

Feb. 15, 1949.

A. B. BRONWELL
COLOR TELEVISION SYSTEM

2,461,515

Filed July 16, 1945

3 Sheets-Sheet 1

Fig. 1.

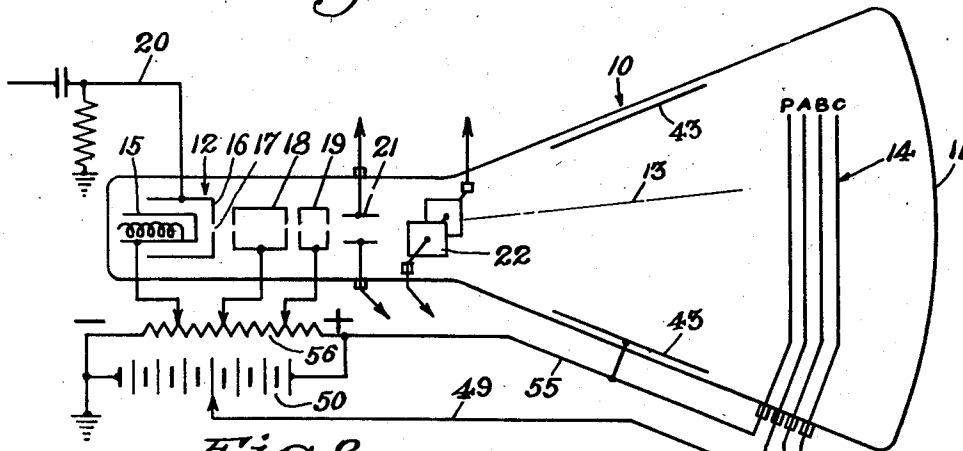


Fig. 2.

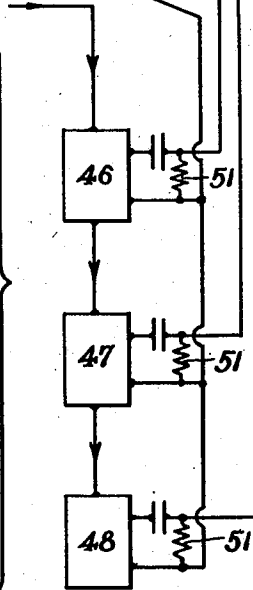
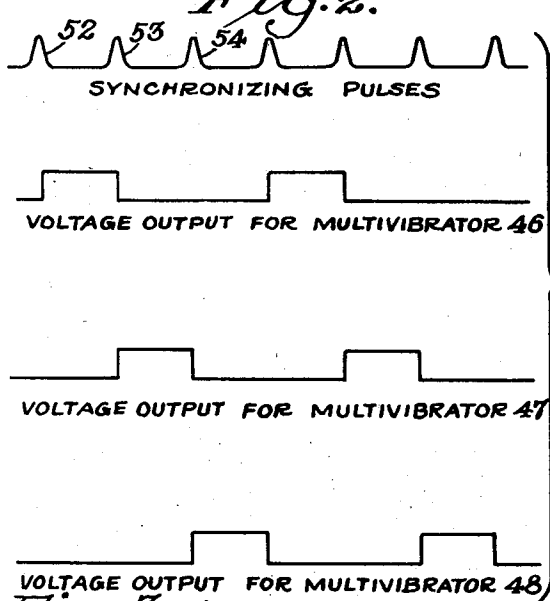
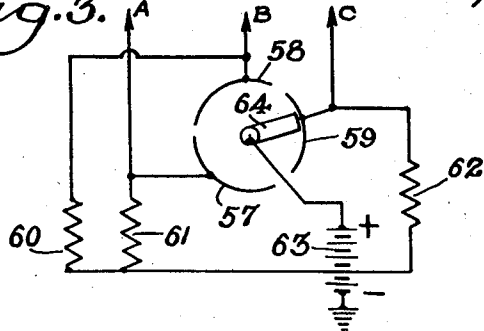


Fig. 3.



