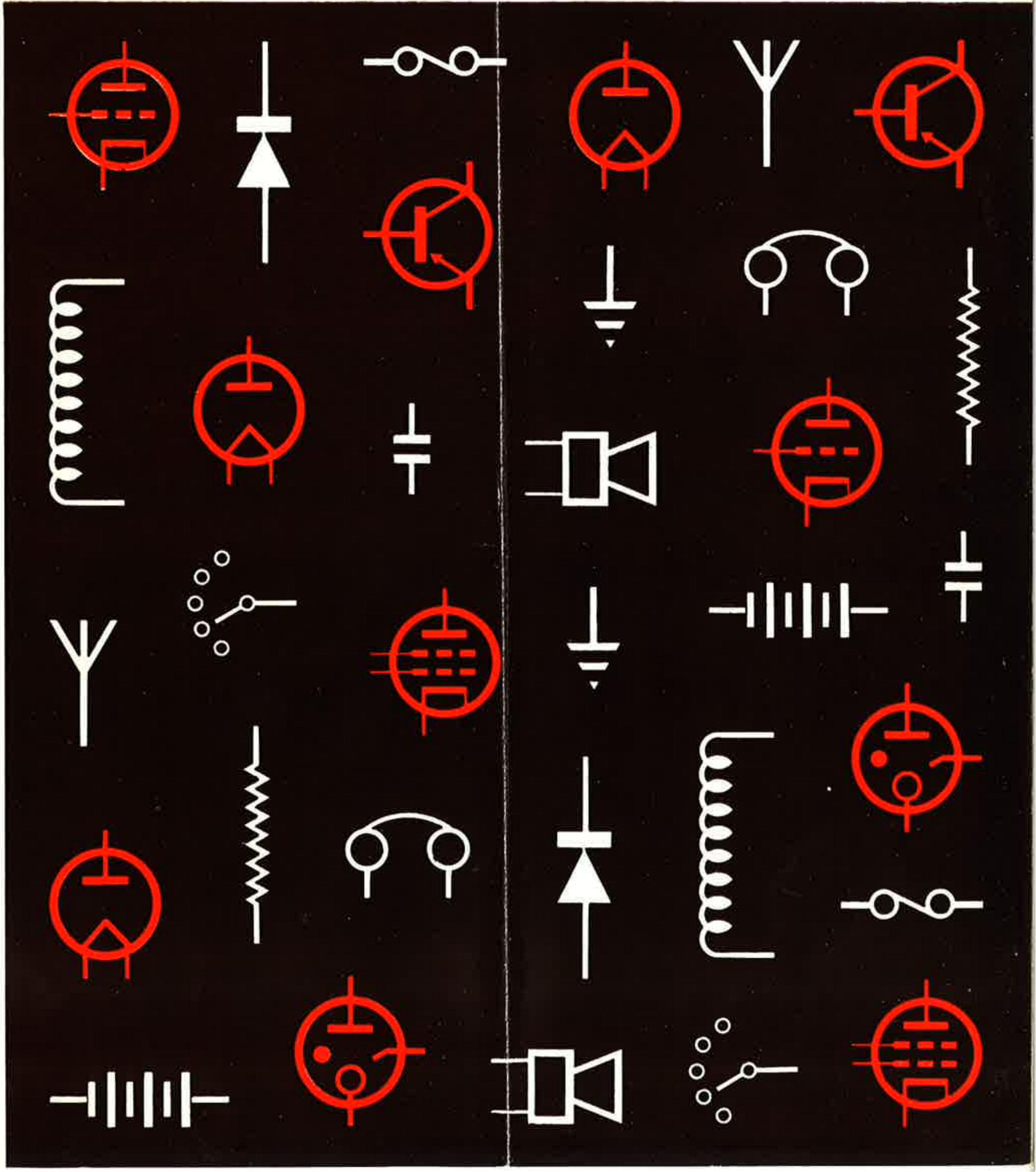
RADIOTRONICS

VOL. 25, No. 7.

JULY, 1960

PRICE ONE SHILLING

REGISTERED AT THE GENERAL POST OFFICE, SYDNEY, FOR TRANSMISSION BY POST AS A PERIODICAL



AN AWV PUBLICATION

RADIOTRONICS

Vol. 25, No. 7, 1960

Editor, Bernard J. Simpson

IN THIS ISSUE

Radiotronics is published twelve times a year by the Wireless Press for Amalgamated Wireless Valve Company Pty. Ltd. The annual subscription rate in Australasia is 10/-, in U.S.A. and other dollar countries $1.50, and in all other countries 12/6.

Subscribers should promptly notify Radiotronics, Box 2516, G.P.O., Sydney, and also the local Post Office of any change of address, allowing one month for the change to become effective.

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APOLOGY

On page 108 of "Radiotronics" for May, 1960, we described Mr. H. R. Wilshire as an Associate Member of the Institution of Radio Engineers (Aust.). Mr. Wilshire is a Senior Member of the Institution (S.M.I.R.E.) and is also an office-bearer of that learned body.

A New Approach To Sync and AGC Circuitry

H. R. WILSHIRE, S.M.I.R.E. (Aust.) and J. van der GOOT, M.I.R.E. (Aust.)

It is shown that the requirements of sync and agc circuits are similar and can be satisfied by twin pentode valves having two control grids with sharp cutoff characteristics. A circuit using the twin pentode 6BU8 to provide a noise gated sync clipper and keyed agc amplifier is described. AGC level and noise gate controls are included in the circuit. Design considerations in connection with the valve characteristics and maximum ratings are also discussed.

Introduction

Every TV receiver design engineer will agree that the piece of mass produced equipment he calls the "TV Receiver" is probably the most complicated collection of electronic circuitry ever placed in the hands of the average man. This is brought about, of course, by the fact that the satisfactory reproduction of a picture at a remote point requires the reception and utilization of a large amount of information. A not inconsiderable part of this information is the component required to synchronize the writing or deflection circuits of the receiver. The proper assembly of the whole picture requires very accurate synchronism between the relative positions of the electron beams of the picture and camera tubes. An indication of the accuracy required can be gained by realising that for a 21-inch receiver an error of 0.5 microseconds in the start of the horizontal trace will move that part of the picture approximately 5/32 inch relative to an adjacent line.

The synchronizing signals which convey this information need to be extracted from the composite video signal without affecting or being affected by the video content. Since the task they perform is one of great precision it is essential that the form which is necessary to synchronize the particular oscillator be maintained regardless of variations in signal strength, disturbances due to noise interference or customer operation of the controls.

It can be seen immediately that the synchronizing circuits play a vital role and one which links with that of other parts of the receiver. For example the type of oscillator in both horizontal and vertical deflection circuits, the video amplifier, the contrast control and the automatic gain control circuits all play a part in deciding the particular arrangement to be used.

In a similar way the agc function is important. It links, and its design is affected by, the type of tuner, type of video if amplifier and the design of the video amplifier and sync separation stages.

Overriding factors in the choice of the correct circuits for these stages, i.e. sync and agc, are the commercial considerations. The price field in which the receiver is to be sold may mean that cost is a limiting factor. Sales departments generally have fixed ideas on what controls shall be placed in the hands of the customer. They almost always want to use the same chassis in a number of different cabinet styles so the engineer must arrange his controls so that they can be moved without affecting performance.

The synchronizing and agc circuits might therefore be considered as the key and perhaps most important functions in any TV receiver design.

Review of Existing Methods of Sync and AGC

Synchronization

The satisfactory separation of the sync information from the composite waveform is a twofold problem. The sync signals firstly need to be extracted and secondly the process needs to

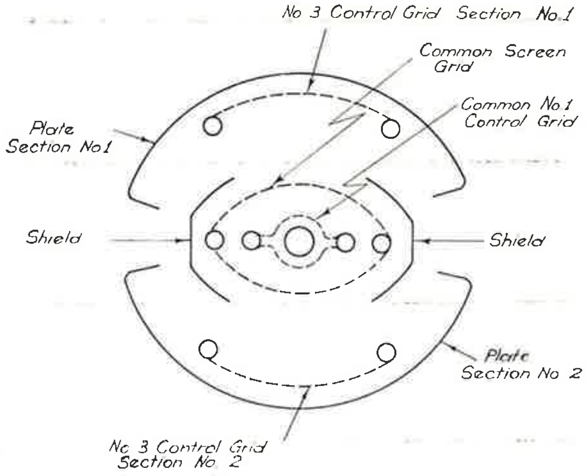


Fig. 1 — Cross-sectional view of the 6BU8.

be made immune to interference by noise. The noise may consist of pulses varying widely in amplitude, duration and repetition rate.

Practically all circuits in use today separate the sync information in the same basic way. The large number of variations in circuit design are caused mainly by the methods adopted to avoid interference by impulse noise. Fundamental separation or the elimination of the video information is obtained using the method outlined later in the discussion of "fundamental circuits for sync clipper and agc amplifiers," and Fig. 7.

The output pulses so derived are then generally integrated to provide a pulse to correspond in time to the vertical sync block, and differentiated to produce sharper pulses at the start and finish of every horizontal sync pulse. These may be further clipped, amplified and inverted in phase by a second valve. This then is the fundamental method of sync separation.

Complications introduced to provide noise immunity may be grouped under the following main headings:

(a) Amplitude limiting before the sync separator.
(b) Choice of a low ratio for the release to attack time constants.
(c) The use of networks which reduce the response of the sync clipper to pulses of duration longer than the sync pulses.
(d) Noise inversion.
(e) Noise gating.

(a) introduces complications in the design of the video amplifier and imposes stringent requirements on the characteristics of the valve used in this stage and on the agc circuits.

(b) has the disadvantage of reducing the amplitude of the residual sync pulse and thus increasing the amplitude of the minimum signal required for proper sync clipping.

(c) has merit and is combined with one of the other methods in practically every circuit in use today.

(d) is very effective but introduces circuit complexity.

(e) is also very effective and provided the correct valve is used adds very little in the way of components.

Noise gating involves the use of a circuit in which an electronic gate is arranged so that it is held open for a normal noise-free signal and is closed by the presence of a noise pulse which exceeds the amplitude of a sync pulse. In this way the effect of the sync output on such a noise pulse can be made almost zero.

This principle will be discussed more fully after some consideration has been given to the problem of agc.

Automatic Gain Control

This function in a TV receiver is concerned with automatically controlling the gain of the signal amplifier stages so as to provide a constant amplitude signal at the video detector. The many varieties of circuits which exist to do this job can be split into two main groups — the simple and the amplified types. Each of these in turn can be subdivided into other classifications.

Simple System. There are two types of simple agc circuit commonly used. In one the agc voltage is taken directly from the video detector, normally through a large isolating resistor. With this method, since the diode detector time constant is of necessity very fast the negative dc control voltage will vary with the video content of the composite signal. The large isolating resistor, in combination with a large bypass capa-

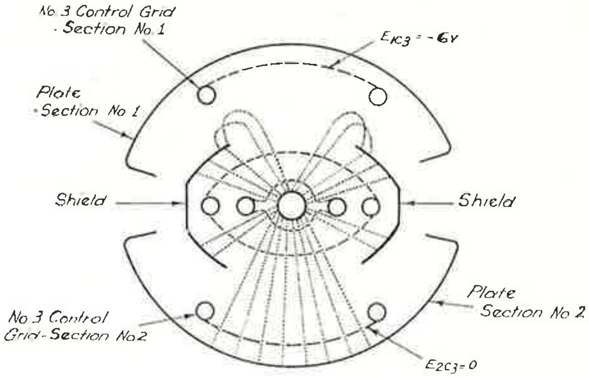


Fig. 2 — Electron Distribution with Negative Bias on Grid No. 3 (1) and Zero Bias on Grid No. 3 (2).

citor, form a filter network with a time constant of the order of 0.1 to 0.5 seconds and will prevent fast changes in scene brightness being transferred to the agc line. However, slower changes will cause variations in the agc voltage. This is undesirable since the gain of the tuner and picture if amplifier valves then will vary with the video content as well as the carrier level and the effective level of the dc component of the video signal will be reduced. In addition the agc voltage developed in this way is far too small to provide good control or to allow the use of sufficient delay on the tuner agc voltage to produce good overall signal/noise characteristics for medium strength signals.

In the second method, a separate diode is used. It is fed from the same point as the video detector. With this method the diode load time constant can be selected to provide peak detection which has two advantages. Firstly, the agc voltage developed is proportional to the sync tip level and is not affected to any appreciable extent by the video content. Secondly, the voltage derived is larger than that obtained with the first system. However, it still suffers from the disadvantage of providing a control voltage which is too small to provide either near constant video input to the video amplifier or the reduction of tuner noise which is essential if good overall signal/noise characteristics are required for medium strength input signals. There is an additional disadvantage in this system due to the dissimilar charge-discharge time constants of the peak rectifier. Sustained noise pulses which exceed the sync tip amplitude will increase the negative bias developed and will cause the gain of the receiver to be decreased in the presence of noise.

Amplified System. The big difference between this and the simple system is the fact that amplification takes place in developing the negative control voltage. Many varieties of the basic circuit exist, all differing in their response to disturbances such as variations and interruptions in carrier level and noise.

The amplified systems are split into two main groups — those which use the amplification of the video amplifier by taking the negative voltage developed at the sync separator grid and those which use an amplifier — either time keyed and/or noise gated — to amplify the sync pulses.

Negative voltage obtained from the separator grid has the following disadvantages:

(a) It is proportional to the average of the video modulation,

(b) It is still too small to allow the use of effective delay on the tuner and

(c) It allows the possibility of "lock-out".

