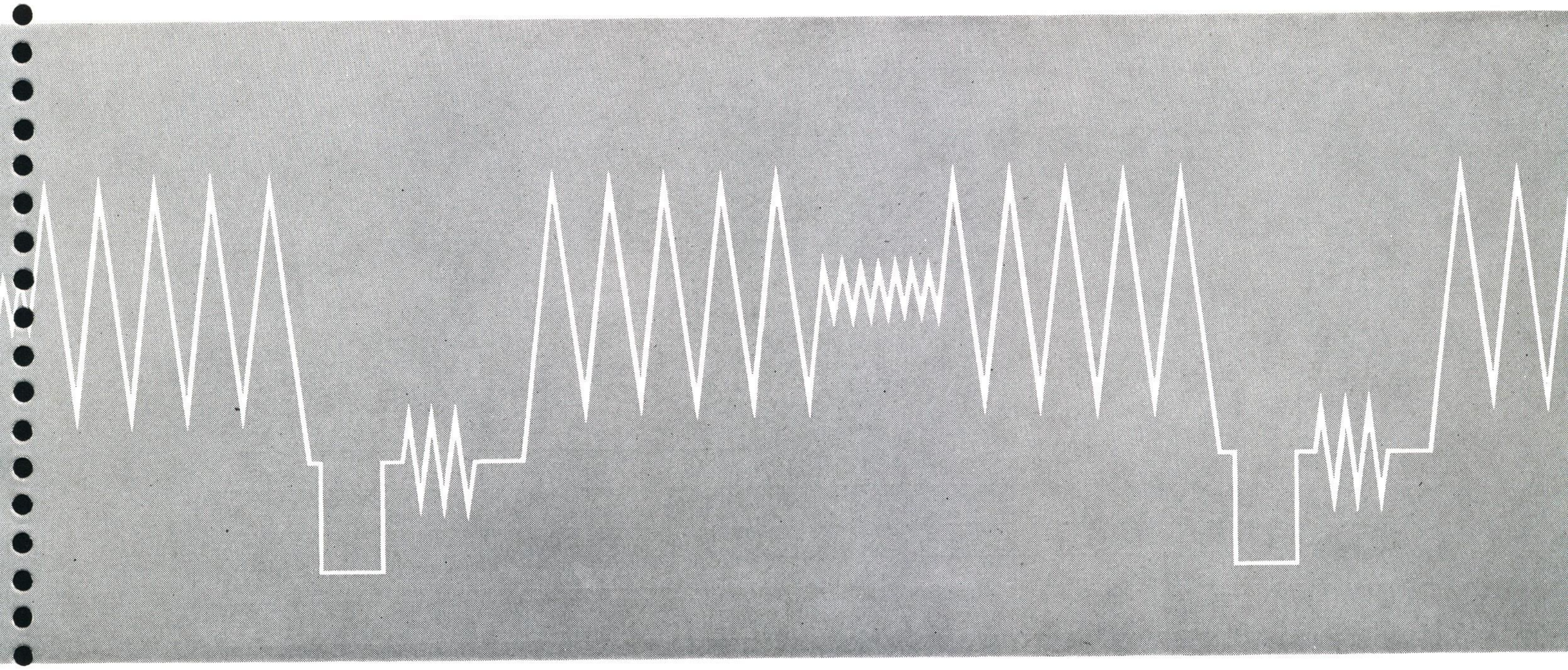
KDLO TV

TELEVISION SIGNAL ANALYSIS

TELEVISION
Signal Analysis



American Telephone and Telegraph Company

Long Lines Department

May, 1955

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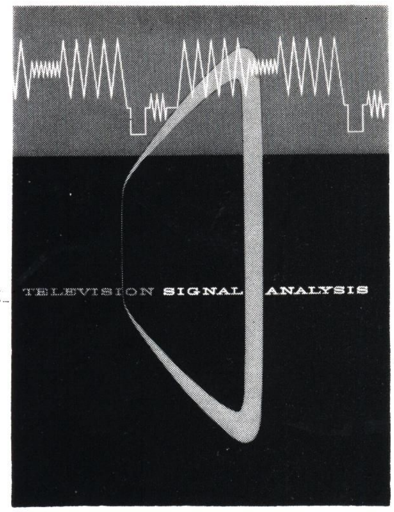


Introduction

This booklet has been prepared as a general reference for telephone employees who are concerned with the analysis of television signals transmitted over Company lines. Such analysis has as its purpose a determination of the quality of the signal as received at various points along its transmission path; and, if signal impairment appears, a diagnosis of its probable cause. This will naturally lead to the taking of such corrective measures as may be indicated.

It is clear that, to have any significance, the observation of signals requires the use of monitoring devices that are always capable of giving a faithful representation of the actual signal on the line. Correct adjustment and proper maintenance of these devices must, therefore, be assumed. Granting this, any observed deficiency in the signal must either be present in the output of the camera equipment or be the result of failure of the transmission system to carry the signal without distortion from its point of origin to the distant monitoring point.

Properly to discharge his responsibilities, the ~~telephone~~ technician must first know what the signal delivered by the camera looks like in comparison with the signal which he is receiving. If this comparison indicates that undue distortion is being introduced by the transmission system, he may wish similarly to compare his received signal with the signals received by other monitors back along the line in order to isolate the section of the transmission system that is at fault.

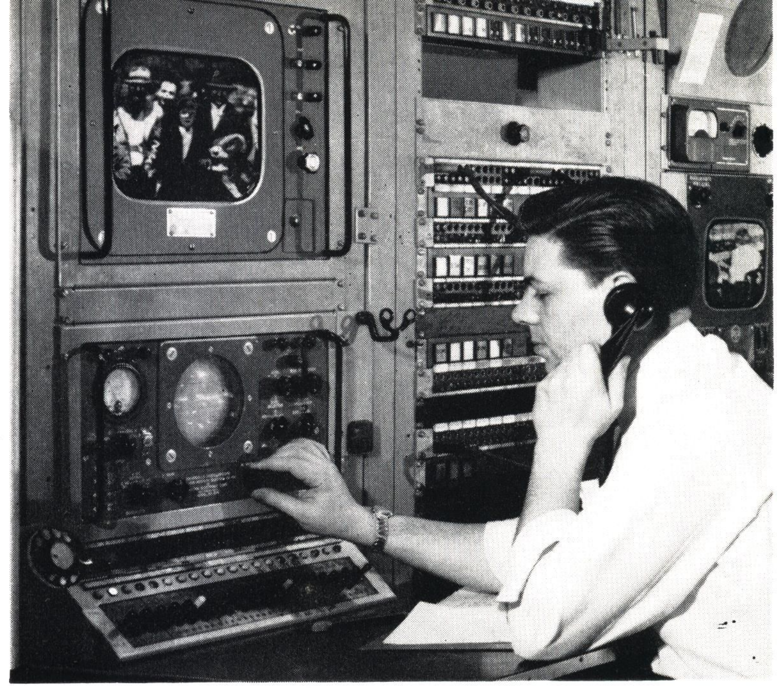
A single observer, of course, cannot make simultaneous observations of a signal at a number of different points. Comparisons, therefore, depend upon telephone communication between observers who may be located at widely separated points and who may be associated with entirely different communications or broadcasting organizations.

For such communication to be fully effective, it is necessary that the observing devices employed at all points be sufficiently alike to produce signal representations that are directly comparable in kind. It is also necessary that all observers have a common understanding of what constitutes the normal signal representation. Similarly, each should be able to recognize the appearance of the more usual types of signal impairments that may from time to time occur. In addition, skill in diagnosing the probable general cause of any observed impairment is highly desirable as a first step in facilitating the location and correction of the fault responsible.

It is obvious that effective communication between observers further requires that each use a language that is readily understood by the others. As in most new arts, the growing television vocabulary has tended to develop some confusion, with several different words or phrases being used for the same thing in many cases. In this booklet, an attempt has been made to select in each case the particular words or designations that seem to have gained the widest acceptance at this time.

With the principal objective of promoting desirable common understandings of both signal forms and their nomenclature, the following pages first discuss satisfactory monochrome and color television signals as they appear in standard oscilloscope and picture monitor representations, and illustrate the generally accepted designations for their several principal components. Following this, various types of test signals are discussed. The major types of video signal impairments are then listed, and each type is considered separately. Significant features, as they appear to the monitoring observers in both oscilloscope and picture monitor representations, are illustrated and discussed. Finally, a glossary of video terms is presented.

Much of the photographic and descriptive material included has been prepared with the help of the Engineering groups of the American Broadcasting Company, the Columbia Broadcasting System, the Dumont Television Network and the National Broadcasting Company, all of whom have been extremely cooperative. This booklet, then, endeavors to represent the viewpoints of both the broadcasting industry and the telephone company.



The Television Signal

A picture monitor in a broadcaster's studio or a telephone company television operating center might depict a test pattern as shown in Figure 1. This picture is free of discernible defects as evidenced by the facts that straight lines are straight, circles are round, that there is a complete range of grays, and there are no other obvious distortions.

The complete analysis of the picture signal, however, cannot be determined by the picture monitor alone. In the operation and maintenance of network television transmission, it is also necessary to analyze the signal using a cathode ray oscilloscope (A-scope). The A-scope permits the display of the voltage-time characteristics of both the horizontal scanning interval and the vertical scanning interval.

FIG. 1 — UNIMPAIRED VIDEO SIGNAL — PICTURE MONITOR PRESENTATION

1. Horizontal Scanning Interval

Figure 2 is the horizontal video signal presentation of the monochrome test pattern of Figure 1 as seen on the A-scope with a sweep rate of about 7,875 cycles per second (one-half the 15,750 cycle line rate). As shown, polarity of the signal generally displayed on A-scopes used in broadcasters' master control rooms and telephone company television operating centers is "Black Negative."

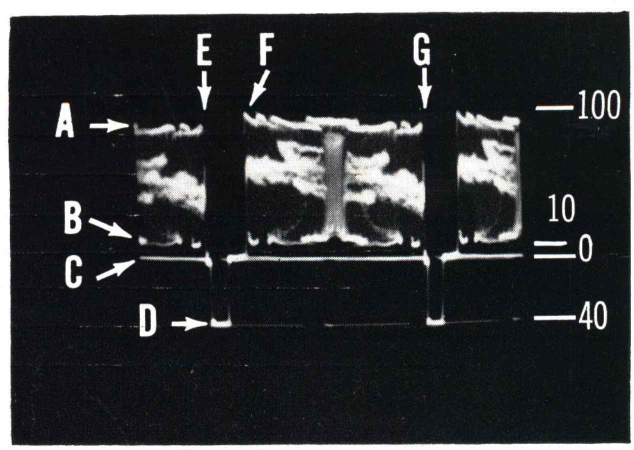


FIG. 2 — UNIMPAIRED VIDEO SIGNAL — A-SCOPE HORIZONTAL PRESENTATION

A. White Peak
B. Black Peak
C. Blanking Level
D. Synchronizing Level
E-G — Complete Horizontal Interval = 63.5 microseconds (μs)
E-F — Horizontal Blanking Interval = 10.05 microseconds (μs)
F-G — Picture Signal = 53.45 microseconds (μs)

The complete video line signal for one scanning line, included between E and G, requires a time interval of 1/15,750 or 63.5 microseconds. The horizontal blanking interval nominally requires 10.05 microseconds of this time as indicated between E and F, and the picture information utilizes the balance of the time, or 53.45 microseconds. The left side of the picture is indicated at F and the right side at G.

The horizontal and vertical sync pulses, which synchronize the sweep circuits in the receiver with those of the camera, determine the timing of the scanning lines and thus permit accurate location of each element being scanned. The horizontal synchronizing pulse is shown in the blanking interval, with a voltage level corresponding to D.

The picture brightness information is carried between A and B, with the peak white amplitude of the picture at A and the peak black amplitude of the picture at B. In the case of test pattern signals, these peaks correspond to reference white and reference black levels, in which range it is expected that normal program picture information will fall. Any video voltage less than that at A will produce an increasingly darker gray until black is reached at B. Thus the region between A and B carries the picture brightness information in terms of voltage, the instantaneous level of the voltage corresponding to the brightness at that particular instant of time.

The "Setup" of the picture is the difference in voltage between the blanking and reference black levels, as indicated between C and B in Figure 2. On the IRE voltage scale, which has been adopted for industry-wide use, the setup value for network transmission is normally 10.

It may be seen that if a picture has no black, but only goes from white to dark gray, the minimum video voltage will not approach blanking level as closely as it would if the picture contained full blacks. This picture would appear to have a high setup. On the other hand, the video voltage should not extend through reference black level. Broadcasters attempt to maintain a reference black in all transmissions to obtain the most pleasing effect. Many of their studios are now equipped with electronic devices to maintain proper setup leaving the studio.

Typical proportions for a one-volt peak-to-peak composite signal as displayed on an oscilloscope with an IRE scale are 40 divisions of sync, 10 divisions of setup and 90 divisions of picture information, as shown in Figure 2.

Figure 3 is an expanded view of the horizontal blanking interval with its component parts, including the horizontal synchronizing pulse and adjacent signal, identified. The nomenclature tabulated here, if universally used, will minimize confusion when tracing a signal impairment to its source.

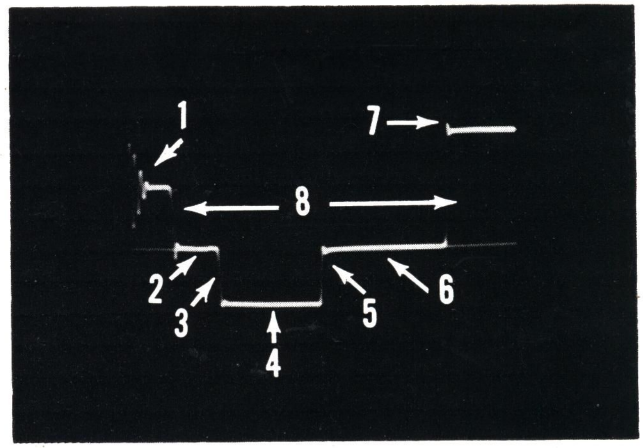


FIG. 3 — UNIMPAIRED VIDEO SIGNAL — A-SCOPE EXPANDED HORIZONTAL PRESENTATION

1. Video Voltages at Righthand Side of Picture
2. Front Porch = 1.25 μs
3. Leading Edge of Sync
4. Tip of Sync = 5.0 μs
5. Trailing Edge of Sync
6. Back Porch = 3.8 μs
7. Video Voltages at Left Side of Picture
8. Horizontal Blanking Interval = 10.05 μs

The front porch isolates the synchronizing pulse from transients or overshoots in the video signal at the end of the scanning line. This is done so that the synchronizing circuits in receivers or customer stabilizing amplifiers will not be triggered prematurely, thus producing a picture with successive horizontal lines displaced in a sporadic manner, which would result in jitter or possible tearing.

The leading edge of the sync pulse is used to synchronize the horizontal sweep oscillators in most monitors and receivers, and to trigger some clamping circuits. Excessive slope or curvature of the leading edge of the sync pulse may cause erratic synchronization of a monitor or receiver, or even complete failure of synchronization if sufficiently serious. It may also cause clamping failure in transmission equipment.

The tip of the sync pulse is used as the reference point in the d-c restorers of monitors and some oscilloscopes, and in the d-c restoration or clamping stages of telephone company equipment.

A pulse derived from the trailing edge of the sync pulse is used to trigger the clamping circuits in most types of stabilizing amplifiers used by broadcasters. Serious slope or curvature of the trailing edge of the sync pulse will cause improper operation of these stabilizing amplifiers, resulting in tearing and rolling in the reproduced picture.

The back porch completes the horizontal blanking interval. If the operation of the sweep circuits of a monitor or receiver be considered, it will be realized that when the electron beam has traversed the picture tube from left to right, it cannot return to the left side of the tube (retrace) instantaneously, but requires a small amount of time to do so. If picture voltages were permitted to occur immediately after the horizontal sync pulse, the picture components they represent would be visible during retrace. The duration of the back porch interval includes the time required for the sweep circuits to retrace completely, prior to the occurrence of picture information.

While the broadcasters' stabilizing amplifiers are triggered by the trailing edge of the sync pulse, they clamp on the back porch. This type of clamper amplifier employs a time delay RC circuit which is generally adjusted to delay start of clamping action until sometime during the first quarter of the back porch interval. The clamping or reference level is usually the average level over a one microsecond (one-quarter) position of the back porch interval. Therefore, if the back porch is seriously deformed or contains a large amount of noise, these amplifiers will clamp improperly, resulting in an impaired or useless picture to the customer although the picture may appear usable at the serving telephone office.

2. Vertical Scanning Interval

Figure 4 is the video signal presentation of Figure 1 as seen on the A-scope during the vertical scanning interval, using a sweep rate of approximately 30 cycles per second.

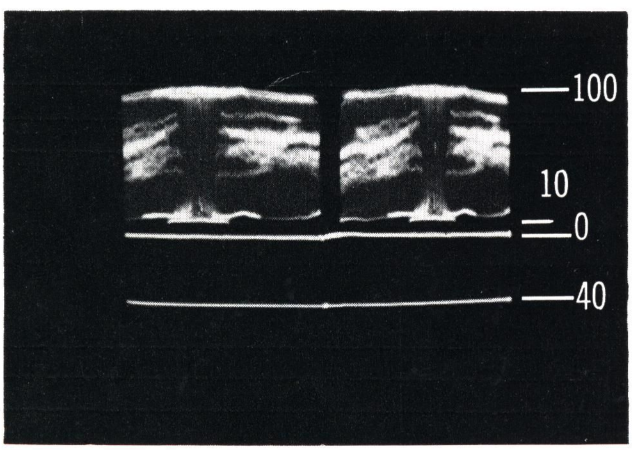


FIG. 4 — UNIMPAIRED VIDEO SIGNAL — A-SCOPE VERTICAL PRESENTATION

The levels of white peaks, black peaks, blanking and tip of sync indicated in Figure 4 are of the same value on the IRE scale as shown for Figure 2. The vertical synchronizing pulse, with the associated equalizing pulses and blanking pulses, may be seen in the center of the picture. This presentation will reveal many of the common types of low frequency trouble, such as clamping failures, 60 or 120 cycle interference or serious signal distortions.

Figure 5 is an expanded view of the vertical blanking interval with the component parts identified. Certain signal distortions that cannot be detected in the normal presentation may be seen in the expanded view.

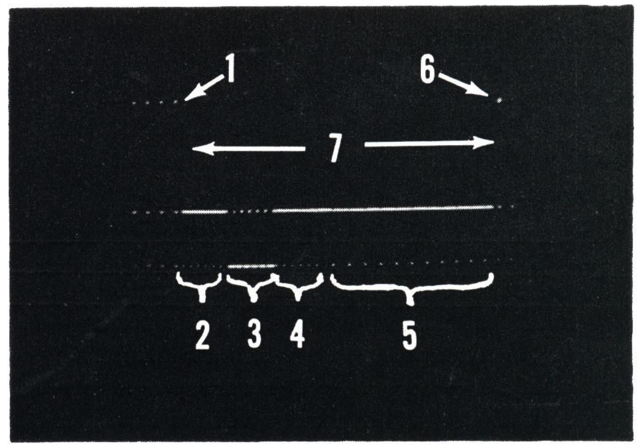


FIG. 5 — UNIMPAIRED VIDEO SIGNAL — A-SCOPE EXPANDED VERTICAL PRESENTATION

1. Picture Voltages, Bottom of Picture
2. First Group of 6 Equalizing Pulses
3. Serrated Vertical Sync Pulse
4. Second Group of 6 Equalizing Pulses
5. Horizontal Sync Pulses
6. Picture Voltages, Top of Picture
7. Vertical Blanking Interval

The requirements imposed by interlaced scanning create the necessity for the equalizing pulses. The odd and even fields occur sequentially at the rate of 60 fields per second. The top line of an odd field starts at the top left side of the raster and the bottom line ends at the bottom center of the raster, while the top line of an even field starts at the top center of the raster and the bottom line ends at the bottom right side of the raster. Therefore, it may be seen that if the vertical synchronizing pulse occurred immediately following a horizontal scan, the vertical pulse integrator capacitor in a receiver would have a different residual charge depending upon whether the vertical sync pulse followed an even or odd field. The fact that the vertical synchronizing pulse occurs one half line nearer a horizontal sync pulse following an odd field than it does following an even field would result in imperfect interlacing if the first group of six equalizing pulses were not provided. The presence of these equalizing pulses preceding every vertical synchronizing pulse interval results in the vertical pulse integrator capacitor in a receiver having the same residual charge at the beginning of the vertical pulse, regardless of whether it follows an odd or even field. These six equalizing pulses occur at one-half horizontal line intervals, which is at twice line frequency, or at the rate of approximately 31,500 pulses per second.

The serrated vertical sync pulse has a duration of approximately three full lines and has serrations occurring at the same rate as the equalizing pulses. These serrations are provided to keep the horizontal sweep oscillators in receivers and monitors synchronized and running smoothly during the vertical synchronizing pulse. Alternate serrations function as horizontal sync pulses.

The second equalizing pulse group follows the serrated vertical sync pulse. These equalizing pulses also occur at twice line frequency. The first and second set of equalizing pulses, along with serrations of the vertical sync pulse, permit stable operation of the horizontal sweep oscillator for the two different horizontal line conditions between the odd and even and between the even and odd fields.

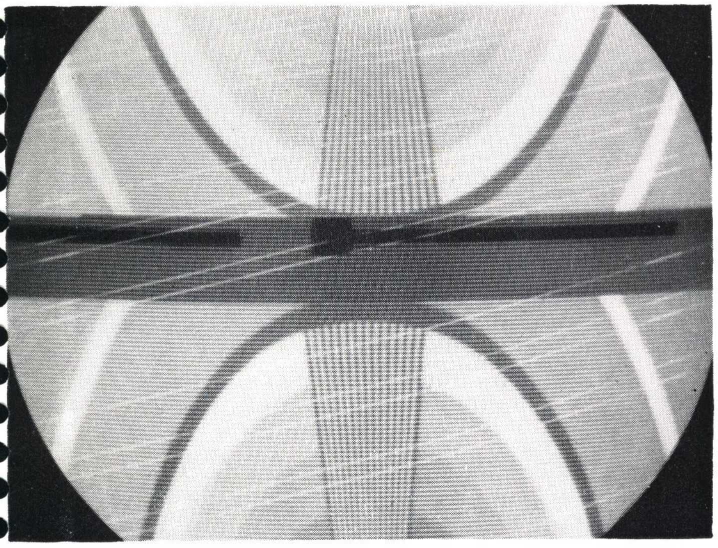


FIG. 6 — VERTICAL BLANKING — PICTURE

The portion of the vertical blanking interval between the end of the second set of equalizing pulses and the first video information of the new field (4 and 5 of Figure 5) is provided to allow time for the vertical sweep circuits in receivers to return the electron beam completely to the top of the picture tube before the video information of the new field starts. By adjusting the vertical hold control of the picture monitor and increasing the brightness, a presentation similar to Figure 6 can be obtained. This shows the vertical blanking interval as a wide dark bar. The black bars represent equalizing and vertical sync pulses.

3. NTSC Color

Fig. 7 presents the horizontal display of an NTSC color signal on a wide-band A-scope. This particular signal is shown in black and white by Fig. 8. As can be

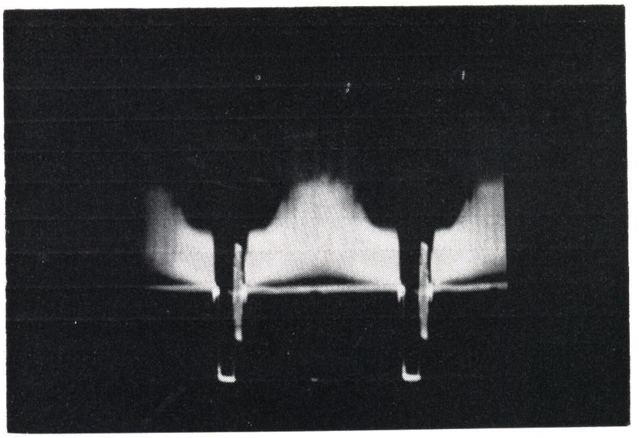


FIG. 7 — COLOR SIGNAL — HORIZONTAL — WIDEBAND

seen, the A-scope presentation is similar in appearance to that of a monochrome signal in so far as horizontal blanking, sync and picture information is concerned. The burst of high frequency during the back porch interval represents the most distinguishing feature of the color signal observed on the A-scope. This is the color sync burst, comprising 8 to 11 cycles of 3.6 mc voltage. The peak-to-peak amplitude of the color burst should be the same as the amplitude of the horizontal sync pulse, i.e., 40 divisions on the IRE scale. The color burst is centered voltage-wise at blanking level, and time-wise it starts about one-tenth of the total back porch interval from the trailing edge of the sync pulse. Another distinguishing feature is the presence of video information

FIG. 8 — COLOR SIGNAL — MONOCHROME PICTURE

below black level, which varies with the hue and saturation of the colors being televised.

For color transmission the horizontal scanning frequency is 15,734.264 ± 0.044 cycles per second rather than the nominal value of 15,750 cycles per second; the vertical scanning frequency is 59.94 cycles per second rather than the nominal value of 60 cycles per second. The complete video signal for one scanning line requires a time interval of 1/15,734 or approximately 63.6 microseconds. The horizontal blanking interval requires approximately 10.5 microseconds of this time and the picture information utilizes the balance of the time, or 53.1 microseconds. This compares closely with the nominal intervals shown in Figure 2 for the monochrome signal, the increase in blanking for the color signal being mainly in the back porch interval.

If the picture content of the signal could be resolved, it would be seen that where color is scanned, the signal includes the 3.6 mc color sub-carrier varying in both amplitude and phase. By operating the A-scope using the IRE roll-off characteristic, the color signal appears as in Fig. 9, with practically all of the color information removed. Now the scope presentation represents the luminance, or monochrome portion of the signal only.

A-scope presentation of color signals at vertical sweep rate, using either the wide-band or IRE roll-off characteristic, do not differ from monochrome signal presentations except for the presence of the high-frequency color information. Such a presentation is shown by Figure 10, which was taken on a wide-band scope.

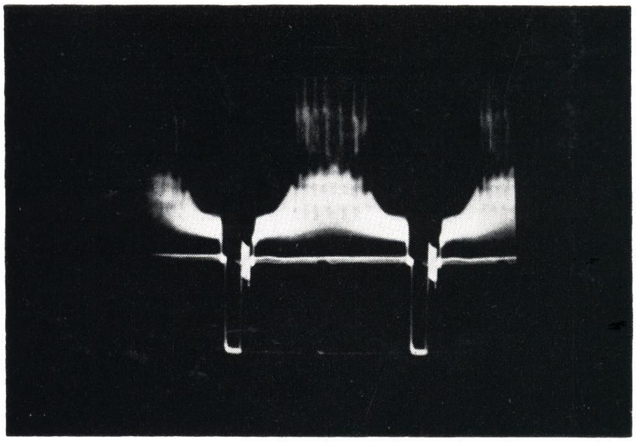


FIG. 9—COLOR SIGNAL—HORIZONTAL—IRE ROLL-OFF

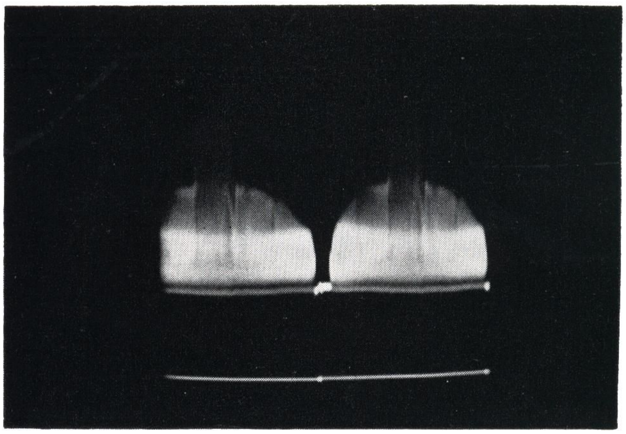


FIG. 10 — COLOR SIGNAL — VERTICAL — WIDEBAND

Television Test Signals

This section describes some of the test signals used in lineup and maintenance of television channels.

1. Sine Waves

Sine wave measurements are frequently used to determine gain-frequency characteristics of transmission channels. These signals generally are obtained from the 61B or 61C signal generator. The 70A or 70B power meter, a thermocouple instrument, is used for measuring. To provide accurate measurements at frequencies below 10 kc, clamping circuits along the transmission path must be disabled. Simple sine wave measurements are not suitable where gating circuits are used, as in certain types of radio relay systems, to set the carrier rest frequency at the time of the horizontal sync pulse. In such cases, synchronizing pulses must be present for faithful reproduction of transmission conditions.

2. Monoburst

The name "monoburst" has been applied to the resulting composite signal which is illustrated in Figure 11. The complete monoburst signal consists of single frequency sine waves plus sync pulses at the line rate, a blanking interval, and a means for varying the setup and the amplitude of the sine waves. The presence of the sync enables monoburst signals to operate gating circuits and clampers in normal fashion. Monoburst signals are measured and interpreted using a calibrated oscilloscope.

3. Window Signal

As viewed on a picture monitor, the window signal is a large square or rectangular white area with a black background. Fig. 12 is a typical window signal viewed on a picture monitor. Figs. 13 and 14 show the horizontal and vertical presentations on an A-scope. The picture signal has but two normal levels, reference black and white. The white level can be adjusted, but is

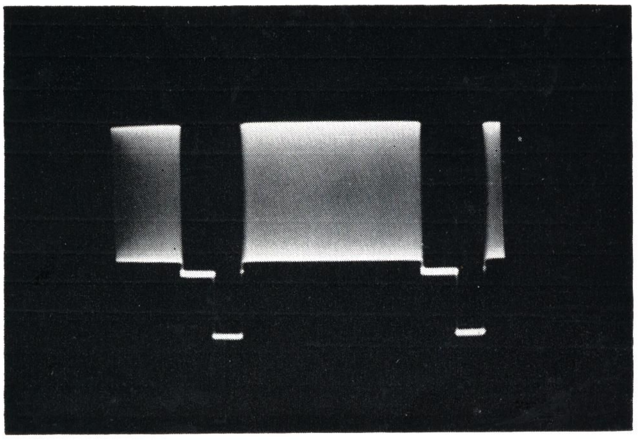


FIG. 11 — MONOBURST SIGNAL — HORIZONTAL

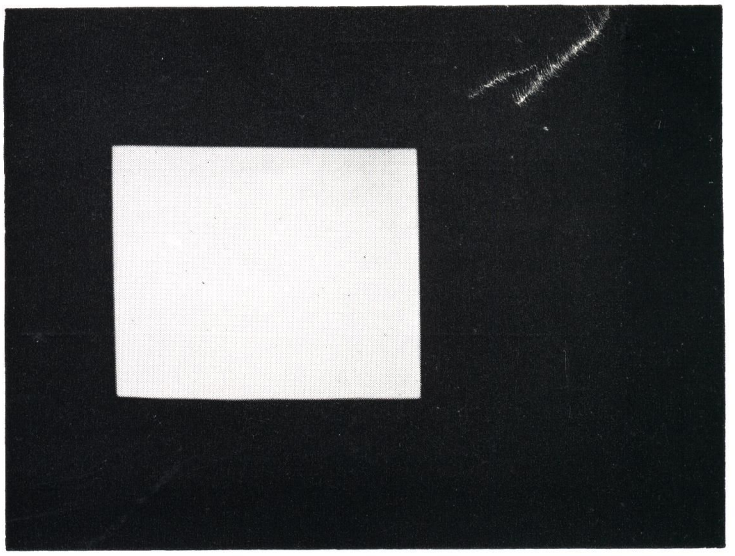


FIG. 12—BROADCASTER'S WINDOW SIGNAL—PICTURE

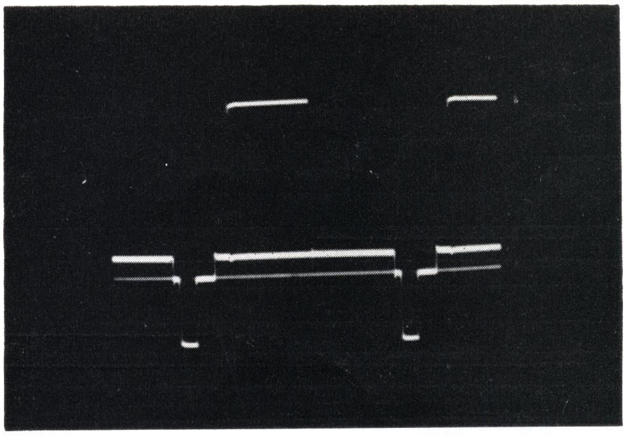


FIG. 13 — BROADCASTER'S WINDOW SIGNAL — HORIZONTAL

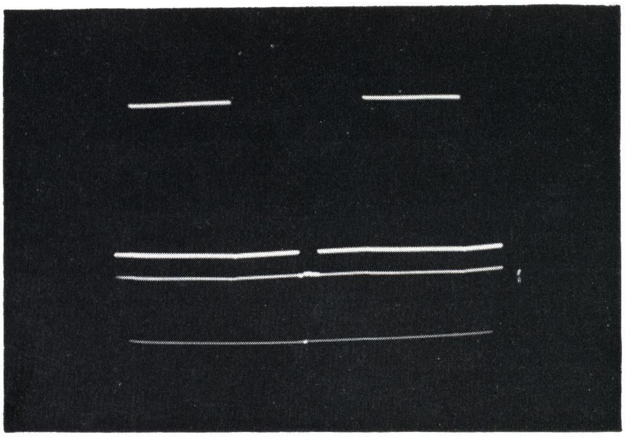


FIG. 14 — BROADCASTER'S WINDOW SIGNAL — VERTICAL

usually set at reference white. In order to locate the maximum energy content of the signal in the lower portion of the total frequency band, the white area is adjusted to cover ¼ to ½ total picture width and ¼ to ½ total picture height.

