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KEN-RAD
RADIO TUBES

Techni-talk on AM, FM, TV Servicing

SYNCHRONIZING PULSES AND CIRCUITS

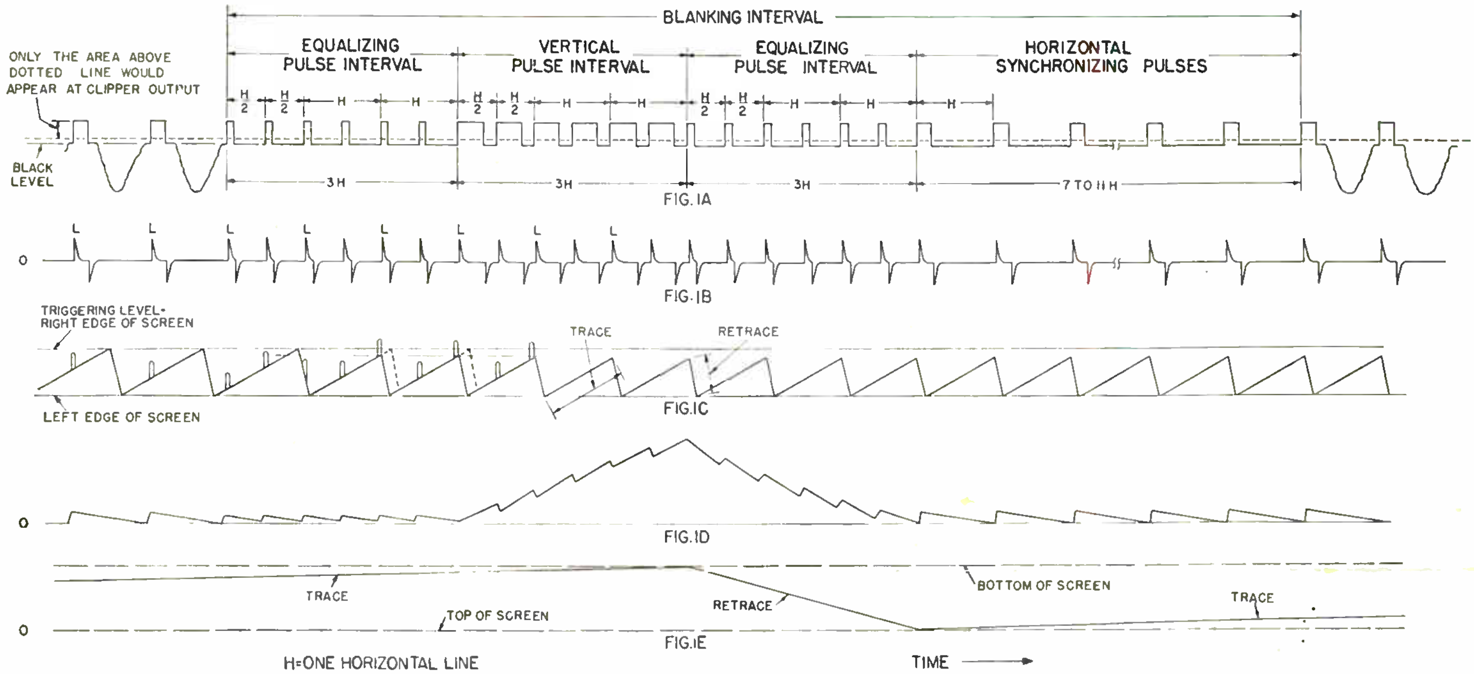


Fig. 1. The composite drawing shown above illustrates the effect of the "blanking interval" on the different circuits and on the electron beam in the picture tube. Fig. 1A represents a normal television signal as it should appear at the input to the picture tube. Fig. 1B illustrates this same signal as it would appear at the output of the differentiating circuit. Fig. 1C shows the movement of the electron beam across the picture tube as a result of the sawtooth wave generated in the horizontal oscillator. The first six waves also show the effect of the pulses, appearing directly above in Fig. 1B, on the horizontal oscillator. Fig. 1D illustrates the action of the integrating circuit which triggers the vertical oscillator, causing the electron beam to return to the top of the screen as shown in Fig. 1E. The effect of each pulse appearing in Fig. 1A is shown directly below on Figs. 1B, 1C, 1D and 1E.

The previous issue contained a description of the blocking oscillator and the multivibrator circuits as used in both vertical and horizontal deflection circuits. Before discussing the sine-wave type of sweep generator which is used only in horizontal deflection systems, the synchronizing portion of the video signal and the operation of the clipper and separator circuits will be explained.

A normal television signal as it should appear at the input to the picture tube is shown in Fig. 1A. This illustrates from left to right, the bottom two lines of a picture plus six equalizing pulses, then the vertical synchronizing pulses, six more equalizing pulses, a number of horizontal synchronizing pulses (usually from seven to eleven), and then the top two picture lines of the next field. The portion of the signal appearing above the black level is equal in importance to the portion which contains the picture information, as it is this portion which is used to keep the horizontal and vertical sweep circuits in step with the transmitter.