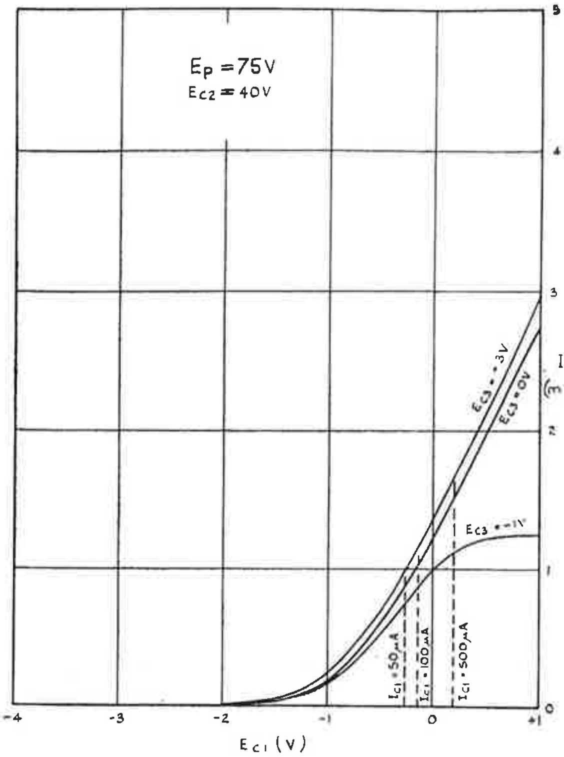


Fig. 3 — Curves of Plate Current versus No. 1 Grid Voltage with No. 3 Grid Voltage as Parameter, and with Typical Values of Screen Voltage. (See also opposite page.)

Although circuit cunning can partly overcome the first difficulty by using in addition part of the voltage developed at the video detector, the other problems are fundamental and detract a great deal from the circuit's comparative simplicity. The two types of amplifier treated in this paper — (a) true noise-gated and (b) time keyed which may also be noise gated — have some differences in characteristics but both meet all the major requirements of a good agc system.

For the true noise-gated arrangement the valve's plate is supplied with a direct voltage. The gating function is carried out using a pentode which has two control grids each capable of controlling the flow of plate current. A positive going composite signal is applied to the second control grid (grid No. 3) and the sync pulses are extracted as outlined later in the discussion of "fundamental circuits for sync clipper and agc amplifiers." A negative-going component (180° phase shift) is also applied to the first control grid with its amplitude arranged so that a superimposed noise pulse which exceeds the sync pulse amplitude will cut off the plate current.

In the time-keyed arrangement the plate is supplied with a pulsed voltage instead of a direct

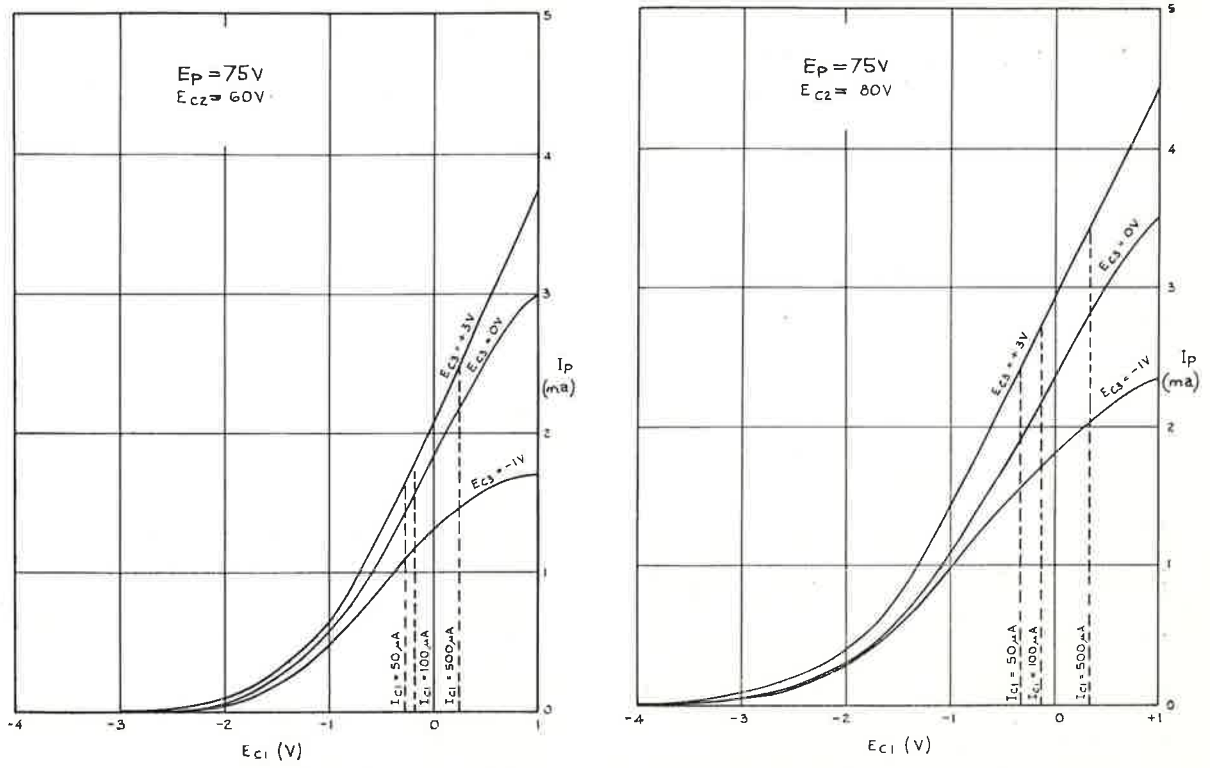


Fig. 3 — (Continued)

voltage so that plate current flows only during the retrace time of the horizontal deflection circuit. During this time the sync pulses are present on the control grid, and the plate current, and hence the developed agc voltage, is proportional to the amplitude of the sync pulses and the blanking level, and can only be affected by noise if it occurs during the retrace interval. In a similar way to that described for the first method a pentode with two control grids can be used with the agc determining voltage applied to grid No. 3 and a gating voltage applied to grid No. 1. For this case, i.e., an agc amplifier which is time keyed, the addition of noise gating can improve the overall receiver performance. The effect of the noise is to reduce slightly the agc voltage, increase the gain of the tuner and/or if amplifier and produce a higher peak to peak video waveform at the video amplifier grid. This produces a somewhat higher contrast and if the video amplifier has been properly designed will cause compression of the noise pulse and effectively a better signal/noise ratio.

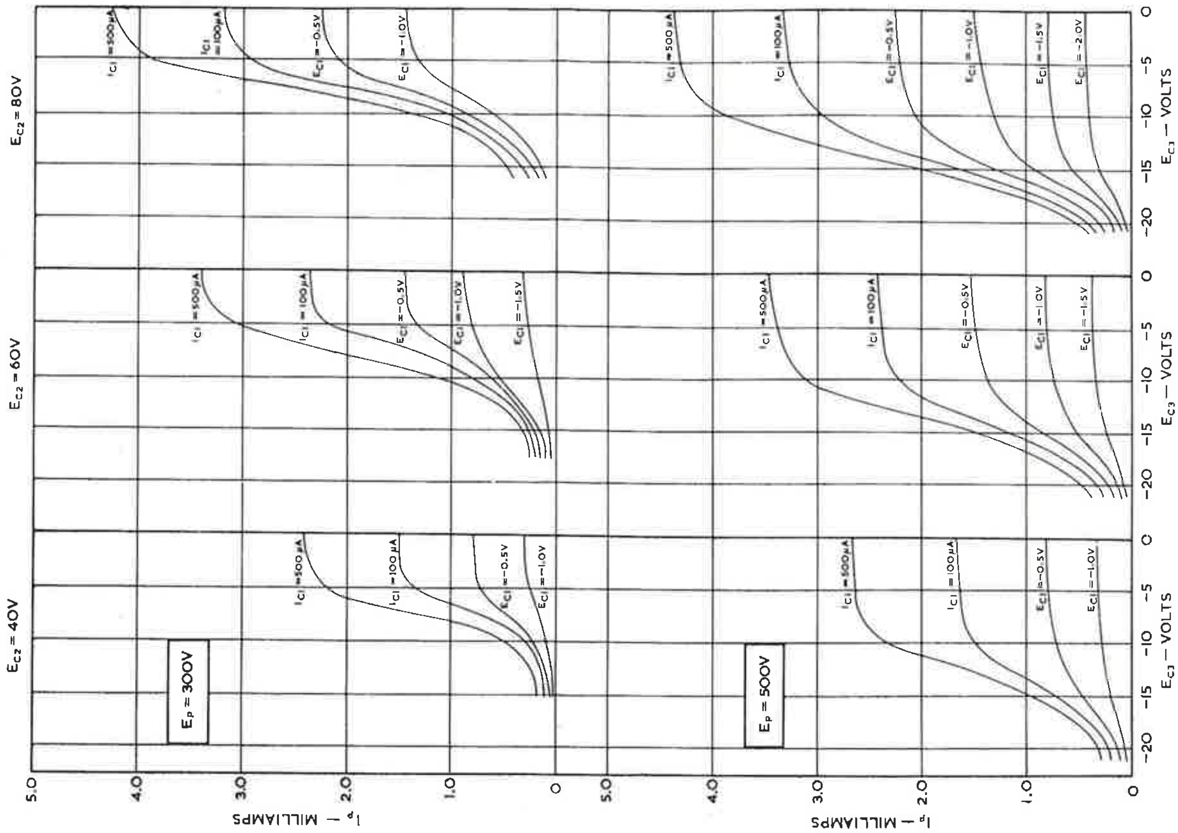
In both types the agc loop has high gain (product of the gains of the video and agc amplifiers), very good noise performance and is capable of developing a sufficiently high negative control voltage to maintain an almost constant level at the video detector and to allow the use of a large enough delay on the tuner bias to ensure minimum noise effects.

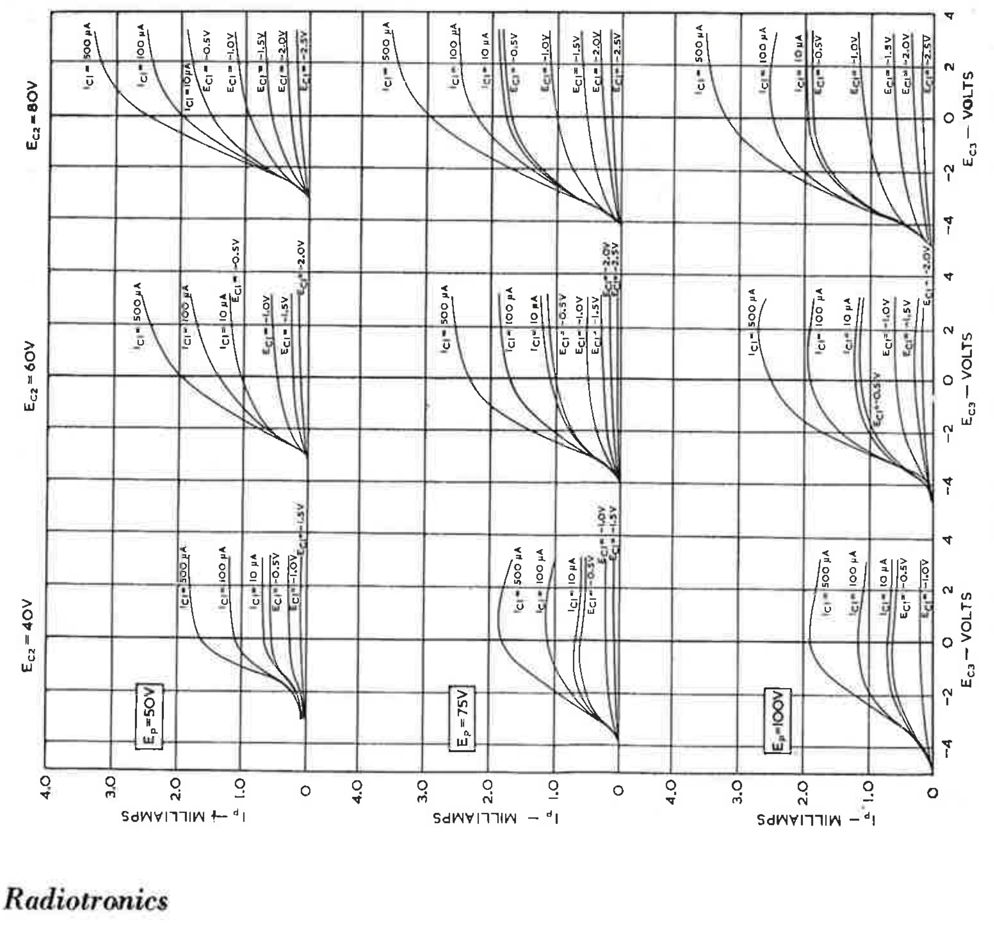
The 6BU8 — Twin Pentode for Sync Clipping and AGC Amplification

It has been shown that many of the requirements of sync and agc circuits are similar. For example for best performance they both should depend on the sync pulses only and they both should be immune to noise. As discussed above these qualities can be obtained by using for each function a somewhat similar valve containing two control grids having sharp cutoff characteristics. These facts, when combined with the need to use the same gating voltage for both applications, led to the development of a dual valve — the twin pentode 6BU8.

In this valve, a cross sectional view of which is shown in Fig. 1, the cathode, control grid No. 1 and screen grid are common to both halves. The control grid No. 3 and plate are separate and are positioned on each side of the screen grid. Each half of the valve has identical characteristics. The control grid No. 3 and plate in one half are used for sync, and in the other for agc.