The window signal is useful for a number of checks and tests when observed on picture monitors or A-scopes, including:

1. Convenient check for level or continuity — Using a window of known white level, the peak-to-peak voltage of the signal may be read easily on a calibrated oscilloscope, using the IRE roll-off characteristic.
2. Measurement of sync compression or expansion — Comparison with the office transmitting the window signal of horizontal sync and white levels on calibrated scopes using IRE roll-off, permits accurate evaluation of these linearity characteristics at the receiving point, so that any necessary corrective action can be taken.
3. Minimizing streaking and smearing — Observation of this test signal on scopes using the IRE roll-off characteristic at both vertical and horizontal rates, enables evaluation of streaking and smearing and adjustments to be made on clamper-amplifiers and low frequency equalizers to minimize these impairments. When using a picture monitor for observation of streaking or smearing, it is essential to insure that it is free from internal defects which might give false results.
4. Observation of ringing — The presence of ringing may be detected using wide-band scopes, properly calibrated, and expanding the horizontal presentation to a convenient scale. Ringing amplitude may be measured directly. Its frequency may be calculated by counting the number of ringing cycles occurring during a know time interval. Ringing also may be seen on picture monitors when receiving this signal.

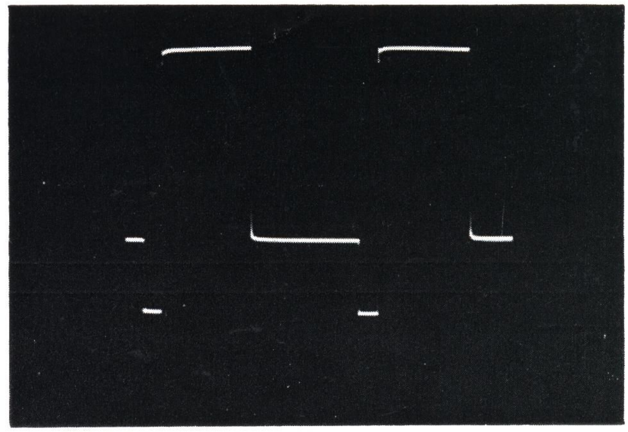


FIG. 16 — 61C WINDOW SIGNAL — UNMODULATED — HORIZONTAL

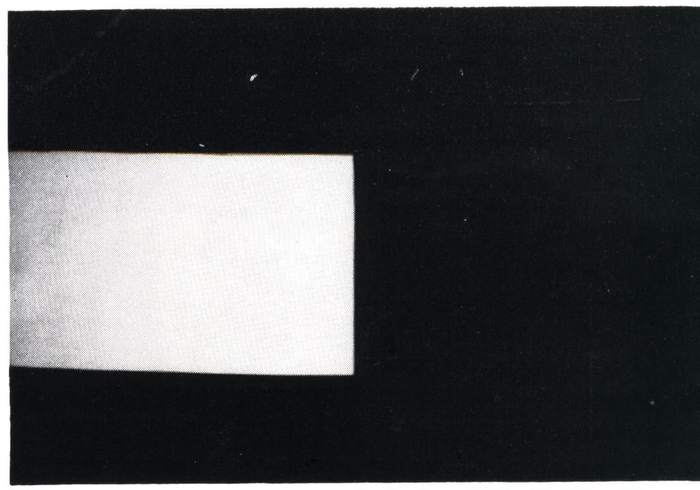


FIG. 17—61C WINDOW SIGNAL—MODULATED—PICTURE

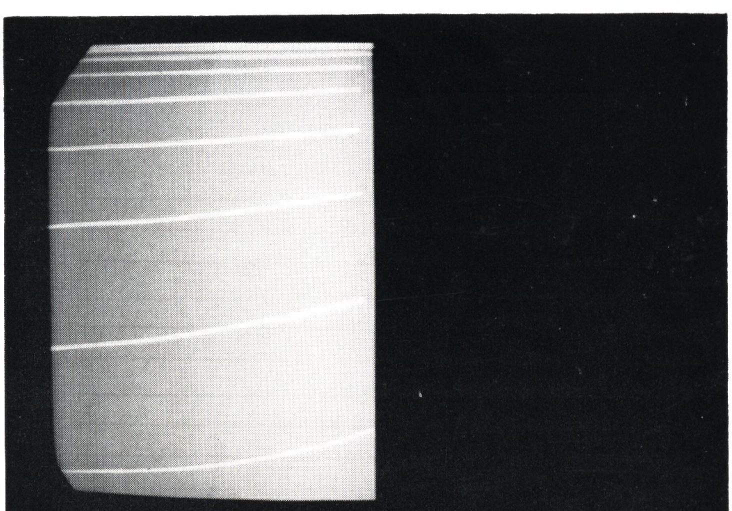


FIG. 15 — 61C WINDOW SIGNAL — UNMODULATED — PICTURE

The window signal generally used by the broadcasters contains both horizontal and vertical sync information, as in Figs. 12, 13 and 14. In this type of signal, the white window is adjustable in size both horizontally and vertically, and also is adjustable in position anywhere on the black background.

The window signal provided by most telephone company generators, such as the 61C signal generator, provides a white area adjustable in width from the left edge of the raster, with a black area in the remaining portion as shown in Figs. 15 and 16. Sync pulses are provided at the horizontal rate, (15,750 per second). The window signal provided by the earlier model signal generator (61B) is similar but not as suitable for streaking tests because the black and white areas are reversed, the white area being adjustable in width from the right edge of the raster. There is no adjustment of height for either the 61B or 61C white window, but by modulating these signals at a 60 cycle rate, by means available within the set, a window of approximately ½ the picture height can be obtained, as shown in Fig. 17. Horizontal and vertical presentations on an A-scope are shown by Figs. 18 and 19. Since none of these signals have vertical sync information, the vertical retrace of the monitor is not blanked, and the retrace lines are visible. This does not interfere with observation.

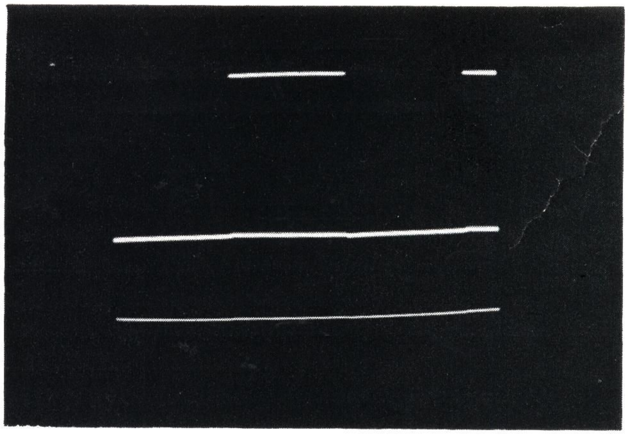


FIG. 19—61C WINDOW SIGNAL—MODULATED—VERTICAL

4. 47A Transmission Measuring System

The 47A transmission measuring system is used for measurements of differential phase and differential gain of facilities used for color television transmission (change in phase or gain at 3.6 mc as level is varied from black to white). The test signal consists of a 15.75 kc sine wave with positive peaks at reference white level and negative peaks at blanking level, plus horizontal sync pulses inserted at negative peaks. On this sine wave, which corresponds to the luminance signal, there is superimposed a lower level 3.6 mc (3579.545 kc) sine wave signal corresponding to the chrominance signal. The 3.6 mc signal is thus periodically raised and lowered through the region between blanking and white levels. At the receiving locations, instantaneous differential phase or differential gain at 3.6 mc is displayed and measured on a low-frequency high-gain oscilloscope.

The 47A system consists of a transmitting unit (47B), and a receiving unit (47C). Test signals and presentations on receiving sets, are illustrated by Figs. 20 through 25.

For comparison, Fig 26 illustrates a staircase signal transmitted over the layout having a 2 db differential gain.

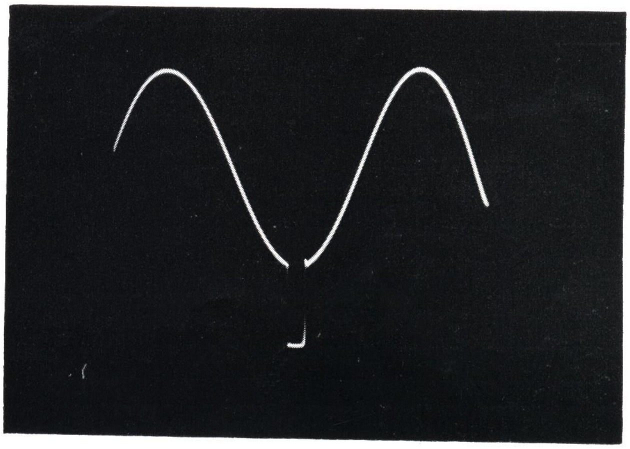


FIG. 20 — 47A TMS — TEST SIGNAL — UNMODULATED — HORIZONTAL

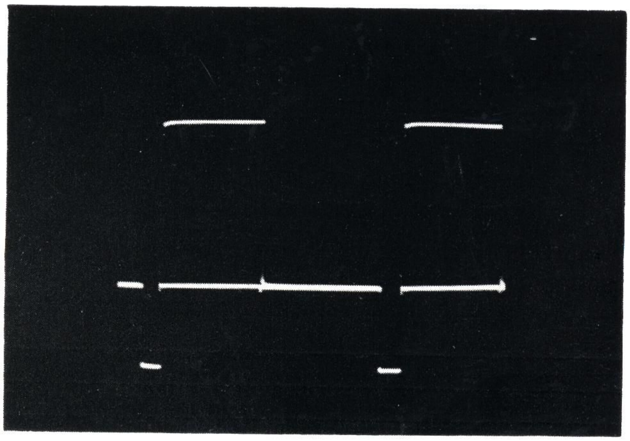


FIG. 18 — 61C WINDOW SIGNAL — MODULATED — HORIZONTAL

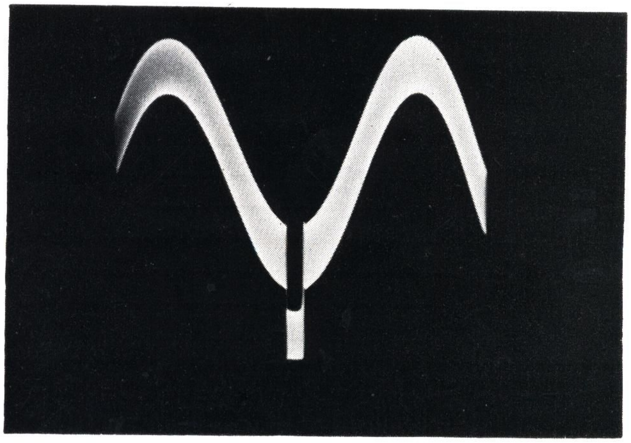


FIG. 21 — 47A TMS — TEST SIGNAL — MODULATED — HORIZONTAL

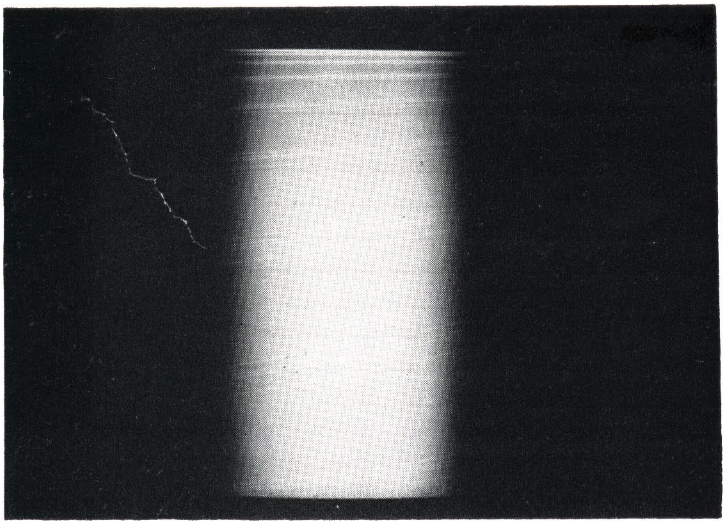


FIG. 22 — 47A TMS — TEST SIGNAL — PICTURE

Receiving set (47C) presentations are illustrated for the following conditions.

FIG. 23 — 47A TMS — RECEIVING UNIT PRESENTATION — MINUS 27° DIFFERENTIAL PHASE

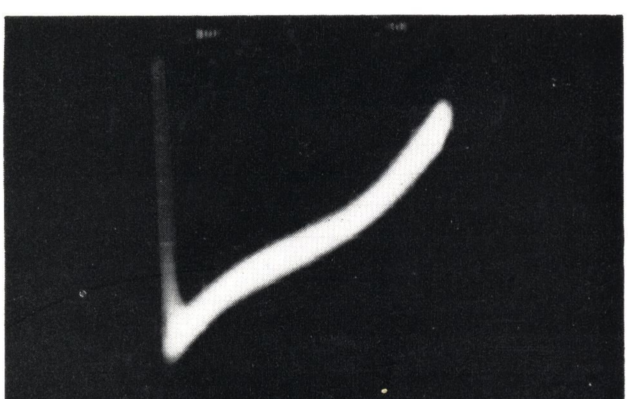


FIG. 24 — 47A TMS — RECEIVING UNIT PRESENTATION — PLUS 27° DIFFERENTIAL PHASE

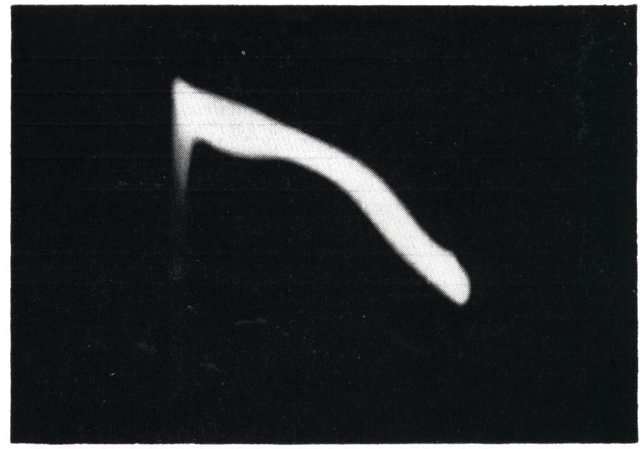


FIG. 25 — 47A TMS — RECEIVING UNIT PRESENTATION — 2 DB DIFFERENTIAL GAIN

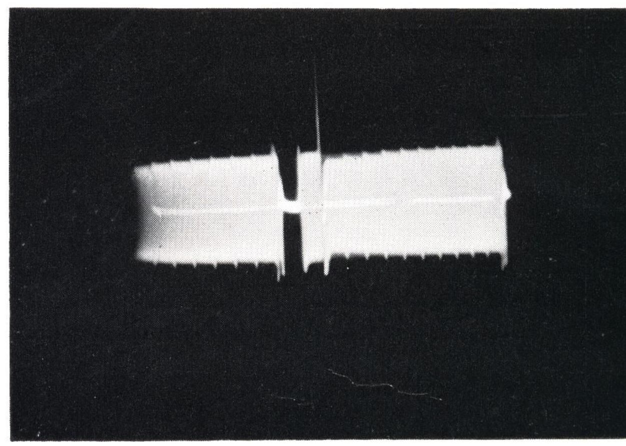


FIG. 26 — STAIRCASE SIGNAL — HORIZONTAL — 2 DB DIFFERENTIAL GAIN

5. Multiburst

A multiburst signal is used for rapid measurements of gain at a few predetermined frequencies.

One form of multiburst signal, illustrated in Fig. 27, consists of a burst of peak white (white flag) followed by bursts of six sine wave frequencies from 0.5 mc to 4.2 mc, plus a horizontal sync pulse, all transmitted during one line interval. The white flag provides white level reference signal. Fig. 28 indicates the burst frequencies normally used, but these may be varied. Vertical sync information is also provided in some types of multiburst generators.

Some of the earlier models of multiburst generators do not include the white flag; that is, six sine wave bursts occupy the entire interval between sync pulses.

At the receiving point the signal is observed on an oscilloscope. For gain measurements, the peak-to-peak amplitudes of the individual bursts are measured and compared. The accuracy of measurement is subject to the limitations of the oscilloscope. The principal uses are to observe:

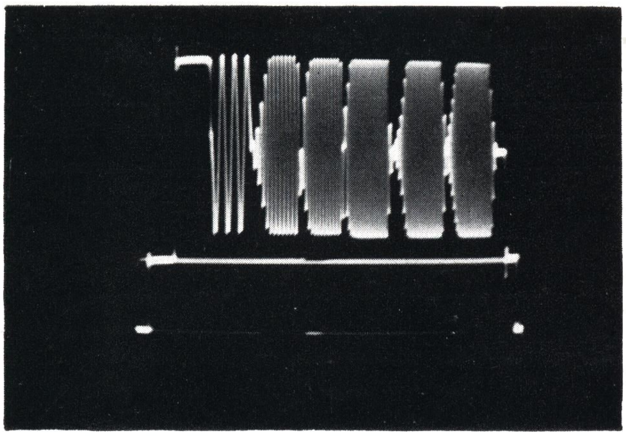


FIG. 27 — MULTIBURST SIGNAL — HORIZONTAL

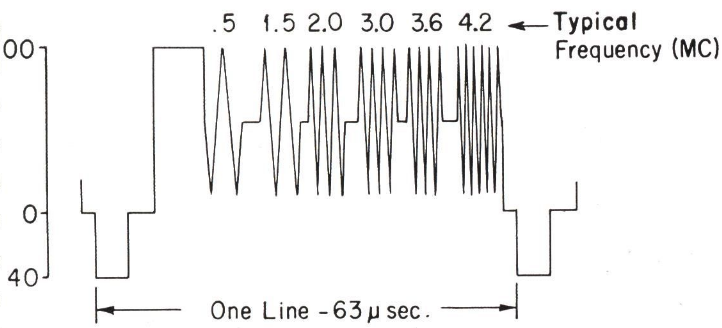


FIG. 28 — MULTIBURST SIGNAL — FREQUENCIES NORMALLY USED — HORIZONTAL

1. Quick check of amplitude frequency response.
2. Changes in setup.
3. Black or white compression.
4. Compression which may be selective with frequency.

Figs. 29 and 30 illustrate respectively gradual dropping and rising gain-frequency characteristics. These figures should be compared with the normal signal illustrated by Fig. 27. For information, the picture monitor presentation is shown by Fig. 31, and the A-scope vertical presentation is shown by Fig. 32.

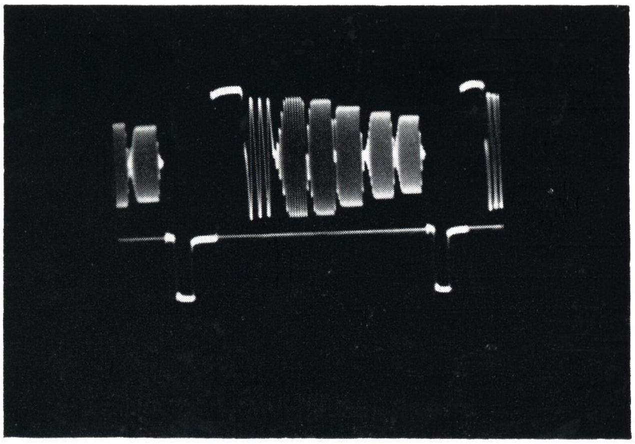


FIG. 29 — MULTIBURST SIGNAL — GRADUAL LOSS — HORIZONTAL

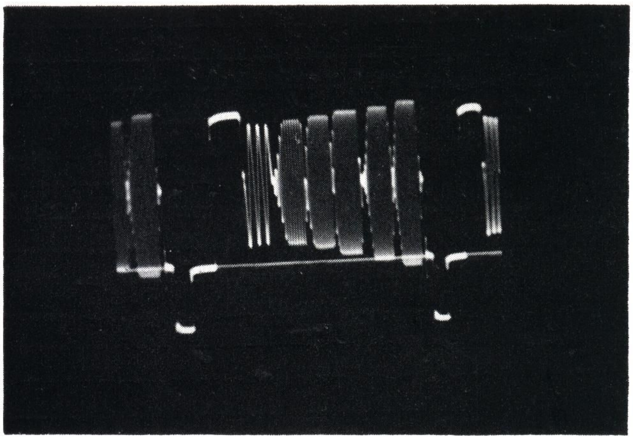


FIG. 30 — MULTIBURST SIGNAL — GRADUAL GAIN — HORIZONTAL

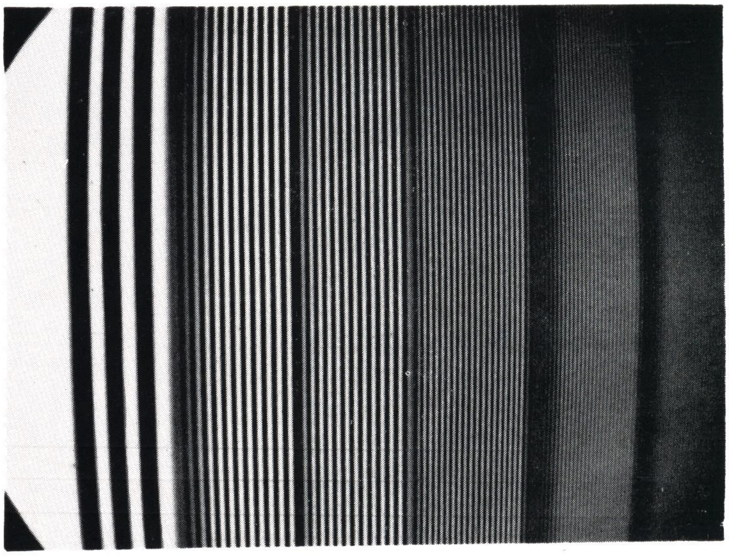


FIG. 31 — MULTIBURST SIGNAL — PICTURE

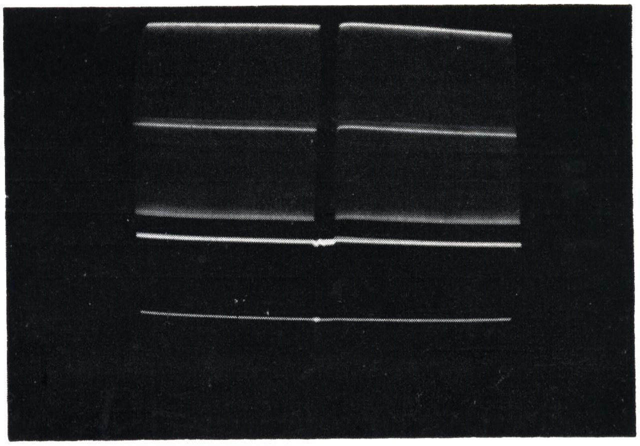


FIG. 32 — MULTIBURST SIGNAL — VERTICAL

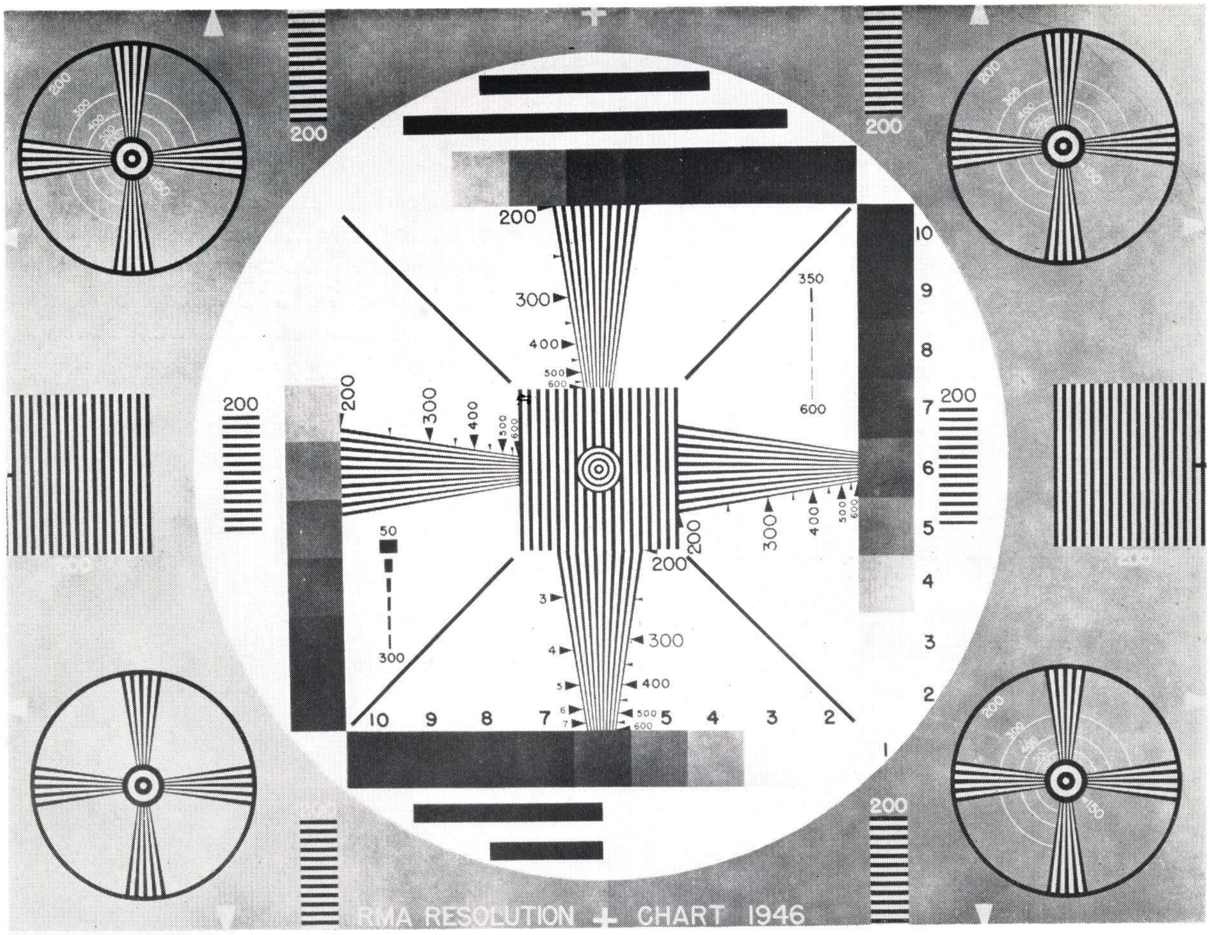


FIG. 33 — RETMA TEST PATTERN — PICTURE

6. Test Pattern — RETMA

Standard test patterns are valuable in determining the performance of video systems because the distant viewer knows what the original picture looks like, and can therefore readily detect distortions. The test pattern illustrated in Figure 33, is a reproduction of a test chart developed by the RETMA Data Bureau. It is used mainly as source material for local test of broadcasters' equipment, such as cameras, etc.

The following is a description of the use of the pattern in checking the quality of the picture and interpreting the results. In all cases it is assumed that the picture monitor has been properly adjusted.

Horizontal Linearity — This may be determined by checking the large circle, the four corner circles, and the three squares of "200 line" vertical bars, one on each side of the picture and one in the center. The circles should show no distortion and the horizontal length of all squares should be equal.

Vertical Linearity — The circles plus the six sets of short "200 line" horizontal bars may be used to check linearity of the vertical sweep. The circles should show no distortion and the overall height of the sets of bars should be equal.

Contrast — The four bars at the ends of the central wedges are the gray scales. Each is composed of 10 squares varying from maximum white brightness to approximately 1/30th of this value. If the received signal has the proper distribution of grays, it will be possible to distinguish all squares in the scales. Loss of distinction between the individual squares is an indication that the gain of the overall system is not constant over the full range of the input voltages.

Aspect ratio — The four gray scale bars should form a perfect square.

Interlace — The quality of interlace may be checked by noting the condition of the four diagonal lines in the center. A serrated or jagged line indicates pairing of the interlace lines.

Streaking — Streaking following any one of the two horizontal black bars, at top and bottom of the large circle, indicates low frequency phase and/or amplitude distortion. The bars represent half cycles of square wave signals ranging from about 30 kc for the longest to 100 kc for the shortest. They help to locate the frequency range within which the phase distortion takes place. For instance, if it is near 100 kc, the short bar will have more intense streaks than the others.

Ringing — The vertical wedges and the short vertical lines or ringing bars, marked 50 to 300 in the lower left quadrant of the circle, along with those marked 350 to 600 in the upper right quadrant, are used to check ringing. The frequency of the ring will be indicated on the vertical wedges by the vertical position at which the strongest ring is indicated to the right or left of the wedge. Similarly, the short vertical line that gives the strongest ring will also indicate the ringing frequency.

Resolution — Resolution is measured in terms of "lines."

Vertical resolution, the resolution from top to bottom of the picture, is expressed in the number of horizontal lines that can be resolved. Therefore, the horizontal wedges in the test pattern are used to measure vertical resolution. Vertical resolution depends primarily on the size and shape of the picture tube scanning beam spot, rather than the high-frequency response or bandwidth of the receiver or transmission path. Therefore, vertical resolution measurements are omitted from network operating tests.

Horizontal resolution is based upon the number of distinct black and white dots (vertical lines) that can be reproduced by the picture monitor in three-quarters of the usable (visible) length of a horizontal scanning line. This length of three-quarter width is selected because it equals the height of the picture and, therefore, gives a basis for direct comparison between horizontal and vertical resolutions. The vertical wedges are used to determine horizontal resolution.

