

June 3, 1941.

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2,244,240

DIRECT CURRENT INSERTING DEVICE

Filed Dec. 22, 1938

3 Sheets-Sheet 1

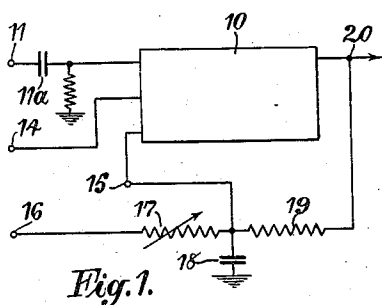


Fig. 1.

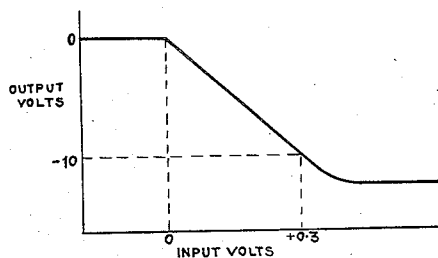


Fig. 2.

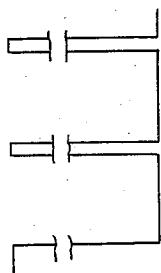


Fig. 3.

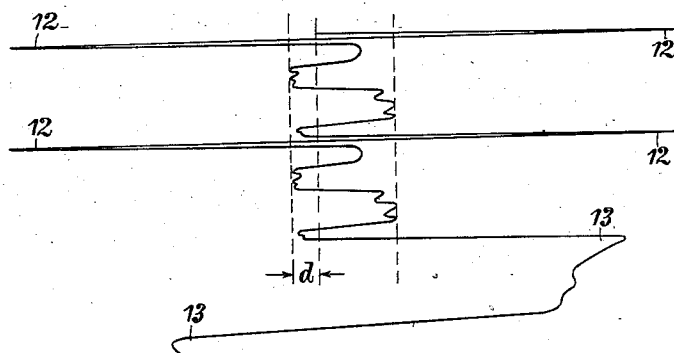


Fig. 4.

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3 Sheets-Sheet 2

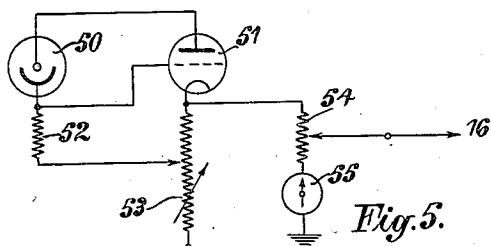


Fig. 5.

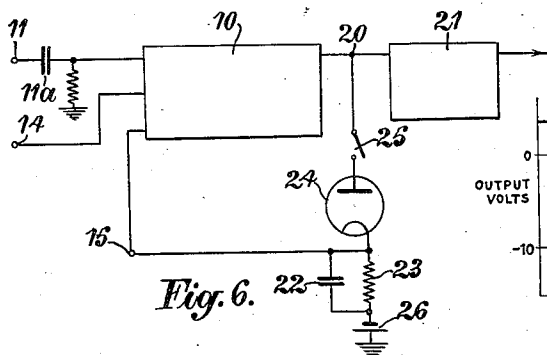


Fig. 6.

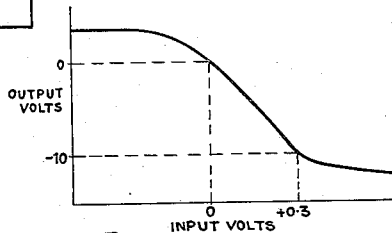


Fig. 7.

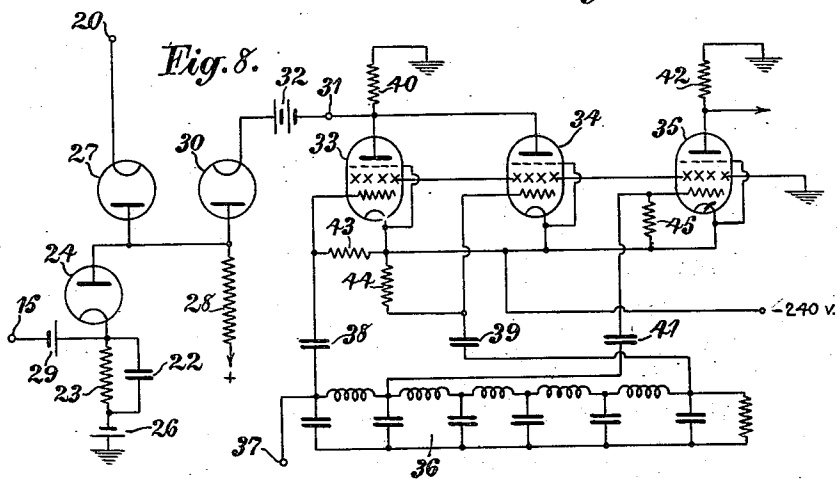


Fig. 8.

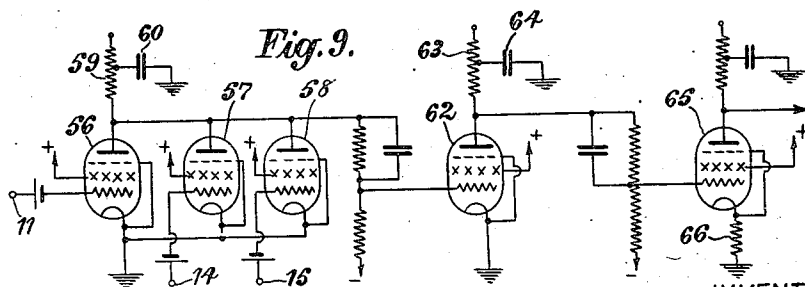


Fig. 9.