The signal, as it appears in Fig. 1A with the top and bottom lines completely scanned, would arrive at the picture tube grid thirty times a second or at the end of every other field. This is due to interlaced scanning which means that every other line is scanned in each field with the lines skipped being scanned in the following field. There are two fields of 262½ lines in each frame containing 525 lines. Of these 525 lines about forty lines are lost due to the twenty line blanking interval for each field. This leaves only about 485 lines which are actually used for picture information.

Due to each field containing 262½ lines, every other field ends at about the center of the last picture line with the following field beginning at about the center of the first picture line. This point on the bottom line as well as the starting point on the top line can usually be seen on any TV set by adjusting the height control so that the top and bottom line of the picture is visible.

At this time only a field which ends with a complete picture line as shown in Fig. 1A will be discussed. The different parts of this signal will be explained and illustrated with the unretouched photographs in Figs. 2, 3, 4 and 5. The two horizontal sync pulses on the left of Fig. 1A are typical of the type which appears at the end of each horizontal line containing picture information. The duration of the horizontal sync pulse at the black level is approximately 10 μs. The horizontal sync pulse lasts for approximately 5 μs and therefore occupies about fifty per cent of the horizontal blanking period. The step on the left of the pulse is known as the "front porch" which is considerably narrower than the "back porch" which is the step on the right. The reason the "back porch" is wider is to allow sufficient time for horizontal retrace which is about 7 μs in most receivers. The result of the horizontal sync pulse is shown in Fig. 2. The gray area to the left of the vertical black line represents the "front porch" and is the same color as the areas in the test pattern which are normally black. The vertical black line is the result of each synchronizing pulse and the gray area to the right represents the "back porch." This part of the video signal can also be seen on most TV receivers by increasing the brightness level and rotating the horizontal hold control. In horizontal automatic frequency control systems, it may be necessary to adjust the phasing control on the horizontal discriminator transformer. This is usually the bottom adjustment. By increasing the brightness level the areas which are normally black appear gray; however the "blacker than black" level which is the sync pulse area still appears black.

The purpose of the six equalizing pulses, which occur at half line intervals, is to prevent slight differences in voltage between successive fields from interfering with the timing of the vertical oscillator. These pulses also keep the horizontal oscillator in synchronization during this period. The action of the horizontal oscillator during this period is shown in Fig. 1C. The photograph shown in Fig. 3 and enlarged in Fig. 4 illustrates the action of the electron beam during the interval between fields. The duration of the equalizing pulse is one-half the

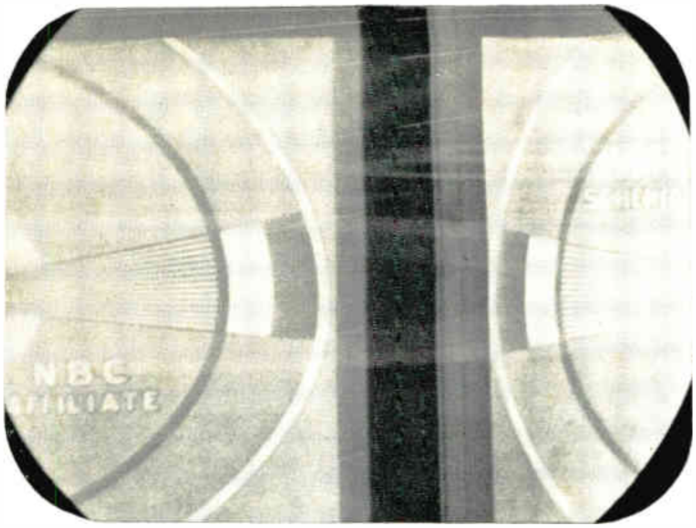


Fig. 2. This photograph shows the effect of the horizontal synchronizing pulses.

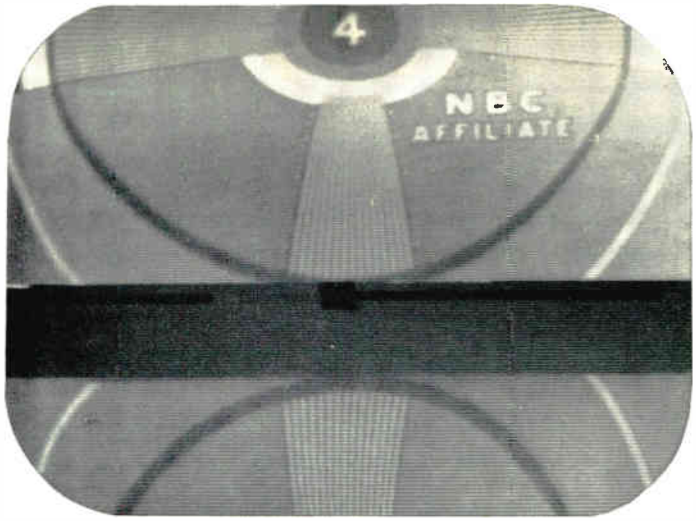


Fig. 3. This photograph shows the effect of the different pulses within the blanking interval.

