

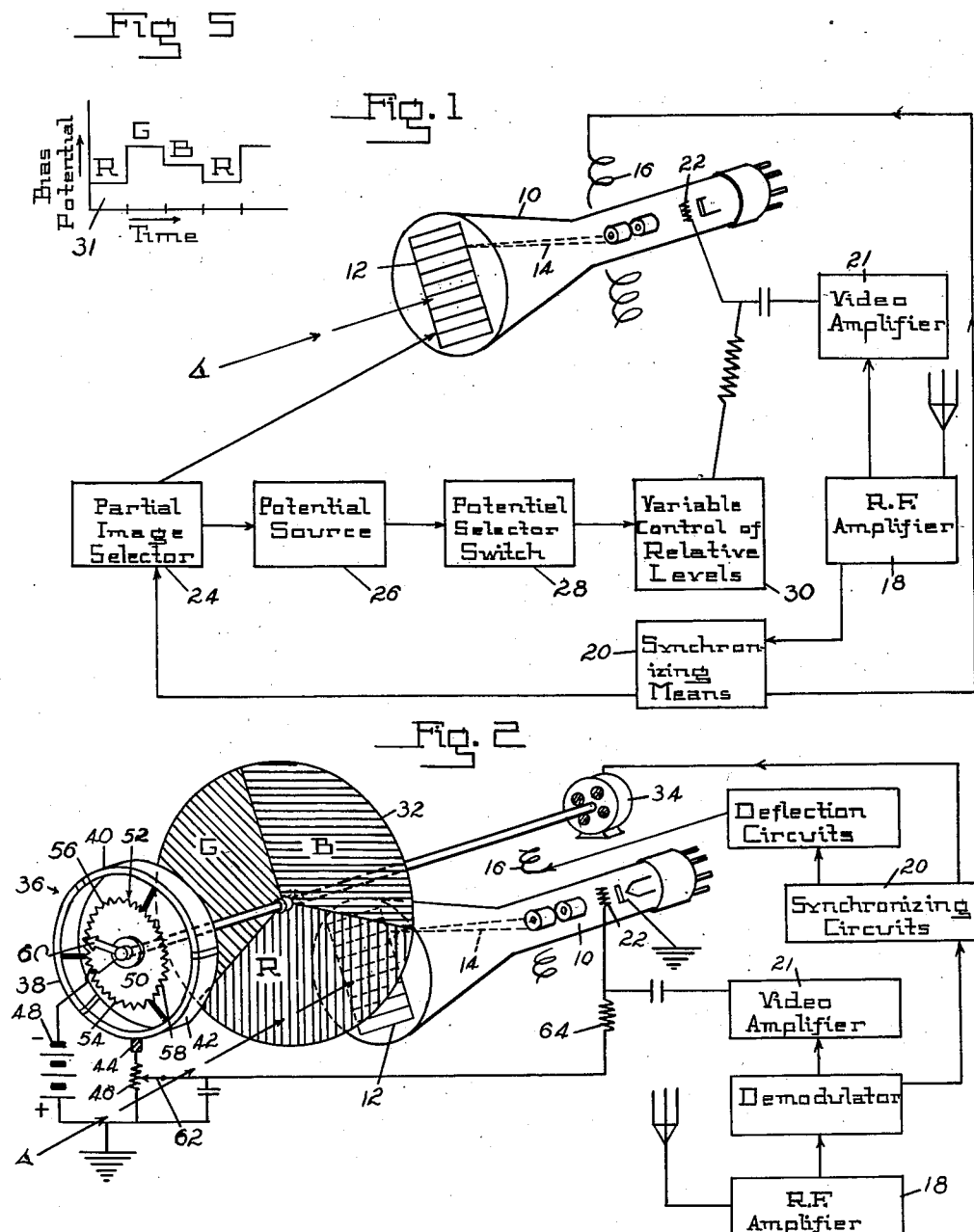
June 14, 1949.

T. W. CHEW
COLOR TELEVISION SYSTEM

2,473,276

Filed May 23, 1946

2 Sheets-Sheet 1



Thornton W. Chew
by ^{Inv.} Seviner and Parker
A.H.J's.

