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2,463,038

DIRECT CURRENT INSERTION CIRCUIT

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Fig. 1.

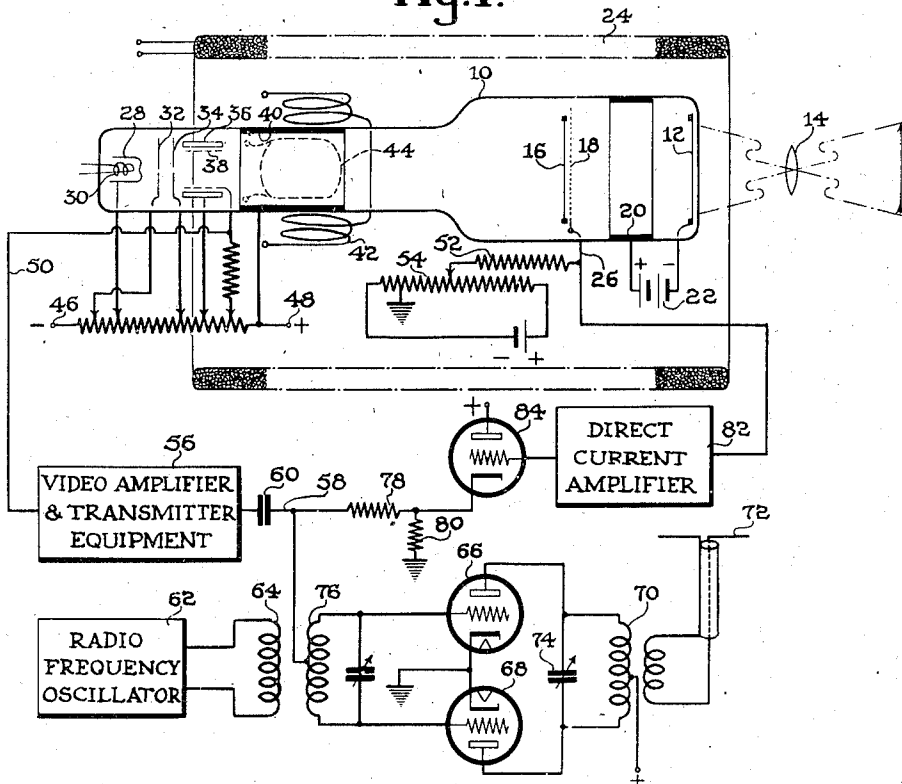
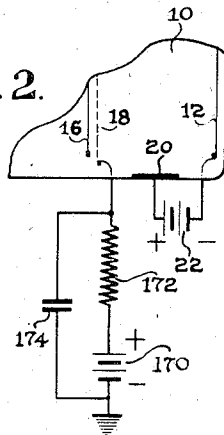


Fig. 2.



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2,463,038

DIRECT CURRENT INSERTION CIRCUIT

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2 Claims. (Cl. 178—7.2)

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This invention relates to an improvement in television transmitting systems and is a division of my U. S. patent application Serial No. 543,666, filed July 6, 1944. More particularly, this invention relates to an improvement in the operation of a television transmitter wherein a television image pickup tube of the "Orthicon" or low beam velocity type is employed.

As is well known to those skilled in the art, a television transmitter includes, broadly, a television pickup or camera tube or translating device for converting an optical image into a series of electrical or video signals, with means for amplifying or increasing the intensity of the produced electrical or video signals. After the signals have been amplified, they are then used to modulate a radio frequency carrier in order that they may be transmitted to remotely located receivers. Simultaneously with the transmission of the video signals, synchronizing impulses are transmitted for maintaining the required degree of synchronous operation between the transmitter and receivers.

The television pickup tube may be of various types, but so far as the present invention is concerned, television image pickup tubes of the "Orthicon" or low beam velocity type will be considered. Such tubes generally include a light responsive surface upon which an optical image is projected in order that photoelectrons are caused to be emitted from the light responsive surface as a function of the light intensity directed thereon. These photoelectrons are then brought to focus upon an additional electrode where an electrostatic charge image is produced and which is an electrical replica of the optical light image.

This electrostatic charge image is then scanned by a cathode ray beam at low velocity in order to produce the television image signals and in order that the charge image may be cancelled or partially cancelled prior to the next scanning cycle.

