Dec. 1, 1953 H. G. LUBSZYNSKI ET AL 2,661,392

COLOR TELEVISION

Filed Dec. 13, 1947

Fig. 1.

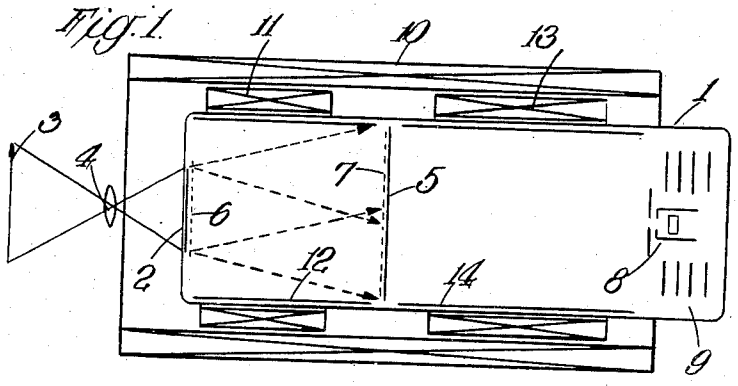


Fig. 2.

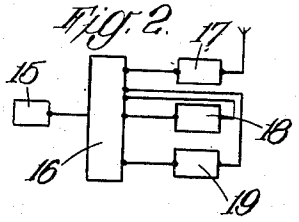


Fig. 3.

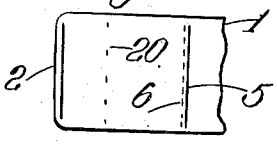


Fig. 4.

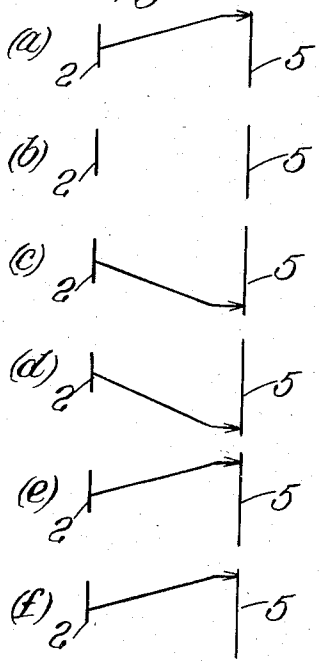


Fig. 5.

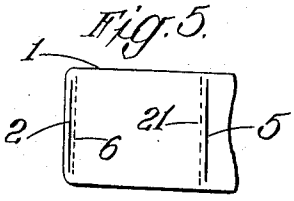
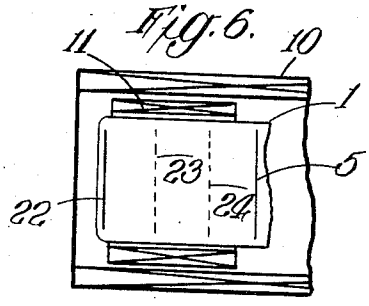


Fig. 6.



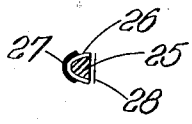


Fig. 7.



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COLOR TELEVISION

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12 Claims. (Cl. 178—5.4)

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This invention relates to electron discharge apparatus for generating signals suitable for use in colour television.

Various proposals have heretofore been made for generating colour television signals, but most of these prior proposals have relied upon the use of colour filters through which an image of an object for transmission is projected onto a suitable screen from which picture signals can be derived. The use of colour filters for generating picture signals for colour television purposes is undesirable from many points of view and the object of the present invention is to provide an improved apparatus for generating picture signals for colour television in which the use of colour filters for generating signals is avoided.