Vertical or horizontal resolution can be measured in terms of lines by determining the point on the horizontal or vertical wedges respectively up to which it is possible to distinguish distinct lines.

The wedges in the center and the four corners are calibrated in lines. They all vary from 200 at the large end to 600 at the small end. The vertical and horizontal linearity bars are all spaced for 200 line resolution. The concentric circles in the centers of the corner circles are at 150 line spacing. Those at the center of the large circle are at 300 line spacing.

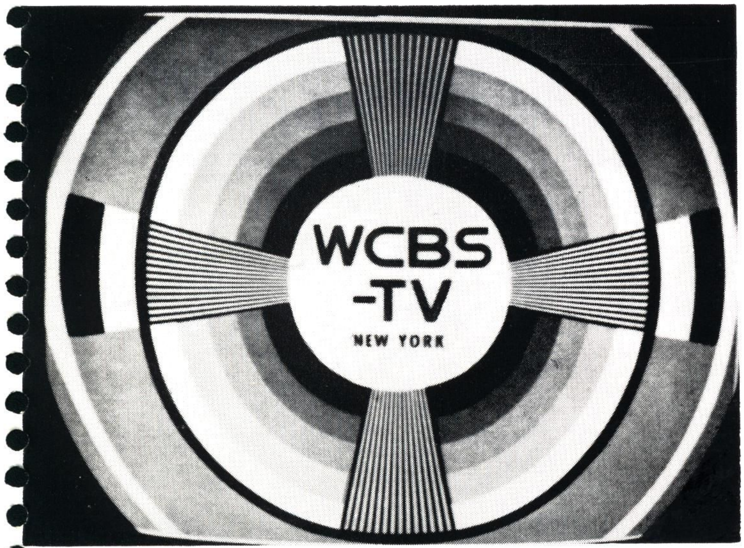


FIG. 34—UNIMPAIRED PICTURE—TYPICAL TEST PATTERN

7. Test Pattern—Typical Broadcasters

Various types of test patterns are employed by the different broadcasters for alignment of their circuits and monitors, and for use by service men in the adjustment of home receivers. The test pattern illustrated in Fig. 34 is a typical pattern and employs many of the features included in the standard RETMA pattern.

The following is a description of the use of this test pattern:

Linearity — The circles, and the horizontal and vertical wedges, can be used to check both the horizontal and vertical linearity. The circles should be round and the wedges of equal length.

Contrast — The five circles extending from black to white offer a check of the grays in the received signal. If the signal has the proper distribution of grays, all circles will be seen in varying shades of gray from black to white.

Streaking and Smearing — Streaking following any of the letters in the center of the test pattern indicates low frequency distortion. Echo, smear, following whites, etc., can also be noted at these points. Streaking can also be seen at the right outside edge of the horizontal wedge.

Resolution — Resolution can be determined by noting the point to which the lines can be distinguished on the vertical and horizontal wedges. The resolution of the vertical wedges on the test pattern illustrated extend from 150 to 320 lines, and on the horizontal wedges from 150 to 350 lines. This value will differ among the various broadcasters' patterns, depending upon the width of the wedge lines.

Ringing — Ringing can be noted on the sides of the vertical wedges. Ringing frequency will be indicated by the vertical position at which the strongest ring is observed.

8. Color Bars

The broadcasters use various color bar signals for the adjustment of their equipment including color monitors. They may also transmit this signal over transmission facilities for test purposes.

As shown in Fig. 35, on a monochrome picture monitor, the color bar signals will appear as corresponding bars in various densities of gray, the densities depending upon the individual values of luminance. The wideband A-scope horizontal presentation can indicate whether or not the white reference of the luminance signal and the color information have the proper amplitude relations. Fig. 36 illustrates a typical presentation, the colors for this particular pattern being identified in Fig. 37. For this color bar signal, if the color burst signal is of correct amplitude, and if the positive excursion of the cyan bar is at 99% of white level, with the negative excursion of the green bar at black level, it can be assumed that the overall signal is in good condition from an amplitude standpoint. Figs. 38 and 39 show vertical and expanded horizontal presentations of this signal.

The broadcaster may observe the color bar signal on a vector display oscilloscope (variously known as a vectorimeter, vectorscope, chromascope, etc.) to measure absolute amplitudes and phase angles for equipment adjustments. Differential phase and gain measurements of limited accuracy may also be made by this means.

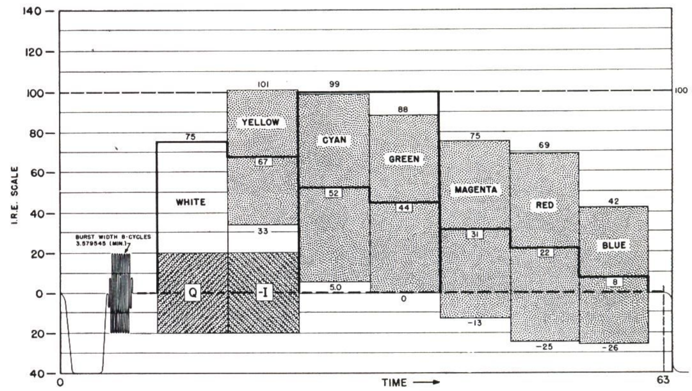


FIG. 37 — COLOR BAR SIGNAL — TYPICAL COLOR INFORMATION

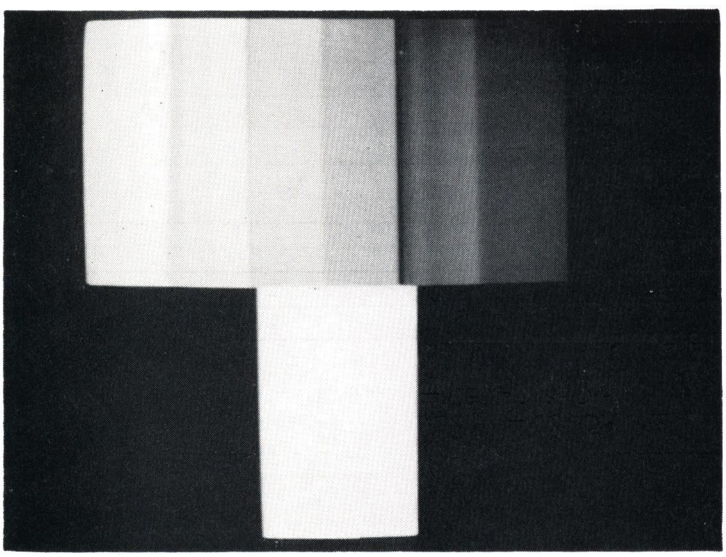


FIG. 35—COLOR BAR SIGNAL—MONOCHROME PICTURE

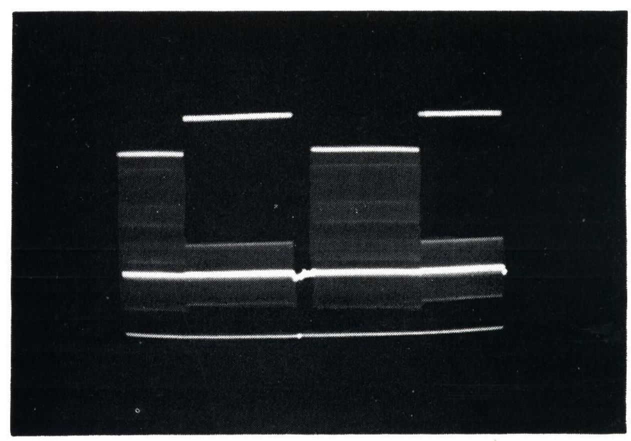


FIG. 38 — COLOR BAR SIGNAL — VERTICAL

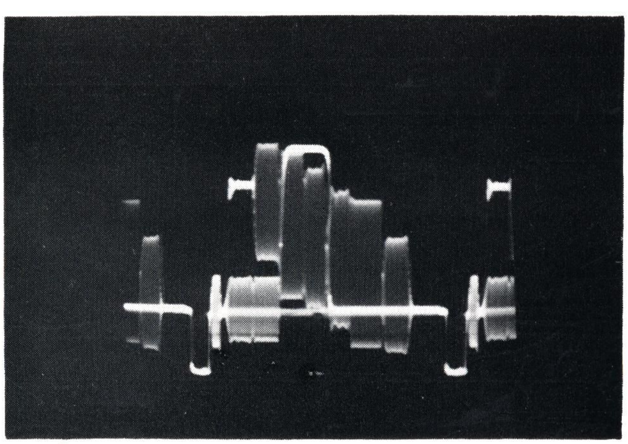


FIG. 36—COLOR BAR SIGNAL—HORIZONTAL—WIDEBAND

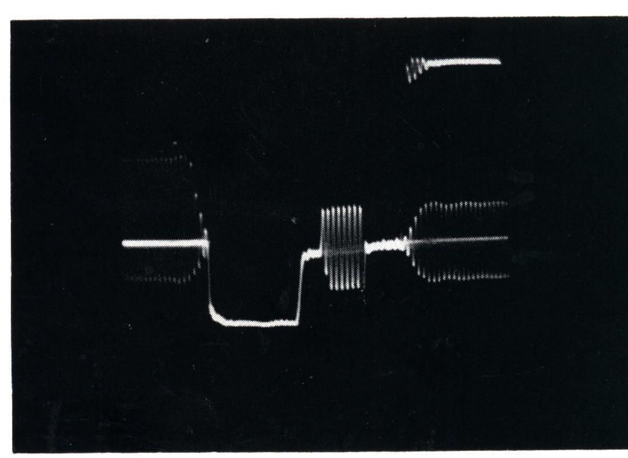


FIG. 39—COLOR BAR SIGNAL—EXPANDED HORIZONTAL

9. Staircase

The techniques most commonly used by the broadcasters at present for the measurement of differential phase and differential gain involve the transmission of a staircase signal, as in Figure 40. A sine wave, usually at 3.6 mc, is superimposed on 10 steps extending progressively from black to white level. At the receiving point, the high-frequency sine wave is separated from the low frequencies of the steps by a high-pass filter and displayed on the oscilloscope as in Fig. 41. Any difference between the amplitudes of the blocks represents differential gain. By means of a color signal analyzer, used in conjunction with the receiving oscilloscope, differential phase may be measured.

The staircase signal, without sine wave added, is also used in some cases as a linearity check, as shown in Fig. 42. In this case, the relative height between steps is used as an indication of compression or non-linearity. Fig. 43 illustrates for information the picture monitor presentation of a staircase signal.

In some forms of the staircase signal, a single scanning line of stairsteps may be followed by several lines of adjustable amplitude. The amplitude is adjusted to permit changes in the overall duty cycle, principally for tests on television broadcast transmitters. Fig. 44 illustrates a signal with a duty cycle having 90% window and 10% staircase.

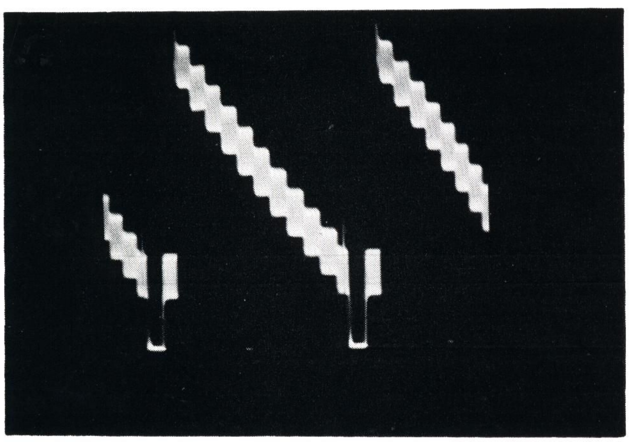


FIG. 40 — STAIRCASE SIGNAL — MODULATED — HORIZONTAL

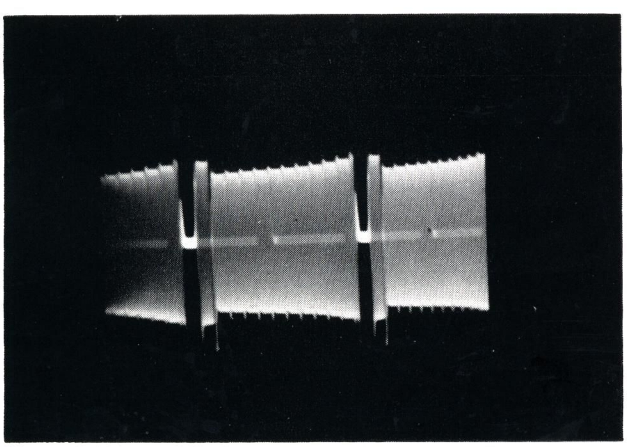


FIG. 41 — STAIRCASE SIGNAL — MODULATED — HORIZONTAL — THROUGH HIGH PASS FILTER

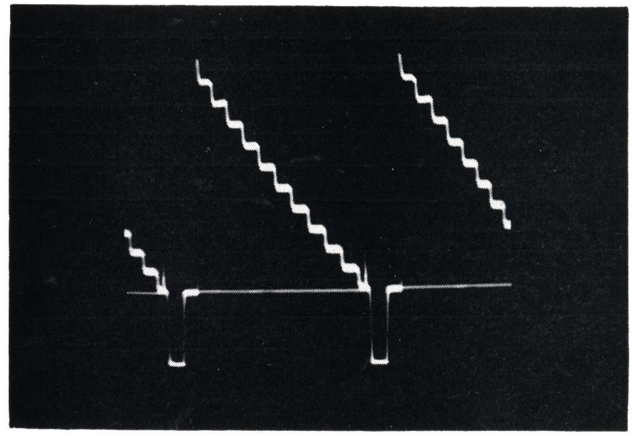


FIG. 42 — STAIRCASE SIGNAL — UNMODULATED — HORIZONTAL

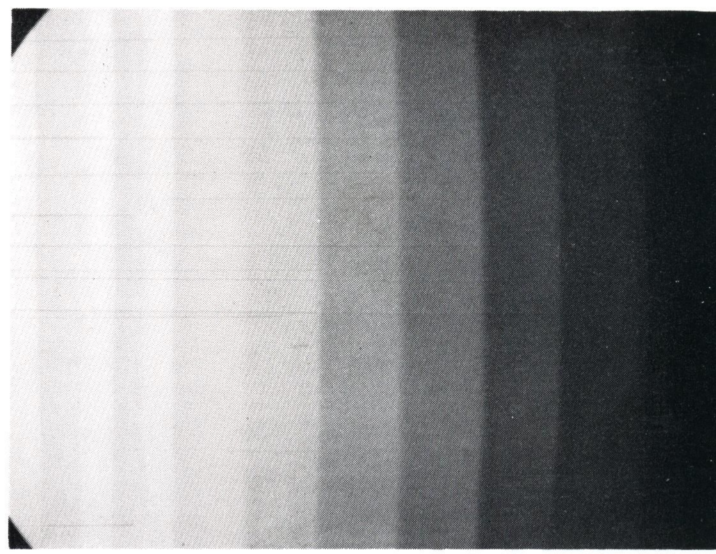


FIG. 43 — STAIRCASE SIGNAL — PICTURE

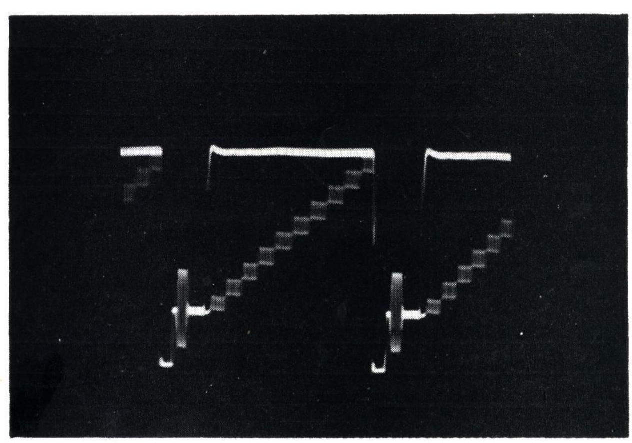


FIG. 44 — STAIRCASE SIGNAL — VARIABLE OVERALL DUTY CYCLE — HORIZONTAL

Signal Impairment Analysis

Television network facilities are designed to transmit picture signals so that they will be received at the distant connection in a condition to give a satisfactory reproduction of the signal furnished by the customer. The network transmission facility is only part of the transmission path from camera to receiver. The other elements contributing to the faithfulness of the reproduced scene are:

- **(a)** Performance of camera and other studio equipment.
- **(b)** Performance of local loop facilities not included as part of the network facilities; i.e., studio to transmitter link.
- **(c)** Performance of the broadcaster's transmitting facilities.
- **(d)** Radio path between broadcast transmitter and the receiver; i.e., distance, obstructions, interference.
- **(e)** Ability of the receiver to reproduce a picture from the signals received.

Since all of the above elements must work together, discrepancies occurring in any of the individual units will affect the received picture adversely. The broadcaster and the telephone company have no control over the last two links in the chain — the path from the transmitter to receiver, and the home receiver. However, network transmission from camera to the broadcaster's transmitter generally involves close cooperation. Because of the necessity of using different pickup points and cameras, or the necessity of rearranging the network facilities to meet customers' requirements, it is essential that each transmission element be engineered and maintained with this flexibility in mind.

The composition of a television signal, as discussed previously, determines the objectives for network facilities. Compared to telephone transmission, the bandwidth is of the order of 1000 times as great, the amplitude distortion requirements are about 10 times as severe in spite of the wider band, and interference requirements are about 3 times as severe. In addition, delay distortion requirements are more severe. Since color television signals are more complex than monochrome signals, they are correspondingly more difficult to transmit.

Distortion of video signals during transmission may be the result of trouble conditions, or inherent limitations of the facilities in the transmission path. This distortion in general will be apparent in the oscilloscope presentation of the signal and will show in the picture monitor as an impairment. The A-scope signal distortions and picture monitor impairments fall into several categories. The following pages illustrate a number of typical distortions as observed on picture monitors and A-scopes, together with an explanation of the causes. In many instances it has been found necessary for photographic reproduction reasons to introduce impairments beyond the degree to which it would be expected to find them under actual conditions. This is particularly true of the picture monitor photographs where a given impairment generally has greater effect upon the eye under actual conditions than is evident in the photographs.

1. Level Irregularities

(A) General — An essential factor in good television operation is the maintenance of correct video levels both at broadcasters' and telephone company locations. The observed effect of incorrect levels as seen on picture monitors and A-scopes is dependent upon the magnitude of error, whether the level is constant or varying, and whether all or only part of the frequency range is affected. This section is concerned with level errors that affect the entire frequency range in a relatively uniform manner. Such level irregularities can be caused by improper amplifier gains or pad losses along the transmission path, defective electron tubes or other components, or by change in camera level from broadcasters' studios or pickup points.

(B) Long Duration Level Changes

(B-1) HIGH LEVELS—Small increases in level cause an increase in the overall picture brightness and a general loss of contrast. Larger changes may result in

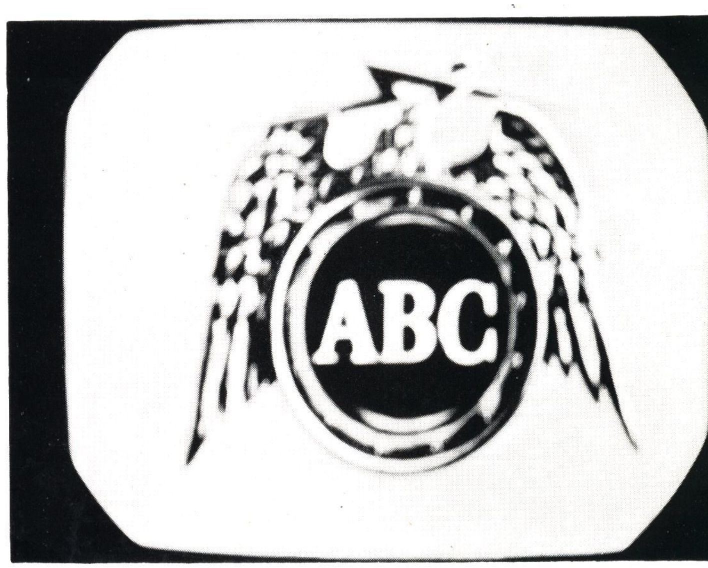


FIG. 45 — BLOOMING

more serious defects. Blooming, bleeding whites, clipping and sync compression are long duration impairments generally caused by an increase in level sufficient to cause some degree of overloading.

BLOOMING (Fig. 45)—is an increase in the size of the scanning spot with resultant loss of detail in white areas due to overloading the picture tube. The A-scope presentation will appear normal when the difficulty is due to high gain setting of the monitor itself.

BLEEDING WHITES (Fig. 46-48)—As the level is increased on the network to an extent where overloading occurs, the A-scope, in addition to indication of too high level, will also show evidence of clipping, or compression, as indicated by the square tops of the wave forms of Figs. 47 and 48. The picture (Fig. 46), as observed will have lost contrast, and may appear to have white areas "bleeding" into black, although the defocussing found under blooming conditions may not exist. The effects shown in Figs. 46-48 were obtained by overloading an amplifier.

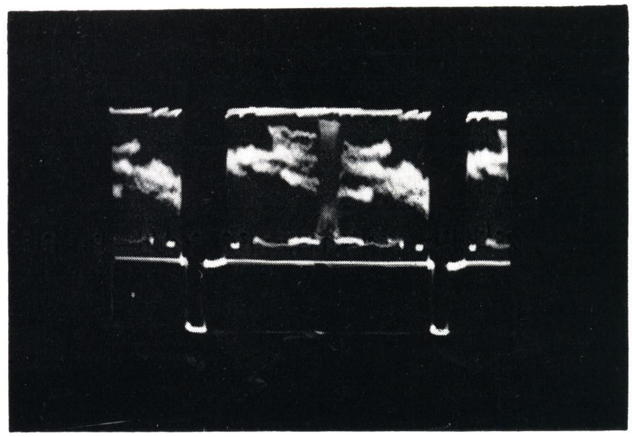


FIG. 47 — BLEEDING WHITES — HORIZONTAL

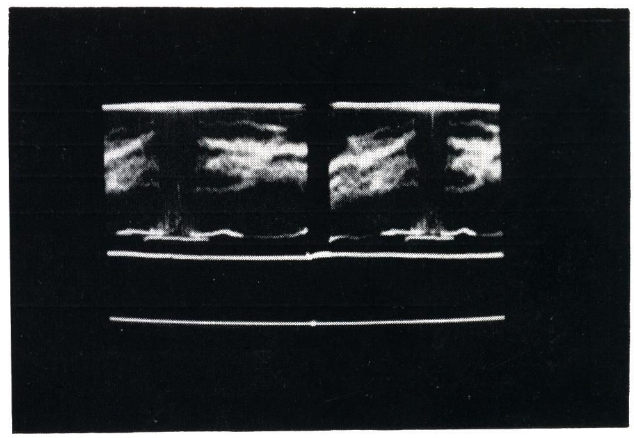


FIG. 48 — BLEEDING WHITES — VERTICAL

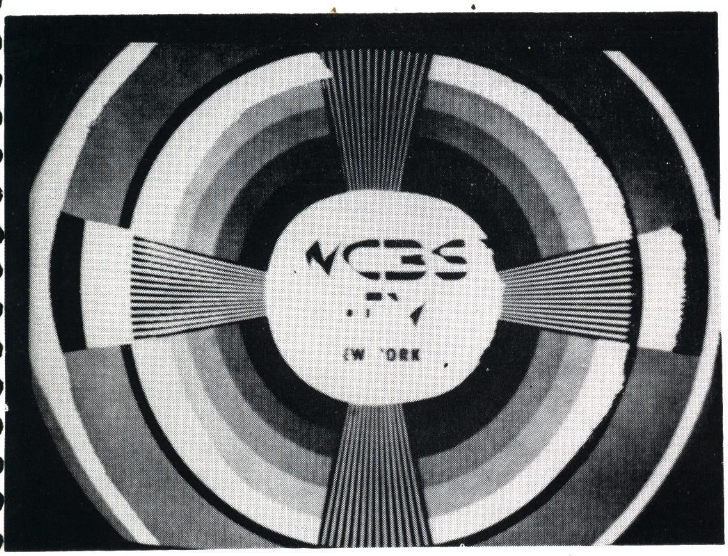


FIG. 46 — BLEEDING WHITES

BLACK OR SYNC COMPRESSION (Fig. 49)—High level conditions sufficient to cause overloading may also result in black peak or sync compression. Here the sync pulse amplitude is reduced and loss of contrast may be noticeable in the black region. If the sync signals are sufficiently compressed, difficulty will be experienced in keeping pictures in step. Fig. 49 illustrates sync compression as seen on the oscilloscope at horizontal rate. The sync level in this case reads approximately 30 on the IRE scale, or about 10 divisions lower than normal. The picture monitor, in this case, showed no evidence of trouble.

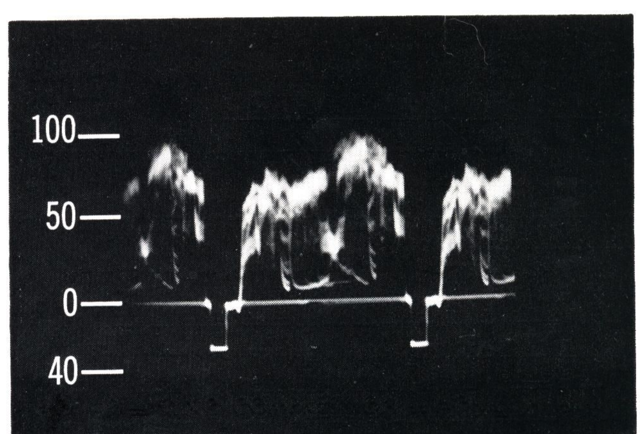


FIG. 49 — SYNC COMPRESSION — HORIZONTAL

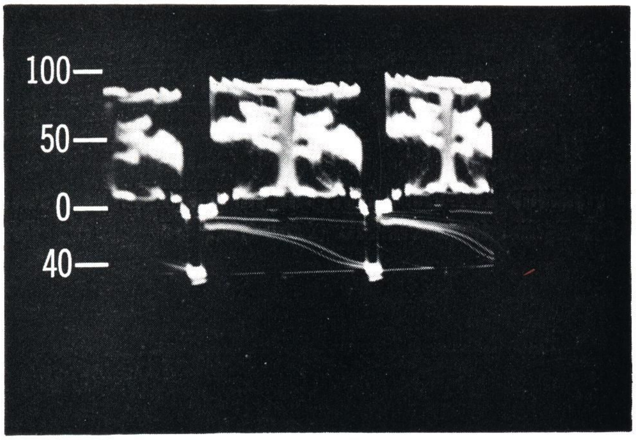


FIG. 50 — PARTIAL CLAMPING FAILURE — HORIZONTAL (A-SCOPE PRESENTATION EXPANDED TO NORMAL HEIGHT)

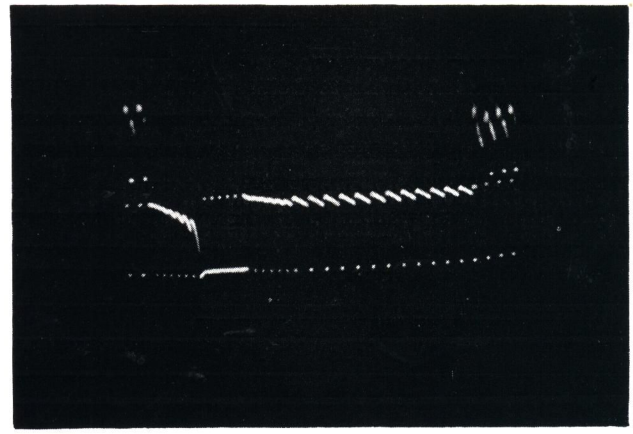


FIG. 51 — PARTIAL CLAMPING FAILURE — EXPANDED VERTICAL

(B-2) LOW LEVELS (Figs. 50, 51) — Lower than normal levels cause a decrease in average picture brightness and make the signal more susceptible to interference. When the television signal level is reduced by only a small amount, ill effects are not likely to be noticed. As the signal is transmitted through clamping or stabilizing circuits at still lower levels, clamping action will be partially or completely lost. Streaking, smearing and loss of synchronism may occur. Figs. 50 and 51 illustrate a signal transmitted through a clamper-amplifier at about one-half normal level. Partial failure of clamping is seen on the A-scope at horizontal and vertical rates. The picture was not affected appreciably. The impairments observed when clamper failure occurs will depend upon the amount of low frequency distortion present in the signal. The results of complete clamping failure are discussed at a later point.

(C) Short Duration Level Changes—Intermittent level changes, either at regular or irregular intervals, may have several causes. Fluctuating a-c line voltage, hunting regulators in power supplies or on transmission facilities are some of the possible sources for this type of trouble. These usually give short changes in picture brightness, evident on A-scopes as momentary voltage changes. If of sufficient magnitude, frame rolls, momentary tearing, etc., may be observed.

BOUNCE AND BREATHING—In operating parlance **bounce** is the condition where there are sudden irregular changes in level, while **breathing** is the condition where the changes occur more slowly and at a regular rate.

2. Transmission-Frequency Irregularities

(A) General—Uniform amplitude response and linear phase shift throughout the pass band of a television network transmission system are characteristics to be desired. In addition, the shape of these two characteristics beyond the pass band, usually at the high frequency end, should be such that the gain characteristic gradually rolls off without affecting the phase characteristic. A large family of impairments to picture transmission is caused by inability to attain these conditions, or by adjustments or troubles affecting them. Some of these impairments differ from each other so greatly in manifestation that they do not appear related. In this section the impairments resulting from distortions in various parts of the video band are grouped together; that is, those affecting field rate and harmonic frequencies, those affecting line rate and its first 10 or so harmonics, and those affecting frequencies above about 200 kc.

The set of figures from 52 to 59 show some of the relationships between low and high frequency distortion. A telephone company window signal was used for these tests. Fig. 52 shows an essentially undistorted test signal for reference. In the remaining figures both attenuation and related phase distortion are present. Minimum phase shift networks were used to vary the gain-frequency characteristic.

LOW FREQUENCY GAIN CHANGES (Figs. 53, 54)—Figs. 53 and 54 illustrate a relative 1.0 db increase or decrease, respectively, of frequencies below about 100 kc. With the low frequencies increased, there is illustrated the case of positive streaking in which the length of time for the streak to disappear is determined by the shape of the curve at the transition from white to black. The reverse case, with low frequencies decreased causing long duration overshoots at transitions, illustrates negative streaking.

HIGH FREQUENCY GAIN CHANGES (Figs. 55-57)—Figs. 55 and 56 show results when frequencies above about 100 kc are affected. The networks used give a gradual modification of characteristics with frequency, so that at 3.0 mc the gain-frequency characteristic is changed by minus and plus 1.5 db respectively. Figure 55, with the high frequencies depressed, shows some loss of sharpness or rounding-off of transitions, much less and of shorter duration than Figure 53. The fine detail in a picture would thus be impaired in this transmission. The small overshoot or spike evident in Figure 56 is the result of raising 3.0 mc by only 1.5 db.

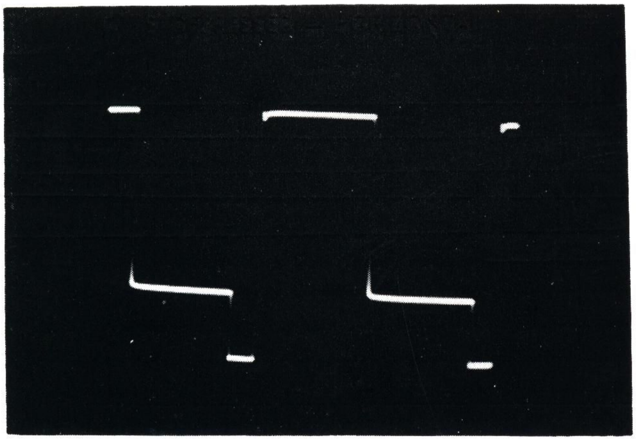


FIG. 52—WINDOW SIGNAL—UNIMPAIRED—HORIZONTAL

This spiking is similar to that in Figure 54 but of much shorter time duration. Carried far enough, and possibly at a somewhat lower frequency, this sort of thing will result in "edge effect" — a distinct outline following an object, of a tone opposite to that of the object itself.

