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COLOR TELEVISION SCREEN

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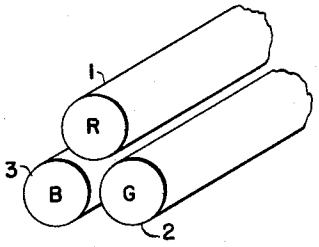


Fig. 1

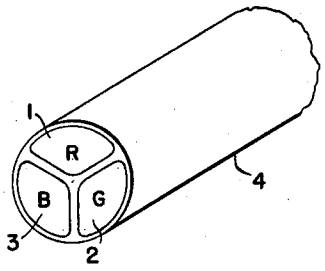


Fig. 2.

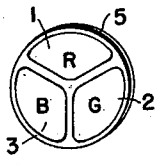


Fig. 3.

Fig. 4.

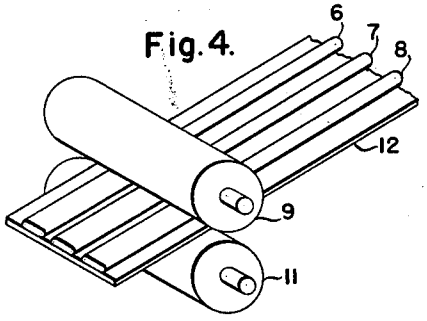
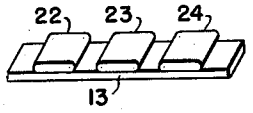


Fig. 5.



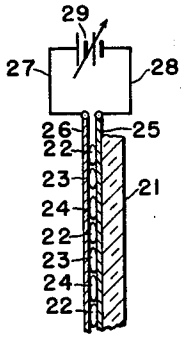


Fig. 6.

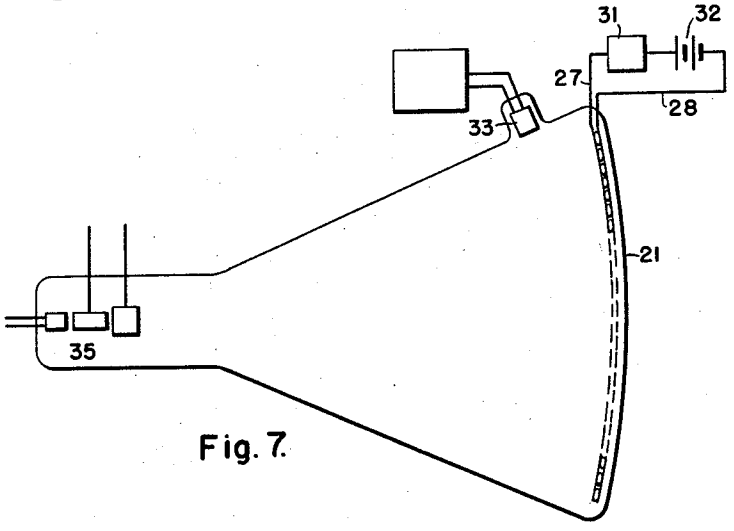


Fig. 7.

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COLOR TELEVISION SCREEN

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Application February 19, 1953, Serial No. 337,710

1 Claim. (Cl. 313—73)

My invention relates to color television receivers and in particular relates to a new type of kinescope embodying a novel electron phosphor screen for reproducing television images in color.

Practically the only color television system today that has been proved really successful in reproducing high grade pictures employs a kinescope which projects a cathode ray beam through fine holes in a mask-plate onto dots of red-emitting, green-emitting and blue-emitting phosphor distributed in a precisely-spaced aray on the viewing screen. This requires a tolerance of less than ±0.0015 inch in positioning the mask and the dots, which can be attained in factory production only at the expense of very costly rejects and shrinkage.

Such precise tolerances are inevitable in any color-reproduction system which relies on positioning to attain color-separation in reproduction, so that a change of approach to solution of the problem is necessary. My system effects this change by resorting to electric potentials to determine the color of the light being emitted by the screen phosphors at any instant, and this general method probably offers the ideal approach to a practicable solution. The kinescope screen would probably be in many respects almost indistinguishable in geometry from those of present black-and-white picture tubes and should require no greater precision in manufacture than do the latter.

There are strong reasons for thinking that it will be possible ultimately to produce phosphors containing in the same crystal different activators which will make the color of the phosphor a function of the energy of the electrons in the beam impinging on the phosphors of the reproducing screen. Development of such phosphors which will be technically satisfactory may, however, require several years of fundamental research. My present disclosure relates to two expedients which may be short-cuts to the same goal.