When a light image of mixed colour is projected onto a photo-electric cathode, photo-electrons are released from the cathode and the velocity of the electrons so released depends on the colour of the elemental areas of the image illuminating the photo-electric cathode. Thus, if one elemental area of the photo-electric cathode is illuminated with blue light then the maximum emission energy of the photo-electrons released from this elemental area will be greater than the maximum emission energy of photo-electrons released from another elemental area of the photo-electric cathode which is being illuminated for example with green light, and a substantial fraction of the electrons released by the blue light will have emission energies exceeding the maximum emission energy of the electrons released by the green light. Similarly the maximum emission energy of the electrons released by the green light will be greater than the maximum emission energy of photo-electrons released from an elemental area of the photo electric cathode which is being illuminated by red light and substantial fraction of the electrons released by green light will have emission energies exceeding the maximum emission energy of electrons released by red light. The present invention is based on the principle of utilising the difference of emission energies of electrons released by light of different colours in order to generate picture signals for colour television.

The present invention provides apparatus for generating picture signals for colour television wherein means are provided for utilising the difference in energy between electrons released by light of one colour compared with light of another colour to generate picture signals representative of different colour components of an image.

The apparatus for carrying the invention into effect may comprise means for separating electrons released by a light image of mixed colours into one group containing electrons released by light of one colour and into a second group containing electrons released by light of a second

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colour mixed with said first colour, and signal generating means which is arranged to utilise said groups of electrons so as to generate one set of picture signals representative of components of said image of said first colour and a second set of picture signals representative of components of said image of said second colour.

The apparatus employed in the invention may comprise an electron discharge device following the same general construction as has been proposed for generating monochromatic picture signals, the apparatus, however, being modified by the provision of said electron separating means. Preferably, the group of electrons is caused to impinge on a target electrode of the charge-storage type, the target electrode being scanned by a cathode ray beam so as to restore the elements of the target electrode to datum potentials, the arrangement being such that the image is ultimately effectively separated into sets of picture signals representative of the primary colour components of the image.

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

Figure 1 illustrates diagrammatically an electron discharge device suitable for use in the invention,

Figure 2 is a block diagram of a television transmitter operating in accordance with one embodiment of the invention,

Figure 3 is a diagrammatic view of a modification of the discharge device shown in Figure 1,

Figure 4 is a diagram illustrating a different manner of operating the device shown in Figure 1,

Figure 5 illustrates diagrammatically a modification of the device shown in Figure 1 for use with the manner of operation shown in Figure 4,

Figure 6 illustrates diagrammatically a further embodiment of the invention, and

Figure 7 illustrates a modification of the arrangement shown in Figure 6.

The present invention is based on the phenomenon that when a light image of mixed colours is projected onto a photo-electric cathode the emission energies of the electrons released from the photo-electric cathode depends on the colour of the incident light. By setting up a suitable field it is possible to exercise a control on the released electrons which is dependent upon their emission energies and thereby separate released electrons into groups according to the emission energies of the electrons and hence according to the colour of incident light. For example, the control may be effective to produce one group containing electrons released by light of a first colour, another group containing electrons released by light of a second colour mixed with said first colour and a third group containing electrons released by

light of a third colour mixed with said first and second colours, the first group of electrons can then be employed to obtain a set of picture signals corresponding to said first colour, the first and second groups can be employed to obtain a set of picture signals corresponding predominantly to said second colour by substantially balancing out said first colour, and similarly the second and third groups can be employed to obtain a set of picture signals corresponding predominantly to said third colour. The control may for example be exercised by applying potentials to a control electrode disposed adjacent to a photo-electric cathode such that effectively only electrons released with energies exceeding a predetermined value are permitted to pass said electrode. Figure 1 of the drawings illlustrates an electron discharge device suitable for use in one form of the invention and which, when used in conjunction with the circuit shown in block form in Figure 2, enables television signals to be obtained which are representative of the three primary colours of a coloured image.