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3 Sheets-Sheet 3

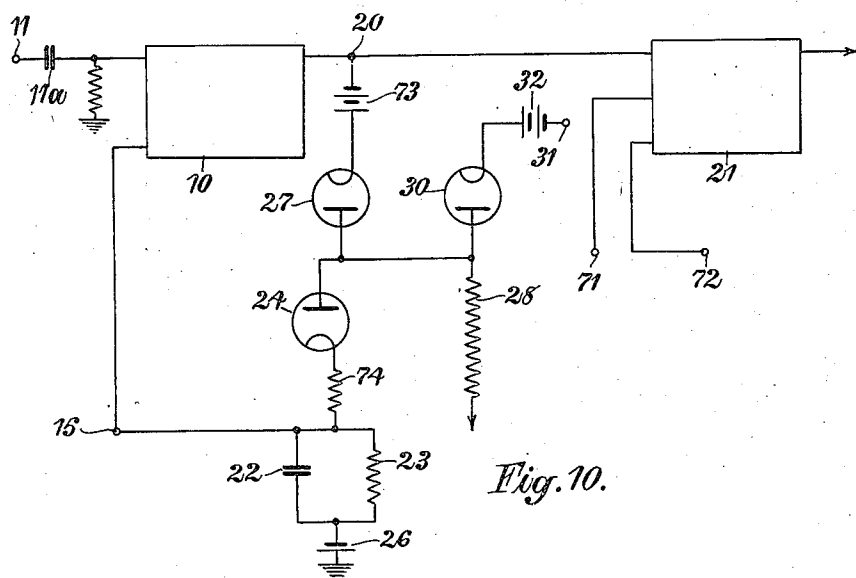


Fig. 10.

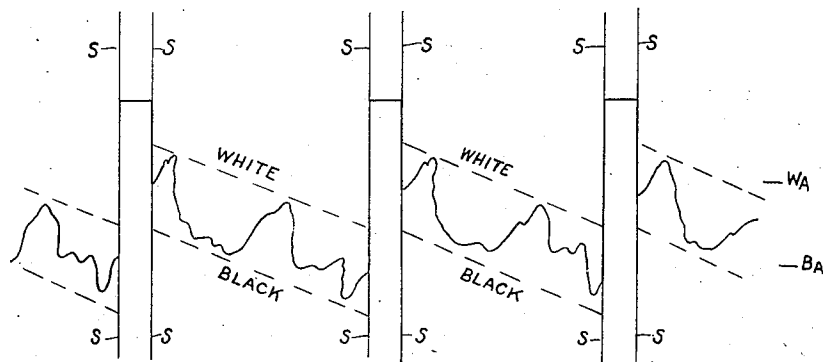


Fig. 11.

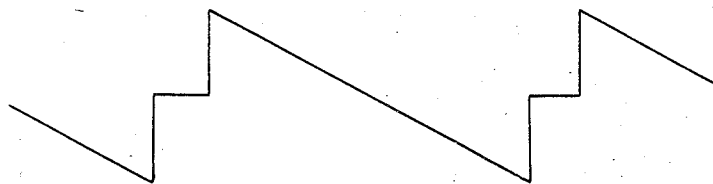


Fig. 12.

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2,244,240

DIRECT CURRENT INSERTING DEVICE

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Application December 22, 1938, Serial No. 247,163
In Great Britain December 24, 1937

3 Claims. (Cl. 178—7.3)

This invention relates to electric signal transmission systems and has particular but not exclusive reference to television systems.

It is known that the television signals obtained from certain electronic scanning devices of known type in which charges proportional to the brightness of the individual points of the scene being viewed are stored upon a mosaic surface and released by means of a scanning beam of electrons are often imperfect. The picture signals in general do not contain the D. C. or low frequency components representative of the background intensity of the scene, and in the intervals between the scanning of successive lines and frames spurious signals are often generated. On the other hand in order to be utilised conveniently, these picture signals should have no such spurious signals and should contain the D. C. or low frequency component so that the background intensity of the scene shall be correctly reproduced.

Methods for the removal of these spurious signals and the re-insertion of the missing D. C. or low frequency component have already been proposed. In British Patent Specification No. 450,675, the spurious signals are removed by adding pulses during their occurrence and displacing them beyond the amplitude range of the desired picture signals so that they can be removed by amplitude limitation. The D. C. or low frequency component is then reinserted with reference to the peak picture signals in the black direction, and further pulses are added to reduce the signal to black during the line and frame intervals. This method has the disadvantage that the signals given by the scanning device must be considerably amplified before they can be operated upon in this manner, and as the spurious signals are frequently of very large amplitude relatively to the desired picture signals, overloading is likely to take place in the amplifiers.

It has also been suggested that the D. C. or low frequency component of the scene being viewed should be obtained from a separate photo-cell having the same field of view as the scanning device and added at a suitable level to the picture signal obtained from said scanning device. This method has the advantage that the D. C. or low frequency component can be correctly reinserted whether the scene being viewed contains a black element or not. On the other hand, it has the disadvantage that the D. C. or low frequency component must be added before the spurious signals are suppressed, as the removal of these spurious signals may in effect

constitute the addition of a D. C. component, so that the insertion of the D. C. component is dependent on the form of the spurious pulses.

One of the objects of the present invention is to provide an improved arrangement for the reinsertion of the D. C. or low frequency component into television or like signals and a further object is to provide improved means for the removal of spurious signals from television signals.