One possibility lies in making the particle size of the phosphor very small, mixing with a suitable binder such as nitrocellulose, and extruding the resulting paste into filaments of diameter of the order of five to ten mils. Three such filaments, respectively composed of a red-emitting, a green-emitting and a blue-emitting phosphor, are continuously pushed through a suitable die.

One object of my invention is to provide a new and improved system for producing color television pictures.

Another object is to produce a new and improved kinescope for color picture reproduction purposes.

Another object is to provide new and improved methods of producing tubes suitable for reproducing pictures in color.

Another object is to provide an improved type of color picture reproduction which employs irradiation of the screen with auxiliary radiation from a source local to the receiver to increase the brightness at which the emitters of certain colors radiate light when signals of corresponding color are arriving at the picture screen.

Yet another object is to employ screens in which electroluminescent phosphors are stimulated by signals of a particular color to emit light of that color with increased brightness when they arrive at the receiver.

Another object is to provide a novel structure for color-picture reproducing tubes.

Still another object is to provide color picture reproducing screens of a novel type.

Yet another object is to provide a novel method for producing phosphor screens which are controllable in color in response to electric potential effects.

Other objects of my invention will be evident to those skilled in the art on reading the following description taken in connection with the drawings, in which:

Figure 1 is a view in perspective of a component of my improved phosphor screen at an intermediate point in its process of manufacture;

Fig. 2 is a similar view of the subject matter of Fig. 1 at a second stage of the process of manufacturing it;

Fig. 3 is a similar view of the same component at a still more advanced stage of the process;

Fig. 4 is a view in perspective illustrating one step in a different process of manufacturing components for a phosphor screen in accordance with my invention;

Fig. 5 is a similar view illustrating the component initially shown in Fig. 4 at a yet more advanced stage in the manufacture;

Fig. 6 is a detailed view of a kinescope screen employing my invention; and

Fig. 7 illustrates a kinescope employing a screen according to my invention.

Referring in detail to Figs. 1, 2 and 3, particles of three different phosphors which respectively emit red, green and blue light are made up with a fineness of five to ten mils. This may be done in any way known to those skilled in the art, for example by grinding and sieving. The red-emitter may, for instance, be rhombic $Zn_3(PO_4)_2$:Mn, the green-emitter may be $ZnSiO_4$:Mn, and the blue-emitter may be a mixture of 50% $CaMg(SiO_3)_2$:Ti and 50% Cubic ZnS:Ag. The energy required in an incident electron to excite light of a given intensity in a given phosphor may be varied by mixing with the phosphor certain materials such as thoria or silica or other refractory substances. Thus it is possible to control the light intensity which the respective phosphors are caused to emit by an electron beam having a given accelerating voltage, maintaining the light intensity of, say, the green and blue phosphors low and exciting the red phosphor to full intensity by giving the screen a lower potential relative to the electron gun; fully exciting the green when desired by giving the screen an intermediate potential; and fully exciting the blue phosphor only when a high potential is given the screen. The accelerating voltage or electron energy may be modified by varying the potential between the cathode of the electron gun and the screen, thereby determining the excitation of selected phosphors. The video intelligence may be impressed on the control grid of the electron gun and thus the intensity of the electron beam is controlled by varying the number of electrons.

Corresponding with the above principle, the green-emitting phosphor powder is admixed, for example, with finely divided silica, let us say, having a particle diameter of from 3 to 5 microns in the amount of about 5 to 10 percent by weight; and the blue-emitting phosphor powder is admixed with thoria of about 3 to 5 microns particle diameter in the amount of about 10 to 20 percent by weight.

The powders made as just described are respectively mixed in any of the ways well-known in the filament art with a binder such as nitrocellulose and extruded through

dies to produce three filaments of substantially circular or other suitable section of about 5 to 10 mils in diameter which are then combined as indicated in Fig. 1. One way of combining the three filaments as shown would be to use a die with three outlets positioned as shown by the circular filament ends in Fig. 1, the respective outlets communicating with separate containers of the three mixes of phosphor and binder.

The trefoil filament **1, 2, 3** of Fig. 1 may then be coated with more of the binder and passed through a second die having a circular outlet of area slightly greater than the aggregate area of the three component filaments, from which it will emerge with a cross-section like that shown in Fig. 2. The filament **4** together with its coating of binder is thin, having a diameter of twenty to twenty-five mils, for example, and is sliced in a microtome to a thickness of about one to three mils to form flat pellets **5** such as appear in Fig. 3.

A large number of these pellets are then settled, through water or other suitable liquid vehicle, on the face of the glass screen for a picture tube. The pellets will settle flat against the screen face forming a sufficiently uniform layer of thickness determined by the length of the settling period. The layer may then be dried and the binder removed by heating to a temperature of around 150 to 200° C. Use of phosphors having different excitation threshold may supplement the addition of inert powders as a means of differentiating the excitation voltages to which the respective colors respond.