Figure 1 illustrates an electron discharge device which constitutes a pick-up tube similar to a device known as an "image orthicon." The discharge device shown comprises an evacuated envelope 1 having at one end a photo-electric cathode 2 onto which a light image 3 of mixed colours can be projected through a suitable optical system indicated at 4. On projecting an optical image onto the photo-electric cathode 2 photo-electrons are released which are projected and focussed onto a charge-storage target electrode 5. Adjacent to the cathode 2 is disposed a control electrode 6 in the form of a grid which, in operation, is biassed in such a way as to allow, first, only electrons liberated from the cathode 2 by blue light with energies exceeding the maximum emission of energy of electrons released by green light, then electrons liberated by blue light mixed with green light with energies exceeding the maximum emission energy of electrons released by red light and finally all the electrons liberated by blue light mixed with green and red light to be transmitted through the interstices of the electrode 6 and caused to impinge on the target 5. It will be convenient to refer to electrons liberated with energies exceeding the maximum emission energy of electrons released by green light as "blue" electrons, to refer to electrons liberated with energies not exceeding the latter maximum but exceeding the maximum emission energy of electrons released by red light as "green" electrons, and to refer to electrons liberated with energies not exceeding the last-mentioned maximum as "red" electrons. It will of course be appreciated that a number of the "green" electrons may in fact be liberated by blue light, while a number of the "red" electrons may in fact be liberated by blue and green light, but these should not prevent satisfactory operation of the apparatus. The target 5 is of the so-called double-sided type and on the side of the target 5 facing the cathode 2 is a collector electrode 7 in the form of a grid for collecting secondary electrons released from the target 5 whilst on the side of the target 5 remote from the photo-electric cathode 2 is an electron gun indicated conventionally at 8 which serves to generate a beam of electrons for scanning the target 5, scanning of the target 5 by the beam of the gun 8 serving in known manner to restore the elements of the target 5 to an equilibrium potential, electrons which are not employed for

restoring the elements being returned to multiplying electrodes indicated at 9 which serve in known manner effectively to multiply the returned electrons, the final electron stream serving to develop picture signals. The discharge device shown in Figure 1 is arranged within a coil 10 which serves to set up a substantial axially symmetrical magnetic field which is necessary for the operation of discharge devices of the kind shown in Figure 1. A pair of coils 11 is provided between the cathode 2 and the target 5, these coils having applied thereto, in operation, a rectangular pulse waveform in such a manner that the photo-electrons released from the cathode 2 are caused to be projected alternately onto the upper and lower portions of the target 5, as indicated by the dotted lines, the photo-electrons being projected on to each portion for the duration of a colour frame. The electron beam from the gun 8 is arranged to scan the electron images applied to the target 5 in such a phase that during one colour frame the beam always scans that portion of the target which has been charged by photo-electrons during the previous colour frame. The electron image from the cathode 2 is focussed by the coil 10 and is accelerated onto the target electrode 5 by a cylindrical anode 12 applied to the wall of the tube 1. The electron beam from the gun 8 is also focussed by the coil 10 while deflecting coils, some of which are shown at 13 impart the line and frame scanning deflections to said beam from the gun 8, the electrons from the gun 8 being accelerated by a cylindrical anode 14 applied to the wall of the tube 1, as shown.

The control electrode 6 as aforesaid is arranged to be biased by means of potential pulses in such a manner that first blue electrons are released for a predetermined interval equal to the duration of a colour frame, these blue electrons being projected say onto the upper portion of the target 5 and the charges produced by said electrons being stored by the target 5. Then the potential applied to control electrode 6 is changed so that it allows blue and green electrons to be released, the electron image resulting from these blue and green electrons being projected onto the lower portion of the target 5 for an interval of equal duration and during the projection of blue and green electrons onto the target 5 the upper portion of the target is scanned by the beam emanating from the gun 8. Then the potential applied to the control electrode 6 is again changed so that it allows blue, green and red electrons to be released, these electrons being projected onto the upper portion of the target 5 during which period the lower portion of the target is scanned by the beam of the gun 8 and so on, so that the output of the tube derived from the multiplying electrodes 9 consists of three sets of signals. The first set of signals is generated during one colour frame and is representative of the blue component of the image, the next set of signals is generated during the next colour frame and is representative of the blue and green components of the image, whilst the third set of signals, which is generated during the following colour frame is representative of the blue, green and red components of the image, the said sets being generated in the same sequence during successive colour frames.