According to one feature of the invention apparatus for the reinsertion of D. C. or low frequency components of electric signals is provided, comprising an amplifier which is capable of amplifying D. C. or low frequencies and to which signals which have lost their D. C. or low frequency components are fed, means for obtaining a corrective signal from the signals amplified by said amplifier, said corrective signal being dependent upon the departure of the signals from the value they would have were the D. C. and low frequency components present, and means for feeding said corrective signal back to said amplifier in such a sense as to tend to produce the corrective D. C. and low frequency output from the amplifier.

According to another feature of the invention apparatus for the reinsertion of D. C. or low frequency components of electric signals is provided comprising an amplifier which is capable of amplifying D. C. and low frequencies and to which signals which have lost their D. C. or low frequency components are fed, means for comparing the D. C. or low frequency output of said amplifier with a D. C. or low frequency signal which represents substantially the correct value of the lost D. C. or low frequency components, so as to obtain a corrective signal dependent upon the departure of the signals from the value they would have were the D. C. and low frequency components present, and means for feeding said corrective signal back to said amplifier in such a sense as to tend to produce the correct D. C. and low frequency output from the amplifier.

According to yet another feature of the invention, apparatus for the reinsertion of D. C. or low frequency components of electric signals is provided comprising an amplifier which is capable of amplifying D. C. and low frequencies and to which signals which have lost their D. C. or low frequency components are fed, means for obtaining a corrective signal from the signals amplified by said amplifier, means for switching said first mentioned means into a condition to develop said corrective signal only at intervals during the occurrence of said signals, said cor-

rective signal being dependent upon the departure of the signals from the value they would have were the D. C. and low frequency components present, and means for feeding said correct signal back to said amplifier in such a sense as to tend to produce the correct D. C. and low frequency output from the amplifier.

It has been found that with a standard television transmitting tube in which an optical image is projected onto a photo-sensitive mosaic screen the signals between lines, when the scanning beam is blacked out, bears for a given beam current a fixed relationship to the average picture black. These signals, which may be termed the "blacked out" signals, usually correspond in absolute amplitude to a very bright white. These signals can therefore be used as a reference level for black, and a system of D. C. reinsertion using this feature is described in British Patent Specification No. 449,242, page 6, line 99 et seq. It has been found that the "blacked out" signals from a transmitting tube of the type described in British Patent Specification No. 442,666 are also related to average black. In this case the signal amplitude more nearly corresponds to black.

Another object of the present invention is to utilise said signals which have a fixed amplitude relation to "black" for D. C. reinsertion purposes.

According to a further feature of this invention said means for obtaining a corrective signal are switched into a condition to develop said corrective signal during the occurrence of said interspersed signals having a fixed amplitude relation to "black."

According to yet a further feature of the invention in television apparatus for the reinsertion of the D. C. or low frequency components of television signals which have interspersed between the picture signals further signals having a substantially fixed amplitude relation to "black," there are provided means for obtaining a signal for reinserting the D. C. or low frequency components from said further signals, and wherein said picture signal requires the addition of shading correction signals, and means are provided for obtaining a shading correction signal which is applied to the picture signals prior to the reinsertion of the D. C. or low frequency components, said shading correction signal having during the occurrence of said further signals a substantially fixed value independent of the amplitude of said shading correction signals so that on the addition of said shading correction signals to the television signals said further signals maintain a substantially fixed amplitude relation to "black" which is substantially independent of the shading correction signals.

In order that the said invention may be clearly understood and readily carried into effect it will now be more fully described with reference to the accompanying drawings in which:

Figure 1 shows diagrammatically a circuit arrangement according to one embodiment of the invention,

Figure 2 illustrates the characteristic amplifier curve of the amplifier employed in the embodiment of Figure 1,

Figure 3 shows the wave form of pulses employed for suppressing spurious signals,

Figure 4 illustrates a typical wave form obtained from a television signal generator in which spurious signals are generated in the intervals between successive lines and frames,

Figure 5 illustrates a circuit for obtaining a

control potential for use in the embodiment of Figure 1,

Figure 6 illustrates a circuit similar to Figure 1, but employing a modified arrangement for obtaining a control potential,

Figure 7 shows the characteristic amplifier curve of an amplifier forming part of the circuit shown in Figure 6,

Figure 8 shows part of the circuit embodied in Figure 6 in greater detail, and

Figure 9 illustrates part of a D. C. amplifier employed in the invention.

Figure 10 illustrates an embodiment of the invention where "black-out" signals are employed for D. C. reinsertion purposes and

Figures 11 and 12 are explanatory diagrams.

The invention will be described with reference to Figures 1-4 as applied by way of example to a television transmission system on the assumption that spurious signals are generated in the intervals between successive lines and frames although it will be understood that the invention in some aspects is equally applicable to cases in which no spurious signals, which would produce an adverse effect, are generated or are present.

The arrangement shown in Figure 1 comprises a D. C. coupled amplifier 10 having a substantially flat frequency characteristic from zero to the highest modulation frequencies required by the television picture (say 2.5 m. c. for 400 lines, 25 pictures per second). This amplifier is so constructed that it has an overall amplitude characteristic which is limited in both directions, and preferably sharply in the black direction, the cut-off point of the amplifier characteristic corresponding to black. Such a characteristic is shown, for example, in Figure 2. Zero output corresponds to black and peak linear output to white. The absolute zero output volts may have any value relatively to earth, but for simplicity it is assumed that a bias source has been introduced in the output of the amplifier so as to bring the sharp cut-off point representing black to exactly 0 volt. Further in the example considered white output is taken as being -10 volts. The amplifier is assumed to have three similar input terminals as may be obtained by a first stage consisting of three valves with their anodes connected in parallel and their three control or input grids providing the three input terminals. The gain of the amplifier is assumed to be 30, and again for simplicity it is assumed that biasing means are introduced such as to make the sum of the three inputs equal to zero volts for zero volts output. The amplifier is arranged to reverse the sense of the signals so that a direct feedback from output to input is in the negative sense. To the input terminal 11 are applied vision signals positive, that is to say a positive change of volts corresponds to an increase of brightness. The amplitude of these signals may be 0.3 volt black to white so that the corresponding output of the amplifier is 9 volts.

