

FINK

Television Engineering Handbook

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DONALD G. FINK, *Consulting Editor*

TELEVISION ENGINEERING HANDBOOK

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DONALD G. FINK, *Consulting Editor*

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TELEVISION ENGINEERING HANDBOOK

PREPARED BY A STAFF OF SPECIALISTS

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TELEVISION ENGINEERING HANDBOOK

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To KEITH HENNEY

For a lifetime of inspiration and guidance

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15-10 TELEVISION RECEIVER CIRCUIT FUNCTIONS AND BLOCK DIAGRAMS

quencies) and improves the signal-to-noise ratio. Second, the narrower passband permits an increase in amplifier gain, resulting in increased amplifier output level.

The mechanism for obtaining the desired change in amplifier response is termed *pole shifting* and is detailed in Chap. 16. The action is to change the tuning of a circuit as a function of the plate current of an associated amplifier stage. For example, in Fig. 15-8 the input circuit tuned to 42.6 and 45.9 mc, under conditions of high a-g-c bias (strong r-f signal), may be retuned toward sound-carrier frequency and picture-carrier frequency, respectively, under conditions of low a-g-c bias.

15.203 Picture Detectors and Video Amplifiers. *Typical Detector Circuit.* The typical second detector is a diode arranged to follow the instantaneous peak value of the amplitude-modulated picture carrier. The video waveform of one scanning line is of the form of Fig. 15-9 (see Chaps. 2 and 10 for discussion of the complete video

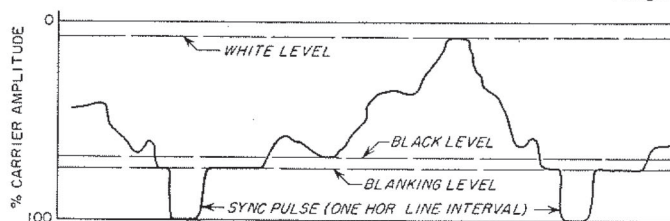


Fig. 15-9. Detector video output waveform (4.5-mc intercarrier beat signal not shown).

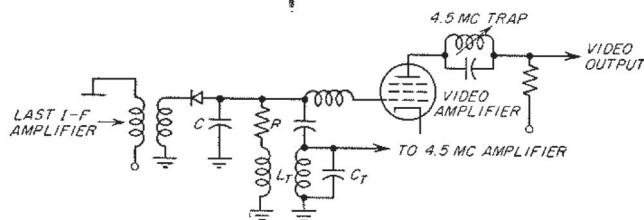


Fig. 15-10. Detector circuit with intercarrier sound take-off.

signal). Figure 15-10 is a typical circuit. The video-signal spectrum at this point includes the d-c component of the modulation and extends to an upper-frequency limit which includes the 4.5-mc intercarrier beat. The usual diode load circuit includes an impedance R across which the video modulation frequencies are developed and a bypass capacitance C for carrier frequencies. Crystal diodes are used almost exclusively in receivers with 41.25- to 45.75-mc i-f carrier frequencies and thermionic diodes in receivers with 21.25- to 25.75-mc frequencies. The crystal is preferred in the 40-mc range because of its lower shunt capacitance, as mounted in the receiver.

The video bandwidth must be maintained to the maximum modulation frequency utilized (typically 4.5 mc for intercarrier sound). Video peaking circuits are usually employed to achieve maximum level. However, the load impedance is limited by circuit shunt capacitances to approximately 4,000 ohms, and this limits the rectification efficiency with typical diodes to about 60 per cent. The detector is matched to the i-f output stage by suitable transformer to deliver maximum voltage to the detector load with suitable transformer bandwidth.

The detector is usually d-c-coupled to the video amplifier. The lower limit of detector output signal is approximately 0.5 volt peak to peak on weak r-f signal input. The upper limit, on strong r-f signal input, varies from 2 volts in receivers with high-gain a-g-c systems to 8 volts with low-gain a-g-c systems.

The polarity of rectification can vary depending on the design of the following video amplifier and the method of picture-tube drive. Usually it is such as to make maximum picture carrier (sync-pulse modulation) a negative voltage output.

FUNCTIONAL BREAKDOWN AND BLOCK DIAGRAMS

15-11

Since the video signal includes the d-c component, an averaging-type filter section provides a simple a-g-c voltage source. Such a system is moderately responsive to picture-carrier modulation (producing more bias on black picture content than on white picture content) but is adequate to maintain carrier gain within satisfactory limits in inexpensive receivers or as a supplementary a-g-c voltage in more complex systems.