Fig. 57 goes one step further by increasing the 3.0 mc gain to + 3.0 db and then cutting off rather abruptly. The result shows that an oscillatory transient, or ringing, has developed. With minimum phase shift, the ringing should be about equal on each side of the transitions. This was not the case here.

BOTH LOW AND HIGH FREQUENCY GAIN CHANGES (Figs. 58, 59)—Figs. 58 and 59 illustrate cases where the gain-frequency characteristic is not flat at either end of the spectrum. In each case there is a 3.0 db rise at approximately 3.0 mc. At the lower frequencies, Fig. 58 has a 1.0 db loss and Fig. 59 a 1.0 db gain. It can be seen that the individual characteristics previously illustrated are still recognizable, and that adjustments at one end of the band do not compensate, in general, for maladjustments at the other

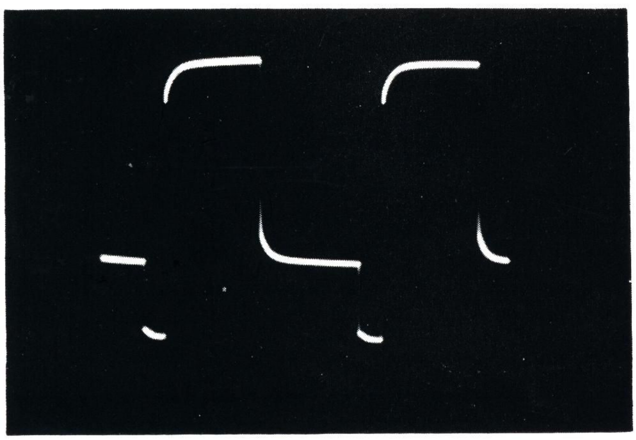


FIG. 53 — WINDOW SIGNAL —
LOWS RAISED — HORIZONTAL

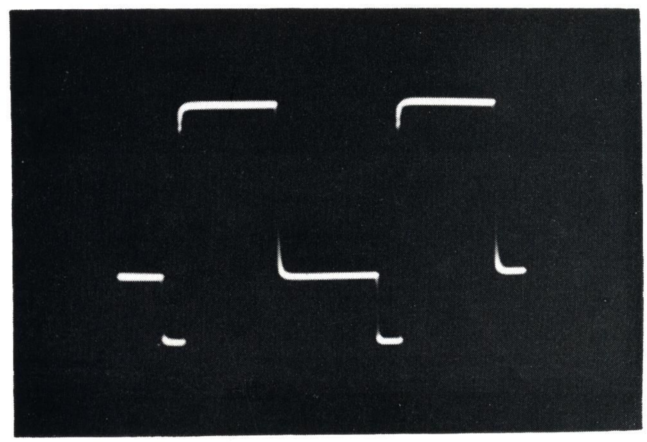


FIG. 55 — WINDOW SIGNAL —
HIGHS DEPRESSED — HORIZONTAL

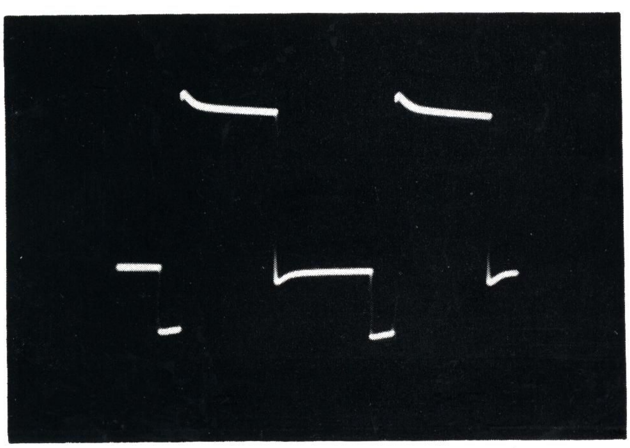


FIG. 54 — WINDOW SIGNAL —
LOWS DEPRESSED — HORIZONTAL

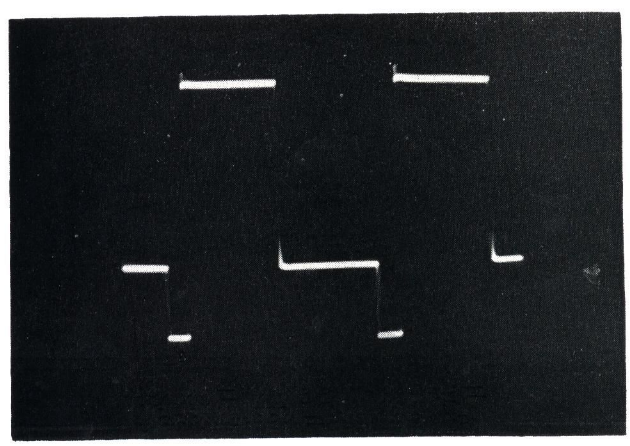


FIG. 56 — WINDOW SIGNAL —
HIGHS RAISED — HORIZONTAL

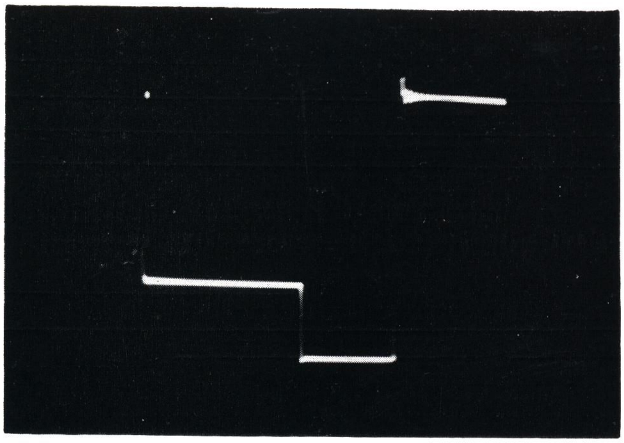


FIG. 57—WINDOW SIGNAL—RINGING—HORIZONTAL

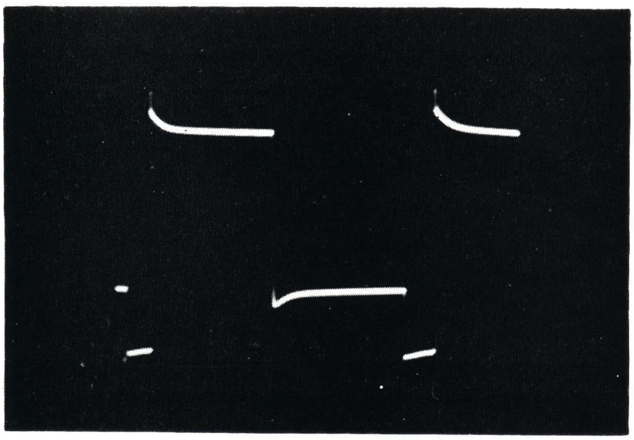


FIG. 58 — WINDOW SIGNAL —
LOWS DEPRESSED, HIGHS RAISED — HORIZONTAL

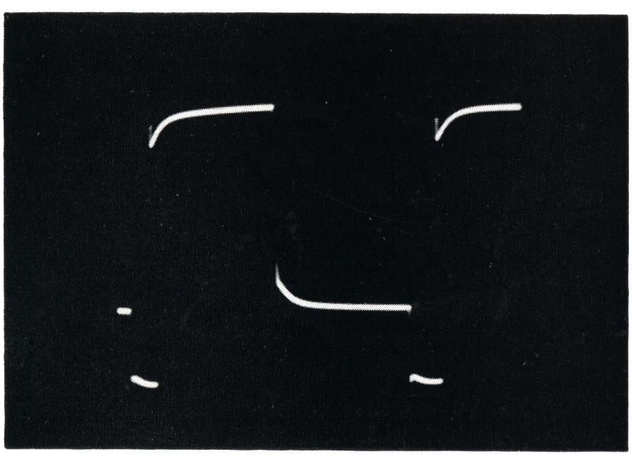


FIG. 59 — WINDOW SIGNAL —
LOWS RAISED, HIGHS RAISED — HORIZONTAL

end. The short duration spike, for example, is evident regardless of the lower frequency adjustment.

It should be noted that the sync pulse itself shows evidence of all these distortions. In the usual case, clamper action will tend to minimize these effects on tips of sync pulses. However, transitions between porches and sync, and in the vertical interval, are always available for observation and have been found to be sensitive indicators of the troubles described. Further detail on specific types of impairments is given below.

(B) Streaking and Smearing — Streaking is caused by transmission distortions in the frequency region up to about 200 kilocycles. Smearing generally is caused by distortions at somewhat higher frequencies. They affect almost equally both color and black and white signal transmission.

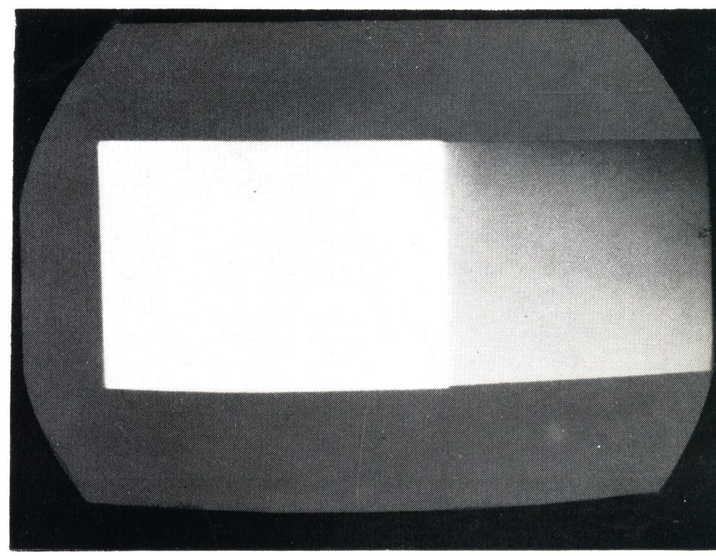


FIG. 60 — POSITIVE STREAKING — WINDOW SIGNAL

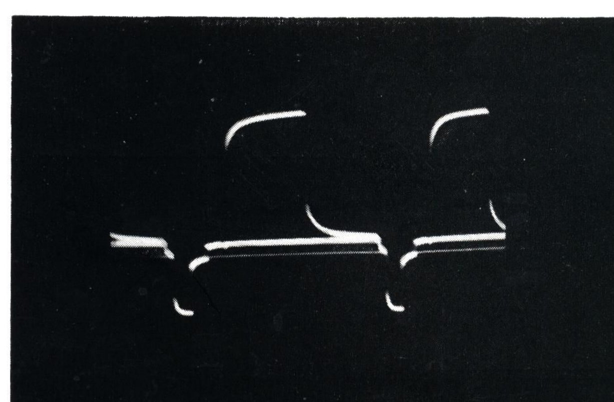


FIG. 61 — POSITIVE STREAKING —
WINDOW SIGNAL — HORIZONTAL

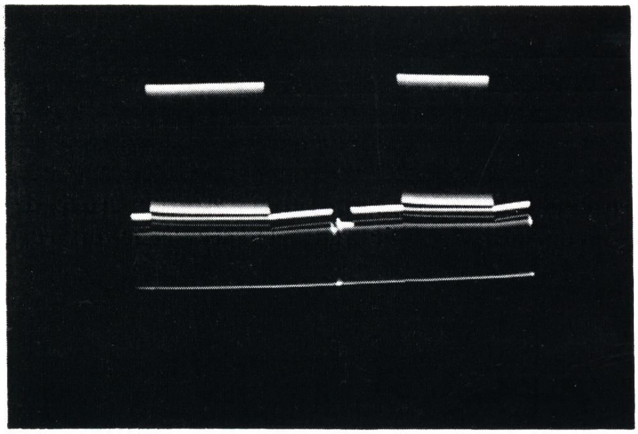


FIG. 62 — POSITIVE STREAKING — WINDOW SIGNAL — VERTICAL

Distortions that cause streaking and smearing can occur in any part of the transmission system from the camera to the television receiver. Prevention of these defects requires very close control of transmission characteristics in the lower frequency portion of the video band.

The amplitude and phase characteristic tolerances at the very low end of the frequency band, say below half line frequency, are probably not so critical but have not been evaluated accurately. When the signal is clamped, the amplitude characteristic at 60 cycles can be allowed to vary considerably. Furthermore, it can be deliberately adjusted to depart from a uniform response at 60 cycles, or other points below half line frequency, in order to provide phase correction at line frequency and its harmonics.

(B-1) STREAKING (Figs. 60-71) — Streaking is the appearance of an error luminance in the picture, extending horizontally towards the right edge of the picture from some point in the picture marked by a sharp transition in luminance. Streaking is most prominent for a change from a high luminance to a low luminance or vice versa. Since this type of impairment generally is caused by transmission irregularities in the region of the 15,750 cycle line scanning rate, or its first few harmonics, the horizontal size of the object also affects the amount of streaking. An object whose horizontal length is ½ that of a complete scanning line would generally be most vulnerable to streaking. Streaking is especially apparent when the objects move vertically in the scene and the streaking moves with them.

If the streaking is the same shade as the original figure (white following white, or black following black) it is called positive. If the streaking is the opposite shade, it is called negative. Figs. 60-71 illustrate picture monitor and A-scope presentations of positive and negative streaking.

In Fig. 61, the leading edge of the white window approaching white level is heavily rounded, while the trailing edge of the white window approaching black level rolls off gradually, indicating black following black, and white following white, or positive streaking. The vertical presentation, Fig. 62, reveals in the signal region below the white level, a heavy trace above black level, the height of this trace being a measure of the streaking or white following white. In like manner, Fig. 65 is the horizontal presentation for negative streaking, or black following white, and white following black. Here the manifestations are just the opposite from Fig. 61; that is, there is a high peak, or white level, on the transition from black to white, while the trailing edge of the white window dips below blanking and gradually restores to reference black level. The vertical presentation, Fig. 66, shows a heavy trace, or following black, in the window signal region, which is the opposite to Fig. 62. The picture monitor presentations (Figs. 60, 64, 68) show this streaking; however, in practice a comparison of A-scope presentations using suitable signals is preferred because of the possibility of streaking caused by the picture monitors.

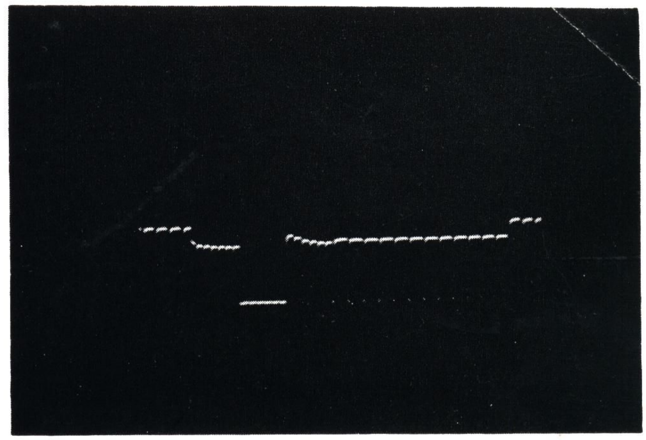


FIG. 63 — POSITIVE STREAKING — WINDOW SIGNAL — EXPANDED VERTICAL

In addition to the foregoing, comparison of the A-scope presentations for positive and negative streaking reveals opposite tilts of front and back porches and tip of sync for the horizontal presentations (Figs. 61, 65, 69); and of the trace between the first and second sets of equalizing pulses for the vertical presentations (Figs. 63, 67 and 71).

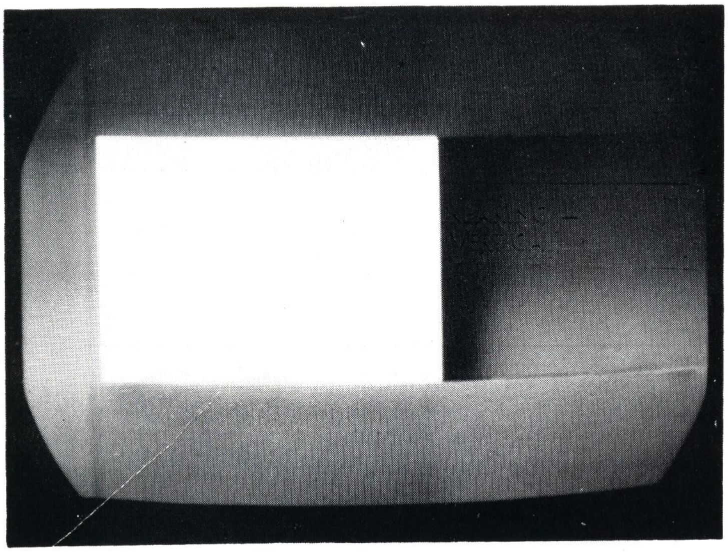


FIG. 64 — NEGATIVE STREAKING — WINDOW SIGNAL

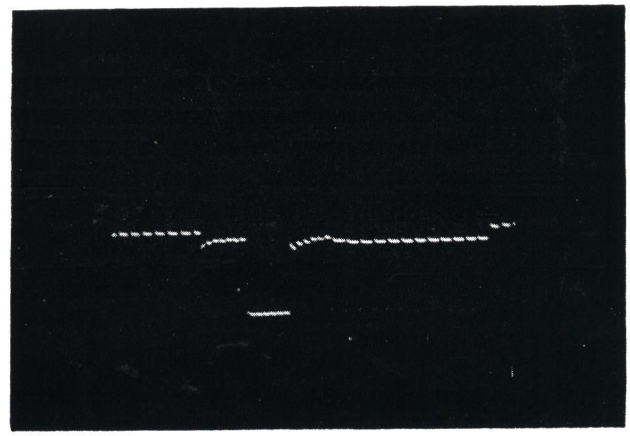


FIG. 67 — NEGATIVE STREAKING — WINDOW SIGNAL — EXPANDED VERTICAL

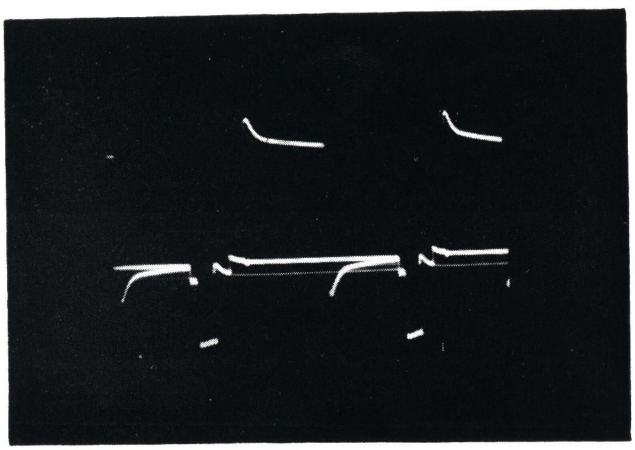


FIG. 65 — NEGATIVE STREAKING — WINDOW SIGNAL — HORIZONTAL

FIG. 68 — NEGATIVE STREAKING — TEST PATTERN

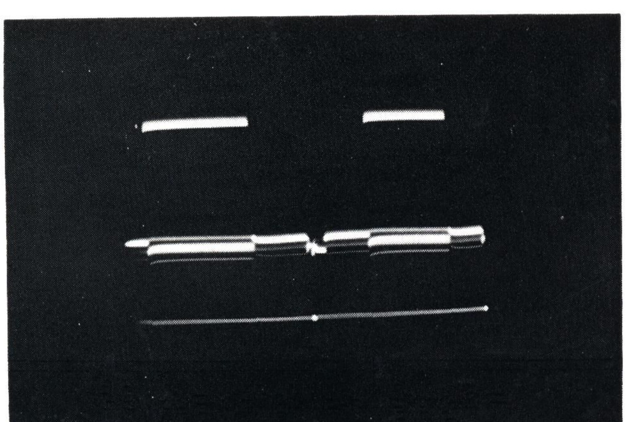


FIG. 66 — NEGATIVE STREAKING — WINDOW SIGNAL — VERTICAL

FIG. 69 — NEGATIVE STREAKING — TEST PATTERN — HORIZONTAL

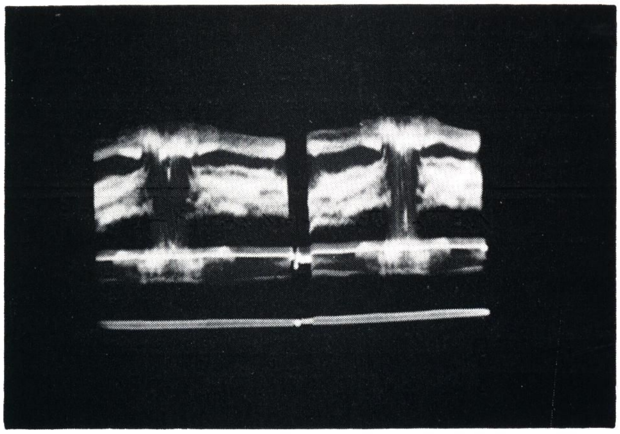


FIG. 70 — NEGATIVE STREAKING — TEST PATTERN — VERTICAL

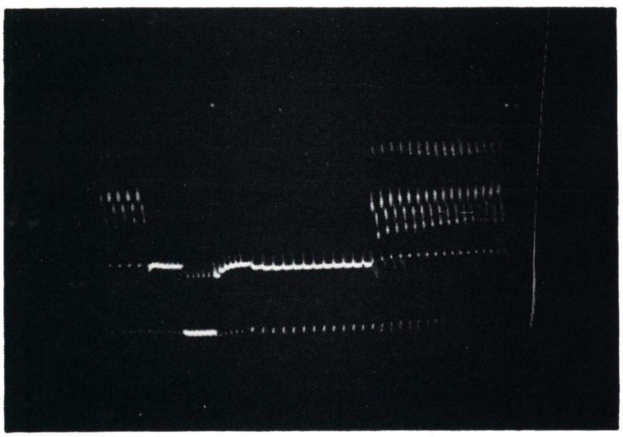


FIG. 71 — NEGATIVE STREAKING — TEST PATTERN — EXPANDED VERTICAL

FIG. 72 — SMEARING — TEST PATTERN

(B-2) SMEARING (Figs. 72-75)—Smearing is a distortion similar to streaking. The impairment is a blurring of the vertical edges of objects in the televised scene and the whole picture looks as if it had been smeared along the horizontal axis. The smearing error luminance may also be of the same or opposite sign as the luminance it follows.

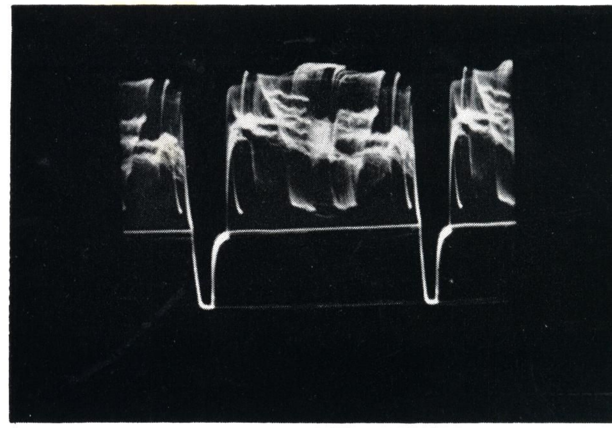


FIG. 73 — SMEARING — TEST PATTERN — HORIZONTAL

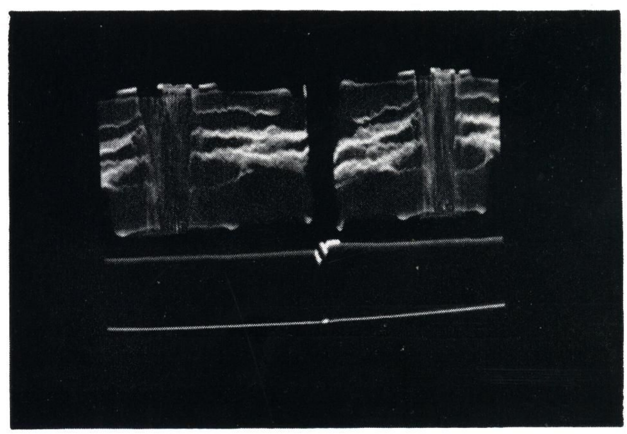


FIG. 74 — SMEARING — TEST PATTERN — VERTICAL

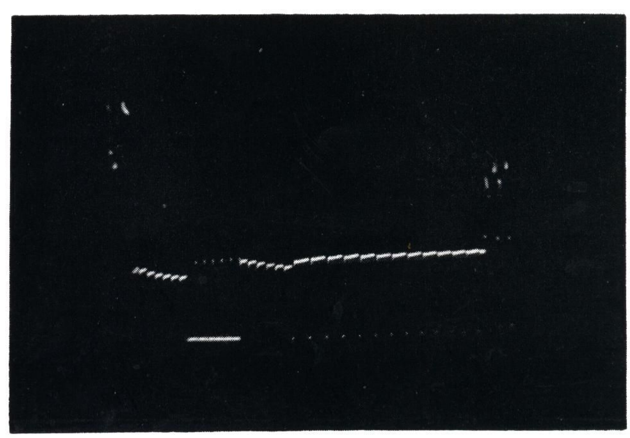


FIG. 75 — SMEARING — TEST PATTERN — EXPANDED VERTICAL

FIG. 76 — LOW SETUP — TEST PATTERN

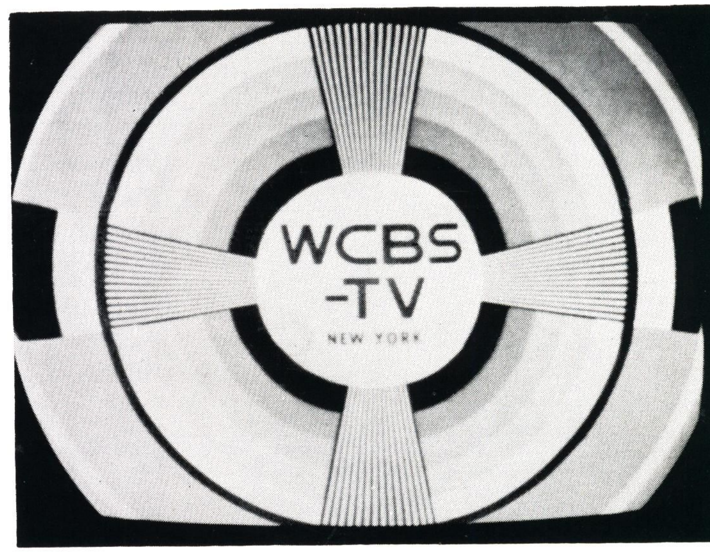


FIG. 79 — HIGH SETUP — TEST PATTERN

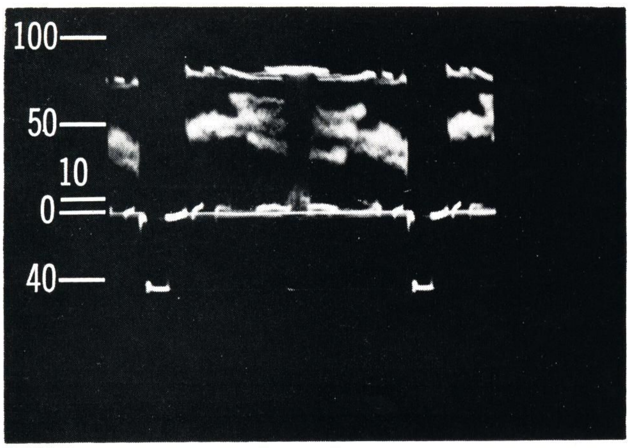


FIG. 77 — LOW SETUP — TEST PATTERN — HORIZONTAL

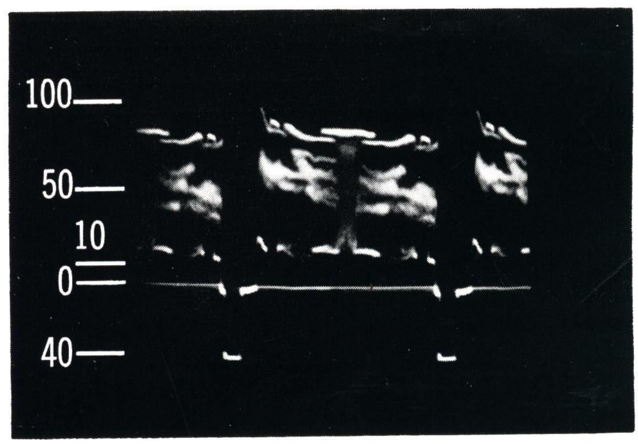


FIG. 80 — HIGH SETUP — TEST PATTERN — HORIZONTAL

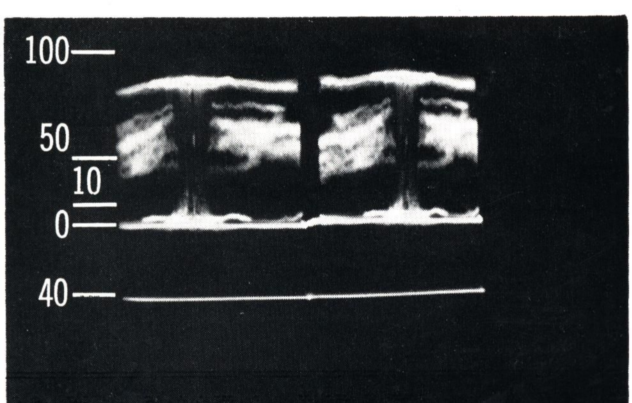


FIG. 78 — LOW SETUP — TEST PATTERN — VERTICAL

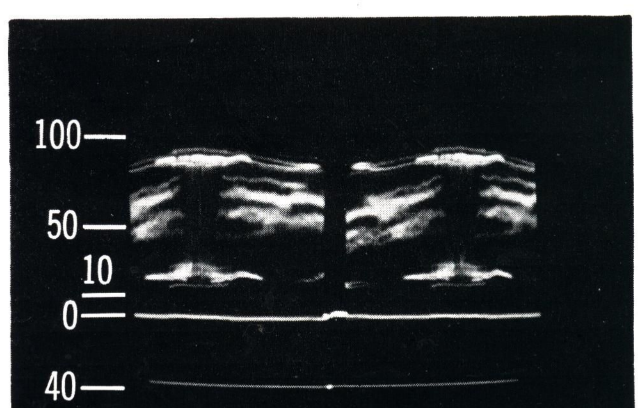


FIG. 81 — HIGH SETUP — TEST PATTERN — VERTICAL

(C) Change of Setup (Figs. 76-81)—The setup of the picture is the difference between the blanking and reference black levels as viewed on the A-Scope using IRE roll-off. For normal operation this is 10 divisions on the IRE scale. Setup variation along network facilities is mainly affected by the lower portion of the frequency band, excessive transmission-frequency loss in this region causing too little setup, and excessive transmission-frequency gain in this region causing too much setup.

(C-1) LOSS OF SETUP (Fig. 76-78)—Low setup results in pictures having more contrast than normal. The whites in the scene will be unchanged but some of the normal grays may become almost black. Some streaking may also occur due to the deviations in the gain and phase characteristics at low frequencies. When loss of setup occurs to the point where the picture signal punches through the blanking level, normal clipping functioning of the customer's stabilizing amplifier will cause loss of this picture information. In severe cases, erratic operation of the customer's stabilizing amplifier may occur, and the picture will be unusable.