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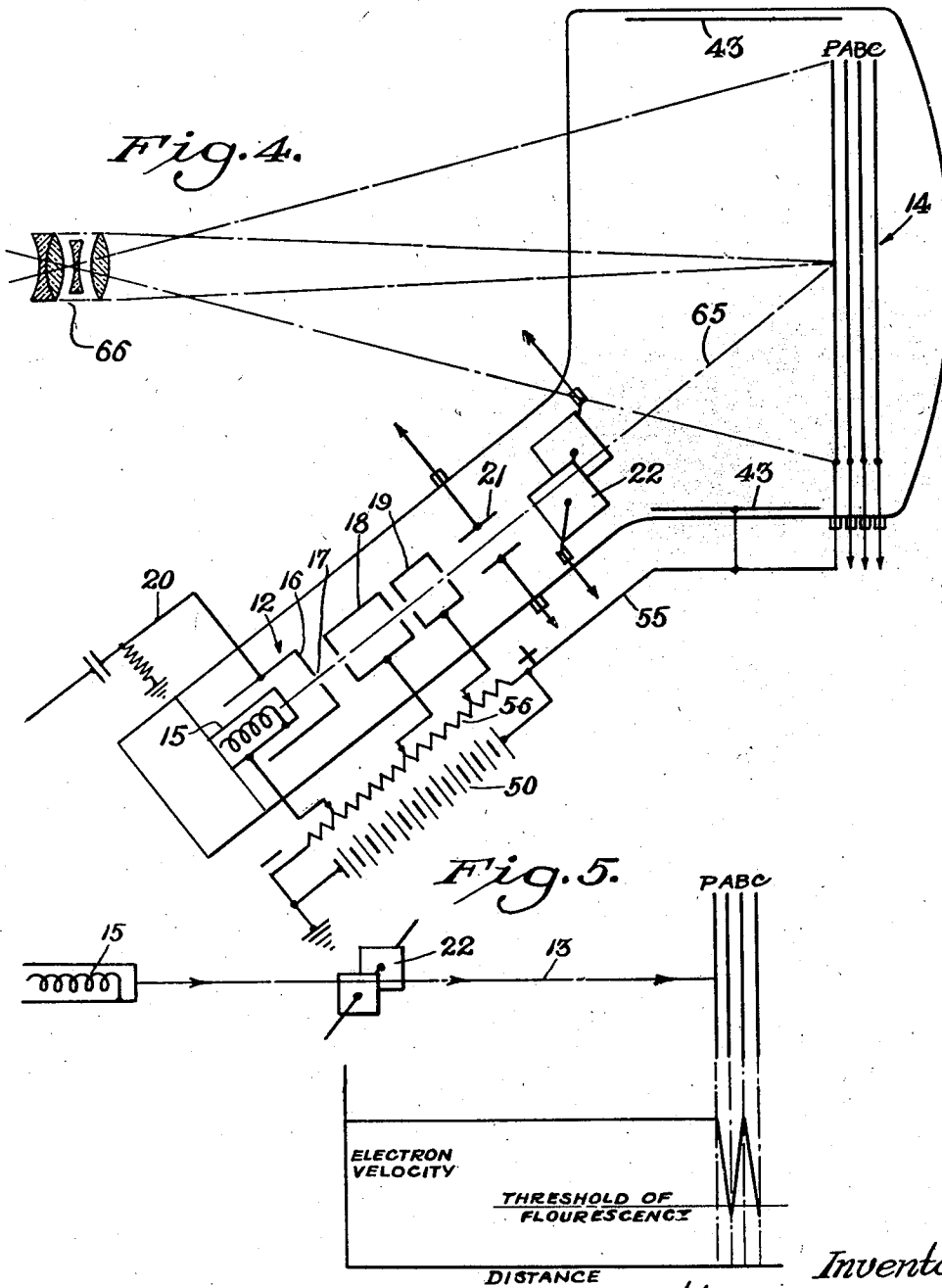
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3 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE

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COLOR TELEVISION SYSTEM

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16 Claims. (Cl. 178—5.2)

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In the past, color television has been attempted in a single viewing tube by using two or more electron guns directed on a fluorescent screen or target of special design. One such screen fluoresces on its rear face in red and the front face is in prismatic form with one face of the prisms fluorescing in green and the other in blue. In another type of color television a single electron gun is used and the screen is made up of a plurality of parallel conductors arranged in a single plane coated alternately with red, yellow and green fluorescent materials. In this system, however, relatively high potentials must be maintained between the different conductors if the electron beam is to be directed to the proper fluorescent material with the result that voltage breakdown between the parallel conductors is almost inevitable, particularly if the conducting strips are closely spaced for good picture definition.

In the present invention, an entirely different principle is employed for creating a natural color television image. Generally speaking, it consists of controlling the velocity of the electron beam as it passes through a series of fluorescent materials, each of which fluoresces with a different color under electron bombardment, so that only the desired fluorescent materials are caused to fluoresce at a given instant of time. The fundamental principle upon which my system is based takes into account the fact that the electron velocity of a freely traveling electron varies directly as the square root of its potential. Thus, the velocity of electrons striking any screen is dependent upon the screen potential and by reducing the potential of those screens which it is desired should not fluoresce and raising the potential of the screen which it is desired should fluoresce, a selective color sequence may be obtained at the receiver. In order to make it possible to maintain potential differences between the various color screens, they are made conducting or semi-conducting and are stacked parallel to but electrically insulated from each other. Separate leads are brought out from each screen so that the screen potentials may be commutated in the same color sequence and in synchronism with the color sequence at the transmitter.

