazardly checking some parts two or three times, but will also avoid overlooking the one part that is causing all the trouble.

Intermittents caused by microphonics

Microphonics are most often associated with vibrating elements in vacuum tubes, but any other part that moves can also produce this trouble. Try jarring the receiver gently and watch for telltale signs of flashing on the screen. If tube tapping doesn't produce the same result, go to work on resistors and capacitors. When you locate the offending part, tape it to the chassis with a bit of Scotch tape. If, for some reason, the component is mounted on its own leads (and these are long) stiffen the leads by soldering an additional wire along their length. Components mounted near speakers are subject to vibration so look at these with suspicion.

Moving parts

Moving parts in the receiver are subject to wear and can produce intermittents. These would include all variable resistors (volume, brightness and contrast controls) channel selector and fine tuning. Fortunately, these are easy troubles to identify. Controls mounted on the rear apron or on the chassis (since they are not adjusted so often) require less attention, but don't overlook the possibility of their being not-so-innocent bystanders.

chapter 2

ghosts

ALTHOUGH there is another type of trouble known as spooks,[1] here we chase ghosts and want to know if they are in the set or not. If you've ever spent an hour or so orienting an antenna, only to find that the ghost was due to circuit action in the receiver, you know the reason why.[2]

If the spacing and intensity of a ghost change when an indoor antenna is substituted for the existing one, you know that the set is not at fault. If the ghost is internal, its spacing and polarity will not change appreciably.

A look at the principal causes of external ghosts shows why. A reflected ghost is due to interference in the time the reflected signal takes to reach the set. In Fig. 201, path ABC is the route of the reflected signal. The path is longer than the direct route AC, and the ghost arrives after the regular program material. The time delay is constant and can be changed only by reorienting the antenna. There is one ghost for each reflecting surface.

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[1] Spooks, often confused with Barkhausen oscillation, show up as a thin vertical line on the extreme-left hand side of the raster. Generally this trouble can be ignored since it is usually covered by the mask. Spooks are produced by radiation from the deflection circuits and picked up by rf and and if circuits in the receiver. If the line shows on the screen, extend the width of the picture to push the line behind the mask. Eliminate spooks by putting rf chokes (1 to 15 μh) in series with the heater, cathode and plate circuits of the damper tube.

[2] Ghosts can sometimes produce horizontal jitter, a condition in which the screen shows a second image having a back-and-forth jump. For a complete analysis of this trouble, refer to Chapter 10, page 85.

Transmission-line mismatch at the antenna or set can cause ghosts. A corroded contact, introducing a high resistance at the antenna connection, is a prime source of this trouble. A break

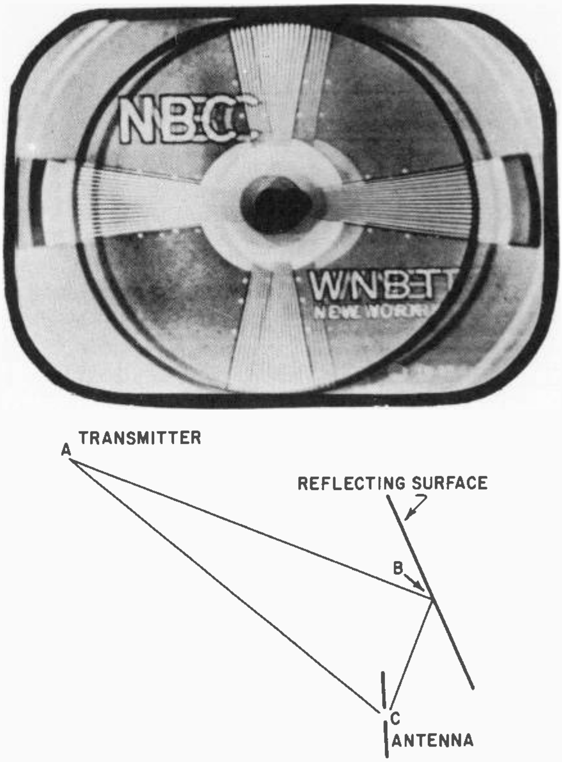


Fig. 201. *Direct- and reflected-signal paths result in a trailing, external ghost. The photo shows a trailing ghost caused by a reflected signal.*

in the lead-in where it passes through a window is also a frequent cause of ghosts. The ghost will be spaced in proportion to the distance of travel of the standing wave (L1 in Fig. 202) for an antenna mismatch, or distance L2 for trouble at the window.

This type of ghost is temporarily eliminated by using an indoor antenna, since the ghost will disappear or its spacing will change.

Internal ghosts

Closely allied to external ghosts is direct signal pickup by the tuner. If an rf tube in the front end picks up a signal, it will have a time difference with the main signal picked up by the antenna and fed into the set. It may have a different polarity — the main signal may be white while the ghost is black. This ghost appears to the left of the main signal, as a leading ghost.

The fine-tuning control will cause a change in the time delay (and phase, too) of the main signal, affecting the spacing between the two signals. This is known as a tunable ghost — one that will change its spacing and polarity due to tuning. *All tunable ghosts are internal and are caused by the set itself.*

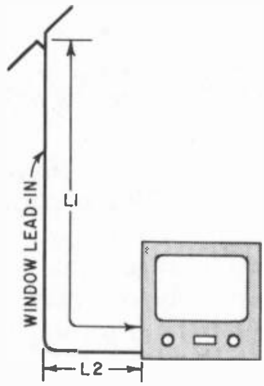


Fig. 202. *Mismatching or breaks in the antenna lead-in produce ghosts due to standing waves.*

A tunable ghost may be due to other faults, but the direct-pickup type is readily localized. Movement of the body near the TV set (particularly the tuner) will change the ghost's intensity, but will not affect the main signal (unless an indoor antenna is used).

The remedy is to shield the inside of the set, particularly around the tuner. Sheet aluminum can be used for this purpose. Ground the shield to the set's chassis. Another remedy is to install a better antenna (more ghosts of this type come from indoor antenna installations) so that the main signal will be much stronger. The agc system will then reduce the ghost so it will not be prominent.

If a signal is fed back from some later portion of the set into a stage nearer the antenna, a ghost results if the amplitude of the fed-back pulse or picture element is sufficient. (Such feedback of sync is often the cause of horizontal jitter.)

Fig. 203 shows several such feedback paths. An if path may be like REG 1. It produces a trailing ghost. Spacing depends on the time difference of the main and feedback paths. Any ghost involving the intermediate-frequency amplifier can be altered appreciably in appearance by varying the fine-tuning control.

The intermediate-frequency is affected by such tuning, and hence the appearance of the main signal with a similar change in the ghost. Therefore, a tunable ghost must be internal and pass over some tuned circuit of the set.

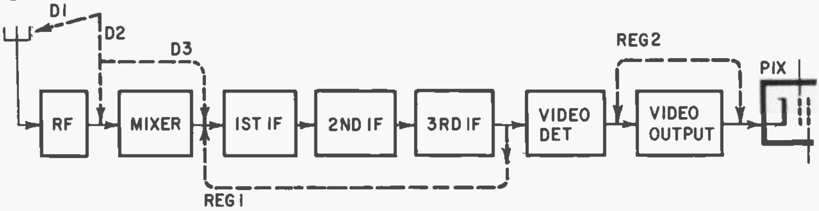


Fig. 203. *This block diagram shows pickup and regeneration paths. Direct pickup at D1 and D2 causes leading ghosts. Regeneration paths — REG 1 and REG 2 — produce trailing ghosts.*

Localizing such a ghost is ticklish. Changing the bias on a stage by altering the value of a cathode resistor may furnish a clue — shunt the resistor with another. The appearance of the ghost will change if that stage is part of the feedback path. (The mixer or converter may be considered as an intermediate-frequency amplifier for this test.) By finding the stages over which the regeneration path extends, we can find the point of injection of the spurious signal. Then, the necessary steps to stop the feedback are taken — shielding, lead dress, decoupling filters in B-plus, agc lines, etc.

Video amplifier regeneration over a path like REG 2 in Fig. 203 can cause a ghost. Its intensity will be varied with respect to the main signal by varying the contrast control. Moving leads around the base of the video amplifiers will further confirm this section as the cause. Appearance of a ghost due to video regeneration changes in intensity with different programs and different stations. The usual cures for regeneration apply here.

Phase-shift ghosts

Another ghost, with an appearance similar to direct pickup, is the phase-shift type. If this kind of ghost is noted, and is due to misalignment, it will be tunable. It will have an opposite polarity (white ghost for a black signal or vice versa). The tunability proves that the ghost is internal. Proper adjustment of the intermediate-frequency tuning will cure one type of such ghosts. Another type is due to the failure of the fine-tuning control to cover the entire range. This ghost is eliminated by adjusting the local oscillator slug or trimmer.

An internal ghost by design is the ringing of the peaking coils in the video amplifier-detector sections. High frequencies of the video signal shock-excite these coils into oscillation which is so loaded (damped) with resistance that only two or three

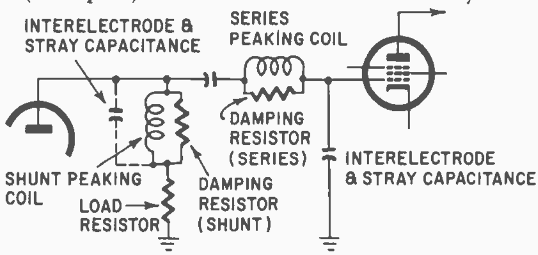


Fig. 204. *Video amplifier using shunt- and series-peaking coils. The Q of the coils is lowered by the resistors shunting the coils, but ringing can occur.*

cycles of oscillation are permitted. A change in the value of the coil resistance or shunting resistance may cause the ringing to become excessive (visible).

Fig. 204 is a typical interstage circuit using ringing coils — shunt and series types. Note the associated damping resistors. If the resistance of any damping resistor rises appreciably, the normal ringing of Fig 205-a will become the abnormal ringing of Fig. 205-b. Each upper portion of the cycles represents black while each lower peak is white. We have evenly spaced rings decaying in intensity on the screen as a result. These may be distinguished from multiple reflections on an antenna lead-in by the fact that rings follow only short portions of the horizontal lines, while transmission-line reflections follow all abrupt changes whether long or short.

Another way to distinguish ringing from multiple reflections (as with an antenna or set mismatch of the transmission line) is by varying the contrast control. This will reduce the amplitude of the video signal applied to some of the peaking coils at least, and also the intensity of the rings.

Excessive ringing (five or more separate rings or ghosts) is cured by lowering the resistance shunting one or more peaking coils. Shunt each in turn with a resistor of the value given on the set's schematic. The symptom will disappear (to one or two rings) when the bad resistor is found. If excessive ringing is due to a design fault, lower the resistance on all coils. Cut out any old resistors. Their value may change (again) or parasitic oscillation may develop when resistors are paralleled in this circuit.

Interlaced ghost

Another internal ghost is caused by a sidewise displacement of horizontal lines. The trouble stems from a slight shifting of alternate fields. This type of ghost is not tunable and remains constant in value with rotation of the contrast control. Close

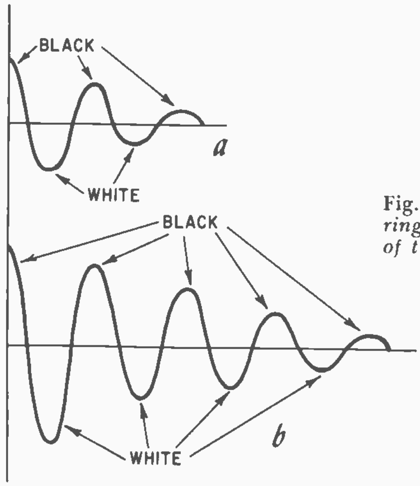


Fig. 205. *Normal ringing (a). Excessive ringing (b) takes place when the values of the shunting resistors (across the peaking coils) increase.*

inspection of the picture will show that each alternate horizontal line is displaced – use a magnifying glass.

The trouble is in the horizontal output tube's grid circuit. The grid leak is too low, the tube is defective, voltages applied are not correct, or the drive control is leaking (capacitor-shunt type). Excessive pickup of vertical pulses by misplaced wiring has also caused this trouble.

chapter 3

oscillator squegging

THE OLD farmyard pumps produced water in spurts as a result of regular up-and-down motion of the handle. Water did not flow between the spurts (on the handle's upstroke).

A squegging oscillator produces a similar output. Fig. 301-a shows squegs (groups or packets of oscillations) with intervening "dead" spaces. There is no oscillation and no output during

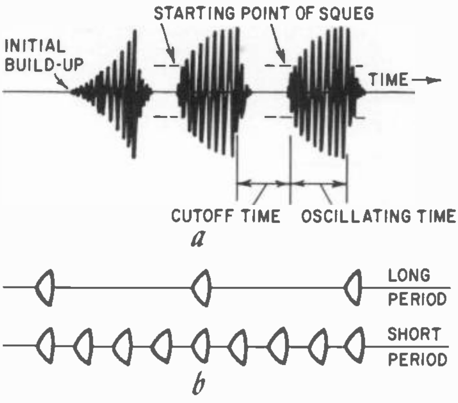


Fig. 301. *Squegs are built up in groups or packets that can recur regularly. Typical case of build-up (a) and (b) long and short dead times of the oscillator.*

this dead time. The length of the oscillation period and the dead time are not necessarily equal, but depend on circuit constants, as does the period or repetition frequency of the squegs.

This period may be very low, measurable in minutes, or very high and measured in microseconds.

Symptoms of squegging

If the local oscillator of a radio set squegs, it punches holes in the sound as if a mechanical chopper had been inserted in the set. This is because no intermediate frequency is produced when there is no oscillation – during the dead times of Fig. 301-a.

The frequency of the squeg may vary like the quench periods of a superregenerative receiver. The oscillatory packets may close up or spread apart (Fig. 301-b). If the frequency is in the

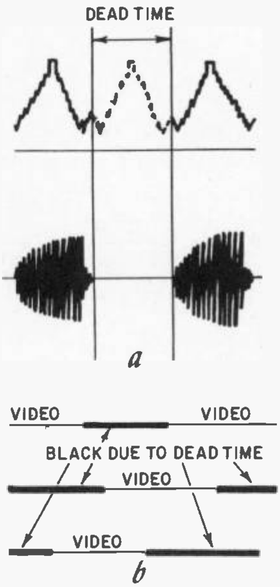


Fig. 302. *Dead time (a) correlated with video information. The dead time can cover part of a synchronizing period, either horizontal (as shown here) or vertical. Dead-time symptoms (b) indicate squegging. Successive periods are black. Some can occur during blanking and appear at the finish and start of an active trace.*

audible range, a radio receiver with a squegging local oscillator will produce sounds varying from a buzz to "plops." A squeg rate above audibility will result in a high hiss level or an increase in noise on a station.

Local-oscillator squegging of a TV front end punches holes in the picture and sound intermediate frequencies. The eye will often see the effects on the picture even though the sound may not seem to be affected.

As an example, if the dead period is 10 microseconds, about one-fifth of a horizontal line will be black – due to absence of video information for that part of the 54 μsec of active scan.

The squeg can occur during the blanking period, but due to the repetitive nature of squegs, succeeding dead times will fall on the active portion of the line.

As dead time increases, some of the dead spots will fall during sync pulse time. The condition is illustrated by Fig. 302-a. Losing one horizontal pulse now and then will not affect the horizontal sweep stability very much due to the flywheel action of the horizontal afc and horizontal oscillator. But loss of an appreciable portion of the vertical pulse groups will lead to vertical stability impairment (rolling, loss of interlace) far more rapidly. The black spaces in the picture information definitely tie the trouble to squegging though (see 302-b).

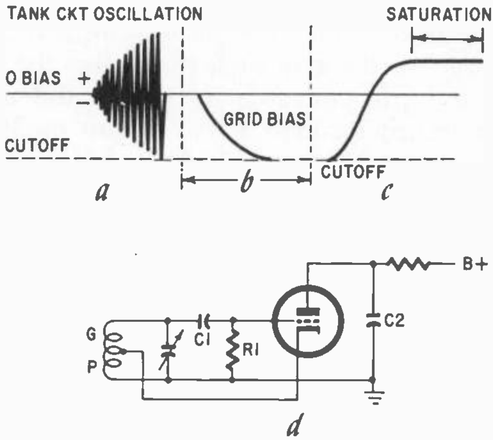


Fig. 303. *Oscillatory buildup (a) in tank circuit. Corresponding grid bias developed (b). Characteristic curve (c) showing cutoff and saturation and (d) Hartley oscillator circuit for illustration.*

Multivibrators and blocking oscillators may squeg as well as sine-wave types. Stoppage of the vertical oscillator results in bright compressed lines where the trace has stopped. The brightness tapers off rapidly, but not immediately, as in conventional retrace and a part of the lower portion of the picture is missing. (The vertical oscillator does not drive itself into retrace but merely stops in this case.) Stopping of the horizontal oscillator results in loss of high voltage in flyback systems, and no line is visible during the dead period of the squeg.

At high rates of squegging, the result may be a flicker. Examination under a magnifying glass will reveal the loss of video information if the local oscillator is at fault, or loss of all line structure if the horizontal oscillator is acting up (due to no high voltage).

Causes of squegging

Squegs are caused by circuit conditions that cut the oscillator tube off for a definite time, then turn it on again.

The most common cause is periodic cutoff. A grid-capacitor–grid-leak combination with too long a time constant is the most usual reason.

Fig. 303 shows how this happens in the Hartley oscillator circuit of Fig. 303-d. Oscillations build up rapidly (Fig. 303-a) and increase the negative grid bias developed across the grid resistor (Fig. 303-b), since the grid is driven positive each cycle and attracts electrons which have to leak off through R1. The increasing charge on the grid capacitor drives the tube to cutoff and holds the grid voltage at or near cutoff until enough electrons have leaked through R1 to permit oscillation to begin again. This is the dead period of Fig. 301-a.

The charge of the grid capacitor leaks off and the oscillations start again. The grid bias does not have to return to zero — only to a level that permits oscillations to start. The squeg cycle repeats itself.

Increase of the grid resistor value is the most common cause of a too-long time constant. Check with an ohmmeter or shunt the resistor with another. Less common is increase in value of the grid capacitor. Test by substitution or measurement on a capacitor checker. If an abnormally low value of shunt resistance (across the grid resistor) is needed to stop the squeg, an increase in the capacitance is very likely.

Too much feedback can cause squegging. In the circuit of Fig. 303-d, the P-part (plate or feedback winding) of the tank coil induces a feedback voltage in the G-part (grid or input winding). If this is excessive, the height (amplitude) of oscillations shown at Fig. 303-a will result in excessive grid bias (Fig. 303-b) and squegging.

The feedback voltage is dependent on the position of the tap on the tank coil and the gain of the oscillator tube. Excessive B-plus voltage may be the cause — check it with a voltmeter. A new tube may cause a squeg as its mutual conductance may be too great in a critical circuit— tubes have a manufacturing tolerance like other components! The tap may have been misplaced ever so slightly in manufacture, so that the number of turns on the P-portion is too great. (A new coil is the usual remedy unless the tap can be moved.)

Improper dressing of the leads to tube electrodes (socket terminals) when making other repairs may result in a squeg. Fig. 304 is a typical oscillator circuit found in TV tuners. Feedback is through the interelectrode capacitance between plate and grid. There is some stray capacitance due to tube leads, pins, socket lugs, connecting wires, etc. But if this capacitance is abnormally increased by pushing the connecting wires too close together, a squeg can result.

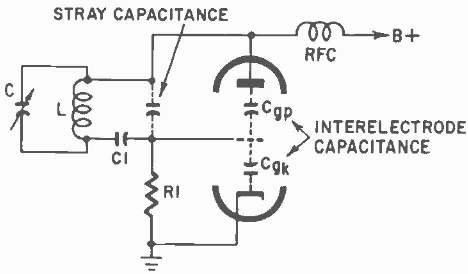


Fig. 304. *Excessive stray capacitance in some oscillators can cause squegging.*

Saturation squegging

In some types of oscillators, the "tube" of Fig. 303-d is plural — the feedback is taken over several stages. Should one of the tubes in the amplifier be driven into saturation and permitted to remain there for a period of time, then squegging will result just as if the tube were cut off. Since plate current cannot change in the saturation region (it is already maximum) no oscillatory feedback can occur and the input voltage on the grid cannot be maintained. Checking the grid bias on all tubes will reveal this condition, which is the result of too positive a bias on one or more grids. It can happen because of a leaking coupling capacitor — one of the more common causes of saturation squegging.

Multivibrator squegging

Multivibrators and blocking oscillators may present symptoms resembling squegs that are not true squegs. (Normal blocking oscillator operation is actually a form of controlled squegging.) Any intermittent operation will cause an effect resembling squegging. First, see that the tube itself is not intermittent (substitute). Then check for possible poor contact on the variable resistor that acts as a frequency control (hold control in TV sweep generators).

In Fig. 305 for example, intermittency could result from poor contact of the slider arm of R2 (hold) or intermittent opening of C2 (coupling capacitor). This would resemble squegging with the same symptoms.

An increase in value of either C1 or R1 of Fig. 305 will result in a true squeg. So too will appreciable change of the values of R3 and R4, which operate in conjunction with C2 and R2 to flip the multivibrator over. These components control the regeneration or recycling of the right tube. R4 and R5 control recycling of the left tube in addition to the amplification of the tube itself.

Blocking oscillators may squeg (apparently) due to any intermittency in their components. As in the case of multivibrators, the time constant of a grid circuit may be altered but

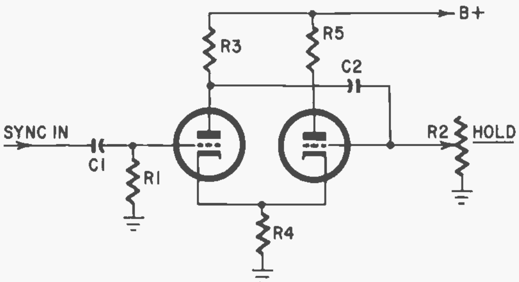


Fig. 305. *Typical cathode-coupled multivibrator circuit to illustrate true and apparent squegs in this type of oscillator.*

this symptom will show up as too low a frequency of sweep just like excessive values of either C2 or R2 in the multivibrator circuit of Fig. 305. Here one has the trouble of low sweep frequency rather than squegging as the symptom.

The rather high peak voltages of the waveshapes on components in both multivibrator and blocking oscillator circuits tend to produce intermittents. The best way to be sure is to substitute parts — particularly the capacitors — in such circuits rather than spend too much time trying to locate a defective one.

chapter

4

video if oscillation

Oscillations in the video if strip possibly produce more inferiority and self-distrust among service technicians than any other fault of TV receivers. Methods of troubleshooting this type of oscillation are usually involved and often time-consuming. This simplified method saves much of the time and most of the worry.

Symptoms

The first question is: When should video if oscillation be suspected? When the audio is normal and the video information is present but not entirely legible. The raster may be streaked with long white lines or have a spotted appearance unaffected by changes in the contrast control setting. The presence of oscillations can be quickly verified by connecting a vacuum-tube voltmeter across the detector load resistor as indicated in Fig. 401. The normal voltage readings at this point, with no input signal, will vary from 0.5 to 1, due to the space charge of the detector tube and the small amount of rectified voltage caused by normal disturbances such as noise. Oscillation increases the voltage to some high value. In extreme cases it may read as high as 35 volts.