The velocity of the electrons forming the scanning cathode ray beam is generally low or substantially zero at the mosaic or target electrode and is generally so arranged that in the absence of a positive charge on the target electrode, very few or none of the electrons of the scanning cathode ray beam are permitted to reach the target but are returned to an electrode within the "Orthicon" tube. When a positive charge image is present on the target electrode or on any portion thereof, a certain number of the electrons constituting the cathode ray beam are permitted to strike the target electrode to neutralize the charge condition at the particular area, with the

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result that the number of electrons that are returned to a collector electrode within the tube is less than the total number constituting the generated cathode ray beam. The "Orthicon" may also include one or more stages of electron multiplication in order that the intensity of the produced image signals may be increased within the "Orthicon" tube, per se.

Due to the construction of the "Orthicon" tube, which will be explained in more detail later, a direct current component of the television image signals is generated, and this direct current component is a function of the average brilliance or light intensity of the optical light image projected on the television pickup tube. Since the direct current component is a function of average light intensity, this component may then be used and corresponds to the proper direct current component that should be associated with the television image signals in order that proper automatic background control may be made available at the television receiver.

Heretofore the transmission of the direct current component has been brought about by relatively complex circuit arrangements included at one or more points in the television transmitter. The transmission of the direct current component is highly desirable in order that the average brilliance or intensity of the produced television image at the receiver may be properly controlled. In the above referred to parent patent application, a very simple arrangement is described in detail whereby the transmission level may be conveniently controlled in accordance with the direct current component, and in accordance with the average intensity of the optical light image without the necessity of using involved direct current insertion circuit arrangements at various points in the transmitter intermediate, the pickup tube and the modulator.

For optimum operation of a television pickup tube of the "Orthicon" type, it is frequently desirable to alter the average potential of the target electrode in accordance with the light conditions in order that the sensitivity of the tube may be maintained at a desired level. In previous operations of television pickup tubes of the "Orthicon" type, an adjustment has frequently been provided whereby the average potential of the target electrode may be changed manually in accordance with the lighting conditions, but, in the present invention a circuit arrangement has been provided whereby this average potential may be altered automatically in accordance with the prevailing light conditions and inten-

sities. By reason of such an automatic variation in the average potential of the target electrode, the television pickup tube may then be operated at or near its optimum condition at all times regardless of the average intensity of the optical light images projected on the light responsive surface of the pickup tube.

The purpose of the present invention, therefore, resides in the provision of a circuit arrangement whereby the average potential of the target surface in a television pickup tube may be automatically altered in accordance with the prevailing light conditions in order to maintain optimum operation of the television pickup tube.

Various other purposes and advantages of the present invention will become more apparent to those skilled in the art from the following detailed description, particularly when considered in connection with the drawings, wherein like reference numerals represent like parts, and wherein:

Figure 1 represents one form of the present invention for transmitting the direct current component of the television image signals; and

Figure 2 shows a form of the present invention whereby the average potential of the target electrode of a television pickup tube may be altered in accordance with the prevailing light intensity conditions.

Referring now to the drawing, and particularly to Figure 1, thereof, there is shown as illustrative of the operation, a television pickup tube 10 of the "Orthicon" type. Such a tube may be of the general type disclosed in U. S. Patent No. 2,403,239 issued to Albert Rose, and entitled "Target electrode for electron discharge devices." In the embodiment herein shown the tube may be assumed to include a light responsive surface 12 positioned on the inside of the tube and, in some cases, on the inside surface of the end wall of the tube. An optical light image is focused upon the light responsive photoelectric surface 12 by means of an appropriate lens system 14 in order that photoelectrons may be emitted from the light responsive surface in accordance with the light intensity of the optical light image. The television pickup tube also includes a target surface 16 which may be in the form of an extremely thin glass diaphragm or plate having a predetermined degree of electrical conductivity. Located between the target electrode 16 and the light responsive surface 12, and generally quite adjacent the target surface 16, is a fine wire mesh screen 18. For accelerating the photoelectrons liberated from the light responsive surface 12 in the direction of the target surface 16 and wire mesh screen 18, an accelerating ring or anode 20 is provided. This ring may be in the form of a conducting coating positioned on the inside wall of the television pickup tube. The accelerating ring 20 is maintained at a positive potential with respect to the light responsive surface 12 by means of a source of potential 22.