One advantage of this method of multi-color television system is that when, at any instant, one screen, such as the red screen, is fluorescing brightly, the other two screens may have their potentials adjusted so that these screens fluoresce faintly. Not only does this produce a better definition and brighter image but also gives a better

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blending of color. Also it tends to make less noticeable the changing color sequence from one frame to the next.

The principal object, therefore, of the present invention is to provide a television system incorporating this novel principle and to provide the necessary component parts for use in the system.

Further and other objects and advantages will become apparent as the disclosure proceeds and the description is read in conjunction with the accompanying drawings in which—

Fig. 1 is a diagrammatic view showing a preferred embodiment of the invention;

Fig. 2 is a diagram which shows one type of timing sequence for applying additional positive potential to the component screens of the beam target;

Fig. 3 shows an alternate method of commutating the application of potential to the component screen of the beam target;

Fig. 4 is a schematic view of a receiving tube embodying the present invention but designed for image projection;

Fig. 5 is a diagram which illustrates the manner in which the electron beam velocity varies as the electrons pass through the screen surfaces;

Fig. 6 is a view which illustrates the staggered relation of the conductors which comprise the composite screen of Fig. 12;

Figs. 7, 8 and 9 show, respectively, the manner in which the conductors may be arranged in the component screens of the beam target so as to prevent undesirable shadows from the conductors;

Fig. 10 is a front view showing the screens of Figs. 7, 8 and 9 assembled for beam reception;

Fig. 11 shows a coarse mesh screen which is suitable for use as a constant potential anode immediately adjacent to the image screen on the electron gun side;

Fig. 12 shows another way in which the image-creating screens may be constructed;

Fig. 13 shows a holder for supporting the multiple screens in proper relationship to each other to stagger the conductors, and is a sectional view taken on the line 13—13 of Fig. 12;

Fig. 14 is an enlarged sectional view similar to Fig. 6 but showing an alternate way of coating the grid wires and conductors of one of the screens with fluorescent material;

Fig. 15 shows an enlarged cross-sectional view of a composite screen target in which the conductors on fluorescent material are formed in strips on a screen base of insulating material;

Fig. 16 shows a fragment of a screen in which

the entire front surface of the screen is semi-conducting and coated with a fluorescent material;

Fig. 17 shows a screen made up of a plurality of intercalated plates having their edges semi-conducting and coated with a fluorescent material; and,

Fig. 18 shows the manner in which the composite plates of the screen in Fig. 17 may be connected together to apply varying potentials to selected groups of the intercalated plates.

It should be understood that in the accompanying drawings, no attempt has been made to draw the parts to scale and many parts have been greatly exaggerated or enlarged to clearly illustrate constructional features.

It should also be understood that the invention is not limited to the particular embodiments herein disclosed but, on the contrary, may be variously embodied within the scope of the appended claims. Also it may be used in other applications, as for example, colored oscillography.

Referring first to Fig. 1, a cathode ray tube 10 is diagrammatically shown which comprises an evacuated glass shell 11 into which an electron gun, generally designated 12, is sealed for projecting an electron beam 13 on an image-creating device generally designated 14.

The gun is of conventional form and includes a heated cathode 15, a control grid 16 having an aperture 17 for directing the electron flow in beam form, and accelerating and focusing anodes 18 and 19.

As is well known, the transmitted television picture signal, after being detected, and the synchronizing pulse removed, is introduced into the receiving tube 10 through a conductor 20 connected to the control grid 16 and the electron beam is thereby modulated with the picture signal.

The direction of the beam is controlled by conventional vertical and horizontal deflecting means which may be either electrostatic or electromagnetic—electrostatic means being illustrated in Fig. 1 and comprising vertical deflecting plates 21 and horizontal deflecting plates 22 which are connected in a known manner with sawtooth generators synchronized by multi-vibrators controlled by the vertical and horizontal synchronizing pulses in the transmitted television signal. If electromagnetic deflection is used, well known arrangements of multi-vibrators and sawtooth generators may be used to control the beam deflection.