As an alternative to admixing silica or other powders with the phosphors, filaments comprising simply the respective color-emitting phosphors and nitrocellulose binder may be extruded, as described above, and the filaments then coated by dipping or dragging the filament through a suspension of silica or other refractory powder above described in water or other suitable vehicle. Alternatively, gaseous compounds of silicon or thorium may be used to deposit silica or thoria from the gaseous phase on such filaments.

Where filaments thus coated are used, the arrangements shown in Figs. 4 and 5 may be used to produce pellets for deposition on the screen. Thus red-emitting, green-emitting and blue-emitting phosphor filaments **6, 7, 8** coated as just described are passed through rolls **9, 11** in contact with a strip **12** of nitrocellulose to which they are attached by mere pressure or by additional binder. The strip **12** is then sliced into little rods or pellets by the microtome, producing a unit **13** illustrated in Fig. 5. The units **13** could be settled through liquid as previously described in connection with those of Fig. 3, or electrophoretic methods might be used to insure their flat deposition on a glass surface coated with a thin transparent coating made from tin chloride in ways well known in the electronics art.

Electrophoretic methods of depositing finely divided materials are described in an article by Troelstra "Applying Coatings by Electrophoresis," Philips Technical Review, April 1951, page 293. In general, a transparently thin conductive coating of any well-known type is deposited on the surface to be covered with phosphor; the screen is then placed in contact with a water or other liquid suspension of the phosphor or other particles to be laid down; and an electric field impressed normal to the conducting surface until a coating of the desired thickness of the suspended particles accumulates.

Another arrangement by which the different color-emitting phosphors may be successively excited to intense luminosity in correspondence with the color signals being transmitted to a color television receiver may be made up as follows. There are numerous phosphors known in the art which emit light of much greater intensity when they are irradiated with infrared rays or some other type of radiation at the same time an electron beam is incident upon them. The phosphors $ZnSiO_4$:Mn and 50% $CaMg(SiO_3)_2$:Ti and 50% cubic ZnS:Ag, referred to above as producing respectively green light and blue light under electron bombardment, might be mentioned as among these.

In accordance with the general principles of this modification of my invention, particles or rods formed in the way already described and deposited on glass to form screens are stimulated not only by electron bombardment from the cathode ray beam in the kinescope but are also irradiated at the proper times by such stimulating radiations as ultraviolet light and soft X-rays, or whatever other radiations may be most desirable stimulators. Thus, in operating such a system, the auxiliary radiation would be shut off so that the electron beam alone bombarded the screen when a red color signal was being transmitted to the receiver; then when the green color signal arrived, the infrared radiation, let us say, would be turned on to irradiate the screen in addition to the cathode ray beam; and when the blue picture signal began to come in, the other type of radiation would be turned on in place of the infrared radiation, the electron bombardments by the cathode ray beam still continuing. When found desirable, the intensity of the cathode ray beam could be altered coincidently with the turning on of either of the auxiliary radiations where such a procedure increased the color effectiveness of the screen.

Still another expedient for emphasizing the color emission of one of the phosphors, when desired, is to be found in the phenomenon of electroluminescence in which certain substances, notably cadmium sulfide and properly processed zinc sulfide and silicon carbide, are rendered luminous by a rapidly varying electric field traversing their particles. The brightness of light at any instant in the case of electroluminescent materials is approximately proportional to the rate of change of voltage gradient. Arrangement making use of this phenomenon in certain types of image intensifier tubes are described and claimed in application Serial No. 283,094 of Everet W. Vaughn et al., filed April 18, 1952, for a "Fluoroscopic Image Tube," and assigned to the assignee of this application.

In Fig. 6 is shown a detailed view in cross section of a portion of the picture screen of a kinescope arranged for use of the auxiliary light stimulation procedure just described. Thus a glass screen **21** is provided, in the manner described in connection with Figs. 1 through 5, with a layer of pellets **22, 23, 24** respectively comprising a red-emitter such as rhombic $Zn_3(PO_4)_2$:Mn, a green-emitter such as zinc silicate:manganese ($ZnSiO_4$:Mn) and a blue-emitter such as 50% $CaMg(SiO_3)_2$:Ti and 50% cubic ZnS:Ag. The surface of the glass screen **21** on which such pellets rest is preferably coated with a thin layer **25** of transparent conducting material such as NESA, a transparent glass marketed by the Pittsburgh Plate Glass Co. of Pittsburgh, Pa. The outer surface of the pellets is likewise coated with a transparent layer **26** of some conductive material such as nickel, gold, silver or the conductive glass NESA sold by the Pittsburgh Plate Glass Co. of Pittsburgh, Pa., which may, for example, be deposited by evaporation in vacuo onto a collodion film formed as described in the application Serial No. 264,196 of Richard L. Longini and Donald L. Coles filed December 29, 1951 for a Heat Sensitive Element, now U.S. Patent 2,727,118 issued December 13, 1955 and assigned to the same assignee as the present invention. The conducting layers **25** and **26** are connected to inleads **28** and **27**, respectively, upon which an electric gradient may be impressed at will from a variable voltage source **29**.

