Design Considerations for Minimizing Ripple and Interference Effects in Horizontal-Deflection Circuits

This Note describes methods for identifying and eliminating some picture disturbances which originate in the horizontal-deflection circuits of television receivers. The effects discussed are ripple, which appears as alternate dark and light vertical bands in the raster, and 'spook' interference, which appears as a narrow black vertical band very near the left margin of the raster. Although ripple is frequently called 'ringing', the term 'ringing' more aptly describes only one of several possible causes of ripple.

Ripple Due to Beam-Current Modulation

The specific cause of ripple can usually be determined from the appearance of the raster and a few simple tests. The first step in locating the specific cause should be to determine whether the ripple is caused by modulation of the picture-tube beam current or by modulation of the scanning current. Modulation of the beam current results from coupling between the deflection circuits and the video-amplifier or kinescope-grid circuits. Because such coupling does not affect scanning, no change in horizontal linearity is associated with ripple due to beam modulation. Observation of the circle of a test pattern or, preferably, of a straight diagonal line in a picture will usually indicate if any linearity disturbance is present. The placement of two capacitors, 0.5 microfarad or larger, at the socket of the kinescope, one between grid No. 1 and cathode and the other between grid No. 2 and cathode, should eliminate any ripple due to modulation of the beam current. If this test indicates that coupling between the deflection circuits and the video circuits is the cause of ripple, conventional methods may be used to locate and eliminate the coupling.

Ripple Due to Modulation of the Scanning Current

Scanning-Current Modulation Originating in the Deflecting Yoke—

One common cause of ripple is improper neutralization of the horizontal-deflecting coils. Improper neutralization results in modulation of the scanning current and, consequently, variations in horizontal linearity. Distinguishing characteristics of this kind of ripple are:

1. The raster lines are wavy in the vicinity of the ripple.
2. Ripple is most intense at the extreme left of the raster.
3. The ripple is not uniform in appearance from top to bottom of the raster; it is usually barely perceptible at a point near the center (vertically) of the raster.
4. Marked changes in beam focus may be apparent in the vicinity of the ripple.
5. The appearance of the ripple may be changed by adjustment of the ion-trap magnet or other device which alters the position of the beam inside the neck of the kinescope.

Although some of these symptoms could be caused by omission or a marked change in value of the damping resistor across each vertical-deflecting coil, these resistors are rarely omitted and their value is not critical. The usual cause of these symptoms is improper neutralization of the horizontal-deflecting coils. Neutralization is accomplished with specific values of series resistance and capacitance across the horizontal-deflecting coil which is at the highest ac potential above ground. For satisfactory neutralization, the value of resistance is not critical; in the laboratory, adequate neutralization can usually be obtained with no resistor by exact adjustment of a variable capacitor. The major advantage of using the resistor is that the adjustment becomes less critical and, therefore, in practice a capacitor of fixed value can be employed. However, even when the resistor is used, the capacitor tolerances should not exceed five per cent.

Although the values of resistance and capacitance in the yoke-neutralizing network may be correct, almost all yokes produce a series of two or three very narrow bright vertical lines at the extreme left of the raster. Although this disturbance exhibits all of the symptoms enumerated above, it is not eliminated by conventional methods of yoke neutralization. Fortunately, this type of disturbance, which is difficult to eliminate, is usually in the blanked portion of the raster and off the screen. The cause of this remaining ripple is apparently imperfect coupling between the windings of the individual deflecting coils. Because it is impracticable to make electrical connection to the portions of individual coils requiring neutralization in production-type yokes, the circuit designer can do very little to eliminate this ripple.

Scanning-Current Modulation Originating in the Horizontal-Output Transformer—

Another common cause of ripple, also evidenced by modulation of scanning current, is ringing in the horizontal-output transformer. Ringing is damped oscillation which occurs in resonant circuits formed by leakage inductance and distributed capacitance in the transformer. Such ringing may modulate the scanning current and cause raster ripple. This ripple, however, is different from that due to improper neutralization of the horizontal-deflecting coils in that it is uniform in intensity from top to bottom of the raster.