The image-creating means or beam target 14 comprises a plurality of parallel screens A, B and C, each of which is of minimum thickness, say on the order of one-tenth of a millimeter, is at least semi-conducting, is relatively transparent to light and electrons, and is coated with a fluorescent material which fluoresces with a desired color when subjected to electron bombardment of sufficient intensity. The purpose of this arrangement is so that each of the screens will be made to fluoresce by the direct bombardment of the fluorescent material by primary electrons from the electron beam, and all but the last screen (i. e., the screen farthest away from the electron gun) should be relatively transparent to light and electrons, in order to be reached by the primary electrons from the beam. Even the last screen should be transparent to light if the image is to be viewed from the far side of the electron gun.

The individual screens may take different forms, as shown in Figs. 6 to 18, inclusive.

For example, the screen A may take the form shown in Fig. 7 and consist of a metal frame 23 having a plurality of metal grid wires 24 tightly stretched vertically across the frame and supported at one or more points along their length by horizontal grid wires 25. The wires may be of nickel, German silver, tantalum, tungsten, or any other suitable metal. The wires should be of the smallest possible diameter and preferably the vertical wires 24 should be spaced apart on the order of one one-hundredth of an inch.

Similarly, screen B shown in Fig. 8 may be of like construction but in this case, the parallel conductors 24 are horizontal instead of vertical and the supporting grid wires 25 are, in this case, vertical instead of horizontal.

Screen C, shown in Fig. 9, is also of similar construction but the conductors 24 in this case, are set diagonally across the frame 23, and the supporting grid wires 25 are set diagonally across the frame at right angles to the conductors 24.

Preferably, in all three screens A, B and C shown in Figs. 7, 8 and 9, the supporting grid wires 25 are interwoven with the parallel conductors 24 as shown in Fig. 14. In each instance, the thin wires are drawn taut before being anchored to the frame 23, which may be done by welding or in any other suitable manner.

Each of the screens A, B and C, shown in Figs. 7 to 9, inclusive, is coated with suitable fluorescent material fluorescing in a different color. For example, the screen A may be coated with a material fluorescing in red, the screen B with one fluorescing in blue, and the screen C with one fluorescing in yellow or green. The fluorescent material may be applied to the screen by dipping the entire screen into a bath containing the fluorescent material or it may be applied by spraying, settling or painting on the wires, either before or after they are mounted in the frame, with fluorescent material bonded to individual wires as shown in Fig. 6 or coating the entire screen as shown in Fig. 14. The particular fluorescent materials used may be selected from the large number of fluorescent materials whose properties are well known but preferably are chosen from those which are most transparent to light and electrons and which have approximately the same threshold of response to electron bombardment. For example, the fluorescent materials identified in Pender and McIlwain's Electrical Engineers' Handbook, third edition rewritten, section 15, page 17, may be used with Zn_2SiO_4 for the green color, CaWO_3 for blue and Mg_2SiO_4 for red.

When the screens A, B and C, shown in Figs. 7 to 9, inclusive, are assembled to form the composite image-creating screen, they present the appearance shown in Fig. 10 and it will be apparent to those skilled in the art that the reason for using vertical, horizontal and diagonal conductors in the three screens is to avoid undesirable shadow effects. It will be understood, of course, that in assembling the three screens, they should be insulated from one another, as by mica or plastic, or, the frames themselves may be made of insulating material using a thin metallic border strip to join the conductors contained within the frame.

Instead of employing screens in which the conductors 24 are set at different angles, each of the screens A, B and C may be composed of say horizontal wires closely spaced and of minimum

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thickness with their intermediate portions supported by transverse, in this case, vertical grid wires 25. With these wires accurately located in the metal frame, shadow effects may be avoided by slightly displacing the three screens as they are mounted in their holder, generally indicated at 26 in Fig. 13. In other words, if the screen B is displaced downwardly from the screen A a distance amounting to one-third of the distance between the individual conductors 24, and the screen C is displaced another one-third of the distance between the conductors 24, the conductors take on a staggered relation such as shown in Fig. 6 so that the conductors of one screen will not obscure the fluorescence produced on another screen, nor will the conductors of one screen block electron flow to the conductors of a screen in rear of it.

The holder shown in Fig. 13 is, of course, greatly magnified and is preferably made of plastic, mica, or other suitable insulating material. It comprises stepped clamping members 27 and 28, each of which is step recessed, as shown in Fig. 13, to offset screens A, B and C in the manner previously described and to hold the composite screen in tightly clamped relation. A constant potential screen P, which will be described later, is also clamped within the holder 26 and suitable marginal insulators 29 separate the components of the image-creating target. The clamps 27 and 28 are secured together in any suitable manner as by screws 30.