Typical signals such as are obtained from a cathode ray scanner of the storage type are shown in Figure 4. In the intervals between successive lines and frames unwanted signals of very large amplitude are generated, the signals indicated at 12 occurring in the intervals between successive lines and those at 13 occurring in the intervals between successive frames. The composite signals are purely A. C. and as shown in Figure 1 are fed through a condenser 11a s

that they require an added D. C. component to make black in the signal input correspond to zero volts. This required added D. C. component is indicated by the distance d in Figure 4. Another input terminal 14 of the amplifier 10 is supplied with suppression pulses shown diagrammatically in Figure 3 for suppressing the undesired signals 12 and 13. These pulses are large negative pulses occurring between lines and frames, one line pulse and a part of a frame pulse being shown in Figure 3. The suppression pulses are not shown to scale but their amplitude must exceed amply the probable peak amplitude of the unwanted signals. The suppression pulses are provided by a suitable generator, which is synchronised with the generator of the scanning oscillations which deflect the cathode ray of the scanning device.

The third input terminal 15 of the amplifier, is supplied with a voltage which is derived from a brightness control voltage and the average output voltage. A photo-cell may be arranged at the scanning device so that it is illuminated by light from the scene or film which is being scanned. The output from the photo-cell, D. C. amplified if necessary is applied to terminal 16. For no illumination the potential arriving at terminal 16 is made for convenience of explanation equal to zero. For an increase of brightness of the scene the potential at 16 moves in the positive direction, the increase of potential for a full white scene being of the order of 10 volts. This potential is applied through a variable resistance 17 to a shunt condenser 18 and from this to the third amplifier input terminal 15. The condenser 18 also receives potential through a resistance 19 connected as shown to the output terminal of the amplifier 10.

Suppose now that a black scene is presented to the scanning device. The voltage at terminal 16 will be zero and the input terminal 11 will be zero (except for possible off set from zero due to the unwanted signals not being symmetrical about the zero line) during the picture portion of the lines and frames. Strong unwanted signals are generated in the intervals between lines and frames, and the suppression pulses will be added to the unwanted pulses so as to drive the unwanted signals beyond the black cut-off point of the amplifier so that effectively black signals occur in the intervals between lines and frames. With the picture signals zero during picture periods the output at terminal 20 will be zero so the charge on condenser 18 will be zero. Suppose now, however, the picture signals are not quite zero but a little positive, a negative output at terminal 20 will be obtained which will charge condenser 18 negatively and provide a negative bias input which will tend to suppress the positive picture input, and almost completely suppress it.

If now the scene is illuminated giving signals such as shown in Figure 4, the output from the photo-cell will give a potential at 16 proportional to the area of the curve representing picture from black to peak white, excluding the unwanted signals which do not represent the scene being transmitted. The unwanted signals in the intervals between lines and frames are suppressed as above described. If the signals at the output of the amplifier 10 appear with black at zero potential and white at a negative potential, the area under the curve, i. e. the mean negative potential of the output terminal will be the mean picture brightness and will be equal to (or pro-

portional to) the positive potential of the control voltage at terminal 16. That is to say, there will again be no charge on condenser 18 assuming that the resistances 17 and 19 are equal. If however, the output signals at terminal 20 do not have black represented by zero volts, then the average value of these signals will not be equal and opposite to the control voltage at terminal 16 and the condenser 18 will be charged and the charge applied to terminal 14 as an input bias tending to produce the correct average signal at the output 20. Since the amplifier has considerable gain, only a small change of bias is necessary at the input to correct for a large error at the output so that the mean negative value of the output signals follows the positive control potential at terminal 16. To allow for varying sensitivity of the control photo-cell circuit and to allow for varying sensitivity of the scanning device and amplifiers preceding the terminal 16 the resistance 17 is made variable. In setting the circuit the correct potentials are set up at all points for a black picture. A picture is then shown projected on to the scanning device and the photo-cell and the resistance 17 is then adjusted until the signals representing black are just zero at the output terminal 20. With this adjustment there is in effect an allowance made for the slight resultant positive charge required on the condenser 18 to provide the necessary input bias. Once adjusted, if the pictures change in average brightness, the feedback of voltage to the input will automatically maintain a balance between the average output voltage and the control voltage derived from the photo-cell. In effect these two voltages are subtracted and the difference fed back to the input of the amplifier. In the example described a bright picture was represented by a negative output and a positive control voltage was derived from the photo-cell so that an electrical addition produced the required subtraction of the individual effects.

The gain and voltage figures given for the amplifier are purely by way of example, the device being capable of operation with a wide range of values. For the gain stated above the resistance 19 may be of the order of 1 megohm and the condenser 18 of the order of 0.3 μ f. for 50 frames per second. Desirable values can be found by trial and error, the time constant of condenser 18 and resistance 19 being chosen sufficiently long to avoid detriment to the low frequency response of the amplifier and sufficiently short to enable a quick brightness control to be obtained. In practice the voltage representing black need not be zero, and the absolute voltage representing black may have practically any value relatively to earth potential. It is convenient, however, to make the output potential representing black equal to the control potential representing black, so that the adjustment of resistance 17 does not affect operation for a black picture. Furthermore these two potentials can very conveniently be earth potentials so that an earthed artificial line or potentiometer can be used to vary the control voltage. Such an additional attenuator may be inserted in the photo-cell circuit and ganged to the gain control of the amplifier preceding the terminal 11.