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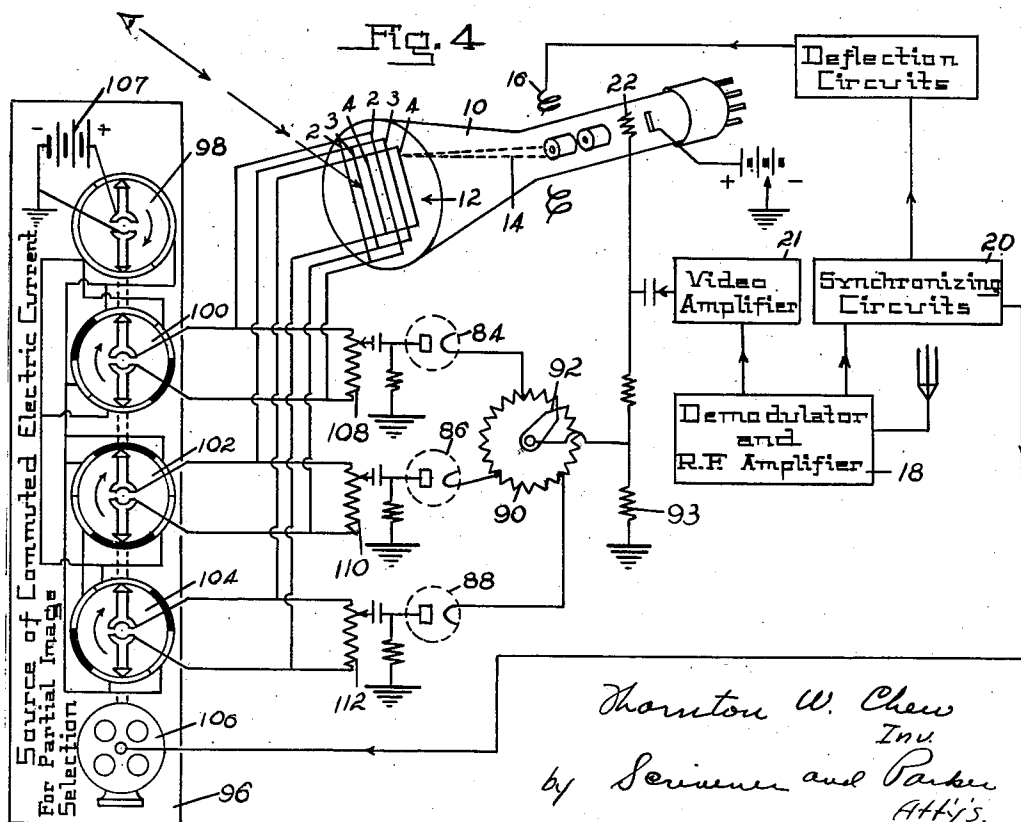
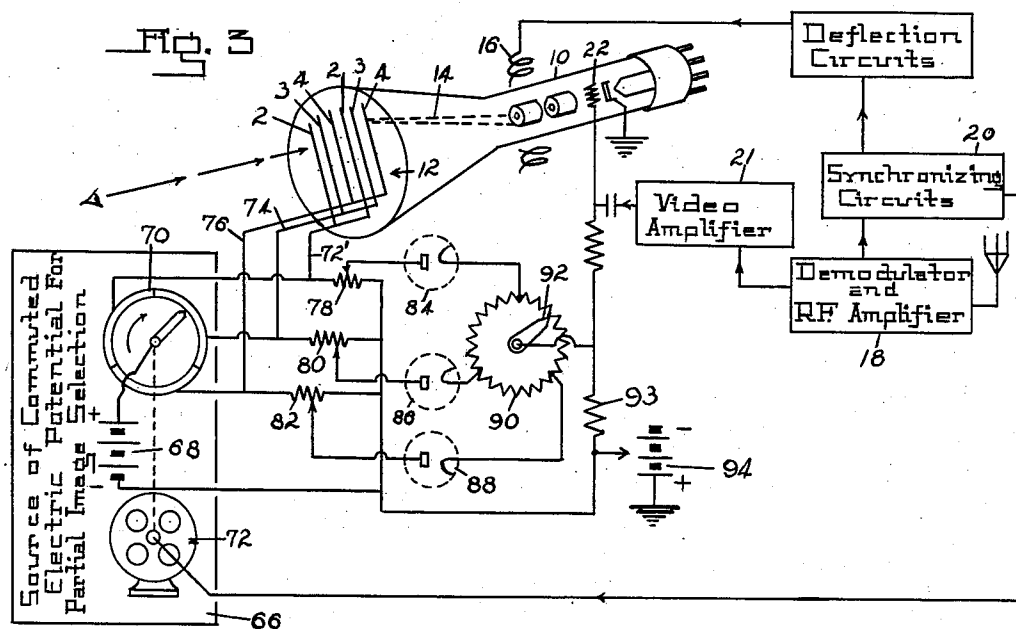
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Thornton W. Chew
Inventor
by Seivener and Parker
Attys.

