

July 13, 1948.

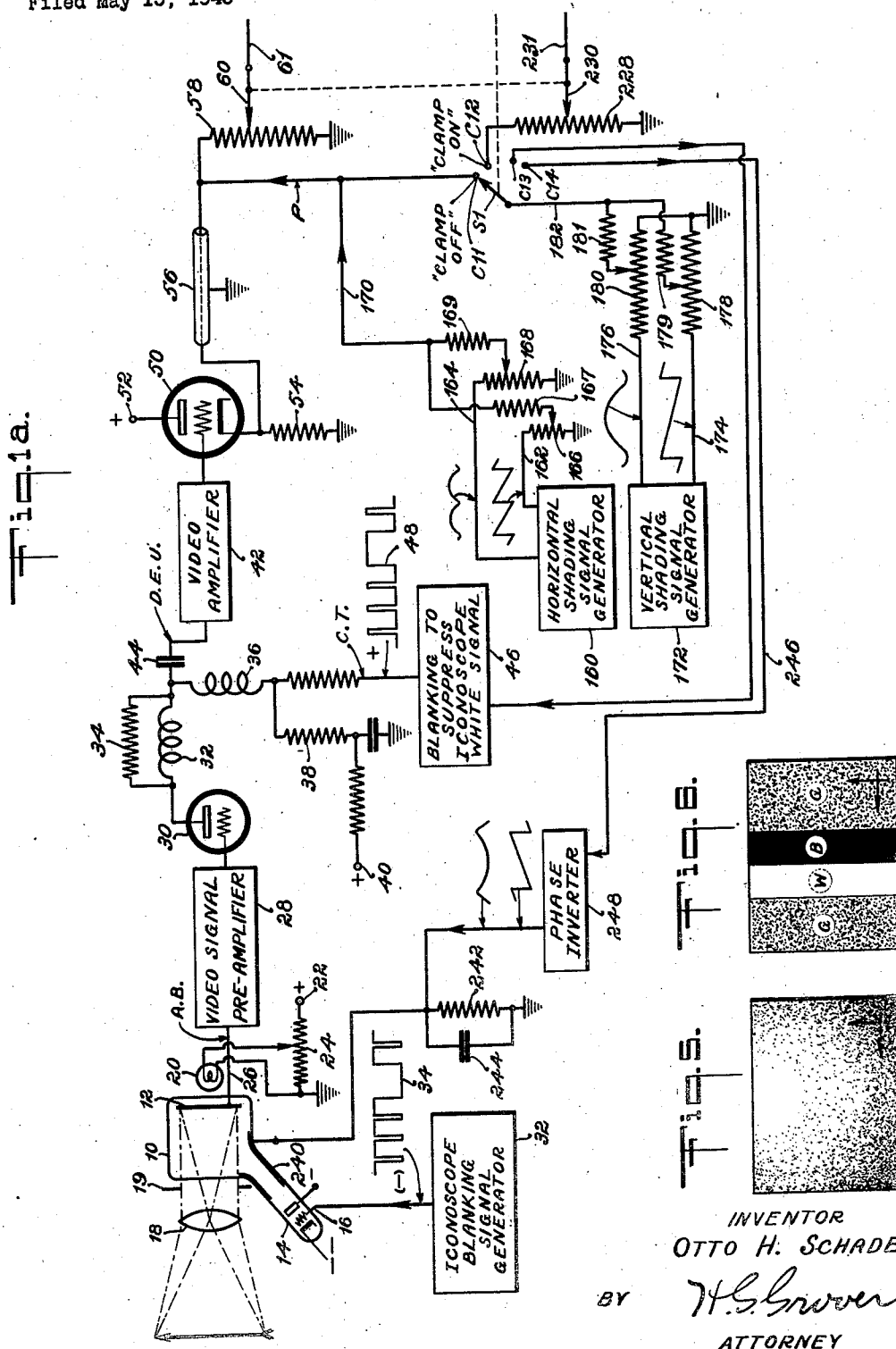
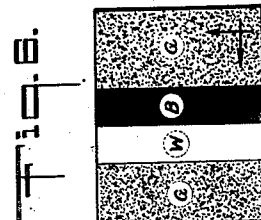
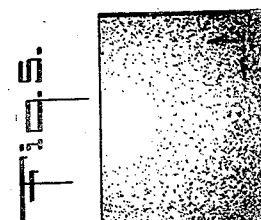
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2,445,040

DARK SPOT CORRECTOR

Filed May 13, 1943

5 Sheets-Sheet 1



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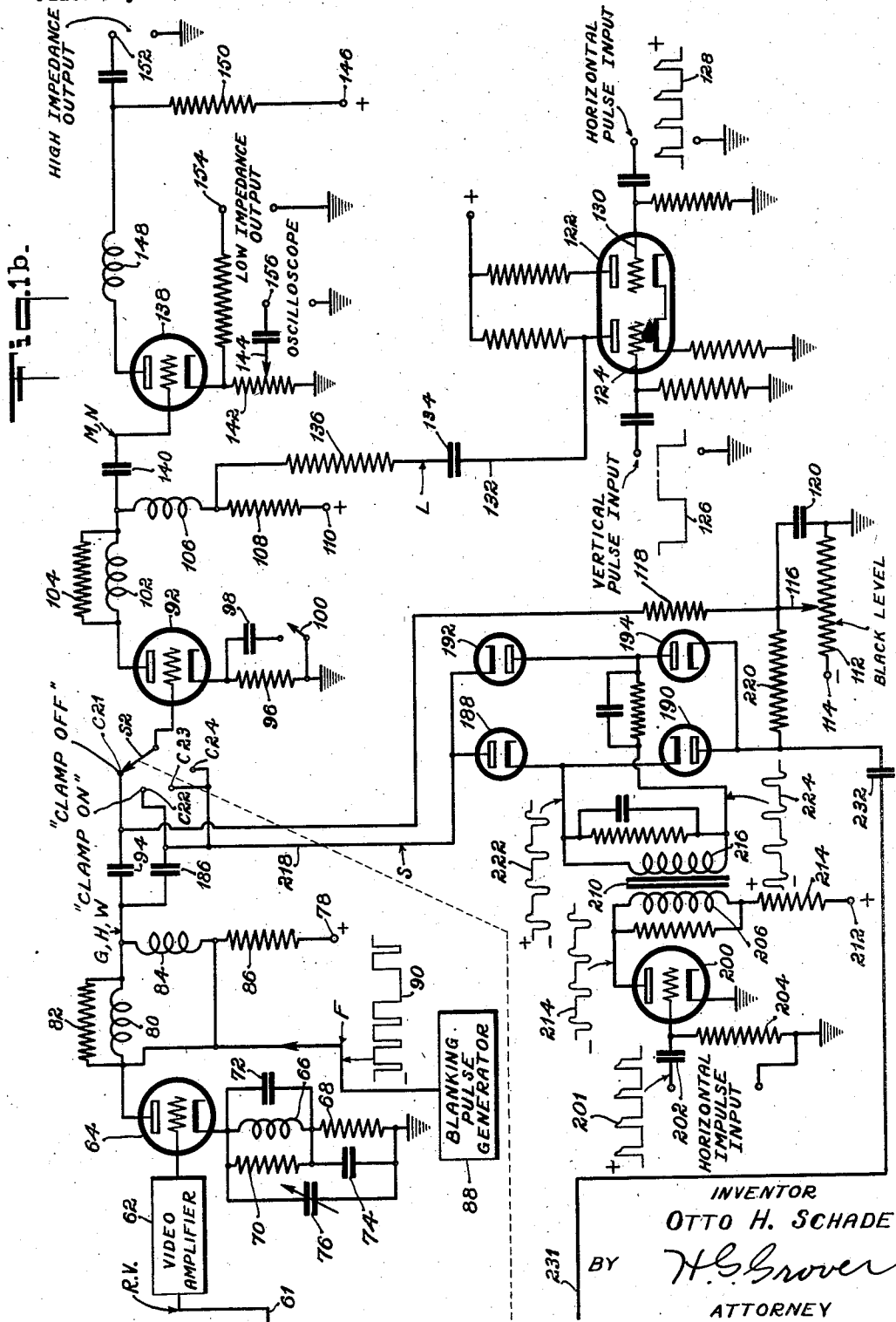
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DARK SPOT CORRECTOR

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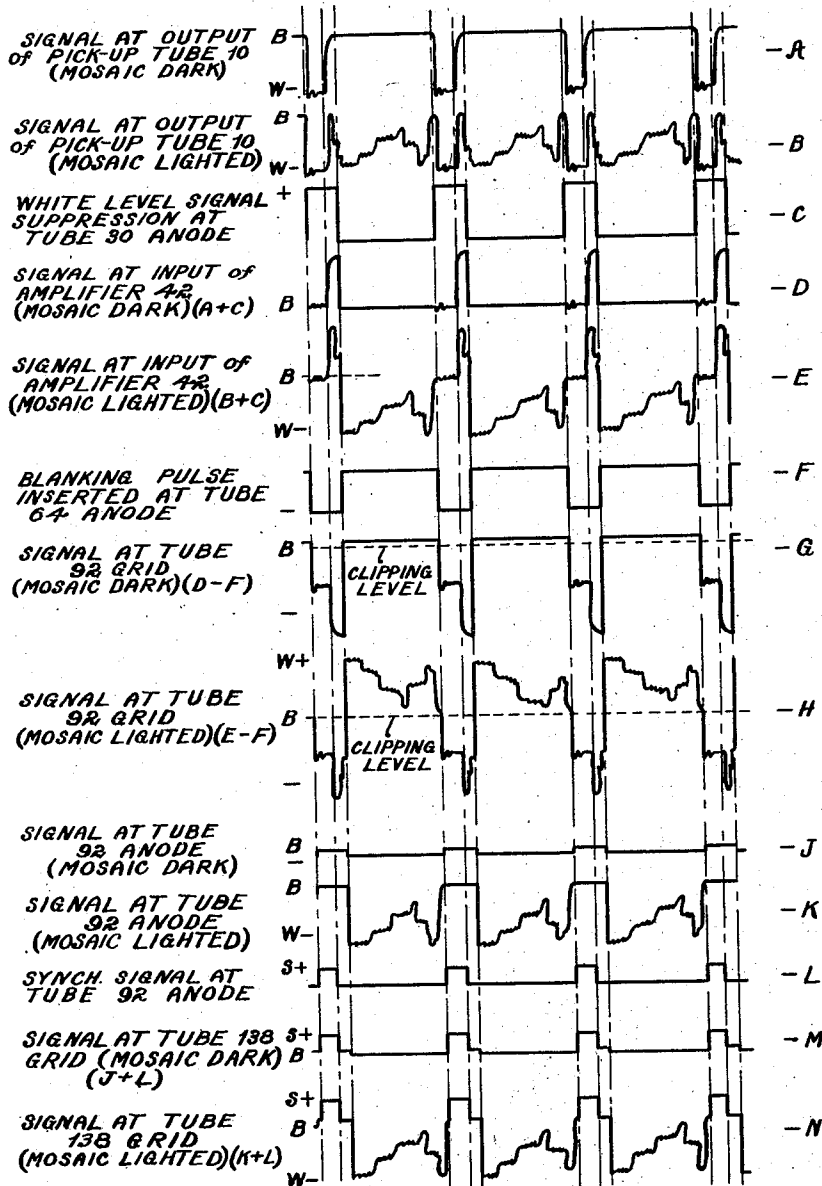
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Fig. 2.