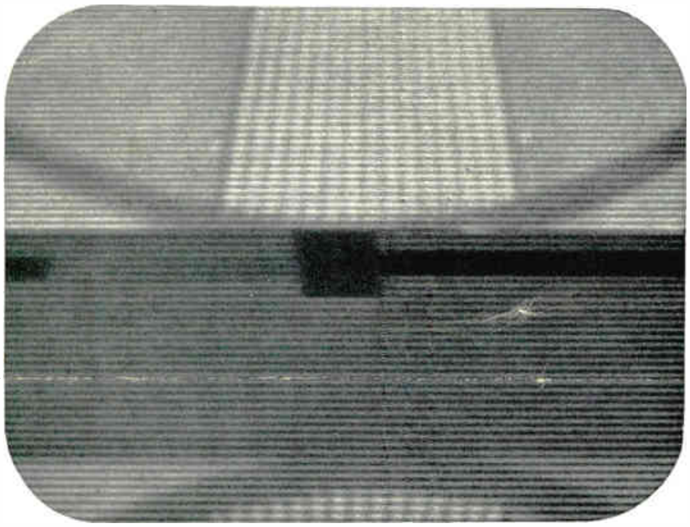


Fig. 4. The above photograph is an enlargement of Fig. 3.

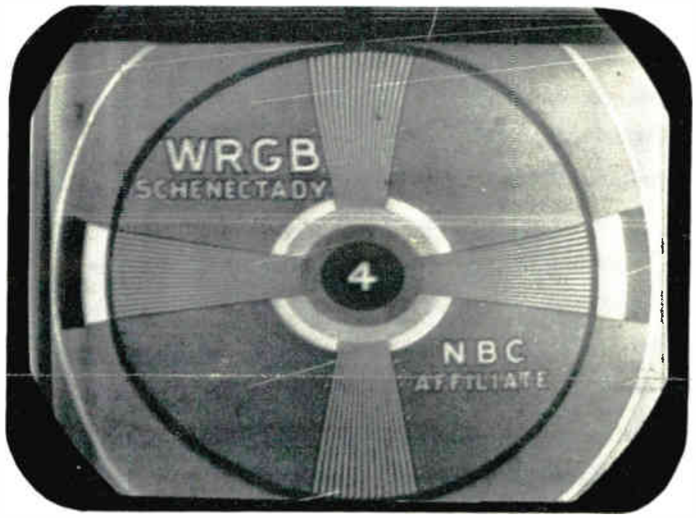


Fig. 5. Here the action of the vertical oscillator is shown as it is triggered, returning the electron beam to the top of the screen.

duration of the horizontal sync pulse or 2.5 μs. This is the reason why the three lines at the bottom of the black vertical bar which is due to the horizontal sync pulse are visible in Fig. 2. The black square in the center of Figs. 3 and 4 represents the equalizing pulses which occur in the center of each line during the equalizing pulse interval.

Referring again to Fig. 1A and Fig. 3 we shall follow the electron beam as it reaches the end of the last picture line. At this time the beam is blanked out and the first equalizing pulse trips the horizontal oscillator causing the beam to retrace, returning it to the left side of the screen. The beam then starts the horizontal trace portion of its cycle which moves the beam toward the right side of the screen. As it reaches the center the second equalizing pulse in Fig. 1A blanks it out for the duration of this pulse which is 2.5 μs. The beam then continues to the end of the line. It is then blanked out by the third equalizing pulse which again trips the horizontal oscillator returning the beam to the left side. This same action continues for three horizontal lines as shown in Figs. 1A, 3 and 4.

The first vertical synchronizing pulse which is 31.75 μs long now causes the beam to be blanked out as it starts the fourth line of the blanking interval. This is the long horizontal black bar extending across Figs. 3 and 4. The beam is blanked out until it almost reaches the center. At this time it returns to the black level (gray in photograph) due to the serrations in the vertical pulse (Fig. 1A) which keep the horizontal oscillator in synchronization during the vertical pulse interval. These serrations appear as the break in the long black horizontal line to the left of the black square in Figs. 4 and 5. The interval of each vertical serration is 4.4 μs after which the beam is blanked out until it almost reaches the end of the horizontal line. At this time it is again visible due to the second downward serration in the vertical pulse interval returning the beam to the black level. The beam remains visible as shown in Fig. 3 until it reaches the third vertical pulse which triggers the horizontal oscillator returning the beam again to the left and in position to trace the second line of the vertical pulse interval. This same action continues for a total of three horizontal lines sometime during which the vertical oscillator is triggered returning the beam to the top of the screen.

The electron beam can be seen starting from the bottom toward the top in Fig. 5 which indicates that the vertical oscillator was triggered just as it reached one of the serrations. The beam is visible during this interval as previously explained due to the brightness being increased which makes the normally black areas appear gray. These same serrations can be seen at several other places to the left of the center and also near the right edge. The path of the beam during vertical retrace can be visualized by following the direction of the retrace lines as they zigzag from left to right toward the top of the screen, remembering of course that the horizontal retrace from right to left is much faster than the trace portion, and therefore is practically a horizontal line. You will notice that the lowest diagonal retrace line on the right side and in line with the word "AFFILIATE" is at about the same level as the second line in the center. This is due to the retrace lines representing two successive fields.