The shield shown in Fig. 1 is internally connected to the screen grid and as can be seen from Fig. 2 carries out three main tasks — it prevents electrons from flowing around the No. 3 grids to the plate, catches electrons turned back by





◄ **Fig. 4 (a) — 6BU8 — Curves of I_p versus E_{c3} with E_{c1} and/or I_{c1} as a Parameter. Values of Plate and Screen Voltages shown are typical of Sync-Clipper Operation.**

Fig. 4 (b) — 6BU8 — Curves of I_p versus E_{c3} with E_{c1} and/or I_{c1} as a Parameter. Values of Plate and Screen Voltages shown are Typical of Keyed AGC Amplifier Operation. ►

a negative grid No. 3 and prevents electrons bombarding the glass bulb.

To give some idea of the magnitude of the control voltages required at each electrode the main characteristics are shown in Fig. 3, 4 and 5.

It should be remembered that (1) the grid No. 1 has applied to it the negative going video waveform, (2) the circuit values are arranged so that normally in the absence of noise the grid is held slightly positive with a resultant flow of grid current, and (3) noise pulses on the video waveform, since they are negative-going, change the grid potential from a positive value to one which cuts off the plate current. In the sync separator half the grid No. 3 has coupled to it a positive-going video waveform through an RC circuit with a time constant long enough to clamp the signal at the positive sync tip level and provide a bias which depends on the peak to peak magnitude and the dc component of the signal.

Fig. 3 then shows the plate current versus grid No. 1 bias with the grid No. 3 bias as parameter and with typical values of screen and plate voltages. The sharp plate current cutoff characteristic can be seen.

Fig. 4 (a) shows the plate current versus grid No. 3 bias with the grid No. 1 bias or current as parameter. Values of plate and screen voltage which are typical of sync-clipper operation are shown. The No. 3 grid can be seen to have the sharp plate current cutoff characteristic which is required for good sync clipping.

Fig. 4 (b), which is applicable to keyed agc operation, shows the same characteristics as in Fig. 4 (a) except that the plate voltage ranges from 300 to 500 volts.

Finally, Fig. 5 shows a typical family of plate characteristics with the No. 3 grid bias as parameter.

The operation of the circuit and the effect of the valve's characteristics will be dealt with more fully later in the paper.

Fundamental Circuits for Sync Clipper and AGC Amplifiers

Before discussing the circuitry of a sync clipper and agc amplifier using the 6BU8 some further consideration will be given to the development of sync and agc functions from the composite video waveform as laid down by Australian Broadcasting Control Board (ABCB) standards. This waveform, showing the characteristics which are important from the point of view of sync and agc, is shown in Fig. 6.

The tasks of the sync clipper and agc amplifier are: (1) the separation of the sync information from the composite video waveform by removing the video component and (2) the development of a negative agc voltage which is proportional to the sync tip amplitude, E_{ST}, (Fig. 6). These functions will be dealt with in some detail first of all for the special case where the composite signal is free from noise. Later the complication introduced by noise will be treated.

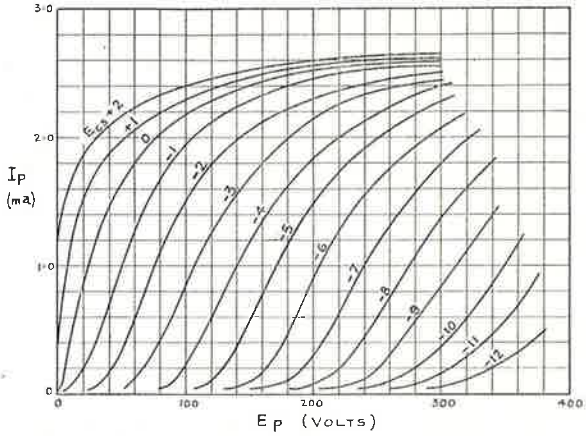


Fig. 5 — Curves of I_p versus E_p with E_{c3} as a Parameter for I_{c1} = 100 microamps and E_{c2} = 67.5 volts.

In the absence of noise the grid No. 1-to-cathode potential of the 6BU8 is kept close to zero by means of positive grid current. Under these conditions the 6BU8 can be considered to consist of two identical triodes which have a common virtual cathode and in which each of the No. 3 grids are the control grids. One half is to be used for sync clipping, the other half for agc amplification.

Sync Clipping

The circuit diagram of a sync clipper is shown in Fig. 7 (a). When the control grid of the valve is driven positive, grid current flows charging C1 with a potential which makes the grid negative with respect to the cathode. A transfer characteristic of the valve has been drawn in Fig. 7 (b) and shows the way in which the very tips of the sync pulses drive the grid positive. The

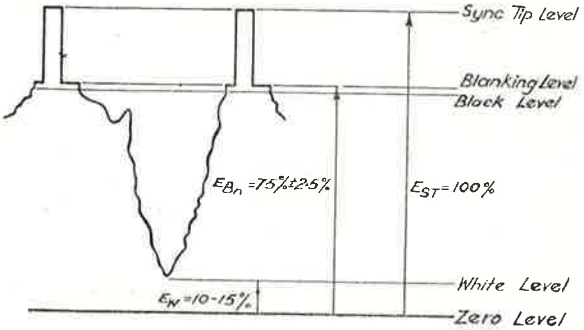


Fig. 6 — Diagram Showing Relative Levels in the Standard ABCB Composite Video Waveform.

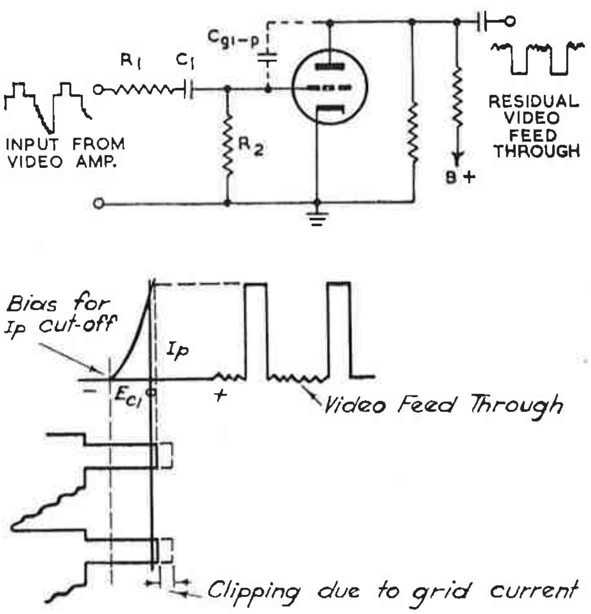


Fig. 7 — (a) Circuit Diagram of a Sync Clipper. (b) Transfer Characteristic of the Valve in (a), Showing Separation of the Sync Information.

blanking level is more negative than the bias required for plate current cutoff. The resulting plate current is derived from the sync pulses only. The voltage appearing across the plate load represents therefore the sync information and is negative-going. The residual video feed-through shown in the sync output is due mainly to coupling through the plate grid No. 3 capacitance of the valve.

AGC Amplifier

In the following section two types of agc amplifiers are described. The first type operates with a positive direct voltage on the plate. Because the agc voltage must take the form of a bias which starts near zero and goes negative, this arrangement requires the use of a negative supply voltage of the order of -75 volts (following section). The second type operates with a keyed plate voltage supply. The keying pulses are derived from the horizontal flyback pulses.

AGC Amplifier with DC Plate Voltage. A simplified circuit diagram of an agc amplifier with a dc plate voltage has been drawn in Fig. 8 (a). A positive-going composite video signal is applied to the control grid of the valve. Resistors R7, R6 and R1 form a voltage divider dimensioned such that with the valve cut off the plate voltage is of the order of +70 volts and point P is near ground potential. Fig. 8 (b) shows the transfer characteristic of the valve and the manner in which the amplified plate-current pulses are obtained from the horizontal sync pulses when a composite video signal is applied to the grid. The amplitude of the plate-current pulses is determined by the amplitude of the applied video signal and the setting of R10. When the average plate current increases, the current through R7 increases also and the average plate voltage decreases. Therefore point P will become more negative with respect to ground. So with increasing amplitude at the grid, P becomes increasingly more negative. Conversely with decreasing amplitude at the grid, P becomes less negative.

The advantage of this type of agc amplifier is that the problem of "lock-out" does not exist. (Lock-out is described below.) However this system requires a negative dc supply of approximately -75 volts at 0.75 milliamps. Fig. 9 shows three alternative circuit arrangements for this negative voltage supply. The diodes shown can

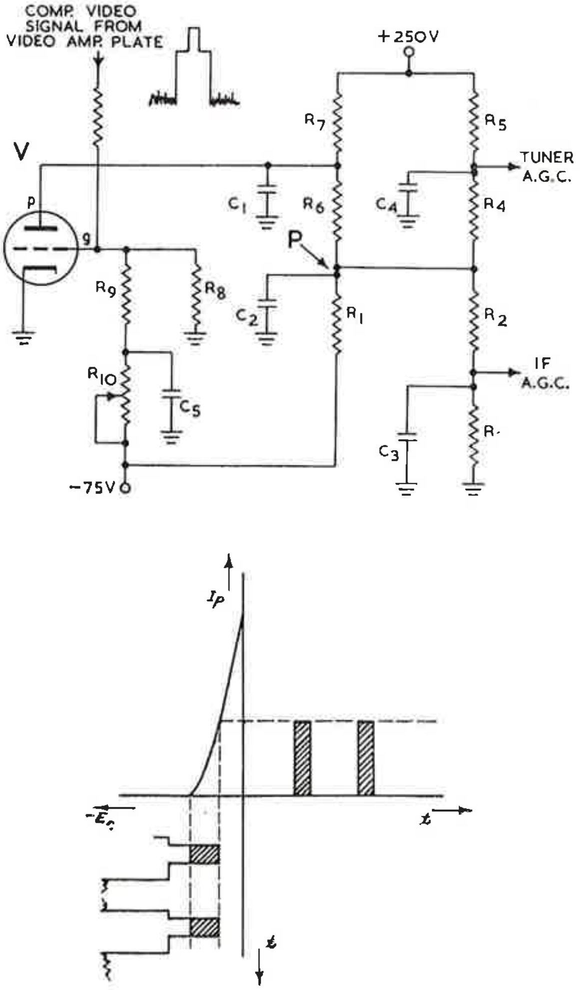


Fig. 8 — (a) Circuit Diagram of an AGC Amplifier with Direct Plate Voltage. (b) Transfer Characteristic of the Valve in (a), Showing Generation of Plate Current Pulses by the Sync Pulses at the Control Grid.

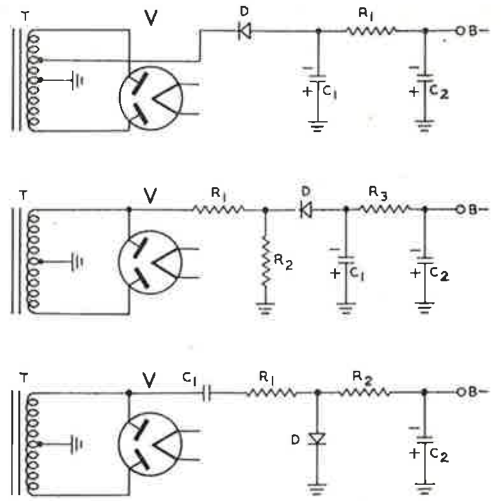


Fig. 9 — Circuit Arrangements for Negative DC Voltage Supplies.

take the form of either a thermionic valve or a semiconductor.

AGC Amplifier with Keyed Plate Voltage. Fig. 10 (a) shows a simplified circuit diagram of a keyed agc amplifier. A positive-going composite video signal is applied to the control grid of the agc amplifier with its amplitude and level arranged as indicated in Fig. 10 (b). When the horizontal oscillator oscillates in synchronism with the received video signal, the valve will conduct during every horizontal pulse. The plate voltage pulses are of the order of several hundred volts. The resulting plate current pulses will charge C1 with a polarity as indicated in Fig. 10 (a). The amount of charge depends on how far the sync pulses at the grid are able to drive the plate

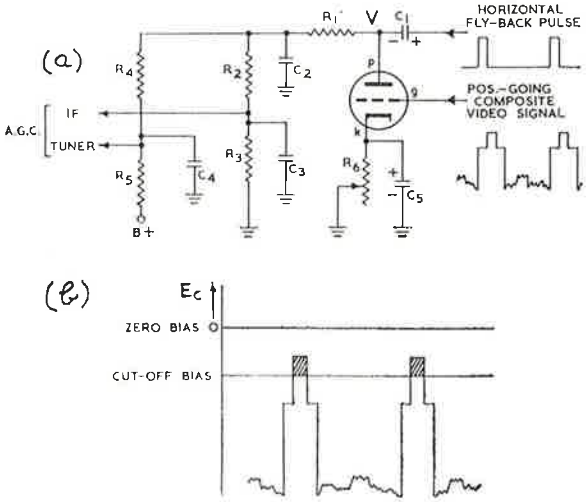


Fig. 10 — (a) Circuit Diagram for a Keyed AGC Amplifier. (b) Voltage Waveform at the Control Grid of the Valve in (a).