UNITED STATES PATENT OFFICE

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COLOR TELEVISION SYSTEM

Thornton W. Chew, Washington, D. C.

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7 Claims. (Cl. 178—5.4)

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This invention relates to color television systems and more particularly to improvements in television receivers.

Television images in natural colors have heretofore been transmitted by forming separate, partial images of the object in terms of each of a plurality of primary color components, usually red, blue and green. At the receiver, these partial images are superposed to produce a composite image having colors and shades similar to that of the object.

In order to obtain faithful and accurate reproduction of the range of colors of the object, it is necessary that the composite reproduced image, contain the proper proportion of each of the primary color components. Such faithful reproduction has heretofore been difficult to achieve because of color distortion in the receiver when the video signal is reconverted into the light image. For example, distortion may occur as a result of variations in the efficiencies of luminescence of the phosphors constituting the screen material in the cathode ray tube. Such variations are inherent in the practicable manufacturing tolerances in the production of the phosphors and their deposit as screens, as well as in the physical response of the phosphor materials to electron bombardment. Moreover, the effective life of the various phosphors differs, and the color range of the emitted light, which may be properly proportioned when the screen is new, changes with age and becomes improperly proportioned, thus producing an image wherein the color components are distorted.

It is accordingly one of the features of the present invention to provide a television system which overcomes the difficulties and disadvantages of prior systems.

A further feature and object of the invention resides in the provision of a color tone control for a television receiver which is so arranged as to provide a local adjustment for compensating for variations in the proportions of the primary color components, so that faithful color reproduction is assured.

Another object comprehends a local adjustment whereby any desirable distortion in the reproduction of the color range of the object may be readily and quickly secured.

A still further object is to provide in a color

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television receiver, a novel and effective arrangement for compensating for the manufacturing tolerances and the aging effects of the screen phosphors which have heretofore prevented faithful reproduction of an object in natural colors.

Still another object is to provide in a color television receiver, a local adjustment whereby any desired region of the color spectrum may be accentuated or reduced, thus enabling a ready variation in shading and intensity of the color image.

Other objects and novel features of the invention will appear more fully hereinafter from a consideration of the following detailed description when taken in connection with the accompanying drawings which are illustrative of several forms of the invention. It will be expressly understood however, that the drawings are utilized for purposes of illustration only, and are not designed as a definition of the limits of the invention, reference being had for this purpose to the appended claims.

In the drawings, wherein similar reference characters refer to similar parts throughout the several views;

Fig. 1 is a block diagram of a color television receiver illustrating the color tone control features constituting the present invention;

Fig. 2 is a diagrammatic view of one form of the invention which employs a mechanically operated color filter disk for selecting the partial images;

Fig. 3 is a diagrammatic view of another form of the invention which includes a cathode ray tube screen made up of a plurality of separate elements to which electric potentials are sequentially applied for selecting the partial images;

Fig. 4 is a diagrammatic view of a still further modified form of the invention wherein the partial images are selected electromagnetically, and

Fig. 5 is a graph illustrating the principles of the present invention.

