March 26, 1940. K. SCHLESINGER 2,194,571

TELEVISION RECEIVING RECTIFIER

Filed Feb. 24, 1936 2 Sheets-Sheet 1

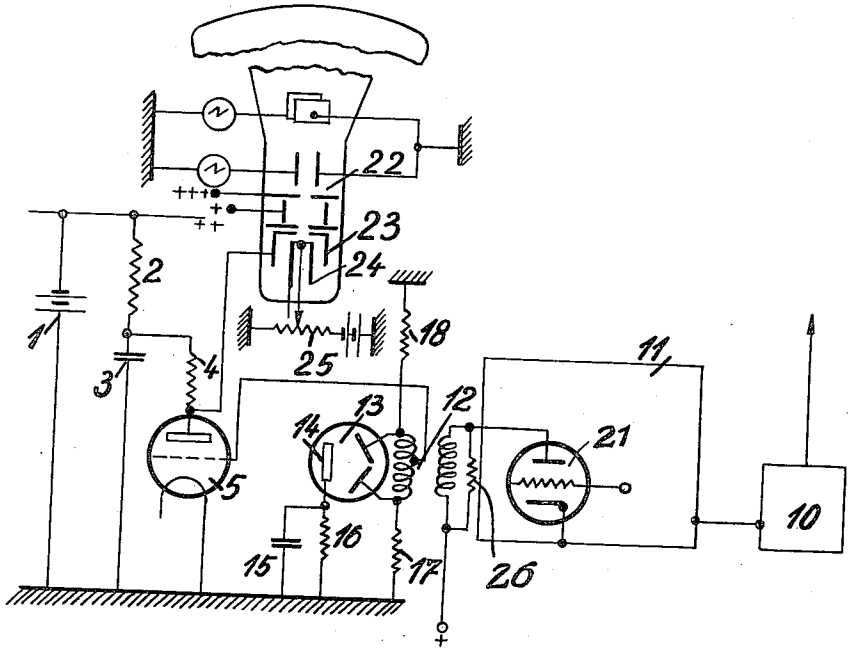

Fig. 1

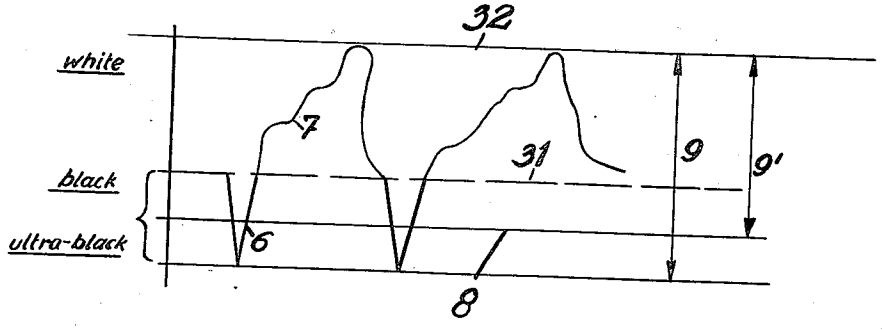

Fig. 2

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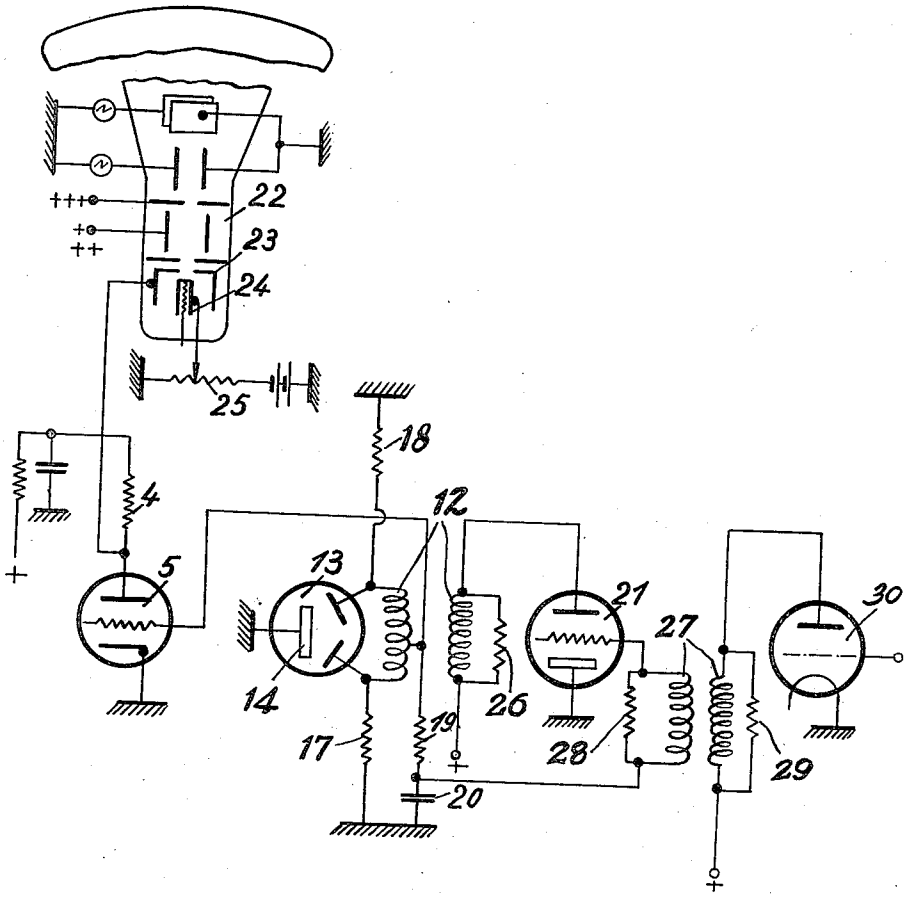

Fig. 3

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UNITED STATES PATENT OFFICE

2,194,571

TELEVISION RECEIVING RECTIFIER

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1 Claim. (Cl. 178—7.3)

The synchronizing process generally used in modern television practice entails the result that only a fraction of the available characteristic length of the output valve at the receiver can be employed for reproduction of image signals, whilst the remaining part must be reserved for the synchronizing impulses. Good halftone reproduction of the image can only be satisfied by the use of a very straight valve characteristic. The characteristics of amplifier tubes, however, can only be regarded as straight over limited ranges so that if only a restricted anode potential is available then it is only possible to obtain a similarly restricted maximum linear alternating potential output. In practice it is reckoned that the maximum linear anode alternating potential output is about 60–70% of the anode battery potential. In order to obtain bright images on the image screen, e. g., of a cathode ray tube, however, it is necessary that the output shall be able to supply a pre-determined maximum image alternating potential, e. g., in the case of very brilliant images the control grid of an image reproducing cathode ray tube would require a maximum image potential of about 60 volts for reproducing white image point on the image screen. If heretofore the anode battery potential is only sufficient to produce a linearly amplified output of 60 volts (for which purpose the anode battery potential should be about 100 volts) then this battery potential would not also be sufficient for accommodating on the linear characteristic of the final valve the synchronizing impulses which would have an amplitude of about equal magnitude.

An object of the invention is to overcome this difficulty.

The present invention is directed to a method of improving the half-tone reproduction in television and relates to amplifiers for television purposes at the transmission and/or receiving ends, wherein the method of operation on the characteristic curve of the amplifier is chosen to be such that the amplitudes of the synchronization signals are amplified on the bent part of the characteristic curve, whilst the image signals are applied to the linear part of the characteristic curve.

Accordingly the amplitude of the synchronizing impulses with respect to the amplitude of the image signals is decreased during their passage through the receiver or the transmitter circuits.

To enable the invention to be clearly understood, it will now be described with reference to the accompanying drawings in which

Fig. 1 shows part of a circuit of a television receiver according to the invention.

Fig. 2 shows the wave form of one of the types of transmission referred to.

Fig. 3 is a modification of the circuit of Fig. 1.