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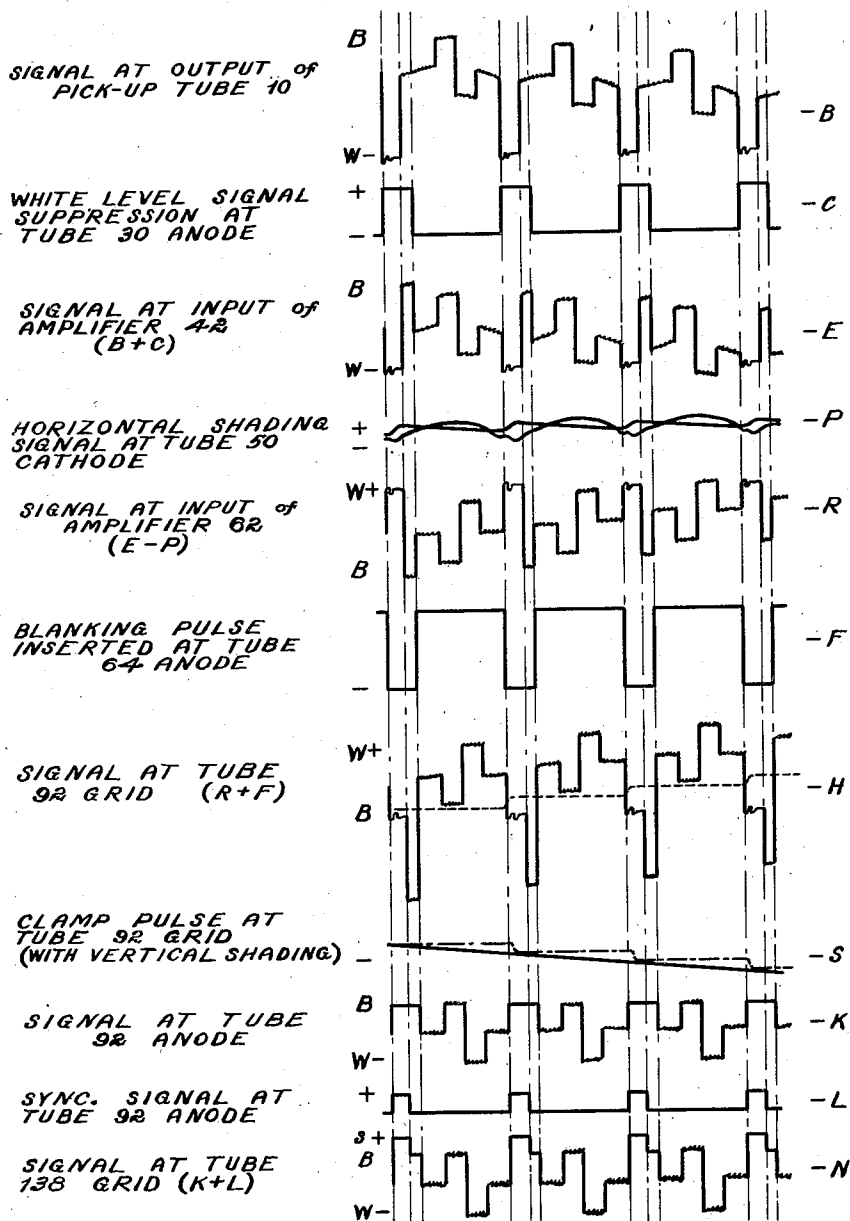
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Fig. 3.



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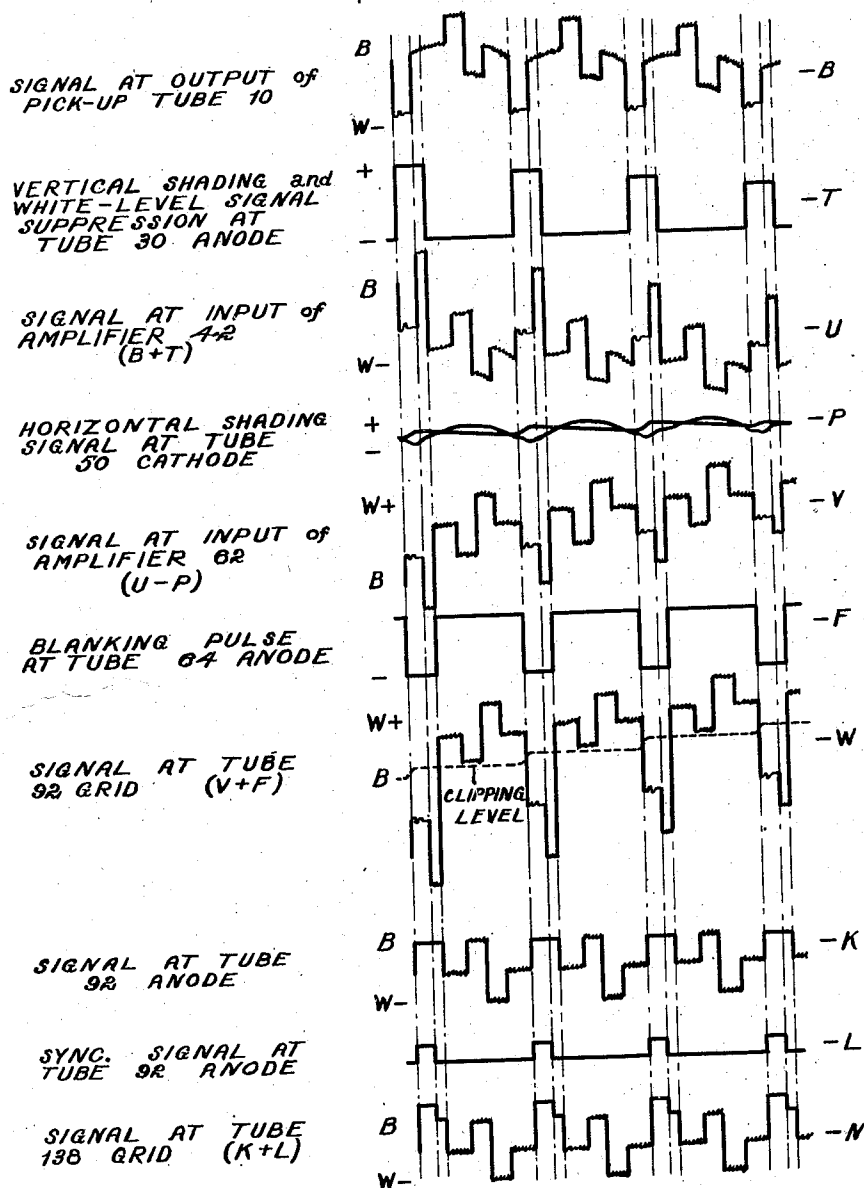
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Filed May 13, 1943

Fig. 4.



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UNITED STATES PATENT OFFICE

2,445,040

DARK SPOT CORRECTOR

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Application May 13, 1943, Serial No. 486,766

9 Claims. (Cl. 178—7.2)

1 This invention relates to an improvement in television systems, and more particularly to an improvement in television transmitting systems.

In a television transmitting system, particularly when the television pickup tube employed is of the storage type such as the "iconoscope," the generated picture signals contain, in addition to the desired signals, voltage variations which are produced as a result of "dark spot," and also signals which are produced as a result of current modulation of the scanning cathode ray beam, such as, for example, the usual blanking of the beam of electrons.

The undesired spurious signals developed during the blanking interval, as well as the undesired dark spot signals, must be removed before transmission of the signals in order that the received picture will appear to have proper tone values without any undesired distortion or improper shading. Furthermore, in the transmission of the picture signals through the various amplifiers at the television transmitter, the direct current component of the signals is lost, with the result that some means must be provided for relating the picture signal series to a predetermined and proper voltage level.

In a television pickup tube of the storage type, there is virtually always some lack of uniformity of response throughout the entire target electrode, and this lack of uniformity of response results in the generation or production of a signal which is generally known as the "dark spot" signal, and in some instances the variation in signal strength as a result of dark spot may, in fact, exceed the amplitude or intensity of the desired picture signals. A large percentage of the dark spot signal may be removed through the use of "back-lighting," but that portion of the dark spot signal which cannot be eliminated by back-lighting must be removed by the injection of opposing potentials which are generally known as "shading" signals. In conventional television transmitting systems, shading signal generators are normally provided, the generators having means whereby the wave form, as well as the amplitude and polarity of the shading potentials, may be controlled prior to their being combined with the picture signal series.

Furthermore, in a television pickup tube of the "iconoscope" type, the scanning cathode ray beam is generally blanked or reduced to substantially zero current intensity during the return deflection of the scanning beam, and if no back-lighting is employed at the television pick tube, substantially no signal will be generated during the in-

2 stants that the beam is blanked. If, however, back-lighting is employed, a "white" signal will be generated during the blanking of the scanning cathode ray beam, and the light intensity of the back-lighting source somewhat determines the amplitude or intensity of the generated white signal.

With optimum bias lighting, a white signal of predetermined value will be generated and this value will remain substantially fixed regardless of the brightness of the optical image projected upon the mosaic or target electrode if the pickup tube is operated in accordance with the present invention. The white signal that is generated during the blanking interval is caused by photoemission currents from the tube walls to the mosaic or target electrode, these currents being normally balanced by secondary emission from the target electrode during the actual scanning operation. When the scanning cathode ray beam is interrupted, as during the blanking intervals, the production of the secondary electrons at the target electrode is suddenly stopped with the result that the secondary electrons no longer are permitted to flow to the tube walls, but photo-electrons continue to flow from the tube walls to the mosaic electrode. Since the intensity of the white signal that is generated during the blanking interval is then a function of the number of photoelectrons that flow from the inside walls of the television pickup tube to the mosaic electrode, the intensity of the white signal will also be a function of the amount of light permitted to strike the photo-sensitized walls of the tube. In order to maintain the white signal more or less uniform under various operating conditions, it is, therefore, desirable to have a constant amount of light fall on the tube walls in order that a constant amount of photo-electron emission may flow from the tube walls to the mosaic electrode during the blanking intervals.

Therefore, in accordance with the present invention, if the tube walls are permitted to obtain light only from a back-lighting source, this photoemission may be held substantially constant. The present invention, therefore, contemplates the use of a mask positioned in the optical path of the television pickup or camera tube in order to prevent any light from the object area from reaching the tube walls. The mask is so situated and so shaped that light from the object area is permitted to fall only upon the surface of the mosaic electrode, with the result that the photo-electronic emission from the tube walls is in response to light incident thereon originating at

the black-lighting source only. When a mask is so used, the white level signal may, therefore, be maintained substantially uniform with the result that the undesired dark spot signal may be materially reduced and may be made quite consistent irrespective of the over-all light intensity of the object area, and also irrespective of any changes in the over-all light intensity of the object area.

The white signal generated during the blanking interval is often of appreciable intensity, and for best operation of the television transmitting system, the white signal should be suppressed prior to any appreciable degree of amplification of the picture signals in order to avoid overloading the picture signal amplifier.

In the present invention provision is made for reducing the intensity of the white signals that are generated during the blanking interval in order that overloading in succeeding stages of the picture signal amplifier will not occur.

The present invention also provides means for injecting shading control potentials in order to remove the undesired variations in picture signal strength that are caused by the dark spot response and any lack of uniformity of response of the television pickup tube.

Means are also provided in the present invention for automatically setting the level of the picture signals after they have been amplified to a predetermined degree, and this automatic level setting circuit will be referred to in general as the "clamp circuit." The action of the clamp circuit consists generally in resetting the zero level of the video or picture signal during horizontal retrace intervals. In one mode of operation the intensity of the picture signal is brought to a predetermined adjustable value during each horizontal return interval, i. e., during the interval between each successive line of the picture. This particular voltage or level may be constant, or in some instances it may be cyclically variable in order to produce a desired vertical shading effect.