Space limitation does not permit a detailed discussion of a field which ends with a half line. It can be understood however by referring to Fig. 1A and imagining that the right half of the last picture line before the blanking interval is removed and these one and one-half lines moved to the right. The nine lines representing the equalizing and vertical pulse intervals would be unchanged. The space between the last equalizing pulse and the first horizontal pulse would be increased to one full line moving all of the following pulses one-half line to the right. The "back porch" of the last horizontal sync pulse should also extend half-way across the first picture line. The horizontal oscillator would then be triggered by the sync pulses during the equalizing and vertical pulse intervals which were not effective in the previous field.

(Continued on page 5)

Tele-Clues

The Tele-Clues in this issue indicate eight more different defects which may occur in different circuits of a TV receiver.

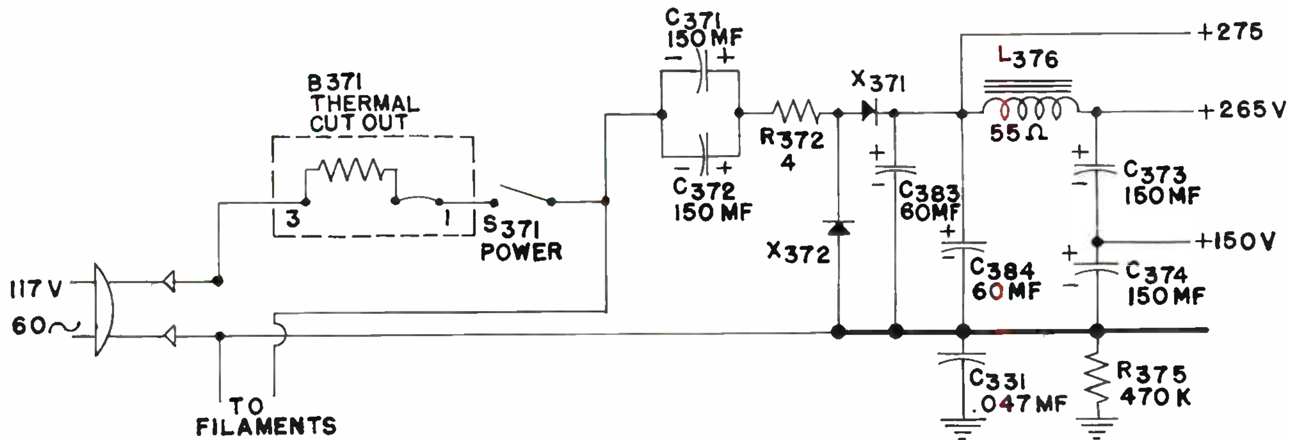
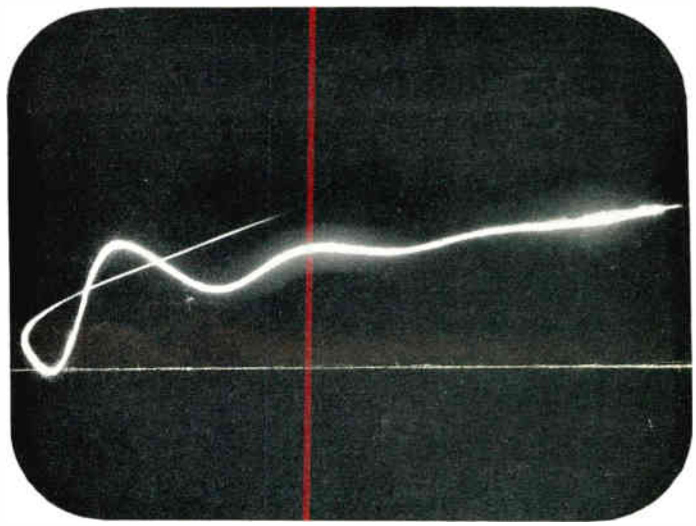


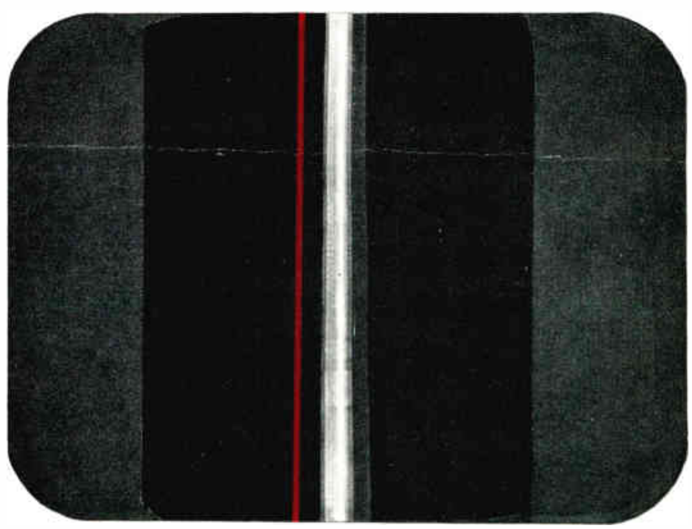
Fig. A. Selenium rectifier type power supply circuit used in GE Model 805 receiver.

Tele-Clue No. 17. Alternate light and dark vertical bars with a large white area to the right is the result of filter condenser C374 in Fig. A being open. Adjustment of the horizontal hold control would not straighten the picture due to loss of plate voltage on the afc tube which was supplied from the 150 v point.