Referring more particularly to Fig. 1, a color television receiver, embodying the features of all the modifications to be described hereinafter, is illustrated therein as including a cathode ray tube 10 having a screen 12 adapted to be scanned by an electron beam 14 under the influence of deflection means 16, in a well known manner.

Any conventional receiving system may be employed, and as shown, such a system may include the radio-frequency amplifier 18, synchronizing means 20 and a video amplifier 21 for applying the video signal to the control grid 22 of the tube 10.

In order to secure the novel and advantageous color tone control of the present invention, a novel arrangement is provided whereby the proportions of light emission of the respective primary color components may be adjusted by varying the proportion of excitation supplied to the screen by the electron beam during the transmission of each partial image. More particularly a partial image selector 24 is controlled synchronously with the synchronizing means 20 and the former is associated with a potential source 26 which supplies a separate potential for each partial image, a potential commutator or switch 28 which successively selects and passes these potentials, and a variable control 30 for varying the relative levels of biasing potential applied to the control grid 22 as for example the sequence of relative levels per graph 31. In the conventional television receiver, this graph 31 would show a straight horizontal line because a direct current potential bias is applied to the control grid to fix the average beam intensity, above and below which the video frequency signal potentials vary to form the image. The herein disclosed invention superimposes upon these another direct current bias potential which varies with each successive partial image. Thus the invention includes a device 28 for obtaining a potential from the device 24 which selects the partial images, together with a construction 30 for causing portions of such potential to be applied as a bias to the control grid 22, such portions varying according to the color of the partial images. As will appear more fully hereinafter, such biasing potential controls the intensity of the color components of the image and may be varied at will in order to secure any desired shading of the components, individually or in combination, for the purpose of achieving the desired effect.

One embodiment of the present invention is more particularly illustrated in Fig. 2, as being associated with a receiving system of the type wherein the partial images are selected by mechanically alternating a group of color filters interposed in the optical path between the eye of the observer and the screen of the cathode ray tube. In such case, the screen may include a phosphor mixture which, during luminescence, emits approximately equal amounts of red, blue and green light. Fidelity of color reproduction in this system depends upon the proper combination of spectral transmission characteristics in the color filters and the spectral emission characteristics in the phosphor mixture of the screen.

More particularly, the partial image selector comprises a filter disk 32 having red, blue and green segments, R, B and G respectively, which disk is rotated by any suitable type of motor 34, in the optical path between the observer's eye and the luminescent screen 12. In this manner, the observer alternately sees red, blue and green partial images which combine to form a composite color image by persistence of vision. Variations in the image are caused by the electron beam 14 which is modulated by the video amplifier 21 and deflected by the usual deflection circuits 16, it being understood that rotation of the filter disk and deflection of the electron beam are synchronized with the sequence of transmis-

sion of the partial images from the transmitter by the synchronizing circuits 20.

In order to provide the variable color tone control of the present invention, a suitable commutating device 36 is synchronously driven with the disk 32 by the motor 34, and comprises three segments 38, 40 and 42, which are insulated from each other and which are adapted to have sliding contact with a stationary brush 44. The latter is included in a series circuit comprising a potentiometer 46 and a potential source, such as a battery 48, the other side of the circuit being connected with a contact ring 50 by any suitable means such as a brush or slip ring connection. Included as a part of the rotatable commutator, is a closed resistance ring or voltage divider 52 having three equal sections 54, 56 and 58, opposite ends of each of which are connected with adjacent commutator segments as shown. For example, section 54 is electrically connected between segments 38 and 42, section 56 is connected between segments 38 and 40, while section 58 is connected between segments 40 and 42. Arm 60, which contacts the resistance ring 52 may be manually rotated throughout 360 degrees to any desired position for adjustment of image color quality. Following the adjustment, the arm is stationary with respect to the commutator 52 and rotates with the latter.