Causes of video if oscillation

The exact cause of oscillation is often difficult to determine, but it can usually be attributed to one of two things: misalignment or a defective component in the if strip. It is comparatively easy to correct a misaligned if strip. Oscillations are usually caused by two or more if transformers being tuned too close to the same frequency. The method recommended here is to locate the if transformer that is tuned to the highest frequency and turn the tuning slug all the way out. Next, the transformer that corresponds with the lowest frequency is located and its tuning slug turned all the way in. If one transformer is normally tuned to the center frequency of the bandpass, its tuning slug is approximately centered. Any other if transformers should be adjusted either to a quarter- or halfway position between the others, depending upon their frequency. This will result in an extremely wide response but eliminates any tendency toward oscillation. The alignment can now be finished by following the manufacturer's alignment table for that particular model.

Oscillation caused by components

Suppose that after going through this procedure, oscillation still remains. The voltmeter again indicates an excessive amount of voltage across the detector load resistor as one of the if slugs is adjusted to its normal setting. Then oscillation is attributable to a defective component, a trouble that is often difficult to isolate. A change in value of a loading resistor across an if transformer, a leaky coupling capacitor, an increase in value of plate or grid load resistors are all sources of oscillations. A leaky coupling capacitor permits a portion of the high positive plate voltage to leak over to the grid of the following stage. This positive voltage on the grid reduces the normal bias on the tube and results in excessive gain in the stage, allowing oscillations to develop. An increase in value of grid or plate load resistors permits the Q of the stage to rise above normal, and again excessive gain causes oscillation.

A method for quickly locating the stage in which the oscillations are originating is to bypass the grid of each video if tube with a .001-μf capacitor to ground. The capacitors eliminate the tendency of oscillations to build up and, by bypassing them one by one (starting at the stage preceding the detector) while observing the voltmeter for a decrease of voltage across the detector load resistor, you can determine exactly in which stage they are being developed. For this purpose make several capacitors with short leads and clips to save time.

Voltage checks

To find the exact cause of the trouble once the stage in which it originates is isolated, measure and compare with the manufacturer's information the plate, grid and cathode voltages of the tube. If the grid voltage measures less negative than normal, a leaky capacitor or gassy tube is indicated. Measure the

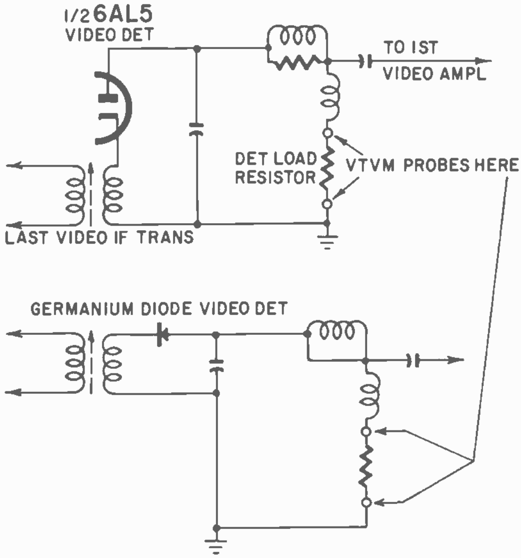


Fig. 401. *Basic schematic of typical tube and crystal diode TV detector circuits, showing probe placement across the diode load.*

voltage at either end of the grid load resistor. It should read the same at both points with respect to ground. If not, keep the voltmeter connected to the grid of the tube and remove the tubes on either side of the coupling network. If the bias voltage on the grid still remains less negative than normal, the coupling capacitor is defective and should be replaced. If the voltmeter gives a normal reading after the tubes have been removed, check for a gassy tube by replacing it with one known to be good.

If, after replacing the tube, the bias still remains at an abnormal value, resistance tests must be made. Turn off the receiver and allow sufficient time for the tubes to cool. Then measure the plate, screen, grid and decoupling resistors for a change in value. A deviation up to 10% of the manufacturer's stated values is considered normal. Other possible causes of oscillation are open heater or screen bypass capacitors or an open decoupling capacitor in the plate or grid circuits. Also be sure to check the lead dress – some receivers are very critical. The plate and grid leads must be kept as far apart as possible to prevent undesirable feedback.

The source of trouble is usually found to be a leaky, open or shorted capacitor or a resistor that has changed in value. If none of these defects appear, measure the resistance from grid to ground. It should correspond to the value of the grid load resistor. If it doesn't, remove the leads from the grid terminal and measure the resistance from the terminal to ground. The resistance meter should give an infinite resistance reading – if not, the socket must be replaced, preferably with a low-loss unit. The author has run into this heartbreaking TV oddity several times. It's a real puzzler to the service technician who is unaware of its possibility.

Fortunately, oscillation in video if circuits is not too common a problem. When it does occur, the troubleshooting procedure outlined here may help the service technician to correct the trouble quickly and efficiently.

chapter 5

picture quality control

THERE are several simple ways to improve the picture quality of any television receiver or, more exactly, to better adapt it to the spectator's taste. Such a control is similar to the tone control on radio receivers and, like its audio counterpart, will probably provoke hot discussion.

However, the customer is always right in the long run, and if he likes his picture over-sharp or over-soft, by all means let him have his way. Besides, the very name *P*icture *Q*uality *C*ontrol (PQC) is an important sales point.

The general principle of picture quality control (PQC) is to modify the receiver's overall response curve, either in the post-detection video amplifier or the if amplifier. In this way, one can boost the low or high frequencies in the picture at will.

When low frequencies are boosted, the apparent contrast is better, the blacks and whites are deeper, the large areas are uniform and the overall effect is a general softening of details and outlines. Definition is reduced, and the picture lacks details. This is adequate when the spectator is some distance from the receiver, where details are lost anyway. At such a distance, the improvement in large areas does much to provide a more pleasing picture.

When high frequencies are boosted, outlines are sharper, the transitions from black to white or white to black are better and the details appear more clearly. The overall impression of high definition and sharpness can be further improved if boosting is carried to the point where a fine white line follows black surfaces and vice versa. A supposedly uniform shade may exhibit changes in density over large areas, and blacks and whites may be less deep.[1]

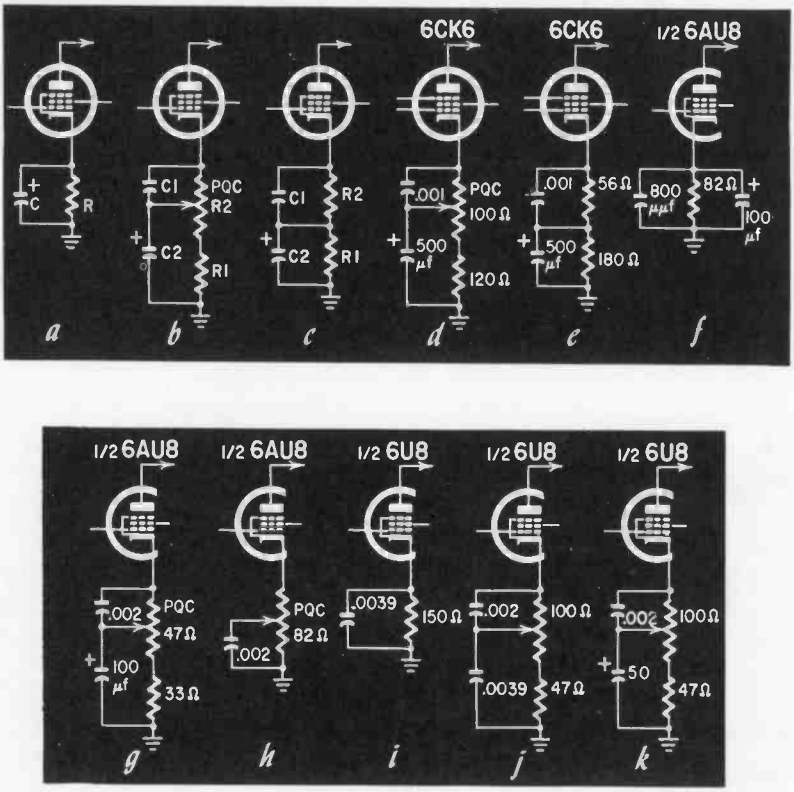


Fig. 501. *Techniques for using and controlling cathode (negative) feedback.*

Let us now examine some practical circuits, first when PQC is applied to the video amplifiers and then when it is incorporated in the if amplifier.

[1] Circuits for modifying the response of TV video and video if circuits have been used in a number of TV sets in the past. The 1956 Conrac Fleetwood sets used a variable capacitor as a manual definition control across the secondary of the second video if transformer. It was used to peak the video carrier and sharpen the picture or attenuate the carrier and soften it. Some Radio Craftsmen RC-100 receivers had a local-distance switch for the same purpose. The switch shorted a section of one of the video if coils to peak the video signal. The DuMont RA-340, Capehart CX-38X and some models of other makes had if circuits whose response varied automatically with agc bias to provide optimum pictures under different signal strengths.

Cathode feedback

A very simple and effective way to control the response curve of a video tube is to include selective negative feedback in its cathode circuit. Usually, this circuit consists of a resistor (R) of a few hundred ohms shunted by a large-value electrolytic capacitor (C) (see Fig. 501-a). When the PQC is included, the circuit looks like Fig. 501-b. The dc cathode bias is provided by resistor R1 and potentiometer R2 in series, the total value of R1 + R2 being equal to R in Fig. 501-a. The high-value electrolytic capacitor C2 is connected between slider and ground, and a small-value additional capacitor C1 is connected between slider and cathode. When the slider is at the cathode end of R2, the circuit is exactly equivalent to Fig. 401-a and the video response curve is undisturbed. When the slider is at the low end of R2, there is cathode negative feedback which reduces the tube's overall gain. However, R2 is shunted by C1, and the value of this capacitor is such that it practically short-circuits R2 for the highest frequencies of the video spectrum, thus suppressing feedback and insuring full gain of the tube at high frequencies.

If the PQC is not going to be manually controlled, replace R2 with a fixed resistor of the same value, as in Fig. 501-c. This circuit appears in a number of forms in many television receivers, where it is used as part of the video amplifier compensation system to obtain a flat response curve. The purpose of the PQC is different, as we have seen previously. Note that adjusting the PQC does not modify the overall gain for low and medium frequencies. A practical circuit, used in the French *Opera* receivers, is shown in Fig. 501-d. For the American standard, the value of the small capacitor should be increased to .002 μf.

In some models, the same manufacturer uses a fixed PQC as in Fig. 501-e. Here again, the value of the small capacitor should be .002 μf for the American standard. This circuit is easy to add to an existing receiver, keeping in mind that the total cathode resistance should be the same as the original value. As there is also a slight reduction in video gain the receiver must have some reserve in this respect. This, however, is never bothersome, for the PQC would hardly be installed in marginal cases.

The circuit of Fig. 501-b has been tried on a G-E 17T025 receiver. The original diagram is given in Fig. 501-f, and the modified version in Fig. 501-g. The existing cathode resistor may have a low value, say less than 100 ohms. If this is so, the resistor can be entirely replaced by a potentiometer. This has been done in the G-E receiver, as in Fig. 501-h, with better results. A certain amount of parasitic wiring capacitance is unavoidable, but it does not hinder circuit action. Sometimes it can be made part of the correcting capacitor.

It may turn out that the cathode resistor is shunted by a low-value capacitor as part of the correcting network. This happens

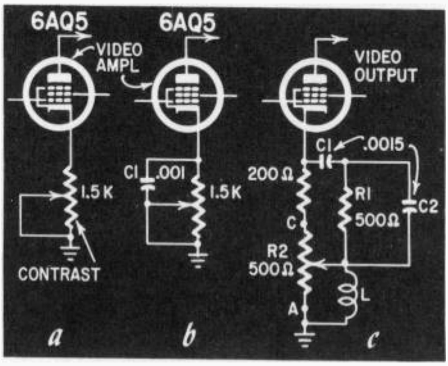


Fig. 502. *Modification of a contrast control circuit for picture quality control.*

in the first video amplifier of a Philco 7L70 represented in Fig. 501-i. There are two possible solutions. Either the existing capacitor is used across the fixed resistor (Fig. 501-j) or it is replaced by an electrolytic capacitor (Fig. 501-k). The latter circuit gives a better range of control. Note that this PQC provides for an increase and decrease of high frequency gain.

The examples show that installing cathode PQC in the video amplifier of a TV receiver is neither difficult nor expensive. It will, moreover, prove profitable to the alert service technician.

Automatic PQC

A number of receivers use cathode feedback or cathode bias as a contrast control. Simple modifications let you add PQC to such receivers. Moreover, most circuits lend themselves to the installation of automatic PQC. Take the already cited Philco 7L70 as an example. Its second video amplifier uses a 6AQ5 with contrast control in the cathode, as in Fig. 502-a. The simple addition of a .001-μf capacitor (Fig. 502-b) introduces automatic PQC. For distant stations and low-level signals, where high-frequency boosting is undesirable, the slider is at or near the cathode end for maximum gain. This effectively puts the capacitor across a low-value resistance and its effect is small. For local stations and high-level signals, when the picture can stand high-frequency boosting, the slider is at or near ground, the capacitor is connected across a high-value resistance and its effect is maximum. Thus the amount of PQC increases automatically with the level of the received signal.

A somewhat similar arrangement is, in fact, provided in some TV receivers, such as the RCA 21-T series, or the Westinghouse V-23 series. In the latter the shunt capacitor is replaced by the parasitic wiring capacitance, mainly due to the shielded cable connecting the cathode to the contrast control.

Improved cathode PQC

More sophisticated circuits can be devised. An example is given in Fig. 502-c. It represents the video output stage of a

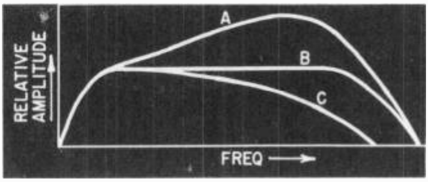


Fig. 503. *Effect of the circuit of* Fig. 502 *on the video-frequency response.*

German Loewe-Opta model. Neglecting L for the time being, the circuit is similar to Fig. 501-b, except that C1 has been replaced by R1, C1, C2 to obtain a more progressive effect. However, inductor L is also included in the cathode circuit. As its impedance increases with frequency, the cathode feedback increases and the gain decreases for the high frequencies of the video spectrum. Its effect is exactly opposite to that of a capacitor.

Inductor L resonates with its parasitic shunt capacitance near the upper end of the video spectrum, say 3.5 or 4 mc.

The 500-ohm potentiometer does two jobs. When its slider is at the ground end, inductor L is short-circuited and put out of action. Simultaneously, the shunt effect of the capacitive branch C1–C2 is at maximum, so that the negative cathode feedback is reduced and the gain is increased for the upper video frequencies, as before (Fig. 503, curve A).

When the slider is on the cathode side, the shunt effect of the capacitors is minimum. At the same time, the inductor comes into play, the negative feedback is increased and the gain is reduced for the high video frequencies (Fig. 503, curve C).

Between these two extremes, any intermediate effect can be obtained at will. The values of the elements are so chosen that the capacitive and inductive effects just balance each other when the slider is set halfway. This corresponds to the normal response curve (curve B in Fig. 503).

Grid PQC

A different type of control is used on some Nordmende receivers. Since the video amplifier contains correcting inductors to

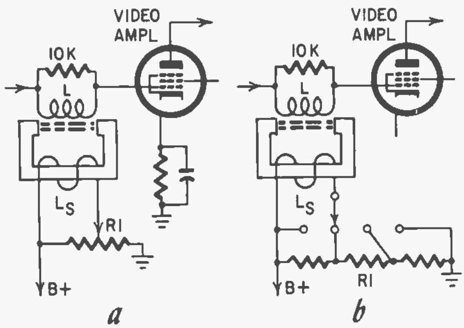


Fig. 504. *The inductance of the series correcting coil L is varied by putting the core in the field of an electromagnet.*

insure that the response curve is flat up to the higher limit of the video spectrum, a simple PQC could be obtained by modifying the inductance value of the compensating coils. However, this introduces some difficult practical problems, mainly due to the distance between the control and the coils. A neat solution has been found by the German makers. The PQC is obtained by varying the inductance of series correcting coil L in the grid circuit of the video amplifier (Fig. 504-a). This coil is wound on a ferrite core, and this core is placed in the field of an electromagnet. The magnetic field can be adjusted to any value with the help of potentiometer R1, and the ferrite core is more or less saturated. Its permeability varies with saturation, and so does the inductance of coil L.

With the slider halfway, coil L is such that it has the correct inductance value for normal flat response. Modifying the current through saturating coil L_s thus provides for lifting or lowering the high-frequency part of the video response curve.

This continuous PQC can be replaced by a step-by-step control, as in Fig. 504-b. Actually, in the German receiver three pushbuttons are provided. One is labeled "Live", another "Film" and the third "Brilliant." The last one may be added to the other two. This arrangement gives the viewer a choice of light tonalities exactly equivalent to the fixed positions (voice–music) of certain radio tone controls.

PQC in the if amplifier

The PQC can be obtained by modifying the if response curve. Normally, this curve is adjusted so the if value of the

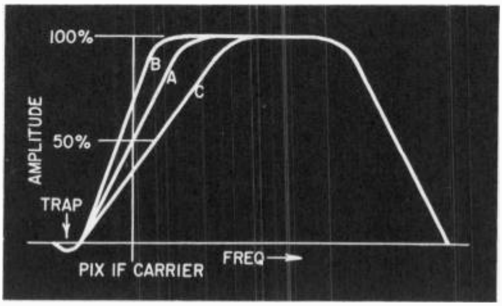


Fig. 505. *Effect of modifying the intermediate-frequency response curve.*

carrier corresponds to a loss of 6 db, that is 50%, in gain, relative to the center of the passband. This is indicated by curve A in Fig. 505. For such tuning, the overall response curve of the receiver is flat down to very low frequencies. If, by deliberate mistuning, the if curve becomes curve B, there is an overamplification of the low frequencies. Conversely, curve C attenuates the low frequencies. The effects of such mistunings are well known to the technician; they are very easy to obtain, sometimes quite unintentionally, when tuning the if amplifier.

They can, however, be put to good use for PQC. A simple arrangement is given in Fig. 506. The circuit is included in some French *Oceanic* receivers and is labeled "Definition Corrector." The if corresponding to the carrier is 27.5 mc. Tuned circuit L–C1 is a trap circuit, normally resonating on 27 mc and coupled to the cathode of the last if amplifier tube by a small primary winding.

When potentiometer R2 is at its maximum value, the shunting effect of capacitor C1 on the tuned circuit is negligible and the trap resonates on 27 mc. The tuning of the if amplifier is such that the if carrier corresponds then to an attenuation of 12 db, and the low video frequencies are strongly attenuated (curve A, Fig. 507). When the potentiometer is in the short-

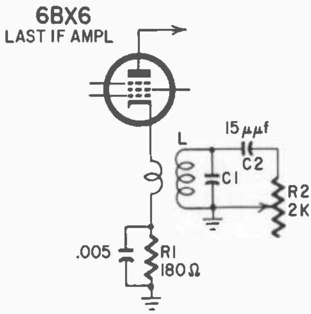


Fig. 506. *Modification of the intermediate-frequency response is obtained using this definition-corrector circuit.*

circuit position, capacitor C2 shunts the trap circuit and shifts its resonance to 25 mc. The attenuation on the if carrier is then only 3 db (curve B, Fig. 507) and there is an overamplification of the lowest part of the video spectrum.

The setting of the potentiometer provides any intermediate curve between curves A and B, including, at mid-setting, the normal curve with 6-db attenuation of the if carrier.

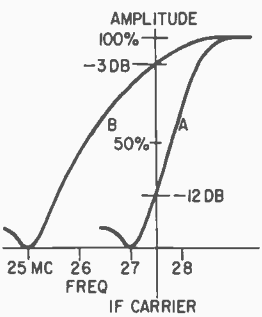


Fig. 507. *Effect of the circuit of Fig. 506 on low video frequencies.*

This circuit may be added across a trap circuit in an existing receiver. It uses only one capacitor and one carbon potentiometer.

Combined PQC

The two principles of picture quality control, in the if and in the video amplifier, can be used jointly in a combined PQC. A commercial circuit, developed by Schaub-Lorenz, appears in a somewhat simplified form in Fig. 508. A trap circuit L1–C is connected at the output of the mixer tube and tuned to 39.5 mc, slightly above the if carrier frequency. The setting of potentiometer R1 determines the damping and hence the efficiency of the trap. The result is Fig. 509. The effect is, as before, a variable attenuation of the if carrier.

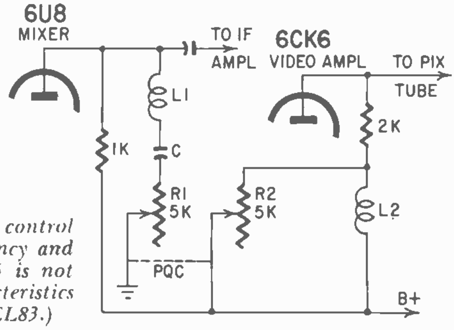


Fig. 508. *Combined picture quality control circuits in the intermediate frequency and video amplifier stages. (The 6CK6 is not a readily available tube. Its characteristics are similar to those of the EL83.)*

On the video side, in the anode circuit of the video output tube is correction coil L2. This coil is shunted by potentiometer

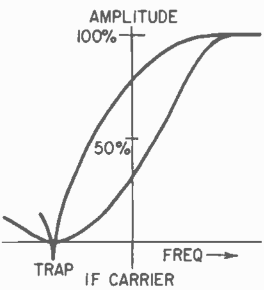


Fig. 509. *Effect of potentiometer R1 in Fig. 508 on trap efficiency.*

R2, so that its effect in high-frequency boosting depends on the setting of R2.

R1 and R2 are ganged, and the same control accordingly determines the amount of PQC in the if and video amplifiers.

Amplified PQC

An elaborate PQC has been devised by Schaub-Lorenz. Its principle is entirely different from the preceding circuits. The complete diagram of the video amplifier is in Fig. 510.

Notice first the use of a plate and cathode loaded triode after the detector. The intercarrier sound take-off is on the grid. The low impedance cathode circuit feeds the video amplifier through a potentiometer which constitutes the contrast control.

The coupling circuit to the 6CK6 video amplifier is more or less standard. It includes series correction coil L and crystal clamping diode D in the grid circuit.

The originality of the circuit is in the use of the pentode section of the 6U8.

Across inductance L appears a voltage which is roughly the derivative of the video signal. That is, for each rapid transition

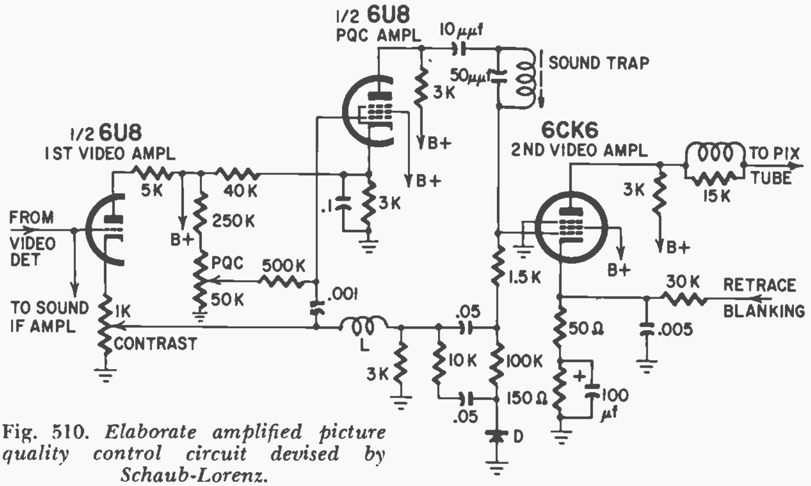


Fig. 510. *Elaborate amplified picture quality control circuit devised by Schaub-Lorenz.*

of this signal, a pulse appears across L and is applied to the grid of the pentode part of the 6U8. This pulse is amplified and reversed in phase at the plate of this tube, and applied to the short-time-constant coupling circuit which again differentiates it. Each plate pulse is then transformed into a pair of short opposite pulses.