Referring now to Figure 2 of the drawings, the signal output from the device shown in Fig 1 is amplified by an amplifier 15 and the three sets of signals aforesaid are passed to a switching

device 16, the construction of which is such that the signals are passed in accordance with the phasing of the intervals in which they are generated to a transmitter 17 or to a storage device 18 or 19, or to a combination of them.

The devices 18 and 19 may each comprise for example an electron discharge device having a target electrode which can store charges and which can be scanned on one side with a high velocity beam of electrons and on the other side with a low velocity beam of electrons. If with this arrangement, the first set of picture signals is caused to modulate the high velocity beam of electrons in the device 18 during one colour frame, a positive charge image is produced on the storage electrode representative of said set of signals, and during the subsequent colour frame the signals are reproduced by scanning with the low velocity beam of electrons so as to discharge the storage electrode, a signal plate being provided capacitatively with the storage electrode from which the reproduced signals are derived. The reproduced signals can then be combined on opposite phase with the second set of signals in a suitable amplifier the resultant of the combined signals being signals which are representative effectively only of the green electrons, the second set of signals being simultaneously caused to modulate the high velocity beam of electrons in the device 19 so that after storage they can subsequently be combined in opposite phase with the third set of signals, so as to produce signals representative effectively only of red electrons. Alternatively the storage devices 18 and 19 may each comprise an electron discharge device having a charge storage electrode provided at one side with a signal plate capacitatively associated with the storage electrode and at the other side with a control electrode in the form of a grid or grill which is maintained at a uniform potential, means being provided for scanning the storage electrode with an unmodulated beam of electrons from the side at which the grid is located. If, with this arrangement, the first set of signals is applied to the signal plate of the device 18 during one colour frame while the storage electrode is being scanned by said beam of electrons, a charge image will be produced in said storage electrode representative of said first set of signals. During the subsequent colour frame, the second set of signals can then be applied to the signal plate while the storage electrode is being again scanned by the beam of electrons, and a resultant signal derived from the signal plate which is representative of the difference of the two sets of signals, and therefore representative predominantly of the green component of the original image. The second and third sets of signals can similarly be combined in appropriate phase with the aid of the other storage device 19 whereby signals are obtained from the latter device which are representative predominantly of the red component of the original image.

The sequence of operation of the switching device 16 may be as follows: the first set of signals is caused by the device 16 to be fed to the transmitter 17 during said first colour frame, said set of signals being simultaneously fed to the storage device 18. The second set of signals is then fed during said second colour frame by the device 16 to the storage device 18 and also to the storage device 19 whilst the output of the device 18 is fed to the transmitter 17. The output signals from the device 18 will then be representative of the green component of the original image

unmixed with the blue component. Then the third set of signals is fed during said third colour frame to the storage device 19, the output signals of this device then consisting only of the red components of the original image. At the same time the storage device 18 is conditioned to receive the first set of signals of another colour frame by discharging the elements of the storage electrode. Similarly, during the next colour frame the storage device 19 is conditioned for commencing the next cycle. Since the first set of signals, which are representative of the blue component of the image, is fed directly to the transmitter 17, whilst the signals representative of the green and red components of the original image are derived from the storage devices 18 and 19, it will of course be necessary to employ suitable amplifying or attenuating means in the channels feeding the transmitter 17 and the devices 18 and 19 so that the respective signal amplitudes are effectively proportional to the original signals derived from the device shown in Fig. 1. These amplifying or attenuating means can also be used to correct if required the colour response of the photo-electric cathode 2. It is possible that imperfect signals will be derived from the devices 18 and 19 when a moving object is projected onto the cathode 2, but since the frame frequency for a colour television transmission will necessarily be increased compared with a monochromatic system, these imperfect signals may not be a serious disadvantage.