The removal of the undesired vertical dark spot signal or component may be accomplished by varying the clamp level cyclically during each field deflection, thus allowing for the "tilt" existing in the natural zero level during retrace periods. Since the clamp circuit is effective only during each horizontal return interval, it cannot be used to alter the signal intensity during any one line interval, but the clamp circuit may be used to alter the picture signal series in its relation to a predetermined axis during each line interval, and accordingly the circuit may be used to eliminate additive signals of any frequency substantially lower than the horizontal deflection frequency. Since the horizontal deflection frequency is of the order of more than 15,000 cycles per second (assuming presently existing practice), hum voltages, microphonics and low frequency distortion in the amplifier, as well as the vertical dark spot signal may be removed by the clamp circuit. The clamp circuit also eliminates errors in low frequency response of the amplifier, and stabilizes the amplifier insofar as any tendency to relaxation oscillations or "bouncing" is concerned.

By reason of the fact that the clamp circuit is effective only during intervals between each succeeding line, it cannot be used to correct for any errors occurring during each line or having a frequency of occurrence equal to or in excess of the line deflection frequency. Because of this it is necessary that the picture signal amplifier have

substantially zero phase shift or amplitude loss at and above the horizontal deflection frequency.

The invention disclosed herein also includes means for injecting or inserting synchronizing signals that may be used to maintain a television receiver in synchronous operation with the transmitter, the synchronizing signals also being effective, in some instances, to produce the desired return beam blanking in the receiver.

In the present invention provision is also made for obtaining either low or high impedance composite output voltage variations representative of picture signals, black level signals and synchronizing signals. A provision is also made whereby a series of signals may be derived from the system suitable for application to an oscilloscope for monitoring purposes.

In addition to a compensation for the undesired vertical dark spot signal through the use of a cyclic variation in the clamp level, the present invention also provides means whereby the undesired vertical dark spot signal may be compensated by modulating the intensity of the signals used to suppress the white signals generated during the blanking interval. Such an arrangement has the effect of altering the tilt of the signals generated during horizontal blanking, and by reason of this alteration and the operation of succeeding portions of the system, effective vertical shading may be accomplished.

The present invention also provides a still further means for compensating for the undesired vertical dark spot signal by modulating the collector electrode of a television pickup tube to thereby vary the potential difference between the inside wall (the collector electrode) of the television pickup tube and the mosaic electrode. A variation in this potential difference affects the number of photo-electrons that are permitted to flow from the tube wall to the mosaic electrode, and also affects the number of secondary electrons and photo-electrons that are permitted to flow from the mosaic electrode to the collector electrode or tube walls. By modulating the potential of the collector electrode in a television transmitter tube it is, therefore, possible to introduce, in effect, a desired vertical shading component by the elimination of the undesired vertical dark spot signal at the television scanning or pickup tube.

It is, therefore, one purpose of the present invention to provide means whereby the white signal generated during horizontal blanking intervals may be maintained substantially uniform irrespective of the light intensity of the object area and irrespective of any changes in the light intensity of the object area.

Another purpose of the present invention resides in the operation of television pickup tubes of the storage type under conditions which minimize dark spot correction voltages, and which operate to maintain the undesired dark spot signal substantially stable and uniform irrespective of the light intensity of the object area in order that automatic level setting circuits may be used.

Another purpose of the present invention resides in the operation of "iconoscopes" or similar television pickup tubes such that consistent black levels in the picture signals may be maintained independent of gain or amplification adjustment, together with means for inserting vertical shading signals in combination with these circuits.

Still another purpose of the present invention resides in the operation of a television pickup of

the "iconoscope" type in such a manner that the undesired dark spot signal will not change appreciably with changes in the light intensity of the object area, thereby to preclude the necessity of altering the intensity of the shading signals with changes in the light intensity of the subject matter being televised.

Another purpose of the present invention resides in the provision of means in a television transmitter for reducing the effective intensity of white level signals generated during blanking of the cathode ray beam in a television pickup tube.

A further purpose of the present invention resides in the provision of means for inserting shading signals at line deflection frequency for compensating for undesired dark spot signals in a horizontal direction.

Another purpose of the present invention resides in the provision of means for inserting shading signals of vertical or field deflection frequency in order to remove undesired dark spot signals or shading extending in a vertical direction.

A still further purpose of the present invention resides in the provision of means for injecting a blanking signal for reducing the intensity of the picture signals between individual line elements, or for causing the signals occurring during the blanking interval to extend in a direction corresponding to and at least equal to black in the picture.

Still another purpose of the present invention resides in the provision of means for automatically resetting the level of the picture signals during the intervals between each succeeding line element.

Another purpose of the present invention resides in the provision of means for varying the automatic level setting means or clamping means cyclically at vertical deflection frequency in order to compensate for undesired vertical shading effects.

A still further purpose of the present invention resides in the provision of an amplifier in a picture signal amplifier series with means whereby the potential applied to the control electrode of the amplifier tube may be reset to a predetermined potential value during each interval between each succeeding line element of the picture.

Another purpose of the present invention resides in the provision of an amplifier tube in a television amplifying system wherein the control electrode of the tube is supplied with picture signals during each line interval, and has applied thereto a predetermined potential between each line interval in order to reset or relate the picture signals to a predetermined potential level.

A further purpose of the present invention resides in the provision of means whereby the vertical shading signals may be injected into the system by means of the automatic level setting means or clamp circuit, together with means whereby the vertical shading signals may be directly applied to the picture signal series when the clamp circuit is not in use.

A further purpose of the present invention resides in the provision of means whereby the average potential of the control electrode of one of the amplifying tubes in the television amplifier may be maintained at a predetermined potential when the automatic level setting circuit or clamp circuit is not in use.

Another purpose of the present invention resides in the provision of means whereby the un-

desired vertical dark spot signal may be eliminated by an appropriate variation in the degree of suppression of the white signal generated during the horizontal blanking interval.

Still another purpose of the present invention resides in the provision of means for effecting a compensation of the undesired vertical dark spot signal by introducing an appropriate tilt or variation in the signal strength of the white signal generated during the horizontal blanking intervals.

A further purpose of the present invention resides in the provision of means whereby the undesired vertical dark spot signal may be eliminated by a modulation of the potential of the collector electrode of the television pickup tube.

A still further purpose of the present invention resides in the provision of means whereby the differential potential existing between the mosaic electrode and the collector electrode of the television pickup tube may be cyclically varied in order to preclude the generation of an undesired vertical dark spot signal.

A still further purpose of the present invention resides in the provision of means whereby both horizontal and vertical synchronizing signals may be mixed with the picture signals to produce a complete composite series of signals representing the picture signals, the black level signals and the synchronizing signals.

Various other purposes and advantages of the invention will become more apparent to those skilled in the art upon reading the following detailed description, especially when considered in connection with the drawings, wherein

Figures 1a and 1b show a schematic diagram of a preferred form of the present invention;

Figures 2, 3 and 4 show curves representing potential variations present at various points of the circuit shown in Figures 1a and 1b; and

Figures 5 and 6 represent, respectively, dark spot and lighting conditions of the mosaic.

Referring now to the drawings, and particularly to Figure 1a thereof, there is shown therein a television pickup tube 10 of the "iconoscope" or charge storage type having a target or mosaic electrode 12 and an electron gun structure 14 to develop a cathode ray scanning beam (not shown) to scan the mosaic. The electron gun structure also includes a control electrode 16. Associated with the pickup tube is an optical system 18 by means of which an optical image may be projected upon the mosaic or target electrode 12. A mask 19 is interposed along the optical path to permit only the target electrode 12 to be illuminated by light from the object area and to prevent any light from the lens system from striking the inside walls of the tube 10. Positioned adjacent the television pickup tube 10 is a source of incandescent light 20, which is preferably energized from a source of direct current applied to the terminal 22, the intensity of the light emitted from the source 20 being controlled by means of the potentiometer 24. The source of light 20 provides an adjustable amount of back-lighting or wall-lighting for the television pickup tube.

The mosaic or target electrode 12 of the television transmitting tube 10 also includes a signal plate to which is connected conductor 26. Voltage variations or signals generated by the television pickup tube when the mosaic electrode 12 is scanned by the cathode ray beam will be present at conductor 26, and these are applied to a video signal pre-amplifier 28. The intensity of the signals present on conductor 26 is increased by the

pre-amplifier 28 and the amplified signals are then applied to the control electrode of a further amplifier tube 30. The pre-amplifier 28 is shown merely schematically since appropriate pre-amplifier circuits are well known to those skilled in the art. Furthermore, only the control electrode and anode of tube 30 are shown in order to simplify the drawings, and these elements form a sufficient representation of the amplifier tube 30 for the purpose of the present invention. The cathode circuit of tube 30 is, in fact, somewhat involved, and may actually include an electron discharge path to compensate for the inherent high frequency attenuation introduced by the load circuit of the television pickup tube. One circuit arrangement for the cathode circuit of tube 30 is shown and described, for example, in Schade Patent No. 2,378,797, issued on June 19, 1945. Various other portions of the present invention are also shown in schematic form, since the elements so shown are well known to those skilled in the art, and by representing these circuits schematically, the description of the present invention may be materially simplified.

For blanking the scanning cathode ray beam generated in the television camera or image pickup tube 10, and "iconoscope" blanking signal generator 32 is provided which generates a voltage variation such as shown by the curve 34, and these voltage variations are then applied to the control electrode 16 of the television pickup tube 10. Since the voltage variations extend in a negative direction and each impulse occurs during cathode ray beam return intervals, the cathode ray beam is substantially suppressed or blanked during each horizontal and each vertical retrace interval.

As explained above, by reason of the presence of the wall-lighting source 20 a signal will be generated by the television pickup tube during each blanking interval, and this signal will extend in a "white" direction, the signal being termed the "white level" signal. Since the intensity of the white level signal is controlled by the quantity of photo-electrons that continue to flow from the tube walls to the mosaic electrode during the blanking interval, the white level signal intensity will also be a function of the light incident upon the tube walls during such intervals. To maintain the white level signal substantially constant it is, therefore, desirable to maintain the lighting of the tube walls substantially constant. This is accomplished in the present invention by providing the mask 19, and when it is positioned, as stated above, to preclude any light from the object area from reaching the tube walls, the lighting on the tube walls may be maintained substantially uniform since the light thereon originates only from the back-lighting source 20. Even when the mask 19 is provided, the amplitude of the white signal pulse may not remain absolutely constant unless the potential difference between the inside wall of the television pickup tube and the mosaic or target is maintained substantially constant. This constant potential can be obtained only when "light shading" from the source of light 20 has been adjusted to obtain a perfectly uniform dark signal. However, such a situation is difficult to accomplish, and although the dark spot signal may be materially reduced by the source of light 20, some residual signal almost invariably remains. As a result, there will normally be a certain predetermined "tilt" or variation in the intensity of the white level signal, the variation in intensity of the white level signal

being cyclically repeated for each vertical deflection of the cathode ray beam.

As will be explained later, "iconoscope" beam current blanking by the blanking signal generator 32 is necessary during vertical and horizontal retrace periods to permit operation of the automatic level setting circuits or clamp circuits. Horizontal blanking may, however, be eliminated, but when an automatic level setting circuit is used in instances when no horizontal blanking is employed, bad streaking will result since the automatic level setting circuit effectively removes the low frequency picture signal component. It is desirable, therefore, that both horizontal and vertical blanking be employed and, furthermore, it is desirable that especially the base line between blanking impulses have a constant level in order to eliminate undesired beam current modulation or transients.