Although the foregoing has been described with reference to an amplifier in which the cut-off and the black level are coincident, in practice a slight tolerance may be left between the two. For example the cut-off may be at +0.2 volt so as to ensure that black signals are not cut-off or at-

tenuated at the inevitable curvature close to cut off point.

One arrangement for developing the D. C. control bias from a photo-cell viewing the scene to be transmitted will now be described with reference to Figure 5. The photo-cell 50 has its cathode connected directly to the grid of a valve 51 and also through a resistance 52 of say 2 megohms to a tapping point on a variable cathode resistance 53 of the order of 60,000 ohms connected to a negative potential source of say 240 volts. The anodes of valve 51 and photo-cell 50 are connected to a positive potential of say 240 volts. The cathode of the valve 51 is connected to a potentiometer 54 the lower end of which is earthed through a sensitive meter 55. With the photo-cell in the dark, the cathode load of the valve 51, or the tapping of the photo-cell load, is adjusted to give zero meter reading, that is zero output volts to the potentiometer 54. The control voltage for application to the terminal 16 can then be taken from a tapping point on the potentiometer 54. Care should be taken to see that the photo-cell is actuated by light from just the same scene as that transmitted in the form of useful picture signals by the scanning device.

A further embodiment of the invention in which the brightness control voltage is derived from the picture signals by means of an observing device in the form of a rectifier, will now be described with reference to Figures 6-8.

Parts in Figure 6 which correspond to similar parts in Figure 1 are given the same reference numerals. The characteristic of the amplifier 10 in this example does not, however, cut off sharply at black but continues beyond black (zero volts) a short distance in the positive direction as shown in Figure 7. Associated with the amplifier is a further amplifier 21 in this case considered as having no gain, which cuts off sharply at or just positive of zero or the voltage corresponding to black and is arranged to make the overall amplification characteristic similar to that shown in Figure 2. Positive picture input such as shown in Figure 4 and negative suppression pulses such as shown in Figure 3 are fed to the input terminals 11 and 14 as before. The third input terminal is supplied with a bias potential obtained from a condenser 22 and resistance 23 constituting the load of a diode rectifier 24. Diagrammatically the anode of the rectifier 24 is shown connected through a switch 25 to the output terminal 20 of the first amplifier 10. This switch is controlled by pulses which are of the same form as the suppression pulses, but preferably of slightly longer duration, beginning before the suppression pulses and ending after them, both for lines and frames. The effect of these pulses is to open the switch 25, so that the switch is always open when suppression pulses are applied to the amplifier. Of course the mechanical switch arrangement shown is not practicable, and is only illustrated for explanatory purposes.

The operation is as follows: The spurious signals and suppression pulses passing through the amplifier produce positive signals at the terminal 20, but these do not operate the rectifier 24 since during these periods the switch 25 is open as above described. During picture signal periods, the most positive signals at terminal 20 are those due to the black objects in the picture. The peaks of these signals are rectified by the rectifier 24 and produce a negative bias at the amplifier input 15 which is effective to reduce the

peak amplitude of these signals almost to zero volts, the departure from zero being that necessary to produce the small bias potential at the amplifier input. The rectifier load i. e. condenser 22 and resistance 23 is earthed through a slight negative bias potential 26 so as to ensure rectification even if the peak black signals are slightly negative. By inserting a controllable bias in the lead between the rectifier output and the amplifier input, the exact level of the peak black signals can be adjusted. The signals from the amplifier 10 are then limited to the required black amplitude, or to a level slightly positive of black in the following amplifier 21. The time constant of the rectifier load may be of the order of 1 second, the resistance 23 being say 5 megohms and the condenser 0.2 μ f. The values of voltages and amplifier levels and gains are only given by way of example and can be widely varied in practice.

Figure 8 shows one arrangement for replacing the diagrammatic switch of Figure 6. In this figure it is assumed that the output of the first amplifier 10 of Figure 6 has a low impedance, such as is obtained for example, by taking the output from the cathode of a valve. The terminal 20 is connected through a rectifier 27 to the anode of rectifier 24 as shown. The rectifier 27 is maintained normally conductive by a resistance 28 of say 50,000 ohms connecting the anodes of the rectifiers 24 and 27 to a positive potential of say 100 volts. This causes the anode of rectifier 27 to be slightly more positive than its cathode which can be allowed for, as regards amplifier input bias by means of a suitable bias source as shown at 29 in Figure 8. A third rectifier 30 has its anode connected to the anodes of rectifiers 24 and 27 and its cathode fed with the modified negative suppression signals at terminal 31. These signals are assumed to be negative pulses with respect to earth potential and similar in form to those shown in Figure 3. A bias battery 32 is employed so as to maintain the cathode of rectifier 30 normally positive, so that it will not conduct when the rectifier anodes are made positive by slight positive signals at the terminal 20. The negative signals at terminal 31 will cause the cathode of rectifier 30 and its anode to become very negative. Consequently the whole current (2 m. amps.) passing through the resistance 28 will be absorbed and thus cause the anodes of rectifiers 24 and 27 to become negative. This will prevent positive pulses at terminal 20 passing through rectifier 27 and also the negative excursion of the anode of rectifier 24 will not produce any rectification. Thus during the negative suppression pulses the rectifier is in effect disconnected from the terminal 20. In the absence of suppression pulses rectifier 30 is non-conducting owing to the action of rectifiers 27 and 24. The arrangement therefore performs the function of the switch 25 in Figure 6.