These pulses are added to the original video signal at the grid of the video amplifier. One of the pulses will be in such a direction that it will sharpen the rise of the signal. The other pulse will be in the opposite direction and produce a sharp white outline around black areas and a sharp black outline around white areas.

A trap circuit, tuned to the sound if, has been provided in series with the short time constant coupling circuit.

This circuit does not modify the response curve. It does not increase the bandwidth.

It does, however, improve the apparent definition of the picture by shortening the transitions and setting them against a contrasting outline. All in all, the picture looks sharper and crisper.

chapter 6

troubleshoot the horizontal oscillator

HORIZONTAL oscillators have become pretty well standardized, at least down to three or four basic types. Specialized sweep-circuit testers can make testing and repairing these circuits much easier. But, even with a minimum of test gear, many tests can be made.

Horizontal sweep circuits have a dual purpose. They sweep the electron beam across the picture-tube screen and provide high voltage to the picture tube. The circuit also provides pulses for keyed agc, phase-comparison afc, etc. It is this interlocking nature of these functions that makes circuit analysis so complicated so often.

In practice, if we remember the basic principles of each circuit and apply our tests in the proper order, there should be little trouble. Just take that full 10-count on the service procedures.

Good sound, no raster

First, let's assume we get a set with the typical complaint — good sound, no raster.[1] The first step is to check all tubes, preferably by substitution. If this doesn't work, leave the good tubes in the set until other tests have been completed. This avoids double troubles — defects caused or aided by tubes with mar-

[1] With no raster as a symptom, first verify absence of high voltage and then work back to the control grid of the horizontal-output tube. Drive voltage troubles (insufficient drive, wrong waveshape, etc.) call for troubleshooting the horizontal oscillator.

ginal characteristics. Find the major trouble first, then see how many of the original tubes can be replaced without interfering with performance.

Next check point is the B-plus supply. Check the voltage at the filter input. The B-plus supply should be within 10% of normal before going further.

The next step is to check the schematic and find out what type oscillator circuit is used. Check voltages against the sche-

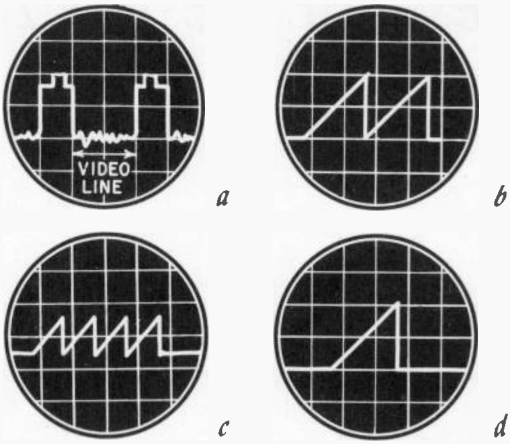


Fig. 601. *Composite video and horizontal oscillator waveforms. Two lines of video (a) with sync and blanking pulses. The drawing (b) shows the oscillator on frequency. The remaining illustrations (c and d) show a fast oscillator and a slow one.*

matic. Dc voltage measurements around the stage check it out pretty well. However, a scope is much faster. Just connect a strong signal to the set and hook your scope to the video detector output.

Set the scope's sweep to hold two horizontal sync pulses on the screen. This locks it on 7,875 cycles, half the horizontal oscillator frequency. Now, transfer the scope probe, without changing the horizontal sweep frequency, to the horizontal oscillator circuit. The pattern of Fig. 601-a shows two lines of video with sync and blanking pulses. Fig. 601-b shows the oscillator running at normal speed. Fig. 601-c is too fast. Four pulses are seen. Fig. 601-d shows too-slow operation, with only a single pulse visible. Each wrong pattern points to a certain defect.

A scope finds horizontal oscillator troubles much faster than any other test instrument. As you can see, simply connecting it to the oscillator shows whether or not it's running. The simple test outlined here indicates if it is running at the right frequency. Actually, always make this test first; voltage and other measurements should come later. If the scope shows the oscillator is running on frequency, we can eliminate quite a few tests in that circuit.

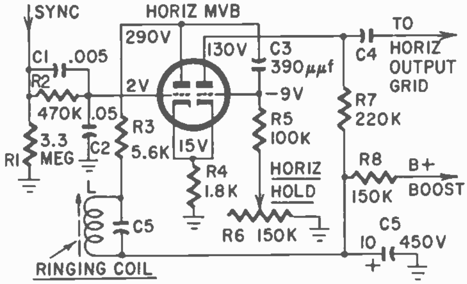


Fig. 602. *Typical horizontal oscillator using a cathode-coupled multivibrator.*

Assume we have found the oscillator not running[2] or running at the wrong frequency. Obviously, we've got to repair this trouble before we can go any further, because the oscillator signal is absolutely essential to the performance of the rest of the circuit.

Cathode-coupled multivibrator

Look at Fig. 602, a typical oscillator circuit. It is the popular cathode-coupled multivibrator, using a ringing coil for stabilization. Like others, this circuit always uses a twin-triode tube — 6SN7, 12AU7, 12BH7, 6CG7, etc. Common coupling between the two cathodes makes the circuit work as a multivibrator. The L-C network in the plate circuit of the input half of the tube stabilizes the oscillator. Its natural resonant frequency must be exactly 15,750 cycles per second. At this frequency, it is shock-excited into oscillation by the sawtooth pulses from the multivibrator.

If the oscillator is not running, shown by a lack of signals on the scope, take dc voltage measurements around the circuit. Those in Fig. 602 are typical of the circuit, but consult the set's schematic for exact values. The negative voltage at the grid of the output half of the tube is a fairly good indication of oscillation when a scope is not available. If the dc voltages are all

[2] This can result in damage to the horizontal-output tube. See page 69.

within 10% of normal and the oscillator still isn't working, a detailed check of components is in order. Only a few could cause trouble under the circumstances — R5, R6, C3 and ringing coil L.[3]

The next step is to ground the sync input grid. The control action of the horizontal afc used with this type of oscillator puts a dc correction voltage on this grid to hold the oscillator on frequency. If there is a defect in the afc circuit, too much dc will be found on the input grid, and the oscillator may be blocked or trying to run far off frequency. Grounding this grid puts it somewhere near where it should run, around zero volts. Now, if the oscillator is OK, it will be free-wheeling somewhere near the right frequency and you should be able to hold a picture on the screen by adjusting the horizontal hold control. The picture will not lock in, of course, as you have removed the sync input. If it does this, the oscillator is all right and you can look for sync troubles — defective tubes, resistors, leaky coupling capacitors, etc.

If this step does not get the oscillator working, leave the short in place and short the ringing coil. If the plate load resistor is around the value shown, 5,600 ohms, add enough resistance in series with it to bring the total value up to about 15,000 ohms minimum. Otherwise, the plate circuit impedance will be too low and the circuit won't work. Now, the only frequency-determining parts left in the circuit are two resistors and one capacitor — R5, R6 and C3. If the oscillator still refuses to work, check them, preferably by replacement. Even a very small leakage in C3, for example, throws the oscillator so far off frequency that it cannot possibly work. A change in the value of R5, the grid resistor, also upsets things here. Once again you should be able to hold a picture on the screen momentarily by adjusting the hold control.

A popular variation of this circuit omits potentiometer R6, leaving only the fixed resistor R5 in the grid circuit. The ringing coil's slug is brought out through either the front or back panel of the set and marked "Horizontal Hold." In these circuits, the oscillator should work without the ringing coil in the circuit. The constants of the R-C network must be such that the oscillator's natural frequency is very close to 15,750 cycles. If the circuit won't work without the ringing coil, remove R5

[3] Shorted turns in the ringing coil can cause horizontal jitter. This trouble is described in Chapter 10.

temporarily, substitute a potentiometer of approximately the same value, and rotate it until the oscillator is on frequency. (With the ringing coil still shorted!) Remove the potentiometer, measure the portion of the resistance used and install a fixed resistor of the same value for R5.

Now, take the short off the ringing coil, and adjust the slug for a locked-in picture. With this setting, the oscillator will be

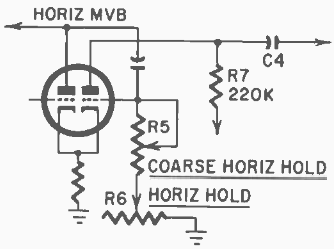


Fig. 603. *This horizontal oscillator circuit has two potentiometers in the horizontal hold circuit.*

much more stable. We have used this method for some time on many sets with a reputation for horizontal instability and it has always given a decided improvement. At this point, we still have the input grid grounded. If this is removed and the picture promptly falls badly out of sync, there is definitely trouble in the phase-comparer circuit. Check all resistors and capacitors there, also the tube for unbalance, etc.

Frequency jumping

Many sets, especially those not having a resistance type control for horizontal frequency adjustment, are noted for taking off. (They may, during a sudden change in line voltage or in the presence of noise or even during a station break, jump to a much higher or lower frequency than 15,750.) Numerous diagonal lines appear on the screen, and the oscillator is so far off frequency that it is impossible for the sync discriminator to pull it back in. The customer usually cures this trouble temporarily by turning the set off and then turning it on again.

The cure here is to short the ringing coil with a jumper as before and, using either a resistance substitution box or a 250,000-ohm potentiometer in place of the oscillator grid resistor (R5 in Fig. 602), vary this resistance until a picture is locked in. Remove the jumper from the ringing coil, lock the picture in with the ringing coil slug and check the value of the substituted resistance. Use this value for the permanent grid resistor.

A variation of Fig. 602, used in some Philco and Zenith sets, has two potentiometers in the horizontal hold circuit (Fig. 603). This allows a very good adjustment of the horizontal hold circuit. To adjust these two potentiometers correctly, set the front-panel horizontal hold control to center, short the ringing coil and adjust auxiliary potentiometer R5 for a stationary picture. Then take the short off the ringing coil and adjust it until the picture is locked in. This centers the operating point of the user's horizontal hold control and makes for maximum stability. Philco puts this adjustment on the top or rear apron of the chassis. Zenith puts it on the rear apron and marks it "coarse horizontal." Either way, its purpose is the same and it is adjusted in the same way. In fact, if a given set is horizontally unstable, you can add this control, mounting it in an empty hole on the back of the chassis.

Christmas-tree effect

Here we are again concerned with the correct adjustment of the horizontal oscillator. The effect has several names: Christmas-treeing, mode-hopping, squegging,[4] etc., but it is all the same thing. The horizontal oscillator is trying to operate (momentarily) at the wrong frequency and the correction circuit is yanking it back on frequency bodily! This is happening several times per second, causing the peculiar effect. Run a complete realignment of the horizontal oscillator circuit. Follow the procedure described under the heading of frequency jumping on page 49.

Critical horizontal hold

Sometimes the horizontal oscillator is in a condition in which it is just barely working, with the slightest disturbance throwing it out of sync completely. The trouble is often due to a resistor having shifted in value. The most likely one would be the 470,000-ohm unit (R6 in Fig. 604) which feeds the horizontal oscillator. If it has increased in value (a common complaint) it would make the oscillator unstable. Also, check the resistors in the grid circuit of the control section of the oscillator.

Piecrust (cogwheel effect)

On occasion a piecrust or cogwheel effect is noted in the pic-

[4] For a discussion of oscillator squegging, see Chapter 3, beginning on page 25.

ture — vertical lines in the picture look like permanent waves. The waves may vary from a very few cycles to several hundred, depending upon the nature of the defect. This condition is often called hunting because in reality that is what the oscillator is doing — hunting for the proper frequency to lock in on according to the information of an improperly filtered sync discriminator circuit.

Cause of hunting

The condition is almost always caused by insufficient filtering at the controlled grid of the horizontal oscillator. In the schematic (see Fig. 604) a .05-μf capacitor (C5) is used from this grid to ground. Often the filter consists of a .01-μf capacitor from grid to ground, with a 0.1- to 0.25-μf unit in series with a resistor across it. In the latter case check all *three* components carefully. These filter units along with the .005-μf capacitor (C6) and 470,000-ohm resistor (R6) in parallel, tend to prevent sudden changes of sync information from controlling the oscil-

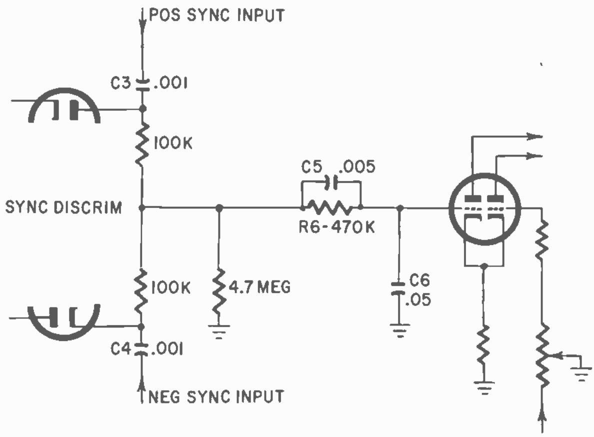


Fig. 604. *The coupling network between the sync discriminator and the horizontal oscillator can cause a jump in oscillator frequency.*

lator instantaneously. This, among other things, improves the noise immunity of the circuit.

This is just a beginning

Numerous other troubles can occur in the horizontal oscillator circuit. Always remember that the horizontal amplifier (see Chapter 8) is a direct load on the oscillator, and defects in it may cause the oscillator to stop or change frequency.

The Synchroguide circuit

About the next most common horizontal oscillator circuit is the pulse-width afc or Synchroguide circuit. It is similar to the circuit just described, in that it uses the same type of sine-wave stabilization as the horizontal oscillator. The major difference lies in the circuit's frequency-determining elements. A complete discussion appears in the following chapter.

chapter 7

the synchroguide

THE Synchroguide is perhaps one of the most widely used horizontal oscillator circuits in the modern TV set. It is normally stable. However, when the circuit is internally upset by improper adjustments or component failure, it has idiosyncrasies unlimited! So, to troubleshoot a Synchroguide circuit sensibly (see Fig. 701), you must be familiar with its peculiarities.

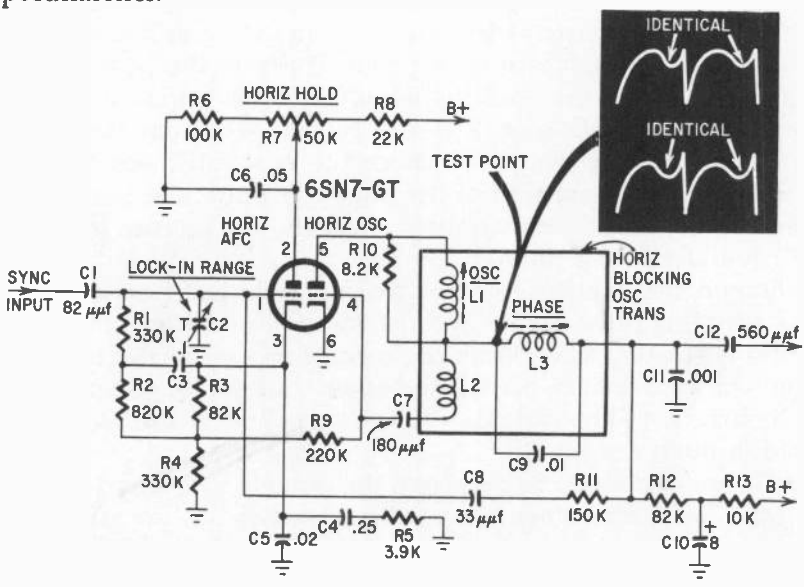


Fig. 701. *Basic Synchroguide circuit. Either waveform is correct. See* Fig. 703.

Even an engineer would not always make a good technician when repairing a Synchroguide, because the inoperative circuit no longer docilely abides by the engineering design built into it. A good practical technician, unencumbered by excess theory, may often find and repair the defect while a theory-oriented man is still wondering how it could possibly occur. It is much easier to apply the proper theory after the defect has been found!

The Synchroguide breaks down into three parts: the blocking oscillator, the control circuit and the stabilizing circuit.

The blocking oscillator is rather conventional and may be redrawn as in Fig. 702. A number of good texts are available

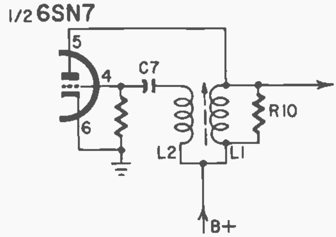


Fig. 702. *Basic circuit of the blocking oscillator found in the Synchroguide.*

to explain blocking oscillator theory, but, for the practical technician, it may not be particularly important. All the technician has to know is that the circuit, properly connected, will operate if all components are OK.

The control circuit is somewhat more complicated and requires some explanation. For control it uses the pulse-width method – phase relations between the sync input and the sampling pulse (through R11–C8 in Fig. 701) from the oscillator's output are compared. Since the sync pulse occurs at a specific time as compared to the sampling pulse, the composite width is definite. When adjusted properly, the picture locks in horizontally at this point.

Should the oscillator slow down, the sync pulse appears on the sampling pulse earlier and the composite width of the grid pulse is greater. This causes the control section of the tube to conduct for a longer period, increasing cathode bias in a positive direction. The cathode voltage is applied to the oscillator grid through resistor R9.

The more positive voltage from the cathode to the grid speeds up the oscillator. When the oscillator speeds up, the width of the composite pulse is reduced and balance is re-established. The opposite effect reduces the oscillator's frequency, if it should go up.

Remember, as in most controlled oscillators, the control circuit cannot change the oscillator's frequency very much. In fact, the control circuit should operate *before* the oscillator changes frequency (1 cycle or more). The correcting circuit

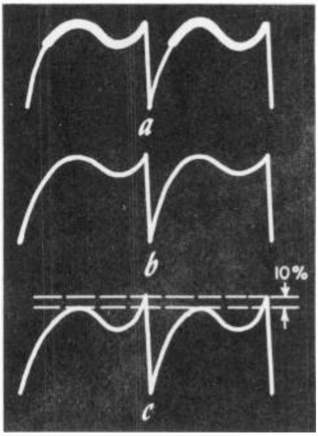


Fig. 703. *Synchroguide waveforms. The superimposed sine wave (a) is shown in heavy lines. The drawing (b) shows the normal waveform that appears at the test point in* Fig. 701. *Some manufacturers recommend the bottom waveform (c).*

operates on the change of *phase*. Actually, phase change corresponds to a frequency change of less than a few cycles in this discussion. The phase angle is, of course, changed when the oscillator changes frequency.

In a properly operating circuit, the leading edge of the sync pulse always comes before the peak of the sampling pulse, regardless of whether the oscillator is moving up or down in frequency. The shape and phase of the sampling pulse are controlled by R11–C8.

The anti-hunt circuit consists of R5, C3, C4, and C5. It prevents overcorrection, which would cause weaving. It also helps keep the oscillator from triggering on individual pulses or on noise.

Stabilizing the Synchroguide

Network L3–C9 is the stabilizing circuit, often called the phase adjustment. The correct setting for the circuit is important for stable Synchroguide operation.

The stabilizing circuit is shock-excited into sine-wave oscillation during the passage of the sawtooth blocking-oscillator plate current. It is interesting to note that this circuit is not resonant at the horizontal oscillator frequency, but is resonant at a somewhat higher frequency (about 1½ times). This is apparent when we look at the Synchroguide waveform on the scope. What we see is a sine wave superimposed on the sawtooth wave (see Fig. 703-a).

The method of formation of the Synchroguide waveforms of Fig. 703 is shown in Fig. 704. The oscillator produces a sawtooth. The ringing coil adds a sine wave. The resulting waveform is the combination of sine wave plus sawtooth.

The stabilizing circuit is needed because a blocking oscillator tends to fire as soon as any pulse arriving at the grid makes the tube start conducting. It is obvious then that, if a large pulse occurred, at any time during the period just before the oscillator was ready to conduct, the tube would fire. This means that an unstabilized oscillator would not necessarily follow the sync-pulse frequency and could be triggered into oscillation by noise pulses, voltage changes, etc.

The superimposed sine wave, however, causes grid and plate voltages to go down during the time the oscillator would be most susceptible to random firing. The sine wave also causes the grid and plate voltage to rise very quickly from this low value so any triggering pulse has to fall near the natural frequency of the oscillator. This waveform is shown in Fig. 703-b and will be recognized as the normal Synchroguide waveform! Stabilizing the blocking oscillator is important to proper operation of the circuit, as we have said, but it is also responsible for "mode hopping," "gunboating" or "squegging."

This comes about because (as mentioned earlier) the stabilizing circuit is not tuned to the horizontal frequency. When the stabilizing circuit takes over, because of improper adjustment or a circuit fault, we get the characteristic condition. It is the effect that makes the raster appear to overlap in the center and is usually accompanied by an audible output caused by the violent fluctuation of the blocking oscillator.

Actually the oscillator is firing twice, once during the normal peak of the waveform and once again when the sine wave or broad hump causes the tube to conduct. As the sine wave and the sawtooth are not in harmonic relation, the erratic condition or squegging exists.

Service

A number of faults appear in the Synchroguide and are often hard to troubleshoot — symptoms between one defective component and another are very similar.

Squegging[1] is perhaps the most prevalent defect and often happens when the set is off channel. It is a fair test of Synchroguide stability when it does not squeg off channel. This doesn't mean that the Synchroguide should not be checked with an oscilloscope for the proper waveform. It will work even with

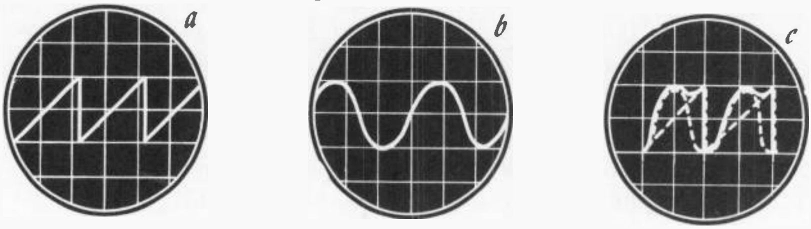


Fig. 704. *These drawings show in more detail how the waveforms of* Fig. 703 *are developed. The oscillator produces a sawtooth (a). The ringing coil adds a sine wave (b). The combination of the sine wave and sawtooth (c) is the waveform illustrated in* Fig. 703.

an incorrect waveform but, because it has a very critical squegging point, a slight drift may throw it into tantrums. Always check with a scope, using a low-capacitance probe at the *test point* (junction of L1, L2, L3 in F g. 701). If a low-capacitance probe is not available, a 5-μμf capacitor in series with a direct probe will work satisfactorily.

The waveform should conform with those shown in Fig. 703. Waveform C is recommended by some manufacturers; partially to compensate for drift in the circuit. You will note the sharp peak is about 10% higher than the broad portion of the curve.

Drifting oscillator

If the Synchroguide drifts more than a few parts in 15,000, it must be repaired. No instrument available to the technician can detect such small drift, so he has to work at the problem slightly backward. In nearly all cases, drift is caused by either the blocking-oscillator transformer or by leaky capacitors in the oscillator or control circuit. Fortunately, only a few transformers have been found defective, except some on specific runs of sets which are now out of production. The most frequent cause of drift is leaky capacitors. It is not unusual to find two or more that are leaky and causing drift.