(C-2) INCREASE IN SETUP (Figs. 79-81) — High setup results in reduced contrast range and reduced signal to noise ratio.

(D) Ringing (Figs. 82-86)—Ringing generally results from the transmission of sudden tonal transitions over a system that has a finite pass band with a sharp cutoff at the upper end of the frequency range. It may also result from a marked transmission discontinuity at some frequency below cutoff. When a signal containing a sudden transition is applied to such a circuit, damped oscillations or ringing will occur at approximately the frequency of cutoff or other discontinuity, the duration of the ringing depending upon the sharpness of the discontinuity. Ringing will be accentuated by a rising gain characteristic preceding the discontinuity.

The RETMA test pattern and the typical broadcaster's test pattern shown in Figs. 33 and 34 are sensitive indicators of ringing. The phenomenon will be apparent as additional lines on either or both sides of the vertical wedges. These lines will be strongest at the vertical position corresponding to the frequency of cutoff or other discontinuity of the circuit elements causing the ring.

Ringing may also be detected by using the A-scope horizontal presentation to note the presence of damped oscillations following sharp transitions in the signal. It is possible to observe the transitions during the blanking interval, such as sync pulse to back porch. The window or other square wave type of signal is also suitable for noting this type of distortion. The ringing frequency can be determined by counting the number of complete oscillations appearing in a known time interval and converting to frequency by using the following formula:

Ringing frequency = Number of Oscillations × 10^6 ÷ Time interval in microseconds.

$$f = n \times \frac{10^6}{t\ (\mu s)}$$

The accompanying illustrations were produced by introducing sharp cutoff at approximately 3 mc (Figs. 82, 83) and 4 mc (Figs. 84, 85). Close observation of Fig. 86 will reveal, to the lower right of the necktie, that there is in succession a trailing white, a trailing black, and a second lower level trailing white, indicating a damped transient or ringing. Had this following signal been damped to the extent that only one white edge trailed the necktie, the impairment might be described as "edge effect" as covered in Overshoots, following.

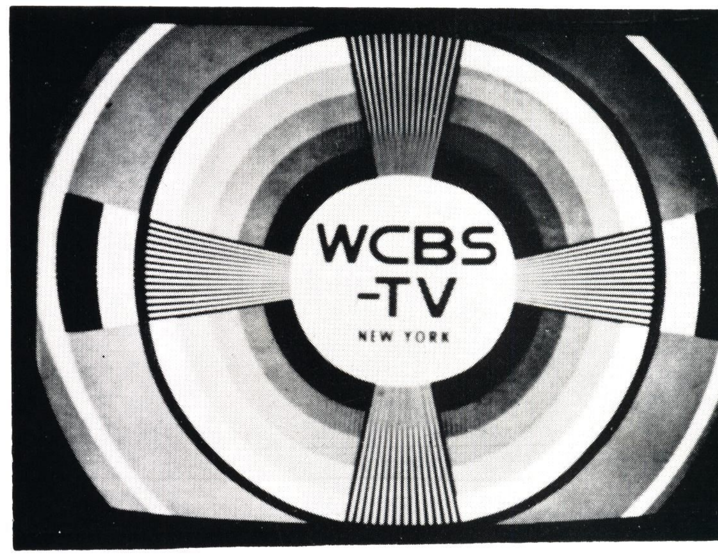


FIG. 82 — RINGING (3 MC) — TEST PATTERN

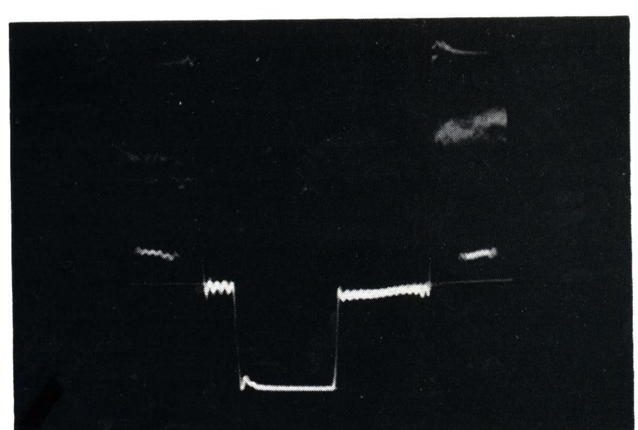


FIG. 83 — RINGING (3 MC) —
TEST PATTERN — EXPANDED HORIZONTAL

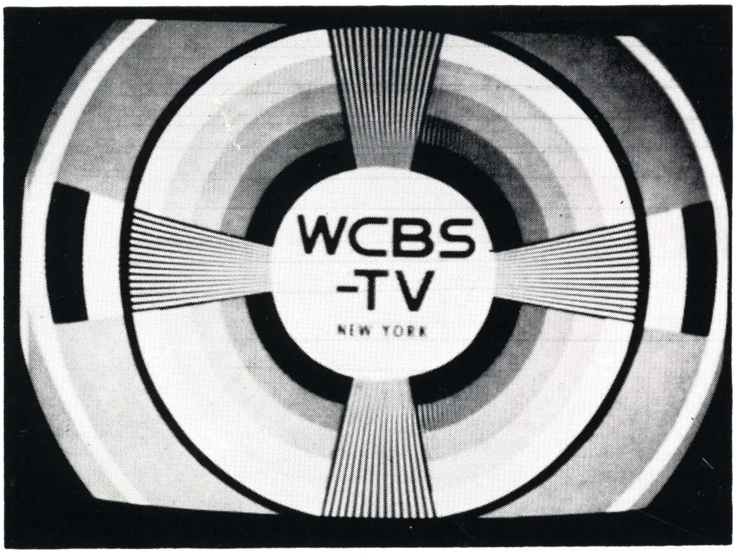


FIG. 84 — RINGING (4 MC) — TEST PATTERN

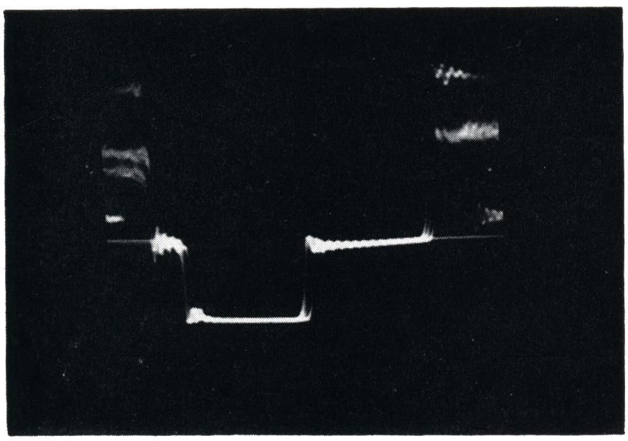


FIG. 85 — RINGING (4 MC) —
TEST PATTERN — EXPANDED HORIZONTAL

FIG. 86 — RINGING

(E) Overshoots (Figs. 87, 88)—In a television signal, an overshoot is an excessive response to a sudden change in signal. A sharp overshoot is commonly referred to as a spike. An overshoot is generally caused by excess gain at high frequencies. In vestigial sideband systems, another possible cause is insufficient carrier to sideband ratio.

(E-1) FOLLOWING WHITES OR BLACKS (Fig. 87)—Overshoots within the picture area result in impairments to the picture called following white or black (edge effect). These appear as a black outline to the right of white objects and a white outline to the right of black objects. In Fig. 87 this is most evident as a white edge following the man's head. A black edge follows the white of the handkerchief. Wide following whites or blacks are similar to negative smear.

FIG. 87 — EDGE EFFECT

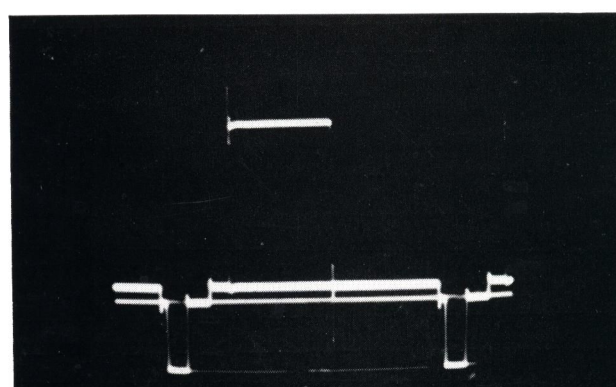


FIG. 88 — OVERSHOOTS — WINDOW SIGNAL — HORIZONTAL

(E-2) OVERSHOOT ON BACK PORCH—An overshoot of the trailing edge of the sync pulse is called a "positive spike on the back porch." If this extends above black level, it may be visible in the picture as a gray vertical bar due to illuminating portions of the horizontal return traces. Fig. 88 illustrates a slight overshoot on the back porch.

OVERSHOOT ON FRONT PORCH—An overshoot of the transition from picture to blanking is called a "negative spike on the front porch." Since this is below black level, it will not be visible in the picture. However, if the overshoot is of sufficient magnitude, it may cause improper triggering of stabilizing amplifiers, monitors or clampers, with serious tearing or complete loss of picture. Fig. 88 also shows a slight overshoot on the front porch.

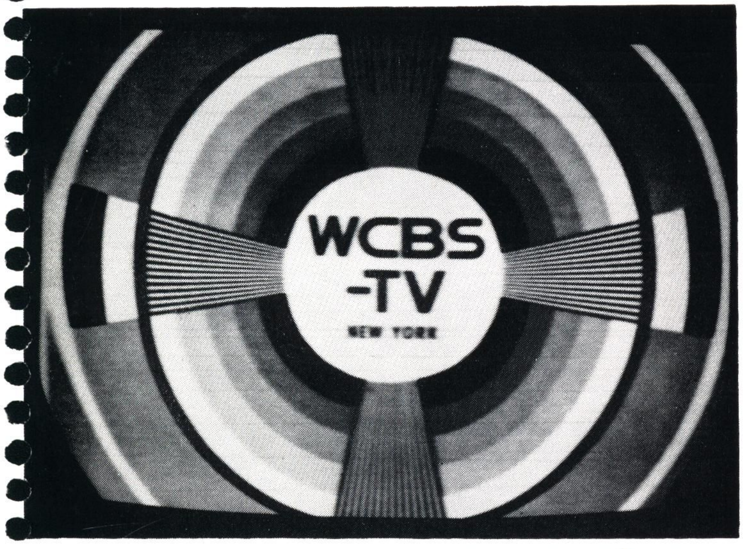


FIG. 89 — LOW RESOLUTION — ROLL-OFF FROM 1 MC

(F) **Resolution** (Figs. 89-91)—Resolution is the ability to reproduce detail in a transmitted picture. Resolution is measured in lines, as discussed under the descriptions of the RETMA and broadcasters' test patterns. The degree of resolution can be affected by the dimensions of camera and receiver scanning beams. Horizontal resolution is also a function of bandwidth. A rule of thumb is that 1.0 mc of bandwidth corresponds to 80 lines of resolution. For maximum resolution with a given bandwidth, a flat amplitude and linear phase characteristic up to the point of cutoff would be favored. However, the resulting sharp cutoff would cause ringing. Assuming a transmission system having the same pass band, but rolled off gradually with frequency, the resolution will become poorer as lower and lower frequencies are selected as the start of the

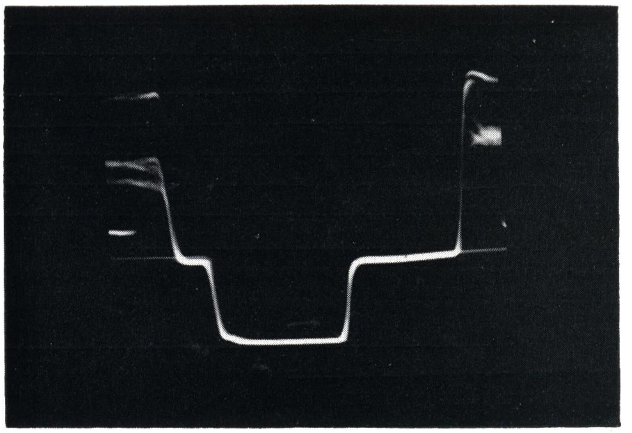


FIG. 90 — LOW RESOLUTION — ROLL-OFF FROM 1 MC — EXPANDED HORIZONTAL

roll off, but transient effects in the region of cutoff will be reduced. The actual shape of a pass band, then, is a compromise between transient effects in the region of cutoff and the distortion introduced at lower frequencies (loss of resolution) by the extent and shape of the roll off.

In addition to frequency response, excessive noise also can mask fine picture detail and result in apparent loss of resolution.

Figs. 89 and 90 show test pattern transmissions when the high frequencies are strongly rolled off starting at about 1 mc. The A-scope expanded presentation shows loss of sharpness at transition points. Fig. 91 illustrates loss of both horizontal and vertical resolution caused by too large a receiver scanning spot.

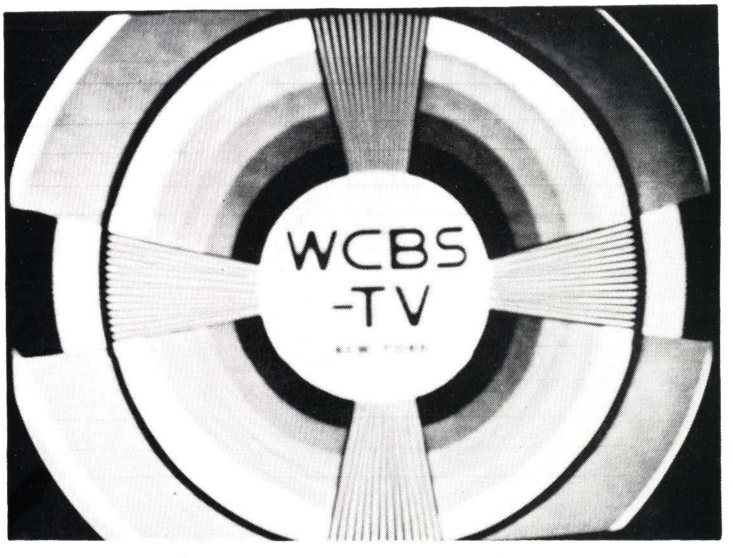


FIG. 91 — LOW RESOLUTION — RECEIVER SCANNING SPOT TOO LARGE

(G) Hour Glass (Fig. 92)—When multiburst signals are transmitted over a video facility having a transmission-frequency response characteristic such that the middle multiburst test frequencies are attenuated with respect to both the lower and higher test frequencies, the resulting A-scope presentation of the multiburst test signal has been referred to as the "hour glass" effect. The frequency characteristic usually results from partial equalization, such as would occur when compensating for a facility having a gradually increasing loss with frequency, using an equalizer effective only in the upper portion of the frequency band. As improvement is made in the facility having increased loss with frequency, less compensation is required from the high end equalizers eliminating the "hour glass."

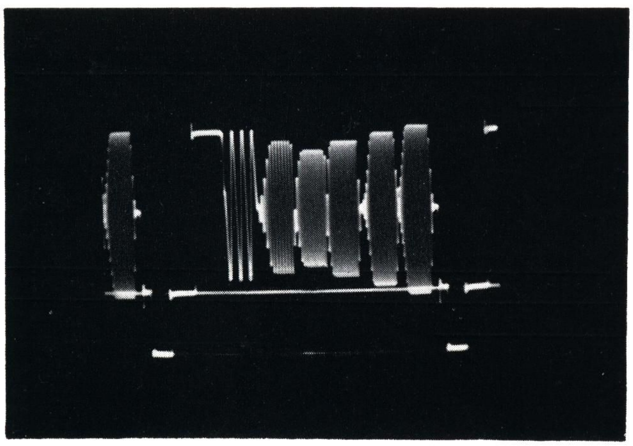


FIG. 92 — HOUR GLASS EFFECT

(H) Echoes (Figs. 93-105)—An echo signal, or ghost, can be defined as a duplicate of the original video signal displaced horizontally from the original signal. A complete reproduction of the original signal is called a ghost, while a partial reproduction is called an echo or reflection. Ghosts and echoes are due to impairment in the transmission path which causes the signal pulses to reach the viewer at two or more discrete times. Generally, the echo signal is weaker than the original signal, so the echo picture is also weaker than the main picture. When two or more echo patterns are present, one pattern usually predominates and the others are relatively weak.

The impairment effect of the echo picture not only varies with echo signal strength but also with the time offset and the nature of the original video signal. This is illustrated by Fig. 93.

As a practical matter, echo signals are generally not a true reproduction of the original signal, since the conditions that give rise to echo signals are usually not

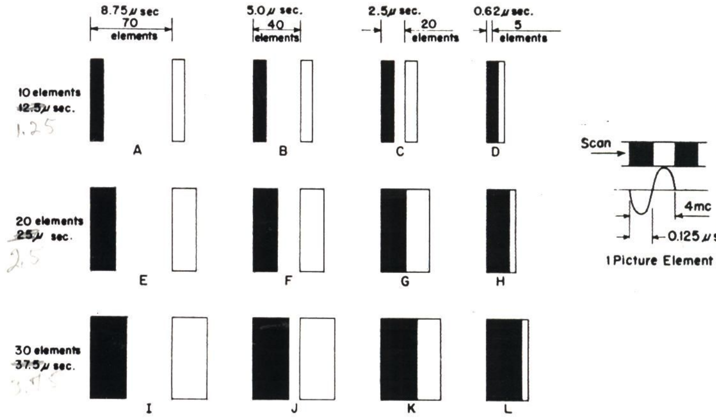


FIG. 93 — ECHO IMPAIRMENT EFFECT VS. IMAGE SIZE AND ECHO DISPLACEMENT

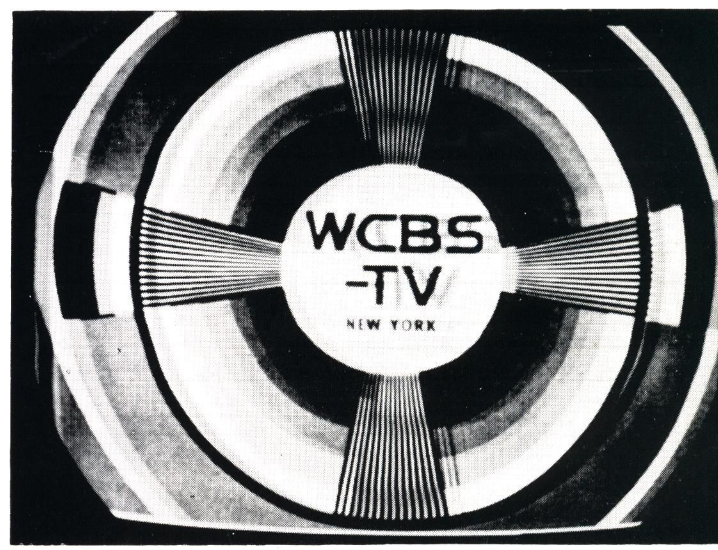


FIG. 94 — POSITIVE ECHO — TEST PATTERN

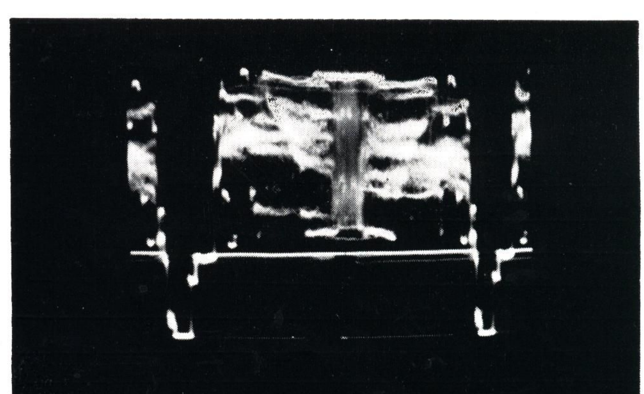


FIG. 95 — POSITIVE ECHO — TEST PATTERN — HORIZONTAL

linear throughout the band. This adds still another variable factor, since distorted echo signals result in a lesser picture impairment effect than undistorted echo signals. Echoes may be either leading or lagging, and they may be either positive (same tonal range) or negative (reverse tonal range). Figs. 94 to 101 show positive lagging echoes; Figs 102 to 105 show negative lagging echoes.

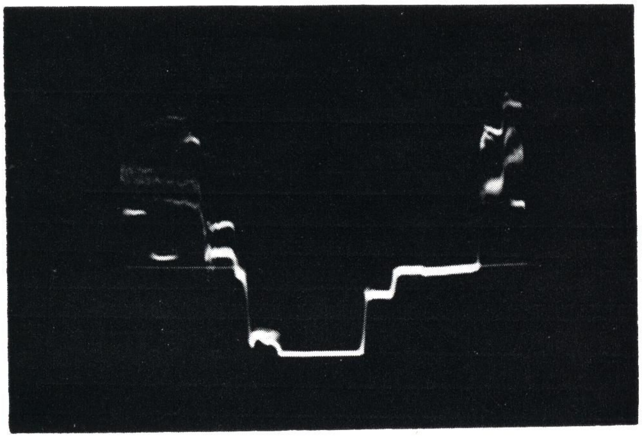


FIG. 96 — POSITIVE ECHO — TEST PATTERN — EXPANDED HORIZONTAL

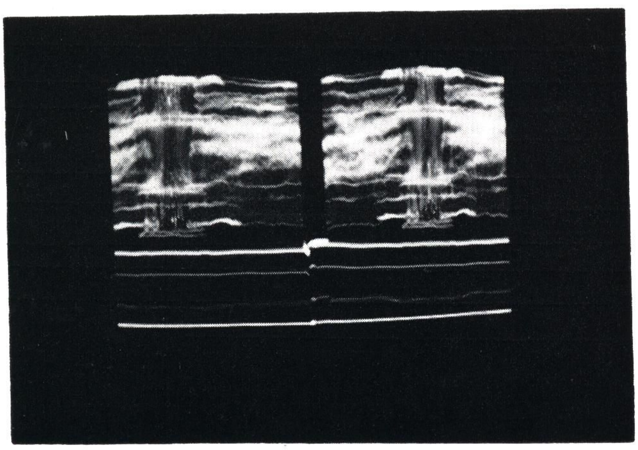


FIG. 97 — POSITIVE ECHO — TEST PATTERN — VERTICAL

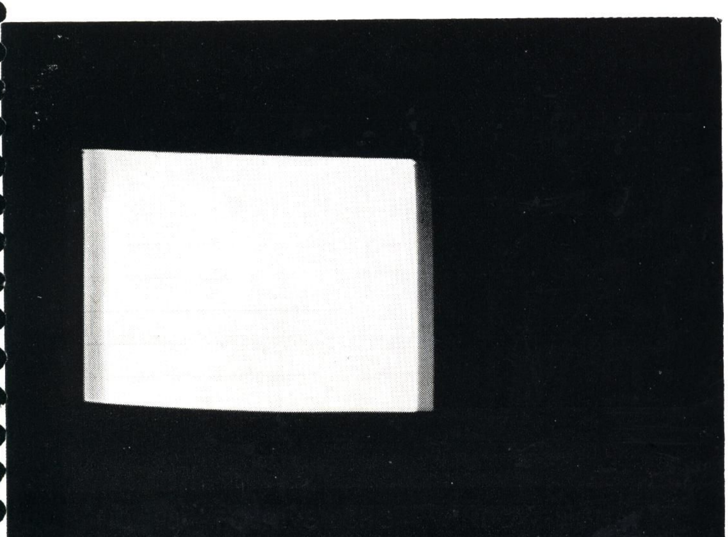


FIG. 98 — POSITIVE ECHO — WINDOW SIGNAL

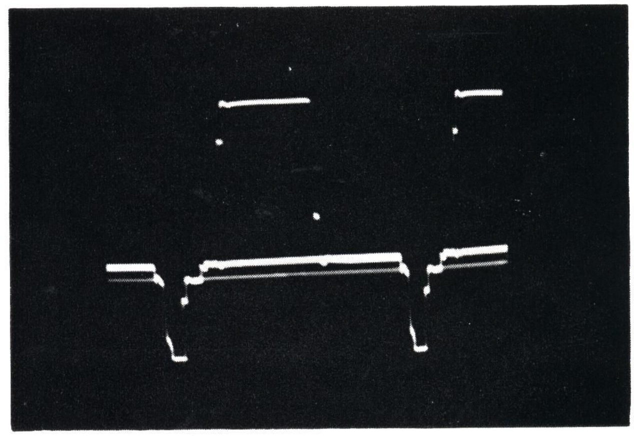


FIG. 99 — POSITIVE ECHO — WINDOW SIGNAL — HORIZONTAL

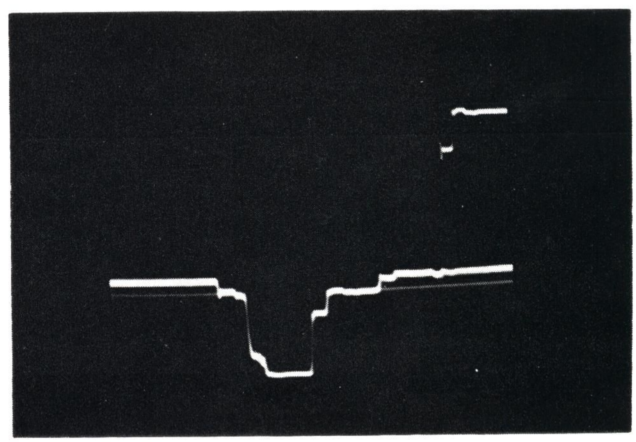


FIG. 100 — POSITIVE ECHO — WINDOW SIGNAL — EXPANDED HORIZONTAL

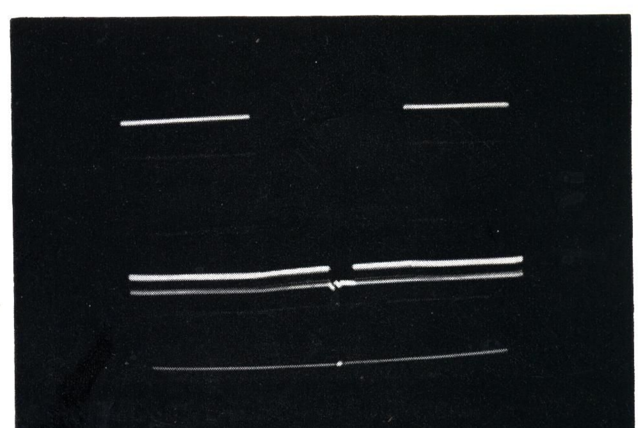


FIG. 101—POSITIVE ECHO—WINDOW SIGNAL—VERTICAL

FIG. 102 — NEGATIVE ECHO — TEST PATTERN

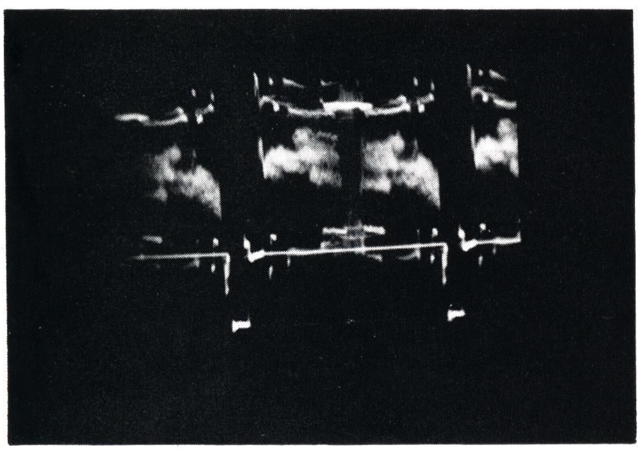


FIG. 103 — NEGATIVE ECHO —
TEST PATTERN — HORIZONTAL

The most usual cause of ghosts and echoes seen on home receivers is two transmission paths from the broadcast station to the receiving location—the direct path and a second path produced by a reflection from some tall building or high point of terrain. The ghost is offset to the right of the direct image by an amount of time equivalent to the difference in length of transmission time of the two paths. Transmission over the reflected path is generally attenuated, as compared with the direct path, so the ghost appears weaker than the direct signal. When FM radio signals are used, as in radio relay systems, an impairment from a reflected path generally does not result in a television picture with a distinct echo, since its echo-producing signal would be smothered by the FM capture feature of the radio relay receivers.

Ghosts and echoes may also be produced in transmission facilities due to troubles or unsatisfactory adjustments. A trouble such as impedance irregularity in a cable section or an improperly terminated cable will produce electrical reflections which are delayed in transmission compared with the original signal, and thus produce ghosts or echoes. Ghosts will be produced if the irregularity affects substantially the whole video frequency band, and echoes when only a part of the frequency band is affected.

The same effects can also be caused by non-uniformity of gain and delay-frequency characteristics. In particular, a gain-frequency characteristic having periodic peaks and valleys across the frequency band will act the same as an impedance irregularity on cable affecting a broad band of frequencies.

The spacing of the reflected image or images from the original object and from each other is determined by the location of the irregularity in the frequency spectrum and usually may be calculated by the relationship that the reflection displacement in seconds is equal to the reciprocal of the frequency in cycles at

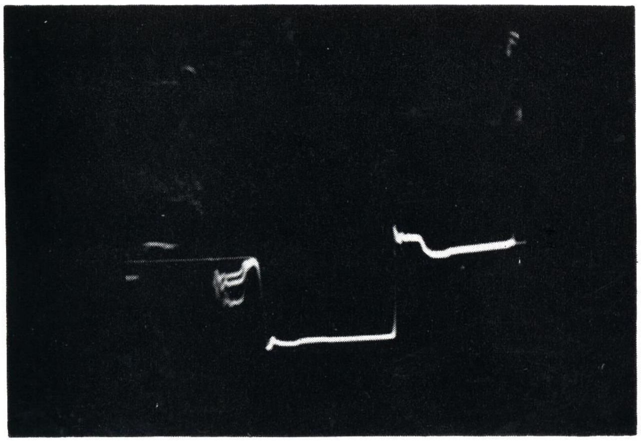


FIG. 104 — NEGATIVE ECHO —
TEST PATTERN — EXPANDED HORIZONTAL

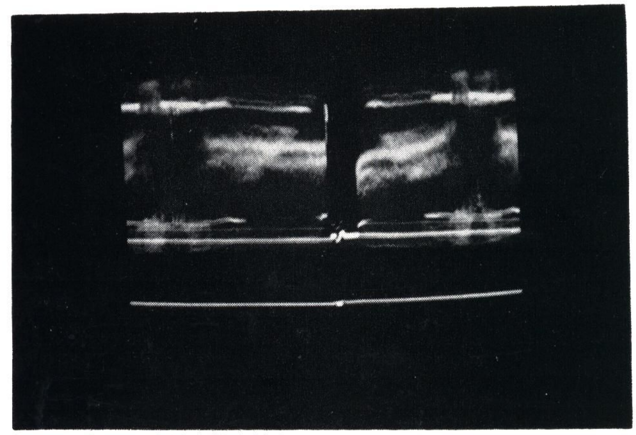


FIG. 105—NEGATIVE ECHO—TEST PATTERN—VERTICAL

which the irregularity occurs. For example, an irregularity occurring at 500 kc will produce reflections displaced from the original and from each other by two microseconds. Remembering that one line in a television picture (exclusive of blanking) is equal to about 53 microseconds, we can then see that in this case the reflections will be displaced by a fraction of the total picture width equal to 2/53, or about three-eighths of an inch in the case of a 10 inch picture tube. Where carrier type facilities are involved, it should be remembered that this is a video frequency calculation, and that further conversion to carrier frequencies may be required. The number of reflections is dependent upon the sharpness of the irregularity, being only one for a broad irregularity and increasing in number with irregularity sharpness.