For maintaining proper focal condition of the photoelectrons, and for assisting in maintaining proper focus and direction of travel of an electron beam generated in the opposite end of the tube, an electromagnetic winding 24 is provided which surrounds substantially the entire television pickup tube in order to produce an electromagnetic field extending in a direction parallel to the axis of symmetry of the tube. This coil is generally located as close as conveniently possible to the television pickup tube and has a length corresponding to approximately the entire length of

the tube. The electromagnetic field produced by the coil 24 (which may be energized from any appropriate but not illustrated direct current source) causes the photoelectrons that are emitted from the light responsive surface 12 to remain in a properly focused condition as they are projected from the surface 12 to the wire mesh screen 18 and the target electrode surface 16.

The accelerating potential applied to the conducting ring 20 is of such a magnitude as to move the photoelectrons released from the surface 12 at a velocity such that the electrons are projected through the mesh screen 18 and impinge upon the target surface 16. Their impact velocity at the target surface 16 is sufficient to produce secondary electrons in a ratio of about three to one arriving primary electron and these produced secondary electrons are then collected by the mesh screen 18 to produce a current in a circuit associated with the mesh screen. The production of the secondary electrons at the target surface 16 causes a positive charge to be produced on the surface of the thin target membrane 16 that is adjacent the mesh screen. Inasmuch as an optical image is projected on the light responsive photoelectric surface 12, and since the emitted photoelectrons are brought to focus upon the surface of the very thin target membrane 16, the distribution of the positive charge image on the surface of the target 16 will be in accordance with the distribution of light intensity over the image area at the light responsive surface 12.

The glass or other material of which the very thin membrane 16 is composed has a predetermined small amount of conductivity and inasmuch as the membrane is very thin, this positive charge image will appear on the opposite side of the target surface 16, i. e., the side adjacent the electron gun structure of the "Orthicon." The charge image is, however, not diffused in a lateral direction in view of the fact that the thin membrane has an appreciable lateral resistance component, and by reason of its very much reduced thickness (of the order of a few microns), this resistance component is not materially effective in preventing the transfer of the charge from the one side to the other. Secondary electrons which are collected by the mesh screen 18 are conducted from the "Orthicon" along conductor 26.

The opposite end of the "Orthicon" television pickup tube includes an electron gun structure having a cathode 28, with which is associated a heater element 30. A control electrode 32 is positioned adjacent the cathode and next adjacent the control electrode is a screen grid 34 which functions as an initial accelerating electrode and also as the first stage of a secondary electron multiplier. Following the screen electrode 34 is a cylindrical electrode 36 which is the first anode of the electron gun structure, and which also constitutes the second stage of an electron multiplier. Located within the cylinder 36 is a cylindrical grid 38 for collecting secondary electrons from the final stage of the multiplier, as will be later explained.

The second anode 40 of the electron gun structure may preferably be in the form of a conducting coating on the inside surface of the tube, and by reason of the relative potentials of the first anode 36 and the second anode 40, the generated cathode ray beam may be brought to focus at the plane of the target surface 16, assisted by the field produced by coil 24. For deflecting the generated cathode ray beam in mutually perpendicular directions, horizontal de-

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deflecting coils 44 and vertical deflecting coils 42 are provided. These coils are energized from appropriate deflection generators (not shown) by a wave form necessary to produce the desired linearity of deflection. The deflection of the cathode ray beam takes place within the boundaries of the produced electromagnetic deflection fields, and after the beam emerges from these fields it is then projected linearly through the tube along a path parallel to the axis of symmetry of the tube so that the cathode ray beam impinges upon the target surface 16 at an angle normal to that surface.

For maintaining proper relative potentials between the electrodes of the electron gun structure, a source of potential may be applied to terminals 46 and 48 between which a potentiometer or "bleeder" is connected. By adjusting the point of contact of the various electrodes along this bleeder or potentiometer, proper potentials may be applied to the various electrodes relative to each other.

In operation, the acceleration of the generated cathode ray beam is such that it is directed at the target surface 16 at a relatively low velocity, and the target surface 16 is operated at a potential negative with respect to the second anode 40. In view of this differential potential, the scanning cathode ray beam undergoes a deceleration in the region between the second accelerating anode and the target surface 16, and the potentials are so adjusted that in the absence of a charge image on the surface 16, a majority or possibly all of the electrons constituting the scanning cathode ray beam are brought to zero velocity at the surface of the target or just prior to reaching the surface. The electrons are then re-attracted by the second anode, and retrace the previously travelled path to finally impinge upon the surface of the screen electrode 34 that faces the target area.