As little as 20 megohms of leakage should not be ignored in any circuit, especially not in the Synchroguide. *This is not leakage measured by a low-voltage ohmmeter.* A regular ohmmeter is practically useless as a capacitor checker, yet many technicians

[1] Oscillator squegging is discussed in detail in Chapter 3, beginning with page 25.

still rely on it. A capacitor that shows a 1-megohm leakage on a capacitor checker using 200 or 300 volts may show no leakage at all on a sensitive ohmmeter.

Capacitor checker

Fig. 705 is the circuit of an inexpensive capacitor leakage tester that will find 99% or more of the faulty capacitors in a Synchroguide or any other circuit. It applies about 300 volts to the capacitor under test through an indicating device consisting of an NE-2 neon lamp. It is sufficiently isolated from the power line so that an isolation transformer is unnecessary. Just be sure you don't make any connections to the instrument's chassis. One end of the capacitor must be lifted for the test, of course, and the TV set should be disconnected from the power line to eliminate any possible false indication. The neon lamp will blink on, then go out if the capacitor is good and there is no leakage.

A dpst pushbutton switch prevents accidental shock by shorting the test leads except during the test and discharging the capacitor after the test.

Check all capacitors in the Synchroguide circuit if drift is suspected. It doesn't take very long and often saves untold grief.

On occasion, and with certain circuits, drift or apparent drift is caused by defects in the preceding sync circuit. If the oscillator will not lock in, except at the extreme range of the controls or perhaps not at all, the sync circuit should be eliminated as suspect by removing the sync tube or grounding its grid. If doing this affects the position of the controls very much, check the sync circuit.

Off frequency

A Synchroguide's operating on the wrong frequency is often caused by the same things which cause drift. Another item which causes off-frequency operation is a broken slug in the oscillator coil. This sometimes happens in shipment. Simply inclining the set to make the slug move in the coil form usually uncovers this defect.

An especially frequent offender is C6, the capacitor from the arm of the horizontal hold control (R7) to ground. On rare occasions, resistors can change value and cause off-frequency operation. But this is not likely unless some other component in the circuit has caused extra current flow through them.

Open resistors are common and often for no apparent reason. Resistors of normal tolerance may be used as replacements in a properly operating Synchroguide. If a critical value of resistance is required to make the circuit operate properly, there is probably another fault in the circuit. A normally operating circuit that suddenly develops trouble can never be considered cured just because a certain value resistor used to replace one

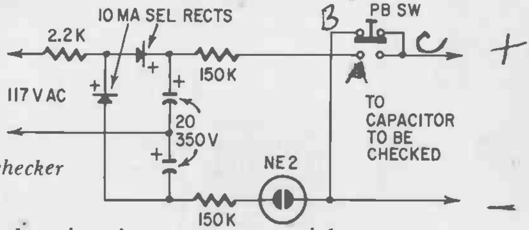


Fig. 705. *Simple capacitor checker tests for leakage.*

of a different value causes the circuit to operate with apparent normalcy! A circuit that has worked will work again, so don't do a makeshift repair – more than likely you will be borrowing trouble!

Instability

Improper adjustment of the phase stabilizing coil (L3) causes instability more often than almost any other one thing. It can also be caused by any of the troubles which result in drift or off-frequency operation. The point is, don't let Synchroguides get you down. Even if it means checking each part separately, it is still worth the effort and it really doesn't take long once you make up your mind to it.

Don't imagine that the instability is inherent. It just isn't true! The Synchroguide will operate without instability. Don't overlook C10, the electrolytic decoupling filter capacitor used in many designs. If it opens or develops a high impedance, instability is sure to result. A quick look across it with the scope will satisfy your mind on this one. Less than 0.5 volt peak to peak should be across this filter, at the horizontal frequency.

In the home

Although field adjustment without a scope is not recommended, it can sometimes be done with a fair degree of accuracy.

Simply connect a jumper across the phase stabilizing coil (L3) and remove the sync from the control tube either by lifting the sync tube or grounding its grid (not the control tube).

Adjust the oscillator slug in L1 until a picture is visible float-

QUICK CHECK CHART

Defect	Possible Cause (In order of probable failure)	Remedy
Drift	Leaky C6, C7, C1, C9, C8	Check and replace
	Defective transformer	Replace
	Leaky C5, C4	Check and replace
Instability	Incorrect waveform	Adjust with scope (see text)
	Open C10, C4, C5, C3, C9, C8 Open R10 Leaky C7, C8, C1 Defective transformer Open L1 Open R5	Check and replace
Off Frequency	Incorrect adjustment	Readjust
	Shorted or leaky C6 Open R8, R6, R7	Check and replace
	Broken slug in transformer	Replace slug or transformer
	Shorted C5 Open C10 Shorted or leaky C1, C3	Check and replace
	Incorrect adjustment C2	Readjust

ing by. Remove the jumper and adjust the phase stabilizer slug until the picture floats by with no instability. Reinsert the sync and make any minor adjustment necessary to lock the picture. If a major readjustment is required, it is likely that some component is defective, and the entire circuit should be checked.

The Synchroguide is stable when operating properly, but *extremely* unstable otherwise. It is susceptible to internal troubles as much or more than any other circuit in the TV. A capacitor leaky by a given amount will give altogether different symptoms than the same capacitor with a different amount of leakage. It is impossible to picture all the symptoms prevalent in defective Synchroguides, but fortunately they all bear a family resemblance. So, with a little experience, it shouldn't be difficult to spot the wild Synchroguide and tame it right there on the spot! Use the quick check chart shown above to help you.

chapter 8

servicing the horizontal output stage

THE horizontal output stage of a TV receiver has two important functions. It generates the sawtooth currents that sweep the electron beam across the face of the picture tube, and it supplies high voltage for the picture tube. These happen simultaneously, but to make things a bit clearer we'll take them one at a time.

The horizontal output tube is always a power pentode, with a hefty current rating. It is biased to operate class-B or class-C, so that plate current flows for only a small part of the input cycle. The drive voltage (input signal) from the oscillator has

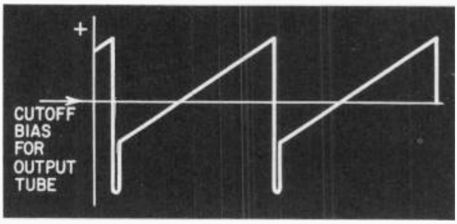


Fig. 801. *Trapezoidal voltage on the control grid of the horizontal output tube.*

a special shape. It is not a sawtooth, but a trapezoid (Fig. 801). This combination of a sawtooth and square wave is necessary because it causes a pure sawtooth wave of current to flow through the deflection yoke windings. This gives us the linear deflection we've got to have.

The plate load for the horizontal-output tube is a transformer which is coupled to the deflection yoke windings. The yoke is the load for the transformer secondary and the combination of the two (transformer and yoke) makes up the total load for the output tube. When the output tube is conducting, a pulse of current flows through the primary winding of the transformer. This generates a similar pulse in the secondary.

Fig. 802 shows the waveform of the current pulse in the yoke. Notice the point on the waveform marked "output tube cutoff"? Right there, the peak of the sawtooth portion has been reached

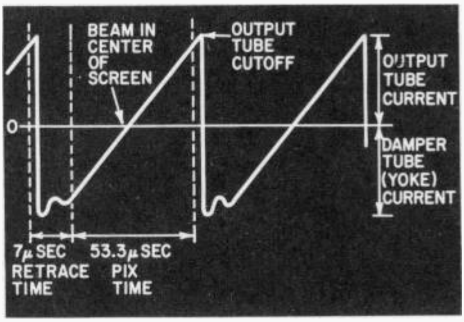


Fig. 802. *Sawtooth current through the yoke developed by the trapezoidal voltage.*

and the grid voltage has dropped below the operating point – the tube is cut off and plate current stops flowing.

The pulse stores energy in the form of a magnetic field built up around the transformer secondary. When the output tube is cut off, the field collapses back through the winding, inducing another pulse of current *in the same direction*. Thus, when the first pulse is applied (horizontal output tube conducting), the magnetic field created around the yoke starts the electron beam in the picture tube moving from left to right (from a theoretical resting position in the center of the screen). When it reaches the right edge, the horizontal output tube stops conducting. The resultant collapse of the field generates a sharp pulse in the windings that snap the beam all the way across the tube. Then, the field still present keeps the beam moving from left to right, until it reaches the center again.

At this time the output tube takes over again and begins to conduct. The next pulse moves the beam the rest of the way across the screen. The combination of these two actions gives us a linear sweep.

When the stored energy in the transformer collapses, it induces a pulse of current in the primary. The rate of change of the current during this time is very fast and causes a high (pulse) current to flow in the primary. The pulse induces a very high voltage in the primary (it acts as an autotransformer)

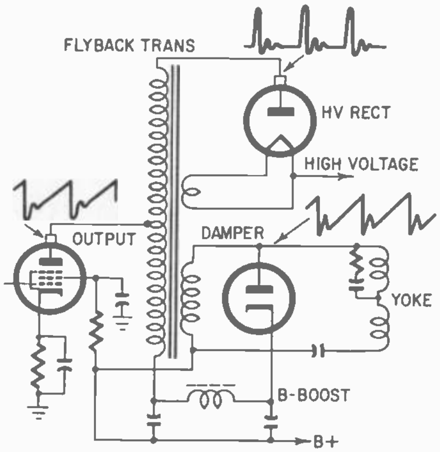


Fig. 803. *Horizontal output circuit. Autotransformer action puts a high voltage pulse on the plate of the high voltage rectifier tube.*

which is applied to the high-voltage rectifier, as in Fig. 803. The total time for a complete cycle is 63 μsec. Of this, 56 μsec is used for the sweep and 7 μsec for retrace. The rest goes into the front and back porches. The inductive kick used to generate the pulse of high voltage has led to the name of *flyback* for these transformers.

Flyback–yoke system

The transformer–yoke system has inductance and, like any circuit having inductance, it also has a natural resonant frequency. During retrace (flyback time) the collapse of the field shock-excites the whole system into oscillation. For reasons which we will get to in a moment, the whole system is designed to be naturally resonant at the fundamental frequency of the retrace time — 70 to 72 kc.

Ringing on left side of the raster

We get these oscillations because of the nature of our sweep system. We can't get rid of them so we do something useful with them. First, we get a rapid retrace. And second, by making the whole system resonant at the retrace frequency, we increase its efficiency tremendously and get a much larger pulse of current in the primary to be made into high voltage! If we let the oscillations die out normally, it would upset the sweep and the waveform would look something like Fig. 804. This would cause ringing on the left side of the raster.

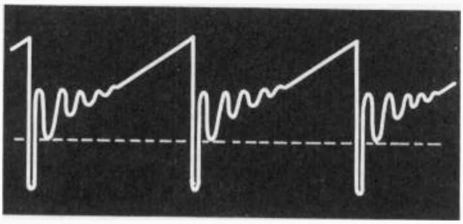


Fig. 804. *Natural shape of the waveform in the yoke and flyback without a damper tube.*

To get rid of the unwanted portion of these oscillations, we connect a half-wave rectifier across the yoke, as in Fig. 805. Now, during retrace, the pulse makes the cathode of this rectifier (the damper tube) positive, so the tube does not conduct and, in effect, is not even there! After the pulse passes the zero line,

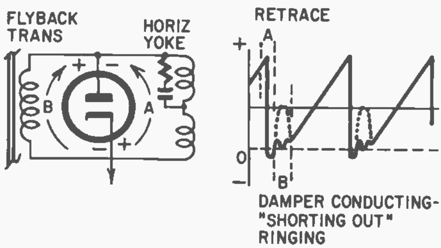


Fig. 805. *Polarity of flyback pulse during retrace makes damper cathode positive so damper does not conduct. When ringing voltage starts, the damper cathode is negative and the tube conducts heavily, shorting the ringing.*

it changes polarity. The next half-cycle applies a positive voltage to the plate of the damper, and it conducts heavily, shorting the undesired halves of the pulses. This damps the ringing and leaves us with an almost perfectly linear sweep.

So there's your circuit action. The oscillator drives the output tube which in turn drives a tuned circuit, the flyback–yoke combination. You know what happens when a tuned circuit is thrown out of resonance – there's a drop in the stage's output. So, whenever we replace a component in the flyback or yoke circuit, we must use a replacement that will restore the whole circuit to its original resonant condition! This is the reason for using exact-duplicate yokes, flybacks, etc.

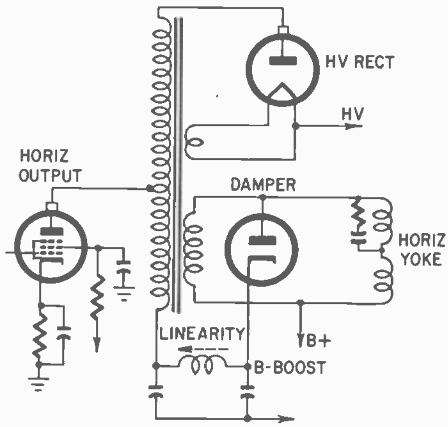


Fig. 806. *Horizontal output transformer having separate primary and secondary windings.*

The most important sections of the circuit are the components that determine resonance – the flyback, yoke, and any capacitors which may be connected in the circuits. The high voltage generation is actually almost incidental. We can get high voltage by simply winding on more wire "above" the output tube plate, so we do!

The same thing applies to the boost voltage. When the damper tube conducts it acts like any half-wave rectifier and a positive voltage appears on its cathode. But the way the damper is set up, with the B-plus applied to its plate, the added voltage appears in series with the B-plus. This gives us a source of higher voltage (the boost voltage) used to furnish plate voltage for the vertical and horizontal output stages.

To get a dc voltage from the high-voltage pulse, we must rectify it. A special rectifier, with very wide spacing between its plate and filament, is used to prevent flashover. The filament must be above ground, so it is powered by wrapping a turn or two of wire (exceedingly well insulated wire!) around the core of the flyback. Output is taken from the filament, sometimes through a filter consisting of a large resistor and a 500-μμf capacitor. Many sets use the inherent capacitance between the conductive graphite (Aquadag) coating on the picture tube and the chassis as this capacitor.

Three flyback circuits

That's about all we need on the basic circuit. Now let's look at the three basic circuits used in commercial TV sets. They differ only in the yoke connections and you'll have to examine the schematic to see just which one you have.

1. The transformer circuit uses a separate secondary winding to drive the yoke (Fig. 806). B-plus is fed into the flyback

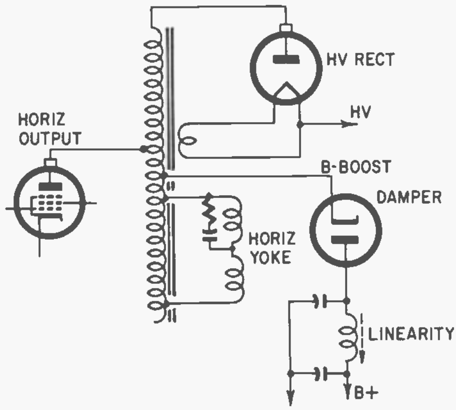


Fig. 807. *Autotransformer type of horizontal output transformer.*

through its secondary and the damper tube, and the high rf (the spike of voltage from the flyback action) is applied to the damper's plate. Boost voltage is developed at the damper's cathode and fed back through the linearity-coil circuit and the transformer's primary to the plate of the output tube.

2. The autotransformer circuit has only a single winding, and drives the yoke by connecting it across taps on that winding. B-plus is fed to the plate of the damper through the linearity coil. Boost voltage, of course, appears at the damper cathode and feeds the output tube plate through the flyback winding (Fig. 807).
3. The direct-drive circuit uses a simpler flyback that consists of only the plate and high-voltage winding as shown in Fig. 808. The yoke is connected in series at the lower end, back to the damper cathode and the boost voltage. Most of these can be identified by the flyback, which does not

have an iron core, but either a plastic or paper form. You've noticed, of course, the identical nature of the high-voltage section of the winding on all of these circuits – all are autotransformers with the plate of the high-voltage rectifier connected to the top of the total winding.

Servicing tricks

Servicing any receiver, radio or TV should be handled back to front. Start at the output (speaker or picture tube) and work toward the antenna, repairing all troubles as you go. Servicing horizontal output stages demands a different approach. First,

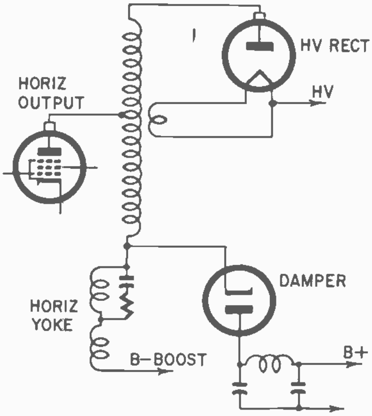


Fig. 808. *Direct drive type of horizontal output transformer.*

isolate the whole circuit in your mind – oscillator, output tube, flyback, damper, yoke and high-voltage rectifier. Now, think of this circuit as if it were a radio transmitter. Transmitter servicing is entirely different. We start with an oscillator, feed it into a power amplifier through a tuned circuit, then to an antenna. In this case, our "antenna" or load, is the yoke and the high-voltage rectifier, but the basic operation is just the same. So if we can think of the circuit as a transmitter, it'll be easier to service!

We worked on the oscillator in chapters 6 and 7. From now on we'll assume it is working perfectly and any troubles lie in the output stage. Testing in this circuit is a process of elimination. You can use any of several places as your starting point. But practically everyone makes a routine examination of the set, noting which tubes are lit, checking the high-voltage fuse, measuring the B-plus voltage and checking to see just what symptoms the set shows. Once you discover there is no high voltage, you can start eliminating the various things which could cause it.

The most common causes should be checked first – the tubes. All should be replaced, checking the set each time. A good order of replacement is: high-voltage rectifier, damper, horizontal output and oscillator. If this does not bring the raster back, leave the good tubes in until you're finished and proceed with the rest of the tests.

First, see if you can draw an arc from the plate of the high-voltage rectifier with the blade of a screwdriver. *(You should know that the screwdriver must be insulated. Anyway, you'll remember it the second time!)* Normal arc is about ¾ inch long and a bright blue. If the output tube plate cap is exposed, you should get a very short arc there. No arc at either plate means that there is no high-voltage pulse reaching the rectifier plate. At this point, disconnect the yoke and repeat the test. If a below-normal arc appears at the high-voltage rectifier plate, the yoke may be defective. Check it for shorts and leaky balancing capacitor–resistor networks. If possible, substitute another yoke of the same inductance (the horizontal section is all you need) and see if the high voltage comes up to normal. If it does, the yoke is definitely bad. If not, the trouble may be in the flyback or the output tube.

Weak output

In many of the newer sets, test points are easily accessible – oscillator plate, output tube grid and screen, etc. Measure voltages at these points and check them against the schematic. The scope is a valuable instrument for checking this circuit. By placing its probe *close to but not touching* the plate lead of the output tube you can see if there is any pulse voltage there and after a while get a pretty good rough idea of its normal amplitude.

Weak output may be caused by low drive, open coupling capacitors or incorrectly set drive adjustments. This can be quickly checked with the scope and a voltage calibrator. Measure the peak-to-peak amplitude of the drive signal at the control grid of the horizontal output tube. For the old 50° sets it should be about 50 volts, 65 volts for 70° sets, 75 volts for 90° and 90–105 volts for the 110° sets.

Measure the screen voltage of the output tube. A shorted tube, replaced some time before, may have damaged the screen resistor. Normal screen voltages for common tube types are: 6CD6, 6AV5, 175 volts; 6AU5, 6BQ6, 6CU6, 6DQ6, 200 volts, and the 6BG6, 350 volts. These are maximum values. In TV sets you'll find variations below this figure, but not too many. The screen voltage should never be more than the amount given or screen dissipation will be too large.

Cathode voltage should be checked if a protective resistor is used. Many circuits simply ground the cathode, but others use a small resistor (100–150 ohms) in the cathode to protect the tube against drive failure. Remember the radio transmitter? These tubes are just like final amplifiers — if operated without an input signal (drive), the plate currents reach excessive heights and destroy the tube in a short while. So if you see the plate of the horizontal output tube turning red, turn the set off quickly and check to see why the output tube isn't getting any drive signal!

Special testers

Several test instruments are made solely for checking flyback–yoke systems and all are worth their cost. Some are signal substituters that provide signals which can be used on the output tube grid in place of the set's horizontal oscillator. Also, with the aid of a horizontal output tube in the instrument, they will drive the flyback and yoke without the set's output tube. This test tells you definitely whether there is trouble in the flyback.

Other test instruments check components out of the circuit. They detect shorted turns in flybacks and yokes by using the resonant-circut principle we discussed earlier. (A winding with a shorted turn will not resonate at its proper frequency, and its output will be very low.)

One such instrument can even be connected directly into the horizontal output circuit and reads all quantities concerned with it. Resistance readings can be taken in the B-plus and boost circuits, screen resistors and cathode resistors measured, and all voltages checked in actual operation, merely by turning switches.

Finally, by using test adapters or by opening the cathode circuit, the total current (plate and screen) of the output tube should be measured. (If the tube uses a cathode resistor you can measure the IR drop across it and calculate the tube current.) This is the most important reading as far as tube life is concerned. Maximum currents should be 6AU5, 6AV5, 6BQ6, 6CU6, 6BG6 – 100 ma; 6DQ6 – 140 ma, and 6CD6 – 170 ma. If tube current is higher, tube life will be short indeed! Too-high tube current can be caused by incorrect screen voltage, low drive on the grid, improper bias in the cathode (if used) or by a severe mismatch in the yoke circuit. Leaky or open screen or cathode bypasses can also cause troubles. Whenever any major repairs are made to the flyback system, always measure the plate current of the horizontal output tube; too much means an inevitable callback!

Yoke troubles

Beside the standard symptom of yoke trouble, which is a trapezoidal raster, there are several other reliable indications. The best of these is the absence of boost voltage – your damper tube will have only B-plus on both cathode and plate. A good rule for boost-voltage value is that it should be at least 100 volts above the B-plus. So if the raster is dim or nonexistent and the boost is gone, look for trouble in or around the yoke.

Checking the yoke

There are several ways. The quickest, described on page 69, is a regular flyback-yoke tester.

A good home-made test is the substitution of a yoke with duplicate characteristics. Note that in this test we're not interested in getting a complete yoke with the exact characteristics needed. All we need is a yoke that is within about 20% of the inductance value of the original, so that we can be certain that the original is defective.

Most of us have at least two or three new yokes in stock. One of them should come close enough for test purposes. If not, a yoke from another TV set may be used. Disconnect the horizontal windings of the original and connect the test yoke. Now, measure high voltage, boost, etc., to see if it comes back to normal. If so, the original yoke is defective. Before discarding it though, take a good look at wiring, the balancing network and the connecting leads. Many yoke troubles come from minor wiring shorts or loose connections.

Yoke inductance

There is a certain amount of tolerance in yoke inductance, but not too much – 15% to 20% according to various authorities. Fortunately, there are only about 10 inductance values in common use in horizontal yokes, and 5 in the vertical sections. There are a large number of combinations of these values, of course. Table I shows the range of inductance to be expected in each section.

TABLE I — Inductances of Deflection Yokes

Horizontal *(mh)*	Vertical *(mh)*
8.3	3.5
10.3	11.5
12.5	12.3
13.5	40.0
18.5	42.0
19.0	48.0
25.0	50.0
30.0	

Some typical symptoms of yoke trouble are trapezoidal pictures, ringing in the raster causing wrinkles and bright lines at the left side (look for the telltale bending of the scanning lines that denote raster instead of video troubles), insufficient height or width. Either of the last two may be found with or without the trapezoidal shape. A very good indication is a loss or lowering of boost voltage. Watch out for troubles which seem to be in the yoke but aren't. Typical of these are open boost filter capacitors which can cause a wrinkled and slightly trapezoidal raster. This usually happens in sets which draw vertical output current from the boost. A tipoff to this is found in the vertical linearity control which will act as a brightness, width and high-voltage control all in one! The brightness control will also change the shape of the raster.

