

April 3, 1951

E. G. RAMBERG
 FLUORESCENT COLOR SCREEN FOR
 ELECTRON OPTICAL SYSTEMS
 Filed Jan. 23, 1946

2,547,775

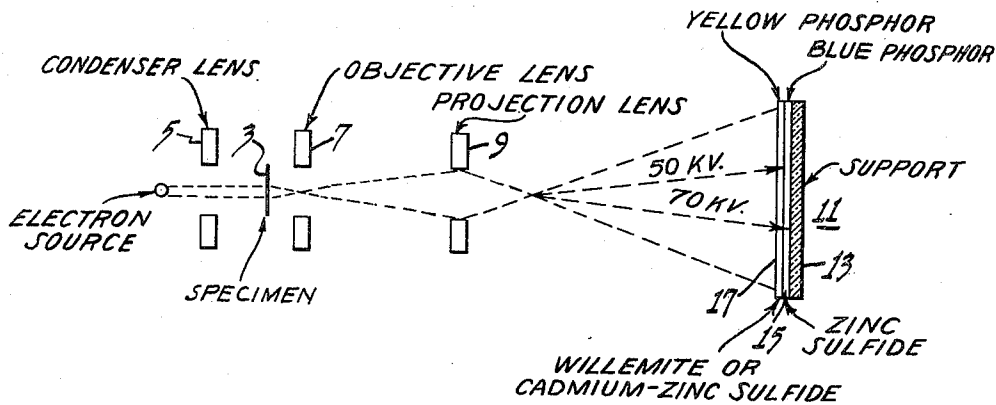


Fig. 1

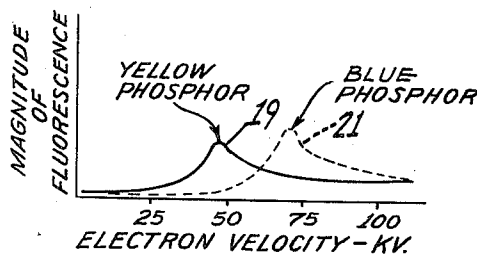


Fig. 2

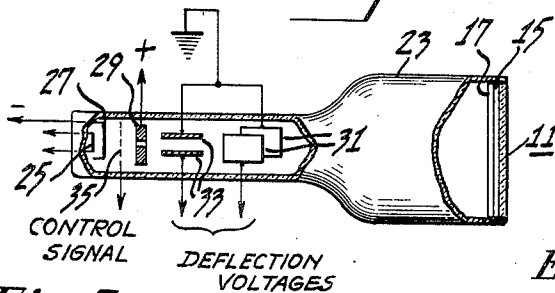


Fig. 3

INVENTOR
 Edward G. Ramberg
 BY *CD. Huska*
 ATTORNEY

UNITED STATES PATENT OFFICE

2,547,775

FLUORESCENT COLOR SCREEN FOR
ELECTRON OPTICAL SYSTEMSEdward G. Ramberg, Feasterville, Pa., assignor
to Radio Corporation of America, a corpora-
tion of Delaware

Application January 23, 1946, Serial No. 642,950

3 Claims. (Cl. 250-164)

1

This invention relates generally to electron optical systems and more particularly to improved fluorescent color screens for indicating differences in the velocity of electrons bombarding such screens.

Frequently it is desirable to record differences in the velocity of electrons impinging upon a fluorescent screen employed in electron optical systems such, for example, as an electron microscope or a cathode ray oscilloscope or television kinescope. When constant velocity electrons are applied to irradiate a microspecimen in an electron microscope, variation in the velocity of electrons derived from the specimen may be interpreted in terms of the materials comprising the specimen or of variations in the thickness of the specimen. The constant velocity electron beam derived from the electron gun of a conventional cathode ray oscilloscope or television kinescope also may be varied in velocity by fluctuating or variable potentials applied to a control electrode operative upon the electron beam.

The instant invention contemplates the use of a multicolor fluorescent screen for use in an electron microscope or cathode ray oscillographic device for recording the differences in the velocity of electrons impinging thereon in terms of the color or colors of the screen fluorescence.

The color selective electron responsive fluorescent screen according to the invention may comprise, for example, two or more parallel layers of different fluorescent materials which provide different color light emission. For example, a thin layer of willemite or cadmium-zinc sulfide which provides yellow light emission may be superposed upon a layer of zinc-sulfide which provides blue light emission in response to electron bombardment.