The "iconoscope" blanking signal generator represented schematically at 32 in the drawing, therefore, supplies both the horizontal and vertical blanking signal impulses as a combined composite series of signals. The composite series of blanking signals may be generated in the proper wave form and in a composite series by employing an impulse mixing circuit such as shown and described in Schade Patent No. 2,363,809, issued on November 28, 1944. When separate impulses of horizontal and vertical deflection frequency are applied to the impulse mixing circuit, the impulses are combined and are also made rectangular in wave form. Inasmuch as the impulse mixing circuit is clearly shown and described in the above mentioned application, it is not believed that it need be specifically shown and described herein.

For simplicity, the operation of the present invention will first be described on the assumption that the white level signal remains substantially constant, and also on the assumption that no dark spot signal is present in the picture signal series generated and supplied by the television pickup tube 10. Furthermore, it will also be assumed that the automatic level setting circuit or clamp circuit is not employed. Under these assumed circumstances, the series of curves shown in Figure 2 are applicable. In these curves two operating conditions have been shown, one condition being for a dark or unilluminated mosaic, and the other condition being when an optical image is projected on the mosaic.

In order to assist in relating the curves shown in Figures 2, 3 and 4 to the circuit shown in Figures 1a and 1b, the curve identifying letters have been applied to the circuit diagram at the appropriate points. Curves A and B shown in Figure 2, therefore, represent voltage variations available at the output conductor 26 of the television pickup tube 10 under conditions of a dark mosaic and of an illuminated mosaic, respectively. It will be noticed that in the curve shown at A in Figure 2, the white level signal remains constant and, furthermore, substantially zero signal is generated between each blanking interval, indicating a dark mosaic and the lack of a dark spot signal. In curve B, the white level signal is also constant but interposed between each blanking interval are series of picture signals, each representing a line element of the picture. It will also be observed in curve B of Figure 2 that the white level signal is substantially equal to or exceeds the maximum white picture or video signal.

The signals represented by curves A and B of Figure 2 are then applied, as stated above, to the

video signal pre-amplifier 23, where their intensity is increased, and after amplification they are then applied, in reversed polarity, to the control electrode of another amplifier tube 30. As stated above, only a portion of this tube is shown for the sake of simplicity, and the anode of the tube is maintained at a positive potential by means of a load circuit including a series peaking coil 32 and parallel resistance 34, a further inductance member or shunt peaking coil 36 and a load impedance 38. This load circuit is connected between the anode and terminal 40 to which a positive potential is applied. The amplified picture signals are then applied to a further video amplifier 42 by way of coupling condenser 44.

For reducing the intensity of the white level signal, a blanking signal or impulse series is inserted between the amplifier tube 30 and the amplifier 42. This blanking impulse series is provided by the blanking signal generator 46 which generates a wave form such as shown at 48. These same blanking impulses that are used to reduce the intensity of the white level signals are also represented by curve C of Figure 2, and when these blanking or white level signal suppression impulses are superimposed upon the picture signal series present in the anode circuit of tube 30, the effective amplitude of the white level signals may be brought to substantially zero (i. e., to a level representative substantially of black in the picture).

The picture or video signals present at the conductor 26 have a polarity such that white (e. g., a high light in the scene being televised) is in a negative direction, and if a single or an odd number of amplifier stages are included in the pre-amplifier 23, the picture or video signals in the anode circuit of tube 30 will also have a polarity such that white extends in a negative direction, as indicated in the curves A and B of Figure 2. After the blanking impulses are combined with the picture signals to suppress the white level signals, a series of signals will then result corresponding to curves D and E of Figure 2. Curve D is, therefore, the combination of the curve A and the curve C, while curve E represents a combination of curves B and C.

It will be observed that the duration of the blanking or suppression pulse exceeds the television pickup tube blanking interval, with the result that a short positive or blacker-than-black signal will result. Curve D, therefore, represents the potential variations at the input of video amplifier 42 under conditions of a dark mosaic, while curve E represents the potential variations present at the input of amplifier 42 for the condition of an optical image on the mosaic of the television pickup tube.

After the signals are amplified by the amplifier 42 they are then supplied to a further amplifier tube 50 having at least a cathode, a control electrode and an anode. The anode is connected to a terminal 52 to which is applied a positive potential, while the cathode of tube 50 is connected to ground by means of a cathode load resistance or impedance 54. Naturally, amplifier picture or video signal output may be derived from the anode of tube 50 or if, as indicated in the drawing, a low impedance output is desired, then the picture or video signal output may be derived from the cathode of tube 50. This connection is frequently desirable since in some instances it may be necessary to transmit the picture signals over a coaxial cable to a further video amplifier

or so-called "line" amplifier. The coaxial cable is, therefore, represented at 56 and this cable terminates at a volume control or potentiometer 58 having a movable contact 60.

As stated above, it is assumed in this description of the operation of the present invention that no dark spot signal is present at the output of the television pickup tube, and consequently no shading is necessary. Accordingly, a description of the injection of the shading control potentials will not at present be given.

Picture or video signals having an intensity determined by the position of the movable contact 60 along the volume or gain control 58 are then applied, by conductor 61, to a further video or picture signal amplifier 62 (see Figure 1b), the output of which supplies signals to the control electrode of a further amplifier tube 64. This amplifier tube includes at least a cathode, a control electrode and an anode, and the cathode is connected to ground through a series connected inductance 66 and resistance 68. The inductance has connected in parallel therewith a resistance 70 and condenser 72, while a further condenser 74 is connected in parallel with the resistance 68. An adjustable condenser 76 is connected between the cathode and ground or a point of fixed potential. This network provides a transient compensating network, and when the condenser 76 is properly adjusted the effects of undesired transient conditions in the amplifier may be nullified.

The anode of tube 64 is maintained positive with respect to its associated cathode by connection to positive terminal 78, the connection including series peaking coil 80, parallel resistor 82, series inductance 84 (shunt peaking) and load impedance 86. Voltage variations present at the anode of tube 64 will then have a wave form similar to the curves D and E of Figure 2, except that the polarity will be reversed. Accordingly, white in the picture will extend in a positive direction.

For assuring that the signals present at the anode of tube 64 during beam return time intervals have an intensity at least equal to or extending beyond black in the picture, means is provided for injecting blanking impulses into the signal series at the anode of tube 64. When these blanking impulses are then combined with the picture signals present at this point, the intensity of the signals occurring between adjacent line picture signals will always be at least equal to black and extend in a blacker-than-black direction regardless of the position of slider 60 on the gain control potentiometer 58 (Figure 1a). For supplying these blanking impulses, a blanking signal generator 88 is provided which generates a wave form such as shown at 90 in Figure 1b. This same wave form is also represented by curve F in Figure 2, and when these impulses are mixed with the picture signals present at the anode of tube 64, a resultant series of signals corresponding to the curves G and H of Figure 2 will be produced.

It will be noticed by comparing curves G and H with curves D and E, respectively, that the signals present during the blanking interval are caused to have an intensity extending in the blacker-than-black region (black level is indicated by the dotted line in curves G and H).

As stated above, it is assumed that the clamp circuit is not in use and, accordingly, the switch S2 will be assumed to be in the "clamp off" position, i. e., in engagement with contact C—21. Under these circumstances, voltage variation such

as represented by curves G and H in Figure 2 will then be supplied to the control electrode of a further amplifier tube 92 by way of coupling condenser 94.

The tube 92 includes at least a cathode, a control electrode and an anode, and the cathode is connected to ground by way of cathode resistance 96. This resistance has a condenser 98 connected in parallel therewith when the switch 100 is in the closed position. However, when the switch is placed in the open position the condenser is not included in the circuit. This switch provides a gamma control of the picture signals and by positioning the switch in the closed or the open position, the black level clipper tube 92 or amplifier tube may be made to have a linear amplification or may be caused to amplify according to a square law. When the condenser 98 is included in parallel with the resistance 96, the characteristics of the amplifier tube are according to a square law, whereas if the condenser 98 is not included in the circuit, the amplification is substantially linear. When operated as a linear amplifier, the "iconoscope" gamma is preserved, which is desirable for optimum or good lighting conditions. If, however, the lighting conditions are poor, then the condenser 98 should be included in parallel with the resistance 96 to cause the tube 92 to have a characteristic such that a square law amplitude distortion with increased gain for signals representative of white may result to correct for the change in response of the "iconoscope" under poor lighting conditions and to produce a substantially linear signal versus light characteristic or unity gamma, which is psychologically desirable under poor lighting conditions.

The anode of tube 92 is maintained positive with respect to its cathode by means of peaking coil 102 and parallel resistance 104, as well as inductance 106 and load impedance or resistance 108. These elements are connected between the anode and terminal 110 to which a source of positive potential is applied.

The tube 92, assuming the switch S2 to be in the "clamp off" (C21) position, has its control electrode maintained at a fixed average potential with respect to the cathode. For maintaining this predetermined bias, a black level control potentiometer 112 is provided, the resistance element of the potentiometer being connected between negative terminal 114 and a point of fixed potential or ground. A movable contact 116 of the potentiometer is connected to the control electrode of tube 92 by way of grid resistor 118. In order to filter the potential applied to the terminal 114, a condenser 120 is provided which is connected between the movable contact 116 and ground. By an adjustment of the movable contact 116 along the potentiometer resistance 112, it is possible to vary the average potential (i. e., the direct potential) of the control electrode of tube 92 with respect to its cathode with the result that the clipping level of the tube may thereby be controlled.

In curves G and H of Figure 2, dotted lines are shown corresponding substantially to black in the picture signal, and this will be assumed to be the clipping level of tube 92 for a predetermined position of the movable contact 116. Under these conditions any signal having a negative polarity extending beyond the clipping level will bias the tube 92 to cut-off, with the result that no current will pass therethrough. Accordingly, a picture signal series will be present at the anode of tube

92 corresponding substantially to the curves J and K of Figure 2.

Curve J of Figure 2, as indicated, is the voltage variation present when the mosaic electrode 12 is non-illuminated, whereas curve K represents the voltage variations under the conditions when an optical image is projected on the mosaic electrode 12. It will also be observed, particularly from curve K of Figure 2, that the signals representative of white in the picture extend in a negative direction at the anode of tube 92. The voltage variations at this point in the circuit include only the picture signals with the potential level of the voltage variations reduced to a value corresponding to black in the picture for those intervals between adjacent picture lines or line elements.

At this point the synchronizing signal series is injected into the circuit in order that a composite series of picture, black level and synchronizing signals may be produced.

For the injection of the synchronizing signals tube 122 is included, this tube comprising two separate triode elements. A series of impulses of vertical deflection frequency having a wave form similar to that indicated at 126 is supplied to control electrode 124, while impulses of horizontal deflection frequency having a wave form such as indicated at 128 are applied to the control electrode 130. By reason of the operation of tube 122, a composite series of impulses is then present in the output conductor 132 representing a composite of both horizontal and vertical synchronizing impulses. These impulses as present at conductor 132 extend in a positive direction, and are added to the picture signal series present at the anode of tube 92 by parallel insertion through condenser 134 and resistance 136. The duration of the horizontal driving impulses represented by curve 128 is preferably 30% to 40% shorter than the blanking impulses supplied by the generator 88, so that the horizontal synchronizing impulses do not extend throughout the entire blanking interval.

The vertical synchronizing impulses have a duration corresponding to $1\frac{1}{2}$ to 2 line intervals, this duration being sufficient to maintain the receiver in synchronous operation. The composite series of synchronizing signals as provided by tube 122 is not in accordance with the present R. M. A. standard when such driving impulses are applied to the control electrodes of tube 122; however, by application of proper driving impulses, a series of composite synchronizing signals could be generated corresponding to the prescribed R. M. A. standard series. The operation of tube 122 will not be explained in detail since its operation is clearly shown and described in the above mentioned Schade Patent No. 2,363,809.