In Figure 8 are also shown three valves 33, 34 and 35, and a delay network 36 for producing the required switch operating and the suppression pulses for application to the terminal 14 from master positive suppression pulses, applied at terminal 37. These latter pulses are applied to the delay network from the ends of which signals are passed through condensers 38 and 39 to the input grids of valves 33 and 34, the anodes of which produce the switch operating signals across a common anode resistance 40. The third valve 35 has applied to its input grid

through condenser 41 signals from an intermediate tapping in the delay network and produces the suppression pulses across an anode resistance 42. These signals are passed to the amplifier input terminal 14. The condensers 38, 39 and 41 are provided with high resistance leaks 43, 44 and 45, and are arranged to pass grid current on each master pulse from terminal 37, so that the valves 33, 34 and 35 are self-biasing. The master pulses are of such amplitude as to cut-off the valves 33, 34 and 35 in the absence of the pulses so that the switch operating and suppression signals have an "off" value of zero volts. The cathodes of the valves 33, 34 and 35 are connected to a negative potential of, for example, 240 volts. By using the two valves 33 and 34 for generating the switch operating pulses these pulses are arranged to overlap the suppression pulses which latter are derived from a point on the delay network so chosen as to give an output at terminal 20, after being delayed slightly by amplifier 10, lying within the combined pulses from the two valves 33 and 34. The pulses applied to terminal 31 each have a central portion of greater amplitude. This however is not of importance as it will only serve to drive the already negative cathode of rectifier 30 further negative and will not adversely affect rectifier 24. A suitable value for the anode resistance 40 is about 1,000 ohms which enables a 30 volt pulse to be obtained with a valve capable of passing 30 milliamperes. The anode resistance 42 may be only 300 ohms, which provides an ample 9 volt pulse for application to the amplifier input 14.

An example of a type of amplifier amplifying down to very low frequencies and D. C. which may be used as the amplifier 10 will now be described with reference to the circuit diagram shown in Figure 9 which illustrates part of a complete amplifier. The first three valves 56, 57 and 58 (shown as pentode valves) have their anodes connected together and connected to the positive terminal of a source of anode current through a resistance 59 which is decoupled to earth through a decoupling condenser 60 as shown. The cathodes of the valves are connected to earth whilst the three input grids are connected respectively through biasing batteries to the terminals 11, 14 and 15. The three valves feed a second amplifier valve 62 through a D. C. coupling of the type described in British Patent Specification No. 456,450. The valve 62 is also shown as a pentode with its anode resistance 63 de-coupled by condenser 64. This amplifier stage in turn feeds a further amplifier valve 65 in the same manner. This further valve 65 has a resistance 66 in its cathode lead so as to straighten its characteristic.

The feed of the valve 62 is kept low so that if its anode current is cut off completely only a moderate positive swing arrives at the grid of the valve 65, which swing will not cause grid current to flow owing to the lengthened grid base due to the cathode resistance. Successive amplifier stages are similarly prevented from passing grid current, the cathode resistances increasing progressively, the last amplifier valve having a cathode resistance of say 700 ohms so as to give a sharp cut-off in the black direction. The anode of the last amplifier valve can then be D. C. coupled to the grid of a valve having its load in its cathode so as to produce a low output impedance. The correct grid potentials are obtained by applying suitable negative potentials as shown.

Alternatively, a push-pull amplifier as described in British Patent Specification No. 482,740 may be used. Such an amplifier employs valves in push-pull pairs having a high common cathode resistance to suppress any push-push signals. The D. C. coupled amplifier described in said specification may be given a sharper cut-off to its characteristic by adding separate resistances in each cathode of the last stage as well as the high common cathode resistance. In using such an amplifier for the amplifier shown in Figure 1, input and output terminals may be chosen so as to give negative signals in the output for positive signals at the input. Alternatively negative picture signals may be applied to the amplifier in such a manner that negative signals are also obtained in the output. The bias potential can then be applied as in Figure 1. Further, the suppression pulses may, if desired, be supplied through the condenser 18. A small resistance may be inserted between condenser 18 and earth and the negative suppression pulses may then be developed across this resistance. If this resistance is only say 200 ohms, it will not cause appreciable feed-back of high frequencies via the high resistance 19 which may be of the order of 1 megohm. By this means the picture signals, the bias and the suppression pulses may all be added without employing more than the normal two inputs of the push-pull amplifier. Of course, using a push-pull amplifier for Figure 1, only one output will be used for feeding the control potential to the input. Both outputs may be used however, for driving further devices.

Figures 10, 11 and 12 illustrate the invention as applied to the case where further signals are interspersed with the picture signals, said further signals having a substantially fixed amplitude with relation to "black."

The embodiment of the invention will be described with reference to a system working on the line "blacked out" signals only, but of course, the invention can be applied to frame "blacked out" or both line and frame "blacked out" signals.

In order that observation of the "blacked out" signals can be made only during the "blacked out" signals, it is necessary to control the observing device so that it is active for no longer than such signals. Preferably the observing device is switched on for a shorter period than the "blacked out" signal and this is effected by means of a pulse called the short black out pulse. The short black out pulse lies totally within the long black out pulse which is used to switch off the beam of the scanning tube. The expression "lies totally within" means that the short pulse begins after and ends before the long pulse. This relationship applies to the point where the effects of the long black out pulse (i. e. the "blacked out" signal) meets the short black out pulse, that is, at the observation point. Long cables from the pulse generator to the picture resolving device and back, and delays in amplifiers may necessitate the long pulse being advanced in phase at its generating point. The necessary overlapping of such pulses is described in British Patent Specification No. 449,242, page 7 lines 113 et seq. and a suitable circuit is shown in Figure 3 of that specification.