Due to the fact that the electrons that are returned from the target surface do not remain in exact focal condition and do not retrace exactly the same path, these electrons will not, in general, pass through the aperture in the screen electrode 34 and upon striking the surface of this electrode, secondary electrons will be generated. These secondary electrons are then attracted by the first accelerating anode 36, and the acceleration is sufficient to again produce secondary electrons on the inside surface of the cylindrical electrode or first accelerating anode 36. These potential differences are generally so regulated that the ratio of secondary electron emission at both the screen grid 34 and the first anode 36 is of the order of four or five to one. The secondary electrons produced on the inside surface of the first anode 36 are then collected by the cylindrical grid structure 38 where they are conducted from the tube along conductor 50.

When an optical image is projected on the light responsive surface 12, as explained above, an enhanced electrostatic charge image will be produced on the target surface 16 by reason of the production of secondary electrons. Since secondary electrons are produced at the surface 16, the electrostatic charge image will be positive, with the result that the positively charged elemental areas of the target surface 16 will assist in attracting electrons constituting the scanning cathode ray beam to the surface 16.

Since these electrons arrive at very low velocity, no secondary electrons are generated as a result of the impinging scanning beam electrons,

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but the attracted electrons of the beam will operate to neutralize or counteract the positive charge present over the areas traversed by the beam. This cancellation results in an absorption of a certain number of the electrons constituting the cathode ray beam with the result that the electrons that are permitted to return along the scanning beam path are reduced in number in proportion to the intensity of the charge image so that fewer electrons strike the first secondary electron emissive surface 34.

Since the distribution of the positive charge image on the target surface 16 is in accordance with the light distribution over the optical image, a different number of electrons will be absorbed from the scanning cathode ray beam as the beam traverses the target area which will result in a current modulation of the electrons that are returned to the screen electrode 34. By reason of the secondary electron multiplier action, this current modulation is amplified, and since the current modulation is a function of the charge image present on the target electrode 16, amplified television image signals are present on conductor 50. It is not necessary that the secondary electron multiplier be included in the television pickup tube since image and video signals could be derived directly from the screen electrode 34, in which case an isolating resistance would be included in the conductor for applying the desired potential to this electrode.

In accordance with the above described operation of the "Orthicon" tube, television image signals may be obtained from conductor 50 and a variable direct current is present on conductor 26 by reason of changes in the average light intensity of the optical image projected on the light responsive surface. The fine mesh screen 18 is connected by way of a resistance 52 to the movable terminal of a potentiometer 54, and a low potential difference is applied to the ends of the potentiometer resistance. This adjustment is provided in view of the fact that for optimum operation of the television pickup tube, the average potential of the mesh screen 18 should be slightly altered in accordance with the average lighting conditions and should, for example, be operated at something of the order of 0.5 volt negative for very bright scenes to 1.0 volt positive for very dim scenes. This slight change in the average potential of the fine mesh screen 18 may be looked upon as a fine or vernier adjustment of the beam velocity at the vicinity of the target surface 16, and determines the average number of electrons removed from the scanning beam by the target surface.

Since the electron current flow from the fine mesh screen 18 is a function of the average light intensity, this current may form a basis of and corresponds to the direct current component of the television image signals. This direct current component may be conveniently used to control the transmission level from the television transmitter thereby affording an accurate reinjection of the direct current component of the television signals.

Figure 1 of the drawing shows schematically a video signal amplifier and transmitting equipment 56 which includes apparatus for affording the desired signal blanking, synchronizing signal insertion and other desired components to the television image signals series, as is well known to those skilled in the art. The signals available at the output of the apparatus shown generally at 56, therefore, corresponds to those which are

normally used to modulate the television transmitter, except that no attempt has been made in the video amplifier and transmitting equipment 56 to accurately carry through the direct current component. The output from the video amplifier 56 is available at conductor 58 by way of coupling condenser 60.