Fig. 7 shows a kinescope of conventional type provided with a screen such as that described in Fig. 6. The conductive layers of the screen are provided with inleads **27** and **28** connecting them through an electronic switch **31** which may be of the type described in an article entitled "A 45-Degree Reflection Type Color Kinescope," page 1201 of October 1951, Proceedings of the Institute

of Radio Engineers published by the I.R.E., New York City, by which a voltage from a suitable source 32 may be impressed between said conducting layers at periodic intervals corresponding to the transmission of blue picture elements. The enclosure of the kinescope in Fig. 7 is likewise provided with a source of ultra-violet light 33 which may be turned on and off by an electronic switch 34 in synchronism with the transmission of the blue light pictures and which is positioned to irradiate the screen.

The kinescope is provided with a conventional electron gun system 35 for scanning in the usual way the phosphor layer of its picture screen 21. With the above-described arrangement, the electron beam bombards the screen but the auxiliary radiation source 33 and voltage source 32 are turned off when a red light picture signal comes into the receiver. Then when a green light signal comes in, the voltage of electroluminescence stimulator 32 is turned on so that the electron beam will produce an intense luminosity from any one of the pellets on the picture screen which emits green light and on which it is incident at the time. Then when the blue picture signal comes in, the electroluminescence generator 32 is turned off and the ultra-violet source 33 is turned on thereby causing the blue-emitting pellets on the screen to flash into high intensity while the red-emitting and green-emitting pellets on which the electron beam is incident, are less than intensely luminous.

Excitation of such stimulations respectively of the red-emitting, the green-emitting and the blue-emitting phosphors on the screen thus in synchronism with the incoming color signals of the picture will stimulate light of the proper color to correspond point by point over the surface of the screen as the scanning operation lays down the picture. Electron switches and their control circuits suitable for energizing the auxiliary radiation sources in synchronism with incoming picture signals are well known in the art of color television today. To give one instance, the October 1951 I.R.E. Proceedings, above-mentioned, describes such switching and control arrangements for color television.

The above-described system may be adapted to both frame sequential and dot sequence types of transmission as will be readily apparent to men skilled in the color television art.

I claim as my invention:

A color-picture receiver comprising means for projecting a scanning beam into incidence upon a picture screen, said screen comprising elemental areas which emit lights of different colors at the point of incidence of said beam, conducting sheaths sandwiching said elemental areas, means to suffuse said screen with radiation of a predetermined wave length, and leads for impressing a variable electrical gradient between said sheaths.

References Cited in the file of this patent

UNITED STATES PATENTS

2,239,887	Ferrant	Apr. 29, 1941
2,286,478	Farnsworth	June 16, 1942
2,287,308	Herbst	June 23, 1942
2,337,569	Pritchack	Dec. 28, 1943
2,372,903	Lynch	Apr. 3, 1945
2,413,459	Lynch	Dec. 31, 1946
2,493,200	Land	Jan. 3, 1950
2,543,477	Sziklai et al.	Feb. 27, 1951
2,545,420	Sziklai	Mar. 13, 1951
2,566,713	Zworykin	Sept. 4, 1951
2,580,073	Burton	Dec. 25, 1951
2,598,504	Carlson	May 17, 1952
2,635,203	Pakswer	Apr. 14, 1953
2,728,025	Weimer	Dec. 20, 1955
2,728,870	Gungle et al.	Dec. 27, 1955
2,730,644	Michlin	Jan. 10, 1956
2,768,318	Bradley et al.	Oct. 23, 1956
2,778,971	Sunstein	Jan. 22, 1957

OTHER REFERENCES

DeMent: Fluorochemistry, Chemical Pub. Co., Inc., New York, 1945, pages 295 to 297.

Garlick: Luminescent Materials, Oxford at the Clarendon Press, 1949, pages 145 and 146.

Destriau: "The New Phenomenon of Electrophotoluminescence and Its Possibilities for the Investigation of Crystal Lattices," Philosophical Mag., vol. 38, 1947, pages 700 and 775.