TABLE II — Inductance vs Resistance of Deflection Yokes

Inductance *(mh)*	Resistance *(ohms)*
Horizontal	
8–10	13–15
12–14	18–20
18–21	30
24–25	38–40
30	50
Vertical	
3.3	3.6
40	40–45
45	50–55
48	55–65

If you lack information about the yoke, a rough guess can be made from the dc resistance. Table II gives the approximate resistance values for the various yoke windings. This should be used for substitution tests only, unless no service information at all is available, a situation seldom found today. Service literature from manufacturers, service-data publications and yoke manufacturer's catalogues, all have very comprehensive lists of almost all sets made within the last several years. If half of a yoke winding is burned up, resistance measurements can be made by reading the undamaged half, then doubling the reading. When replacing the yoke, be sure to duplicate the R-C network originally used, for the best matching and elimination of ringing in the raster.

chapter 9

servicing auxiliary circuits

Let's take a look into a few of the more ignored spots in the receiver's circuitry. The vertical output stage should be a good place to begin.

Retrace blanking defects

The vertical output circuit contains a simple network that in its many forms is being used more and more. This network

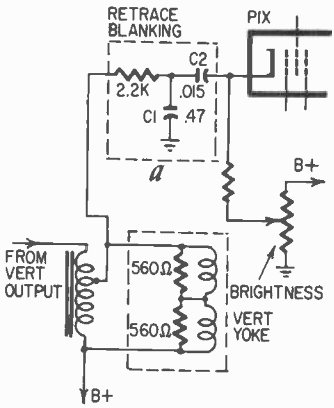


Fig. 901. *Retrace-blanking network found in vertical output stages. The vertical yoke coils are shunted by a pair of damping resistors.*

for retrace blanking is shown in Fig. 901. In normal operation it supplies a vertical retrace pulse of the proper polarity and spike shape to the picture tube to cut it off during the vertical retrace period. Fig. 902 shows the scope pattern of the blanking

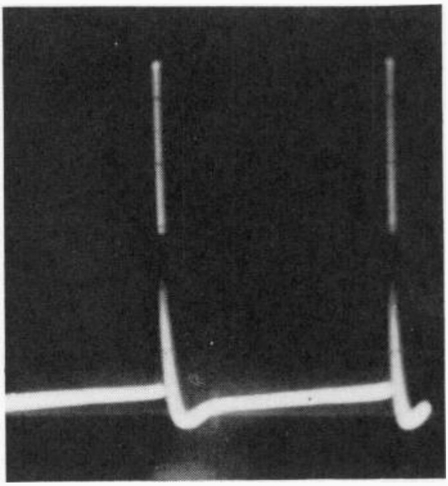


Fig. 902. *Waveform of the blanking pulse applied to the picture tube.*

pulse applied to the picture tube. It is during this interval that slanting horizontal lines (retrace lines) can form on the screen. Fig. 903 shows retrace lines caused by reversed polarity of the blanking pulse.

The values of the circuit components are chosen and arranged to pass only the quicker retrace pulse and very little of the

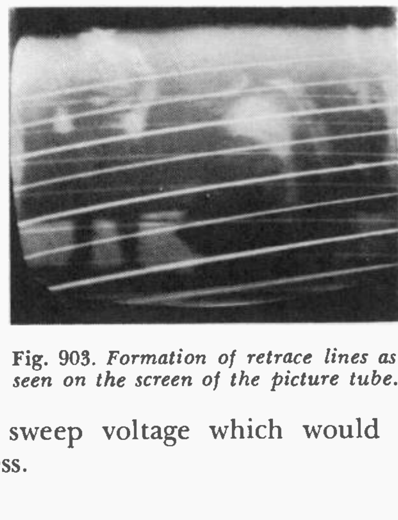
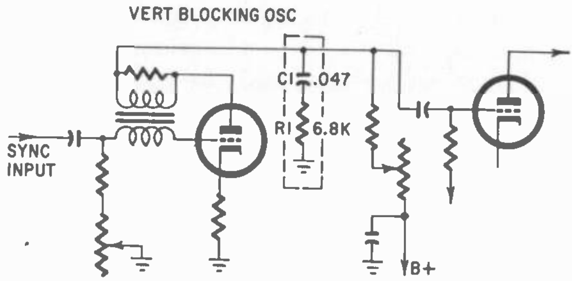
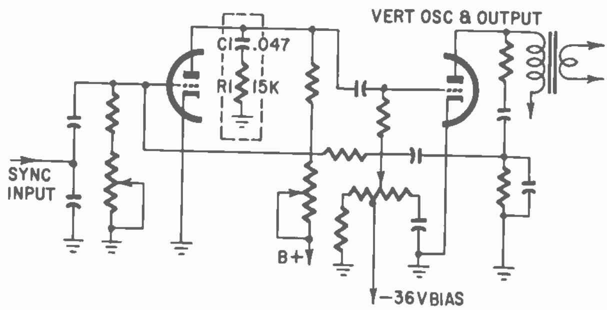


Fig. 903. *Formation of retrace lines as seen on the screen of the picture tube.*

actual vertical sweep voltage which would harmfully affect screen brightness.



a



b

Fig. 904. *Sawtooth capacitor in a vertical blocking oscillator (a) and in a vertical multivibrator–vertical output circuit (b).*

Troubles in retrace-blanking circuits are usually caused by one or both of the capacitors developing leakage or a direct short. A short or leakage in capacitor C1 (Fig. 901) can reduce

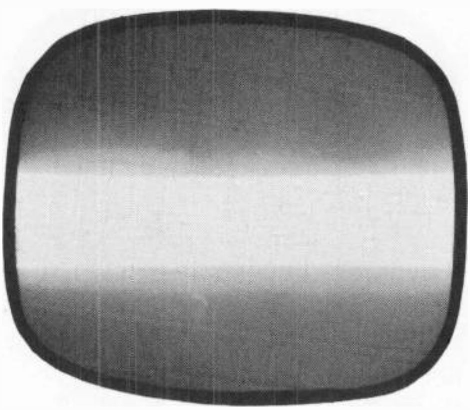


Fig. 905. *Condition produced by open sawtooth capacitor in vertical blocking oscillator.*

vertical size as well as allowing retrace lines to form. A shorted or leaky C2 can black out the screen because it injects practically the full vertical sweep voltage into the picture tube. An open component in this circuit will be indicated by the presence of

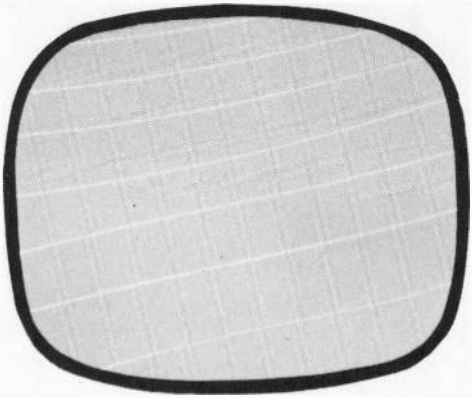


Fig. 906. *Normal number of retrace lines.*

retrace lines and the absence or distortion of the retrace-blanking pulse.

Vertical peaking

When the sawtooth capacitor (C1) in a vertical blocking oscillator opens (Fig. 904-a), the condition shown in Fig. 905 develops. If the resistor (R1) shorts or loses resistance, vertical

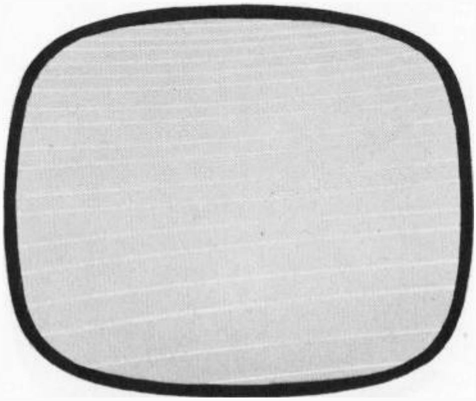


Fig. 907. *Condition due to a shorted resistor in the sawtooth forming network of a vertical blocking oscillator. The number of retrace lines has doubled.*

interlace is destroyed and double the number of retrace lines form. Fig. 906 shows a normal number of retrace lines. Fig. 907 shows the result of a shorted resistor in the sawtooth-forming network.

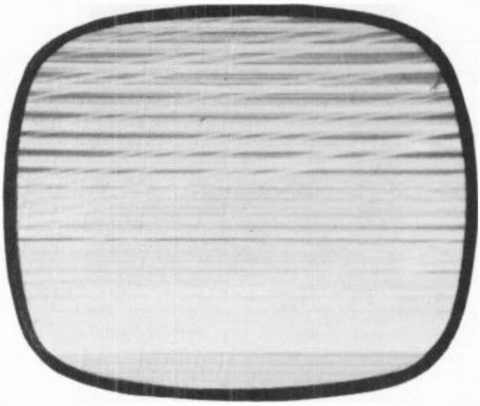


Fig. 908. *Vertical-sweep distortion produced by sawtooth capacitor in vertical-multivibrator–vertical-output circuit.*

The sawtooth capacitor (C1) in a combination vertical-multivibrator–vertical-output circuit (904-b) can produce vertical-sweep distortion, like that shown in Fig. 908, when it opens. When the resistor (R1) in this network goes down in value, severe nonlinearity, like that seen in the spacing of the cross-hatch pattern in Fig. 909, occurs. Waveforms at the input

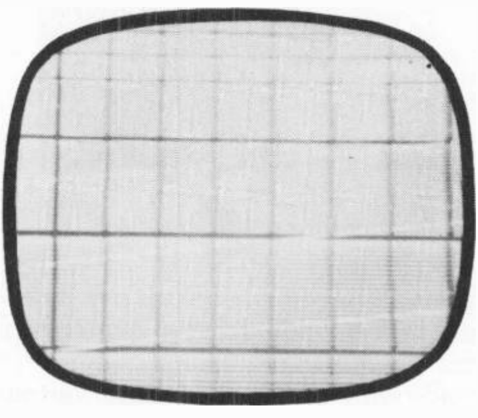


Fig. 909. *Nonlinearity caused by reduced value of resistance in sawtooth network of vertical-multivibrator–vertical-output circuit.*

plate in this circuit are similar to those in vertical-blocking oscillators except that a sharper square wave is formed when the sawtooth capacitor opens as in Fig. 910.

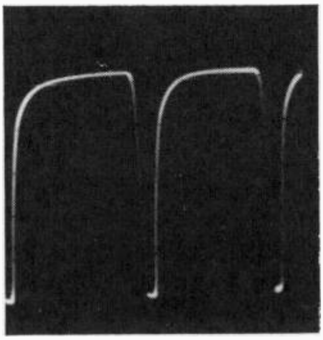


Fig. 910. *The waveform at the input plate of the vertical-multivibrator–vertical-output circuit becomes a fairly sharp square wave when the sawtooth capacitor opens.*

Yoke damping defects

The two 560-ohm resistors across the vertical yoke coils (Fig. 901) have a purpose similar to that of the damper tube in the

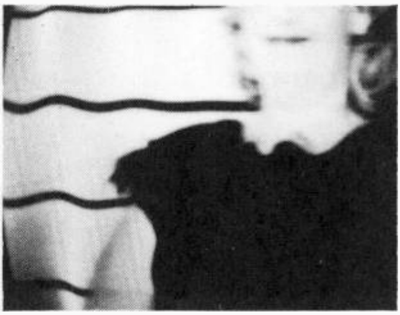


Fig. 911. *Ripples caused by open resistors across the vertical winding in the yoke.*

horizontal output transformer's secondary. The damper tube loads the circuit, making it difficult for any transient oscillations to exist.

A similar condition exists in the vertical output transformer and yoke coils but, because vertical retrace is slower, transient oscillations are of much lower amplitude and duration and a damper tube is not needed. These two shunting resistors provide sufficient loading so that transient oscillations cannot exist. They also damp any voltage peaks or spikes that might be picked up from the horizontal yoke coils.

Abnormal operation may not always be apparent — with these resistors disconnected, many older sets will still perform normally — it depends on the yoke efficiency or Q. On modern

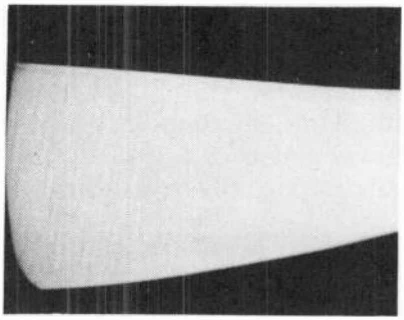


Fig. 912. *Keystoning caused by shorted vertical winding in the yoke.*

high-efficiency yokes, if these resistors are removed or open, ripples will form on the left edge of the screen that are indistinguishable from those caused by an improper-size horizontal yoke capacitor (see Fig. 911). Direct substitution is the best test in this case.

A shorted resistor can cause vertical raster keystoning like

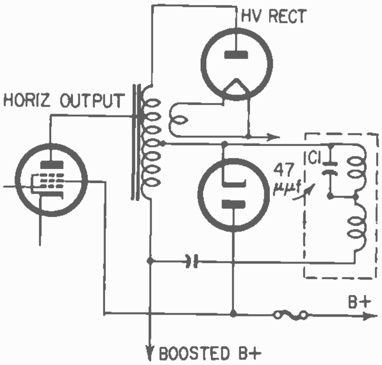


Fig. 913. *The capacitor (C1) across the top half of the horizontal yoke coils has a damping action.*

that produced by a shorted yoke coil (see Fig. 912). Therefore, an ohmmeter check of these vertical yoke-shunting resistors should be made before replacing a yoke for vertical keystoning.

The small capacitor (C1) across the high side of the horizontal yoke coils (Fig. 913) has somewhat of a damping action, also. Ripples on the left side of the screen can also be due to interaction or crosstalk between the vertical and horizontal deflection coils.

Crosstalk

The basic purpose of this capacitor across the top half of the horizontal deflection coils, the half farthest from B plus, is to balance the capacitance of both horizontal yoke coils (with respect to ground). Thus any coupling to the vertical deflection coils from the horizontal coils is equally out of phase. Interaction and crosstalk can thereby be nullified.

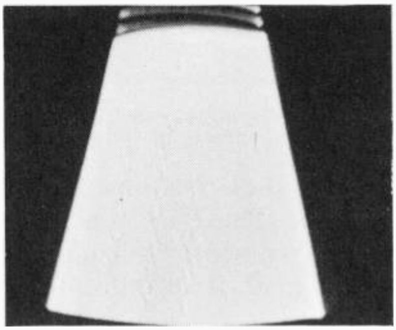


Fig. 914. *Horizontal keystoning caused by shorting of capacitor C1 in Fig. 913.*

However, even on many new sets, some ripples are evident on the left edge of the screen. Assuming that the vertical yoke resistors are not defective in these sets, an adjustment of the value of the horizontal yoke capacitor can correct or improve this condition.

Temporarily substitute a mica trimmer adjustable from 10 to 100 $\mu\mu f$ for the original yoke capacitor and adjust for best results. When the best setting is found, remove the capacitor carefully and measure its value. The indicated value will be correct for the horizontal yoke capacitor for that particular yoke and set.

Another common trouble that can be caused by this capacitor is horizontal keystoning when it shorts. This defect is shown in Fig. 914. Incidentally, a replacement horizontal yoke capacitor should be rated at 1,500 volts or more due to the high spike voltage present in yoke circuits.

Servicing stacked B-supply circuits

In series- or stacked-B supplies the plate resistance of a vacuum tube is considered as part of a voltage-divider network. Generally, the audio output tube is placed in series with if and other tubes, and the full B plus applied across the group.

The audio output tube in a stacked-B supply is an electronic regulator, acting as a variable resistor in series with the plate resistance of a string of tubes whose plate supply voltage is the 150-volt B bus, in this example. Fig. 915 shows the audio output circuit used in a TV receiver. R_x denotes the several tubes fed from the 150-volt line. The rheostat action of the audio output tube is controlled by the voltage at the junction of R2 and R3,

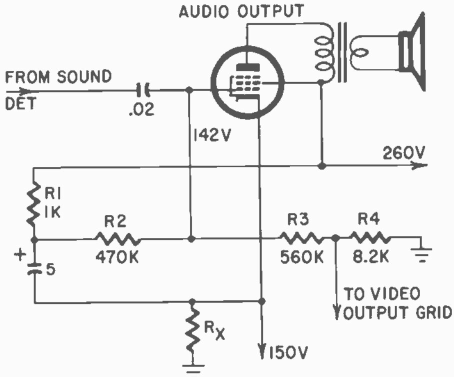


Fig. 915. *Schematic shows the basic circuit in a typical stacked-B system.*

which is held relatively constant, and the voltage at the cathode.

If the B-plus voltage decreases, the cathode voltage falls off. This decreases the bias on the audio output tube and produces an increase in the plate current flow. The increased flow through R_x then raises the cathode voltage, restoring it to its original 150-volt value. An increase in B-plus voltage produces the opposite effect.

The regulated 150-volt bus in this circuit supplies the plate voltage to the front end, video if amplifier, bias to the picture tube cathode, sync clipper, sync amplifier, the sound if amplifier plus one or two other circuits. Therefore, if something happens to the audio tube we may expect any of many symptoms: the sync circuit will be disturbed; there may be no picture due to failure of the 150-volt bus supply to the front end and the video if tubes; if the audio output tube develops a short from plate or screen to cathode, the 150-volt bus would rise to about 260 volts and some components may fail.

The resistors supplying the plates and screens from the 150-volt B bus may overheat if such a short were to develop. The increased voltage increases the current and the heat produced.

It is not practical to test each and every component under such circumstances. Perhaps the best idea is to repair the set and then run it at a high line voltage on the bench. Or, at least, remember that the trouble may not be completely cured merely by replacing a shorted audio output tube.

An open-circuited, or nearly so, audio output tube will affect all tubes fed from the 150-volt line. No picture may be due to a bad or weak audio tube!

Troubleshooting

Since the controlled bus (150 volts here) may affect many other sections of the receiver the first test is tube substitution no matter what the symptoms indicate. Even the high voltage may be missing due to supply of the horizontal oscillator by the controlled lower-voltage bus. The circuits supplied vary considerably with different receivers.

The next procedure, if substitution does not help, is voltage readings at the plate, grid and cathode of the audio output tube.

If the audio tube is cut off or does not pass normal current, the high B plus rises and may be 25–50 volts more than normal. Likewise, the voltage at the R2–R3 junction will rise since it is independent of the controlled B bus. The audio tube may have a very high resistance. If so, the 150-volt bus will be lower than normal.

A lower than normal 150-volt bus with a higher than normal supply voltage might be due to a change in value of the resistors controlling the audio grid voltage. These are frequent offenders and can be checked with an ohmmeter. Use at least 5% resistors in any replacements.

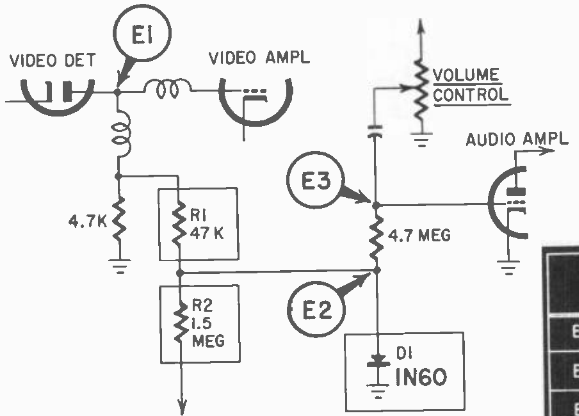
An unfortunate combination of excess tolerance of resistors may add so as to throw the circuit out of order even though the individual resistors may be well within tolerance. The bias voltages must be tailored to fit! A high-resistance shunting resistor or a low series resistor will assist in this correction.

A leaky capacitor from the controlled bus to ground may cause trouble. All voltages will be low, the audio tube will become extremely hot and may even burn out. Check the voltage after about 5 minutes' operation following the replacement of a dead audio tube. In one case a shorted audio tube damaged this capacitor. Then it became leaky, and the audio tube "wore out."

The tubes on the controlled bus — mixer, if, etc. — must draw about normal current. If the voltage remains persistently high or low on the controlled bus while bias and supply voltages are near normal, then check these tubes by substitution. In one case the current to each had to be measured with a milliammeter before the trouble was discovered.

Eliminating warmup buzz

All television receivers have some sort of agc to help maintain



	DURING WARMUP	AFTER WARMUP
E1	−22V	−2V
E2	−16V	+0.2V
E3	−16V	−0.7V

Fig. 916. *Circuit for eliminating the nuisance of warmup buzz. The chart at the right gives voltages at test points E1, E2 and E3.*

a constant video detector output regardless of variations in the signal at the antenna. The simpler systems used in low-cost sets usually allow a three- or four-fold variation at the detector; the deluxe receivers generally hold the change to about 10%. What we are concerned with here is a strange performance complaint that is a byproduct of this better agc action.

These deluxe sets invariably use keyed agc. This circuit derives control bias for the set's rf and if stages by using a keying pulse supplied by the horizontal deflection system. Therefore, during warmup and prior to lock-in of the horizontal system, no control bias is applied to the rf and if stages. This lack of control voltage allows overloading, and intermodulation takes place between the video and the sound. The result is a raucous 60-cycle buzz blasting out of the speaker.

Although this situation is not new and has been more or less tolerated by the general public for a number of years, a simple innovation has pushed it into the aggravation stage in the last year. Many manufacturers are now incorporating preset volume controls with either push-pull or a push-push on–off switch. This leaves the volume set for normal listening during warmup instead of at the lower level that is generally used with the rotary on-off system.

Readers who would like to eliminate this annoying warmup buzz can easily make the necessary modification. Except for the three new elements – R1, R2, and D1 – the diagram in Fig. 916 shows a conventional TV circuit.

Operating theory is straightforward. During warmup, the overloaded if strip puts an abnormally high signal voltage on the video detector which rectifies it, thereby deriving a high negative voltage. This negative voltage is used to bias the audio amplifier into cutoff during this period. The voltages in the diagram show that the warmup video voltage is —22. The values of R1 and R2 are selected so E2 is –16 volts during warmup and the audio amplifier is cut off. When the detector finally falls to its normal value of —2 volts, E2 goes a little positive, thereby restoring the audio tube. In the interest of audio quality, we preserve the negative contact voltage of E3 (—0.7 volt), so a germanium diode clamp is added to keep the value of E2 from going too far positive.

chapter

10

horizontal jitter

SUDDEN sidewise shifts of a TV picture (or raster) are characteristic of horizontal jitter. The entire screen may be involved or only sections of horizontal lines. The second image may be equal in intensity but is usually weaker, resembling a ghost. Jitter is distinguished from ghosts by the back-and-forth jump or flutter.