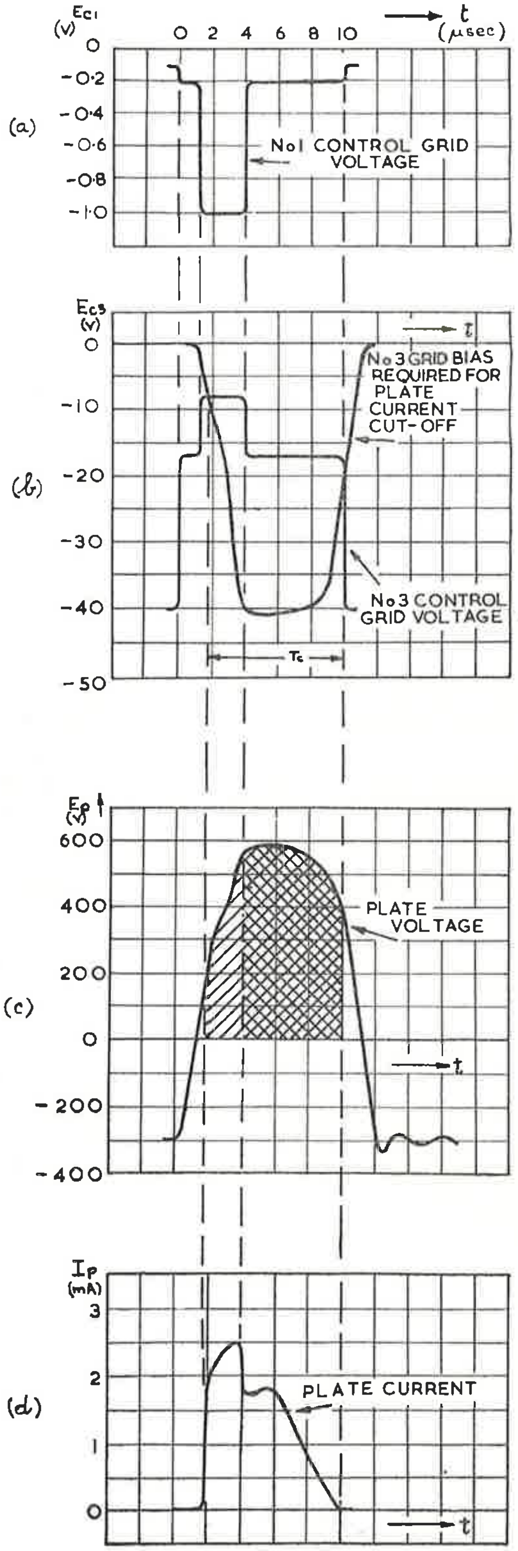


Fig. 11 — Waveforms at the Electrodes of a Noise-gated-keyed AGC Amplifier: (a) at Grid No. 1; (b) at Grid No. 3 (also shown is the Grid No. 3 bias required for plate current cutoff); (c) Plate Voltage; (d) Plate Current.

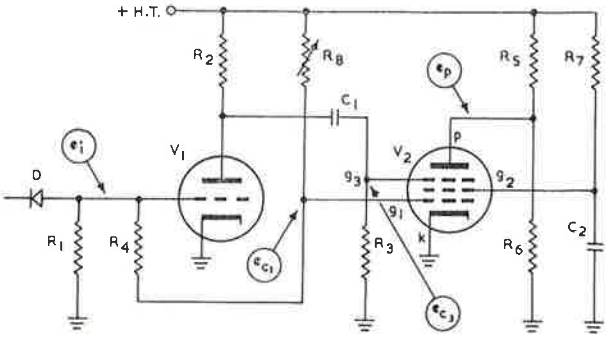


Fig. 12 — Circuit Diagram of a Noise-gated Sync Clipper.

into conduction by extending in a positive direction past the bias required for plate current cutoff. R6 determines the bias at which the video signal is applied to the grid and consequently determines the charge on C1 for a given amplitude of the video signal. During the intervals between sync pulses C1 discharges through R1, R2, R3, R4 and R5. The pulsating negative voltage appearing at the plate of the valve is smoothed by R1 and C2. The if agc voltage is again smoothed by R2, R3 and C3. The tuner agc voltage is similarly smoothed by R4, R5 and C4. If the input voltage to the receiver increases, the sync pulses extend further past the bias required for plate current cutoff and the charge on C1 increases. Consequently the average dc voltage applied to the if and/or the tuner becomes more negative with a resultant decrease in overall gain. Conversely a decrease in input voltage results in an increase in the gain of the receiver.

Lock-out

Referring to Fig. 10 it will be seen that the valve conducts only if the bias at the grid during the plate voltage pulse is above (more positive than) the bias required for plate current cutoff. This will always be the case if the horizontal oscillator is in synchronism with the transmitter to which the receiver is tuned. However, when the receiver is switched on from cold or switched to a different channel some time will elapse during which the horizontal oscillator is out of synchronism with the transmitter. In that time interval many plate voltage pulses occur while the grid potential is at or below the bias required for plate current cutoff. Consequently little agc voltage is developed and the gain of the receiver is high. If the gain is so high that one or more amplifying stages prior to the agc amplifier are overloaded to such an extent that the sync tips are compressed, then no sync pulses are available at the input of the sync clipper. The horizontal oscillator is not synchronized and since the agc voltage remains at a low value the "out of sync" condition remains. The receiver is then said to suffer from "lock-out". Since the developed agc voltage in the system with a dc plate voltage, as described above, does not depend on the horizontal oscillator being synchronized, the latter system cannot produce "lock-out".

However, the keyed agc amplifier can also be designed to prevent "lock-out" if the valve used has the characteristics of a triode, i.e., where the bias required for plate current cutoff is given approximately by E_p/μ. By applying high plate-voltage pulses derived from those developed during the retrace of the horizontal deflection circuit the grid base can be greatly extended while the sync pulses are present. This is illustrated in Fig. 11 which shows typical conditions applying to a 6BU8.

Fig. 11 (a) shows the sync pulse applied to the No. 1 control grid which is the noise-gating grid. The effect of this grid will be ignored for the moment since it does not affect the "lock-out" condition. As discussed elsewhere in this article, the part of the 6BU8 furthest away from the cathode can be considered as a double triode with a common cathode. In the agc section the signal voltage, i.e., the positive-going composite video signal, is applied to the No. 3 grid which becomes the control grid of the effective triode. Fig. 11 (b) shows this voltage plotted using the same time axis as for Fig. 11 (a). Also shown is the bias required for plate current cutoff under the influence of the pulsed plate voltage which is plotted in Fig. 11 (c).

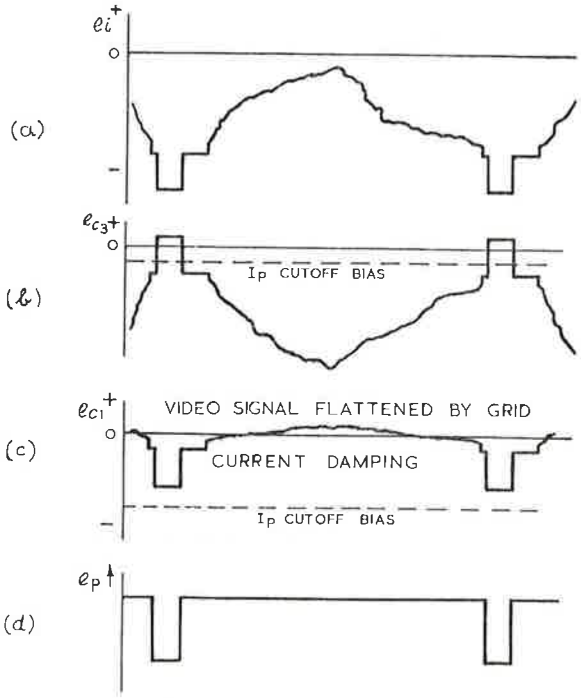


Fig. 13 — Waveforms Relating to Fig. 12 under Conditions of No Noise: (a) at the Video Detector; (b) at Grid No. 3 of V2; (c) at Grid No. 1 of V2; (d) at the Plate of V2.

When the horizontal oscillator is synchronized, plate current can flow only during the sync tip and the back porch. Plate current is therefore not influenced by video voltage. However, if the horizontal oscillator is out of synchronism plate current flows during the plate voltage pulses when the video voltage at the control grid is above (more positive than) the bias required for plate current cutoff. Naturally, the higher the plate voltage the higher the plate current. So while the horizontal oscillator is in synchronism, the agc voltage depends on blanking and sync tip level only. But when the oscillator is initially out of synchronism, the agc voltage depends on the video voltage level during the time intervals the plate-gate is open. As soon as the agc voltage is high enough to prevent the receiver from overloading, the horizontal oscillator locks in and the stable condition is obtained.

The triode-like characteristics of the outer half of 6BU8 can be seen from the plate families in Fig. 5.

Noise Gate

Fig. 12 shows the simplified circuit diagram of a noise gated sync clipper. D is the video detector diode and R1 the video detector load resistor. An output waveform as shown in Fig. 13 (a) appears across R1. V1 is an amplifier of the composite video signal and, for the circuit arrangement where this amplifier is intended for sync and/or agc only and a separate amplifier is used to drive the picture tube, may take the form of a triode. The negative going signal from Fig. 13 (a) is amplified by V1 and appears positive going across the plate load. This signal is applied to the No. 3 control grid of the sync clipper, V2. The sync tips are clamped at grid No. 3 in a manner identical with that described previously. The waveform is drawn in Fig. 13 (b). The negative going signal from the video detector is applied to the No. 1 control grid of V2, via R4. R8 is so chosen that the sycn tips are a little above the bias required for plate current cutoff as shown in Fig. 13 (c). This bias is determined mainly by the screen voltage and to a minor extent by the potential at grid No. 3 and the plate voltage. The screen voltage is determined by R7 and the plate voltage by the divider R5, R6. The potential of grid No. 3 is slightly positive during the sync tips. The resultant plate voltage waveform is drawn in Fig. 13 (d).

Fig. 14 shows the same waveforms as in Fig. 13 but with noise pulses present. Whenever a noise pulse occurs during a sync tip there is little or no output voltage from V2. Since the horizontal oscillator is controlled by some form of afc system the oscillator will free-run during such a noise pulse. Between sync pulses the afc system is relatively immune to noise pulses. The overall effect of noise on the frequency and phase of the horizontal oscillator is therefore very much reduced.

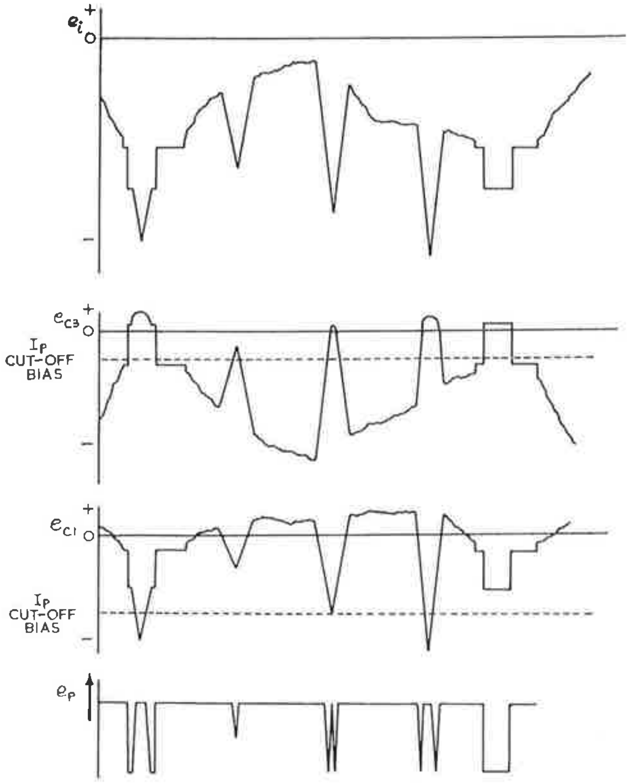


Fig. 14 — Waveforms Relating to Fig. 12 with Noise Pulses Present: (a) at the Video Detector; (b) at Grid No. 3 of V2; (c) at Grid No. 1 of V2; (d) at the Plate of V2.

Automatic Gain Control amplifiers such as have already been described in this article can also be made into noise-gated amplifiers along similar lines as described for the sync clipper. The general effect of noise on such an agc amplifier is that the developed agc voltage decreases with a resultant increase in receiver gain. With a properly designed video amplifier (V1 in Fig. 12) an increase of signal-to-noise ratio at the output of V1 is obtained. In Fig. 15 a transfer characteristic of V1 (Fig. 12) has been drawn. Two horizontal sync pulses with noise pulses have been drawn projected on the grid voltage (E_c) axis. The sync pulse (a) shows the case where the agc voltage and hence the amplitude of the sync pulse is assumed to have remained unaffected by noise, e.g., a keyed agc amplifier with no noise gating. The sync pulse (b) shows the case where the agc voltage is assumed to have decreased and hence the amplitude of the sync pulses to have increased by the presence of noise, e.g., a noise-gated keyed agc amplifier. The signal-to-noise ratio at the input of V1 is the same in both cases.

From the resulting plate current (I_p) it can be seen that the signal-to-noise ratio at the output of V1 has remained practically unchanged for pulse (a). However, for pulse (b) it has substantially increased because of the compression of the noise pulse. It is, therefore, of advantage to operate any video amplifier in such a way that the sync tips drive the grid close to plate current cutoff.

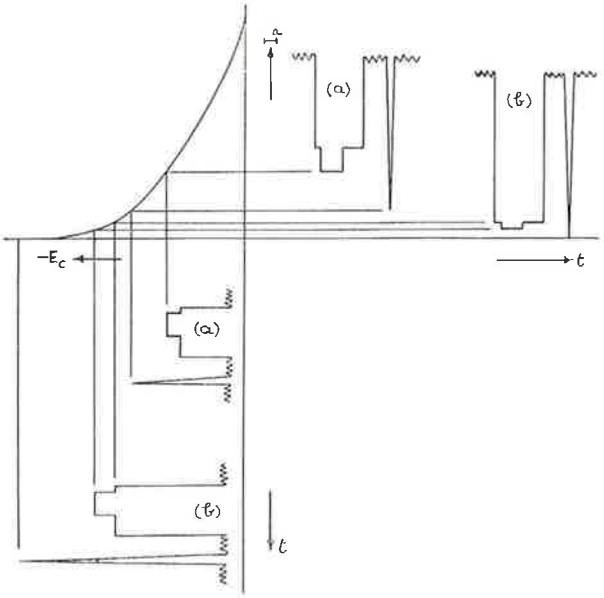


Fig. 15 — Transfer Characteristic of a Video Amplifier Valve showing the Improvement in Signal/Noise Ratio with Increasing Input Amplitude.