Inter-carrier (Sound) Detection. In intercarrier sound receivers, the detector load must pass the 4.5-mc intercarrier beat frequency to the sound take-off point. Some receivers use a form of 4.5-mc trap coupling, either in the detector load or in the inter-stage coupling between detector and first video. In this case, the intercarrier and

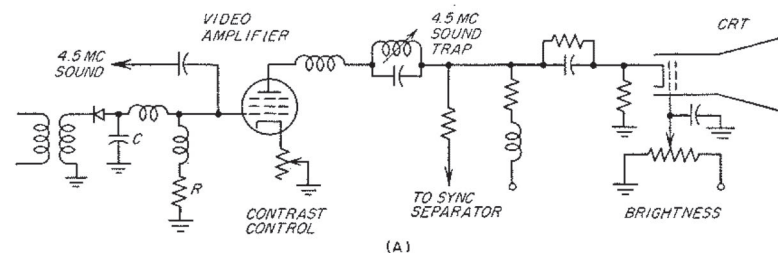


Fig. 15-11A. Single-stage video amplifier—d-c coupled.

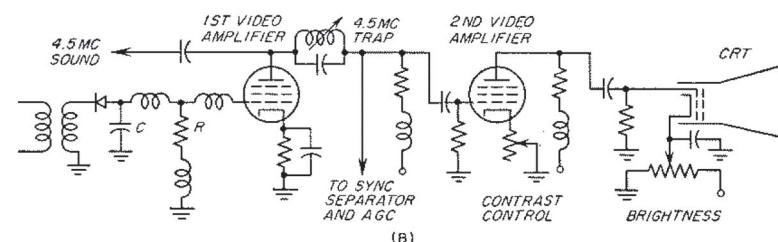


Fig. 15-11B. Two-stage video amplifier—a-c coupled.

beat signal is attenuated prior to the video amplifier and is picked off across the trap impedance. Figure 15-10 shows one type of detector circuit. A tuned circuit $L_T C_T$ tuned to 4.5 mc is coupled across the detector load as a selective carrier pick-off circuit, and a 4.5-mc carrier rejection trap is included in the first video amplifier plate.

When the sound pick-off point is located in the video amplifier plate circuit, the detector load must pass the intercarrier beat frequency without excessive attenuation. Several forms of sound pick-off circuits are included in the video amplifier circuit of Fig. 15-11.

Video Amplifier Circuits. The video amplifier serves to obtain a level suitable for driving the picture tube; an output of about 100 volts peak to peak assures full drive of the picture tube over its modulation range. The required video amplifier gain is a function of the second detector level, which in turn is set by the a-g-c system.

Single-stage Amplifiers. Single-tube video amplifiers are adequate for many applications. The simplest circuit is a single-stage pentode amplifier, with sync negative on its grid, d-c-coupled to the detector, driving the picture-tube cathode with sync positive (Fig. 15-11A). The contrast (amplifier-gain) control is usually an unby-passed variable resistor in the cathode circuit. A contrast range of 5 to 1 is usual for good picture control; such a range poses a problem if the video amplifier is included in the sound, a-g-c, or synchronizing-signal pick-off circuits. An alternative device is a frequency-compensated potentiometer as the amplifier plate load. This provides a more constant level for sound or sync signal pick-offs if located in the video ampli-

fier plate circuit. Care must be taken to avoid excessive shunt capacitance in this arrangement, or the peaking required to maintain a good video response may become excessive. A 4.5-mc trap is always included in the video amplifier circuit to prevent the intercarrier sound signal from being visible on the picture tube.

Two-stage Amplifiers. Two-stage video amplifiers are usually arranged to drive the picture-tube grid with sync negative (Fig. 15-11B). The contrast control shown is a variable resistor in the second-stage cathode circuit. The sync signal is usually picked off after the first amplifier.

D-c Restoration. The video waveform at the second detector includes the d-c component of the signal; that is, the voltage levels corresponding to black and white at this point do not change with the modulation of the signal. For accurate rendition of the tonal values of the picture, the d-c component must be included in the signal on the picture tube. In single-stage amplifiers d-c coupling can be used. In multi-stage video amplifiers d-c coupling is subject to drift problems. When such amplifiers are used, the d-c component may be restored by a leveling diode (d-c restorer) connected to maintain the peak of the video signal (sync-pulse peak) at constant voltage. In practice, the d-c component of the video signal is only one factor in the requirements for accurate tonal rendition. Other requirements include stabilization of picture-tube-modulation characteristic by control of operating voltages, constant level of video drive, and constant depth of modulation of the picture carrier. Changes of these or other levels may require resetting the brightness control to obtain proper picture shading. Therefore, simple de-restoration is only an approximation to accurate control of tonal values. Many receivers (the majority in current practice) are built without d-c coupling or restoration. Such a-c-coupled receivers are characterized by the maintenance of the average value of the picture modulation (averaged over several fields) fixed at a level set by the manual brightness control.