The rate of shift can be rapid or very slow. A slow jitter may look like Fig. 1001. Here the picture is displaced to the right

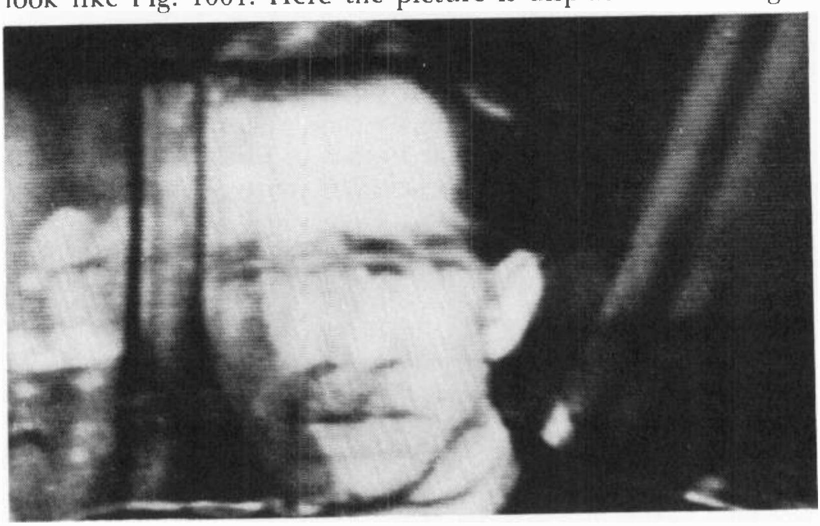


Fig. 1001. *Jitter with long flutter rate. Displacement to right persists for several consecutive fields.*

for several fields and returns to its normal starting point on the left for a few fields. The intensity of the double image is proportional to the length of time spent in each of the two fields.

A rapid jitter may present only a confused jumble of lines. The horizontal shift can be seen only on close inspection. Such a picture resembles the multiple overlapping of images produced by too high a horizontal frequency.

Causes of jitter

Instability of the horizontal sweep is the underlying cause. Any part of the sync system from the transmitter to the horizontal output tube in the receiver can be at fault. As an example let's take one type of jitter which occurs frequently and see why it happens.

Ghosts[1] from reflections, either transmitter-wave or lead-in, produce visible symptoms in the form of a second picture (or ghost). More important is the presence of a second sync pulse in the composite video signal (Fig. 1002). The "ghost" pulse will try to trigger the horizontal oscillator just like the true pulse. Despite the afc system, the oscillator will often try to lock on to both pulses. If both pulses can make the horizontal oscillator waver between them, we get horizontal jitter.

When the horizontal oscillator is triggered by the true pulse, horizontal sweep starts farther to the left, as shown in Fig. 1002. When the spurious second pulse takes control, the horizontal lines start farther to the right. The type of displacement shown by Fig. 1002 causes tearout of sections of lines — not a complete tearout, but part of the picture is displaced to the right. If the horizontal oscillator locks onto the false pulse for half the time, we would get an effect similar to that in Fig. 1001. A number of fields will start at the extreme left in response to the true sync pulse of the direct signal. Then some fields — not necessarily the same number, and usually less — will start farther to the right in response to the spurious or false pulse.

Vertical instability

The vertical ghost pulse may not be strong enough to trip the vertical oscillator because the long time constants of the integrator network tend to prevent this condition. Therefore, vertical instability may or may not accompany horizontal jitter.

The ghost can be seen on the TV screen. The presence of the false sync pulse may be observed on a scope connected at

[1] Techniques for eliminating ghosts are described in Chapter 2, page 19.

the video detector. As a final check, switch the TV set to a channel which has no ghost or a much weaker one. If a ghost pulse was the trouble, jitter will either disappear or become less evident.

To cure horizontal jitter caused by ghosts, get rid of the ghost – try antenna orientation, a more directional antenna, matching the transmission line, etc. If the tuner picks up too much signal directly, it can cause a ghost. This kind of ghost

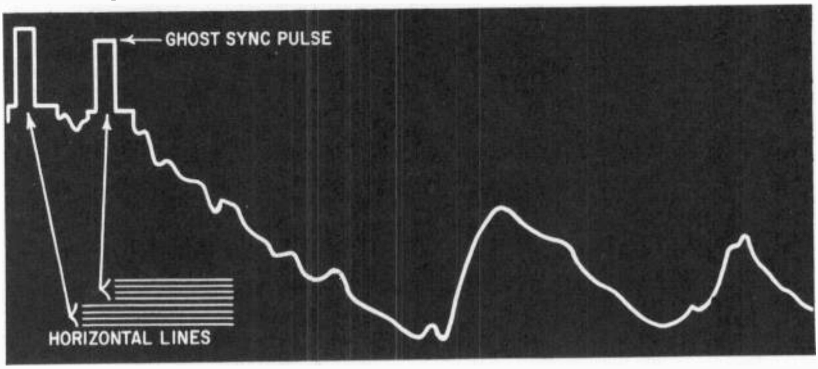


Fig. 1002. *Relation between spurious sync pulses and displacement of sections of horizontal lines.*

pulse may lead the true pulse and the image will be displaced to the left rather than the right.

If the jitter from a ghost cannot be eliminated by getting rid of the ghost, careful adjustment of the horizontal oscillator's frequency and hold controls will help. Also check the afc circuit and put it in the best possible operating condition. Check the sync circuit for proper clipping action with a scope. A slight change in the clipping level will often clip more of the false pulse than the true one and the jitter may be removed. These ideas should be applied only if conventional methods fail to rid the set of the ghost pulse.

Internal false sync pulses

Closely allied to jitter caused by an external ghost is jitter caused by false horizontal sync pulses produced in the TV set. Such pulses are produced in two ways:

► Injection of a false pulse back into the set at some earlier stage.

► Production of a spurious pulse by regeneration.

Other causes are pulses that are similar to false sync pulses – video information that has not been removed properly in the sync clippers or strippers. Peaks of video information near the black level can act as such false sync pulses if they occur near the horizontal sync pulse. This trouble can be detected by noting that the jitter occurs only when black portions of the picture are at the extreme left or right edges. (Move the picture sideways so you can check the edge.)

Adjust the sync stripping action to remove the picture in-

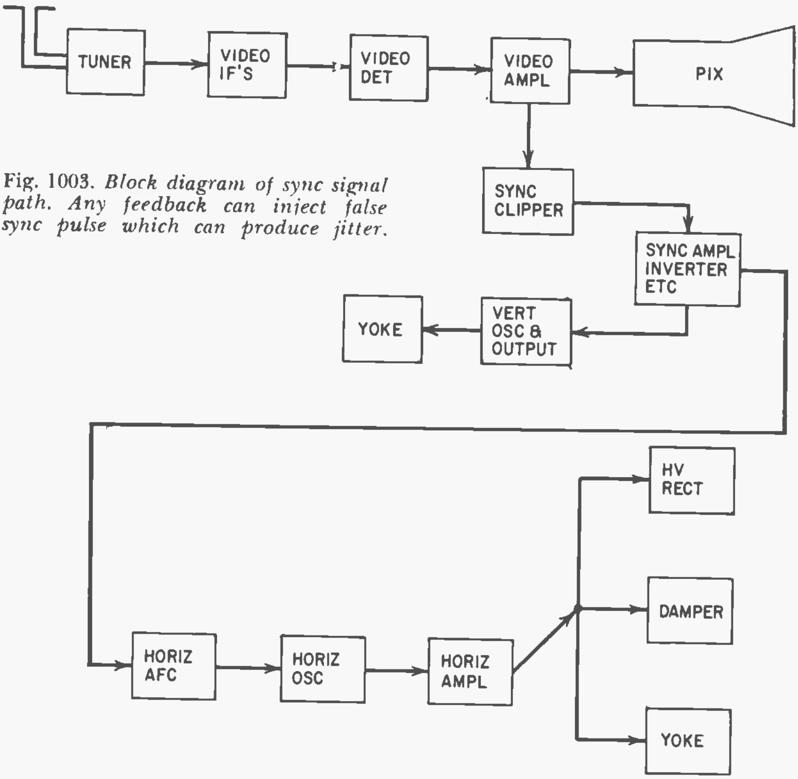


Fig. 1003. *Block diagram of sync signal path. Any feedback can inject false sync pulse which can produce jitter.*

formation more completely to cure this type of jitter. A scope will reveal video information in the supposedly stripped sync.

Injection and regeneration can occur at any stage or over any number of stages wherever the sync signal is present in its normal passage from antenna to the horizontal sweep circuits. Fig. 1003 is a block diagram showing these stages. A common cause of jitter is injection of the horizontal sweep into the antenna circuit, caused by dressing yoke leads too close to the transmission line or tuner. The remedy is obvious – move them away. The yoke–antenna path shows how the horizontal sweep – although on frequency – will produce a delayed pulse if injected back into the set. A similar trouble can arise if the yoke leads are too close to the first, and even the second, video stages.

The lead to the driven element (cathode or control grid) of the picture tube carries a high-amplitude composite video signal. Naturally, it contains high-amplitude sync pulses. And if this lead runs too close to the yoke leads or to earlier stages of the set, a false sync pulse and horizontal jitter can be produced.

Injecting sync pulses from a sync stage into an if stage can cause jitter. Fig. 1004 is an interesting example. A sync screen bypass capacitor C1 (shown in Fig. 1005) and agc filter capacitor C2 are connected to the same ground lug. The solder was not applied to the lug, so only the ends of the capacitor leads

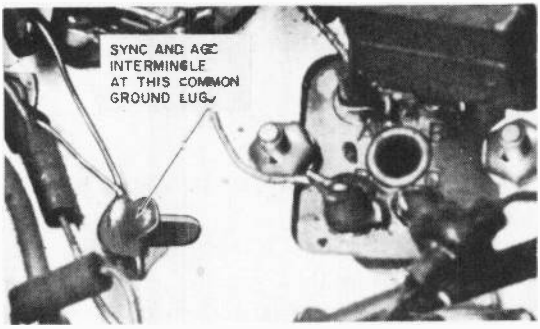


Fig. 1004. *Poorly soldered joint on common ground of a sync and an agc capacitor resulted in jitter. Sync fed into agc and if grids.*

were really soldered together. The contact resistance R_x of the leads to ground was often high. The sync fed directly through to the agc line and the grid of an if tube. Once this ground was resoldered, the set worked perfectly. The sync no longer modulated the composite signal.

Regeneration in the video amplifier or in the if will produce a delayed pulse. The mixer can be considered an if amplifier in this sense. And the mixer acts like an rf amplifier as far as the previous rf tube is concerned. Regeneration anywhere along the line followed by the sync may produce a spurious pulse and jitter.

Frequency shifts

One kind of jitter results from changes in the horizontal frequency which are not caused by a false pulse. For example:

► A resistor that changes value.

► A capacitor that changes value and affects the horizontal frequency.

► A loose coil in a shielded can in some types of oscillator circuits.

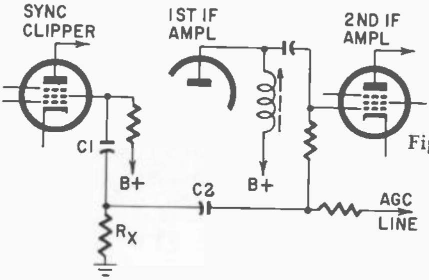


Fig. 1005. *Partial schematic shows what bad solder joint did.*

► Partly shorted turns in a ringing coil (sometimes called a phasing coil—see coil L in Fig. 602 on page 47) in a multivibrator plate circuit.

Troubleshooting external ghosts is simple – we can see the ghost on the picture and infer the presence of the false sync pulse. We get rid of the ghost (or it might be a spook[2]) and the jitter at the same time.

Localizing frequency shifts is simplified by observing the raster and comparing it with a picture. If the raster jumps – jitters – particularly if the set is shaken or jarred, the trouble is somewhere after the sync takeoff from the video stages. We may suspect a shift in horizontal frequency (unsynced) or feedback from a stage after the video into one ahead of it.

With a picture present, the presence of a false sync pulse is readily seen on a scope connected at the video detector. The picture may flutter, but the fluttering pulse is definitely established at this point. Since the contrast control is in the video section, it varies the video gain and the amplitude of the sync, if taken off after the stage controlled by the contrast control. Less sync amplitude means less feedback and this often furnishes a clue. If sync is removed prior to the stage which contains the contrast control, this test fails.

A trimmer capacitor can be installed from the sync line to ground temporarily. Some sets have such a trimmer as a sync lock range control. It works by bypassing some of the sync signal to ground or B-minus, reducing sync amplitude. If such a reduction (by varying the trimmer) makes the jitter disap-

[2] For a description of spooks, and how to eliminate them, see footnote No. 1 in Chapter 2, page 19.

pear, some stage following it must be feeding energy back into an earlier stage. (Excessive sync input is another possibility. If so, just adjust the trimmer and leave it in the circuit as a permanent cure.)

Break the sync feed to the afc and sync the horizontal oscillator manually with the hold (or frequency) control. If jitter persists, on *either* raster or picture, the trouble is in the horizontal system somewhere after the point of the break. Feedback

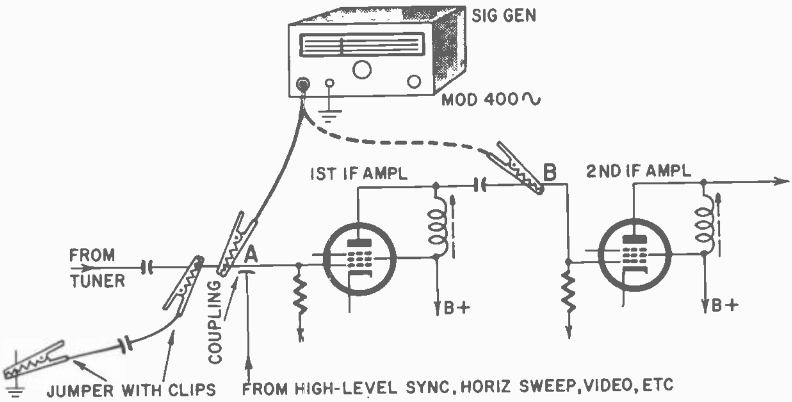


Fig. 1006. *Grounded-grid signal injection technique for localizing entry point of the spurious signal.*

from the horizontal sweep circuits into preceding portions of the set can be uncovered by this method.

At this stage of troubleshooting, check the grid waveform of the horizontal amplifier (see Fig. 801 in Chapter 8). Sync the pix manually. No jitter of the wave should show if the trouble follows the horizontal amplifier. If present, search for the cause at the input (to the horizontal amplifier) or ahead of it.

This check will distinguish some cases of pseudo jitters caused by intermittent components in the horizontal output circuit. These are:

► Loose slug in the linearity coil or width control.

► Defective yoke section.

► Defects in the centering controls and circuits.

► Loose flyback windings. Often, these jitters are excited by microphonic action caused by the speaker. The test may fail if the waveform is fed back to the horizontal afc for comparison and the oscillator is not held in sync manually.

If the trouble is likely to be found in the if or front end, we may go into these stages with an rf probe and scope. At some point we will find the injected or otherwise generated false pulse. By doing so, we localize the stage into which it is injected (or produced) and can give it a thorough going over.

Alternatively, use a signal generator to inject a signal into each rf and if grid in turn. The generator is amplitude-modulated in this test — rf injection without modulation will not furnish a sync signal. The grid of the preceding stage is grounded with a jumper, or a large capacitor.

For example, suppose we are checking the circuit shown in Fig. 1006. If jitter is produced with the signal generator's output at point A, but not at B (grid of first if grounded), we can assume trouble in this if stage. It might take the form of the gimmick coupling shown (a horizontal yoke lead too close to the grid of the first if, etc.).

Sometimes the feedback is along B-plus or avc lines. A quick test is to shunt each bypass capacitor to ground. Use a 0.1-μf 600-volt capacitor.

Sometimes jitter is caused by too long a time constant in the anti-hook filter in the horizontal afc control lead to the horizontal oscillator. If so, suspect a change in value of the resistors. Shunt each one with a potentiometer and vary it. If the jitter disappears, you have localized the trouble. Do not use too low a value of resistance as a replacement unless a check is made to see that hook (pulling at top of picture) is not the result of this modification.

After removing the jitter, retune the horizontal oscillator and any stability controls associated with it. Check all channels after completing the job.

chapter 11

foldover, halos and a cure

HORIZONTAL foldover is a common and annoying problem, yet few technicians know why or how it happens. To understand this problem better, let's begin by analyzing a case of foldover.

Line A in Fig. 1101 shows one line of video information. The inactive portion between the end of one line and the start of the next line has a 10.16-μsec duration. This is made up of a

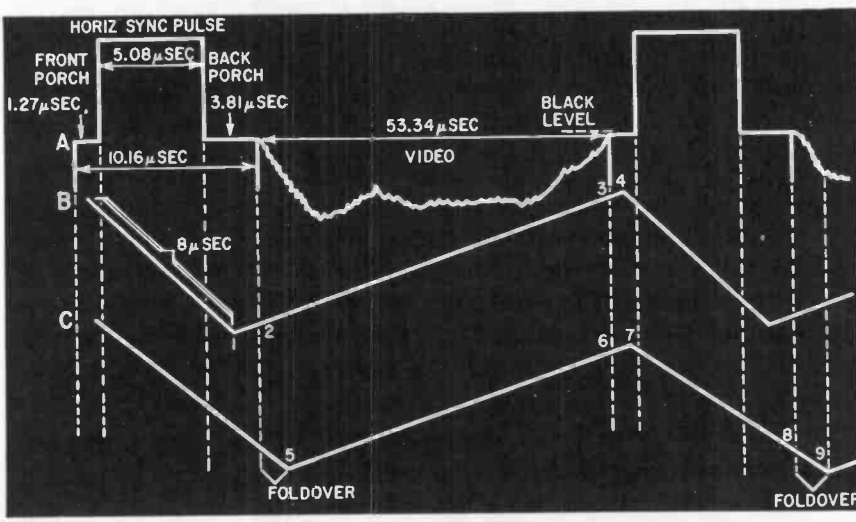


Fig. 1101. *Scanning and retrace vs. video information. Line A is a line of video between two sync pulses. Line B is the normal horizontal scanning waveform. Line C is the horizontal scanning with excessive retrace time, causing foldover.*

1.27-μsec front porch, a 5.08-μsec horizontal sync pulse and a 3.81-μsec back porch.

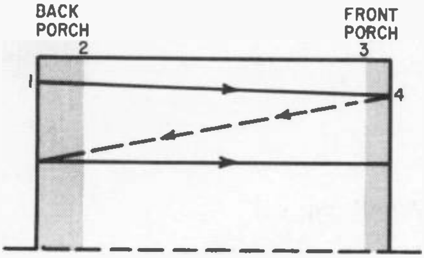


Fig. 1102. *Result of normal scanning. The numbers refer to* Fig. 1101.

Line B (Fig. 1101) shows the sawtooth signal that is fed through the yoke to control the horizontal sweep. Naturally, we

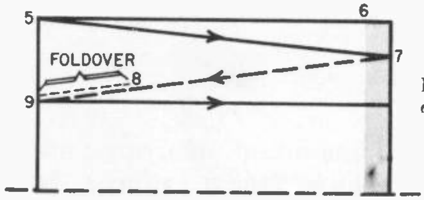


Fig. 1103. *Foldover caused by too long a retrace time. The numbers refer to* Fig. 1101.

want a retrace time shorter than the inactive portion of the video information. An 8-μsec retrace is good and is easy to get when the horizontal stages are carefully designed.

At the start and end of the raster are the two porches. Therefore we get two small black stripes at each side of the picture (Fig. 1102). Actually, these black bands are off the face of the

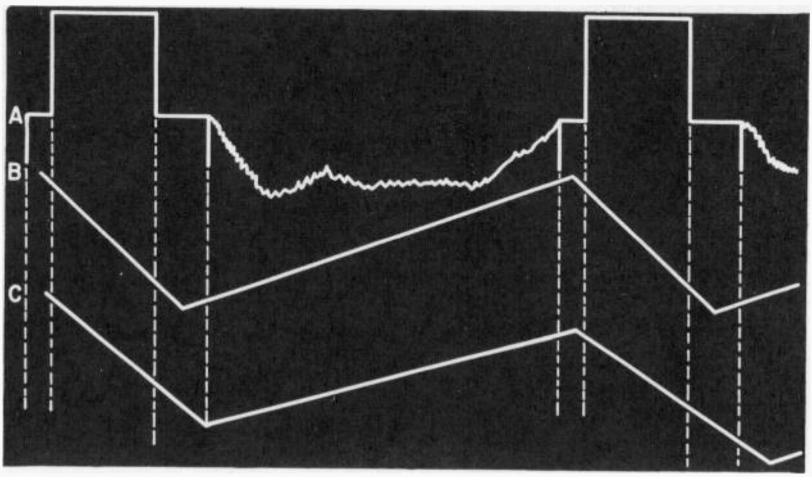


Fig. 1104. *Scanning as in C causes halos on the TV screen.*

TV picture tube and appear only if the picture is moved to the right or left by adjusting the centering controls.

However, if the retrace time is longer than usual (line C, Fig. 1101), it extends into the video portion of the picture and the video information starts during the retrace period and appears on the screen as shown in Fig. 1103. This type of foldover can appear on the right side of the screen too. When this happens, the retrace starts too soon and lasts too long.

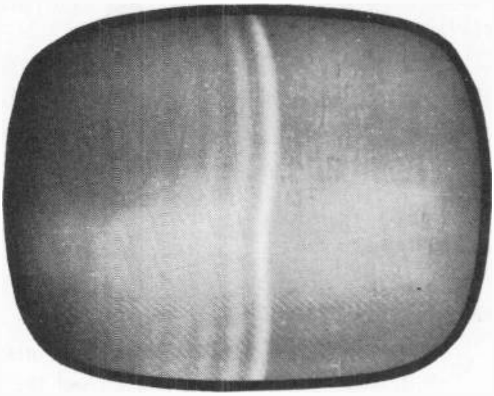


Fig. 1105. *Halos caused by the porch level appearing during retrace.*

Fig. 1104 shows another type of retrace trouble. This one is encountered in a number of 110° deflection TV sets. Again lines A and B are correct. Line C shows a retrace time that is too long but does not run into the video information. It kills the back porch but, since the signal and active trace start at the same time, no serious harm is done. However, this can result in the porch level appearing during retrace as a halo on the screen (see the photo, Fig. 1105) that overlaps the video information. This halo appears on light-contrast pictures and during camera changes when the screen is blank. It occurs because brightness is turned up and contrast decreased, making the inactive portion of the TV signal visible.

The solution to the halo problem is to cut off the CRT during retrace. In this way, as long as the retrace time stays inside the front and back porches, there can be no halo, as the retrace can cause no video information.

Normally, we would keep a tube cut off by applying a pulse to its cathode. However, in the modern TV set, video is applied to the picture-tube cathode. Any sweep pulses fed to this cathode would reduce video output and affect the set's sync.

The control grid cannot be used either. Vertical blanking pulses are usually fed to this grid and horizontal pulses cannot be added without keeping electrode impedance high at 15,750 cycles. The result would be horizontal ringing in the picture.

Because of these problems it is best to apply negative pulses to the screen grid of the picture tube. Fig. 1106 shows the circuit. It also eliminates retrace lines.