The synchronizing impulses supplied by tube 122 are represented by curve L in Figure 2, and when these are combined with the voltage variations present at the anode of tube 92, a composite series of signals will be produced similar to that represented by curves M and N of Figure 2. In the curves represented at M and N it will be noticed that the signals representative of white extend in a negative direction, and the synchronizing signals extend in a positive direction. Signals of this polarity are present in the anode circuit of tube 92 and are applied to the control electrode of tube 138 by means of coupling condenser 140.

This tube operates as a further amplifying tube and/or as an output coupling tube, and includes at least a cathode, a control electrode and an anode. The cathode is connected to ground by

way of cathode potentiometer 142 having movable contact 144, and the anode is connected to a positive terminal 146 by way of inductance 148 and load impedance 150. By this arrangement it is possible to derive a high impedance output series of signals from the output terminal 152 associated with the anode of tube 138, or a low impedance output may be derived from output terminal 154 associated with the cathode of tube 138. Furthermore, for operating an oscilloscope, a voltage variation may be derived from output terminal 156 which is connected to the movable contact 144 of the potentiometer 142.

When an oscilloscope is used for monitoring purposes the horizontal deflection of the oscilloscope may be made to correspond to either the line deflection frequency or the field deflection frequency. The voltage variations available from any of the output terminals 152, 154 or 156 correspond substantially to the curves M and N shown in Figure 2 except that the polarity will be reversed when signals are derived from the output terminal 152.

It will be noticed by inspecting curve N that the voltage variations present at the output terminals of tube 138 include not only the picture signals during each line interval but also blanking signals of black level intensity for intervals between picture signals, the blanking signals having superimposed thereon (during a portion of their time interval) signals extending in a blacker-than-black direction, which naturally are for synchronizing purposes.

It should be borne in mind that the curves shown in Figure 2 (as well as other curves represented in the drawing) do not take into account the increased gain due to the amplification of the various tubes used in the network, but instead are merely shown to represent the voltage variations without regard as to the relative intensities of the signals.

By means of the circuit as so far described, it may be seen that a complete composite series of picture signals, blanking signals and synchronizing signals may be derived from the circuit. This series of signals may then be used for transmission by wire to television receivers, or the same series of signals may be used for modulating a radio frequency carrier for transmission to receiving points.

As previously stated, the above described method of operation is based on the assumption that no dark spot signal whatever is generated, and is further based on the assumption that the white level signals remain constant in intensity. Since it was assumed that no dark spot signal was generated, naturally no shading signals were necessary. Such a condition of operation is decidedly unusual since even with careful adjustment of the intensity and position of the backlighting from the source 20, some residual dark spot signal virtually always remains. Furthermore, it is possible to so operate the television pickup tube that the white level signal remains substantially constant, but this signal may in fact vary slightly. The use of the mask 19, however, as stated above, prevents light from the optical image from reaching the tube wall, with the result that the white level signal may remain substantially fixed.

The present invention, as disclosed in Figures 1a and 1b, will now be described on the assumption that a dark spot signal is generated, so that both vertical and horizontal shading is necessary to compensate for the undesired dark spot

signal. In describing the operation of the system under these conditions, it will be assumed that the dark spot signal is such as that represented in Figure 5, and for simplicity it will further be assumed that the particular picture scanned is such as that represented in Figure 6. The direction of horizontal and vertical scanning is represented by the arrows associated with each of Figures 5 and 6, and since the dark spot pattern represented in Figure 5 and the picture image represented in Figure 6 are those present on the target or mosaic electrode 12 of the television pickup or camera tube 10, the horizontal scanning direction is represented as occurring from left to right while the vertical scanning direction is represented as occurring from bottom to top. It must be remembered that the optical image on the target or mosaic electrode 12 is inverted and is also reversed from left to right due to the action of the lens system 18.

The dark spot pattern shown in Figure 5 is typical of a television pickup or camera tube of the "iconoscope" type, and in order that the effects of the dark spot on the picture signal may be more readily appreciated, a simple picture pattern such as shown in Figure 6 is assumed, which includes two end portions having a gray light value, with two parallel center portions extending in a vertical direction, one of these portions being white and the other black. In scanning across the picture area, therefore, picture signals representative successively of gray, black, white and gray will be produced for each line deflection cycle.

When such a picture is projected on the mosaic electrode, the mosaic electrode having a dark spot response such as indicated in Figure 5, picture signals such as shown by curve B of Figure 3 will be generated by the television pickup tube. During each horizontal beam return interval, it will be observed that a white level signal is generated, and this white level signal is shown as of constant intensity since such a result may be accomplished through the use of the mask 19. In the curve B of Figure 3, black in the picture produces a potential extending in a positive direction, whereas white in the picture produces the opposite polarity effect.

By an inspection of curve B of Figure 3, it will be seen that the gray picture signals for each individual line do not occur at the same signal intensity by reason of the presence of the dark spot. Furthermore, it will be observed that the picture signal strength for each succeeding line of the picture decreases (i. e., approaches a value extending in the direction of the white level signals). This deviation in average intensity of the picture signals for each successive line is a result of the vertical dark spot signal component, whereas the improper value of the picture signals during each individual line is as a result of the horizontal dark spot signal component.

The picture or video signals shown at curve B of Figure 3, therefore, include not only picture signals generated as a result of scanning the picture represented at Figure 6, but also signals representative of the dark spot represented by Figure 5. This signal is then applied to the video signal pre-amplifier 28 and in turn to the amplifier tube 30, where a similar voltage variation or signal is present at the anode of tube 30. At this point impulses are injected into the signal series in order to suppress the intensity of the white level signals, and these signals are derived from the blanking signal generator 46 and have a wave

form such as indicated by curve C in Figure 3 (see also curve 48 in Figure 1a). These impulses, as previously stated, extend in a positive direction, and when combined with the signal present at the anode of tube 30 produce a signal series such as represented by curve E of Figure 3. The combined voltage variations are then applied to the picture signal amplifier 42.

By inspecting curve E of Figure 3, it may be seen that only the white level signal is affected, the picture or video signals remaining substantially the same as generated. It will also be observed that the white level suppression signal represented by curve C has a width greater than the time duration of the white level signal in order to eliminate any undesired transients that may occur at either extreme end of each line deflection.

The picture signals represented by the curve E in Figure 3 as applied to the video amplifier 42 are also present at the cathode of tube 50 and at the volume control potentiometer 58, except that the polarity of the signals at these points is reversed from that shown in curve E of Figure 3.

At this point in the circuit horizontal shading potentials are mixed with the picture signals in order completely to cancel the undesired horizontal dark spot signal component present in the picture signal series. For this purpose a horizontal shading signal generator 160 is provided to which is applied an impulse series of horizontal deflection frequency (not shown). The horizontal shading signal generator includes a circuit arrangement whereby voltage variations of both sawtooth wave form and parabolic wave form in a particular, or either polarity, may be generated with provisions whereby the voltage variations may be confined to one or another portion of the line element. Circuit arrangements for generating horizontal shading control potentials are well known to those skilled in the art, and an example of such an arrangement is to be found in Schade Patent No. 2,312,054, issued on Feb. 23, 1943, or in Seeley Patent No. 2,271,876, granted on February 3, 1942.

For the purposes of the present invention, it is not material what type shading signal generator is employed, since the present invention does not relate to any particular shading signal generating means. Accordingly, and in order to avoid complexities, the shading signal generator is represented schematically and supplies separate shading components, one having a sawtooth wave form as applied to conductor 162 of Figure 1a, the other having a parabolic wave form as applied to conductor 164 of Figure 1a. Associated with these conductors are potentiometers 166 and 168, respectively. The movable contacts of these potentiometers are connected to conductor 170 by way of isolating resistors 167 and 169. By varying the position of the movable contacts along potentiometer resistances 166 and 168, the intensity of the sawtooth and parabolic voltage variations may be individually controlled. The conductor 170 is then connected to the high potential end of the volume control potentiometer resistance 58.

There is shown by curve P of Figure 3 the shading signals necessary to remove the undesired horizontal dark spot signal from the picture signal series. This shading control potential includes components of both sawtooth and parabolic wave form, and for simplicity these wave forms are shown individually although naturally in actual practice a combination of the two

would, in fact, be used. When the voltage variations such as shown by curve P of Figure 3 are combined with the picture signal series such as represented by curve E of Figure 3 (but with reversed polarity) a signal or voltage variation will then be produced similar to that represented by curve R of Figure 3. This voltage variation is present at the input of the video or picture signal amplifier 62, shown in Figure 1b.

By inspecting curve R of Figure 3, it will be observed that the undesired horizontal dark spot signal has now been completely removed, with the result that for each line element picture signals representative of gray (for example) in the picture have a fixed and definite value with no slope or deviation. The same is true for all other picture signals representing a predetermined light value within the same line element. It will, however, be observed that for each succeeding line element the average value of the picture or video signals does not remain fixed, and this deviation of the average value is a result of the undesired vertical dark spot signal component.

The present invention also includes the use of a vertical shading signal generator 172, which may be similar to the horizontal shading signal generator 160 except that it is supplied with impulses of vertical deflection frequency. Voltage variations of sawtooth and parabolic wave form are generated by the vertical shading signal generator, and these voltage variations are present at conductors 174 and 176. They are applied, respectively, to potentiometers 178 and 180 in order that their intensity may be controlled, and the combined vertical shading component is then present on conductor 182. Isolating resistors 179 and 181 are employed between the potentiometers and conductor 182. This conductor is connected to the movable arm of switch S-1 in order that the vertical shading signals may be applied to one or another point in the television system.

As shown in the drawing, switch S-1 is in the "clamp off" position (contact C11); however, when a clamping action is used, as will be described in this assumed operation, the vertical shading signals cannot be injected along with the horizontal shading signals since the clamping action of the automatic level setting circuit would immediately remove the vertical shading component by the clamping action unless the vertical shading signal component were "notched" or "slotted" at horizontal deflection frequency phased with the white level signal in order not to alter the intensity of the white level signal. If both the picture and the white level signals were altered in intensity by the vertical shading signal generator, this alteration would be removed by the clamp circuit, but if only the one or the other signal is altered, then a vertical shading effect can be produced. Inasmuch as "notching" or "slotting" of the vertical shading signal requires considerable complication of circuits, vertical shading has not in general been accomplished in this manner. Accordingly, the undesired variation in picture signal strength because of the vertical component of the dark spot signal will be removed by a manner later to be described, and for this purpose it will be assumed that the switch S-1 is in the "clamp on" position, i. e., cooperating with contact C12. Likewise, as indicated in the drawing, since switch S-1 and switch S-2 (see Figure 1b) are ganged together, the switch S-2 will also be in the "clamp on" position, i. e., cooperating with contact C22.

We now have picture signals corresponding to the curve shown at R in Figure 3 present at the input of the video or picture signal amplifier 62. These signals are then amplified, and are, in turn, applied to the control electrode of amplifier tube 64, and if an odd number of stages of amplification are included in the amplifier 62, then a signal variation similar to and having the same polarity as that represented by curve R of Figure 3 will be present at the anode of tube 64.

At this point in the circuit blanking impulses are combined with the signal series and, as previously described, the blanking impulses are obtained from the blanking pulse generator 88 and have a wave form such as indicated by curve F of Figure 3 (see also curve 90 of Figure 1b). These, when combined with the signals represented by curve R, produce a wave form such as indicated by the curve H of Figure 3. After the blanking impulses have been combined with the signal series, it may be seen that the intensity of the signals during the return time is at least equal to or greater than black in the picture signals. These picture signals are then applied to the control electrode of tube 92 by way of coupling condenser 186, contact C22 and switch S—2. Tube 92 performs a clipping action since the tube is biased to cut-off for signals extending in an excessive negative direction, and the potential applied to the control electrode of tube 92 is such that the voltage variations represented by curve H are clipped at the level indicated by the dotted line. It will be observed that this level changes for each line element, and this change of clipping level is brought about by reason of the action of the clamp or automatic level setting circuit which will now be described.