Referring now to Fig. 1, this shows diagrammatically portions of the circuit arrangement of a television receiver including a final amplifier valve 5 which is supplied with anode potential from a battery 1, which in practice may be replaced by a battery eliminator. A large proportion of the potential from battery 1 is lost in the filter circuit comprising resistance 2 and condenser 3. A further proportion is lost in the anode resistance 4 of valve 5, so that only a small fraction of the available potential is actually applied to the anode of valve 5. In practice the steady anode current of the final stage is about 20 milliamperes and the supply potential is about 250 volts. If the anode resistance 4 and filter resistance 2 amount to 5,000 ohms each, then 200 volts would be lost in these resistances and only 50 volts would be applied to the anode of valve 5. This constitutes a severe limitation in the image current output which can be obtained without introducing considerable distortion in the half-tones of the image.

It will be assumed that the television transmission to be received has a wave shape similar to that shown in Fig. 2, consisting of synchronizing impulses 6 (which reduce the carrier wave to zero) and image signals 7, where the line 31 indicates extreme black and the line 32 indicates extreme white. According to the invention a part of the synchronizing impulse 6 is cut off before being applied to the grid of the final valve 5. The cut-off is represented by line 8, and its level is arranged to be proportional to the amplitude of the synchronizing impulses, that is, it follows the fluctuations in strength of the received signals so that it will cut off any portion of the image signals. It is then no longer necessary, as was previously the case, to accommodate the entire potential range 9, i. e., synchronizing impulse amplitude plus maximum image signals amplitude on the valve characteristic, but only the smaller potential range 9', i. e., part of the synchronizing impulse amplitude plus maximum image signals amplitude. Since the synchronizing impulses correspond to sub-black points on the image screen, the alteration in their wave form produced by non-linearity of their treatment by valve 5 is without effect on the image screen. Since the image signals 7 are not affected by this cut-off process the reproduction of the

half-tones is in no way impaired, but on the other hand a greater proportion of the output of valve 5 corresponding to the straight portion of the valve characteristic is available for controlling the formation of an image in the cathode ray tube.

The cut-off process can be employed either at a high frequency stage of the receiver or at a low frequency stage, that is, before or after rectification of the carrier wave; or in the case of a superheterodyne receiver it can be employed at an intermediate frequency stage. Fig. 1 illustrates an example in which cut-off is effected at a low frequency stage. The modulated carrier wave, generally an ultra-short wave, received by the antenna of the receiver is transposed by means of a local oscillator 10 onto an intermediate wave which is amplified by means of an intermediate frequency amplifier 11.

The final valve 21 of this intermediate frequency amplifier is coupled via an intermediate frequency transformer 12, being damped by a resistance 26 for having a broad resonance curve, to a push-pull double diode rectifier 13 consisting of two anodes arranged symmetrically with respect to a cathode 14 in a high vacuum tube. The cathode 14 is connected to earth via a resistance 16 bridged by a condenser 15. This resistance 16 controls the potential at cathode 14 and the bias of cathode 14 is chosen positive with respect to the steady state of the anode. Therefore this rectifying electrode system is only operative if the operating potential which depends on the amplitude of the impulses applied to the anodes by the transformer 12, is positive with respect to the cathode potential. Accordingly resistance 16 must be sufficiently dimensioned in order to cause the valve 13 to cut-off only the lower portions of the synchronising impulses but not to cut-off any of the black image signal values. It is obvious that the circuit 15, 16 represents a simple means for automatically controlling the bias of cathode 14 by the incoming oscillations. The midpoint of the secondary of transformer 12 is connected to the grid of amplifier valve 5 whilst its outer ends are connected to earth via resistances 17 and 18 and to the anodes of valve 13 respectively. An increase in strength of the carrier wave causes the midpoint of the secondary winding of transformer 12 to become more negative with respect to earth. These electrical charges corresponding to the incoming oscillations are applied to the grid of the amplifier stage 5 and the potential at this grid is controlled by the operating resistances 17 and 18. From the anode of the valve 5, which is biased by the battery 1 via the filter circuit 2, 3, the amplified demodulated image and synchronizing impulses are applied to the control grid 23 of the cathode ray tube 22 so controlling the image reproducing electron beam.