In operation, current from the battery 48 flows through the potentiometer winding 46 to the brush 44 and from the latter to the segments 42, 40 and 38 alternately, through the resistance sections 58, 56 and 54 to the contact arm 60, and back to the battery by way of the contact ring 50. It will be observed that at any given moment, the current flow in the circuit will depend upon the amount of resistance between the brush 44 and the contact ring 50. Such amount depends upon the values of the parallel resistances between the segment contacting the brush 44 and the point of contact between the arm 60 and the resistance ring 52. For example, as shown in Fig. 2, the parallel resistances include the section 58 and a major portion of section 56 on one side, and in parallel with section 54 and a minor portion of section 56 on the other side.

From the foregoing, it will be seen that this parallel resistance will be a maximum for any one segment of the commutator when the arm 60 is removed 180 degrees of rotation from the point of connection of the resistance ring 52 for the one segment. Also, the resistance will be a minimum when the arm 60 coincides with the connection between the segment and the resistance ring. Moreover, for any particular setting of the arm 60, the parallel resistance between the arm and the respective segments will be different, the resistance being less as the angle between the arm and the segment connecting point with the resistance ring is decreased. It therefore follows that the current flowing in the circuit and hence in the potentiometer 46, during operation of the commutator will vary according to the variation of resistance between the brush 44 and the ring 50, depending upon the commutator segment in the circuit.

The variation in current flow just described causes a variation in potential difference across the potentiometer 46 which is applied through a variable arm 62 and a resistance 64 to the control grid 22 of the tube 10. Since such potential difference varies according to the rotary position of the commutator 36 and filter disk 32, the biasing potential applied to the control grid 22,

and hence the intensity of the electron beam 14 will vary synchronously with the operation of the partial image selector or filter disk 32. Further, the sequence of variation of the biasing potential and therefore the relative intensities of the partial images may be selectively varied by adjusting the position of the arm 60 with respect to the resistance ring 52.

In the forms shown in Figs. 3 and 4, the screen 12 of the cathode ray tube is comprised of numerous elemental areas each of which is luminescent to one of the primary color components, and is arranged closely adjacent the other elemental areas luminescent to the other color components. Thus the screen is formed of many recurrent element groups, each of which contains the complete combination of the primary color components. Partial image selecting means is provided in both modifications for causing the electron beam to impinge successively and in synchronism with the transmitter, upon all the elemental areas of one color component and then the others. In the system of Fig. 3, this is accomplished in a manner similar to that shown in the patent to A. V. Bedford, No. 2,307,188 granted January 5, 1943, and includes an arrangement for sequentially electrically charging the screen elements so that the beam is urged toward the desired elements. In the system of Fig. 4, the arrangement is generally similar to that disclosed in my copending application Serial Number 621,397, filed October 9, 1945, for "System for reconstituting natural color television images," and includes a construction whereby commuted electric currents flow in various forms of electromagnets located in the vicinity of the screen to set up magnetic fields which selectively guide or direct the beam in appropriate sequence to the desired elements of the respective color components. In both of these latter systems, fidelity of color reproduction is dependent upon proportioning the excitation of each color component phosphor so that the amounts of light emitted by each are equal, or unequal in strict accordance with a predetermined standard of the transmitter system.

Referring to Fig. 3, the screen 12 includes a plurality of recurrent groups of interleaved elements 2, 3 and 4 which respectively luminesce in one of the three primary color components and which groups are sequentially electrically charged from a source of commuted electric potential 66. More particularly, display of the partial image in one color component at a time is accomplished by applying to the elements of one group, a relatively high potential from a battery or other source 68, such potential serving to attract the electrons of the scanning beam and favor impingement upon the desired elements. To secure the successive display of the partial images in all three of the color components, the positive potential is switched successively to the element groups by any suitable switching device 70 which in this form is operated by a motor 72 which in turn is controlled by the synchronizing circuit device 20. Thus the partial images are selected in a synchronous manner through operation of the device 66 and the charging of the element groups 2, 3 and 4 through connections 72', 74 and 76.