3. Interference

(A) General—Interference is the introduction of extraneous signals into the desired signal. In the case of television transmission, the resulting picture impairments may be in the form of bars, moving spots, salt-and-pepper effect or erratic synchronizing. One form of interference is called noise, this term being used generally to describe natural phenomena such as thermal noise in electronic components; whereas, "interference" generally refers to man made signals, such as extraneous single frequency voltages, cross-talk from another video channel and the like. The term "noise" is a carryover from audio work. In television the effects are visual rather than aural.

Interference can be simply added into the path of the desired signal, or it can modulate the signal itself. Signal modulation by interference may occur in non-linear circuit elements such as vacuum tubes, and results in the whole picture signal amplitude changing at the interfering rate. The two types of interference are difficult to distinguish in a television picture. Treatments that will minimize additive interference, such as filtering, use of clamper-amplifiers for low frequency interference etc., will not affect modulation products. Additive interference is the case discussed and illustrated in this section.

(B) Single Frequency Interference — The appearance on a television picture of extraneous regularly spaced bars or lines indicates the presence of an interfering frequency. At low levels of interference the amount of single frequency interference that can be tolerated varies quite widely, depending on the part of the spectrum in which it is operative.

(B-1) LOW FREQUENCY INTERFERENCE (Figs. 106-113)—A particularly sensitive portion of the spectrum is the immediate region of the field rate, 60 cycles. It has been found that as the level of such an extraneous frequency is increased from a very low value, flicker is much more objectionable than the brightness distortion corresponding to a broad bar pattern. The flicker effect is accordingly controlling in this level region. The tolerable level of interference varies with the flicker frequency (difference between the extraneous and field frequencies), a flicker rate of about five cycles being the most objectionable. This holds for frequencies either side of the field rate; that is, the most critical frequencies are 55 and 65 cycles. To be tolerated, the peak-to-peak amplitude of these interfering frequencies has to be about 54 db less than the peak-to-peak amplitude of the television signal.

Figs. 106 and 109 are cases of 120 cycle and approximately 1,000 cycle interference. For low frequency interference which is an exact multiple of the field rate (60 cycles) the extraneous bars will be horizontal and will remain stationary. The interfering frequency may be determined by multiplying 60 cycles by the number of white or the number of dark bars observed. Two horizontal white bars may be distinguished in the first instance, and sixteen or seventeen for the 1,000 cycle picture. When the extraneous frequency differs slightly from the sixty cycle field rate or its multiples, the bars will remain horizontal but will move vertically through the picture, the rate of motion increasing with the difference in frequency. Interference at 60 cycles and its first few harmonics is frequently called "hum" as it is often caused by defects in power supplies — similar to the audio case.

Low frequency interference shows on the A-scope horizontal presentation as thickened horizontal lines, the thickness indicating the relative amplitude of the interference, as in Figs. 107 and 110 for the 120 and 1,000 cycle cases respectively. The vertical presentation shows no thickening of the trace. The interference may appear as a wave form on the blanking line, horizontal sync tips and sometimes the picture signal, as in Figs. 108 and 111 for the same two examples.

Clamper amplifiers effectively reduce interference at 60 cycles by about 33 db. This figure reduces progressively as the interfering frequency is increased and the clamper is not effective on interference above about 2 kc. (This varies somewhat with the clamper time constant.) Figs. 112 and 113 show the 120 cycle interference of Figs. 107 and 108 after passing through a clamper-amplifier. No impairment is visible on the pictures.

(B-2) GLITCH (Figs. 114, 115)—A type of low frequency interference, which has been commonly referred to by the broadcasters as a "glitch," is observed as a narrow horizontal bar moving through the picture (Fig. 114). Simultaneous observation of the A-scope at field or frame rate will indicate one or more extraneous voltage pips moving along the signal at approximately reference black level. The pip in Fig. 115 was moving rapidly from right to left.

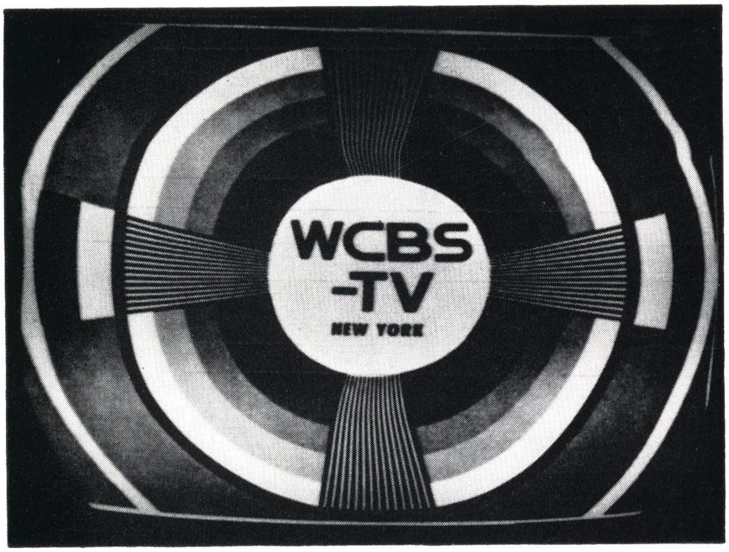


FIG. 106 — INTERFERENCE — 120 CYCLES

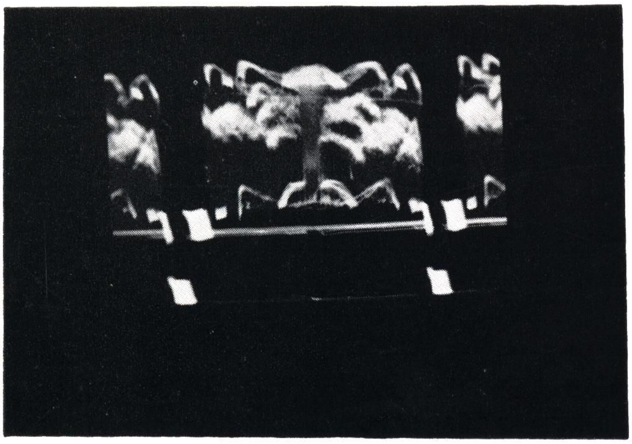


FIG. 107—INTERFERENCE—120 CYCLES—HORIZONTAL

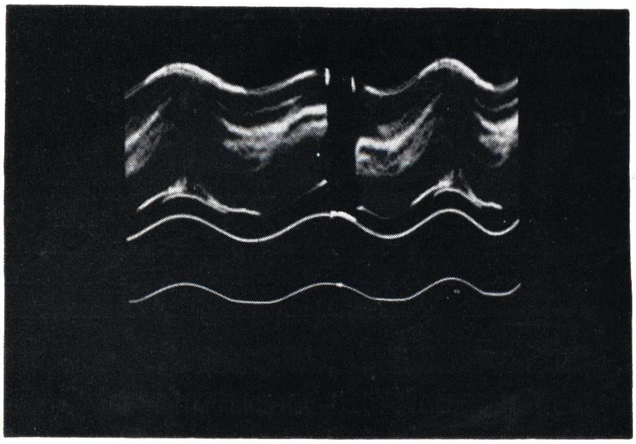


FIG. 108—INTERFERENCE—120 CYCLES—VERTICAL

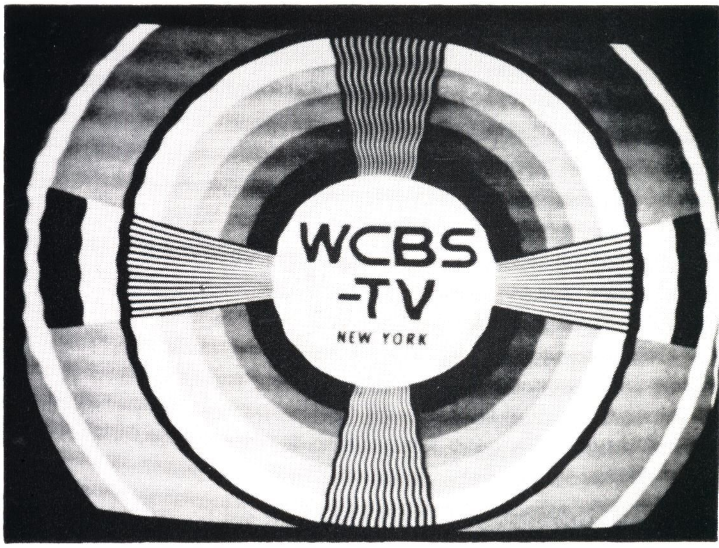


FIG. 109—INTERFERENCE—1000 CYCLES

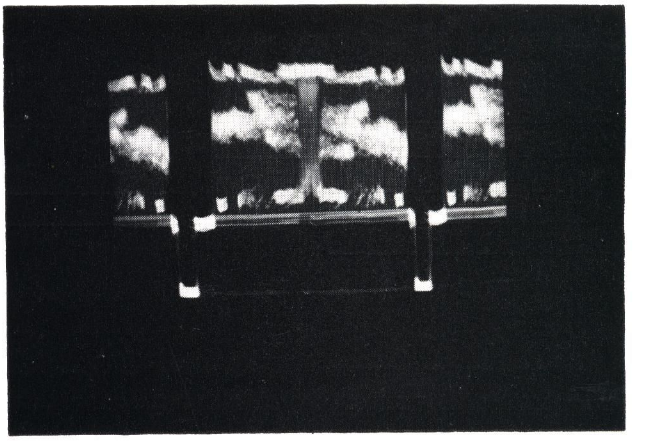


FIG. 110—INTERFERENCE—1000 CYCLES—HORIZONTAL

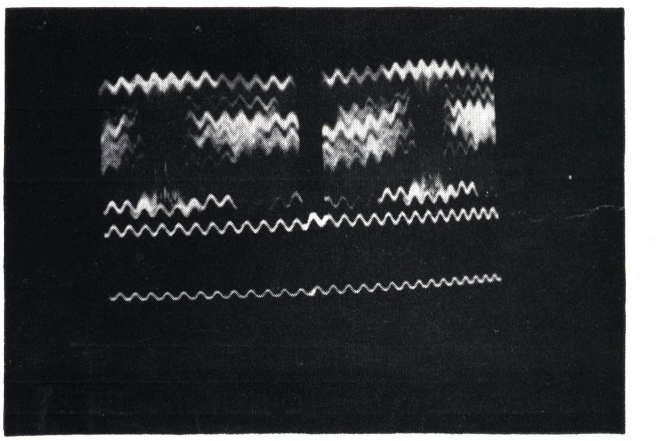


FIG. 111—INTERFERENCE—1000 CYCLES—VERTICAL

This may be present in the signal from the customer's pickups, as a result of a difference in frequency between a remote camera power supply and the customer's local sixty cycle power supply. When using some types of radio relay equipment, the impairment also may result from spiking on the positive and negative sine wave peaks of commercial power supplies. The speed of movement of the dark bar depends on the difference between the frequency of the picture field rate and the frequency of the commercial power supply. Such spiking is sometimes introduced from mercury vapor rectifiers or similar systems feeding back voltage pips at a sixty cycle rate into the commercial power supply. Thus, this is not pure single frequency interference, but has many similar characteristics. It is possible to observe this spiking from such power supplies through use of an oscilloscope bridged on the power line. Effects are eliminated through filtering, either at the source of interference or at the point of connection of the radio relay equipment.

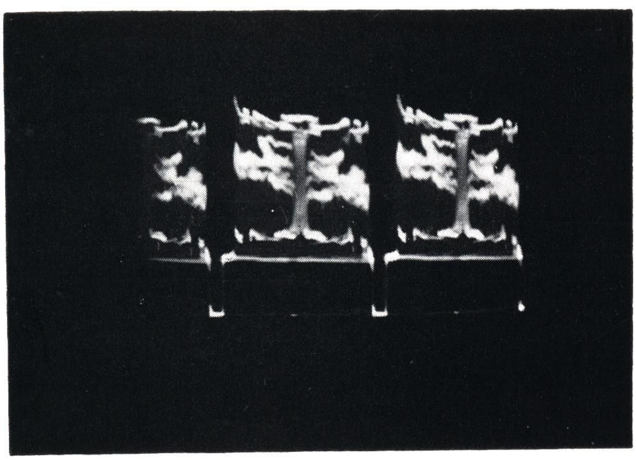


FIG. 112—INTERFERENCE—CLAMPED—
120 CYCLES—HORIZONTAL

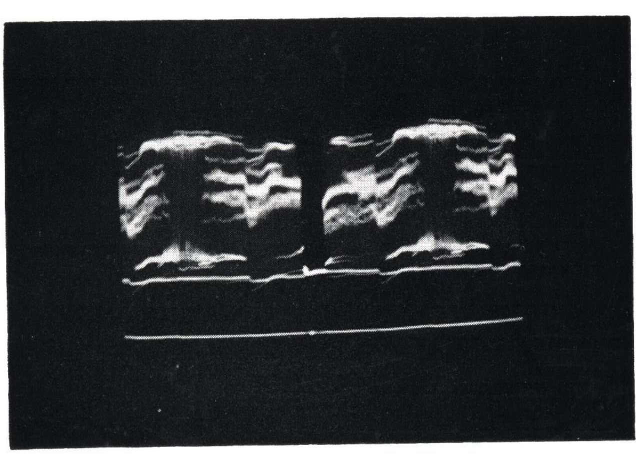


FIG. 113—INTERFERENCE—CLAMPED—
120 CYCLES—VERTICAL

FIG. 114 — GLITCH

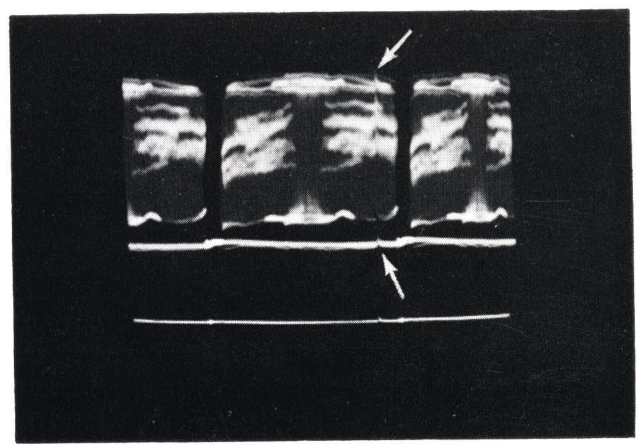


FIG. 115 — GLITCH — VERTICAL

(B-3) HIGH-FREQUENCY INTERFERENCE (Figs. 116-127)—In the region above the line rate, 15,750 cycles, the most critical frequency is found to be in the ½ to ⅓ megacycle range. The maximum tolerable interference level at this point in the spectrum is about 65 db below the signal. High-frequency interference will appear as regularly spaced diagonal or vertical bars which become finer as the frequency increases. If this frequency is an exact multiple of the line rate, the pattern will be stationary and vertical. The interfering frequency may be determined by multiplying the line rate by the number of white or the number of dark bars observed cutting a horizontal cross section of the picture. Figs. 116, 117, 118 and 119 are samples respectively of 31.5 kc, 311 kc, 1.0 mc and 3.6 mc interference. The first picture contains light vertical areas just to the left of center and on the right side of the

FIG. 116 — INTERFERENCE — 31.5 KC

FIG. 117 — INTERFERENCE — 311 KC

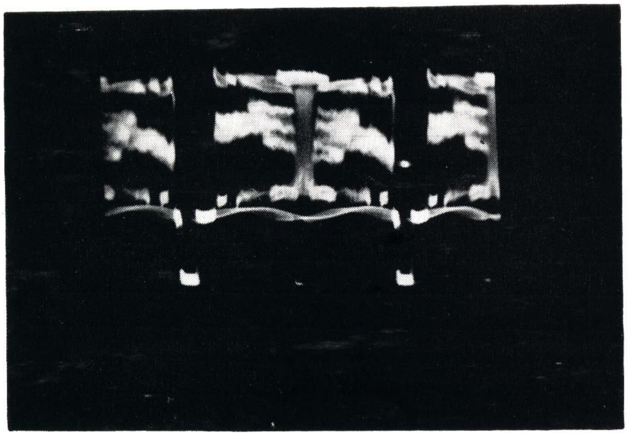


FIG. 120 — INTERFERENCE — 31.5 KC — HORIZONTAL

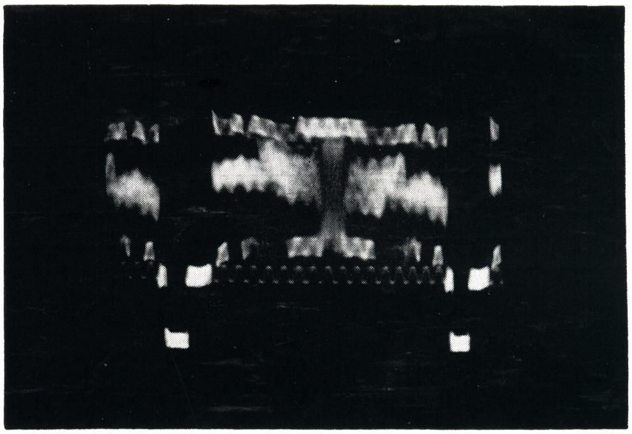


FIG. 121 — INTERFERENCE — 311 KC — HORIZONTAL

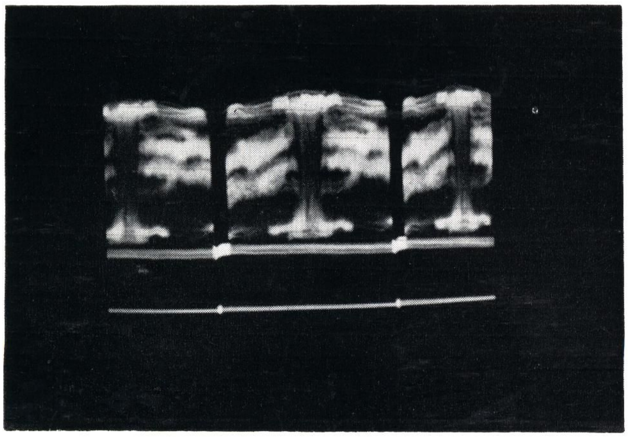


FIG. 124 — INTERFERENCE — 31.5 KC — VERTICAL

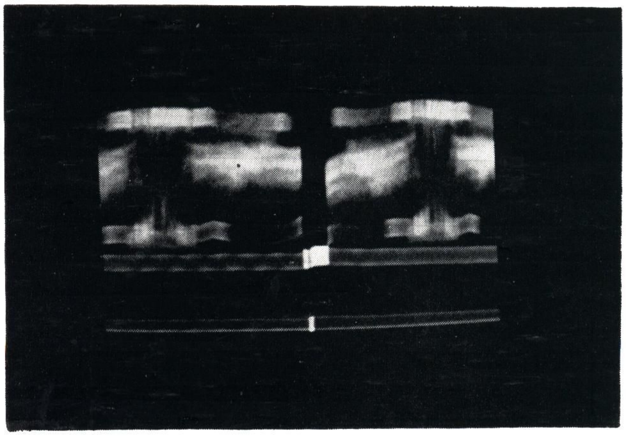


FIG. 125 — INTERFERENCE — 311 KC — VERTICAL

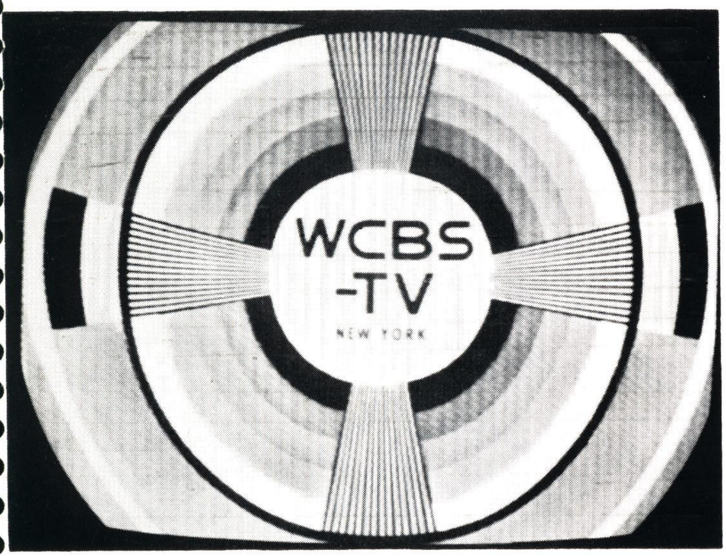


FIG. 118 — INTERFERENCE — 1 MC

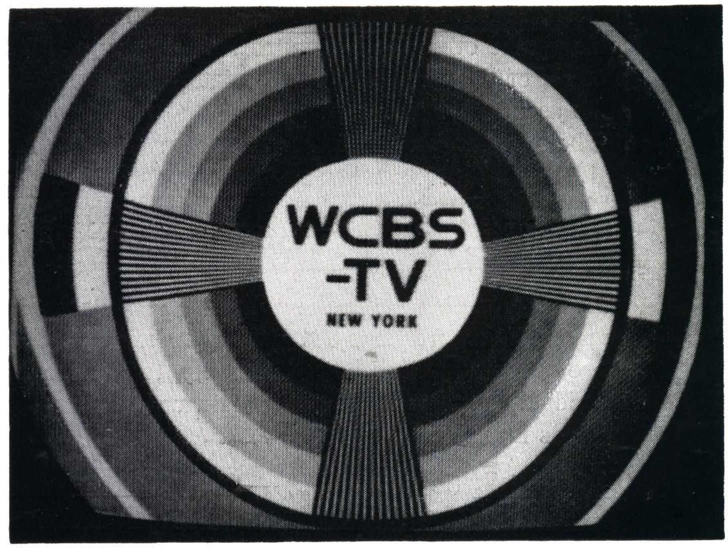


FIG. 119 — INTERFERENCE — 3.6 MC

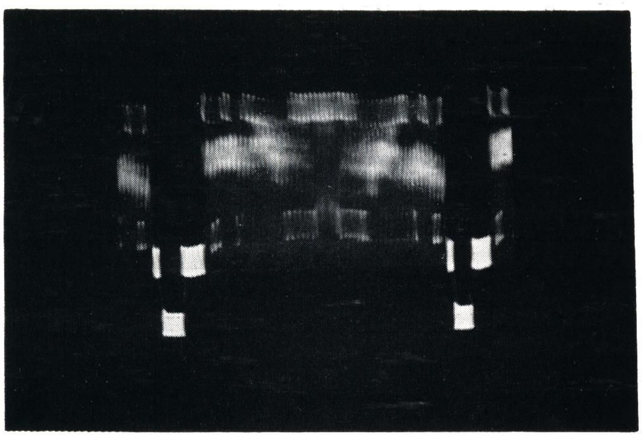


FIG. 122 — INTERFERENCE — 1 MC — HORIZONTAL

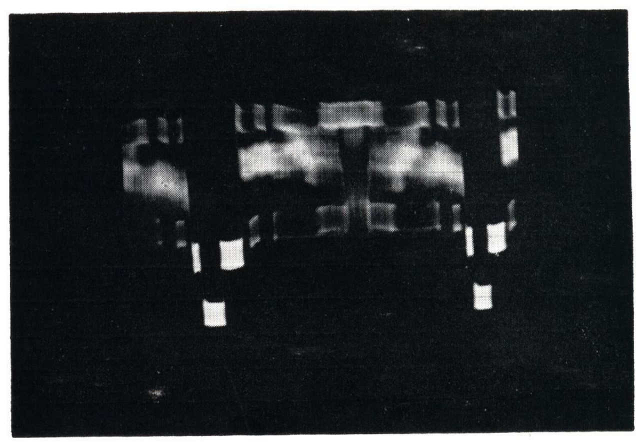


FIG.123 — INTERFERENCE — 3.6 MC — HORIZONTAL

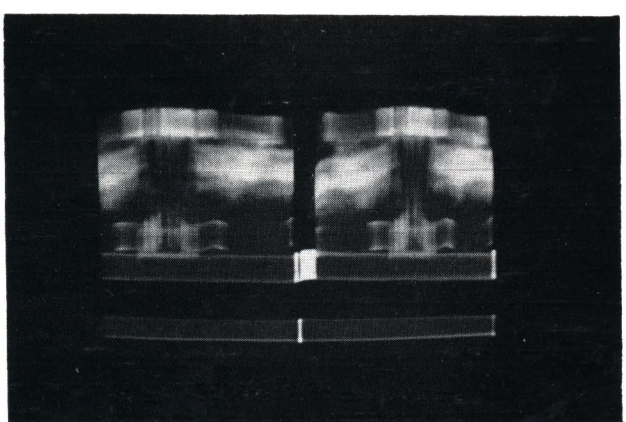


FIG. 126 — INTERFERENCE — 1 MC — VERTICAL

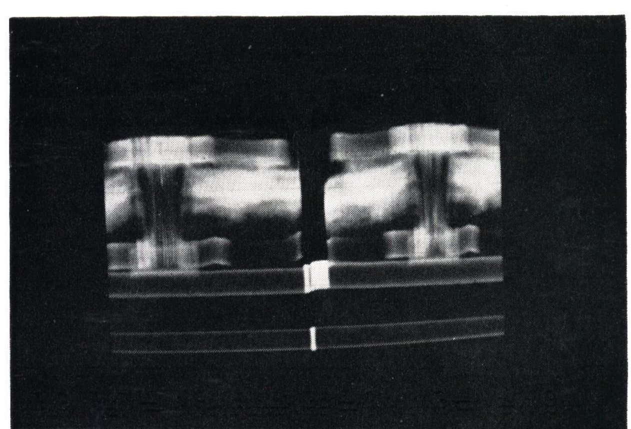


FIG. 127 — INTERFERENCE — 3.6 MC — VERTICAL

pattern, which are difficult to distinguish. The bar patterns on the other three pictures are quite evident and a count of the bars will give the interfering frequency quite accurately.

The A-scope presentations are shown by Figs. 120, 121, 122 and 123 at horizontal rate, and Figs. 124, 125, 126 and 127 at vertical rate, respectively. It will be noted that, on the horizontal display, the interference shows as a wave whose frequency may be determined by counting the cycles appearing in the scanning interval. If the frequency is very high, expanding the scope presentation may be necessary to resolve the individual wave shapes. The vertical trace shows thickening as illustrated.

(C) Crosstalk (Figs 128-130) — Crosstalk, as considered herein, is the effect of coupling between two television channels. If the coupling is strong enough, the result is a weak extraneous image, usually somewhat distorted, superimposed on the main image similar to Fig. 128. Since different video systems normally are not exactly synchronized, rather violent horizontal motion of the crosstalking image usually occurs. Vertical motion is not likely to be so violent, since the field rates usually will be closer together than the line rates.

The most prominent feature of the crosstalking image will be the line and field synchronizing interval. These are, of course, blacker-than-black and they effectively frame the crosstalking image. As crosstalk coupling is reduced, the crosstalking image is no longer visible, but the horizontal interval which appears as a wide black vertical bar, and the vertical interval which appears as a wide black horizontal bar, will be visible moving through the picture. The rate of horizontal and vertical motion will vary with the differences between the sync rates of the two signals. The horizontal interval is usually the most disturbing since it extends the whole height of the raster as a wide black bar, with appreciable motion. The vertical interval is not usually so noticeable.

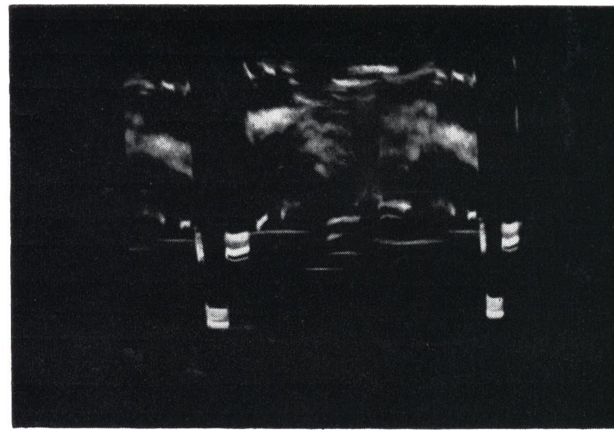


FIG. 129—INTERFERENCE—CROSSTALK—HORIZONTAL

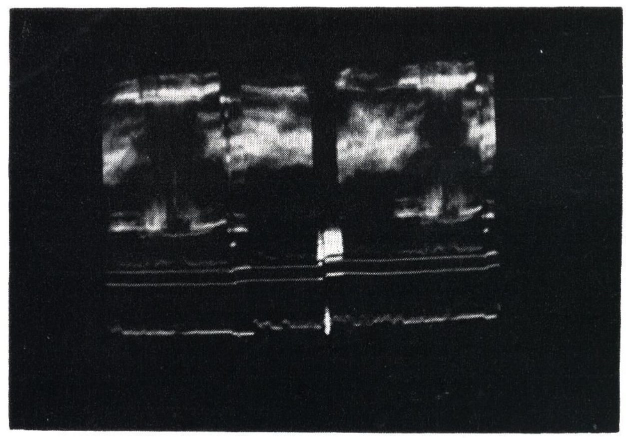


FIG. 130 — INTERFERENCE — CROSSTALK — VERTICAL

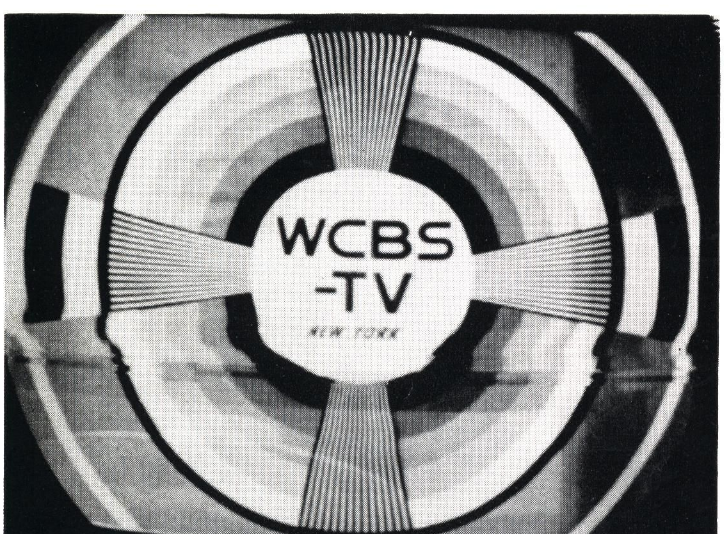


FIG. 128 — INTERFERENCE — CROSSTALK

It would appear that the limiting loss in the coupling path should be 58 db or higher for equal level circuits.

Depending upon the strength of the unwanted signal, the interference may or may not be seen on the A-scope. In the example used, it was necessary for photographic reasons to introduce the crosstalking signal only about 10 db below the desired signal. Therefore, the interfering signal is evident as modulation on both the horizontal and vertical presentations (Figs. 129 and 130).

(D) Random Noise (Figs. 131-136)—This type of noise is of the general type obtained by vacuum tube amplification of thermal noise, but is not necessarily confined to that source. It covers a wide band of frequencies without too much energy variation. The overall rms amplitude is reasonably stable over time intervals corresponding to one line scan. Experience to date indicates that, assuming noise peaks to run around three times the rms value, peak random noise should be limited to approximately 30 db below the picture signal for a 4 mc bandwidth system. It appears that "noise per megacycle of bandwidth" rather than total noise in the band, determines the impairment. An 8 mc system for example, would be 3 db more tolerant to noise than a 4 mc system.

The visual effect of random noise is that the picture acquires a pronounced graininess. When noise is strong enough, this may be called "snow" as shown in Fig. 131. Thickening of the blanking lines and tips of sync pulses is usually evident, as in Figs. 132 and 133, which show the horizontal and vertical scanning intervals of the picture of Fig. 131. These three illustrations are of noise caused by transmitting low level into a microwave repeater and restoring the signal to normal amplitude at the receiving terminal, thus amplifying the thermal noise in the equipment.