In practice the resistance 16 is chosen in its value to be nearly equal to the effective resistance in the grid circuit of value 5. Since this effective resistance is represented by resistances 17 and 18 in parallel connection the total effective resistance of this parallel connection is equal to 5000 ohms, because the resistances 17 and 18 are chosen each one to have a value of 10,000 ohms. Therefore the resistance 16 is chosen to have a value of 5000 ohms. The function of the parallel condenser 15 is to avoid the cathode of valve 13 following the momentary fluctuations of the image signals, and should ensure that the cathode is dynamically earthed.

The circuit 15, 16 has a further beneficial effect in that it counteracts a harmful effect of the filter 2, 3 viz. the effect of producing a fog or veil formation on the image screen.

As already known in the art, the fog formation is due to residual electric charges on condensers in the anode or grid circuits. In the circuit of Fig. 1 the potential signs of the charges on condensers 3 and 15 are opposite so that their effects as regards the fog formation tend to neutralize one another. It is therefore possible, by suitably selecting the capacity of condenser 15 so that the detector circuit has a time constant which is equal to that of the anode circuit 2, 3 to attain the result that disturbances in the image due to fog formation, are considerably reduced. Circuit 2, 3 should have a time constant which is longer than the periodicity of the alternating current supply mains and in practice should be dimensioned to be approximately equal to an image period. In order to attain this same time constant in the cathode circuit it is necessary to have a resistance 16 of 5,000 ohms with a condenser 15 of about 10 mf. As it is subject to only low operating potentials the condenser can conveniently consist of an electrolytic condenser. The cut-off bias increases with increases of the strength of reception so that the proportion of the synchronizing impulses which is cut-off remains approximately constant. The larger resistance 16 is made the larger becomes the proportion of the synchronizing impulses which is cut-off. The image signals can then be more symmetrically placed on the characteristic of the final amplifier valve 5, thus resulting in an improvement in the half-tone reproduction in white.

Fig. 3 illustrates an example in which cut-off is effected at an intermediate frequency stage. A part of the rectified potential from the anode circuit of detector 13, that is, from the grid circuit of the final amplifier valve 5 is fed back to the control grid (or an auxiliary grid) of the final intermediate frequency valve 21 via a filter circuit 19, 20. This filter cicuit 19, 20 is selected to have a time constant which is approximately equal to an image period (e. g. 19=0.1 megohm. 20=1.0 mf). By means of this feed-back circuit the result is attained that with increasing amplitude of the received signals the operating point on the characteristic of valve 21 is gradually displaced into the lower bend of the characteristic. This has the effect that, as soon as the amplitudes of the signals at the grid of valve 21 become comparable with the bias applied via the filter circuit 19, 20, the extreme negative amplitudes are amplified to a lesser extent than the lesser negative amplitudes and the positive amplitudes, i. e. the synchronizing impulses are amplified to a lesser extent than the image signals with the same final result as in the low frequency cut-off method according to Fig. 1. The circuit of Fig. 3 also shows the preceding intermediate frequency amplifier valve 30 which is coupled to valve 21 via a transformer 27 the windings of which are damped by resistances 28 and 29. If desired a separate detector valve may be used for the purpose of feeding back the grid bias to valve 21. A further advantage of the arrangement of Fig. 3 is that it operates in a similar manner to certain fading regulating circuits and tends to maintain constant the mean strength of the oscillations applied to valve 13. In the case of fading regulating circuits, however, it is desired to maintain a linear amplification in the intermediate or high frequency circuit for all ampli-

tudes whereas in the present case the linearity of the intermediate or high frequency amplification is disturbed according to a definite law.

The advantages of both circuits can be combined by incorporating the cathode timing circuit 15, 16 in the cathode circuit of detector 13 in Fig. 3 in the same manner as in Fig. 1, thus combining the elimination of fog formation in the final amplifier with the other advantages.