In order to provide the circuit arrangement of Fig. 3, with the novel color tone control of the present invention, the potentials supplied to the element groups are shunted by resistances 78, 80 and 82 and an appropriate portion of

the potential appearing in these resistances is tapped off the variable contacts of the resistances and is electronically switched into the control grid 22 of the tube 10 by diodes 84, 86 and 88. As shown, the diodes are connected to a resistance ring 90 at equally spaced points and a manually operable arm 92 cooperates with the ring and is connected to the control grid 22 and to a resistance 93. A suitable grid biasing battery 94 is adjustably associated with the other end of the resistance 93.

The potential switched by the diodes, as above described, will be distributed across resistance 93 and the resistance between arm 92 and the diode which at the moment, is conducting current. Since the proportion of potential appearing across resistance 93 may be varied by changing the values of either of these resistances, the proportion of potential passed from each diode to the control grid may be varied by changing the portion of the contact arm 92 on the resistance ring 90. The magnitude of the potential impressed on the control grid 22 will vary in accordance with the potential across resistance 93 and therefore the intensity of the partial image will be inversely proportional to the resistance comprised of the two electrically parallel parts of the resistance ring between the respective diode and the arm 92. This potential applied across the resistance 93 supplements the semi-fixed grid bias potential from the battery 94. It will be understood that any desirable intensity of colors in the composite image as viewed on the screen 12 may be secured by varying the position of the arm 92 with respect to the resistance ring 90. Further individual variations may be secured by varying the potentials supplied the respective diodes by the variable connections associated with the resistances 78, 80 and 82.

Under the condition shown in Fig. 3, where the arm 92 is positioned nearest the connection to the diode 84, the color component connected in circuit with diode 84 will be brightest, the color component associated with diode 88 will be next brightest, and the color component associated with diode 86 will be the least bright. Also under the momentary condition shown in Fig. 3, where the potential of battery 68 and therefore the electron beam 14 is being applied to the screen elements 3, the diode 86 is conducting current and as pointed out above, the partial image displayed by screen elements 3 will be the least bright of the three partial images.

The system of Fig. 4 is substantially the same as that shown in Fig. 3 with the exception of the manner in which the partial images are selected. In this form of the invention, the groups of elemental areas 2, 3 and 4 of the screen 12 are sequentially energized in order to provide recurring magnetic fields surrounding the areas so that the electron beam favors impingement upon the desired group defining a partial image. This image selection is obtained by providing the source of commuted electric current 96 with a plurality of commutators or switching devices 98, 100, 102 and 104 which are operated synchronously with the synchronizing device 20 as by a suitable motor 106. Operation of the motor and the commutators function to selectively and sequentially vary the direction of the flow of current from a battery or other current source 107 to the element groups 2, 3 and 4, as disclosed in my prior application referred to above.

In order to provide the circuit arrangement

of Fig. 4, with the novel color tone control of the present invention the currents supplied to the element groups are shunted by resistances 108, 110 and 112 which are associated respectively with the diode switching devices 84, 86 and 88 and with a switching device comprising a resistance ring 90 and an adjustable arm 92, as in the case of Fig. 3. Here again, the potential from the arm 92 is applied across the grid biasing resistance 93 and functions to apply a varying biasing potential to the grid 22 of the cathode ray tube.

In operation and at the instant shown in Fig. 4, elements 2 and 4 are carrying current, elements 3 are luminescing, and a positive potential across resistor 108 causes diode 84 to conduct current which flows through the resistance ring 90 to the rotatable arm 92 and thence through resistance 93. This current causes a potential drop across resistance 93 which is applied to the control grid 22 as a bias potential which sets a certain level of intensity to the luminescing elements 3. Since arm 92 is nearest to the connection to diode 84, the resistance between the diode and the arm will be less than the resistance between either of the other two diodes and the arm, and therefore elements 3 will be excited to brighter and more intense luminescence than the other elements.

At the next clockwise segment position of the commutator, elements 2 and 3 will be carrying current, elements 4 will be luminescing and diode 86 will be conductive. However, since arm 92 is positioned nearly 180 degrees away from the connection to diode 86, elements 4 will luminesce less brightly than either elements 2 or 3.

At still the next clockwise segment position of the commutator, elements 3 and 4 will be conducting current, elements 2 will luminesce and diode 88 will be conductive. Here again the potential across resistance 93, and applied as a biasing potential to the control grid 22 will be governed by the resistance between the diode 88 and the resistance 93 as determined by the position of the arm 92.