Figure 10 shows a modification of Figure 6 like numerals indicating like parts. The stage 21 is now provided with two additional input leads 71 and 72. For this purpose the input of 21 can comprise three valves arranged with their anodes connected in parallel to a common anode

impedance. The suppression signals are no longer introduced at 14 but at 71 in stage 21. The purpose of lead 72 is for the mixing in of shading (or brightness) correction signals. These signals may comprise saw-tooth waves called "tilt" correction signals and integrated saw-tooth waves called "bend" correction signals such waves being generated, for example, as described in British Patent Specification No. 462,110. As before 21 is assumed to have no gain but has a characteristic which cuts off sharply to make the overall amplification characteristic similar to that shown in Figure 2. The amplifier 10 should have a large available output say about 30 or more volts free of overload, and similarly the early stages of 21 should have a large available characteristic so that there is room to accommodate the tilted signals, i. e., there may be 10 or 20 volts of tilt as well as the 10 volts of picture.

The signals applied to terminal 11 may be represented as shown in Figure 11. They consist of vision signals with a uniform tilt about equal in amplitude to the signals. The "blacked out" signal is in the case shown a steady signal in the whiter than white direction and it has been found that under certain conditions this has, for a given beam current, a constant relationship to the average black level B_A , which relationship is largely independent of the picture brightness. This "blacked out" signal is not of course always in the whiter than white direction, nor is it necessarily a peak amplitude. It may for example lie between average white W_A and average black B_A . On either side of the "blacked out" signals occur spurious signals s which may be in either direction, or even a very quick oscillation in both directions as shown. These spurious signals may be produced by the redistribution of charges on switching off and on the beam. Also the "blacked out" signal may not be quite constant as shown but may tilt or curve a little. It has been found in practice that the "blacked out" signal is more constant if a cathode ray tube picture resolving device is employed which is illuminated by light from a small lamp in a manner similar to that described in British Patent Specification No. 490,845. The signal from the resolving device arrives amplified at 20 to which point are connected the diodes as described with reference to Figure 8 via an adjustable potential 73 shown as a battery. At terminal 31 is applied the short black out pulse which lies totally within the "blacked out" signal which is produced by the long black out pulse. As explained above, this signal, which must in this case be a short positive pulse, shuts off diode 30, thus transferring the current in resistance 28 to diodes 24 and 27, and so connecting line 20 to diode 24. Now at 20 the "blacked out" signal will be negative if the average black is to be zero. The potential 73 should be adjusted until it equals the amount by which the "blacked out" signal is negative of the average black. Then if the average black is zero, the diode 24 will charge condenser 22 to zero. If average black is not zero, then the charge on 22 will alter and this alteration will be fed back into the amplifier input in such a sense as to tend to pull the average black level back to zero. The value of battery 73 can be adjusted manually for a given condition so as to bring the average black to zero. The resistance 23 tends, with battery 26, to make 15 very slightly negative during the line period. This tends to drive line 20 positive (in the case considered line 20

goes some thirty three times more positive than terminal 15 goes negative). During the "blacked out" signal the short black out pulse renders diode 24 conducting and diode 24 begins to charge condenser 22 positively. It does not charge 22 by nearly the amount that the potential of line 20 requires correction, since as soon as line 20 begins to change, the positive charging of condenser 22 makes 15 positive and 20 negative, thus correcting the potential of 20, until 20 is so negative that 27 conducts and robs 24 of its current from resistance 28, thus bringing the potential at 15 to substantially the potential of 20. If the charging of 22 is too rapid, the delay in amplifier 10 may so delay the positive potential on 15 arriving at line 20 as to allow condenser 22 to charge too far. The resistance 74, which may be totally provided by the internal impedance of the diodes is inserted to prevent 22 charging too quickly and thus causing instability or over-correction. Alternatively resistance 74 may be looked on as providing with shunt condenser 22 a high frequency loss in the feed back path, which high frequency loss is sufficient to stop a high frequency oscillation round the feed back circuit due to the inevitable high frequency phase shifts in amplifier 10. Suitable values for a scanning frequency of 10,000 lines/sec. would be 0.003 μ f. for 22, 10 M Ω for 23, and 3 volts for 26. This would give a drift of 0.33 volt at 20 during a line. These values are given only as an example, and in practice can be varied very widely.

The short black out pulses applied at 30 may be produced by an arrangement similar to that shown in Figure 8. In this figure positive suppression pulses were applied at 37 so as to make 27 active during intervals between suppression pulses. In the present case negative pulses used for blacking out the beam of the transmitting tube are applied at terminal 37. If either 33 or 34 are switched on, sufficient negative is applied to 31 to keep diode 27 insulating. Only when 33 and 34 are both switched off will 31 become sufficiently positive to allow 27 to operate. Valve 35 serves to pass the long black out pulse to the scanning tube. It will be obvious that 33 and 34 will only be on simultaneously for a period lying totally within that during which 35 is on. The tap on the delay network 36 for value 35 may of course be advanced from centre to allow for delays in cables, camera and amplifiers, and may in practice lie outside the taps for values 33 and 34, i. e., on an extension of the delay line to the left. The positive line black out pulses from 35 are mixed with frame black out, inverted and applied to the control grid of the scanning tube.

If the D. C. is to be re-established from the intervals between frames, frame black out pulses must be used instead of line black out pulses. If re-establishment is to be from the signals between both lines and frames the control pulses must be a mixture of line and frame black out pulses.

The output from amplifier 10 is mixed in stage 21 with tilt corrector signals (in the case described of some 10 volts amplitude) and also with suppression pulses which should be longer than and embrace the "blacked out" signal. These suppression pulses drive the "blacked out" signal and the spurious signals beyond the black cut-off of stage 21. The potential of battery 73 can as explained before be adjusted manually so as to bring the black of the picture just to the cut off amplitude of stage 21.