If the thickness of the yellow light emissive layer is selected to equal approximately the penetration thickness of the slowest electrons impinging on the screen, these electrons will provide yellow light emission. Somewhat faster electrons will also excite the lower blue light emissive fluorescent layer, thereby providing a combination of both yellow and blue emission with a resultant green color. Very fast electrons will excite the blue emissive layer to a greater extent than the yellow emissive layer, thereby providing substantially only a blue light. In order to obtain wide color differences for relatively small differences in electron velocity, the top or yellow light emissive layer may be selected to have lower light emission efficiency than the bottom or blue light emissive layer.

2

The instant invention is related to applicant's copending application Serial No. 642,949, filed January 23, 1946, and issued June 8, 1948, as Patent No. 2,442,961, which discloses a color photographic plate which responds selectively to impinging electrons of different electron velocity. The instant invention also is related to the system disclosed and claimed in U. S. Patent 2,372,170, granted to Richard F. Baker on March 27, 1945, which discloses and utilizes the fact that photosensitive materials respond with greatest efficiency to electrons within predetermined velocity ranges.

Among the objects of the invention are to provide an improved method of and means for measuring electron velocities. Another object is to provide an improved method of and means for establishing selective fluorescence in response to electron bombardment by electrons of different velocities. An additional object is to provide means for producing selective color fluorescence of a fluorescent screen in electron optical apparatus in response to the impingement thereon of electrons having different electron velocities. A further object is to provide an improved color fluorescent screen providing different color fluorescence in response to variations of the velocity of electrons impinging thereon. A still further object of the invention is to provide an improved color-selective fluorescent screen for electron microscopes, cathode ray oscilloscopes and television kinescopes comprising juxtaposed layers of different fluorescent materials providing different color light emission in response to different velocity electron bombardment. Another object is to provide an improved method of and means for varying the color sensitivity of a multilayer, multicolor fluorescent screen in response to bombarding electrons having different electron velocities.

The invention will be described in further detail by reference to the accompanying drawing of which Figure 1 is a schematic diagram of a typical electron microscope employing a multicolor fluorescent screen according to the invention, Figure 2 is a family of graphs illustrating the selective color light-emissive properties of two phosphors which may be employed to provide a multicolor fluorescent screen according to the invention, and Figure 3 is a schematic diagram of a cathode ray oscilloscope or similar oscillographic device employing a multicolor fluorescent screen according to the invention. Similar reference characters are applied to similar elements throughout the drawing.

Referring to Figure 1 of the drawing, the invention is illustrated in combination with a conventional electron microscope. The system includes an electron source 1 which is focused upon a microspecimen 3 by an electrostatic or electromagnetic condenser lens 5. Electrons transmitted by the microspecimen 3 are focused by an objective lens 7 and projection lens 9 to provide a greatly magnified electronic image at the plane of a fluorescent screen 11. The fluorescent screen comprises a support 13 upon which is deposited an under fluorescent layer 15 comprising, for example, zinc sulfide which provides blue light emission in response to electron bombardment. A second, or outer, fluorescent layer 17 of willemite or cadmium-zinc sulfide is deposited over the first zinc sulfide layer 15 and provides yellow light emission in response to electron bombardment. It should be understood that any other combination of known fluorescent phosphors may be employed to provide the desired multicolor fluorescence in response to electron bombardment of predetermined electron velocities.

The thickness of the outer phosphor layer 17 should be selected to equal approximately the penetration thickness for the slowest electrons impinging upon the screen. Such minimum velocity electrons therefore will produce yellow light emission from the outer phosphor layer 17. Somewhat faster traveling electrons will excite the under phosphor layer 15 as well, providing blue light emission therefrom which, when combined with the yellow light emission from the outer layer 17, will provide a greenish luminescence. Much faster traveling electrons bombarding the screen will excite the under phosphor layer 15 to a greater extent than the outer phosphor layer 17, thereby providing substantially blue luminescence.