The clamp circuit includes four uni-directional current conducting paths 188, 190, 192 and 194. These paths may preferably be simple electron diodes, and in actual practice may constitute two separate duo-diodes such as, for example, tube type 6H6. In order that they may be more clearly represented they are shown in Figure 1b as separate diodes each having a cathode and an anode. The cathodes of diodes 188 and 190 are connected together, as are also the anodes of diodes 192 and 194. Each of the diode elements may be looked upon as separate arms of a bridge circuit, the entire combination operating as an electron switch connected across one diagonal of the bridge. For causing operation of the electron switch, potential variations of opposite polarity and of similar wave form are applied to the cathodes of diodes 188 and 190 and to the anodes of diodes 192 and 194. These voltage variations are derived from tube 200 which includes a cathode, a control electrode and an anode. The cathode of tube 200 is connected to ground, whereas the control electrode has applied thereto potential variations of horizontal deflection frequency, the potential variations extending in a positive direction and having a duration approximately corresponding to the return time of the scanning beam in the cathode ray image pickup or scanning tube. These voltage variations, represented by curve 201 in Figure 1b, are applied to the control electrode of tube 200 by way of coupling condenser 202, and the control electrode is connected to ground by the usual grid resistor 204.

The anode of tube 200 is maintained positive with respect to its associated cathode by the primary winding 206 of transformer 210, one end of the primary winding being connected to the

anode of tube 200 and the other to positive terminal 212 by way of resistance 214. The voltage variations present at the anode of tube 200 are such as those represented by curve 214 of Figure 1b, and these voltage variations induce a potential variation in the secondary winding 216 of transformer 210, having a similar wave form.

One end of the secondary winding 216 is connected to the cathodes of diodes 188 and 190, whereas the other terminal of the secondary 216 of transformer 210 is connected to the anodes of 192 and 194.

The anode of diode 188 and the cathode of diode 192 are connected together, and in turn are connected to the "clamp on" terminal of switch S—2 (contact C22) by way of conductor 218. The anode of diode 190 and the cathode of diode 194 are connected together, and in turn are connected to the movable contact 116 of potentiometer 112 by way of resistance 220. Since a negative potential is applied to the terminal 114 for biasing the control electrode of tube 92 when the switch S—2 is in a "clamp off" (contact C21) position, this same average negative potential will also be applied to the anode of diode 190 and to the cathode of diode 194.

When the switch S—2 is in the "clamp on" (contact C22) position, the biasing of the control electrode of tube 92 is effective insofar as the position of movable contact 116 is concerned only when a conducting path is established by the four diodes of the clamp circuit. This conducting path is present only for a short interval and for a time coinciding substantially with the return deflection of the scanning cathode ray beam.

In the operation of the clamp circuit, when voltage variations or impulses of horizontal deflection frequency are applied to the control electrode of tube 200, voltage variations such as represented by curves 222 and 224 will be present at the output terminals of the secondary 216 of transformer 210. These voltage variations are then applied respectively to the cathodes of diodes 188 and 190, and to the anodes of diodes 192 and 194. When these impulses are applied to these tubes, they are rendered conductive inasmuch as negative impulses are applied to the cathodes of diodes 188 and 190 and positive impulses are applied to the anodes of diodes 192 and 194. During this short conducting interval the charge present on condenser 186 is re-established to correspond to the position of the movable contact 116 along the potentiometer 112.

The action of this clamp circuit or automatic level setting circuit consists in re-setting the zero level of the video or picture signal to a desired value during each horizontal retrace period. As so far described, this value would be constant as determined by the position of the contact 116 along potentiometer 112. However, this value may be cyclically varied in synchronism with the vertical deflection of the cathode ray beam in order to effect a vertical shading of the picture signal series. Accordingly, a shading component may be superimposed upon the normal fixed potential determined by the position of the contact 116 along the potentiometer 112 to remove the undesired vertical component of the dark spot signal. The action of the clamp circuit will, therefore, eliminate additive signals of substantially lower frequency than one horizontal cycle, i. e., hum voltages, microphonics, and low frequency distortion in the amplifier. It also eliminates errors in low frequency re-

sponse and, in addition, its action stabilizes the amplifier tendency toward relaxation oscillations or bouncing.

The clamp circuit as described, in view of the fact that it is effective only during each horizontal retrace interval, cannot correct errors occurring between each horizontal return interval, since the clamp circuit is ineffective during each individual picture line interval. The amplifier, therefore, should have substantially zero phase shift or amplitude loss for all frequencies equal to or greater than the horizontal scanning frequency.

The provision of the transformer 210 is for the purpose of providing a floating triggering potential for the diodes of the clamp circuit and, furthermore, the transformer delays the pulse front so that the diode bridge conducts approximately at the center of the retrace period, i. e., at the center of the interval occupied by the white level signal. The diode bridge circuit which constitutes the clamp circuit must be balanced to prevent insertion of the clamping pulse itself into the picture signal series. This balance requires equal capacitances as well as equal resistances. The bridge capacitances (i. e., the capacitances of the diodes) become unimportant when the conductances of the bridge are low, which in turn requires a reasonably high pulse current in order to produce the necessary potential variations.

It will be further observed that the wave form represented at 222 and 224 of Figure 1b is somewhat rounded or sinusoidal rather than purely rectangular, and this sinusoidal condition is preferable in view of the fact that fewer high frequency components are present in the control potential series. The entire clamp circuit including the diode bridge or rectifier circuit produces its own cut-off potential, and this bias must be higher than the largest picture signal potential in order to maintain the bridge non-conductive between triggering impulses.

In order to remove the undesired vertical dark spot signal component present in curve R of Figure 3, the clipping level or clamp level is cyclically varied at vertical deflection frequency. This is accomplished by supplying the vertical shading signal by way of switch S-1 and contact C12 to the anode of diode 190 and the cathode of diode 194. The "clamp on" contact C12 of switch S-1 is, therefore, connected to ground by way of potentiometer resistance 228 and the movable contact 230 of the potentiometer is connected to these elements of diodes 190 and 194 by way of conductor 231 and coupling condenser 232. The resistance 220, referred to above, is included in the circuit in order to decouple the shading signal component from the black level setting of the potentiometer 112. The average potential applied to the anode of diode 190 and the cathode of diode 194 is, therefore, amplitude modulated in accordance with the vertical shading component and a portion of this amplitude modulation is represented by the solid line of curve S of Figure 3.

Inasmuch as the clamp circuit is effective only during the retrace interval, as explained above, the effective potential insofar as the coupling condenser 186 is concerned is such as that represented by the dash-dot line of curve S of Figure 3. Since the clamp circuit places a different base charge on coupling condenser 186 during each line return time interval, as determined by the vertical shading component, the clipping level is cyclically varied as indicated by the dot-

ted line in curve H of Figure 3, and when the signal is clipped by tube 92 along the dotted line shown in curve H, a resultant voltage variation is produced at the anode of tube 92 such as that represented by the curve K of Figure 3. By inspecting this curve, it may be noticed that the undesired vertical dark spot signal has been completely removed and the signals are related to a predetermined potential level with the result that signals representative of a predetermined light value have a predetermined and fixed intensity. Also, when the position of the movable contact 116 is properly adjusted, the signal strength of the signal series during the blanking interval has an intensity corresponding to black in the picture.

It will further be observed that signals representing those portions of the picture shown in Figure 6 that are black have a uniform level, as do also picture signals representative of gray or white. At this point in the circuit all of the undesired horizontal and vertical dark spot signal has been completely removed, and furthermore, all undesired signals occurring between line elements have been removed and the signals during these intervals have been brought to a level corresponding to black in the picture.

In Figure 1a of the drawing it will be noticed that the movable arm of the gain control 58 is mechanically connected to the movable arm of the vertical shading signal potentiometer 228. Such an interaction is desirable so that the intensity of the vertical shading signals as applied to the clamp circuit may be varied in accordance with the selected position of the gain control. Naturally if the over-all gain of the amplifier were increased the strength of the shading control signals should also be increased to maintain the same degree of shading. By coupling the two controls, it therefore eliminates the necessity of readjusting the shading potentiometer each time the gain or volume is altered.

It is then only necessary to introduce the synchronizing pulse series as represented by curve L in Figure 3, and this is accomplished in the anode circuit of tube 92 by the action of tube 122, as explained above. Accordingly, the series of signals present at the control electrode of tube 138 is such as that represented by the curve N in Figure 3, and this voltage variation includes synchronizing signals, black level signals, and picture signals properly related to a common base level in order that these signals may then be used to produce a picture on a television receiving tube or to modulate a radio frequency carrier for transmission, as explained above.

It may be seen from the above, therefore, that undesired dark spot signals may be removed or cancelled in a television transmitting system, and the picture signals may be related to a predetermined desired black level so that the transmitted picture signals will be properly representative of the light values of the optical image. When the television pickup tube is so operated that the mask 19 prevents any light from the lens system from reaching the tube walls, the white level signal will remain substantially constant. By adjusting the position and intensity of the back-lighting source 20, the intensity of the produced dark spot signal may be materially reduced and the remaining dark spot signal may be removed by inserting horizontal shading signals at a point in the system so that no undesired deviation in picture signal strength will be present for any particular line element. The undesired vertical

dark spot signal component may be removed by altering the clipping level through the use of a clamp circuit which operates during the white level signal interval (return time interval) to vary the clipping level in accordance with the required vertical shading component. The resultant picture signal series is, therefore, free from all undesired dark spot signal potentials and may be used to modulate a radio frequency carrier prior to transmission of the signals to remotely located television receivers. On the screen of the receiver a picture image will be reproduced which is truly representative of the proper light values of the original optical image.

Inasmuch as the white level signal does not vary in accordance with variations in the average light intensity of the masked image projected on the mosaic, it is not necessary to alter the shading signals in either intensity or wave form when the average light intensity of the mosaic electrode is changed, as, for example, during a change in the scene. Heretofore, whenever the average light intensity on the mosaic was changed due to "panning" or movement of the "iconoscope" camera or pickup tube, or due to a change in the light value of the object projected on the mosaic electrode, it has been necessary to alter the shading components since the dark spot signal did not remain fixed. With the present invention, as above described, these disadvantages are no longer present, and complete shading may be accomplished and maintained in a simple and convenient manner.

Suppression or blanking of the white level signal by the generator 46 and subsequent blanking by the generator 88 are both employed since the white level signal suppression is so adjusted to give exact black level, i. e., zero signal level, so that changes in the volume or gain control setting will not alter the black level. The second blanking produced by the generator 88 produces a signal strength during the return time interval such that a fixed clipping margin may be assured.

As stated above, a conventional vertical shading signal cannot effectively be inserted at the same point in the circuit where the horizontal shading is inserted if the clamp circuit or automatic level setting circuit is used, since the operation of the clamp circuit will remove the vertical shading. Insertion of both shading signals at the same point is possible if the vertical shading signal is slotted in order that the signal intensity of the white signal level during blanking will not be affected, but such slotting is inconvenient to produce. According to the above described method of operation, with switches S-1 and S-2 in the "clamp on" position, the vertical shading is accomplished by cyclically varying the clamp level to compensate for variations in signal strength of successive line elements due to the undesired vertical dark spot signal component. This is not the only manner in which vertical shading may be accomplished, and another method of producing the desired vertical shading will now be described.