Thus, it is seen that the diodes 84, 86 and 88 act as electronic switches, completing the circuit only when the current in its associated element group is in one particular direction. Only one diode is conductive during each partial image selection.

It is pointed out that resistances 108, 110 and 112 are so connected that a potential drop appears across them in sequence, related to the sequence of partial image selection. A variable tap on each resistance provides a control of the proportion of each of these potentials to be utilized, while the arrangement of the resistance ring 90 with arm 92 is a single-knob type of variable control providing relative emphasis of any primary color component while allowing choice between the remaining two color components for secondary and tertiary emphasis.

While several embodiments of the invention have been shown and described herein with considerable particularity, it will be readily understood by those skilled in the art, that a wide variety of changes may be resorted to without departing from the spirit of the invention. Reference will therefore be had to the appended claims for a definition of the limits of the invention.

What is claimed is:

1. In a color television receiving system provided with a cathode ray tube having an image

modulated electron beam, and an image screen, means cooperating with said screen for sequentially selecting partial images of different primary color components, and means for varying the intensity of color of said partial images comprising a direct current potential source, means for deriving a potential from said source for each color component, and means controlled synchronously by said image selecting means for sequentially directly varying the average beam energy with said derived potentials to secure a variation in the intensity of color of said partial images.

2. In a color television receiving system provided with a cathode ray tube having an image modulated electron beam, a control electrode controlling the magnitude of energy contained in said beam, and an image screen, means cooperating with said screen for sequentially selecting partial images of different primary color components, and means for varying the intensity of said color components comprising a potential source, means including a voltage divider for deriving a potential from said source for each color component, switch means controlled synchronously by said image selecting means for sequentially directly biasing said control electrode with said derived potentials, and means for varying said potentials at will to secure a variation in the intensity of color of the said partial images.

3. In a color television receiving system provided with a cathode ray tube having an image modulated beam, a control electrode, and a screen comprised of a plurality of elemental areas arranged in a plurality of interleaved groups each of which is adapted to be luminescent in one of the primary color components, means for sequentially selecting partial images of different color components on said screen including means for sequentially applying an electric field from a potential source to said groups, and means for varying the intensity of said color components comprising said potential source, means including a voltage divider for deriving a potential from said source for each color component, diode switch means controlled synchronously by said image selecting means for sequentially directly biasing said control electrode with said derived potentials, and means for varying said potentials at will to secure a variation in the intensity of color of said partial images.

4. In a color television receiving system provided with a cathode ray tube having an image modulated electron beam, a control electrode, and an image screen, means providing partial images of different primary color components, and means for varying the intensity of said color components comprising a potential source, a voltage divider for deriving a potential from said source for each color component, said voltage divider comprising a closed resistance circuit having a plurality of fixed connections thereto and having also a variable contact arm, means connecting said arm and potential source so as to effect a simultaneous increase and decrease of the potentials derived for each color component upon movement of said arm, and means to apply the derived potentials directly to said control electrode to secure a variation in the intensity of color of said partial images.

5. A color television receiving system as defined in claim 2 wherein the voltage divider includes a closed resistance circuit having a plurality of fixed connections corresponding to the different color components, and having also, a variable contact arm, together with means to con-

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nect the arm to the potential source to secure a simultaneous variation of the derived potentials upon adjustment of said arm.

6. A color television receiving system as defined in claim 2 wherein said switch means comprises a plurality of unidirectionally conducting electron tubes.

7. In a color television receiver having a cathode ray tube provided with a control electrode, the method of producing color television images from video signals representing sequentially produced partial images of different primary color components which comprises receiving the signals representative of the sequentially produced partial images, producing a plurality of partial images of different color components from said signals and superimposing said partial images to form a composite color image, sequentially selecting the partial images of different color components as they are produced, deriving a potential for each color component, and applying said derived potentials directly to said control

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electrode to vary the intensity of the produced color components synchronously with the selection of the partial images.

THORNTON W. CHEW.

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