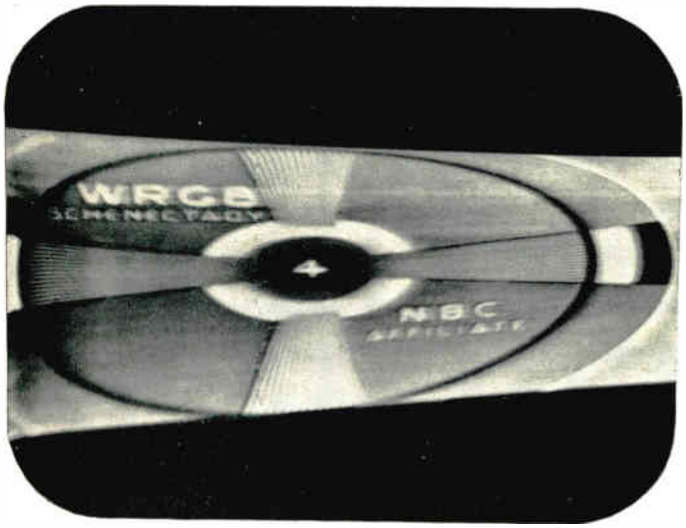


Tele-Clue No. 19. An open in the ground side of the vertical coils in the deflection yoke results in this type of an indication. If the open occurs at the other end of the coils the indication is a straight horizontal line. The waves shown here are due to some horizontal voltage being induced into the vertical windings.

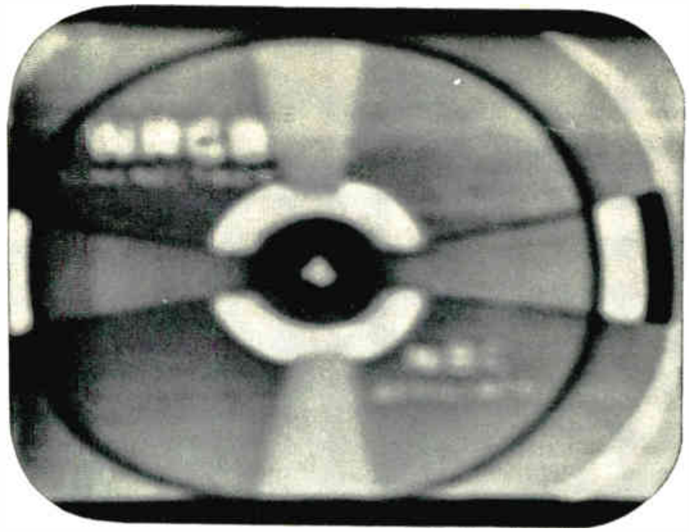
Tele-Clue No. 18. Alternate light and dark vertical bars due to filter condenser C373 in Fig. 1 being open. The condition shown is the result of a reduction of the B+ voltage supplying the horizontal output and damping tubes. The fold-over is due to improper voltage on the horizontal output tube.



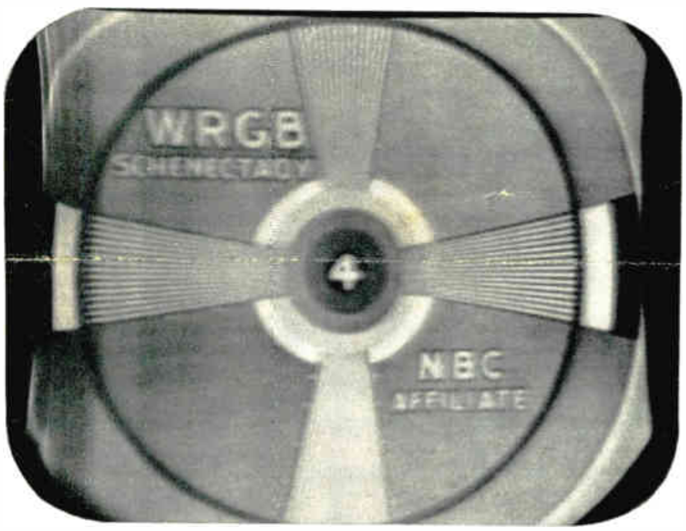
Tele-Clue No. 20. This illustrates the result of an open in the horizontal deflection coils on the plate side of the damper tube. An open in the other side results in only a straight vertical line being visible.



Tele-Clue No. 21. The keystone effect shown here illustrates a short in the vertical windings of the deflection yoke. It is usually necessary to replace the complete yoke since the shorts ordinarily occur deep within the windings. The effect is similar to Tele-Clue No. 1 which indicated a short in the horizontal windings.



Tele-Clue No. 23. The above photograph shows the effect of an open focus coil. Practically the same result is apparent when an open occurs in either the PM or the electro-magnetic type. Poor focus can also be caused by incorrect adjustment of the focus control or coil or a change in value of the resistors in the focus coil circuit. It may also be caused by a low emission rectifier tube or tubes, as any sizable reduction in the voltage will affect the current and therefore the effectiveness of the focus coil.