If it is desired to obtain high color differentiation for relatively small differences in electron velocity, the material of the outer phosphor layer 17 should be chosen to be less efficient than that of the under phosphor layer 15. In the example illustrated, 50 kilovolt electrons will provide greatest excitation of the outer phosphor layer 17, thus producing yellow luminescence thereof, and 70 kilovolt electrons will provide greatest excitation of the under phosphor layer 15, thus producing blue luminescence thereof. Electrons having velocities in the range between 50 and 70 kilovolts will produce varying shades of greenish luminescence. Thus, if the velocity of the electronic image derived from the microspecimen 3 is controlled in any known manner within a desired velocity range, high color contrast will be provided by the multicolor screen. The contrasting colors of the electronic image provided by the screen may be interpreted in terms of variations in thickness or composition of the portion of the microspecimen imaged upon the screen.

It should be understood that any desired number, greater than one, of contrasting color phosphors may be employed to extend the observable velocity range of the electrons comprising the electronic image, and that varying thicknesses of the several phosphor layers may be employed to determine the desired color contrast and sensitivity.

Figure 2 shows a pair of graphs 19, 21, illustrating, respectively, the magnitudes of fluorescence of the screens 17 and 15, respectively, as a

function of the velocity of the electronic image exciting said screens.

Figure 3 illustrates the use of a multicolor screen in accordance with the invention in combination with a cathode ray oscilloscope or television kinescope 23. The oscilloscope includes a heater element 25 for producing electronic emission from an indirectly-heated cathode 27. An anode 29, biased to a high positive potential with respect to the cathode, accelerates the electrons derived from the cathode 27 and focuses them to a fine cathode ray which is deflected laterally and vertically by deflecting elements 31, 33, respectively, which deflect the cathode ray beam across the screen 11. A control electrode 35, connected to a source of control potential, not shown, controls the electron current comprising the cathode ray. The anode 29 is connected to a second source of control potential, determining the velocity of the electrons comprising the cathode ray. The screen 11 comprises a plurality of layers 15, 17 of different phosphors which produce contrasting color luminescence in response to different electron velocities, as described by reference to the system illustrated in Figure 1. It should be understood that the system for controlling the velocity of the electrons comprising the cathode ray may be modified in any manner known in the art.

Thus the invention disclosed herein comprises an improved multicolor fluorescent screen and an improved method of and means for electronically bombarding said screen by electrons of different velocities whereby distinctive color screen fluorescence is provided as a function of the electron velocity. It should be understood that the system described herein may be employed as a basic feature of a color television system wherein color differentiation is accomplished by varying the velocity of the scanning electron beam of the television receiver kinescope.

I claim as my invention:

1. A color-selective electron microscope comprising an electron gun for generating an electron beam, a specimen in the path of said beam having different portions which vary differently the velocity of electrons constituting said beam, and a pair of screens of fluorescent materials having different electron-fluorescent color characteristics responsive to predetermined different irradiating electron velocities, one of said screens being superimposed upon the other, and means for directing said velocity-controlled electron beam upon said screens.

2. A color-selective cathode ray oscilloscope comprising an electron gun for generating an electron beam, means interposed in said beam, for selectively varying the velocity of electrons in different portions of a cross section of said beam, and a pair of screens of fluorescent materials having different electron-fluorescent color characteristics responsive to predetermined different irradiating electron velocities, one of said screens being superimposed upon the other, the screen nearer said gun having a lower light emission efficiency, and means for directing said velocity-controlled electron beam upon said screens.

3. A color-selective cathode ray oscilloscope comprising an electron gun for generating an electron beam, means interposed in said beam, for selectively varying the velocity of electrons in different portions of a cross section of said beam, and a pair of screens of fluorescent ma-

terials having different electron-fluorescent color characteristics responsive to predetermined different irradiating electron velocities, one of said screens being superimposed upon the other, the screen nearer said gun being of a thickness to equal substantially the penetration thickness of the slowest electrons impinging on the screen, and means for directing said velocity-controlled electron beam upon said screens.

EDWARD G. RAMBERG.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

	Number	Name	Date
5	2,058,914	Rudenberg -----	Oct. 27, 1936
	2,096,986	Von Ardenne -----	Oct. 26, 1937
	2,177,691	Dawihl et al. -----	Oct. 31, 1939
10	2,219,929	Kaufmann -----	Oct. 29, 1940
	2,243,828	Leverenz -----	May 27, 1941
	2,440,301	Sharpe -----	Apr. 27, 1948
	2,455,710	Szegho -----	Dec. 7, 1948