Instead of forming the screens of fine wire, the conducting screens may be formed by taking a thin sheet of transparent insulating material such as Cellophane, mica, or the like, and then ruling on or otherwise applying conducting strips of colloidal graphite. Still another way is to use a similar base material coated with photographic emulsion containing a silver salt and then photographing on the plate an image of the desired pattern after which the emulsion is developed and fixed leaving on the insulating base the desired network of transparent conducting lines, as shown in Fig. 15 in which the reference character 31 represents the insulating base or sheet to which the photographic emulsion was applied and which, after developing and fixing, left transparent conducting lines 32. The fluorescent material 33 may then be applied to the conducting strips 32 and the screen assembled in the same staggered relation shown in Fig. 13.

If the photographic emulsion chosen, after exposure to light and subsequent developing and fixing is sufficiently transparent to light and electrons, the entire screen 34 (Fig. 16) of Cellophane, mica, or other transparent insulating material, may be coated with the photographic emulsion, exposed to light and then developed and fixed to form a conducting surface 35 over which the fluorescent material 36 may be applied.

In Figs. 17 and 18, the image-creating screen comprises a plurality of thin intercalated plates 37, each having its forward edge coated with a transparent conducting surface 38 to which is applied a fluorescent material 39 and the plates are stacked in a given order, as shown in Fig. 17, so that every third plate lies in the same vertical plane, those in the vertical plane closest to the source of electrons being coated with a fluorescent material of one color, those lying in the next closest vertical plane being coated with a fluorescent material of another color, and those lying in the remotest vertical plane being coated with a fluorescent material of a third color. The ends

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of the conducting strips may be connected together, as shown in Fig. 18, in which it will be seen that a conducting strip 40 joins the outermost series of conductors, a conducting strip 41 joins the intermediate conducting strips, and a conductor 42 joins the innermost conducting strips. This effectively provides a three-plane separation of potentials for color selectively.

It is not necessary for the fluorescent material on the screens to be on the same side of the screen as the conducting material. As a matter of fact, when the screens are formed using an insulating base of cellulose acetate, mica, glass, or the like, with the conducting lines applied by a photographic process or by inscription, it is unnecessary to employ insulating separators because the base material itself serves this purpose. If desired, with screens of this type, the material of the screen may be reinforced by a grid of very fine wires which are separated rather far apart. This also would help to equalize the potential over the surface of any one screen.

In all of the screens which have been described, the same characteristic is present; namely, the composite image-creating target or screen comprises two or more separate screens, each of which is at least semi-conducting, is relatively transparent to light and electrons, and is coated with a fluorescent material which emits radiations of a desired color when subjected to electron bombardment of sufficient intensity. The screens are insulated from each other so that their relative potential may be varied.

The fundamental principle upon which my multicolor television system is based is the fact that the electron velocity of a freely traveling electron varies directly as the square root of its potential. Therefore, by reducing the velocity of the electron beam below the threshold of fluorescence of those screens which it is desired should not fluoresce, and then raising the velocity of the beam as it strikes the screen which it is desired should fluoresce, it is possible to transmit television signals in predetermined color sequence and by properly coding the transmitted signal, commutate the potentials on the several screens making up the target in synchronism with the transmitted signal so that only the red screen fluoresces on the transmitted red television signal, only the blue screen fluoresces on the transmitted blue television signal, and only the yellow or green fluoresces on the transmitted yellow or green transmitted television signal. The transmission of a given sequence of colored television signals by synchronized rotating color filters is well known and need not be described here, as are also the various methods of scanning every line in sequence or every other line in what is known as interlaced scanning. The scanning may be parallel to the screen conductors or at an angle thereto.

It will be understood that any two or more colors may be chosen for use in any system, although the three primary colors would normally be used. The colors may be changed at the end of every scanning line, at the end of a frame, or at any other desired interval but preferably, they are changed at the end of each line in order to increase the picture definition. This is made possible by the ease of changing from one color to another by merely varying the screen potentials and the horizontal or vertical synchronizing pulses may be used to control the color sequence at the receiver.

Referring now to Fig. 1, there is shown a pre-

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ferred method of commutating the screen potentials in synchronism with the transmitted television signal.

In addition to conventional accelerating and collecting anodes 43, a constant potential screen P is preferably used immediately in front of and closely adjacent to the image-creating screen or target 14. This screen may be formed in a variety of ways, one of which is shown in Fig. 11 in which fine wires 44 are woven together into a coarse grid pattern and mounted in a frame 45 which is clamped in the holder 26 as previously described. The purpose of the constant potential screen P is to fix the potential and hence the velocity of the electrons at a predetermined value, immediately before the electron beam strikes any one of the fluorescent screens A, B and C. Except for the fact that the constant potential screen P is not coated with fluorescent material, and has a very coarse grid pattern, it is otherwise very similar to the screens A, B and C.