Tele-Clue No. 22. This photograph illustrates the effect of poor interlace. The vertical wedges fan out near the center and the lines in the vertical wedge seem to have white steps in them. This is more noticeable in the wedge on the right. Poor interlace may also be caused by poor design or a defective component in the sync or integrating circuits. When the interlacing action is defective the picture will also appear hazy and out of focus. A close inspection of a test pattern however should disclose that the interlacing action is at fault.

Tele-Clue No. 24. This photograph is the result of a heater-cathode short in the horizontal reactance tube in a Westinghouse Model H-196 receiver. The circuit shown in Fig. 2 is typical of that used in a considerable number of different make receivers.

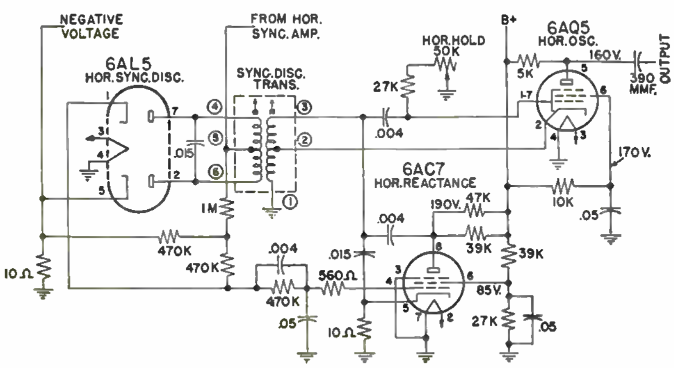


Fig. B. Horizontal oscillator and control circuit as used in a Westinghouse Model H-196 receiver.

TELE-TIPS

1. A picture which fades out intermittently may be due to a poor solder connection at the terminals of the picture tube base. It is a good idea to resolder each terminal by using a hot iron and applying a little additional solder.

2. Slight fluctuations in picture tube brightness may be caused by an intermittently open HV capacitor. Disconnect one side and if the fluctuations are eliminated replace capacitor.

3. A charge may build up between the ion trap and the nearest ground which is usually the focus coil. This may arc across occasionally causing some concern to the set owner. A short piece of wire with a Mueller clip on each end connected between the ion trap and ground will eliminate this complaint.

4. Extremely critical horizontal hold control adjustment especially in 7" sets may be improved by additional filtering. Try bridging each filter condenser with at least a 40 mfd capacitor and watch a test pattern for any improvement.

5. Always try a new 1B3GT HV rectifier tube when loss of HV is indicated. Commercial tube testers obviously can not check these tubes at operating voltages.

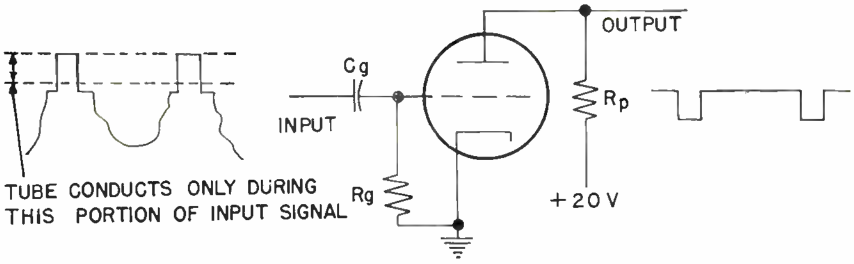


Fig. 6. A clipper circuit showing the input and output wave forms.

THE CLIPPER CIRCUIT

We have seen what happens on the picture tube screen during the blanking interval. Now, the circuits which use these pulses to trigger the horizontal and vertical oscillator will be discussed.

A portion of the complete video signal is picked off at some point between the video detector and the grid of the picture tube. The picture information is then eliminated and the vertical and horizontal pulses are separated and fed to their respective oscillator circuits.

The circuit which removes the picture information from the synchronizing pulses is called a "clipper" or "sync separator" circuit. The composite video signal is applied to either a diode, triode or pentode tube depending upon the signal level required. In some receivers a stage of amplification is used either before the clipper or after or both. A diode tube may be connected for use with either a positive or negative going signal. If, however, a triode or pentode is used the signal must be positive going. Regardless of the type of tube used as a "clipper," a high negative bias is required. This bias is sufficient to prevent current from flowing except when the signal is above the blanking level.

A typical circuit using a triode tube is shown in Fig. 6 illustrating the clipping action of this type circuit. The bias is developed as a result of the grid conducting during the time that the grid is positive with respect to the cathode. This charges the capacitor to the peak potential of the input signal. During the time that the signal is below the peak level the charge on C_g starts to discharge through resistor R_g which due to its high resistance value develops a relatively high bias voltage. Due to the time constant of the C_g, R_g combination, only a very small amount of the charge on C_g will leak off during the interval between pulses. In this way, a sufficient bias is maintained on the clipper tube so that only about the top twenty per cent of the composite signal appears in the output of the clipper tube. Although the synchronizing pulses occupy twenty-five per cent of the composite signal, only about twenty per cent is passed through the clipper. This eliminates the possibility of the black portions of the signal riding through the clipper stage and triggering the sweep circuits prematurely.