Combined Noise-Gated Sync Clipper and AGC Amplifier

From the previous section it may be concluded that ideally, a noise-gated sync clipper and a noise-gated agc amplifier would require two pentodes. However, both pentodes require identical No. 1 grid circuits. Therefore the first grids can be put in parallel. These considerations led to the development of the 6BU8. This valve contains exactly what is required. The two functions, sync and agc, which previously have required two valves can now be carried out with no loss of performance by one valve. Advantages resulting from the use of this dual pentode are lower valve cost, fewer components, reduced heater power and space requirements and, as will be shown later, ease of adjustment by factory, installation and maintenance personnel.

Performance Requirements

(a) The sync clipper shall be designed to provide sync clipping with as low an input voltage as possible. It shall also be possible to synchronize the scanning oscillators when the detected composite video signal is so small that even with the contrast control set to a maximum the picture is hardly visible.

Under noisy conditions with a wide range of input voltages the output from the sync clipper shall be such that the vertical and horizontal oscillators are kept synchronized and "rolling" and "tearing" is absent while a picture is visible.

(b) The agc system shall be such that with a wide range of receiver input voltages the agc voltage increments available at the tuner and controlled if amplifier stages shall be large so that the level of the composite video signal at the video detector changes little. The ratio of tuner-to-if agc voltage shall be large so that the tuner can be given a suitable delay voltage. This means a typical maximum output of -30 volts or more. No "lock-out" shall occur. Noise shall not increase the developed agc voltage and shall preferably decrease that voltage.

(c) Adjustment of controls, agc level and noise gate level, shall be simple and shall not require special equipment or skill.

Simplified Circuit Diagram

Fig. 16 shows a simplified circuit using the 6BU8 in which noise gating is used for both the sync clipper and keyed agc amplifier functions. The figure also shows the video amplifier, V1, and the video detector, D.

Parts of the circuit are later discussed in detail and Fig. 16 is used as a reference. The negative-going composite video signal which appears across the detector load resistance, R1, is applied to the control grid of V1. The amplified composite video signal appears inverted in phase, i.e., positive-going, at the plate of V1. This signal is applied to grid No. 3, the sync clipper control grid and, combined with the noise-gating pulses applied to grid No. 1, produces a negative going sync signal at plate No. 1.

R8 and R9 plus the effective resistance of R10 form a voltage divider and apply part of the output voltage of V1 to the control grid No. 3 (2) of the agc amplifier. The reasons for using this divider are discussed below (see "AGC Amplifier"). The keying pulses for the agc amplifier plate are taken from the horizontal output circuit. Fig. 21 shows how this voltage may be obtained from a capacitive divider across the horizontal yoke. The noise gate is discussed in more detail below.

Design Considerations

In the following sub-sections some aspects of circuit design surrounding the 6BU8 are discussed.

Noise Gate. In Fig. 17 an equivalent circuit is drawn of a noise gate circuit such as presented in Fig. 12.

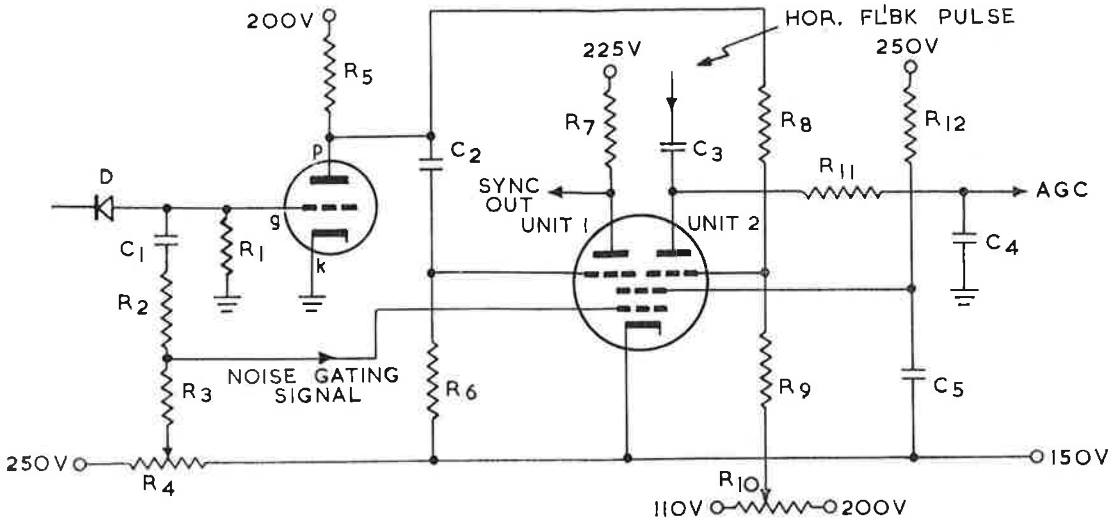


Fig. 16 — Simplified Circuit using the 6BU8 as Sync Clipper and Keyed AGC Amplifier. (Combined Noise Gate).

- G1 is a voltage generator representing the B+ supply.
- G2 is a voltage generator representing the video detector.
- D represents the diode action of the control grid of V2.
- R1 represents R8 in Fig. 12.
- R2 represents R4 in Fig. 12.
- R3 represents the effective series resistance of the video detector.

The current through D (i_d) will be equal to $i_1 - i_2$ providing that $i_1 - i_2$ is equal to or greater than zero. Considering that the forward resistance of D is low compared with R_1 and R_2, point P will remain at or very near ground potential while current flows through D. The voltage e_2 is of an alternating nature (the composite video signal). Then $E_1/R_1 = e_{2\ max}/(R_2 + R_3)$ where $e_{2\ max}$ is equal to the sync tip level of the composite video signal. R_1 and R_2 can be chosen such that $i_1 - i_2$ is zero during the sync tips. Point P is then at ground potential. Now if E_1 is decreased a little, point P will go negative during the sync tips. By making E_1 and/or R1 variable the noise gate can be set to a level slightly above plate current cutoff as described previously.

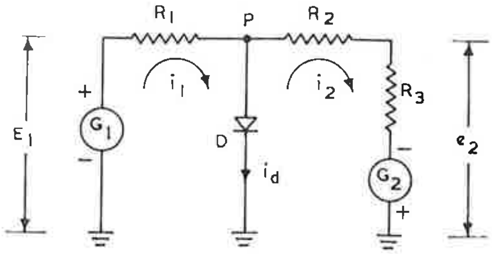


Fig. 17 — Equivalent Circuit of Noise Gate in Fig. 16.

If the cathode of the 6BU8 is at a potential other than ground potential, such as is the case when the 6BU8 is stacked "on top" of another valve, the noise gating signal must be capacitively coupled to the No. 1 grid of the 6BU8. A capacitor is put in series with R4 (see Fig. 12). In this case the dc grid No. 1 resistance of the 6BU8 is determined by R8. This sets the upper limit for R8 at 500,000 ohms which is the maximum permissible No. 1 grid circuit resistance (see 6BU8 valve data sheets). In the circuit of Fig. 21 : R1 = 4,000 ohms, R4 = 33,000 ohms and R8 = 330,000 ohms + effective resistance presented by the 100,000-ohm potentiometer. In this case for the equivalent circuit of Fig. 17, the ratio of R1/(R2 + R3) is approxi-

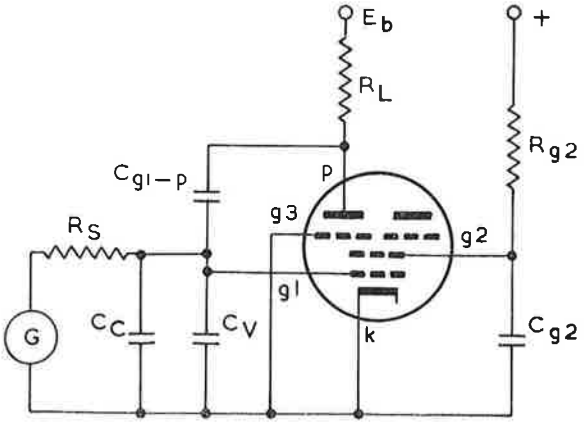


Fig. 18 — Equivalent Circuit of the Noise-gated Sync Clipper Circuit showing the "Miller" Capacitance.

mately 10 and E_1 must therefore be set to approximately 10 x e_{2max}. In the capacitively coupled case e_{2max} depends on the difference between sync tip level and average voltage level at the video detector which may vary from approximately 1 to 2.5 volts in the circuit of Fig. 21. E_1 is then set to approximately 25 volts.

There is another phenomenon affecting the operation of the noise gate which hitherto has been ignored for simplicity. The negative going signal at the No. 1 grid is subject to a form of differentiation due to the changing "Miller" capacitance. An equivalent circuit has been drawn in Fig. 18 : G and R_s are a voltage generator and a series resistance representing the equivalent of the video detector stage, C1, R2, R3, R4 and the dc supply (Fig. 16). R_L is the effective plate load resistance of the sync clipper (it is assumed that the load is purely resistive). C_{g1-p} is the No. 1 grid-to-plate capacitance of the valve plus external circuit capacitance between grid No. 1 and plate. The input capacitance is split into C_c which is the constant input capacitance consisting of the C_{g-k} of the valve plus circuit capacitance, and C_v which is variable (Miller capacitance) and is equal to $(A + 1) \times C_{g1-p}$ where A is the voltage gain between the No. 1 grid and the plate. As was discussed earlier the potential of the control grid of the sync clipper (grid No. 3 in Fig. 18) is close to zero during the tips of the sync pulses. It is assumed here that the sync pulses are applied to grid No. 1 only and that the No. 3 grid remains at cathode potential.

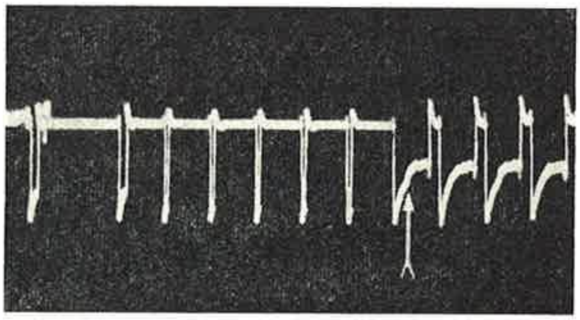


Fig. 19 — Photograph of the Actual Waveform of the last Horizontal Sync Pulses of a Field, the Pre-equalizing Pulses and first Vertical Pulses of the next Field. The Arrow shows the Differentiating Effect Described in the Text.

When the leading edge of the sync pulse drives the No. 1 grid more negative, the No. 1 grid-to-plate gain decreases rapidly. The result is that the voltage across C_c and C_v increases momentarily until it flows off through R_s. This differentiating effect is shown in Fig. 19 which is an oscillogram taken at the No. 1 grid of the 6BU8 and shows the end of a field together with the pre-equalizing pulse train and the vertical sync pulses of the following field.

This phenomenon naturally affects the setting of the noise gate level control because on the leading edges the sync pulses must never go as far negative as the No. 1 grid bias potential required for plate current cutoff (Fig. 13 (a).) In practice the adjustment of the noise gate is quite simple and is described later.

Sync Clipper. There are several factors affecting the design of the sync clipper. It is beyond the scope of this article to elaborate on these factors. Referring to Fig. 7(a) the choice of R1, R2, C1 and the B+ voltage depends on:

(1) The minimum peak-to-peak voltage of the composite video signal required at the input for clean sync clipping and

(2) the noise immunity of the sync clipper.

Unfortunately, values of R1, R2, C1 and B+ which will satisfy (1) will not give good noise immunity and vice-versa. However, since the 6BU8 noise gate circuit provides good noise immunity, the component values in Fig. 21 have been chosen so as to favour requirement (1). Some considerations affecting the choice of the above mentioned components follow:

R2/R1. For the peak-to-peak input voltage at which clean sync clipping takes place to be a minimum R2/R1 should be large and the B+ should be low. After the start of a noise pulse a definite time will elapse before the sync output is restored to normal. This will be short when R2/R1 is small.

C1. For maximum noise immunity to noise pulses of long duration, C1 should be large. For least disturbance by noise pulses occuring at a high repetition rate C1 should be small.

B+. For the case where a limiting sync amplifier follows the sync clipper the B+ voltage should be high to provide maximum noise immunity. The higher the B+ voltage the higher the sync output voltage and the larger the percentage of the sync clipper output voltage which is limited by the sync amplifier. When this percentage is increased the time required for the output of the sync amplifier to become constant after a disturbance by a noise pulse will be decreased.

AGC Amplifier. As was discussed in connection with Fig. 16, the composite video signal from the output of V1 is applied to grid No. 3 (2) of V2 (6BU8) via a divider. The action of this attenuating network is required for the following reasons:

(1) Normally with an optimum design of the amplifier (V1) circuit the sync tip level with respect to chassis will be higher than the cathode potential of V2 and must be reduced to avoid the grid to cathode voltage going excessively positive.