15.204 Picture Tubes and Auxiliary Components. General Structure. The picture tube is a cathode-ray tube, usually intended for direct viewing. The shape of the faceplate must not distort the image when viewed at a large angle from the tube axis. The faceplate contour and structure should minimize external-light reflection, to preserve contrast. These considerations have led to the general adoption of an approximately spherical faceplate with a minimum radius of curvature of about 30 in. The glass typically is of neutral-gray color, with about 75 per cent optical transmission. A cylindrical contour (no vertical curvature) is often used to minimize reflection of light which originates above the viewing level. The illumination of the image is provided by an electron beam focused to a small spot on the faceplate. The beam intensity is modulated by the control grid signal developed by the video amplifier. Simultaneously, the instantaneous position of the beam is controlled by scanning circuits in precise synchronism with the camera scanning circuits.

For acceptable resolution the scanning spot must be small and have negligible astigmatism at beam currents sufficient to produce acceptable highlight brightness.

The picture-tube screen is composed of a phosphor on the inside face of the faceplate, which emits light of acceptable color and color uniformity in all areas of the screen. The color shift must be negligible under all normal operating conditions.

Aluminized screens are produced with a mirror surface of aluminum behind the phosphor. They provide greater light output by reflecting forward the light emitted toward the rear of the tube. Better contrast ratio is also obtained, as the light scattered and reflected within the funnel is substantially eliminated.

External Components. To perform its function, the picture tube must be equipped with certain external devices to control and direct the electron beam. The scanning yoke and high-voltage circuit considerations are discussed in Sec. 15.207.

It is appropriate to consider the picture tube as an electron optical-lens system. The high-voltage electrode system, comprising the second anode of the electron gun and the metal funnel or internal conducting coating in a glass tube, must form a uniform and constant electrostatic field throughout the volume of the tube swept by the scanning beam. Variations in this field result in picture distortions, such as lack of focus or change of picture size or position.

The electron gun usually includes an ion trap and requires an external ion-trap

magnet. The gun is arranged to provide a crossover region (see Chap. 5) which, when imaged on the faceplate, forms a scanning spot of small diameter.

The imaging function is accomplished by the focus unit which provides either an electrostatic or an electromagnetic lens. The depth of focus must accommodate changes in focal length caused by nominal high-voltage changes and must be sufficient to maintain focus at all points on the screen. The focus field must be aligned

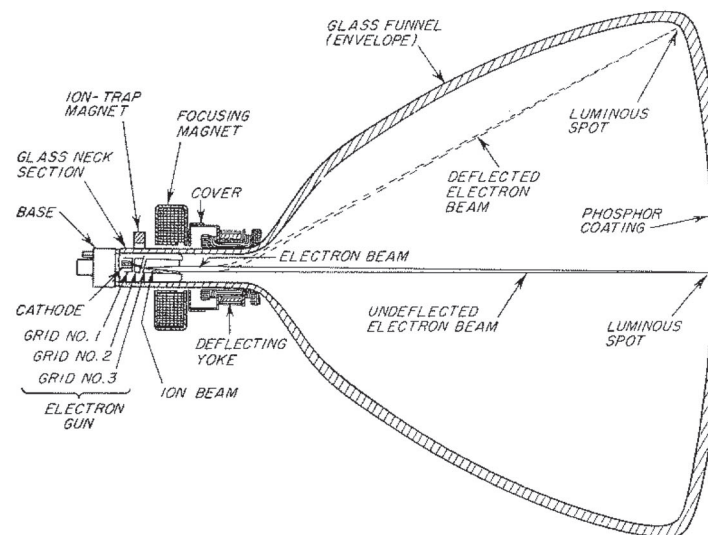


Fig. 15-12. Picture tube components.

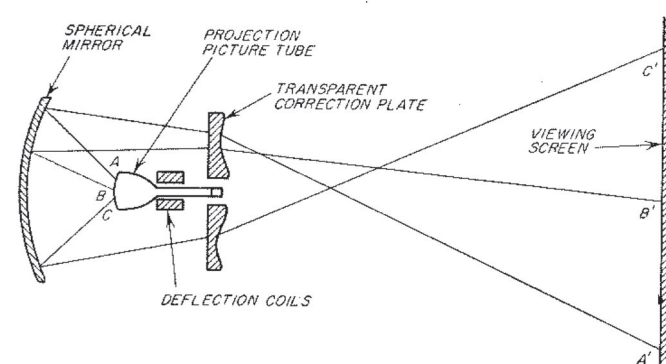


Fig. 15-13. Typical projection arrangement.

with the axis of the tube so as not to displace the image relative to the faceplate, and it must be symmetrical about the electron beam so as to minimize spot astigmatism. Figure 15-12 shows the essential electron optical components.

The deflection yoke deflects the beam in the scanning pattern. The yoke axis, like the focuser axis, must be aligned, and the field produced by the yoke must produce scanning without distorting the spot shape and without causing the electron beam to be intercepted by the bulb neck, which would produce shadowing at the edges of the picture.