The 12AU7's plate connects to the CRT screen. Its grid is fed pulses from the flyback through a simple R-C network. These pulses keep V1 cut off during the normal scanning pe-

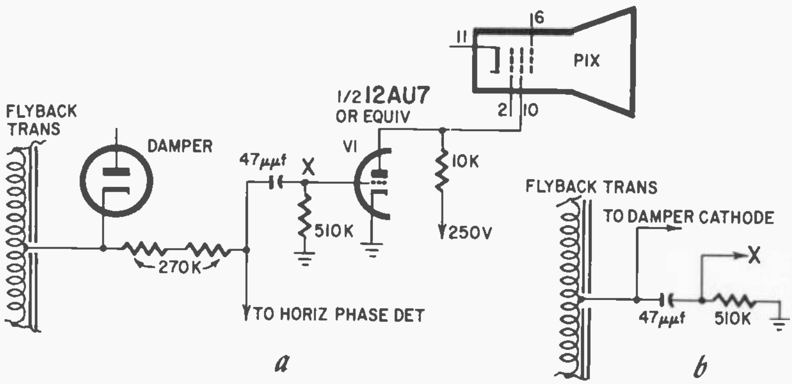


Fig. 1106. *Blanking circuit that eliminates halos and retrace lines. For use in phase detector type horizontal circuits (a) and for use in sets with Synchroguide horizontal circuit (b).*

riod. While V1 is cut off it has no effect and the CRT operates normally. However, during horizontal retrace the triode conducts, lowering the voltage applied to the CRT screen enough to cut off the tube. We used a 12AU7 since the other half of the tube was needed for another purpose. However, almost any medium-mu triode can be used with the same results.

chapter 12

common tv faults

A PICTURE is worth ten thousand words. To the technician, these photos are worth time and money – clearly illustrated TV troubles as seen on the screen, coupled with brief notes on where the trouble can be found, to speed servicing time. No matter how long you have been in business, you haven't seen anything yet!

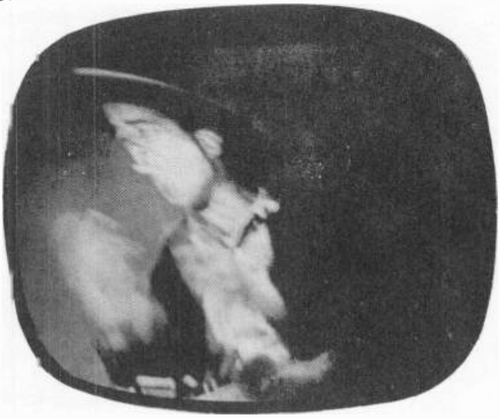


Fig. 1201. *The photo at the right illustrates insufficient vertical gain and poor vertical linearity.*

Symptoms: Picture does not fill screen; vertical linearity poor (Fig. 1201).

Diagnosis: 1. **Insufficient height.** Adjust height and vertical linearity controls. Check vertical output and oscillator tubes and circuit components.

2. **Poor vertical linearity.** Adjust vertical linearity controls. Check vertical output tube and components.

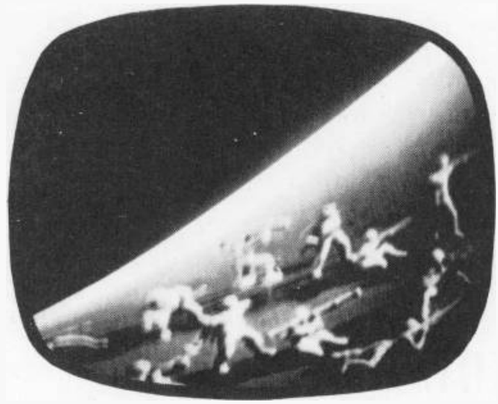


Fig. 1202. *This photo shows the effect when one of the vertical deflection coils is shorted.*

Symptoms: Trapezoidal picture. One of the vertical sides is much smaller than the other (Fig. 1202).

Diagnosis: Shorted vertical deflection coil. Check resistance of each coil separately. Frequently, short occurs in component connected in shunt across coil such as damping resistor or anti-ringing capacitor.

Fig. 1203. *Insufficient contrast accompanied by appearance of retrace lines.*

Symptoms: Lack of contrast; slanting white lines (retrace lines) across part or all of picture (Fig. 1203).

Diagnosis: 1. Loss of vertical sync. Picture may be slightly displaced vertically. Blanking bar does not show — blocked out by mask or slightly oversize picture. Adjust vertical hold. Turn up contrast control.

2. **No blanking.** Picture is steady vertically. Increase contrast, reduce brightness or do both. If fault persists, check vertical retrace blanking circuit. Usual culprit is coupling capacitor to one of picture-tube electrodes.

3. **Bad picture tube.** If everything else checks OK, and if pix seems to lack contrast and brightness, or tends to be muddy when turning up controls, check pix tube.

4. **Insufficient gain.** Check antenna, video if's, video amplifier and particularly the video detector.

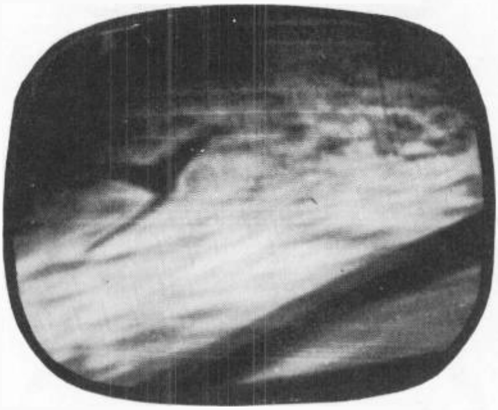


Fig. 1204. *Rolling and tearing caused by complete loss of vertical and horizontal sync.*

Symptoms: No coherent picture obtainable. Black-and-white moving pattern or streaks all over the screen (Fig. 1204).

Diagnosis: **Loss of sync.** Adjust vertical, horizontal hold controls. Check sync circuits, particularly sync separator tube.

Symptoms: Foldover of the picture at the top or bottom of screen.

Diagnosis: Sometimes produced by poorly adjusted vertical linearity and gain controls. If adjustment does not improve condition, try substituting new vertical oscillator and output tubes. The trouble can be caused by a weak low-voltage rectifier tube. If foldover isn't a permanent condition (occurs at only certain times during the day) check to see if combination low line voltage and weak low-voltage rectifier isn't the cause. Can also be produced by almost any defective component in the vertical sweep circuits.

Fig. 1205. *Smearing is usually accompanied by poor definition and focus.*

Symptoms: Horizontal white streaks following dark areas, or vice versa. Smearing (Fig. 1205).

Diagnosis: Poor low frequency response. Adjust fine tuning. Check video amplifier, especially coupling elements and low-frequency connecting networks. Check alignment.

Fig. 1206. *Out-of-focus picture. If the picture goes out of focus when the brightness control is advanced, the trouble is in the high-voltage supply.*

Symptoms: Picture lacks sharpness. When looking closely at screen, sweep lines cannot be distinguished (Fig. 1206).

Diagnosis: 1. Poor focus. Adjust focus control. Adjust ion-trap magnet.

2. Bad picture tube. Change tube.

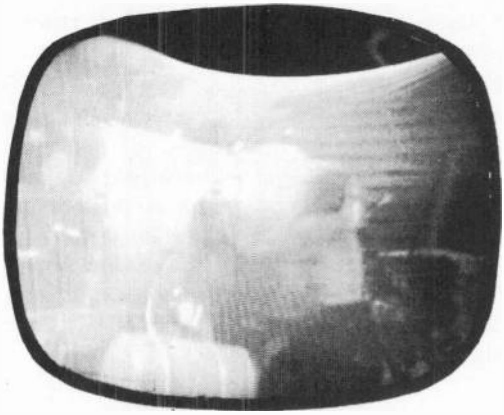


Fig. 1207. *Pincushion effect can be caused by impedance mismatch between horizontal-output transformer and yoke.*

Symptoms: Top of picture bent inward severely (Fig. 1207).

Diagnosis: Pincushion effect. Poorly designed, defective or misplaced deflection yoke. Correcting magnets misadjusted. Deflection yoke not made for this particular picture tube. If some components have been displaced, beware of parasitic dc magnetic field; for example, loudspeaker.

Fig. 1208. *Insufficient brightness. Can be caused by insufficient high voltage, sometimes accompanied by blooming. Condition can be produced by a gassy picture tube. The brightness control may be defective.*

Symptoms: Whites not bright enough, and grays form solid black area (Fig. 1208).

Diagnosis: 1. **Lack of brightness.** Adjust brightness and contrast controls.

2. **Misadjusted ion-trap magnet.** Try rotating and moving it forward and backward a little at a time. Adjust for maximum brightness.

3. **Incorrect voltages.** Check particularly the voltage between picture-tube grid and cathode. Brightness control should vary it between 100 and 0 (or a few volts) approximately. If this voltage does not go down to a low enough value, check components in grid and cathode circuits. If picture tube is direct-coupled, check video amplifier.

Fig. 1209. *Blooming is caused by trouble in the high voltage supply or by a defective picture tube. Check the high-voltage rectifier, horizontal output and damper tubes by substitution. Blooming is sometimes produced by a gassy picture tube or an internal short in the tube. Check the filament resistor of the high-voltage rectifier.*

Symptoms: Whites bloom. As soon as brightness control is advanced, white parts of picture lose all detail and spread. If brightness is increased further, whole picture blows up (Fig. 1209).

Diagnosis: 1. **Poor high-voltage regulation.** Usual culprit is high-voltage rectifier. If not, check high-voltage circuit and particularly filter resistors and capacitors, if any. Look and listen for high-voltage losses (hissing sound, violet corona).

2. **Defective picture tube.** Change it.

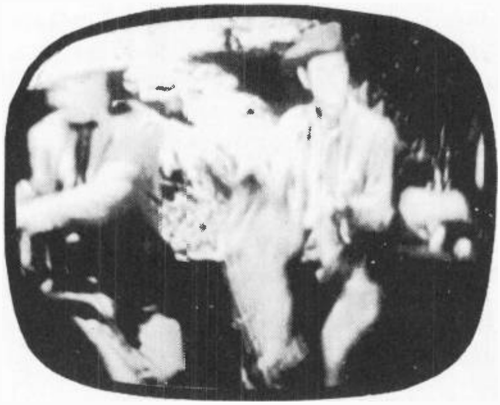


Fig. 1210. *Poor picture detail. Can be caused by misalignment. Trouble is due to loss of the higher video frequencies.*

Symptoms: Picture lacks sharpness. Upon close inspection of screen, horizontal sweep lines are sharp and clearly visible (Fig. 1210).

Diagnosis: Loss of fine detail. Defect is in video section. Adjust fine tuning. Check tuner. Check video amplifier and particularly the high-frequency peaking circuits. A peaking coil may be open or short-circuited. Check alignment.

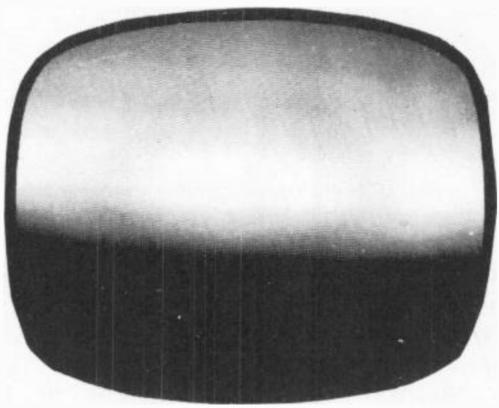


Fig 1211. *Example of 60-cycle hum. Hum pickup can exist in any stage from front end to video amplifier.*

Symptoms: Screen divided horizontally into two wide black-and-white areas (Fig. 1211).

Diagnosis: Hum modulation. Parasitic signal at line frequency is modulating picture tube. Check filtering and decoupling circuits. Check for heater-to-cathode shorts. If some components have been moved, modulation may be due to parasitic ac magnetic field; for example, filter choke.

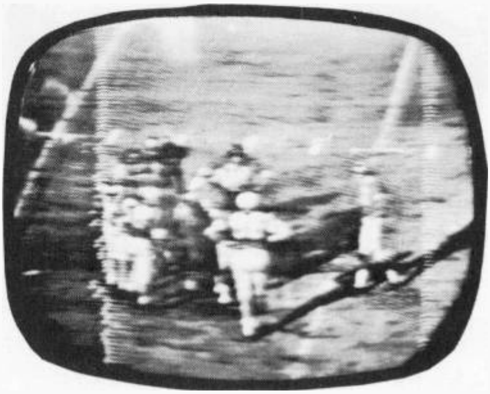


Fig. 1212. *Parasitic oscillation as evidenced by jagged white vertical bars on both sides of the screen. The trouble is often caused by a defective horizontal output tube. Try tube substitution or insert parasitic suppressors in series with tube leads. Adjust all controls in the horizontal sweep circuit.*

Symptoms: One or two vertical white bars across the picture. They can be straight or ragged, and are generally narrow (Fig. 1212).

Diagnosis: 1. Parasitic oscillation in the horizontal output tube. Change the tube. Insert an rf choke or a 100-ohm resistor in the control-grid and screen-grid connections, at the tube socket. Sometimes, taping a small magnet to the tube will eliminate the oscillation. These magnets are available commercially.

2. Incorrect horizontal adjustment.

3. Induction. If the bar is wider and has ragged edges, it may be due to 15,750-cycle induction, for example on the picture-tube cathode or grid leads. Redress the leads. If necessary, replace the wire from the video output to the picture tube with as *short* a length of coaxial cable as possible and ground the outer shield braid at the chassis.

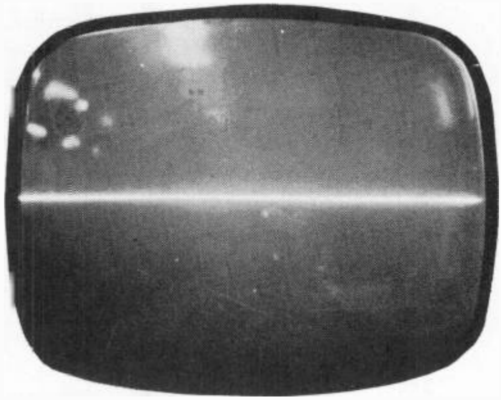


Fig. 1213. *Single bright white line across screen indicates lack of vertical sweep.*

Symptoms: Single horizontal white line across the screen (Fig. 1213).
Diagnosis: No vertical sweep. The defect can be anywhere in the vertical sweep section. To identify the stage, use headphones or a scope to trace the characteristic 60-cycle sawtooth signal. If the sweep signal appears on the plate of the output tube, look for a defective output transformer, yoke or associated components. Check shunt capacitor. If there is no signal on the plate but there is a signal on grid of output tube, look for a defective tube, incorrect supply voltages or defective components. If no signal on plate of vertical oscillator, look for defective tube, wrong voltages or defective components. Check blocking oscillator transformers and resistances in shunt across it.

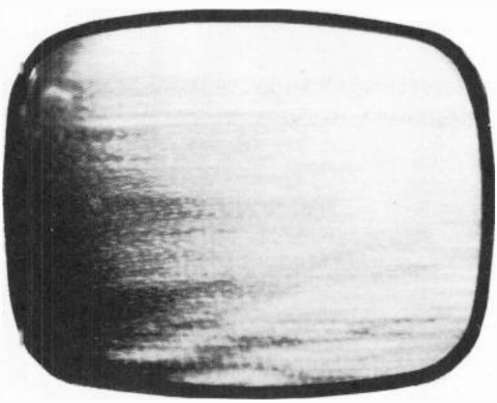


Fig. 1214. *Effect of oscillation. If prior to the picture detector will produce excessive voltage across the detector diode load.*

Symptoms: Tearing of the picture or raster (Fig. 1214).
Diagnosis: Oscillation. Short detector load. If defect disappears, rf or if stages are guilty. If defect persists, video stages

are at fault. Change tubes. Check lead dress, particularly grid and plate connections and the lead carrying the video signal to the picture tube. Check correction coils and shunting components by shorting them. Check decoupling capacitors by bridging them with a good unit. Check voltages. If trouble still persists, look for faulty rf or if stages. Short the grids to ground through a capacitor until defective stage is found. Change tube. Check screens and lead dress. Verify tuning. Check decoupling components. Check voltages. Disable agc. If defect disappears, check agc system, particularly decoupling components.

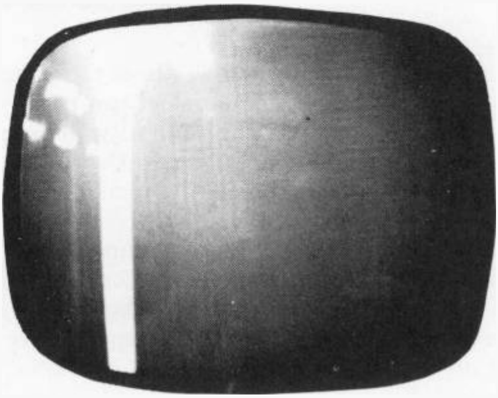


Fig. 1215. *Single thick white bar (brighter than the rest of the screen) appearing at the left side can be due to horizontal foldover.*

Symptoms: A single vertical white bar across the screen (Fig. 1215).

Diagnosis: 1. **Lack of horizontal sweep.** Pattern does not change if brightness is increased, except for blooming. Defective horizontal coils or shunting components. Defective output transformer or associated components. Defective output or damper tubes. Incorrect grid drive on the output tube. Check grid voltage, which should be strongly negative. Components may be faulty or the horizontal oscillator does not function properly. Check tube, voltages and components.

The best method here is to use a scope and observe and measure waveforms.

2. **Horizontal foldover,** always occurring in the left half of the screen, and due to damper tube or associated components. When brightness is advanced, the

sweep appears on the remaining portion of the screen. In other words, the bar is simply a more brilliant part of the raster. Change the horizontal-output tube, check components associated with it, including the horizontal linearity circuit.

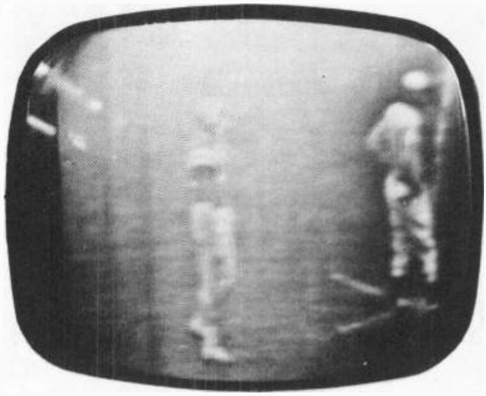


Fig. 1216. *Trouble caused by parasitic oscillation in the vertical sweep circuit.*

Symptoms: Black vertical bars, degrading to the right, on the left side of the screen (Fig. 1216).

Diagnosis: **Parasitic component in vertical sweep.** On close inspection, scanning lines appear wiggly but do not show velocity modulation. Check deflection yoke, particularly the components across vertical coils. Shunt a 0.5-μf capacitor across vertical yoke coils and across secondary of vertical output transformer. Rarely, the parasitic signal will enter the vertical sweep circuits directly. Best way to check and to identify point of entry is to use a scope. The culprit is probably a defective decoupling component or loose shield, or a lead improperly dressed.

Symptoms: Insufficient contrast.

Diagnosis: Often caused by a weak tube located in the signal path between the front end and the picture tube. Sometimes tube will pop out of socket but enough coupling exists to put picture on the screen. Check low voltage B plus. Loss of gain can be due to some open component in rf, if or video stages. Check video detector load resistor. Adjust agc control.

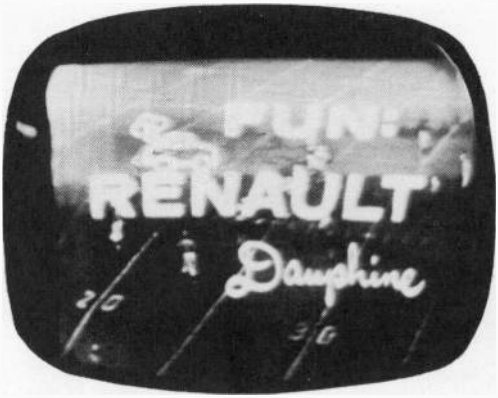


Fig. 1217. *Wiggling vertical lines can be caused by excessive signal.*

Symptoms: Vertical lines wiggle (Fig. 1217).

Diagnosis: **1. Brigitte Bardot effect.** Horizontal sweep is modulated by a parasitic signal. Check deflection yoke for shunting components. Check horizontal output tube and stage. Check phase comparator; particularly time-constant circuit in control-voltage line.

2. Poor filtering. Shunt decoupling capacitors with unit known to be good.

3. Excessive signal or saturation. Check agc system. *Note:* In the photograph, the picture has been purposely uncentered to show the defect on the left-hand vertical side clearly.

Fig. 1218. *Picture is dark, excessively large.*

Symptoms: Low brilliance. Picture too large, can't be reduced (Fig. 1218).

Diagnosis. **Defective high voltage.** Change high-voltage rectifier. Check associated components and circuitry, particularly filter capacitor (if used) and high-voltage lead. Check, readjust horizontal sweep section. Check picture tube, preferably by substitution.

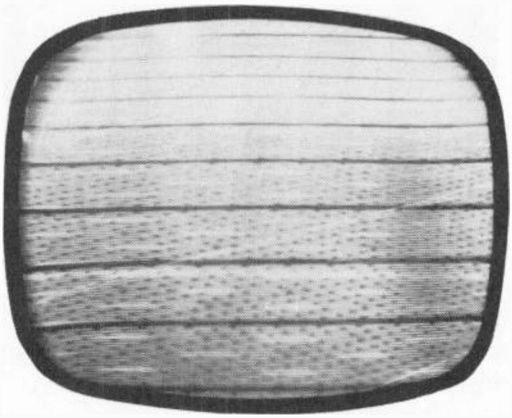


Fig. 1219. *Receiver out of horizontal sync. Bar spacing indicates vertical nonlinearity.*

Symptoms: Horizontal black bars (Fig. 1219).

Diagnosis: **Horizontal sweep out of sync.** Adjust horizontal hold. If unstable, check sync. Use pattern to adjust vertical linearity. If bars are cramped at top, vertical linearity is poor. Readjust vertical linearity and amplitude to get equal spacing between bars, then readjust horizontal frequency.

Symptoms: Picture takes some time to develop. Contrast is poor but becomes better after set has been on for a while.

Diagnosis: Slow-heating tube somewhere between front end and picture tube. Try tube substitution, one at a time, beginning with either front end or video amplifier. Trouble may be picture tube. Try brightener or new picture tube.

Symptoms: Double picture, one above the other.

Diagnosis: Vertical oscillator is working at 30 cycles instead of 60. Adjust vertical hold control. If this makes picture run vertically but picture doesn't lock in, trouble may be increase in vertical oscillator time constant. Check R-C components in grid of oscillator.

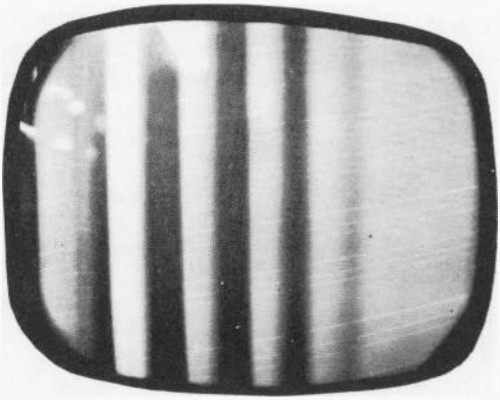


Fig. 1220. *Black vertical bars from center to left side of raster.*

Symptoms: Black vertical bars, degrading to the right, on the left side of the raster (Fig. 1220).

Diagnosis: **Horizontal sweep transient.** Looking closely at the raster, note that the scanning lines are straight, but of varying brightness. This indicates velocity modulation. Check deflection yoke, particularly the components across horizontal coils. Look for defective horizontal output transformer. Change damper tube. Check associated components including horizontal linearity circuits.

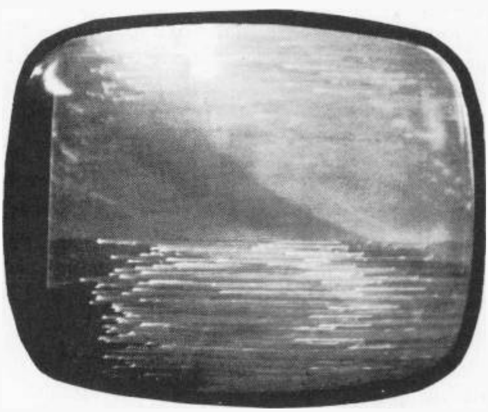


Fig. 1221. *Tearing and jitter caused by intermittent.*

Symptoms: Erratic variations of brightness, eventually with tearing of the raster and jittery picture (Fig. 1221).