Ripple due to ringing in the horizontal-output transformer generally results from inherent design characteristics of the transformer, but it may also be caused or intensified by the particular circuit in which the transformer is used. For example, the use of a width control having too low an inductance value sometimes increases ripple intensity. A change of yoke inductance often affects ripple, even though the transformer taps may be altered to reflect the same impedance to the horizontal-output tube. The addition of capacitance across a portion of the transformer winding can also change the intensity or frequency of the ringing and, therefore, affect the ripple. Insertion of an external capacitor across each portion of the transformer winding, in turn, is often a useful means of locating the portion which causes the ripple. Alteration of circuit capacitance or inductance in order to make an appreciable change in retrace time can change the appearance of the ripple. Although alteration of any of these values of inductance and capacitance may be useful in localizing ringing in the output transformer, it is usually advisable to obtain the transformer manufacturer's recommendations for minimizing ringing.

Identification of Ripple Due to Several Causes

Ripple may be due to several causes all present at the same time. In such a case, none of the suggested procedures applied individually will eliminate all the ripple. It is advisable, therefore, to investigate the causes in order, as follows:

1. Place two bypass capacitors, 0.5 microfarad or larger, at the socket of the kinescope, one between grid No. 1 and cathode and the other between grid No. 2 and cathode. The bypass capacitors will eliminate all beam modulation, not only ripple caused by coupling between the deflection circuits and video circuits, but also all picture information. The blank raster is then used for critical observation of ripple due to other causes in further tests.
2. Substitute a variable capacitor for the fixed yoke-neutralizing capacitor. Commercially available transmitting-type air capacitors having a range up to 75 or 100 micromicrofarads and adequate spacing to prevent arc-overs are suitable, provided a well-insulated knob is placed on the shaft to permit safe handling. The capacitor should be adjusted for best neutralization, the most sensitive indication of which is the straightness of the raster lines. Several values of fixed resistance may be tried in series with the capacitor to obtain optimum neutralization.
3. Any ripple remaining is usually due to ringing in the horizontal-output transformer and may now be investigated without confusion due to the presence of ripple from other causes. One advantage of this sequence of tests is that it helps to indicate whether the ringing in the transformer, which is usually the most difficult to eliminate, would be tolerable if the other sources of ripple were eliminated.

'Spook' Interference

Visible interference in the picture or instability of the synchronizing circuits may be caused by a type of high-frequency radiation from the damper tube and its leads which is picked up in the receiver rf and if circuits. The interference appears in the picture as a narrow vertical line very near the left margin of the raster and looks similar to

Barkhausen oscillation. When this interference was first observed as an effect distinct from Barkhausen oscillation, its nature seemed quite mysterious and, as a result, it became known as the 'spook' in the industry. If the signal is weak, the line is black and has ragged edges; if the signal is stronger, the line has visible crawling 'beats' within its margins. The line usually is not seen because it is in the blanked portion of the raster or off the kinescope screen.

Appearance of this 'spook' interference is coincident with the start of conduction in the damper tube. Shortly after the completion of retrace, the damper-tube current rises from zero to its peak value of approximately 400 milliamperes within a period of the order of 0.1 microsecond. A Fourier analysis of the waveform of this current change would show the high-frequency harmonics to be of appreciable amplitude. These high-frequency harmonics are easily radiated and picked up by the sensitive rf and if circuits of the television receiver. As a result, the 'spook' interference at low radio frequencies is more pronounced; it diminishes steadily at higher frequencies.

In order to minimize 'spook' interference, the antenna and the rf and if circuits should be placed as far as possible from the deflection circuits. It is also desirable to minimize the radiation as much as possible. In the autotransformer type of deflection circuits, most of the radiation usually comes from the B+ wiring connected to the damper-tube plate. An rf choke of the order of 2 microhenries placed in series with the damper-tube plate at the tube socket is quite effective in keeping the rf off the B+ leads; in addition, the use of a mica bypass capacitor of approximately 100 micromicrofarads between B+ and the chassis may be helpful. Small rf chokes in other leads to the damper tube at the socket usually decrease the radiation further. When these steps are taken, virtually the only sources of radiation are the elements of the damper tube itself. It is important, therefore, that the high-voltage enclosure in which the damper tube is located provide adequate shielding from the rest of the receiver, and that coupling between the damper tube and leads which come out of the enclosure be minimized.