The type of discharge device shown in Figure 1 is usually operated with cathode potential stabilisation; that is to say, the target 5 is discharged with a low velocity beam of electrons from the gun 8. With this mode of operation, it is necessary to set up positive charge images on the target 5. The photo-electrons from the photo-electric cathode 2 are therefore projected on the target 5 with sufficient velocity to release secondary electrons, these secondary electrons being absorbed by the electrode 7.

The invention is however, not limited in its use to the general type of discharge device shown in Figure 1 since the invention can also be employed with other kinds of devices. For example it may be applied to discharge devices wherein the electron image from the photo-cathode 2 is projected with a low velocity on the target 5 so as to charge the elemental areas of the storage electrode to negative potentials in dependence upon the intensity of the projected electron image, i. e. so as to form a negative charge image on the target 5, and wherein a control electrode in the form of a mesh is disposed immediately in front of the scanned side of the target 5. Potential differences are thus set up between the elemental areas of the target 5 and the control electrode in dependence upon said negative charge image, the control electrode being maintained at a constant potential. One proposed form of device of this kind is described in United States patent application Serial No. 792,576, and according thereto the target 5 is scanned by means of a beam of electrons of sufficient velocity to release secondary electrons from the target 5. The electrons released from the target 5 escape through the control electrode and are utilised for generating electrical signals by directing them to an electron multiplier, the number of electrons which escape from each elemental area being dependent upon the potential difference established, as aforesaid, between the respective elemental area and the control electrode. In another form of device of

this kind, the target 5 is rendered photo-sensitive on the scanned side thereof, scanning being effected by means of a light spot projected, for example, from the fluorescent screen of a cathode ray tube. The light spot releases electrons from the target 5, the release being controlled as aforesaid by the control electrode. If either form of device of this kind is employed, the grid 6, instead of being disposed adjacent to the cathode 2, may alternatively be disposed as shown in Figure 3 adjacent to the target 5 since the photo-electrons have a low velocity in the vicinity of the target 5. In this case, the photo-electrons released from the cathode 2 are accelerated by a grid 20 and pass through the grid 6 before impinging on the target 5 so as to charge it negatively. By applying suitable potential pulses to the control electrode 6, the target 5 can be charged respectively by blue electrons, blue and green electrons, and blue, green and red electrons.

Instead of deriving signals representative of the three primary colours of the image by the use of the devices 18 and 19 it is possible to obtain signals representative of said primary colours from the aforesaid blue, blue and green, and blue, green and red electrons by causing said electrons to impinge on the target 5 with such energies that the primary/secondary electron emission ratio is varied according to whichever of the three sets of electrons is being projected. For example, the blue electrons released from the photo-electric cathode 2 of Figure 1 can be caused to impinge on the target 5 with such energy that they release more than one secondary electron for each primary electron. The blue and green electrons can be caused to impinge on the target electrode with low energies so that they release substantially no secondary electrons and if the image of the blue and green electrons is superimposed on the target which has been charged by the blue electrons, then the charges due to the blue electrons will effectively cancel one another so that a charge image will result corresponding effectively only to green electrons. Similarly a charge image can be ultimately obtained which is representative only of red electrons. The change in energy of the electrons in order to cause the primary/secondary electron emission ratio to vary may be effected by applying suitable rectangular potential pulses to the photo-electric cathode 2 and the grid 6 of Figure 1 thus effectively varying the potential of the source of electrons. The sense of the pulses may be arranged so that the charge images resulting from the mutual cancellation are either positive or negative according to the type of electron discharge device employed.