The idea of cutting-off the tops of the synchronizing impulses before the signals reach the final stages can also be applied when receiving transmissions which synchronize not with a vanishing carrier wave but with a specially strong carrier wave i. e. one in which the synchronizing impulses have the same sign as image signals corresponding to white image points, in this latter case the valve characteristic should be curved at the top instead of the bottom.

The same method can also be employed at the transmitter; in this case a photo-cell input circuit replaces the local oscillator 10 and 5 becomes the modulation stage of the transmitter. If the transmitter employs direct amplification instead of carrier wave amplification the detector valve 13 is omitted. The impulse cut-off effect, however, can still be obtained viz. by strongly negatively biasing a stage at which the synchronizing impulses have a negative sign so that their amplitude is comparable with the negative bias. If necessary, such stages, in combination with reversing stages for converting a negative image into a positive image, may be deliberately inserted in the output of such amplifiers, i. e. where the amplitudes are the greatest.

The control grid 23 of the image reproducing cathode ray tube 22 (Figs. 1 and 3) is connected to the anode of the output valve 5 by a direct current connection. Assuming that the remainder of the receiver is also designed so that a change in direct current potential introduced at any stage of the receiver produces a corresponding change in the potential of the control grid of the cathode ray tube, then an increase in the degree of high frequency amplification or intermediate amplification at a receiver tuned to a transmission of the kind illustrated in Fig. 2 e. g. due to a variation in steady grid bias at one or more stages will cause all the tone values of the image to be displaced towards white.

The cathode 24 of the cathode ray tube 23 is given a suitable positve bias with respect to the control grid 23 by adjustment of a potential divider 25 which is adjusted once and for all at the factory. The bias is made sufficiently positive so that when there is no transmission being received, the image area is completely black and that, when a transmission is being received which includes only synchronizing impulses but no image signals, the more positve bias thereby applied to control grid 23 is not yet sufficient for setting free a cathode ray. If, in the case of such a transmission which only includes synchronizing impulses so that the carrier wave never exceeds about ¼ to ½ of its maximum value, the degree of amplification of the receiver is increased, the image screen will gradually become luminescent. The greater the bias applied from potentiometer 25 the greater the degree of amplification required in the receiver before the screen becomes luminescent and hence the greater the amplitude variation in the image signals applied to grid 23. The potentiometer 25 is adjusted at the factory to apply such a bias to cathode 24 that when an image of maximum contrast is transmitted, the luminosity of this image on the image screen of tube 22 will swing from the point at which luminosity begins, that is, from black to extreme white.

The rule for the user of the receiver is that the amplifier control is turned up until black parts in the image just commence to brighten up i. e. at least so far until the really black parts of the image are black whilst all the lighter brighter tones have a higher luminosity. The greater the potential applied from potentiometer 25, the greater the output potentials the observer is constrained to apply to the tube 22 when observing the black parts of the image. The maximum luminosity of the image on the screen of tube 22 is proportional to the product of the transmission current strength and the reception amplification.

By means of the arrangements described one attains simultaneously, full use of the maximum available degree of contrast on the image screen together with full use of the available characteristic length of the final valve without there being a possibility of over-control, and a minimum of fog formation.

I claim:

In a television circuit system for receiving image signals and synchronizing impulses modulated on a carrier wherein synchronization is effected by reducing to zero the carrier amplitudes, a rectifier tube in combination with an associated amplifier stage, said rectifier tube having at least cathode and anode, said cathode being given a definite bias with respect to the anode generated by means of a resistance connected with a by-pass condenser within the cathode lead, said resistance being so dimensioned that said rectifier tube is operating linearly as regards incoming impulses above a definite potential amplitude, but is inoperative as regards amplitudes below a definite potential amplitude, said by-pass condenser being used for preventing the cathode from following momentary fluctuations of the image signals, said associated amplifier stage consisting of a common amplifying tube the anode of which being connected to the anode-potential source via a filter circuit, the time constant of said circuit in the cathode lead of said rectifier comprising said resistance with the by-pass condenser being approximately the same as the time constant of said filter circuit in the anode circuit of said amplifier stage.

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