If the constant potential screen P is held at a positive potential higher than that of the deflecting plates, the electrons will be accelerated after deflection with the result that for a given deflecting potential applied to the deflection plates, there will be a larger deflection of the electrons than would occur if the deflecting plates and constant potential grid P were at the same D. C. potential.

One way to control the velocity of the electron beam as it strikes the target 14 is shown in Fig. 1 and comprises a plurality of keyed multi-vibrators 46, 47 and 48 controlling screens A, B and C, respectively. Each of the screens may be normally held at a potential of say 700 volts by a tap 49 from battery 50, the potential being applied to the screens, in each instance, through resistances 51 associated with each multi-vibrator. The multi-vibrators 46, 47 and 48 are constructed and arranged in a well known manner so that when the first synchronizing impulse 52 controlling horizontal deflection, for example, reaches the multi-vibrator 46, it feeds additional potential of say 800 volts in the form of a square voltage wave across its resistance 51, thereby raising the potential on screen A to approximately 1500 volts. When the second synchronizing pulse 53 comes along, the multi-vibrator 46 returns to normal and multi-vibrator 47 begins its square wave impulse, as shown in Fig. 2 and the potential of screen B is raised to approximately 1500 volts while the potential on screen A returns to its normal voltage of 700 volts and screen C also remains at that voltage. When the third synchronizing pulse 54 comes along, multi-vibrator 47 ceases its output and multi-vibrator 48 puts out a square voltage wave which raises the potential on screen C to 1500 volts while screens A and B are at their normal voltage of 700 volts. As additional synchronizing pulses are received, the sequence repeats with the result that the potential on the screens A, B and C are commutated in timed relation to the transmitted television signal. In a three-color receiver, this could be arranged so that every third line or very third frame is scanned in the same color, with the colors rotated in a given sequence. In interlaced scanning, the colors could change at the end of each half frame, for example.

The effect on the electron velocity is shown diagrammatically in Fig. 5. The electron velocity at P being the value determined by the constant potential on the screen P and then assuming that at a given instant screens A and C are not to

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fluoresce but that screen B is to fluoresce, the potential on screen B is brought to approximately the same value as screen P, while the potential on screens A and C is dropped to a point that the electron velocity is below that at which screens A and C will fluoresce to any appreciable degree. In other words, the electron velocity corresponds to the potential on the several screens, with the result that the electron velocity will vary substantially in the manner shown in Fig. 5.

The constant potential screen P may be connected by a conductor 55 with the positive side of the battery 50, as may also the accelerating and collecting anode 43. A resistance 56 may be connected across the battery 50, and the cathode 15, and accelerating and focusing anodes 18 and 19, connected at suitable points to this resistance in a manner well known in the art.

Instead of commutating the potentials of screens A, B and C electronically, as shown in Figs. 1 and 2, the potentials may be controlled by other suitable means, as for example, a rotating commutator such as shown in Fig. 3, which is driven in synchronism with the transmitted television signal. The commutator segments 57, 58 and 59 are connected, respectively, to the screens A, B and C and a constant potential of say 700 volts is applied to the three screens through resistances 60, 61 and 62, respectively, one side of each of which is tapped into battery 63 at a suitable point. The commutator arm 64 is connected to the positive side of the battery so that as it sequentially wipes the commutator segments, additional potential is applied to the corresponding screen with the same effect as previously described.

In the form of the invention shown in Fig. 1, the multi-color television image is viewed through the end of the tube 10 on the side of the screen remote from the electron beam but it may also be viewed from the other side, as shown in Fig. 4 in which the electron beam 65 strikes the target 14 at an angle and is then viewed from the left hand side of the tube or may be projected through a suitable lens system, as shown at 66.

Throughout the specification and claims the statement that each of the parallel superposed screens is relatively transparent to light and electrons, or words of like effect, is intended to mean that each such screen is sufficiently transparent to light and electrons as to permit electrons to impinge upon each of the superposed screens and to permit light emitted from each screen to be viewed by an observer positioned on the viewing side of the composite screen.

Also, the expression "superposed parallel screens" is intended to mean that the component screens are in parallel planes at different distances from the viewer.

I claim:

1. In a multi-color television system, the combination of an electron gun for producing an electron beam, means for deflecting the beam both horizontally and vertically, image-creating means in the path of the beam including a plurality of closely associated parallel screens each being relatively transparent to light and electrons and coated with a fluorescent material which radiates a desired color under electron bombardment, means for modulating the electron beam in accordance with a transmitted television signal, and means for changing the velocity of the electron beam in synchronism with the television signal to cause one of said screens to fluoresce more brilliantly than another of said screens.