Diagnosis: 1. **Bad contact.** Can generally be confirmed by jarring the receiver. May be at the picture tube. Check socket and high-voltage connection. Look for an intermittent short in the picture tube. Poor or intermittent contact in the video stage or defective video tube or a loose wire or bad soldering joint in the wiring associated with the tube might also be the trouble.

2. **Defective high-voltage rectifier or associated components and circuitry.** Change bad part.

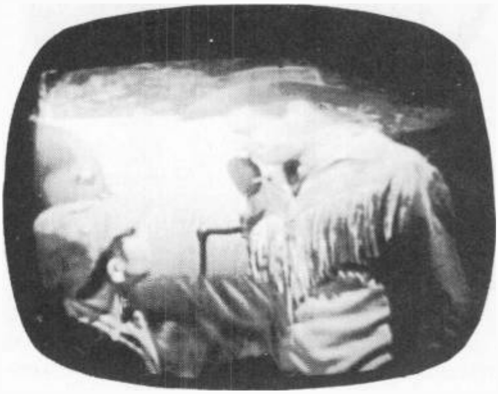


Fig. 1222. *Poor picture produced by misadjusted controls.*

Symptoms: A blank part of the screen is visible above the picture. The lowest part of the picture is lost below the bottom of the screen (Fig. 1222). Do not mistake this defect for the one in Fig. 1229.

Diagnosis: **Poor centering.** The defect can occur horizontally or vertically. Readjust centering controls and align focus assembly. Switch connections to the focus coil. If components have been replaced or moved, watch for magnetic fields of speakers or filter coils.

Symptoms: Raster is small, horizontally and vertically.

Diagnosis: If this condition is accompanied by a decrease in sound volume, look for trouble in the low-voltage supply. May be due to poor vacuum tube or selenium rectifier. This trouble can also be due to excessive high voltage. Above-normal tube current in the horizontal output tube (due to gassy tube) plus excessive drive voltage could produce this condition. Make sure yoke is up against bell of tube.

Fig. 1223. *Picture gets dark from center to right side of screen.*

Symptoms: Irregular luminosity. Brightness decreases from left to right (Fig. 1223).

Diagnosis: **1. Parasitic modulation at the horizontal sweep frequency.** Switch to an empty channel or disconnect the antenna. This makes the fault easy to see. Use a scope at the horizontal sweep frequency to check for the point where the parasitic modulation appears – generally the cathode or grid of the picture tube. Alternately, short picture-tube pins to ground through a 0.1-μf capacitor. Once the point of entry is identified, check the circuit components. The usual culprit is an open decoupling capacitor.

2. Induction at the horizontal sweep frequency. Check lead dress, particularly for leads going to the picture-tube socket or deflection coils. Make sure that shields are properly fastened and grounded, especially in the high-voltage, detector and video parts of the TV receiver.

Symptoms: Bright spot appears on screen after set is shut off. Spot (small in size) gradually moves off to one side, then disappears.

Diagnosis: To reduce or eliminate, turn brightness control up somewhat just before turning set off. The appearance of the spot is normal and is caused by remaining high voltage. Cathode of picture tube does not cool immediately, emits enough electrons to form a beam. Make sure ion trap is positioned for maximum picture brightness.

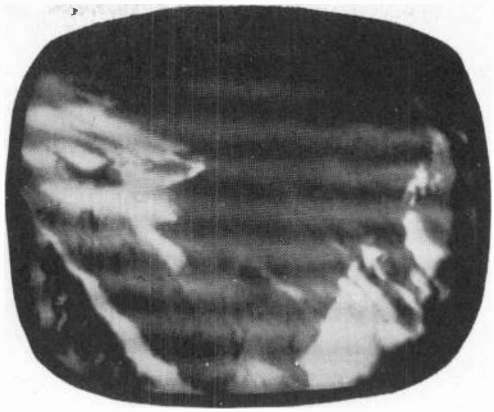


Fig. 1224. *Sound bars in the picture vary with the intensity of the audio.*

Symptoms: Gray or black horizontal bars across the picture, following the rhythm of the audio sound (Fig. 1224).

Diagnosis: **Sound bars.** If the defect is independent of the audio volume: Adjust oscillator tuning. Check video if alignment. Look for out-of-tune sound trap. Also for instability or oscillation in the picture if section. Check the decoupling capacitors and the ground points.

If the defect increases with the sound volume, the audio output stage may be bad. Check tube, bias and grid coupling capacitor. Also look over the audio decoupling circuit and check for a bad B-plus filter.

Microphonic tube can also be the cause. Easily identified by hitting gently with eraser on a pencil. If components have been replaced or displaced, there can be direct induction from the audio output transformer. Check parts or tubes near the speaker.

Symptoms: Picture flutter. Receiver works in fringe area.

Diagnosis: This is a problem which can be tackled in more than one way. Keyed agc with a short time constant helps minimize flutter but cannot eliminate it. When signal levels vary greatly, amplified agc gives a wider dynamic range. Try stacked Yagis to get a very narrow aperture, beamed at the desired station. High-gain antennas also lessen the demands on the receiver's dynamic range. If stacked Yagis do not give the desired flutter reduction, reworking the set for faster agc would be the next logical step.

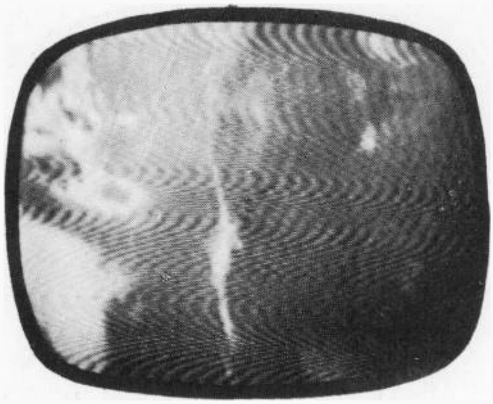


Fig. 1225. *Herringbone pattern produced by interference.*

Symptoms: Unstable wavy lines superimposed over the picture (Fig. 1225).

Diagnosis: Herringbone pattern, due to interference. The trouble can be internal or external. Oscillation in the video or sound if may be the cause. Check screens, decoupling circuits, chokes, lead dress. If due to an interfering transmitter, reorient the antenna, install a trap in the antenna input or use a shielded antenna lead-in (coax cable).

Fig. 1226. *Excessive brightness can be due to insufficient bias on the picture tube.*

Symptoms: Excessive brightness (Fig. 1226).

Diagnosis: Pix tube or video circuits. If brightness control is more or less effective, readjust brightness control. If dc coupling is used between the video stage and the pix tube, an incorrect voltage may be caused by the video amplifier. Check the video amplifier tube and its bias voltage.

If brightness control is practically ineffective, the control may be defective. Check picture-tube cathode and grid circuits. Look for a cathode-to-grid short.

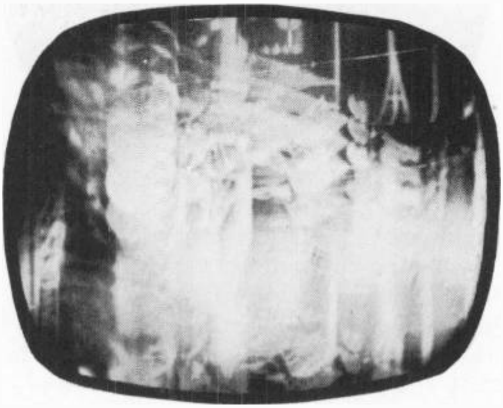


Fig. 1227. *Rolling caused by trouble in the vertical sweep.*

Symptoms: Several pictures superimposed vertically, either stable or moving up or down (Fig. 1227). Multiple picture may lock in, then jump.

Diagnosis: 1. **Vertical sync defective.** Adjust vertical hold control. Replace vertical oscillator. Check circuit. Check sync circuits. Use a scope at frame frequency to follow sync signal from plate of sync separator.

2. **Intense ghosts.** Orient antenna or install more directive unit.

3. **High-voltage arcing.** Find and stop.

Symptoms: Picture has strong whites or blacks. Sound may have buzz.

Diagnosis: If set is located in strong signal area trouble can be due to excessive signal input. Adjust agc control. Trouble may also be in agc system with controlled tubes getting insufficient bias, thus operating with higher than required gain. There is also the possibility of some if regeneration increasing gain excessively. (Also see Fig. 1229.)

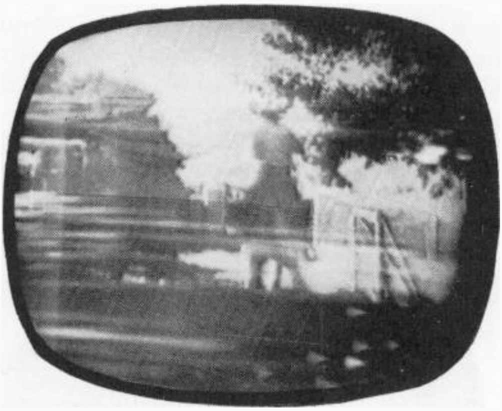


Fig. 1228. *Streaky picture.*

Symptoms: Light, moving streaks over all or part of the picture. Sometimes, the pattern can be identified as a part of the picture, drawn out horizontally (Fig. 1228).

Diagnosis: Part of picture modulation occurs during horizontal retrace. Readjust horizontal hold. Check for excessive retrace time. This can have a number of causes – defective horizontal yoke coils or horizontal output transformer, horizontal output tube or damper, horizontal oscillator or output transformer. Another possibility is a defect in the afc circuit, generally in the phase comparator. Change tube. Check components.

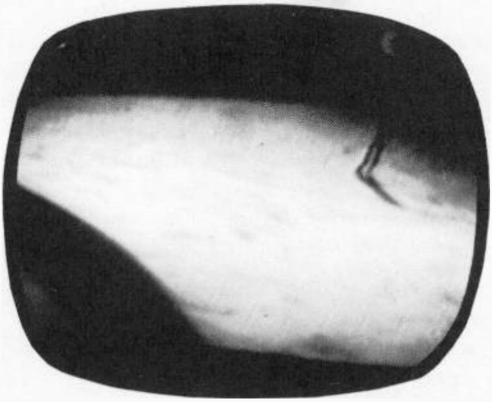


Fig. 1229. *Excessive contrast resulting in an exceptionally dark picture.*

Symptoms: Excessive contrast (Fig. 1229).

Diagnosis: 1. Too much video voltage. Adjust contrast control. Some sets have a preset control or a switch.

2. Excessive field intensity. Insert an attenuator in the antenna lead-in.

3. Defective agc.

4. Receiver misaligned. Delivers excessive low-frequency response. Realign.

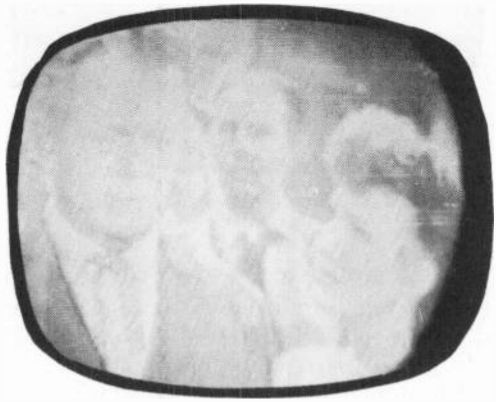


Fig. 1230. *Black area along picture edges. Make sure yoke is as far forward on the neck of the picture tube as possible.*

Symptoms: Black zones in the corners or on the edges of the screen (Fig. 1230).

Diagnosis: 1. Misadjusted ion trap. Generally there is a loss of brightness as well.

2. Deflection coils do not fit snugly against the neck of the picture tube. Adjust yoke.

Symptoms: Sharp sounding buzz.

Diagnosis: Buzz can come from quite a few places. The most familiar buzz is caused by overloading in the if amplifier (through some fault in the agc). A prevalent source of buzz is the vertical blanking signal at the picture tube. Turn the brightness control up and down. If the buzz amplitude changes, the sound is coming from the stray fields around the picture tube and high-voltage supply. Shielding is the best cure. The origin of buzz can be identified by its characteristic shape on a scope. Apply the scope to different stages of the audio circuit. Buzz pulses can even be found in the 4.5-mc sound if in the form of AM on the FM sound signal.

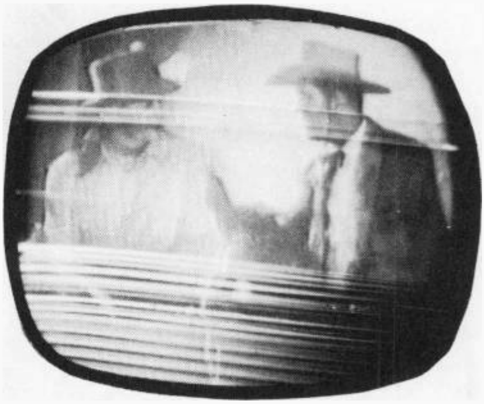


Fig. 1231. *Picture streaking caused by interference.*

Symptoms: Irregular streaks across the picture (Fig. 1231).

Diagnosis: **Static or man-made interference.** Disconnect the antenna. If the static disappears, connect another antenna or a length of wire. If no static now, check the antenna and lead-in installation. If static is still there, try to reorient the antenna or increase its height. Use a shielded lead-in. Using a direction-sensitive portable radio, try to locate the offending equipment. If static originates in the receiver, it may be sensitive to jarring the cabinet. Turn off the lights and have a good look to locate high-voltage arcing or corona. Also look for a defective tube. Use the rubber-hammer method. A poor contact can also be the fault. This can be a dilly. Check stage by stage. Look for poor insulation or arcing anywhere, but generally in the high-voltage section.

chapter 13

servicing gated-beam discriminators

Many TV models have been engineered down to two tubes in the audio section, an output and a gated-beam discriminator–limiter–amplifier. Even the original 6BN6 type has been simplified by the later 6DT6 breed with less critical circuitry. The 6BN6 never oscillates normally while the 6DT6 employs oscillation on low sound inputs to maintain a large output of audio to the audio output stage. Essentially the circuits and alignment are similar for both types and may be considered together.

Buzz control

Aside from the special formed beam type tube, the circuits feature a quadrature coil connected to what would be the suppressor grid of a pentode. In the 6BN6 arrangement (Fig. 1301) there is almost invariably a potentiometer in the cathode circuit for adjustment of residual buzz. In many sets this is called the BUZZ CONTROL. Instead of returning directly to ground as in 6BN6 circuitry, the quadrature coil returns through a time-constant bias network in the 6DT6 arrangement. (See Figs. 1302 and 1303.)

Alignment

As in most places, a bad tube is the commonest trouble-maker and can be eliminated by substitution. Next in order of frequency of trouble is alignment creep due to aging, etc. This alignment is simple and can be carried out with a station signal. There are also miscellaneous troubles which will be treated after alignment.

Field alignment requires a very strong signal and a very weak one. The weak signal is obtained by disconnecting the set's antenna leads. Then:

1. Tune a station for best picture. Attenuate the signal so that it is as weak as possible. Retune for best picture. Set the BUZZ (quieting, etc.) CONTROL at its mid-range position.
2. Adjust all sound takeoff and sound coupling transformers for maximum sound. Recheck. It is important that tuning prior to the gated-beam discriminator be on the button. If two peaks develop, use the peak that is highest in frequency — slug farthest out of the coil or transformer.

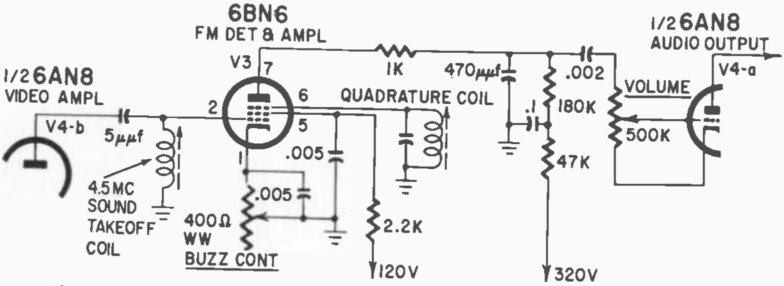


Fig. 1301. *The 6BN6 gated-beam discriminator. The 1,000-ohm resistor in the plate circuit suppresses parasitic oscillation.*

3. Apply a strong signal and do not retune the fine-tuning control. Adjust the quadrature coil slug for maximum sound output. Again select the higher frequency in case of two peaks.
4. Weaken the signal again and set the BUZZ CONTROL for minimum buzz and noise. Retouch all adjustments *except the quadrature coil.* Readjust the BUZZ CONTROL. Retouch adjustments for maximum sound with least buzz.
5. Retune the quadrature coil with a strong signal. Repeat steps 4 and 5 until no further improvement is noted.

Most faults other than tubes also show up in alignment of the 6DT6 circuit:

1. Adjust the quadrature coil slug on a strong signal. A high-impedance voltmeter or vtvm can be connected to the test point between the quadrature coil and its series bias network (see Figs. 1302, and 1303). Output is roughly —5 volts or a trifle less.

2. With a very weak signal (see 6BN6 alignment), adjust the slugs on all 4.5-mc sound takeoff coils and interstage coils or transformers. If two peaks develop, use the higher one in all cases. In tuning the sound takeoff and following interstage coil, the volume and noise will weaken on one side of the peak while on the other side the noise alone will drop immediately. Be careful to get the coil on the peak by listening for noise rather than volume.
3. Repeat steps 1 and 2 alternately until no further improvement is found.

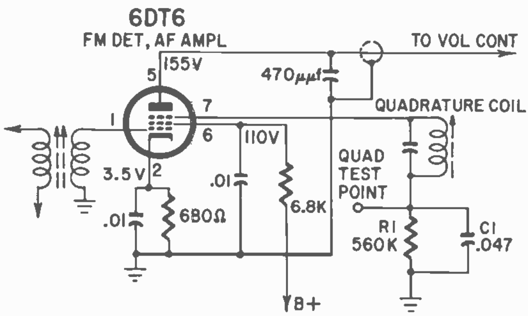


Fig. 1302. *Gated-beam discriminator using a 6DT6. Excessive buzz can be caused by using a cathode resistor of the wrong value.*

High hiss level

If the plate capacitor opens, the symptom will be a high hiss level. Check by shunting it. A similar condition may occur with a drop in the capacitance of the screen and cathode bypass capacitors. Check by shunting with units of roughly the same size. In the 6BN6 circuit, this high noise can arise from improper setting of the BUZZ CONTROL or from instability.

Parasitic oscillation

Parasitic oscillation of the 6BN6 type circuit can be quenched by a resistor in the control grid lead or plate lead or both. Use a value in the plate lead having a range from 820 to 1,500 ohms; in the grid lead from 47 to 220 ohms. (Note the 1,000-ohm resistor in the plate lead in Fig. 1301. A 100-ohm resistor is used in series with the control grid (pin 2) of the 6BN6 by other manufacturers.) One stubborn case needed a 100-ohm resistor in series with the screen grid lead as well. Some manufacturers shunt the secondary of the last if transformer with a resistor of about 47,000 ohms for a similar purpose. Check them in case of high hiss level not accounted for by other causes. In some cases these values will have to be increased or resistors inserted in series with other electrodes.

Excessive buzz

A high buzz level can result from improper alignment of all 4.5-mc adjustments except the quadrature coil. To repeat, these adjustments must be *exact* on a *weak* signal. Recheck after, *and with,* adjustment of the BUZZ CONTROL in 6BN6 types.

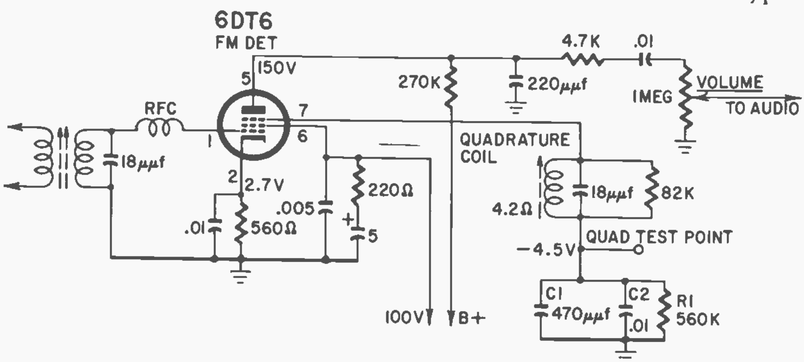


Fig. 1303. *Another 6DT6 circuit.*

Selection of the low-frequency peak may be the cause of the buzz. If there's too much capacitance, the high frequency peak may not be reached — a defective if transformer, shunt capacitor, tube, etc., is the cause. The alignment procedure will localize it to a particular interstage location.

Excessive buzz in a 6DT6 circuit not due to misalignment may be the result of an improper value of the cathode resistor. With aging of other components, the nominal value (even if it agrees with the schematic) may not be satisfactory. A potentiometer may be substituted for the fixed resistor and left in place as a "factory" adjustment. Use about double the value of the fixed cathode resistor; 1,000 ohms is almost always satisfactory. The fixed resistor can be doctored with another resistor in series or in shunt. Although the value for a 6DT6 is far less critical than for a 6BN6, the bias set by the cathode resistor must be such that the no signal (quiescent) operation of the tube is midway between saturation and cutoff. This insures proper limiting action, removing amplitude variations — buzz, noise, etc.

Video amplifier overload

Video amplifier overload also causes an abnormally high buzz level, or an overload due to overdriving can occur in the pix detector or the video if. Should the signal cause cutoff in these stages, the sound has holes punched in it which cannot be removed by any limiter. Co-channel interference is another cause of a high buzz level that no work on the audio proper will cure.

Weak sound

As usual, a defective tube is the most common cause of weak or no sound. Next in order are low electrode voltages which can be readily detected with vtvm measurements.

Misalignment of the quadrature coil will result in weak sound, or no sound in extreme cases. Suspect a defect — shorted turns, changed shunt capacitor, etc. — if the quadrature coil is far from proper alignment.

A wrong peak on the quadrature coil results in low sound level. Recheck alignment. If the higher-frequency peak cannot be reached, the capacitor or coil is defective. When replacing, check for the presence of two peaks and select the higher frequency.

Abnormal detuning of the sound trap or interstage coils will result in weak sound. These will be caught by attempted alignment.

In a 6BN6 arrangement, weak video results in weak sound. With a 6DT6 the gain is due to oscillatory amplification. This is about 3 or 4 to 1 so that good sound is obtained even with an unusable picture. For the 6DT6 to have this advantage it must break into self-oscillation on weak stations. If it cannot oscillate, the gain is lost. Check capacitors by shunting, giving particular attention to the plate and cathode bypasses. Abnormal capacitance drop of the screen bypass can stop oscillation. The damping resistor across the quadrature coil may be too small. In Fig. 1303 this is 82,000 ohms. Try raising it to 100,000 ohms. Do not raise its value too much as the tube is not supposed to self-oscillate on strong signals.

Improper bias applied to the quadrature grid (pin 7 of the 6DT6) due to some defect in the resistors or capacitors of the bias network will cause weak sound. Check these by capacitor shunting and ohmmeter measurement (C1 and R1 of Fig. 1302; C1, C2 and R1 of Fig. 1303). The bias will drop a little from that obtained during alignment to about 3 volts or so. On weak signals self-oscillation maintains this bias.

Wrong voltages

Improper electrode voltages give rise to both weak and buzzy sound furnishing a clue to this condition and can be checked with a vtvm or vom.

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