PULSE SEPARATION

The output of the clipper tube, which contains only the synchronizing pulses as shown in the area above the dotted line in Fig. 1A, is now applied to two separate circuits: (1) A high-pass or differentiating circuit which converts the leading edge of every synchronizing pulse whether it is a horizontal, equalizing or vertical into a voltage pulse which is in turn used to trigger the horizontal oscillator and (2) a low-pass filter or integrating circuit which separates the low frequency vertical pulses so that they may be used to properly time the vertical oscillator.

A basic circuit for a differentiating type filter appears in Fig. 7. The leading edge of each pulse when applied to this circuit causes the small value condenser to charge to the peak of the applied voltage. Due to the very short time constant of the RC combination, the charge is rapidly discharged during the level portion of each pulse resulting in a positive peak appearing across resistor R as shown in Fig. 1B. The trailing edge of each pulse results in negative peaks which appear below the zero line in Fig. 1B. The positive peaks marked "L" which occur one line (1 H) apart can now be used to trigger the horizontal oscillator.

The output of the clipper is also applied to an integrating circuit similar to the one shown in Fig. 8. In this circuit the resistance R is in series with capacitor C and is sufficiently large to prevent C, which has a relatively high value, from charging to the full input potential on any one pulse. The short duration horizontal sync and equalizing pulses cause only a small charge to appear across C resulting in the small sawtooth waveform appearing in Fig. 1D. These waveforms are not of sufficient amplitude to affect the vertical oscillator. The broader vertical pulses which occur during the vertical pulse interval, however, cause the charge on C to build up rapidly as shown in Fig. 1D. This charge, which is the output of the integrating circuit, will continue to rise only when the duration of the pulse itself is greater than the interval between pulses as also illustrated in Fig. 1D. Condenser C charges slightly on both the horizontal and equalizing pulses, but due to the interval between these pulses being relatively long as compared with the pulse duration, very little, if any, charge remains at the end of the interval between pulses. If the duration of the pulse is greater than the interval between pulses, as in the case of vertical pulse interval, then the charge will continue to rise as shown in Fig. 1D. Fig. 1E indicates that the vertical oscillator was triggered at the end of the last vertical pulse. However, the time that the vertical oscillator is triggered varies in different receivers and depends upon the values used in the integrating circuits and also upon the position of the hold control. The approximate points can be determined by increasing the brightness control until the retrace lines are visible and reducing the height control, until the bottom of the raster is visible. Then, with either a test pattern or a picture being visible, rotate the vertical hold control and analyze the movement of the retrace lines as explained in the first part of this article. The point where the beam starts toward the top can be seen and varied as shown in Fig. 5 and by using Fig. 1A as a guide the action of the vertical oscillator can be seen and understood.

Integrating circuits used in TV receivers are usually composed of a network in ladder form of resistors and capacitors instead of only one of each as shown in Fig. 8. By using several resistors and capacitors the circuit is more stable and less likely to be triggered by noise pulses.

TRIGGERING

The time constant of the components in the oscillator grid circuit determines approximately the free-running frequency of the horizontal and vertical sweep circuits. It is the sync pulses, however, that determine the exact frequency. When the sync pulses, which have been converted to positive peaks, are applied to the grid circuit of either the blocking oscillator or multivibrator at a point in its cycle just before conduction; these peaks will cause conduction at that instant thereby keeping the receiver in step with the transmitter.

All oscillator circuits must be adjusted so that the natural frequency is slightly slower than the required frequency. In this way regardless of the point on the waveform at which the sync pulse arrives, it will only be a few cycles before the pulse will arrive at the correct point for proper synchronization. This is illustrated in the first few cycles to the left of Fig. 1C. The first three sawtooth waves and the dotted lines in the next two are longer than those following and indicate that the normal or free running speed of the horizontal oscillator is somewhat slower than the required frequency of 15,750 c.p.s. The sync pulses do not have any effect during the first three cycles because the peak voltage of the pulse riding on the normal wave has not reached a sufficient level to trigger the oscillator. During the fourth cycle, however, the sync pulse does reach the triggering level and the horizontal oscillator is triggered and would continue to be triggered by each succeeding pulse at this same point on the waveform. The horizontal oscillator would then be in step with the transmitter.

If the free running speed were faster than 15,750 c.p.s. the sawtooth waveforms would be shorter. The oscillator would be triggered at the proper point every few cycles but would only stay in sync for a few cycles because the peak of the wave would soon arrive before the sync pulse. The pulse would not be effective again until it arrived just before the peak of the wave. The horizontal oscillator will not, therefore, stay in synchronization unless the hold control is adjusted so that the natural frequency is slightly slower than 15,750 c.p.s. Sync pulses would only appear in the waveform at the input to the horizontal oscillator. The output waveform would only show the effect of those pulses which caused the tube to conduct. The sync pulses which appear on the first few waveforms are shown only to illustrate the position on the output wave at which they would occur, and should not be considered as part of the output waveform. The same conditions also apply to the vertical oscillator except that the vertical hold control must be adjusted so that the natural frequency is slightly less than 60 c.p.s.

In the next issue the horizontal sine-wave type of horizontal sweep generator will be discussed together with the systems used to control its frequency.