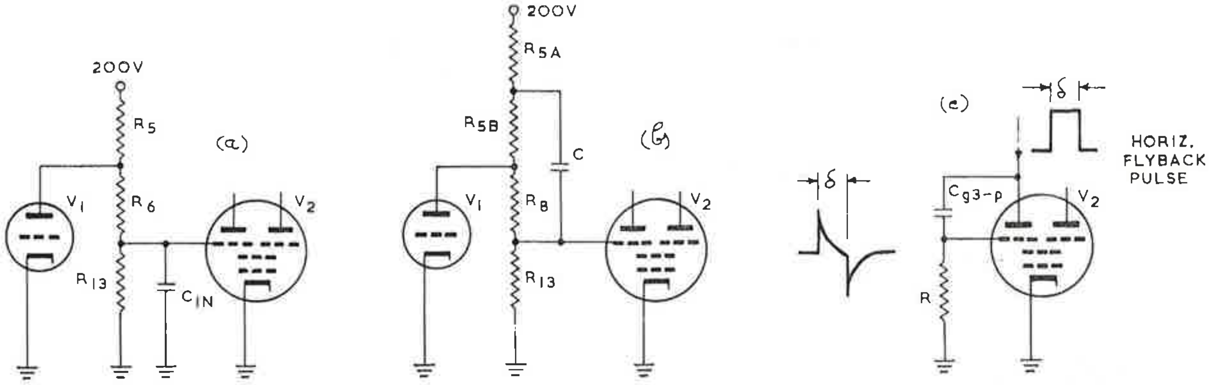


Fig. 20 — (a) Equivalent Circuit Showing the Input Capacitance of the AGC Amplifier (b) Diagram Showing the Input Circuit of the Amplifier with Capacitive Coupling to the Split Load Resistor of the Video Amplifier; (c) Equivalent Circuit Showing the Differentiated Plate Voltage Pulse appearing in the Grid Circuit.

(2) Isolation is necessary between the sync and agc input circuits. Further discussion of this point is presented later.

(3) An agc level control is desirable. This can be provided very simply by making the lowest component in the divider a potentiometer.

To illustrate the need for the divider the magnitude of the voltages applying to a particular circuit will be quoted. If for example, the plate supply voltage of V1 (Fig. 16) is 200 volts, the sync tip level at the plate may be 180 volts with a nominal input voltage. The cathode voltage of V2 is +160 volts and since the sync tip level must be slightly lower than the cathode voltage (Fig. 10) some attenuation is required. The sync tip level actually used is approximately +150 volts. The maximum permissible positive No. 3 grid to cathode dc voltage is +3 volts. The grid current at +3 volts is approximately 1.75 milliamps. The maximum dc voltage that can ever prevail at the plate of V1 is 200 volts, i.e. when V1's plate current is cut off. This sets a minimum value for R8 in parallel with R9. The maximum permissible No. 3 grid circuit resistance is 500,000 ohms. The effective No. 3 grid circuit resistance is R8 in parallel with the series combination of R9 and the effective resistance R10.

The next point of consideration is the frequency response at grid No. 3 (2). Fig. 20 (a) is an equivalent circuit representing part of Fig. 16 which shows the input capacitance of the agc amplifier, C_{in}. The frequency response is determined by the time constant R_{g3} x C_{in}, where R_{g3} = the effective No. 3 grid circuit resistance, and C_{in} = the input capacitance of the No. 3 grid. R_{g3} may be as high as 500,000 ohms. C_{in} is of the order of 50 pf. Then $R_{g3} \times C_{in} = 25\mu s$. The time constant should be such that the voltage rises from extreme white to within 99% of the blanking level in the duration of the front porch, i.e., in approximately $0.22\mu s$. The time constant can be made a minimum by splitting the plate load in the same ratio as R8/R9 and coupling the junction to the No. 3 grid with C, Fig. 20 (b). R5A/R5B is equal to R8/R13.

By returning the bottom of R9 to a variable dc voltage the bias of grid No. 3 (2) can be varied and consequently the agc voltage developed at plate No. 2.

Another limiting factor in the choice of R8, R9 and R10 is the maximum permissible negative dc No. 3 grid voltage which is -45 volts. The minimum possible voltage at grid No. 3 (2) occurs when the agc level control R10 is in the minimum voltage position and with zero output from V1, i.e., with zero output from the video detector.

Fig. 11 shows waveforms relating to the 6BU8 agc amplifier. Fig. 11 (a) shows the waveform at the No. 1 grid. This waveform is idealized. The actual waveform will be similar to that shown in Fig. 19. Fig. 11 (b) is the waveform at grid No. 3 (2). Also shown is the No. 3 grid bias required for plate current cutoff when the plate voltage waveform is as shown in Fig. 11 (c). In Fig. 11 (d) the plate current waveform is shown. There are two main time intervals. During the first interval (sync tip), the No. 1 grid-to-cathode voltage is -1 volt and the No. 3 grid-to-cathode voltage -8 volts. During the second time interval (back porch) the No. 1 grid-to-cathode voltage is -0.2 volts and the No. 3 grid-to-cathode voltage -17 volts. The plate voltage during the first interval is indicated by the single hatched portion in Fig. 11 (c). The plate voltage during the second interval is indicated by the double hatched por-

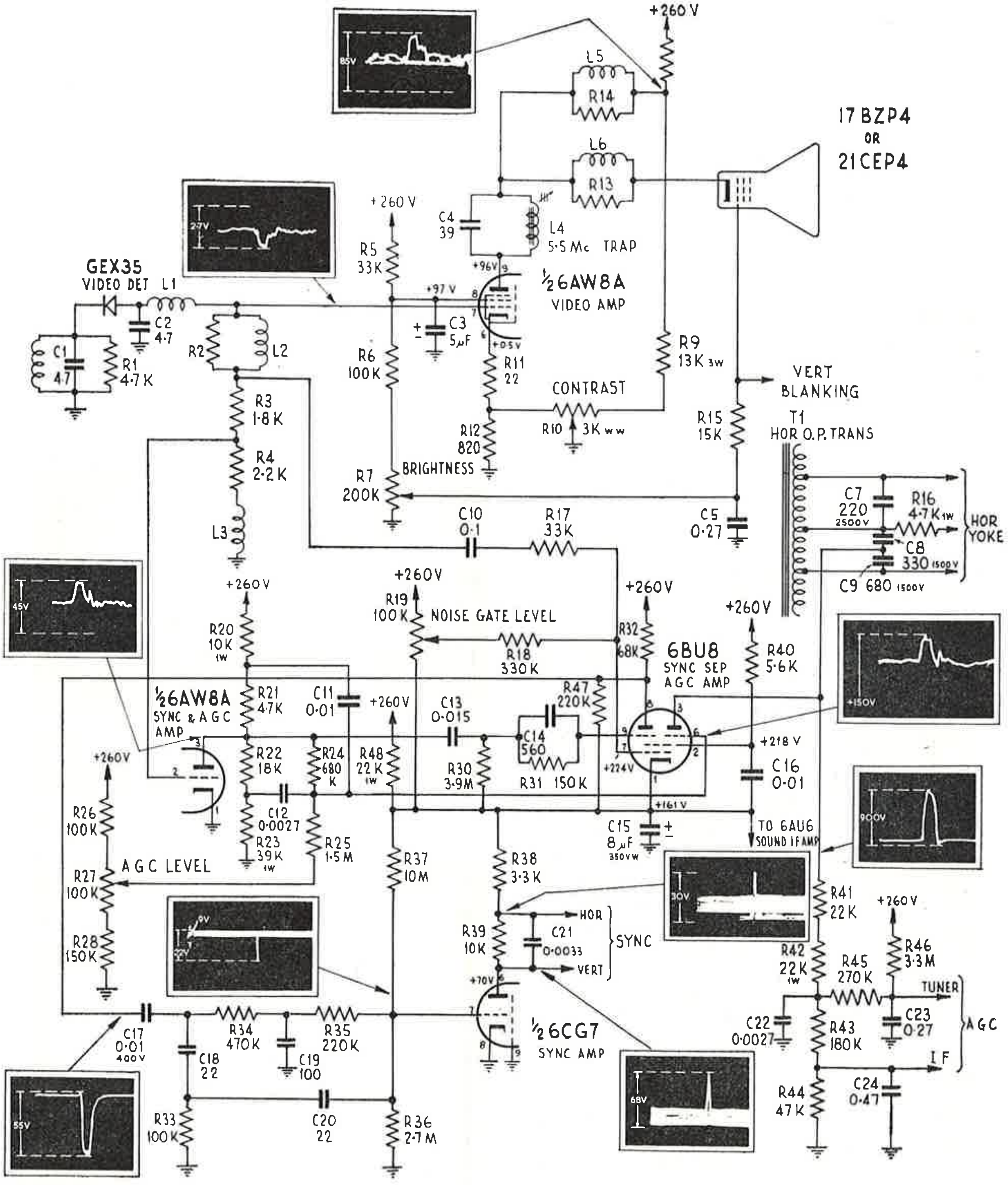
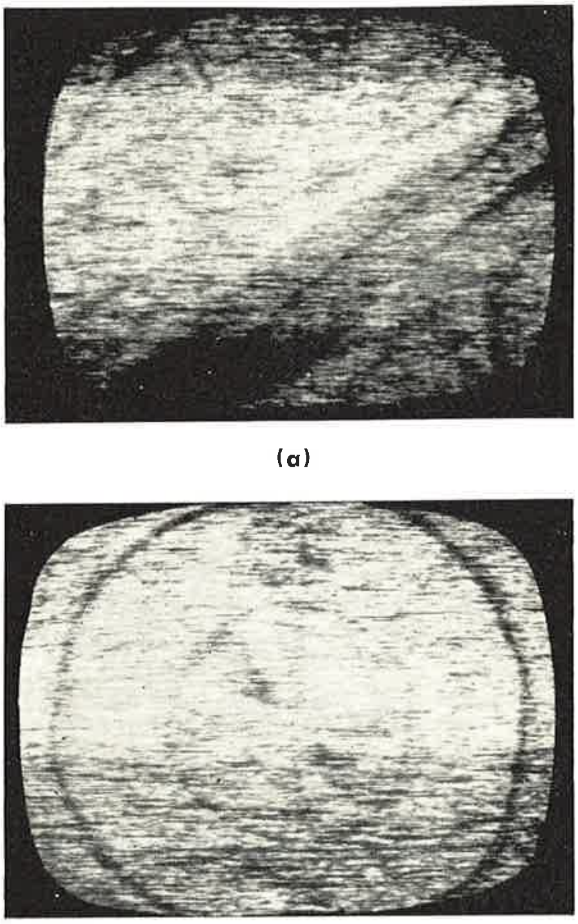


Fig. 21 — Practical Circuit of Noise-gated Sync and AGC Circuit using the 6BU8.


(a)

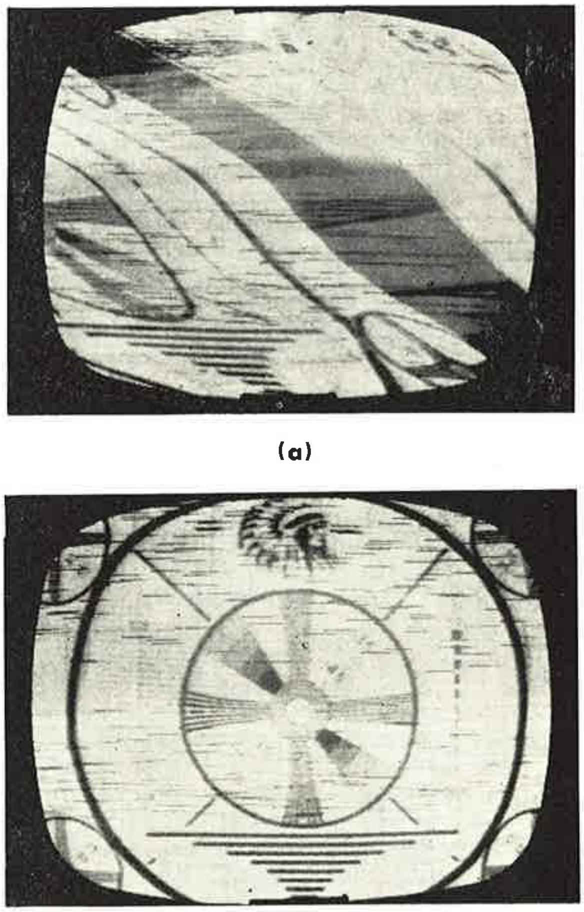
(b)

Fig. 22 — Photographs of the Picture Tube face showing the Effects of High Level Noise on a Fringe Area signal of Approximately 5 microvolts; (a) with Noise Gate Inoperative; (b) With Noise Gate operative.

tion. The developed agc voltage is determined by the plate current, which is the charging current of C3 in Fig. 16, and at the time during which the charging takes place. This is indicated by the area under the plate current waveform. It will be found that the area under the back porch is the larger. The level of the back porch at grid No. 3 (2) is therefore the main factor determining the developed agc voltage.

Reduction of Horizontal Flyback Pulses in the Sync Clipper Input. Because of the capacitance between plate No. 2 and grid No. 3 (2) the plate pulses appear differentiated at the No. 3 grid. This is shown in Fig. 20 (c) in which R is the effective No. 3 grid circuit resistance. The arrangement of Fig. 20 (b) helps to reduce the amplitude of the differentiated pulses because the effective grid circuit impedance has been greatly reduced.

Stacking. Apart from the plate voltage of the keyed agc amplifier the required (positive) electrode voltages of the 6BU8 do not exceed 100 volts. Considering a B+ voltage of 250 volts, a voltage of 150 volts at a current equal to that drawn by the 6BU8 remains. The total B+ can therefore be divided between the 6BU8 and another valve (or valves) by stacking the two in series so that approximately 100 volts is developed across the 6BU8. Also having the cathode of the 6BU8 at approximately 150 volts provides for convenient coupling of the preceding composite video amplifier to the agc amplifier No. 3 control grid. Using the valve in this way provides a normally-desirable saving in B+ current. The current drawn by the stacked valve should be unaffected by video content or input signal strength. In most receiver designs the sync amplifier and sound if amplifier fulfil these requirements and can operate with plate supply voltages of 150 volts or less. The current drawn by the 6BU8 depends mainly on the No. 1 grid voltage and changes with the setting of the noise gate level control, R8, in Fig. 12. It is therefore of advantage to have the impedance at the cathode of


(a)

(b)

Fig. 23 — Photographs of the Picture Tube face showing the Effects of High Level Noise on a Medium Strength signal of Approximately 1 millivolt; (a) With Noise Gate Inoperative; (b) With Noise Gate Operative.

the 6BU8 as low as possible. For instance it is better to stack the 6BU8 with more than one valve and make up the difference in current drawn with a suitable resistor between B+ and the 6BU8 cathode.