The sequence of operations when operating the device shown in Figure 1 in this manner is represented in Figure 4 from which it will be observed that, firstly, as shown at *a*, a blue electron image is focussed onto the upper portion of the target 5 for the duration of half a colour frame so as to form on said target electrode a positive charge image. The electron image is then completely cut off for the remainder of the frame interval, for example, by applying a strong negative bias to the grid 6 as represented at *b*. Then a blue electron image is focussed onto the lower portion of the target 5 for the duration of half a colour frame, so as to form on the lower portion of said target electrode a negative charge image as represented at *c*. Then an image resulting from blue and green electrons is superimposed on the negative blue image for the duration of the remaining half of the colour frame so as to form a positive charge image, the charges resulting from the blue components effectively cancelling and leaving a charge image corresponding only to green electrons. This step is shown at *d*. Then blue and green electrons are focussed onto the upper portion of the target for the duration of half the next colour frame so as to form a negative charge image of blue and green electrons, as shown at *e*. Then a charge image of blue, green and red electrons is superimposed on the negative charge image formed by blue and green electrons for the duration of the remaining half of the last-mentioned colour frame so as to form a positive charge image so that the ultimate charge image set up on the screen 5 is a charge image resulting only from red electrons, as shown at *f*. The scanning of the cathode ray beam from the gun 8 is so phased that the beam always scans the charge image stored during the previous colour frame. Thus, during the sequences *c* and *d* the beam is caused to scan the portion of the target upon which the blue image is formed at *a* in Figure 4 and during the sequences *e* and *f* the beam is caused to scan the green image at *d* in Figure 4 and so on. If any mis-matching of colour occurs due to incorrect secondary emission factors it may be possible to compensate for such mis-matching by varying the ratio of the exposure time of the charge images. Colour fringes resulting from fast-moving objects could be transformed into slightly blurred edges of the correct colour by alternately projecting the images onto the target electrode at a high frequency instead of projecting them separately each for a duration of half a colour field.

In addition, the apparatus illustrated can be operated in such way that interlaced scanning is effected. In that case, each complete scanning raster traced by the beam on the target 5 is effected in two frames or sequences of lines one of which is traced on the lower portion of the target 5 and the other of which is traced on the upper portion of the target 5. By displacing the upper charge image relatively to the lower charge image on the target 5, or vice versa, in the vertical direction by half the vertical displacement which the scanning beam undergoes during a line period, it is arranged that the lines traced on the charge image on the lower portion of the target 5 interlace with the lines traced on that on the upper portion of the target 5. Alternatively, the same result can be achieved by relatively displacing the two sequences of lines which are traced respectively on the upper and lower portions of the target 5. The lines of each sequence are spaced apart to allow the lines of the other sequence to interlace therewith and, in order to remove the charges stored in the gaps between the lines of each sequence, the scanning beam can be caused to discharge these gaps during the return times between successive lines. Since the return times are appreciably shorter than the line times, the beam current may be increased during the return times to assist in discharging the gaps, for example by applying positive potential pulses to the modulating electrode of the gun 8. Simultaneously, the signal output may be suppressed in the amplifier or in the electron multiplier during the line return times. The discharge of the gaps can also be assisted by slightly defocussing the beam during the line return times and simultaneously superimposing rectangular pulses of line frequency on the ver-

tical scanning waveform so that the beam, during the line return times, is shifted slightly backwards in the vertical direction.

Instead of applying pulses to the cathode 2 and grid 6 as aforesaid, the changeover required to afford the positive and negative charge images may be effected by means of a grid 21, as shown in Figure 5, this grid being arranged in front of the target 5 and having suitable potential pulses applied to it. In order to avoid a pickup effect on that half of the target which is being scanned, it may be advantageous to divide the grid 21 into upper and lower portions and merely to apply pulses to that portion of the grid which covers that part of the target electrode which is not being scanned.

Figure 6 of the drawings illustrates a further embodiment of the invention. As shown in this figure there is disposed at the end of the envelope 1 a transparent conducting control electrode 22, then a grid electrode 23 having formed on its side facing the electrode 22 a photo-electric layer and between the grid 23 and the target 5 is disposed a control electrode 24 also in the form of a grid, of high transmission ratio. By suitably adjusting the potentials applied in operation to the electrodes 22, 23 and 24 it is possible to form on the target electrode 5 charge images representative only of blue, green and red electrons.