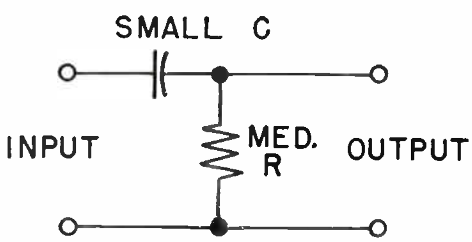


Fig. 7. A basis differentiating circuit.

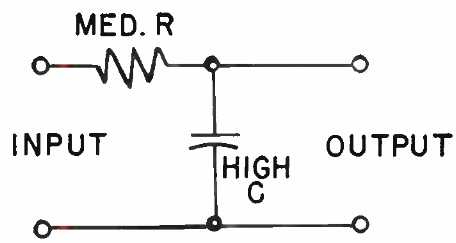


Fig. 8. A basis integrating circuit.

BENCH NOTES

Contributions to this column are solicited. For each question, short cut or chronic-trouble note selected for publication, you will receive $10.00 worth of electronic tubes. In the event of duplicate or similar items, selection will be made by the editor and his decision will be final. Send contributions to The Editor, Techni-Talk, Tube Division, General Electric Company, Schenectady 5, New York.

MATCHING OUTPUT TRANSFORMERS

When installing multi-tapped output transformers, it is often confusing to try to follow charts, and in many cases an incorrect match is made, due to not knowing voice coil impedance. To overcome this and get a perfect match, connect one terminal of the transformer to one side of voice coil. Connect an output meter across the voice coil. Introduce a 400 cycle audio signal to the detector with enough attenuation to show a low reading on output meter with probe on any lug. Then with a probe clipped to the open side of voice coil, touch each lug on secondary of transformer in turn with the probe, noting change in meter reading. The combination of lugs giving highest reading is the nearest match, and will give maximum efficiency.

This can be done with any multi-tapped audio transformer and applies to either primary or secondary.

Herbert F. Taylor, Taylor's Radio Serv.
Thompsonville, Connecticut

RESISTANCE CHANGE

I have found trouble with resistors changing value in critical circuits when the soldering iron is applied too close to the resistor. As an example—on a 1000 ohm resistor using short leads 1/4″ or less the resistance increased between 20 to 30 ohms. By using leads of 5/8″ or longer the resistance change could be kept less than 2 to 4 ohms. Quite an improvement, and the additional length is negligible if the frequency is less than 100 mc. The resistance values were checked before and after by a very sensitive laboratory bridge and the results were surprising and improved by using the leads a little longer.

Donald McFadden, Drexel Hill,
Pennsylvania

HOWL ELIMINATION

I would like to contribute a suggestion for "antenna howl" elimination. This howl I speak of is noise caused by wind passing through guy wires and any vibration of the antenna proper transmitted through roof of building, in some cases creating quite a disturbance. In most cases noise can be eliminated by breaking up guy wire into sections with the use of glass insulators. In severe cases, cork ends of dipoles and insulate points of transmission of vibration to roof of building.

Leonard B. Tarrey
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MORE SHOCK PROTECTION

An excellent way to eliminate the possibility of getting shocked from two AC-DC chassis on the bench at one time is to use your AC Voltmeter and check the potential of the chassis to earth ground. No reading indicates correct polarity of AC plug of all sets on bench. No danger of being shocked if you forget.

Samuel Nicholson
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DON'T DRILL-PUNCH

The use of hand punches to produce holes in radio chassis alterations, such as the installation of a jack for Record Players, is not very well appreciated, in my opinion, by very many radio servicemen. Drilling, unless you cannot get to it with a punch, is strictly obsolete. Drilling shakes the dickens out of a radio chassis, and is open to the very possible objection of the fine chips making an electrical short-circuit, not to mention the tremendous waste of time, as compared to punching holes. A Whitney #5 Jr. hand punch, with punch diameters ranging from 3/32″ to 9/32″, will do the trick to perfection, and in addition, is about as easy to operate as the punch a waitress uses to punch your meal-ticket. There will be no fine chips to cause you to worry on that score, and the tremendous saving of time pleases everyone concerned. You can easily find these punches listed in the Buhl Sons catalog on hand in most every hardware store, since they are commonly used in the tin and sheet metal shops all over the country. The holes can very easily be accurately located, because there is a point on the tip of the punch that fits into the prick-punch mark. In addition, if you want a washer of rather large diameter but with a small hole, you can use this punch on a knock-out that the electricians throw away when they poke a hole in an outlet box. I might add that I install the phono jacks on the outside, rather than on the inside, of the chassis, on AC-DC sets.

While we're on the subject of punching, I'd like to acquaint you with the punching methods used in steel fabricating shops. I had occasion recently to have four 9/16″ holes drilled in a strip of 3/4″ thick iron, and the workman smiled at me and said I ought to get up-to-date: they don't drill any more, but instead punch that size hole in their angle iron and I-beams and etc. that they use for building frame-works. He put those four holes through that 3/4″ iron like he was punching a meal ticket; I was surprised no end. And the holes were certainly satisfactory enough. Of course, radio servicemen aren't going to be needing that sort of thing very often, but it's nice to know about just the same; the four holes would ordinarily have cost me a couple of bucks to have drilled, but the punch man charged me nothing.

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