2. In a multi-color television system, the combination of an electron gun for producing an electron beam, means for deflecting the beam both horizontally and vertically, image-creating means in the path of the beam comprising a plurality of closely associated parallel screens, each being relatively transparent to light and electrons, at least semi-conducting, and coated with a fluorescent material which radiates a desired color under electron bombardment, means for modulating the electron beam in accordance with a transmitted television signal, means for applying selected potentials to said screens to cause the electron beam to have relatively high velocity when striking a screen that is to fluoresce and relatively low velocity when striking a screen that is not to fluoresce, and means for commutating the application of said potentials in synchronism with the transmitted television signal.

3. In a multi-color television system the combination of an electron gun for producing an electron beam, means for modulating the beam in accordance with a transmitted television signal, image-creating means in the path of the beam comprising a plurality of semi-conducting fluorescent surfaces, some lying in one plane at a given distance from the gun and fluorescing in one color and others lying in a parallel plane at a greater distance from the gun and fluorescing in a different color though at substantially the same electron velocity, and means for applying varying voltages to said surfaces in selected sequence and in synchronism with the transmitted television signal to control the velocity of the electron beam in the vicinity of said surfaces and hence their selective fluorescence.

4. In a multi-color television system, the combination of an electron gun for producing an electron beam, means for deflecting the beam both horizontally and vertically, image-creating means in the path of the beam comprising a plurality of closely associated parallel screens, each being relatively transparent to light and electrons and coated with a fluorescent material which radiates a desired color under electron bombardment, means for modulating the electron beam in accordance with a transmitted television signal, means for changing the velocity of the electron beam in synchronism with the television signal to cause one of said screens to fluoresce more brilliantly than another of said screens, and a constant potential, light and electron transparent, screen interposed between the electron gun and the image-creating means and positioned closely adjacent to the latter for fixing the velocity of the electron beam immediately before it strikes the parallel fluorescing screens.

5. In a multi-color television system, the combination of an electron gun for producing an electron beam, means for deflecting the beam both horizontally and vertically, image-creating means in the path of the beam comprising a plurality of closely associated parallel screens, each being relatively transparent to light and electrons, at least semi-conducting, and coated with a fluorescent material which radiates a desired color under electron bombardment, means for modulating the electron beam in accordance with a transmitted television signal, means for applying selected potentials to said screens to cause the electron beam to have relatively high velocity when striking a screen that is to fluoresce and relatively low velocity when striking a screen that is not to fluoresce, and means for commutating

the application of said potentials in synchronism with the transmitted television signal, at least one of said screens being formed of a plurality of closely and evenly spaced fine grid wires coated with said fluorescent material.

6. In a multi-color television system, the combination of an electron gun for producing an electron beam, means for deflecting the beam both horizontally and vertically, image-creating means in the path of the beam comprising a plurality of closely associated parallel screens, each being relatively transparent to light and electrons, at least semi-conducting, and coated with a fluorescent material which radiates a desired color under electron bombardment, means for modulating the electron beam in accordance with a transmitted television signal, means for applying selected potentials to said screens to cause the electron beam to have relatively high velocity when striking a screen that is to fluoresce and relatively low velocity when striking a screen that is not to fluoresce, and means for commutating the application of said potentials in synchronism with the transmitted television signal, at least two of said screens having a plurality of closely and evenly spaced parallel conductors coated with said fluorescent material, the screens being so arranged with respect to each other that the corresponding conductors of said two screens are staggered relative to the electron beam.

7. An image-creating screen for color television including a plurality of superposed parallel screens disposed to sequentially intersect a beam of electrons and each being relatively transparent to light and electrons, at least semi-conducting, and coated with a fluorescent material which radiates a desired color under electron bombardment, at least two of said screens being formed of a plurality of closely and evenly spaced parallel conductors coated with said fluorescent material, the screens being so arranged with respect to each other than the corresponding conductors of said two screens are in staggered relation.

8. An image-creating screen for color television including a plurality of superposed parallel screens disposed to sequentially intersect a beam of electrons and each being relatively transparent to light and electrons, at least semi-conducting, and coated with a fluorescent material which radiates a desired color under electron bombardment, at least two of said screens having a plurality of spaced parallel conductors coated with said fluorescent material, the conductors of one of said two screens being at an angle with respect to the other of said two screens.