Assuming that the maximum emission energies of red, green and blue electrons are a, b and c electron volts respectively, where a is smaller than b and b is smaller than c, then the potential applied to the electrode 22 is maintained in sequence for each colour field at $-c$ volts, $-b$ volts and $-a$ volts respectively, and the potential of the electrode 24 is maintained in similar sequence at $-b$ volts, $-a$ volts and zero volts. When the potential of the electrode 22 is $-c$ volts and the potential of the electrode 24 is $-b$ volts, cannot collect any of the released electrons so that the released electrons pass through the grid 23, and red and green electrons are then repelled by the electrode 24 and caused to return to the electrode 23, blue electrons being however permitted to pass through the interstices of the electrode 24 to the target 5. When the potential of the electrode 22 is $-b$ volts, and the potential of the electrode 24 is $-a$ volts, blue electrons are collected by the electrode 22 while red and green electrons pass through the electrode 23, red electrons being finally reflected to the electrode 23 by the electrode 24 while the green electrons pass to the target 5. When the potential of the electrode 22 is $-a$ volts and the potential of the electrode 24 is zero volts, then blue and green electrons are collected by the electrode 22 and only red electrons pass through the electrode 23 and no electrons are reflected to the electrode 23 by the electrode 24. In this way, red, green and blue electron images are formed in sequence on the target electrode 5. By applying suitable potential pulses to the deflecting coils 11 in timed relationship with the change of potentials on the electrodes 22 and 24, a red image can be formed on the lower portion of the target 5, then a green image on the middle portion of the target 5 and then a blue image on the upper portion of the target 5. The red image is arranged to be scanned by the beam from the gun 8 whilst the green image is being applied to the middle portion of the target, and so on.

If desired, the grid electrodes 23 and 24 may be combined as shown in Figure 7. For example, a mesh 25 of aluminium may be provided which is insulated by the provision of an anodised layer 26, the right-hand side of the mesh 25, as shown in Figure 7, being suitably lapped so that it is not covered by the layer 26 and on the left-hand side of the mesh 25 there is provided a sputtered or evaporated metal layer 27 which replaces the electrode 24, whilst the right-hand side of the mesh 25 is provided with a photo-electric layer 28 which replaces the electrode 23. The electrodes 27 and 28 are thus shown facing the opposite direction from that in Figure 6.

Although the invention has been described as applied to several kinds of electron discharge devices it will be understood that the invention is not limited in its use to electron discharge devices of the kinds described as it can be applied to any suitable device such as has been proposed for generating television signals, such as the so-called image dissectors or electron discharge devices in which the optical image projected onto a target electrode is converted into an electron stream by scanning a photo-electric cathode with a light spot so as to derive from the photo-electric cathode a beam of electrons which scans said target.

We claim:

1. In apparatus for generating picture signals for colour television, an electron discharge pick-up tube having a photo-electrically sensitive surface arranged for exposure to light images of mixed colours, means for establishing a potential field for differentially controlling the electrons released by a light image from said photosensitive surface in dependence upon the energies of said electrons, and means for generating from said differentially controlled electrons picture signals representative of different colour components of a light image.

2. In apparatus for generating picture signals for colour television, an electron discharge pick-up tube having a photo-electrically sensitive surface arranged for exposure to light images of mixed colours, means for separating electrons released by a light image from said photo-electrically sensitive surface, in dependence upon their energies, into one group containing electrons released with emission energies exceeding one level and a second group containing electrons released with emission energies exceeding another and lower level but not exceeding said first level, and means for generating from said groups of electrons one set of picture signals representative of components of said light image of a first colour and a second set of picture signals representative of components of said light image of a second colour.

3. In apparatus for generating picture signals for colour television according to claim 2, said tube having means for generating one set of picture signals from said first group of electrons, means for generating further signals from said second group of electrons, and means for combining said further signals with said first set of picture signals in phase opposition to generate thereby said second set of signals.

4. In apparatus for generating picture signals for colour television according to claim 2, said tube having a charge storage electrode, means for causing said groups of electrons to produce superimposed charge images of opposing polarity on said charge storage electrode to effectively balance out charges representative of electrons having emission energies exceeding said first level

components from the resultant charge image, and means for generating picture signals from the resultant charge image to generate thereby said second set of picture signals.