The tilt and bend correction signals are pref-

erably mixed as A. C. signals. The tilt and accompanying bend correction signals are generated as described in British Patent Specification No. 462,110 by integrating pulses once and twice respectively. The tilt and bend correcting signals are repetitive A. C. signals. Provided the average black of the signal has been correctly chosen, the introduction of suitable A. C. tilt and bend correction signals should produce the correct resultant black level. The arrangement described above should largely eliminate frame tilt i. e. the variation of shading of the picture in a vertical direction assuming horizontal line scanning is employed, but some slight correction may still be found necessary in order to allow for slight variation during the frame in the relative amplitude of the average black of the line and the "blacked out" signal.

The suppression signal on the other hand should be added D. C. or its amplitude should be accurately controlled. With an A. C. coupling the infra-black suppression signals cause the intervals between them to depart from black and to be slightly grey and any variation of pulse length will alter the amount of grey and so the resultant D. C. level. The preferred arrangement is to connect the anode of an additional valve to the anode of a valve in stage 21, having positive signals (white positive, black negative) on its anode. The additional valve is normally shut off so that it cannot add a D. C. signal. The suppression pulses turn the additional valve on and thus add large negative, and so very black signals to signals from the stage 21. A limiting amplifier stage is coupled to the anodes of the two valves described.

If the tilt correction signal, which is essentially a saw-tooth wave, is added ahead of amplifier 10, the return stroke of the saw tooth occurs during the "blacked out" signal and thus spoils it for any useful D. C. control. Even if a circuit were made to average the sloping wave so obtained any slight phase shift of the saw-tooth would alter the result. On the other hand adding the tilt correction signal before amplifier 10, reduces the signal amplitude to be handled by 10. Figure 12 shows a special form of saw-tooth wave which may be added ahead of 10 with impunity. The "flats" during the return strokes are on the A. C. mean line and so do not affect the relative amplitude of the "blacked out" signal and the average black. A similar signal with a "flat" on the A. C. average line may be used for bend correction. These "flats" should embrace the short black out pulse but should lie within the suppression pulse. They may for example be equal in length and effective timing to the long black out pulses. Such pulses may be produced by applying the saw-tooth tilt or bend correction signals to a push-pull amplifier which is carefully balanced. The long black out pulse may be arranged to shut off both valves simultaneously. Because the valves have equal inputs such system will give a push pull output equal to the normal quiescent output of the valves. Alternatively the tilt correction signals may be generated by a circuit such as shown in Figure 4 of British Patent Specification 400,976. The anode voltage waveform of 12 of this figure is of the form shown in Figure 12 of the present invention.

In addition signals may be added earlier in the amplifying chain so as to bring the "blacked out" signals to approximately the same level as

the average black prior to entering 10. Signals, which may be long black out pulses are added, preferably under manual control, so as to make the "blacked out" signals equal in absolute amplitude to the average black signals. If this is done the signals may be passed through a variable gain amplifier before arriving at 10. As the gain of the amplifier is altered there will be no alteration of the relative amplitude of average black and the "blacked out" signal. Without such an added signal, and with a wave such as shown in Figure 11 any change of gain would necessitate altering the potential of 73. With the added signals battery 73 can be omitted and the exact black level into stage 21 adjusted by adjusting the added signals.

If desired the signals which have a fixed amplitude relation to "black" instead of being inherent in the signals or generated by the picture resolving device may be added to the picture signals after the latter are generated, for example, the picture signals may be applied to a valve which is periodically rendered conducting and non-conducting, the non-conducting periods serving to insert the required signals.

I claim:

1. An amplifying system for a television transmitting system wherein signals including alternating and direct current voltage variations are encountered, comprising a direct coupled amplifier, means for suppressing the signals during predetermined short intervals of regular recurrent frequency, and means including an intermittently operating electronic switch operating at the recurrent frequency for re-applying a portion of the direct current components of the amplified signals to the amplifying system at times other than during the short intervals that the signals are suppressed to control the average potential of the voltage variations, said electronic switch comprising three electron discharge devices each having a cathode and an anode, means for connecting the cathode of one of the devices to the output of the amplifier, means for connecting the cathode of another of the devices to the input of the amplifier, means for applying negative control impulses to the cathode of the third device at the said recurrent frequency, and means including a single resistance for connecting all of the anodes to a source of positive potential.

2. An amplifying system for television wherein signals including alternating and direct current voltage variations are present comprising a direct current amplifier, means for suppressing the signals during predetermined short intervals of regular recurrent frequency, means including an intermittently operating electronic switch operating at the recurrent frequency for re-applying a portion of the direct current component of the amplified signals to the amplifying system at times other than during the short intervals that the signals are suppressed to control the average potential of the voltage variations, and means including a light responsive device for determining the portion of the direct current component which is re-applied to the system, said electronic switch comprising three electron discharge devices each having a cathode and an anode, means for connecting the cathode of one of the devices to the output of the amplifier, means for connecting the cathode of another of the devices to the input of the amplifier, means for applying negative control impulses to the cathode of the third device at the said re-

current frequency, and means including a single resistance for connecting all of the anodes to a source of positive potential.

3. An amplifying device for a television transmitting system wherein signals including alternating and direct current voltage variations are present comprising a direct coupled amplifier, means including an electronic switch for re-applying a portion of the direct current component of the amplified signals to the amplifying device to control the average potential of the voltage variations, said electronic switch com-

prising a pair of discharge tubes each having a cathode and an anode, means for connecting the cathode of one of the discharge devices to the output terminal of the amplifying device, means for connecting the cathode of the other discharge device to the input terminal of the amplifying device, means for connecting the anodes together, and means for cyclically varying the potential applied to said anodes whereby said discharge devices are rendered intermittently conducting.

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