9. An image-creating screen for color television including a plurality of superposed parallel screens disposed to sequentially intersect a beam of electrons and electrically insulated from each other each comprising a surface which is at least semi-conducting and is coated with a fluorescent material, and at least one of said screens being relatively transparent to light and electrons.

10. An image-creating screen for color television including a plurality of intercalated plates each having one edge thereof semi-conducting and coated with a fluorescent material, the edges of some plates being inset with respect to the corresponding edges of other plates.

11. In a multi-color television system, the combination of an electron gun for producing an electron beam, means for deflecting the beam both horizontally and vertically, image-creating means in the path of the beam comprising

a plurality of closely associated parallel screens, each being relatively transparent to light and electrons, at least semi-conducting, and coated with a fluorescent material which radiates a desired color under electron bombardment, means for modulating the electron beam in accordance with a transmitted television signal, means for applying selected potentials to said screens to cause the electron beam to have relatively high velocity when striking a screen that is to fluoresce and relatively low velocity when striking a screen that is not to fluoresce, and means for commutating the application of said potentials in synchronism with the transmitted television signal, said commutating means comprising a plurality of keyed multi-vibrators for delivering voltage waves to the screens in selected sequence in response to said beam deflecting means.

12. In a multi-color television system, the combination of an electron gun for producing an electron beam, means for modulating the electron beam in accordance with a transmitted television signal, means establishing synchronizing pulses in the television signal for deflecting the beam both horizontally and vertically, image-creating means in the path of the beam comprising a plurality of closely associated parallel screens, each being relatively transparent to light and electrons, at least semi-conducting, and coated with a fluorescent material which radiates a desired color under electron bombardment, means for applying selected potentials to said screens to cause the electron beam to have relatively high velocity when striking a screen that is to fluoresce and relatively low velocity when striking a screen that is not to fluoresce, and means for commutating the application of said potentials in synchronism with the transmitted television signal, said commutating means comprising a plurality of keyed voltage wave-producing instrumentalities for delivering voltage waves to the screens in selected sequence in response to the synchronizing pulses in the transmitted television signal.

13. In a multi-color television system, the combination of an electron gun for producing an electron beam, means for deflecting the beam both horizontally and vertically, image-creating means in the path of the beam comprising a plurality of closely associated parallel screens, each being relatively transparent to light and electrons, at least semi-conducting, and coated with a fluorescent material which radiates a desired color under electron bombardment, means for modulating the electron beam in accordance with a transmitted television signal, means for applying selected potentials to said screens to cause the electron beam to have relatively high velocity when striking a screen that is to fluoresce and relatively low velocity when striking a screen that is not to fluoresce, and means for commutating the application of said potentials in synchronism with the transmitted television signal, said commutating means including a motor driven rotary commutator for delivering

voltage waves to the screens in selected sequence and in timed relation to the television signal.

14. In a cathode ray tube, the combination of an electron gun for producing an electron beam, means for modulating the beam in a predetermined manner, a fluorescent screen in the path of the beam comprising a plurality of superposed parallel screens disposed to sequentially intersect said beam, each of said screens comprising a surface which is at least semi-conducting and is coated with a fluorescent material, and at least one of said screens being relatively transparent to light and electrons, and means for changing the velocity of at least a part of the electron beam in synchronism with the modulating means to cause fluorescence of selected portions of said screen.

15. An image-creating screen for color television including a plurality of superposed parallel screens electrically insulated from each other and disposed to sequentially intersect a beam of electrons, each screen with the possible exception of the one farthest removed from the beam source being at least partially transparent to light and electrons, and consisting of an insulating base coated with semi-conducting or conducting material, and at least two of said screens being coated with different fluorescent materials whereby said two screens fluoresce in different colors when bombarded by primary electrons from said beam.

16. An image-creating screen for color television including a plurality of superposed parallel screens disposed to sequentially intersect a beam of electrons and electrically insulated from each other, each comprising a surface which is at least semi-conducting and is coated with a fluorescent material, at least one of said screens being relatively transparent to light and electrons, and another superposed parallel screen associated with the fluorescent coated screens and being at least semi-conducting for carrying a constant potential thereon.

ARTHUR B. BRONWELL.

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562,168	Great Britain	June 21, 1944

Certificate of Correction

Patent No. 2,461,515.

February 15, 1949.

ARTHUR B. BRONWELL

It is hereby certified that errors appear in the printed specification of the above numbered patent requiring correction as follows:

Column 10, line 42, claim 7, for the word "than" read *that*; column 11, line 17, claim 11, for "delivereing" read *delivering*;
and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 17th day of May, A. D. 1949.

[SEAL]

THOMAS F. MURPHY,*Assistant Commissioner of Patents.*