5. In apparatus for generating picture signals for colour television, an electron discharge pick-up tube comprising a photo-electrically sensitive surface arranged for exposure to light images of mixed colours, means for separating electrons released by a light image from said photo-electrically sensitive surface, in dependence upon their energies, into one group containing electrons released with emission energies exceeding one level and a second group containing electrons released with emission energies exceeding another and lower level but not exceeding said first level, means for generating one set of picture signals representative of components of said light image of a first colour from said first group of electrons and for generating a second set of picture signals representative of said light image of a second colour from said second group of electrons.

6. In apparatus according to claim 5, said electron separating means comprising a first control electrode, means for applying one potential to said control electrode during intervals to repel all electrons released with emission energies exceeding said lower level and for applying a different potential to said control electrode at other intervals to collect electrons with emission energies exceeding said first level and to repel electrons with lower emission energies, a second control electrode arranged in the path of electrons repelled by said first control electrode and means for applying potentials to said control electrode to allow only the passage of electrons with emission energies exceeding said first level at said first intervals and to allow the passage of all electrons with emission energies exceeding said lower level at said other intervals.

7. In apparatus for generating picture signals for colour television, an electron discharge pick-up tube having a photo-electrically sensitive surface arranged for exposure to light images of mixed colours, means dependent upon the energies of the electrons released from said surface for separating the released electrons alternately into one group containing electrons released with predetermined energies and a second group containing electrons released with different energies, a charge storage electrode, means for directing said groups of electrons alternately to different portions of said charge storage electrode to produce charge images alternately on said portions, means for causing a beam of electrons to scan said portions of the charge storage electrode alternately in reverse order from that in which said charge images are produced in said portions, and means for deriving picture signals representative of different colour components of a light image from the scanning of said charge storage electrode.

8. In apparatus for generating picture signals for colour television, an electron discharge pick-up tube having a photo-electrically sensitive surface arranged for exposure to a light image of mixed colours, potential-operated means for differentially controlling electrons released by a light image from said surface in dependence upon the energies of said electrons, means for applying potentials to said potential-operated means to separate electrons released from said surface alternately into one group containing electrons of predetermined energies and into a second group containing electrons of different energies, and means for sequentially generating from said groups of electrons one set of picture signals representative of a first colour component of a light image and a second set of picture signals representative of a different colour component of the light image.

9. In apparatus for generating picture signals for colour television according to claim 8, said potential-operated means comprising a control electrode pervious to electrons and arranged in the path of electrons released from said photo-electrically sensitive surface.

10. In apparatus for generating picture signals for color television, an electron discharge pick-up tube comprising a photo-electrically sensitized surface arranged for exposure to a light image of mixed colors, means for controlling the path of the electrons released from said surface by a light image in dependence upon the energies of the released electrons, and means for generating from the controlled electrons picture signals representative of different color components of a light image to which said surface is exposed.

11. In apparatus for generating picture signals for color television, an electron discharge pick-up tube having a photo-electrically sensitive surface arranged for exposure to light images of mixed colors, means for separating electrons released from said surface by a light image in dependence upon the energies of said electrons into groups containing electrons with energies in different energy ranges, and means for generating picture signals representative of different color components of the light image from said groups of electrons.

12. In apparatus for generating picture signals for color television, an electron discharge pick-up tube comprising a photo-electrically sensitive surface arranged for exposure to light images of mixed colors, electrode means effective in the path of electrons released by a light image from said surface, means for applying potentials to said electrode means during one set of periodic intervals to separate electrons with emission energies in one energy range from electrons released by a light image from said surface, means for applying different potentials to said electrode means during another set of intervals intercalated with said first set to separate electrons with emission energies in a different energy range from electrons released by a light image from said surface, and means for generating picture signals representative of different color components of said light image from the electrons separated during said different sets of intervals.

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