Summarizing, the advantages of stacking the 6BU8 are improved voltage regulation at the cathode and power saving.

Practical Circuit

Circuit Description

In Fig. 21 a practical circuit of a noise-gated sync and agc circuit using the 6BU8 is shown. Several aspects of the circuit have been dealt with in previous sections. The pentode section of a 6AW8A is used as the video output valve. The contrast control is in the cathode so that relatively long leads to the control can be used. The triode section of the 6AW8A is used as an amplifier for sync and agc. The input voltage for the triode is taken from a tap on the video detector load, R3 and R4. This helps to reduce the capacitive loading of the triode on the video detector. The plate load of the triode is in the form of a voltage divider R20 + R21 and R22 + R23. The two parts of the divider are tapped to reduce the impedance of the agc amplifier control grid (pin 6 of the 6BU8) to a minimum. The 6BU8 is stacked on top of one half of a 6CG7 — the sync amplifier, and a 6AU6 — the sound if amplifier (not shown in the diagram). The agc amplifier plate voltage pulses are derived from the capacitive divider C8/C9 across the lower half of the horizontal yoke. The effective capacitance charged by the plate current, is C8 and C9 in parallel.

The plate load of the sync clipper consists of the resistive divider R32/R47. The output is coupled via C17 to:

(1) the integrating network R34, C19.

(2) the differentiating network C22, R33.

The integrated and differentiated sync signals are coupled to the grid of the 1/2 6CG7, sync amplifier, via R35 and C20 respectively.

Grid current clamping is accomplished by means of R37 and R36. Between pulses the sync amplifier is conducting and C21 is charged. During horizontal pulses C21 discharges only by a small amount. The plate voltage is then 161 volts minus the voltage across C21 (approximately 70 volts) and equals approximately 90 volts. The grid-to-cathode bias required for plate current cutoff under these conditions is approximately -6 volts. During the integrated vertical pulses C21 discharges almost completely and the plate voltage rises therefore to approximately 160 volts. The control grid to cathode bias required for plate current cutoff under these conditions is approximately -11 volts.

This change in operating conditions has two effects. Firstly, due to the higher plate voltage which exists during the duration of the integrated vertical pulse, the plate current and hence the peak-to-peak output voltage are higher. This is most desirable since the vertical pulse is attenuated considerably in a low pass filter before being applied to the vertical oscillator. Secondly, as the effective grid base has been extended from approximately -6 to -11 volts during this time, the amplitude of the integrated pulses at the input of the sync amplifier is required to be larger to ensure that the negative going vertical pulses at the grid extend beyond the now lower grid voltage required for plate current cutoff.

Adjustment of Noise Gate Level Control

In practice, both in the factory and the field, the adjustment of the noise-gate level control to provide optimum noise immunity is very simple. The following steps are required:

(1) Set the noise gate level control R19, Fig. 21, to the approximate centre of its range.

(2) Under the prevailing input signal conditions adjust the agc level control to the point where sync compression is about to commence. This point is perhaps best determined on the strongest channel by first adjusting the control until the picture begins to "tear" or "roll" and then "backing off".

(3) Rotate R19 towards the low voltage (6BU8 cathode) end of its range until sync is lost and then reverse until sync is regained.

(4) Repeat (3) for different channels until sync holds on all channels.

The noise gate can be made equally effective for any position of the agc level control (except of course for a setting where the if amplifier overloads to the point of causing severe compression of the sync pulses). However, after the noise gate level has been set for the selected level of agc no attempt should be made to readjust the agc level control.

It will be found that after setting the noise gate and agc level controls as detailed above optimum noise performance will hold for wide variations in the amplitude of the rf input signal.

Noise Performance

An indication of the noise immunity afforded by the noise gating arrangements of Fig. 21 is shown in the photographs of Figs. 22 and 23. In Fig. 22 are photographs of the screen of the picture tube showing the ability of the noise gate to reduce the effects of high level noise superimposed on a fringe area signal of approximately 5 microvolts. Photograph (a) shows the complete loss of sync and resultant loss of the picture with the noise gate inoperative and (b) the positive "hold" obtained when the noise gate is operative and adjusted correctly.

Fig. 23 is similar to Fig. 22 except that the noise is superimposed on a medium strength signal of approximately 1 millivolt. Photograph (a) shows the disturbance by the noise for the non-gated condition and (b) the complete noise immunity provided by the noise gate.

Acknowledgements

Gratitude is hereby expressed to the management of the Amalgamated Wireless Valve Co., Pty. Ltd., for permission to publish, and to our co-workers in the Application Laboratory for their willing and able assistance in the preparation of the paper.

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BOOK REVIEWS

"GUIDE TO BROADCASTING STATIONS". 12th Edition. Iliffe & Sons Ltd. Size 7¼in. x 4¾in., 110 pages.

This unique book has gained itself a well-earned place in the years during which it has gone into twelve editions. Whilst perhaps not having the same extent of appeal to Australian listeners that it would have in Europe, there is even so enough useful data to recommend it to the serious short wave listener and others in this country.

The main sections of the book list both geographically and in order of frequency all European long- and medium-wave broadcasting stations, over 1,000 European vhf broadcasting stations, the principal European TV stations, and nearly 2,500 short-wave stations of the world. Other data included, some new in this edition, are a 2-page map of the world's broadcasting zones, a standard time chart for the principal countries and areas, a listing of international call-sign allocations, and a list of frequency allocations for various purposes.

"ELECTRONIC COMPUTERS: Principles and Applications". 2nd Edition. T. E. Ivall, Iliffe & Sons Ltd. Size 8¾in. x 5½in., 263 pages, including 32 pages of art plates, 58 figures.

We are all of us becoming increasingly aware of the specialised language of computers, in which words such as "analogue", "digital", "programming" and so on abound. Many of us must confess of having an imperfect understanding of just what it all means. This is bad, for computers are here. Recently two of Australia's largest business houses announced plans to instal equipment to take charge of such functions as stock control and replacement ordering, invoicing and warehousing functions generally.

For those who want to know more about computers, Mr. Ivall's book is recommended. It is intended as a non-mathematical introduction to the principles and applications of electronic computers. It has been designed to appeal to technicians, engineers and students who have some knowledge of electronic or electrical engineering, but some chapters are also suitable for the interested layman. The treatment has been deliberately made as general as possible in order to give a broad background picture of the whole field of computing.

The bulk of the book is devoted to describing the circuitry and construction of both digital and analogue computers, but their rapidly developing applications in industry, commerce and science are also outlined. Here considerable emphasis is placed on the application to "automation" techniques in industry, and also on the computing techniques which are nowadays playing an important part in research and design work.

NEW DEVELOPMENTAL TRAVELLING-WAVE TUBE

A new developmental X-band, electrostatically focused travelling-wave tube capable of delivering a peak radio-frequency power output of 10 kilowatts has been described by engineers of the RCA Electron Tube Division. The design and performance capabilities of the new travelling-wave tube were disclosed in a paper by E. F. Belohoubek, W. W. Siekanowicz, and F. E. Vaccaro which was presented at the 1959 Electron Devices Meeting of the Institute of Radio Engineers at the Shoreham Hotel.

The authors pointed out that previous electrostatically focused travelling-wave tubes using a bifilar-helix construction delivered only about 10 watts. The developmental tube uses different types of slow-wave radio frequency structure, rather than a bifilar helix, to increase its power and frequency capabilities.

The two new radio frequency circuits, developed under contract with the Naval Research Laboratory, are "folded-line" and "capacitively-coupled-bar" structures adapted for electrostatic

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NEW SILICON RECTIFIERS FOR GENERAL-PURPOSE ELECTRONIC APPLICATIONS

1N2858 - 1N2859 - 1N2860 - 1N2861 - 1N2862 - 1N2863 - 1N2864

The 1N2858, 1N2859, 1N2860, 1N2861, 1N2862, 1N2863 and 1N2864 are hermetically sealed silicon rectifiers of the diffused-junction type designed for use in both industrial equipment and consumer-type products.

All seven rectifier types have maximum dc forward current ratings of 750 milliamperes for resistive or inductive loads, and 500 milliamperes for capacitive loads at ambient temperatures up to 75°C.

These silicon rectifiers feature: (1) diffused silicon junctions of extremely high uniformity produced by a special precisely controlled diffusion process, (2) rugged internal mount structure, (3) hermetically sealed, highly reliable, industry-preferred cases, (4) axial leads for flexibility of installation in either hand-wired or printed-circuit equipment designs.

Long life and stability of electrical characteristics of these silicon rectifiers are assured by conservative ratings and the following stringent quality-control tests and procedures: (1) subjection for prolonged periods to high temperatures to assure stable performance, (2) pressure tests for leaks in seals to assure protection against moisture and contamination, (3) tests for forward- and reverse-current characteristics at 25°C, and (4) high-temperature dynamic tests under full-load conditions.

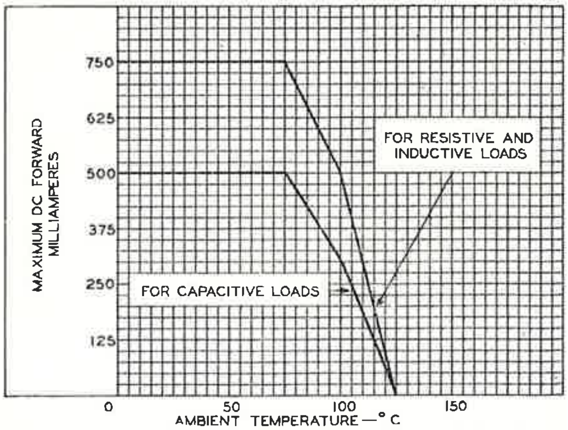


Fig. 1 — Maximum DC Forward Current Versus Ambient Temperature Rating Chart.

GENERAL DATA

Mechanical:

Operating Position	Any
Case	Metal
Envelope Seals	Hermetic

(See also Dimensional Outline)

RECTIFIER SERVICE

Maximum Ratings, Absolute Maximum Values:

PEAK INVERSE AND DC REVERSE VOLTAGE:

1N2858	50 volts
1N2859	100 volts
1N2860	200 volts
1N2861	300 volts
1N2862	400 volts
1N2863	500 volts
1N2864	600 volts

RMS SUPPLY VOLTAGE:

	Resistive or Inductive Load	Capacitive Load
1N2858	35 volts	17 volts
1N2859	70 volts	35 volts
1N2860	140 volts	70 volts
1N2861	210 volts	105 volts
1N2862	280 volts	140 volts
1N2863	350 volts	175 volts
1N2864	420 volts	210 volts

FORWARD DIRECT CURRENT:*

	Resistive or Inductive Load	Capacitive Load
At Ta = 75°C	750 ma	500 ma
At Ta = 100°C	500 ma	300 ma

* See also Rating Charts, Figs. 1, 2.

FORWARD SURGE CURRENT, ONE CYCLE:

At Ta = 25°C 40a

AMBIENT TEMPERATURE:

Operating and Storage .... -65 to +125°C

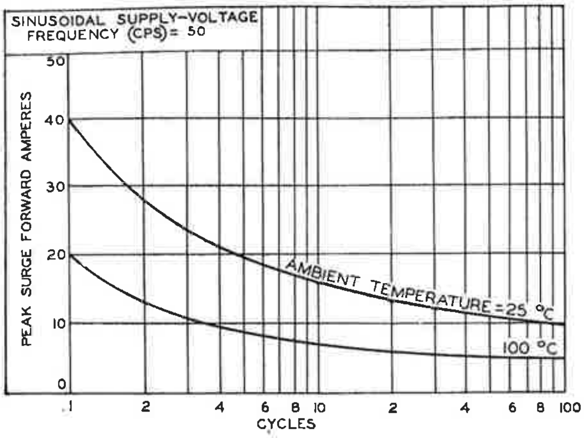


Fig. 2 — Repetitive-Surge Forward-Current Rating Chart.

Characteristics, at Ta = 25°C:
Maximum Forward DC Voltage Drop at DC Forward Current of 500 ma: ..... 1.2 volts

Characteristics, at Ta = 100°C:
Maximum Reverse Current Averaged over one Complete Cycle at Maximum Peak Inverse Voltage and for a DC Forward Current of 250 ma:

1N2858, 1N2859, 1N2860	0.4 ma
1N2861 to 1N2864	0.3 ma

OPERATING CONSIDERATIONS

The maximum ratings in the tabulated data are established in accordance with the following definition of the Absolute-Maximum Rating System for rating electron devices.

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron device of a specified type as defined by its published data, and should not be exceeded under the worst probable conditions.

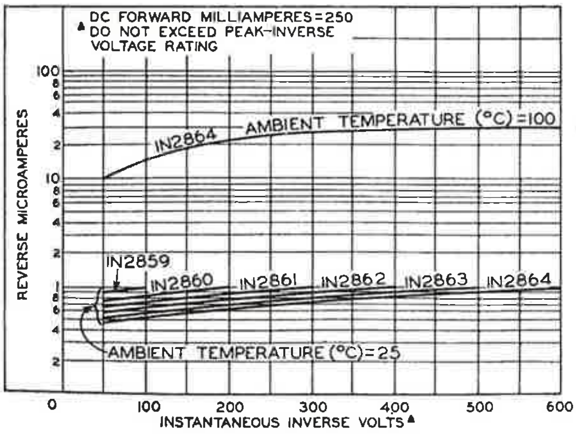


Fig. 3 — Typical Reverse Characteristics.