A radio frequency oscillator 62 is also schematically shown for supplying radio frequency energy at the desired carrier frequency, and this radio frequency energy is applied to the primary winding 64 of a radio frequency transformer. The circuit arrangement also includes modulator tubes 66 and 68 which are operated in push-pull, and the anodes of these tubes are connected to radio frequency output transformer 70, the secondary of which is connected to an appropriate television transmitting antenna 72, or where desired, communication channel such as a co-axial line. The load inductance associated with the anodes of the modulator tubes 66 and 68 is tuned to the desired carrier by means of variable capacitance 74 or other suitable means, and the inductive member connected to the transmitting antenna 72 is naturally coupled to the inductance of this tuned circuit. The control electrodes of the modulator tubes 66 and 68 are connected to opposite ends of the secondary winding 76 of the radio frequency transformer in order that radio frequency energy may be applied to these control electrodes in an out-of-phase relationship. The midpoint of the secondary winding 76 is connected to ground or to an appropriate potential by means of resistances 78 and 80, these resistances, in series, operating as grid resistances for the modulator tubes 66 and 68.

The television video signals available from conductor 58 are applied to the center tap of the tuned grid inductance 76 in order that the control electrodes may be modulated by the output from the video signal amplifier and transmitting equipment 56. Inasmuch as the video amplifier will pass only the alternating current component of the television image signals, the direct current component is not supplied by the amplifier 56. For this purpose the direct current present in conductor 26 associated with the fine mesh screen 18 is utilized to supply the direct current component. This current produces a voltage drop across resistance 52, and the potential thus produced may be applied to a direct current amplifier 82 in order that the intensity of this direct current potential may be increased. The potential available from the resistance 52 is a function of the average or over-all light intensity of the optical image.

After appropriate amplification the direct current potential may then be applied to the control electrode of tube 84 to alter the impedance of the tube, and it will be observed that the resistance 80 forms a load circuit for the tube 84 and may be connected in the cathode circuit of the tube. As the impedance of tube 84 is altered by the potential produced by the direct current component, the amount of current that is permitted to flow through resistance 80 is varied with the result that the potential of the cathode of the tube 84 fluctuates in accordance with the average light intensity of the optical image. This potential then operates as a variable bias on the control electrodes of the modulator tubes 66 and 68 to control the transmission level of these tubes in order that the direct current component of the television image signals may be transmitted.

According to the present transmission stand-

ards, it is desirable that the average potential of the control electrodes of tubes 66 and 68 be altered in a positive direction for a decrease in the optical image intensity, and that the average potential of the control electrodes be altered in a negative direction when the average amount of light contained in the optical image increases. By so altering the potential of the control electrodes, the average amount of radio frequency power transmitted will be increased for relatively dark object areas and will be decreased for relatively light object areas. The reverse control could, however, be exercised if such alterations in transmission levels were desired.

As shown in the drawing, the cathode resistance 80 forms only a part of the entire grid resistance of the modulator tubes 66 and 68. However, in some instances, it may be desirable to exclude resistance 78 so that resistance 80 alone forms the entire grid resistance. Furthermore, it is not necessary that the grid resistance 80 be located in the cathode circuit of tube 84, but such location is chosen for convenience insofar as direct current potentials are concerned. The direct current amplifier 82 may be of any conventional design capable of transmitting relatively slow changes or fluctuations in potential difference.

It will be observed, therefore, that it is possible to alter the transmission level at a television transmitter in accordance with the direct current component of the television image signals so that the transmission level bears a proper and desirable relationship to the average light intensity of the optical image projected upon the light responsive surface in the television pickup tube. This is accomplished in a convenient manner and eliminates the necessity of providing various direct current insertion circuit arrangements in the video signal amplifier and transmitting equipment 56.

As explained above in connection with Figure 1, for optimum operation of the television pickup tube the average potential of the mesh screen 18 should be altered by a small amount in accordance with the intensity of the optical image focused upon the light responsive surface 12. For particularly bright images, the potential of the target 16 and of the mesh screen 18 should be altered in a negative direction whereas, for dim or relatively dark optical images, the potential should be altered by a slight amount in a positive direction. In the past, this small change in potential has been accomplished by a manual adjustment of an element, such as potentiometer 54 shown in Figure 1, but in accordance with the present invention such adjustment or control of the potential of the mesh screen 18 may be made automatic.