FIG. 131 — RANDOM NOISE

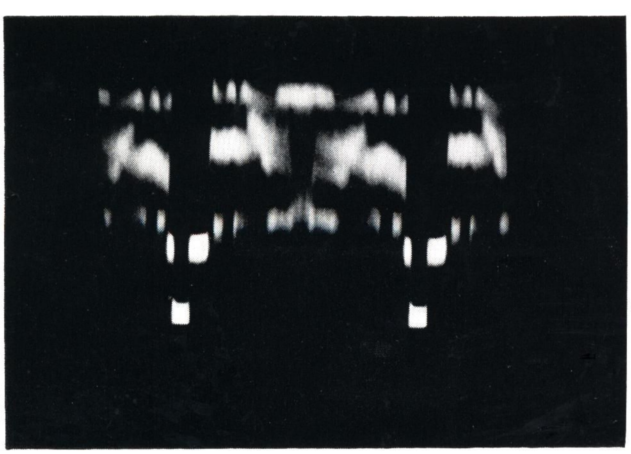


FIG. 132 — RANDOM NOISE — HORIZONTAL

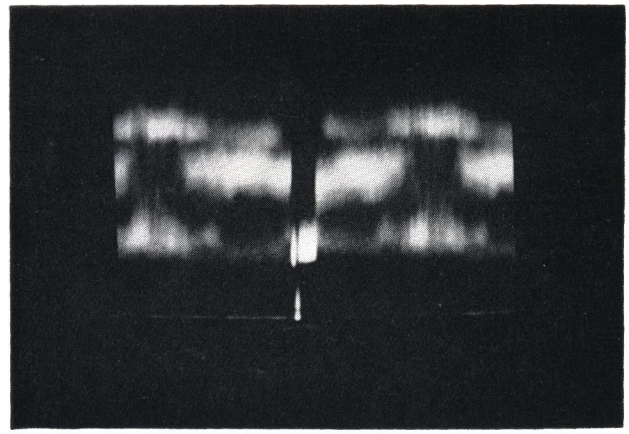


FIG. 133 — RANDOM NOISE — VERTICAL

Fig. 134 illustrates another type of random noise. This is the result of a microwave message channel, with a large number of busy circuits, interfering with the picture channel.

Light random noise, Figs. 135 and 136, visible only in the background of the picture, has been referred to sometimes as "busy background," since variations in intensity of the noise peaks usually cause the appearance of movement of the gray background, with minor thickening of the A-scope traces. This term is used with a different meaning by other groups connected with television and theatrical work, and its use is not recommended for description of television signal impairments. "Light noise" or "light high-frequency noise" are preferred terms.

FIG. 134 — MESSAGE CHANNEL INTERFERENCE

FIG. 135 — LIGHT RANDOM NOISE

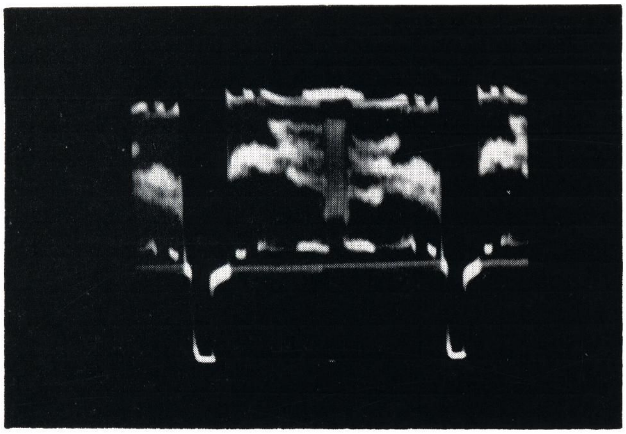


FIG. 136 — LIGHT RANDOM NOISE — HORIZONTAL

(E) Impulse Noise (Fig. 137)—The effect of impulse noise, which is composed usually of intermittent bursts or pulses, is difficult to evaluate. Assuming noise peaks at one per minute, one objective thought to be reasonable is to limit the peak noise to 20 db below the signal level. The division between impulse noise and random noise is not sharp; as the rate of occurrence of noise pulses increases, the more nearly it approaches random noise. Picture impairments resulting from impulse noise, as shown in Fig. 137, are sometimes called "pigeons," since the spots seem to fly across the picture. The picture was obtained by reducing levels on a microwave system just enough to allow a few noise peaks to act on the picture, infrequently and unpredictably enough to be called impulse noise. Unless observation is made of the A-scope at the time of occurrence of the noise pulse, or unless the pulses occur frequently, thickening of blanking lines or other signal indications will not be observed.

FIG. 137 — IMPULSE NOISE

(F) Microphonics (Fig. 138) — When some vacuum tubes are physically disturbed by vibrations due to nearby machinery, shocks from installation operations, or even by loud noises, their elements may vibrate, usually at a rate below 15,750 cycles per second. The varying tube characteristics will cause any signal being handled to be modulated at the vibration rate. Since this may be considered as low frequency interference, the effect on pictures is to add a series of horizontal bars, usually moving and changing in size in accordance with the amplitude and frequency of the vibration. Fig. 138 was obtained by lightly tapping a tube in microwave terminal equipment.

FIG. 138 — MICROPHONICS

4. Miscellaneous

(A) Clamping—The effect on a composite video signal of low frequency distortion is the same as though a low frequency signal were added to the video signal. Thus low frequency interference and low frequency transmission deviations produce similar distortions of the video wave form. Clamping is a process whereby the effects of low frequency interference and low frequency transmission deviations are removed from the video signal. Telephone company clamper amplifiers are designed so that a correcting bias voltage is added to the signal at the start of each horizontal synchronizing pulse, the magnitude and polarity of this correcting voltage being sufficient to keep the tips of the horizontal sync pulses at a fixed reference level.

Since the back porch immediately follows the tip of the synchronizing pulse which has been adjusted to a

FIG. 139 — CLAMPING FAILURE

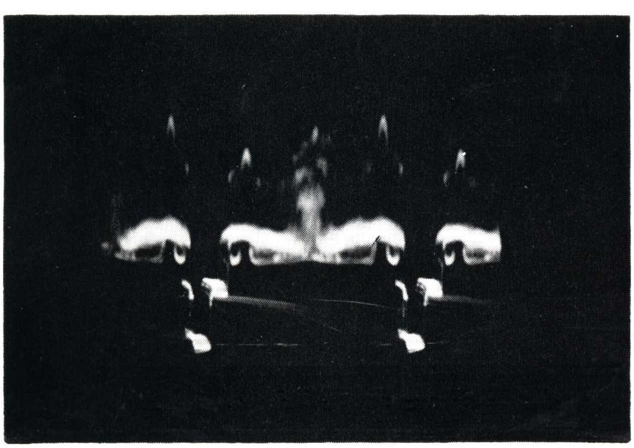


FIG. 140 — CLAMPING FAILURE — HORIZONTAL

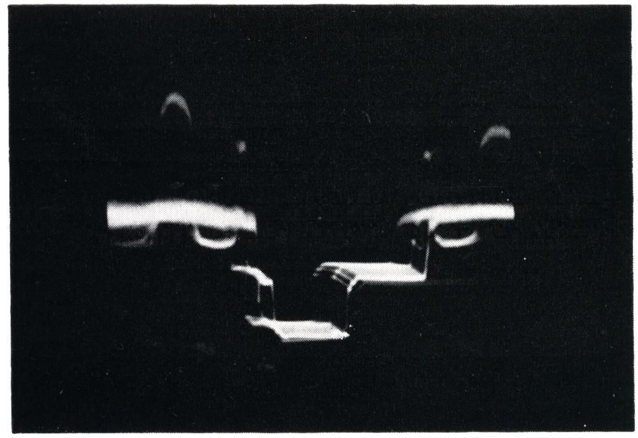


FIG. 141 — CLAMPING FAILURE — EXPANDED HORIZONTAL

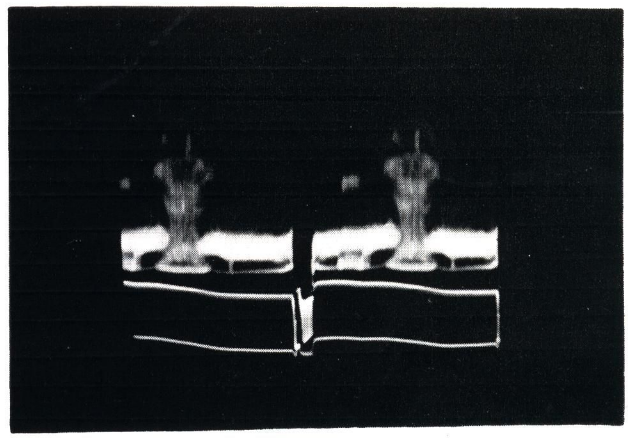


FIG. 142 — CLAMPING FAILURE — VERTICAL

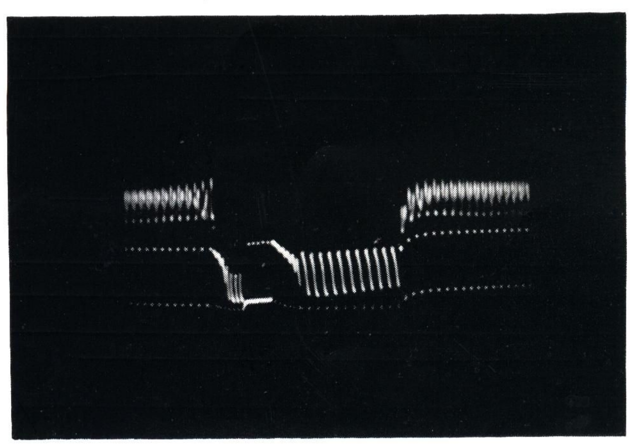


FIG. 143 — CLAMPING FAILURE — EXPANDED VERTICAL

fixed reference voltage, it is subjected to approximately the full clamper correction. The front porch, however, occurs at the end of a line signal, and its level is displaced by the overall frequency distortion change during the preceding line interval. Since the clamper

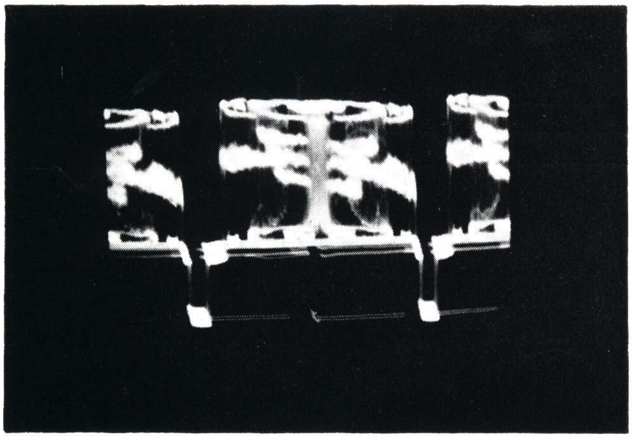


FIG. 144 — LACK OF CLAMPING — HORIZONTAL

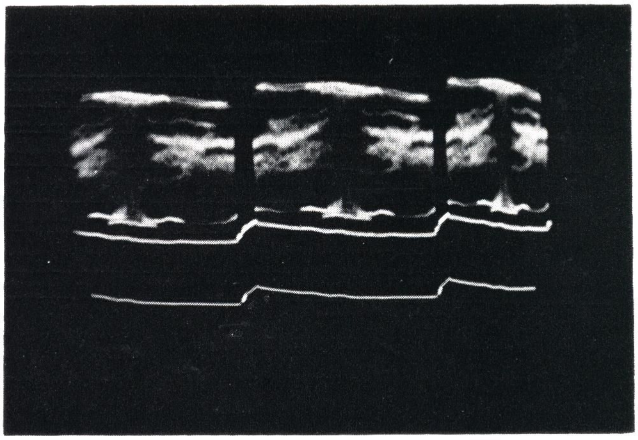


FIG. 145 — LACK OF CLAMPING — VERTICAL

is triggered by the leading edge of the sync pulse, the front porch is unaffected by any subsequent correction that is applied by the clamper. Therefore, if the levels of the front and back porches would be equal except for the low frequency impairment experienced, the correcting voltage supplied by the clamper would be equal to the difference in the level of the two porches. However, porches are frequently displaced due to other causes, such as transmission over a vestigial sideband carrier system where front porch level may vary depending upon the signal level at the end of each scanning line. In general, therefore, porch displacement should not be depended upon as a measure of clamper correction voltage, except under known conditions.

(A-1) LOSS OF CLAMPING (Figs. 139-145) — Loss of clamping results when the output level of the clamper amplifier drops to such a low level as to exceed the range of the clamping amplifier and thus make the clamping action ineffective. Figs. 139-145 show the result of loss of clamping due to low level. Loss of clamping also may be caused by defective tubes or other defective components within the amplifier. Erratic or no clamping action may also result from an overshoot on the leading edge of the front porch sufficiently large to cause the clamper to be falsely triggered, resulting in complete tearing of the picture. In the examples, only a few lines of tearing are visible at the top of the pictures; however, the A-scope reveals an erratic horizontal interval and serious distortion of the vertical blanking interval.

Loss of clamper action on a signal transmitted through a coil is illustrated in Figs. 144 and 145. As previously discussed, the impairments observed due to low frequency distortion are the same as though a low frequency interfering signal were introduced and, therefore, will vary depending upon the nature and amount of low frequency impairment present in the signal being observed. This is shown on the horizontal presentation (Fig. 144) by the thickening of the traces, and in the vertical presentation (Fig. 145) by the varying tilts during vertical blanking and picture intervals.

(B) Serrations (Fig. 146)—Serrations are jaggedness in the vertical and diagonal structure of images as seen in a picture monitor. They result from horizontal displacement of some of the scanning lines due to nonuniformity in the triggering time of the horizontal sweep oscillator. This condition may be caused by a distortion of the leading edge of the sync pulse as a result of interference, streaking, etc. Figure 146 shows serrations of vertical and diagonal lines in the center of the test pattern.

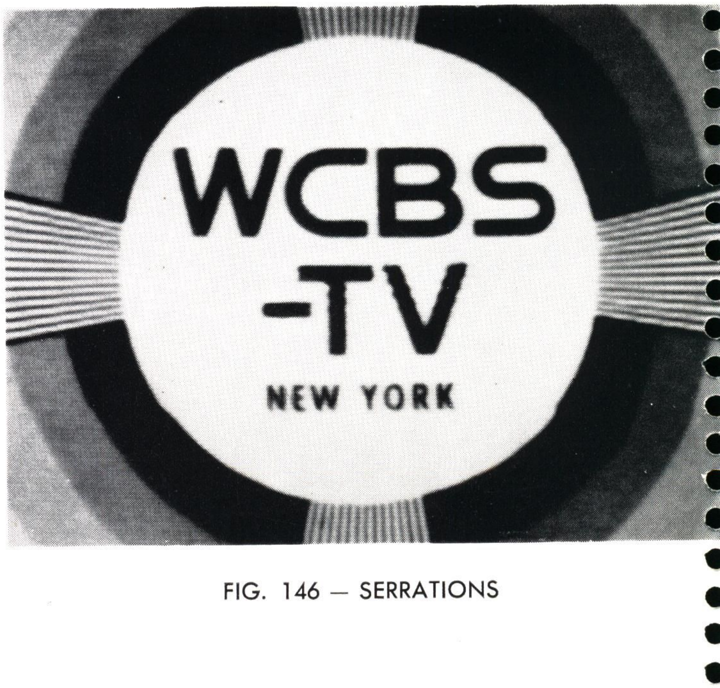


FIG. 146 — SERRATIONS

(C) Tearing (Figs. 147, 148)—Tearing is a horizontal displacement of the scanning lines to the extent that the picture appears torn. Tearing of the picture on the receiver or monitor may be caused by distortion or lack of horizontal sync pulses. It also may be caused by video black peaks or spikes which drop below blanking level near the horizontal sync pulse. Any other form of interference whose amplitude is such as to cause false triggering of the horizontal scanning circuit of a receiver or monitor will give similar effects. One illustration of such tearing is shown in Figure 147.

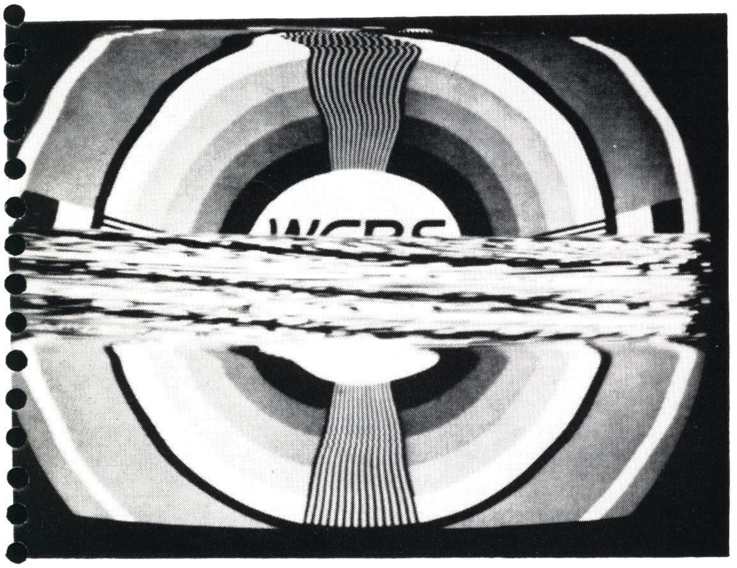


FIG. 147 — TEARING

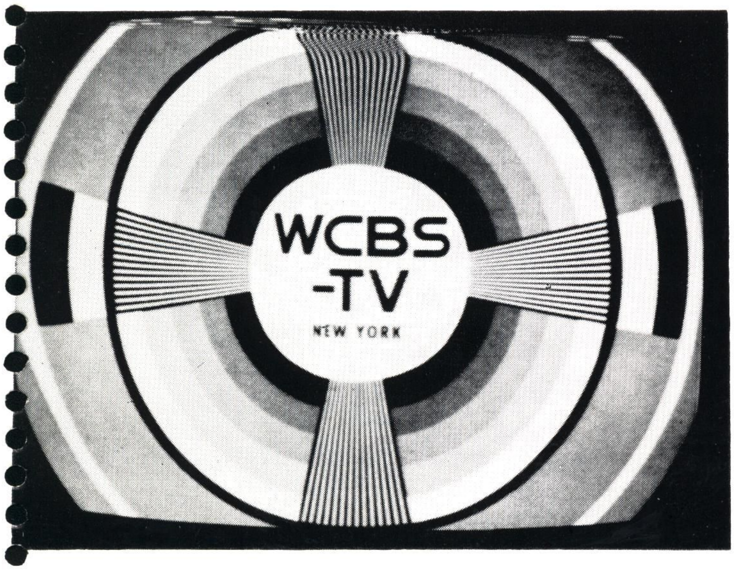


FIG. 148 — TEARING

Tearing at only the top of a picture, as in Fig. 148, is usually caused by impairment or loss of some equalizing pulses. This may be due to sync generator trouble, or improper clamping action due to defective clampers or improper levels.

(D) Non-Linearity (Figs. 149, 151)—The requirement in most transmission circuits and amplifiers that the output be directly proportional to the input over the working range of voltages or power means that these circuits must be "linear." Operation outside the range of linearity may occur when exceeding ratings of equipment, when maladjustments occur, when components such as vacuum tubes age, or due to improper design. The departure from linearity that can be tolerated varies over wide ranges. For example, sync expansion circuits have been built into some telephone company clamper-amplifiers to deliberately "expand" the sync part of the video signal relative to the picture signal to compensate for unwanted compression which may accumulate in transmission. This illustrates that the results of non-linearity may be either compression," which is the more usual, or "expansion."

As discussed in the section on Level Irregularities, is it possible to compress either the negative or the positive peaks of a signal passing through an amplifier. The resulting video signal will contain either "black compression" or "white compression." In analyzing the effects of compression on a sine wave, it can be shown that the compressed signal, in addition to containing the fundamental sine wave, may include a d-c component, and other components made up of harmonics of the original sine wave frequency. When all of these components can be transmitted, the received wave is distorted and limited, as in Figure 149 showing harmonic distortion on the 500 kc burst of a multiburst test signal. Other examples of compression

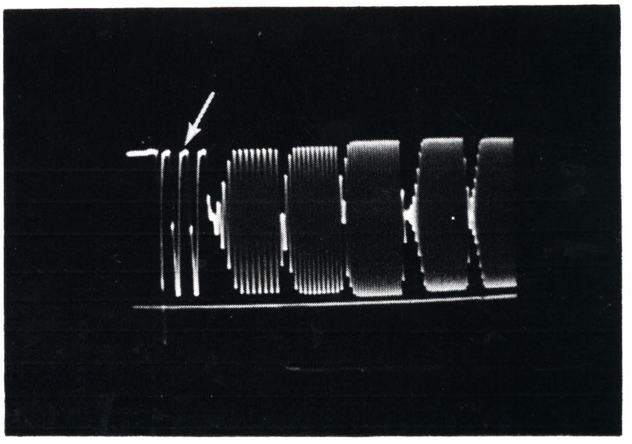


FIG. 149 — HARMONIC DISTORTION — 500 KC

effects are shown in the section of this booklet dealing with level variations such as blooming, bleeding whites, etc. When compression becomes severe it sometimes is called clipping and is observed as a sharp line of demarcation in level beyond which no signal is found.

If the non-linearity is not equal for different impressed frequencies, combinations of effects may result which may be difficult to analyze. Such unequal distortions may occur in feedback amplifiers, where the feedback is a function of frequency in order to maintain overall flatness, or in circuits such as those of video cable amplifiers where the high frequencies are transmitted at somewhat greater levels than the lows in order to partially compensate for succeeding cable loss. Compression of higher frequency components of a signal compared to the lows has been noted fairly frequently.

The multiburst test signal has proved to be a good indicator for this selective type of compression, and may sometimes detect this condition when differential gain measurements indicate no trouble. When this distortion is present, close observation of the higher frequency burst will reveal that the axes of some or all of these bursts are shifted vertically by varying amounts, as in Figure 150. As mentioned above, the distorted

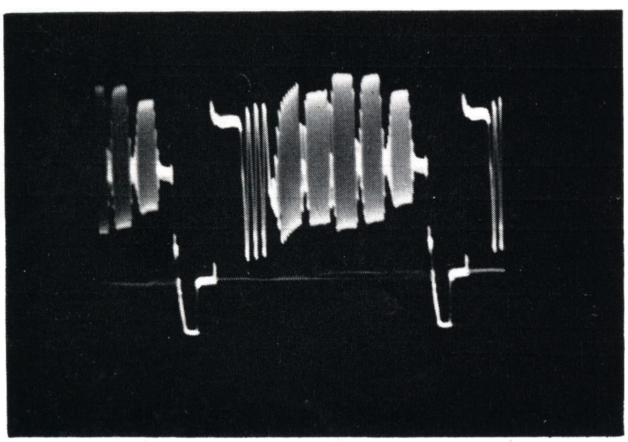


FIG. 150 — AXIS SHIFT

wave contains a d-c, or, in the case of a video type signal, because of the horizontal scanning frequency, a 15,750 cycle component, and harmonics of the distorted burst. For frequencies above about 2.5-3.0 mc, most transmission facilities cut out the burst harmonics leaving only the 15,750 cycle component and the fundamental frequency. This 15,750 cycle component will shift the axis of the multiburst through the burst in question. For frequencies whose second or higher harmonics are passed by the system, the axis shift is not so pronounced, but an expansion of the wave will show distortion, as on the 500 kc burst illustrated in Fig. 149. This shifting of the axis of the bursts has sometimes been called "rectification," because of the

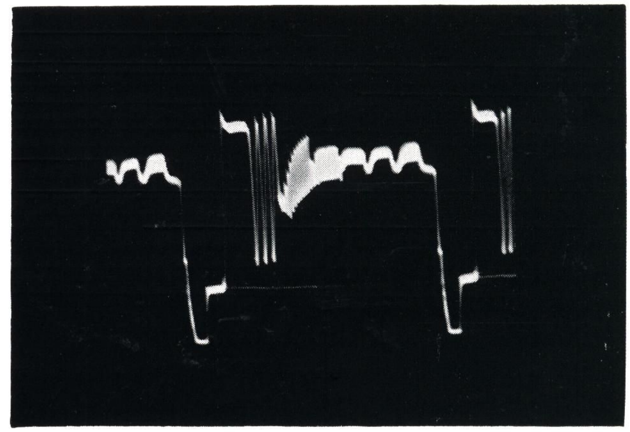


FIG. 151 — AXIS SHIFT — THROUGH LOW PASS FILTER

production of the effective d-c component. Figure 151 is the same signal as Figure 150, but in this case the signal has been put through a low-pass filter which effectively eliminates the higher frequency bursts and makes the axis shift more evident.

(E) Halo (Fig. 152)—Halo usually is the appearance of a black border around unusually bright objects in a televised scene. As shown in Fig. 152, the border may be irregular in size and shape but is easily distinguished from streaking and smearing. It is caused by overloading of the pickup tube in scanning bright objects. While the accompanying figure indicates halo around an object occupying a large part of the viewing screen, it also is commonly noticed when stage lights are reflected from jewelry, eye glasses and other small objects. With certain camera tube operating adjustments, a white area may surround dark objects.

FIG. 152 — HALO

(F) Moiré (Figs. 153, 154)—Meshbeat or moiré effect is the appearance of vertical or diagonal lines on a picture, which resemble high frequency interference. In Figure 153, these lines are most noticeable across the top and bottom of the kitchen cabinet close-up. This difficulty may be caused by image-orthicon cameras where a beat is obtained between the scanning signal and the screen, or mesh, associated with the target plate.

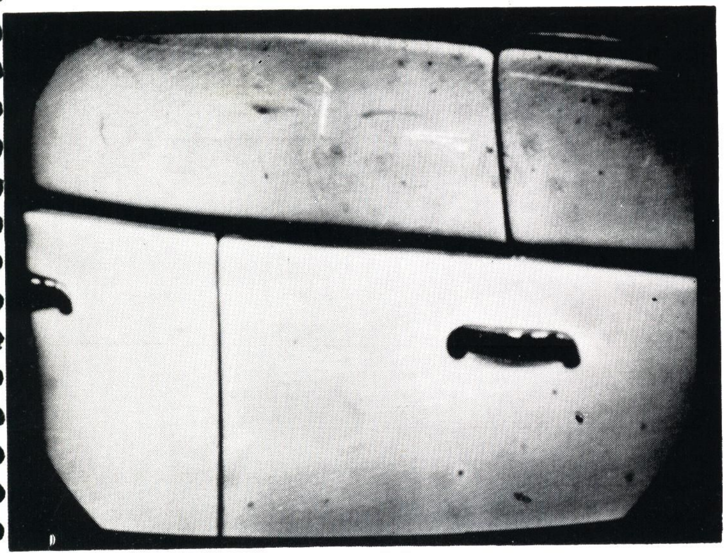


FIG. 153 — MOIRÉ

Moiré pattern is also a natural optical effect when scanning closely spaced picture lines which are almost horizontal. It is evident on the horizontal wedges of the test pattern shown in Figure 154 (which is a reprint of Figure 137, Impulse Noise).

FIG. 154 — MOIRÉ

(G) Burned-In Image (Figs. 155, 156) — A burned-in image is one which persists in the camera output signal when the camera has been focussed on another scene. Figure 155 illustrates the case of a camera having been shifted to one side of a prompting chart, with the original image still visible to the right of the new one. Figure 156 shows a burned-in image of the RETMA test pattern, originally being viewed, superimposed on a close-up of a stove top and grill-work. This phenomenon is associated with orthicon camera tubes where the persistence of the burned-in image depends upon the length of time that the camera is focussed on the original scene, and the brightness of the scene. It may last as long as several minutes in extreme cases.

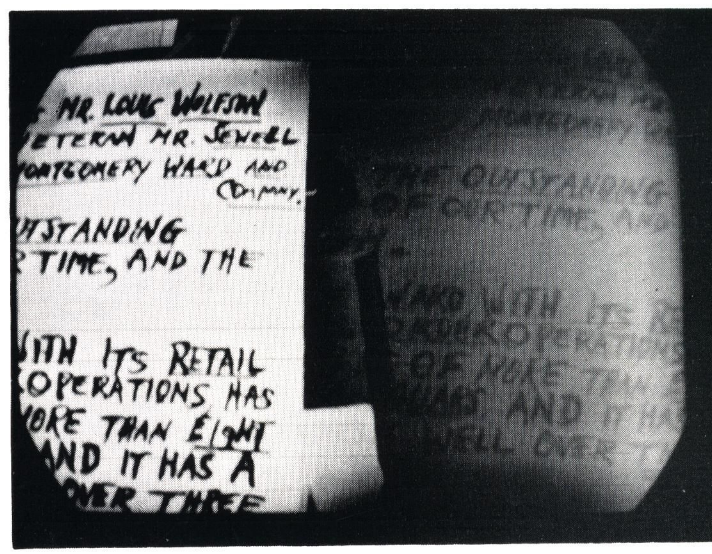


FIG. 155 — BURNED-IN IMAGE

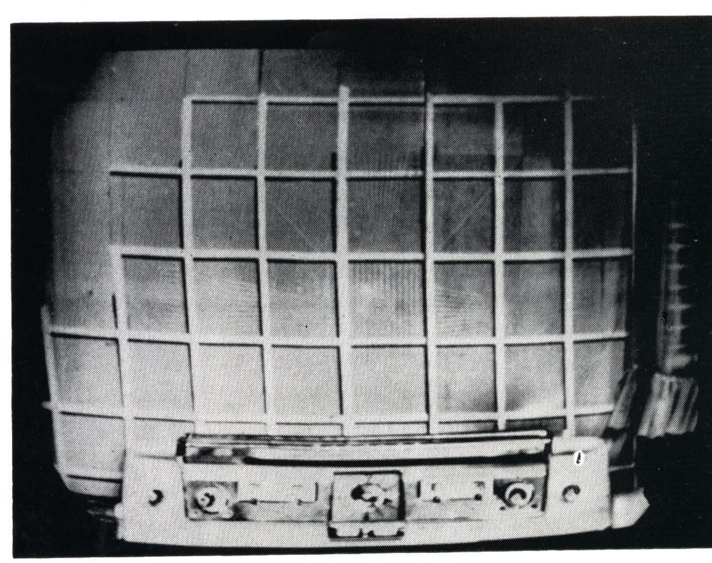


FIG. 156 — BURNED-IN IMAGE

5. Color Signal Impairments

In general, color television signals are subject to the same impairments as monochrome transmissions. However, color television signals may be impaired seriously by additional conditions that might not affect a monochrome picture.

(A) High or Low Chrominance Signal Level — When the chrominance signal component of a color television signal is received at too high a level, colors will increase in saturation; when this component is received at too low a level, colors will tend to wash out. So long as overloading or differential gain is not controlling, the proper relationship in saturation between various hues will be maintained.

A high or low chrominance signal level occurring when luminance signal levels are normal would result from excess gain or loss at the upper portion of the video signal frequency spectrum.

Since the color burst has the same frequency as the color sub-carrier, any transmission characteristic affecting the amplitude of the chrominance signal will usually also affect the amplitude of the color burst (Figs. 157, 158). For rapid location of large deviations it is possible, using an A-scope with a wide band characteristic, to observe the color signal wave form for comparison of color burst and sync pulse amplitudes, which should be the same. However, a comparative measurement of color burst amplitudes is necessary for more precise locations.

Because results can be expressed quantitatively, A-scope location of impairments can usually be made more accurately and rapidly than would be possible using color monitors, although color monitors may be used also for verification.