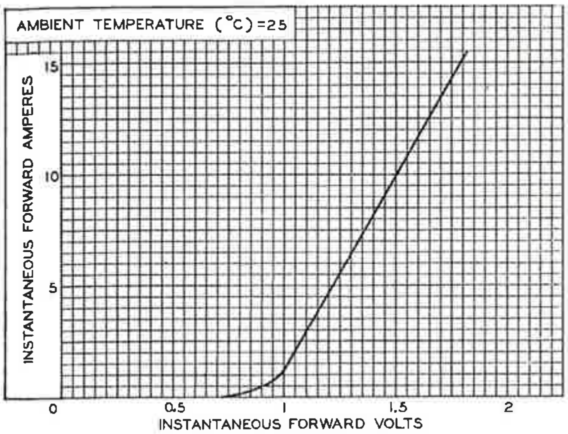
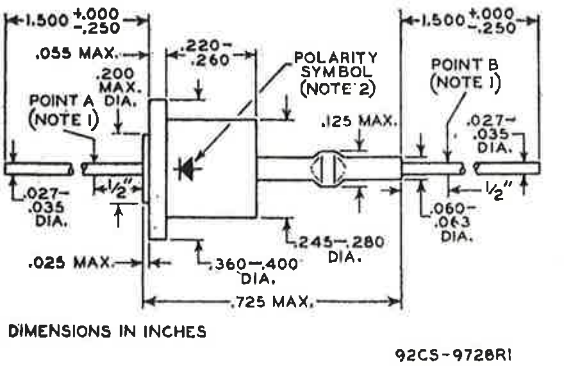


Fig. 4 — Typical Forward Characteristics.

The device manufacturer chooses these values to provide acceptable serviceability of the device, taking no responsibility for equipment variations, environment variations, and the effects of changes in operating conditions due to variations in device characteristics.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any device under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in device characteristics.

A surge-limiting impedance should always be used in series with the rectifier. The impedance value must be sufficient to limit the surge current to the value specified under the maximum ratings. This impedance may be provided by the power transformer windings, or by an external resistor or choke.



NOTE 1: DO NOT DIP SOLDER BEYOND POINTS A AND B.
NOTE 2: ARROW INDICATES DIRECTION OF FORWARD (EASY CURRENT FLOW AS INDICATED BY DC AMMETER.

Fig. 5 — Dimensional Outline.

The flexible leads of these rectifiers are usually soldered to the circuit elements. It is desirable in all soldering operations to provide some slack or an expansion elbow in the leads to prevent excessive tension on the leads. It is important during the soldering operation to avoid excessive heat in order to prevent possible damage to the rectifiers. To absorb some of the heat, grip the flexible lead of the rectifier between the case and the soldering point with a pair of pliers.

When dip soldering is employed in the assembly of printed circuitry using these rectifiers, the temperature of the solder should not exceed 255°C for a maximum immersion period of 10 seconds. Furthermore, the leads should not be dip soldered beyond points A and B indicated on the Outline Drawing.

Because the cases of these rectifiers may operate at potentials which are dangerous, care should be taken in the design of equipment to prevent the operator from coming in contact with the rectifier. It is recommended that these rectifiers be mounted on the underside of the chassis.

DAMPER VALVE ACTION

The damper valve in the horizontal output circuitry of a television receiver is often thought of as simply a valve that dampens unwanted current oscillations in the horizontal deflection coils. Though the valve serves in this capacity, it also has two other very important functions that are sometimes overlooked. Current through the damper valve supplements current through the horizontal output valve in providing for linear horizontal deflection of the electron beam, and at the same time acts as a half-wave rectifier in the development of a "B Boost" voltage.

The raster on the screen of a picture tube is formed by the action of both the horizontal output valve and the damper valve. Current building up in the horizontal output valve accounts for the right-hand two-thirds of the scanning line, as illustrated in Fig. 1; the remaining third of the scanning line is formed by current passing through the damper valve. In a sense, horizontal deflection starts a little to the left of the centre of the picture tube screen, as indicated. As the current builds up in the horizontal output valve current is abruptly cut off at the end of the scanning period, the field about the horizontal output transformer collapses and provides for a fast retrace of the electron beam to the left extreme of the picture tube screen. At this point in the action of the deflection circuit, current is conducted through the damper valve, which causes the electron beam to start scanning from the extreme left of the screen across approximately one-third of the screen, where current through the horizontal output valve takes over again; see Fig. 2.

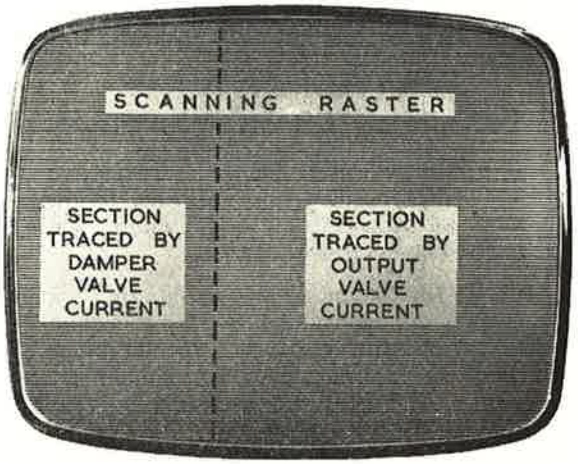


Fig. 1 — Formation of Raster on Picture Tube.

Damper valves are designed to withstand the high values of peak inverse voltage that are created by the instantaneous collapse of current in the horizontal output transformer windings (1 to 2 kilovolts). Most television receivers of recent years have the damper valve heater windings connected to ground through a transformer winding. Damper valves used in these receivers must have good insulating characteristics between the heater and cathode since the cathode operates at a potential that is positive in respect to the heater by the amount equal to "B Boost." A damper valve must also have a high current rating since it may at times handle currents as high as 500 milliamps.

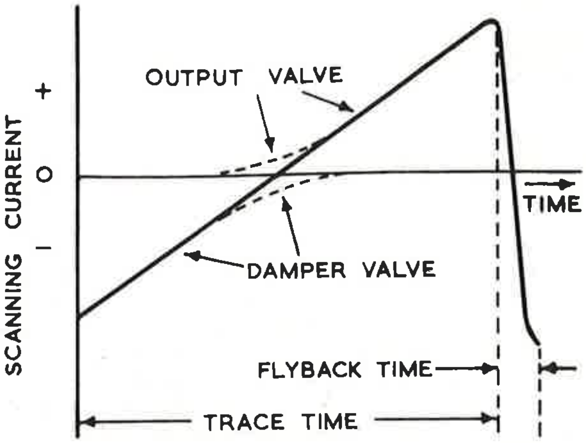


Fig. 2 — Horizontal Scanning Current Waveform.

In addition to the functions mentioned above, the damper valve also serves as a half-wave rectifier in the development of “B Boost” voltage, which is employed in the vertical circuitry and other sections of the receiver. Two sources of voltage contribute to the formation of “B Boost” voltage: B+ voltage from the low-voltage power supply, and rectified deflection voltage obtained from the horizontal output circuitry. The amount of “B Boost” added to the B+ voltage runs up to 250 volts in black-and-white receivers and as high as 375 volts in colour receivers. See Fig. 3.

Defective components in “B Boost” circuitry can affect both vertical and horizontal linearity. Measurement of “B Boost” voltage is important in checking the performance of the horizontal output circuits of a television receiver, but precautions should be taken. Always check “B Boost” at a point where it has been filtered. The “B Boost” voltage should never be measured at the cathode of the damper valve, because of the high peak voltages that exist there. Failure to observe this precaution can cause serious damage to a meter.

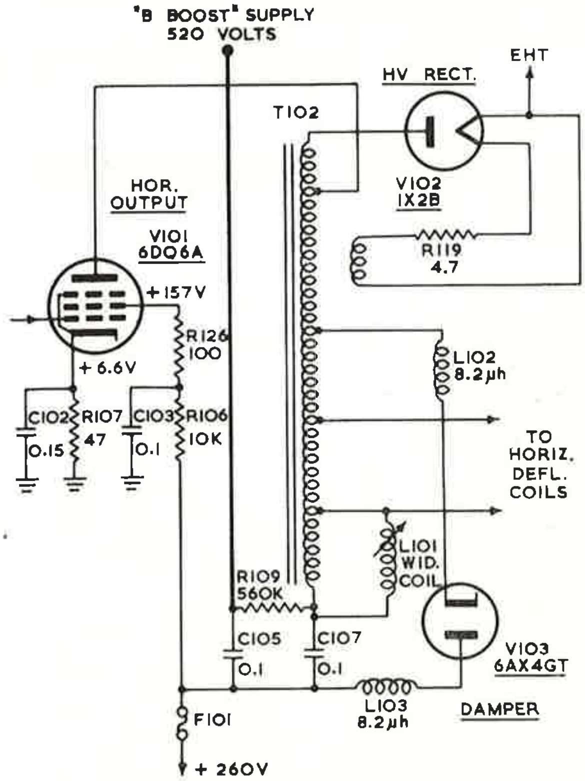


Fig. 3 — Formation of “B Boost” in Horizontal Output Circuitry

(With acknowledgements to RCA)

NEW DEVELOPMENTAL TWT

(Continued from page 151)

beam focusing. An ideal arrangement for realizing maximum perveance in a laminar, parallel-flow electron beam is also derived. The design of the rf circuits is compatible for use with ideal electrostatic focusing electrodes. At high rf signal levels, a peak rf power output of 10 Kw at a collector efficiency of 33 per cent is realized at X-band. (8,000 - 12,000 Mc approximately).

According to the authors, this new tube, like other electrostatically-focused tubes, offers the following major advantages over comparable tubes employing magnetically focused electron beams.

1. Lighter weight of the tube package as a direct result of the elimination of focusing magnets.
2. Freedom from ion oscillation and ion bombardment of the cathode as a consequence of the ions being continually swept out of the beam by the electrostatic fields used for focusing. It is expected that the elimination of ions striking the cathode will result in a longer tube life.
3. Operation over a wide temperature range due to the absence of temperature-sensitive magnetic materials.

NEW THIN PICTURE TUBE FOR RADAR DISPLAY UNDER DEVELOPMENT AT RCA LABORATORIES

A radically new type of thin picture tube, resembling a standard automobile wheel in diameter and thickness, is being developed by the Radio Corporation of America to improve the brightness, detail, and compactness of large-screen military and commercial radar display systems. The new tube has potential application in military fire-control and tracking radar systems and in commercial airport use. It was described at the 1959 Electron Devices Meeting by Harold B. Law and Edward G. Ramberg of the RCA Laboratories technical staff.

The tube, of a type known as a "reflected-beam kinescope", displays its images on a viewing screen 21 inches or more in diameter, employing a tube structure that is only 10 inches long and has a recessed rear area large enough to hold most of the receiving circuit equipment. It was described by the two scientists as an outgrowth of RCA research in electronic display systems for both radar and television.

Installed for operation, the experimental tube resembles a large cylindrical bowl standing on edge, with a bulging front surface and a scooped-out rear. From the centre of the recessed back surface extends a short slender neck containing the electron gun, as in conventional radar and television picture tubes.

The new device was discussed by the RCA scientists in comparison with present conventional tubes used for radar and television display. In conventional tube types, a phosphor screen is mounted on or near the tube face, and the pictures are "written" on the screen by a scanning beam from the electron gun. The motion of the beam is controlled by a magnetic "yoke" around the neck of the tube, causing the beam to bend, or deflect, from side to side across the phosphor screen, progressing from top to bottom of the tube face until the whole surface has been scanned.

In the new RCA thin tube, the phosphor screen is mounted over the curved rear inner surface instead of at the tube face. Instead of striking the back of the phosphor screen, however, the beam approaches the transparent face of the tube, which acts as an "electron mirror" to reflect the beam back to the phosphor.

According to the two RCA scientists, the experimental design has these major advantages:

An effective 180-degree deflection angle—meaning that the electron beam can "write" the picture on a surface extending at right angles from the gun in all directions, thus permitting a large picture display with an extremely short-necked tube. By comparison, present short television picture tubes have a 110-degree deflection angle, achieving a 21-inch display surface in a structure 12 inches long.

A substantial saving in power needed to achieve extremely wide angle operation. In conventional tubes, the deflection angle can be increased further only by increasing the power of the magnets that bend the electron beam. In the experimental tube, the full 180-degree deflection is obtained with the equivalent of a 90-degree deflection system, since the angle is doubled by the reflection from the tube face.

Better detail in the image, which is sharper on the side of the phosphor screen that is struck directly by the electron beam. On the opposite side, viewed in conventional tubes, there is a certain "halation", or diffusion of light, that tends to blur the image.

Extremely compact structure, resulting from the shortness of the tube and the possibility of tucking a large amount of circuitry within the recessed rear area of the tube.

The two scientists stated that the new thin tube also is capable of displaying standard television pictures. They pointed out, however, that at the present time it would operate with about one-fourth the efficiency of present conventional black-and-white television display tubes.

The report on the new tube was one of several technical discussions by RCA scientists at the meeting. Dr. F. H. Nicoll, of the RCA Laboratories technical staff, described a possible new method for amplifying the brightness of moving images, such as motion picture or television material, by means of thin-panel light amplifiers. Experimental light amplifier panels so far have been limited to still or slow-moving images because of slow response in photoconductive material used to control the voltage that produces the brighter light output. Dr. Nicoll described experiments with a small-area unit employing an improved photoconductive material developed at RCA's David Sarnoff Research Centre. He reported "moderate light amplification with speeds in a range suitable for moving pictures".

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