Since the clamp circuit will effectively remove a vertical shading signal injected, for example, at the input of the amplifier 62, unless such shading is slotted, an effect similar to the slotting of the vertical shading may be accomplished by what would amount to a reverse situation in which the intensity of the white level signal impulses is varied to the exclusion of the intensity of the picture signals. This is accom-

plished by modulating the intensity of the white level signal suppression impulses, the modulation occurring cyclically for each vertical deflection and the degree of modulation being determined in accordance with the required amount of vertical shading necessary to compensate for the undesired vertical dark spot signal. The set of curves shown in Figure 4 represents the operation of the present invention under these circumstances, in which case switches S-1 and S-2 are positioned in a third position so that they will cooperate with contacts C13 and C23, respectively.

A series of picture signals will be generated by the television pickup tube similar to those represented by the curve B in Figure 4 when an image similar to that represented in Figure 6 is scanned and when a dark spot condition similar to that represented in Figure 5 is present. The effect of the dark spot signal will be apparent by an inspection of curve B of Figure 4. It will also be observed that the intensity of the white level signal is uniform, and this condition may be brought about by reason of the inclusion of the mask 19, as explained above.

Furthermore, the produced dark spot signal is reduced to a minimum by proper adjustment of the position and intensity of the back-lighting source 20.

In order to suppress the intensity of the white level signals and in order to inject a signal which will subsequently be effective toward the removal of the undesired vertical shading component, a voltage variation such as represented by the curve T in Figure 4 is injected in the anode circuit of tube 30. This signal is derived from the blanking signal generator 46 that normally supplies the signals for suppressing the white level signal, except that instead of the signals having a uniform intensity as represented at 48 in Figure 1a, their intensity is cyclically modulated by the desired vertical shading component which is supplied from the vertical shading signal generator 172 by way of switch S-1. These signals when applied to the blanking signal generator 46 are effective to modulate the intensity of the blanking or suppression signals so that their intensity will vary in a cyclic manner for each vertical deflection of the cathode ray beam. When these signals (which occur at line deflection frequency) are combined with the picture signals present in the anode circuit of tube 30, a resultant wave form will be produced similar to that represented by curve U in Figure 4. Here it may be seen that the dark spot signal remains in the signal series, but the intensity of the suppressed white level signal varies in a manner corresponding to the modulation of the blanking or suppression impulses derived from the blanking signal generator 46 (see curve T of Figure 4). These signals are then subjected to amplification by the video or picture signal amplifier 42 and by the tube 50.

At the output of tube 50 (i. e., at the input of the amplifier 62) a voltage variation will be present similar to that shown by curve U in Figure 4 except that the polarity will be reversed. At this point in the circuit the horizontal shading signal component is injected into the signal series, as was the case in the previously described conditions of operation, and the curves P of Figure 4 represent, for example, the necessary horizontal shading signal component. When the voltage variations represented by these curves are combined with the signal represented by curve

U of Figure 4, a resultant signal similar to that represented by curve V of Figure 4 will be produced, and this signal is then supplied to the video or picture signal amplifier 62. By an inspection of curve V, it will be seen that all of the horizontal dark spot signal has been removed, but the average intensity of each successive line signal varies in a cyclic manner in accordance with the undesired vertical dark spot signal. The cyclic variation of the intensity of the signals occurring during the horizontal beam return interval, however, is still present, this cyclic variation being a result of the injection of the modulated white level suppression signal in the anode circuit of tube 30. It is seen, however, from curve V that the suppressed white pulse level corresponds now to the black or zero level in each of the associated line signals.

After the signals are then amplified by the amplifier 62 and the amplifier tube 64, a waveform such as that represented by curve V in Figure 4 is present in the anode circuit of tube 64. Here the blanking impulses are inserted, as represented by curve F in Figure 4, and these impulses are derived from the blanking pulse generator 88. These impulses are of uniform intensity and their purpose, as explained above, is to alter the potential level of the signals during the beam return interval such that they correspond to an intensity exceeding black in the picture, this excess being inserted to depress ripples and noise signals below the black level so that they may be clipped off by tube 92. The injection of the blanking impulses then results in the formation of a signal such as that represented by the curve W of Figure 4.

Voltage variations such as represented by curve W are then supplied to amplifier tube 92 by way of coupling condenser 186, since, as explained above, switch S-1 and S-2 are in contact with terminals C-13 and C-23, respectively. With switch S-2 in this position, the clamp circuit is then effective but no modulation of the clamping level is employed and instead the anode of diode 190 and the cathode of diode 194 are maintained at a substantially uniform potential determined by the position of the movable contact 116 along the potentiometer 112. Inasmuch as the clamp circuit is effective only during the beam return time interval, the signal applied to the control electrode of amplifier tube 92 will be clipped at a level indicated by the dotted line associated with curve W in Figure 4, which line, it will be observed, always lies a predetermined distance from the signal generated during the beam return time interval. This distance is equal to the height of the blanking pulses shown in curve F when a true black level is desired. This results in clipping the signal series at a uniform level corresponding to black in the picture, assuming, of course, that the position of the contact 116 is properly adjusted.

After the signal has been clipped at this level, the resultant signal present in the anode circuit of tube 92 will then be similar to that represented by curve K of Figure 4. By inspecting this curve it will be observed that not only is the horizontal dark spot signal removed, but the vertical dark spot signal has also been eliminated by action of the level setter or clamp circuit and the clipping action of tube 92, the clipping level being altered in accordance with variations in signal strength during the blanking or beam return time interval. Picture signals representative of black in the picture are, therefore, brought to

the same potential level and the intensity of the signals during the blanking interval has a value representative of black.

At this point in the circuit, i. e., in the anode circuit of tube 92, the synchronizing signals as represented by curve L of Figure 4 are inserted, and these when combined with the signals represented by curve K produce a composite series of signals as shown by curve N of Figure 4. This composite series of signals includes not only the picture signals, but also the blanking signals and synchronizing signals, the latter extending in the direction of blacker-than-black and having an intensity greater than any picture signals. These signals, as explained above, may then be used directly to control the intensity of the cathode ray beam in a television picture tube, or they may be used to modulate a radio frequency carrier.

It may be seen, therefore, that the vertical shading component may be introduced ahead of the level setting circuit, provided the vertical shading component is introduced as a variable intensity signal impulse effective only during the blanking interval as represented by the curve T in Figure 4. As explained above, if the vertical shading is introduced as a continuous voltage variation effective not only during the blanking impulse time but also during the picture signal interval, this vertical shading component will remove the tilt of curve V in Figure 4 but will again be removed by the clamp circuit or level setting circuit. By, in effect, serrating the vertical shading component so that this component affects the signal strength only during the blanking interval, vertical shading may then effectively be introduced. Conversely, it is also possible to similarly insert vertical shading by affecting or altering the intensity of the picture signals only at the output of tube 30, for example, without affecting the intensity, i. e., displacing the "iconoscope" blanking impulses or white level signals. This latter method of shading is not entirely preferred, however, since the variable intensity shading impulses are then effective during the transmission of picture signals, and it is preferable not to inject any correction signal during this interval if the same correction may be accomplished by introducing a voltage which is effective during times other than those intervals occupied by the picture signals, as, for example, during the blanking interval.

A still further and different method of compensating the undesired vertical dark spot may also be exercised by applying a control potential directly to the collector electrode of the television pickup or scanning tube. This method of vertical shading will now be described, and in its description it will be assumed that the switches S-1 and S-2 are in position to engage contacts C-14 and C-24, respectively.

It has been found that, as stated above, the generated dark spot signal may be materially reduced in its inception by proper adjustment of the intensity and position of the back-lighting source 20. When the back-lighting source is properly adjusted, the amount of necessary vertical and horizontal shading is reduced to a minimum. A vertical shading correction may, therefore, be effected by modulating the potential of the collector electrode with respect to the mosaic electrode. When such a modulation potential is applied thereto, and when a mask such as shown at 19 is used in conjunction with the television pickup tube, the vertical shading correction so

introduced will then be sufficient to produce the desired results for virtually any lighting condition since no light from the object per se is permitted to strike the photosensitized walls of the television pickup tube. The differential potential between the collector electrode and the mosaic electrode in a television transmitting tube is normally relatively low, and is of the order of a few volts. Any modulating potential that can be applied to the collector electrode must, therefore, be of relatively low potential if the television pickup tube is to continue to operate in a satisfactory manner.

In Figure 1a, the television pickup or camera tube 10 includes an electron gun structure which comprises a source of electrons or cathode, a control electrode and various accelerating electrodes. In normal practice, the second accelerating electrode is generally maintained at ground potential, whereas the cathode of the electron gun structure is maintained at a negative potential with respect to ground. The second accelerating electrode 240 in Figure 1a, instead of being directly connected to ground, is connected to ground by way of resistance 242 and condenser 244. The resistance 242 and condenser 244 are included in this connection in order that the second accelerating electrode 240, which also functions as a collector electrode, may be potentially modulated at vertical deflection frequency.

For accomplishing this purpose, vertical shading signals as derived from the vertical shading signal generator 172 are applied to the switch S—1 by way of potentiometers 178 and 180. With the switch S—1 in position C—14, these signals are then applied to the conductor 246 and in turn to a phase inverter 248. The output from the phase inverter is then connected to the collector electrode or second accelerating electrode 240 of the television scanning or pickup tube. The phase inverter 248 is necessary since the polarity or direction of voltage change of the vertical shading signals as present at switch S—1 is opposite to that which is required if vertical shading is to be accomplished by an application of appropriate voltage variations to the collector electrode of the television pickup tube. The phase inverter, therefore, amounts to no more than any simple or convenient means for reversing the polarity or phase of the vertical shading signals.

Since, as stated above, the differential potential between the collector electrode 240 and the mosaic electrode 12 of the television pickup tube 10 is quite low, it is preferable that the modulating potentials as applied to the collector electrode not exceed one volt maximum (peak-to-peak). If the back-lighting source 20 is properly positioned and regulated in intensity, the residual or remaining dark spot signal will be so small that a voltage of even considerable less than one volt will be sufficient to effect the desired vertical shading (i. e., the elimination of the vertical dark spot signal) in the television picture signal series.

By modulating the potential of the collector electrode, the efficiency of the television pickup tube may be affected, and since the potential applied to the collector electrode varies cyclically at vertical deflection frequency, the efficiency of the television pickup tube is caused to vary cyclically in the same manner and at the same rate. At the beginning of the vertical deflection cycle for each individual field, the efficiency of the television pickup tube is slightly decreased,

whereas at the end of each vertical deflection cycle the efficiency of the television pickup tube is increased.

The picture signals produced at the signal plate 12 of television pickup tube 10 will, therefore, be compensated for the vertical dark spot with the result that no vertical shading need be added at any succeeding point in the system. The horizontal shading or the variation in light response in a horizontal direction has not at this point in the circuit been accomplished, with the result that horizontal shading signals must be injected at a later time.

The picture signals so generated, which are free of any undesired vertical dark spot signal, are then applied to the video signal pre-amplifier 28 and to the succeeding amplifiers 30, 42, and 50. At this point in the circuit the horizontal shading signal is injected in order to compensate for the horizontal dark spot signals so that the picture signals as applied to the amplifier 62 are then free of any dark spot signal.

No set of curves has been included in the drawings to represent the operation of the system under these conditions, since it is not believed that such would be necessary. The signal generated by the television pickup tube 10 with the collector electrode 240 modulated to compensate for the vertical dark spot would be similar to that represented by curve B of Figure 4, except that the white level signal would have a constant amplitude and the signal may have a small vertical sawtooth component due to capacity coupling between the collector electrode 240 and the mosaic electrode 12. This component would, however, be damped out. This signal contains no vertical dark spot component, and the curves shown at P in Figure 4 represent the horizontal shading component injected at the cathode of tube 50. The wave form at the picture signal amplifier 62 of Figure 1b would, therefore, be substantially the same as curve V in Figure 4 except for a constant white pulse residual since the white level suppression impulses injected at the output of tube 30 are, in this case, of constant amplitude. At this point in the circuit both the horizontal and the vertical dark spot signals will have been removed by the above described means. The usual blanking pulse is then inserted at the anode of tube 64, and, as a result, a series of signals will be generated corresponding to curve W of Figure 4 with the above exception.