Referring now to Figure 2, a portion of the television pickup tube 10 is shown which includes the light responsive surface 12, the anode accelerating ring 20, the fine mesh screen 18, and the target surface 16. The connection to the fine mesh screen 18, rather than being brought to an adjustable potentiometer as was the case in Figure 1, is in this instance connected to a biasing potential 170 by way of a high resistance 172. For removing any rapid fluctuations in potential, the resistance 172 and the potential source 170 are by-passed by condenser 174.

As stated above, the range of potential variation of the fine mesh screen 18 for optimum operation of the television pickup tube is of the order of 1.5 volts, and the value of the resistance 172 should be so chosen as to produce such a

change in potential due to the fluctuation in the current therethrough from the screen 18. In order to place this 1.5 volt variation within the desired operating range, i. e., from -0.5 to +1.0, the potential source 170 is used and should be of the order of 1.5 volts. Since the amount of current available from the screen 18 is a small fraction of a milliampere, the resistance 172 will be of the order of several megohms.

In operation, it will be assumed that an optical image of very low light intensity is projected upon the light responsive surface 12. Under these conditions, very few photoelectrons will be emitted, and as a result, the number of secondary electrons released from the target surface 16 will be relatively low. Accordingly, the current flow through the resistance 172 will be low, resulting in a positive bias of about 1.0 volt on the screen electrode, which is proper for very dim scenes.

Should the light intensity of the optical image be increased, then the number of photoelectrons will accordingly increase, and the number of secondary electrons collected by the mesh screen 18 will also be increased. This increase in current flowing through resistance 172 will cause a voltage drop across the resistance which will be in opposition to the potential of the biasing source 170 to result in a negative potential being applied to the mesh screen 18 of the order of 0.5 volt.

By reason of this arrangement, it may be seen that the desired change in potential of the target electrode 16 and the fine mesh screen 18 may be altered automatically to maintain approximate optimum operation of the television pickup tube without the necessity of making any actual manual adjustments, and where the change in light intensity of the object area is relatively rapid, such an automatic control in the potential of the fine mesh screen 18 is highly desirable.

Although a more or less particular construction of a television pickup tube is herein described, it is to be understood that various other television pickup tubes of the "Orthicon" or low velocity type may as well be employed, and, furthermore, it is not necessary that the pickup tube include an electron multiplier stage or stages. Moreover, although electromagnetic deflection of the cathode ray beam is shown, electrostatic deflection could as well be used, or a combination of electrostatic and electromagnetic deflection is entirely feasible.

Various other alterations and modifications may be made in the present invention 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 invention except as limited by the hereinafter appended claims.

I claim:

1. A television transmitter including a television pickup tube for converting an optical image into a series of television image signals comprising a light responsive surface on which an optical light image may be projected to cause photoelectrons to be emitted therefrom, a target electrode surface displaced from the light responsive

surface and positioned to simultaneously receive substantially all of the emitted photoelectrons, means for accelerating the photoelectrons emitted from the light responsive surface to the target electrode surface at a velocity sufficient to produce secondary electrons at the target electrode surface, a secondary electron collector electrode positioned closely adjacent the target electrode surface for collecting the produced secondary electrons, a source of potential for maintaining the collector electrode at a predetermined average potential with respect to the target electrode, and means connected to the collector electrode including a combination of a high resistance and the source of potential in series across which is shunted a condenser whereby the potential of the collector electrode will automatically vary between predetermined limits in accordance with the number of secondary electrons collected thereby and in accordance with the average light intensity of the optical image.

2. A television transmitter including a television pickup tube for converting an optical image into a series of television image signals comprising a light responsive surface on which an optical light image may be projected to cause photoelectrons to be emitted therefrom an electrode surface displaced from the light responsive surface, means for accelerating the emitted photoelectrons from the light responsive surface to the target electrode surface so that substantially all of the emitted photoelectrons continuously strike the electrode surface at a velocity sufficient to produce secondary electrons at the electrode surface, a secondary electron collector electrode positioned closely adjacent the electrode surface for collecting the produced secondary electrons, a source of potential for maintaining a collector electrode at a predetermined potential with respect to the target electrode, and means connected to the collector electrode including a combination of a relatively high resistance and the source of potential in series across which is shunted a condenser whereby the effective potential of the collector electrode will be caused to vary automatically in accordance with the potential drop produced across the resistance by the variations in the average number of collected secondary electrons.

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