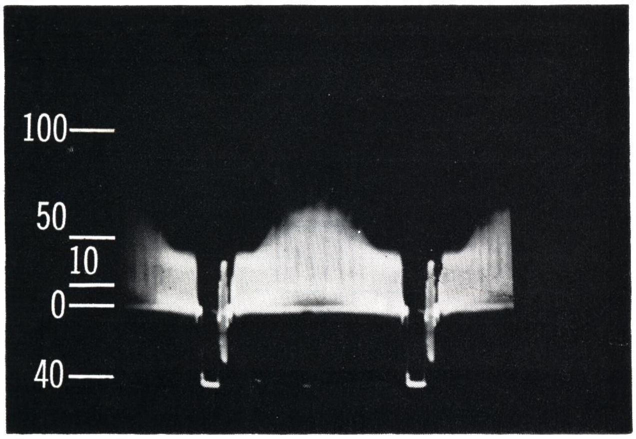


FIG. 157 — HIGH LEVEL CHROMINANCE SIGNAL — HORIZONTAL

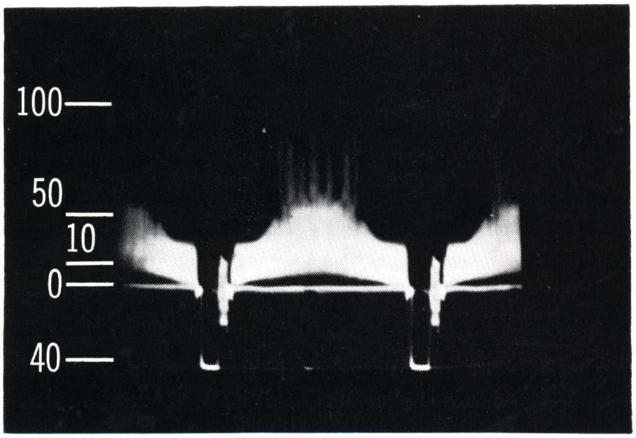


FIG. 158 — LOW LEVEL CHROMINANCE SIGNAL — HORIZONTAL

(B) Loss of Color—In the general case this is caused by very low chrominance signal level. However, such a condition has occurred with an apparently normal color burst, as viewed on an A-scope. In this case, the frequency of the apparent color burst had been shifted from the normal 3.6 mc value during transmission. Color monitors are required for quick location in such cases.

(C) Differential Phase Distortion (Figs. 159, 161) — Differential phase is the change in phase of the 3.6 mc color sub-carrier as the level of the luminance signal on which it rides is varied from blanking to white. It causes error in portrayal of hues. Figs. 159 and 161 illustrate large amounts of differential phase of opposite signs, as compared to Fig. 160 which is a "normal" picture.

In FM radio relay systems, this distortion is usually caused by a non-uniform delay-frequency characteristic in the IF equipment, where varying amplitudes of input signal are represented by varying frequencies. The color burst is always at blanking level and, therefore, will always swing about the same frequency on the radio relay system. Color components of the signal generally are not at blanking level; therefore, the FM swing will be about a different frequency and any difference in delay between the two results in differential phase. In telephone company systems, delay equalizers in IF paths are used to correct for differential phase.

In addition to FM radio systems, differential phase distortion may be experienced in any equipment having transmission paths that vary in phase with level. Hue impairments are observable in color picture monitors, but are not apparent in either monochrome picture monitors or in A-scopes. Color monitors are neither sufficiently precise nor stable to use as a basis for correction of differential phase, and it is therefore necesary to release facilities from service in order to make differential phase measurements. The 47A transmission measuring system is used for proper adjustment of differential phase equalizers.

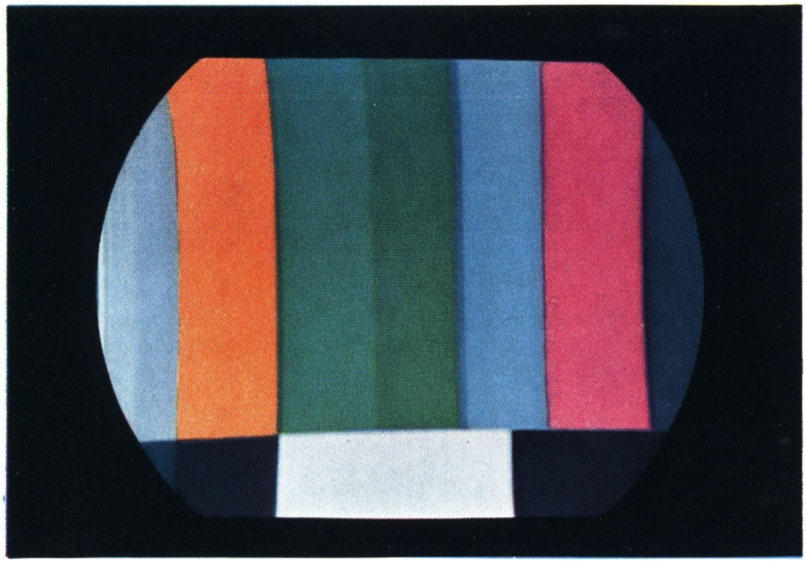


FIG. 159 — COLOR BAR SIGNAL —
YELLOW SHIFTED TOWARD RED

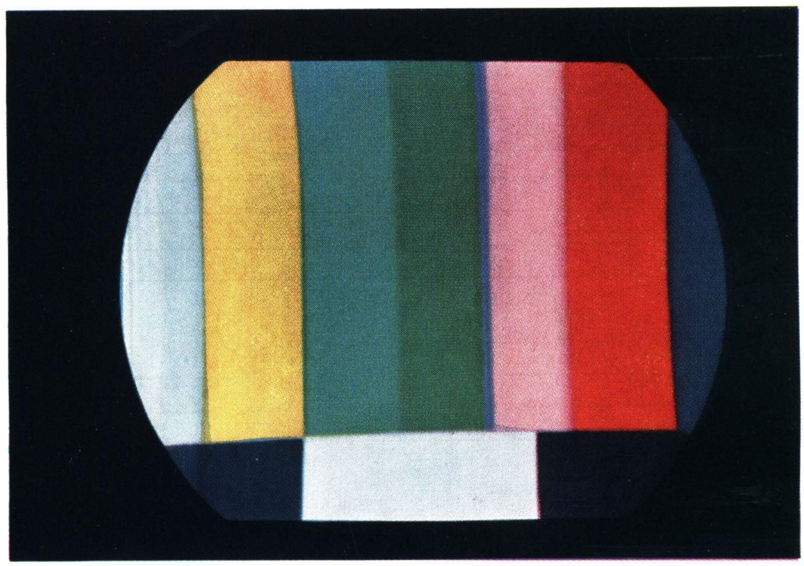


FIG. 160 — COLOR BAR SIGNAL — NORMAL PHASE

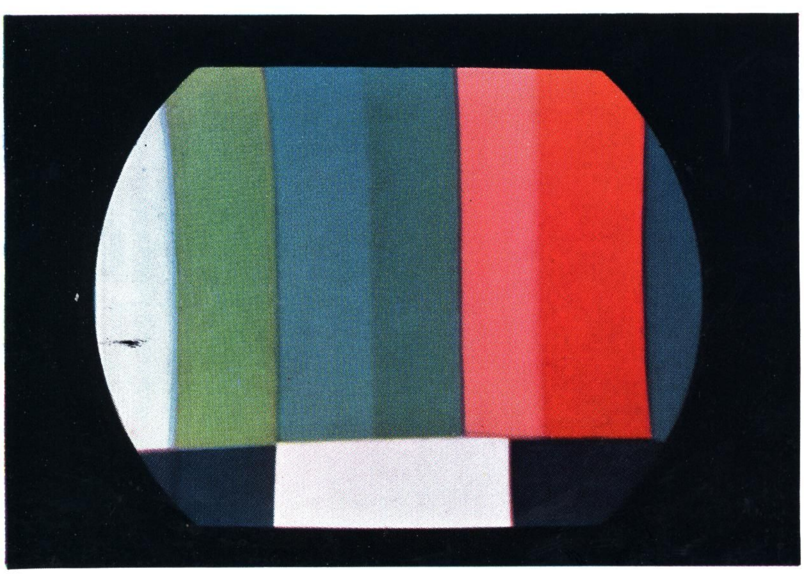


FIG. 161 — COLOR BAR SIGNAL —
YELLOW SHIFTED TOWARD GREEN

(D) Differential Gain Distortion—In color television transmission, differential gain is the change in gain of the 3.6 mc color sub-carrier as the level of the luminance signal on which it rides is varied from blanking to white. It causes error in color saturation of the received picture.

Differential gain is generally observed as signal compression as luminance levels are increased, although expansion can be experienced. The effects of differential gain may be observable in color monitors, depending upon degree. Severe cases of such signal impairment should be evidenced in the A-scope presentation of a color bar test signal as an overloading or expansion condition of the chrominance components. Other than for severe conditions of this type, the facility or equipment to be tested must be released from service for differential gain tests to enable location of causative facility sections.

When excess differential gain is experienced, the first step is to assure that proper amplitude levels have been maintained. Further investigation would include location of the portions of the layout or piece of equipment contributing appreciably to this condition. Clearance is then generally accomplished by replacement of tubes or other defective components.

(E) Leading or Lagging Chrominance — When the chrominance signal is not received at the same time as the luminance signal, colors will appear in the color picture monitor either to one side or the other of the image. For example, a blob of red may occur at lip level to one side or the other of a face. Since the synchronizing of the color signal is governed by the color burst, observation of an A-scope having wide band characteristic will reveal whether the color burst has been shifted from normal position in the back porch interval. A shift to the left results in leading chrominance information. When severe, this impairment might be observed as edge effect on monochrome pictures transmitted over the same facility.

This condition can result from improper delay relationship between the lower and the upper portions of the frequency spectrum over transmission facilities or through equipment. Therefore, envelope delay characteristics of television layouts in color condition should be checked should leading or lagging chrominance be experienced.

Glossary of Television Terms

1. General

This Section defines various terms presently used in the line-up, operation and maintenance of video transmission systems. Experience in providing video service has indicated that a common understanding and use of the terms outlined in this section by the Telephone Companies and the Broadcasting Companies is desirable. Because these terms are intended for practical use by operating personnel, they may differ somewhat in wording from published standards which are not as well suited for the intended purpose.

2. Terms and Definitions

Aspect Ratio: The numerical ratio of picture width to height.

Back Porch: That portion of the composite picture signal which lies between the trailing edge of the horizontal sync pulse and the trailing edge of the corresponding blanking pulse.

Back Porch Tilt: The slope of the back porch from its normal horizontal position. Positive or negative refer respectively to upward or downward tilt to the right.

Bandwidth: The number of cycles per second expressing the difference between the limiting frequencies of a frequency band. For example, the 2.5-3.5 mc band has a width of 1 mc.

Black Compression: Amplitude compression of the signals corresponding to the black regions of the picture, thus modifying the tonal gradient.

Black Peak: The maximum excursion of the picture signal in the black direction at the time of observation.

Blacker-than-Black: The amplitude region of the composite video signal below reference black level in the direction of the synchronizing pulses.

Blanking (Picture): The portion of the composite video signal whose instantaneous amplitude makes the vertical and horizontal retrace invisible.

Blanking Level: The level of the front and back porches of the composite video signal.

Bleeding Whites: An overloading condition in which white areas appear to flow irregularly into black areas.

Blooming: The defocussing of regions of the picture where the brightness is at an excessive level, due to enlargement of spot size and halation of the fluorescent screen of the cathode-ray picture tube.

Bounce: An unnatural sudden variation in the brightness of the picture.

Breathing: Amplitude variations similar to "bounce" but at a slow regular rate.

Breezeway: In NTSC color, that portion of the back porch between the trailing edge of the sync pulse and the start of the color burst.

Burned-in Image: An image which persists in a fixed position in the output signal of a camera tube after the camera has been turned to a different scene.

Camera Tube: See pickup tube.

Cathode-ray Tube: An electron tube assembly containing an electron gun arranged to direct a beam upon a fluorescent screen. Scanning by the beam can produce light at all points in the scanned raster.

Chrominance Signal: That portion of the NTSC color television signal which contains the color information.

Clamper: A device which functions during the horizontal blanking or sync interval to fix the level of the picture signal at some predetermined reference level at the beginning of each scanning line.

Clamping: The process that establishes a fixed level for the picture signal at the beginning of each scanning line.

Clipping: The shearing off of the peaks of a signal. For a picture signal this may affect either the positive (white) or negative (black) peaks. For a composite video signal, the sync signal may be affected.

Color Burst: In NTSC color, normally refers to a burst of approximately 9 cycles of 3.6 mc subcarrier on the back porch of the composite video signal. This serves as a color synchronizing signal to establish a frequency and phase reference for the chrominance signal.

Color Sub-carrier: In NTSC color, the carrier whose modulation sidebands are added to the monochrome signal to convey color information, — i.e., 3.6 mc (3.579545 mc).

Color Transmission: The transmission of a signal which represents both the brightness values and the color (chrominance) values in a picture.

Composite Video Signal: The complete video signal. For monochrome, it consists of the picture signal and the blanking and synchronizing signals. For color, additional color synchronizing signals and color picture information are added.

Compression: An undesired decrease in amplitude of a portion of the composite video signal relative to that of another portion. Also, a less than proportional change in output of a circuit for a change in input level. For example, compression of the sync pulse means a decrease in the percentage of sync during transmission.

Contrast: The range of light and dark values in a picture, or the ratio between the maximum and minimum brightness values. For example, in a high contrast picture there would be intense blacks and whites whereas a low contrast picture would contain only various shades of gray.

Crosstalk: An undesired signal interfering with the desired signal.

Cut-off Frequency: That frequency beyond which no appreciable energy is transmitted. It may refer to either an upper or lower limit of a frequency band.

Damped Oscillation: Oscillation which, because the driving force has been removed, gradually dies out, each swing being smaller than the preceding in smooth regular decay.

Definition: See Resolution—(Horizontal) and (Vertical).

Delay Distortion: Distortion resulting from non-uniform speed of transmission of the various frequency components of a signal; i.e., the various frequency components of the signal have different times of travel (delay) between the input and the output of a circuit.

Detail: Refers to the most minute elements in a picture which are distinct and recognizable. Similar to definition or resolution.

Differential Gain: The amplitude change, usually of the 3.6 mc color subcarrier, introduced by the overall circuit, measured in db or per cent, as the subcarrier is varied from blanking to white level.

Differential Phase: The phase change of the 3.6 mc color subcarrier introduced by the overall circuit, measured in degrees, as the subcarrier is varied from blanking to white level.

Displacement of Porches: Refers to any difference between the level of the front porch and the level of the back porch.

Distortion: The departure, during transmission or amplification, of the received signal wave form from that of the original transmitted wave form.

Driving Signals: Signals that time the scanning at the pickup device.

Echo (or Reflection): A wave which has been reflected at one or more points in the transmission medium, with sufficient magnitude and time difference to be perceived in some manner as a wave distinct from that of the main or primary transmission. Echoes may be either leading or lagging the primary wave and appear in the picture monitor as reflections or "ghosts."

Edge Effect: See Following or Leading White and Following or Leading Black.

Equalizing Pulses: Pulses of one-half the width of the horizontal sync pulses which are transmitted at twice the rate of the horizontal sync pulses during the blanking intervals immediately preceding and following the vertical sync pulses. The action of these pulses causes the vertical deflection to start at the same time in each interval, and also serves to keep the horizontal sweep circuits in step during the vertical blanking intervals immediately preceding and following the vertical sync pulse.

Expansion: An undesired increase in amplitude of a portion of the composite video signal relative to that of another portion. Also, a greater than proportional change in the output of a circuit for a change in input level. For example, expansion of the sync pulse means an increase in the percentage of sync during transmission.

Field: One-half of a complete picture (or frame) interval, containing all of the odd or even scanning lines of the picture.

Field Frequency: The rate at which a complete field is scanned, nominally 60 times a second.

Flash: Momentary interference to the picture of a duration of approximately one field or less, and of sufficient magnitude to totally distort the picture information. In general, this term is used alone when the impairment is of such short duration that the basic impairment cannot be recognized. Sometimes called "Hit."

Fly-back: See horizontal retrace.

Following (or Trailing) Blacks: A term used to describe a picture condition in which the edge following a white object is overshaded toward black. The object appears to have a trailing black border. Also called "trailing reversal."

Following (or Trailing) Whites: A term used to describe a picture condition in which the edge following a black or dark gray object is shaded toward white. The object appears to have a trailing white border. Also called "trailing reversal."

Frame: One complete picture consisting of two fields of interlaced scanning lines.

Frame Frequency: The rate at which a complete frame is scanned, nominally 30 frames per second.

Front Porch: That portion of the composite picture signal which lies between the leading edge of the horizontal blanking pulse, and the leading edge of the corresponding sync pulse.

Frame Roll: A momentary roll.

Gain-frequency Distortion: Distortion which results when all of the frequency components of a signal are not transmitted with the same gain or loss. A departure from "flatness" in the gain-frequency characteristic of a circuit.

Ghost: A shadowy or weak image in the received picture, offset either to the left or right of the primary image, the result of transmission conditions which create secondary signals that are received earlier or later than the main or primary signal. A ghost displaced to the left of the primary image is designated as "leading" and one displaced to the right is designated as "following" (lagging). When the tonal variations of the ghost are the same as the primary image, it is designated as "positive" and when it is the reverse, it is designated as "negative."

Glitch: A form of low frequency interference, appearing as a narrow horizontal bar moving vertically through the picture. This is also observed on an oscilloscope at field or frame rate as an extraneous voltage pip moving along the signal at approximately reference black level.

Halo: Most commonly, a dark area surrounding an unusually bright object, caused by overloading of the camera tube. Reflection of studio lights from a piece of jewelry, for example, might cause this effect. With certain camera tube operating adjustments, a white area may surround dark objects.

Height: The size of the picture in a vertical direction.

High-frequency Distortion: Distortion effects which occur at high frequency. Generally considered as any frequency above the 15.75 kc line frequency.

High-frequency Interference: Interference effects which occur at high frequency. Generally considered as any frequency above the 15.75 kc line frequency.

High-lights: The maximum brightness of the picture, which occurs in regions of highest illumination.

Hit: See Flash.

Horizontal Blanking: The blanking signal at the end of each scanning line.

Horizontal Displacements: Describes a picture condition in which the scanning lines start at relatively different points during the horizontal scan. See serrations and jitter.

Horizontal Retrace: The return of the electron beam from the right to the left side of the raster after the scanning of one line.

Horizontal (Hum) Bars: Relatively broad horizontal bars, alternately black and white, which extend over the entire picture. They may be stationary, or may move up or down. Sometimes referred to as a "venetian blind" effect. Caused by approximate 60 cycle interfering frequency, or one of its harmonic frequencies.

Hue: Corresponds to "color" in everyday use; i.e., red, blue, etc. Black, white and gray do not have hue.

Iconoscope: A camera tube in which a high-velocity electron beam scans a photoemissive mosaic which has electrical storage capability.

Interference: In a signal transmission path, extraneous energy which tends to interfere with the reception of the desired signals.

Interlaced Scanning (Interlace): A scanning process in which each adjacent line belongs to the alternate field.

Ion: A charged atom, usually an atom of residual gas in an electron tube.

Ion Spot: A spot on the fluorescent surface of a cathode-ray tube, which is somewhat darker than the surrounding area because of bombardment by negative ions which reduce the sensitivity.

Ion Trap: An arrangement of magnetic fields and apertures which will allow an electron beam to pass through but will obstruct the passage of ions.

IRE: The Institute of Radio Engineers.

IRE Roll-off: The IRE standard oscilloscope frequency response characteristic for measurement of level. This characteristic is such that at 2 megacycles the response is approximately 3.5 db below that in the flat (low frequency) portion of the spectrum, and cuts off slowly.

IRE Scale: An oscilloscope scale in keeping with IRE Standard 50, IRE 23.S1 and the recommendations of the Joint Committee of TV Broadcasters and Manufacturers for Coordination of Video Levels.

Jitter: A tendency toward lack of synchronization of the picture. It may refer to individual lines in the picture or to the entire field of view.

Kinescope: Frequently used to mean picture tubes in general. However, this name has been copyrighted.

Kinescope Recording: A motion picture film recording of the presentation shown by a picture monitor. Also known as Television Recording (TVR), Vitapix, etc.

Leading Blacks: A term used to describe a picture condition in which the edge preceding a white object is overshaded toward black. The object appears to have a preceding or leading black border.

Leading Whites: A term used to describe a picture condition in which the edge preceding a black object is shaded toward white. The object appears to have a preceding or leading white border.

Line Frequency: The number of horizontal scans per second, nominally 15,750 times per second.

Low-frequency Distortion: Distortion effects which occur at low frequency. Generally considered as any frequency below the 15.75 kc line frequency.

Low-frequency Interference: Interference effects which occur at low frequency. Generally considered as any frequency below the 15.75 kc line frequency.

Luminance Signal: That portion of the NTSC color television signal which contains the luminance or brightness information.

Meshbeat: See moiré.

Microphonics: In video transmission, refers to the mechanical vibration of the elements of an electron tube resulting in a spurious modulation of the normal signal. This usually results in erratically spaced horizontal bars in the picture.

Microsecond: One millionth of a second.

Moiré: A wavy or satiny effect produced by convergence of lines. Usually appears as a curving of the lines in the horizontal wedges of the test pattern and is most pronounced near the center where the lines forming the wedges converge. A Moiré pattern is a natural optical effect when converging lines in the picture are nearly parallel to the scanning lines. This effect to a degree is sometimes due to the characteristics of color picture tubes and of image orthicon pick up tubes (in the latter termed "meshbeat").

Monochrome Transmission (Black and White). The transmission of a signal wave which represents the brightness values in the picture, but not the color (chrominance) values in the picture.

Multiple Blanking Lines: Evidenced by a thickening of the blanking line trace or by several distinct blanking lines as viewed on an oscilloscope. May be caused by hum.

Negative Image: Refers to a picture signal having a polarity which is opposite to normal polarity and which results in a picture in which the white areas appear as black and vice versa.

NTSC: National Television System Committee.

Noise: The word "noise" is a carryover from audio practice. Refers to random spurts of electrical energy or interference. May produce a "salt-and-pepper" pattern over the picture. Heavy noise sometimes is called "snow."

Orthicon (Conventional): A camera tube in which a low-velocity electron beam scans a photoemissive mosaic on which the image is focussed optically and which has electrical storage capability.

Orthicon (Image): A camera tube in which the optical image falls on a photoemissive cathode which emits electrons that are focussed on a target at high velocity. The target is scanned from the rear by a low-velocity electron beam. Return beam modulation is amplified by an electron multiplier to form an overall light-sensitive device.

Orthicon Effect: One or more of several image orthicon impairments that have been referred to as "Orthicon Effect" as follows:

1. Edge effect
2. Meshbeat or moiré
3. Ghost
4. Halo
5. Burned in image

It is obviously necessary to indicate specifically the effect or effects experienced and, therefore, it is recommended that use of this term be discontinued.

Overshoot: An excessive response to a unidirectional signal change. Sharp overshoots are sometimes referred to as "spikes."

Pairing: A partial or complete failure of interlace in which the scanning lines of alternate fields do not fall exactly between one another but tend to fall (in pairs) one on top of the other.

Peak-to-Peak: The amplitude (voltage) difference between the most positive and the most negative excursions (peaks) of an electrical signal.

Pedestal: This term is obsolete.

Pedestal Level: This term is obsolete; "blanking level" is preferred.

Percentage Sync: The ratio, expressed as a percentage, of the amplitude of the synchronizing signal to the peak-to-peak amplitude of the picture signal between blanking and reference white level.

Photoemissive: Emitting or capable of emitting electrons upon exposure to radiation in and near the visible region of the spectrum.

Pickup Tube: An electron-beam tube used in a television camera where an electron current or a charge-density image is formed from an optical image and scanned in a predetermined sequence to provide an electrical signal.

Picture Monitor: This refers to a cathode-ray tube and its associated circuits, arranged to view a television picture.

Picture Signal: That portion of the composite video signal which lies above the blanking level and contains the picture information.

Picture Tube: A cathode-ray tube used to produce an image by variation of the intensity of a scanning beam.

Pigeons: Noise observed on picture monitors as pulses or bursts of short duration, at a slow rate of occurrence—a type of impulse noise.

Polarity of Picture Signal: Refers to the polarity of the black portion of the picture signal with respect to the white portion of the picture signal. For example, in a "black negative" picture, the potential corresponding to the black areas of the picture is negative with respect to the potential corresponding to the white areas of the picture, while in a "black positive" picture the potential corresponding to the black areas of the picture is positive. The signal as observed at broadcasters master control rooms and telephone company television operating centers is "black negative."

Pre-emphasis (Predistortion). A change in level of some frequency components of the signal with respect to the other frequency components at the input to a transmission system. The high frequency portion of the band is usually transmitted at higher level than the low frequency portion of the band.

Raster: The scanned (illuminated) area of the cathode-ray picture tube.

Reference Black Level: The level corresponding to the specified maximum excursion of the luminance signal in the black direction.

Reference White Level: The level corresponding to the specified maximum excursion of the luminance signal in the white direction.

Reflections or Echos: In video transmission this may refer either to a signal or to the picture produced.

1. Signal:
   - 1(a). Waves reflected from structures or other objects.
   - 1(b). Waves which are the result of impedance or other irregularities in the transmission medium.
2. Picture: "Echoes" observed in the picture produced by the reflected waves.

Resolution (Horizontal): The amount of resolvable detail in the horizontal direction in a picture. It is usually expressed as the number of distinct vertical lines, alternately black and white, which can be seen in three-quarters of the width of the picture. This information usually is derived by observation of the vertical wedge of a test pattern. A picture which is sharp and clear and shows small details has good, or high, resolution. If the picture is soft and blurred and small details are indistinct it has poor, or low, resolution. Horizontal resolution depends upon the high-frequency amplitude and phase response of the pickup equipment, the transmission medium and the picture monitor, as well as the size of the scanning spots.

Resolution (Vertical): The amount of resolvable detail in the vertical direction in a picture. It is usually expressed as the number of distinct horizontal lines, alternately black and white, which can be seen in a test pattern. Vertical resolution is primarily fixed by the number of horizontal scanning lines per frame. Beyond this, vertical resolution depends on the size and shape of the scanning spots of the pickup equipment and picture monitor and does not depend upon the high-frequency response or bandwidth of the transmission medium or picture monitor.

Restorer: As used by the telephone company, a network designed to remove the effects of predistortion or pre-emphasis, thereby resulting in an overall normal characteristic.

RETMA: Abbreviation for Radio Electronic Television Manufacturers Association.

Retrace (Return trace): See Horizontal and Vertical Retrace.

R-F Pattern: A term sometimes applied to describe a fine herringbone pattern in a picture. May also cause a slight horizontal displacement of scanning lines resulting in a rough or ragged vertical edge of the picture. Caused by high-frequency interference.

Ringing: An oscillatory transient occurring in the output of a system as a result of a sudden change in input. Results in close spaced multiple reflections, particulary noticeable when observing test patterns, equivalent square waves, or any fixed objects whose reproduction requires frequency components approximating the cut-off of the system.

Roll: A lack of vertical synchronization which causes the picture as observed on the picture monitor to move upward or downward.

Roll-off: A gradual attenuation of gain-frequency response at either or both ends of the transmission pass band.

Saturation (Color): The "vividness" of a color described by such terms as pale, deep, pastel, etc. The greater the amplitude of the chrominance signal, the greater the saturation.

Scanning: The process of breaking down an image into a series of elements or groups of elements representing light values and transmitting this information in time sequence.

Scanning Line: A single continuous narrow strip of the picture area containing high lights, shadows, and half-tones, determined by the process of scanning.

Scanning Spot: Refers to the cross-section of an electron beam at the point of incidence in a camera tube or picture tube.

Serrated Pulses: A series of equally spaced pulses within a pulse signal. For example, the vertical sync pulse is serrated in order to keep the horizontal sweep circuits in step during the vertical sync pulse interval.

Serrations: This is a term used to describe a picture condition in which vertical or nearly vertical lines have a saw-tooth appearance. The result of scanning lines starting at relatively different points during the horizontal scan.

Setup: The separation in level between blanking and reference black levels.

Smear: A term used to describe a picture condition in which objects appear to be extended horizontally beyond their normal boundaries in a blurred or "smeared" manner.

Snow: Heavy random noise.

Spike: See overshoot.

Streaking: A term used to describe a picture condition in which objects appear to be extended horizontally beyond their normal boundaries. This will be more apparent at vertical edges of objects when there is a large transition from black to white or white to black. The change in luminance is carried beyond the transition, and may be either negative or positive. For example, if the tonal degradation is an opposite shade to the original figure, (white following black), the streaking is called negative; however, if the shade is the same as the original figure, (white following white), the streaking is called positive. Streaking is usually expressed as short, medium or long streaking. Long streaking may extend to the right edge of the picture, and in extreme cases of low-frequency distortion, can extend over a whole line interval.

Synchronization: The maintenance of one operation in step with another.

Sync: An abbreviation for the words "synchronization," "synchronizing," etc. Applies to the synchronization signals, or timing pulses, which lock the electron beam of the picture monitors in step, both horizontally and vertically, with the electron beam of the pickup tube. The color sync signal (NTSC) is known as the color burst.

Sync Compression: The reduction in the amplitude of the sync signal, with respect to the picture signal, occurring between two points of a circuit.

Sync Level: The level of the tips of the synchronizing pulses.

Tearing: A term used to describe a picture condition in which groups of horizontal lines are displaced in an irregular manner. Caused by lack of horizontal synchronization.

Television Recording (TVR): See Kinescope Recording.

Transients: Signals which endure for a brief time prior to the attainment of a steady state condition. These may include overshoots, damped sinusoidal waves, etc. and therefore, additional qualifying information is necessary.

Vertical Blanking: Refers to the blanking signals which occur at the end of each field.

Vertical Retrace: The return of the electron beam from the bottom to the top of the raster after completion of each field.

Vestigial Sideband Transmission: A system of transmission wherein the sideband on one side of the carrier is transmitted only in part.

Video: A term pertaining to the bandwidth and spectrum position of the signal which results from television scanning and which is used to reproduce a picture.

Video Band: The frequency band utilized to transmit a composite video signal.

Video-in-Black: A term used to describe a condition as seen on the wave-form monitor when the black peaks extend through reference black level.

Wave-form Monitor: This refers to a cathode-ray oscilloscope used to view the form of the composite video signal for wave form analysis. Sometimes called "A-scope."

White Compression: Amplitude compression of the signals corresponding to the white regions of the picture, thus modifying the tonal gradient.

White Peak: The maximum excursion of the picture signal in the white direction at the time of observation.

Width: The size of the picture in a horizontal direction.

3. Degrees of Impairments

Television picture impairments may be present in varying degrees. In the case of oscilloscope presentations, most impairments can best be described to remote points by indicating the IRE scale readings of the various signal components. In the case of picture monitor presentations, however, impairments generally must be described in qualitative terms rather than quantitative terms, and the exchange of intelligence between remote observers is more complicated. The following descriptive terms, without a sharp line of demarcation being possible, are in common usage for indicating the magnitude of impairments:

Detectable: Impairment is not readily noticeable in a normal picture or oscilloscope display, but can be discerned by a minute inspection of the signal, it sometimes being necessary to vary picture monitor brightness or expand oscilloscope presentations.

Noticeable: Impairment is readily observed.

Objectionable: Impairment interferes with the viewing of the picture.

Uncommercial: Impairment is present to such degree that the program or portion of the program is not broadcast.

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