Under conditions when the vertical dark spot signal is to be removed by a slight modulation of the potential of the collector electrode 240, the switches S—1 and S—2 are positioned to cooperate with contacts C—14 and C—24, as stated above. With switch S—2 in position to contact terminal C—24, the black level setting is then under control of the position of the movable contact 116 along the potentiometer 112. Adjustment of this potentiometer determines the black level setting of the television system.

The circuit also includes the automatic level setting diodes 188, 190, 192 and 194. These diodes, as described above, control automatically the black level, and since there is no modulation of the potential applied to the anode of diode 190 and to the cathode of diode 194, the clipping level will be determined solely by the position of the movable contact along the potentiometer 112. Vertical shading signals under the presently assumed conditions are not applied to the clamp circuit by way of condenser 232

since the switch S—1 is in position to cooperate with contact C—14. The automatic level setting circuit, therefore, performs a clipping action, as represented by the curve W in Figure 4, the signal series being clipped at a predetermined value above the peak black signals occurring during the horizontal blanking interval. As described above, the automatic level setting circuit or clamp circuit is effective only during the initial portion of each blanking interval.

Accordingly, the signal present at the anode of tube 92 will be similar to that represented by curve K in Figure 4, and when the synchronizing signals as supplied by tube 122 are injected into the anode circuit of tube 92, a composite series of blanking, synchronizing and picture signals will then be produced similar to the curve shown at N in Figure 4.

By means of this last described method of operation, it may now be appreciated that the vertical dark spot signal may be effectively eliminated by modulating the potential of the collector electrode within predetermined limits. When the vertical dark spot signal is so removed, no further vertical shading is necessary and for all purposes it may be assumed that the television pickup tube produces no undesired vertical dark spot signal.

Three separate methods have, therefore, been described for producing dark spot signal correction in a vertical direction, these being, respectively, the modulation of the automatic level setting circuit or clamp circuit, the modulation of the blanking or suppression impulses applied to the anode of tube 30, and the modulation of the potential of the collector electrode 240 of the television pickup tube. In each case, the horizontal shading component is injected in the same manner to compensate for the undesired horizontal dark spot signal, this shading signal being injected at the cathode of tube 50, for example. In order to cause the system shown in Figures 1a and 1b to function in accordance with one or another of the three described methods of operation, it is merely necessary to appropriately adjust the position of the switches S—1 and S—2.

Irrespective of the particular method used for compensating for the undesired vertical dark spot signal, the dark spot signal may be reduced to a minimum by proper adjustment of the position and intensity of the back-lighting source 20. Furthermore, by using the mask 19 to prevent light from the image from striking the tube wall, the necessary dark spot correction may be maintained substantially uniform irrespective of picture light intensity since the light from the object or picture to be transmitted is projected only upon the mosaic electrode or target electrode 12 of the television image pickup or camera tube. Unless this is done, the amount and distribution of light which is permitted to fall upon the tube wall (which is inherently photosensitive) will vary in accordance with the over-all light value of the subject being televised, and when such a variation takes place, the intensity and wave shape of the dark spot signals vary correspondingly. If the mask 19 is not used and light is permitted to strike the inside of the tube wall, then a new setting of both the horizontal and vertical shading signal generators and their associated potentiometers is required for each change in the scene since a new shading signal must be generated to compensate for the new and different dark spot signal. With the mask

19 positioned in the camera, the dark spot signal does not vary with picture light content, with the result that no alteration in the horizontal or vertical shading signal generators or their associated potentiometers is necessary, even though the light value of the subject being televised may change considerably as, for example, in outdoor pickups where the camera is moved to include more or less of the sky.

Although the present invention is described somewhat in detail, it is conceivable that various alterations and modifications may be made therein without departing from the spirit and scope thereof, and it is desired that any and all such alterations and modifications be considered within the purview of the present invention.

Having now described my invention, what I claim as new and desire to have protected by Letters Patent is:

1. A television transmitting system including a television pickup tube of the electron storage type having a light responsive electrode on which an optical image may be projected, means for scanning the light responsive electrode to produce image signals which inherently include undesired dark spot signals, means for amplifying the produced image and dark spot signals, an electron switching circuit, means for operating the electron switching circuit at line scanning rate for re-setting the zero level of the amplified signals to a predetermined average voltage level, means for cyclically altering the voltage level at field scanning rate, thereby to eliminate at least a portion of the undesired dark spot signals, and common means for varying the degree of amplification and for varying the degree of cyclic alteration of the voltage level.
2. A television transmitting system including a television pickup tube of the electron storage type having a light responsive electrode on which a charge image is produced in response to the projection thereon of an optical image, means for scanning the light responsive electrode to produce video signals which inherently include undesired dark spot signals, a capacity coupled amplifier for amplifying the produced video and dark spot signals, a pair of shading signal generators for generating two series of shading control voltages, means for combining one series of shading control voltages with the amplified signals thereby to eliminate a portion of the undesired dark spot signals, an electron switching circuit responsive to impulses of line scanning frequency for re-setting the black signal level of the amplified signals to a predetermined average voltage level, means responsive to the other series of shading control voltages for cyclically altering the voltage level at field scanning frequency, thereby completely to eliminate the remaining portion of the undesired dark spot signals, and jointly operated control means for varying the degree of amplification and for varying the degree of cyclic alteration of the voltage level so that the undesired dark spot signals may be substantially completely removed irrespective of the degree of amplification of the signals.
3. A television transmitting system including a television pickup tube of the electron storage type having a light responsive mosaic electrode upon which an optical image may be projected, means to scan the mosaic electrode by a cathode ray beam to produce image signals which include undesired vertical dark spot signals, means including a capacity coupled amplifier for amplifying the produced image and dark spot signals,

an electron switching circuit responsive to impulses of horizontal scanning frequency for re-setting the zero level of the amplified signals to a predetermined average base voltage level, a vertical shading signal generator for generating compensating shading signals for eliminating the undesired vertical dark spot signals, and means for cyclically altering the base voltage level to which the amplified signals are re-set by the generated vertical shading signals thereby to substantially eliminate the undesired vertical dark spot signals.

4. A television transmitting system including a television pickup tube having a light responsive electrode on which an electrostatic charge image is produced in response to the projection thereon of an optical image, means to repeatedly scan the target electrode by a cathode ray beam along a succession of substantially parallel lines in order to produce a succession of line image signals interspersed with white level signals that occur during the scanning beam return time interval, said image signals including undesired vertical dark spot signals, means for suppressing the interspersed white level signals by a predetermined cyclically varying amount, the amount determined in accordance with the extent of the undesired vertical dark spot signal, means to amplify the line image signals and the variably suppressed white level signals, and means to shift the alternating current axis of the amplified signals in accordance with the intensity of the variably suppressed white level signals to thereby effectively remove the undesired vertical dark spot signal.

5. A television transmitting system including a television camera tube having a light responsive electrode on which an electrostatic charge image is produced in response to the projection thereon of an optical image, means to scan the target electrode by a cathode ray beam in bi-dimensional directions at different rates in order to produce a succession of line image signals interspersed with white level signals that occur during the scanning beam return time interval, said line image signals including undesired vertical dark spot signals, means for suppressing the interspersed white level signals by a predetermined cyclically varying amount, the amount determined in accordance with the extent of the undesired vertical dark spot signal, means to amplify the line image signals and the variably suppressed white level signals, a further amplifying tube including a control electrode, means to apply the amplified signals to said control electrode, a source of biasing potential, an electron switching circuit connected between said control electrode and said source of biasing potential, and means for rendering said switching circuit effective to connect said control electrode to said source of biasing potential during the variably suppressed white level signal intervals so that the alternating current axis of the amplified signals may be shifted in accordance with the intensity of the variably suppressed white level signals to thereby effectively remove the undesired vertical dark spot signal.

6. A television transmitting system including a television camera tube of the electron storage type having a light responsive electrode on which an electrostatic charge image is produced in response to the projection thereon of an optical image, means to scan the target electrode by a cathode ray beam in bi-dimensional directions

at different rates in order to produce a succession of line image signals interspersed with white level signals that occur during the scanning beam return time interval, said line image signals including undesired horizontal and vertical dark spot signals, means for suppressing the interspersed white level signals by a predetermined cyclically varying amount, the amount determined in accordance with the extent of the undesired vertical dark spot signal, means to amplify the line image signals and the variably suppressed white level signals, a horizontal shading signal generator for producing voltage variations in accordance with the intensity of the undesired horizontal dark spot signal, means to combine the horizontal shading signal with the amplified line picture signals, a further amplifying tube including a control electrode, means to apply the amplified signals to said control electrode, a source of biasing potential, an electron switching circuit connected between said control electrode and said source of biasing potential, and means for rendering said switching circuit effective to connect said control electrode to said source of biasing potential during the suppressed white level signal intervals so that the alternating current axis of the amplified signals may be shifted in accordance with the intensity of the variably suppressed white level signals to thereby effectively remove the undesired vertical dark spot signal whereby the undesired vertical and horizontal dark spot signals may both be removed from the produced image signals.

7. A television transmitting system including a television pickup tube having a light responsive target electrode upon which an electrostatic charge image is produced when an optical image is projected thereon, means to scan the target electrode by a cathode ray beam to produce a succession of line image signals interspersed with white level signals corresponding to the scanning beam return time interval, said image signals also including undesired vertical dark spot signals, a vertical shading signal generator for producing voltage variations to compensate for the undesired vertical dark spot signals, means for suppressing the interspersed white level signals, the degree of suppression being cyclically varied in accordance with the generated vertical shading signals, means for amplifying the line image signals and the variably suppressed white level signals, and means for re-setting the black signal level of the amplified line picture signals to a predetermined voltage level in accordance with the intensity of the variably suppressed white level signal to thereby effectively remove the undesired vertical dark spot signal.

8. A television transmitting system including a television pickup tube having a light responsive target electrode upon which an electrostatic charge image is produced when an optical image is projected thereon, means to scan the target electrode by a cathode ray beam in bi-dimensional directions at different rates to produce a succession of video signals interspersed with white level signals corresponding to the scanning beam return time interval, said video signals also including undesired horizontal and vertical dark spot signals, a vertical shading signal generator for producing voltage variations to compensate for the undesired vertical dark spot signals, a horizontal shading signal generator for producing voltage variations to compensate for the undesired horizontal dark spot signals, means for sup-

pressing interspersed white level signals, the degree of suppression being cyclically varied in accordance with the generated vertical shading signals, means for amplifying the video signals and the variably suppressed white level signals, means to combine the generated horizontal shading signals with the amplified video signals thereby to compensate for the undesired horizontal dark spot signal, and a further amplifier including an electron switching circuit for re-setting the zero signal level of the amplified video signals to a predetermined voltage level in accordance with the intensity of the immediately preceding suppressed white level signal to thereby effectively remove the undesired vertical dark spot signal whereby both the horizontal and vertical undesired dark spot signals may be effectively removed.

9. A television transmitting system in which image signals and undesired dark spot signals are produced simultaneously, comprising means including an amplifier for amplifying the produced signals, an electronic switching circuit for re-setting the zero level of the amplified signals to a predetermined average base voltage level at predetermined spaced intervals corresponding to the line deflection rate, and means for cyclically altering the base voltage level to which the amplified signals are re-set thereby to eliminate a portion of the undesired dark spot signal, the

cyclical variations corresponding to the field deflection rate.

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