June 8, 1948. E. G. RAMBERG 2,442,961

ELECTRON SENSITIVE COLOR PHOTOGRAPHIC PLATE

Filed Jan. 23, 1946

Fig. 1

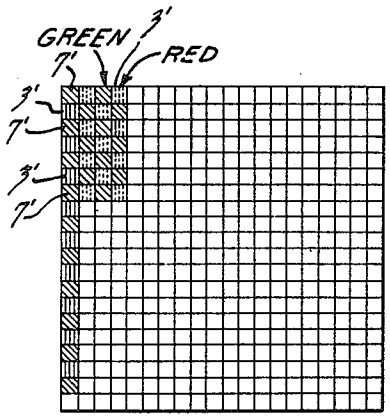


Fig. 2

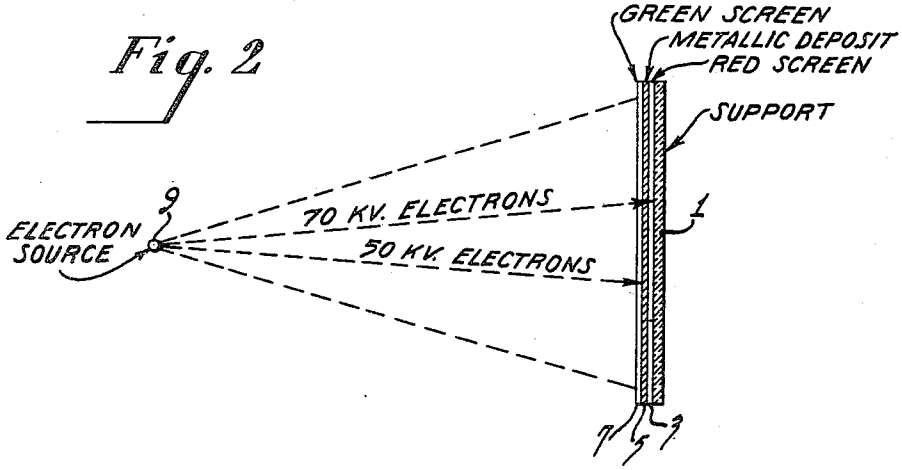
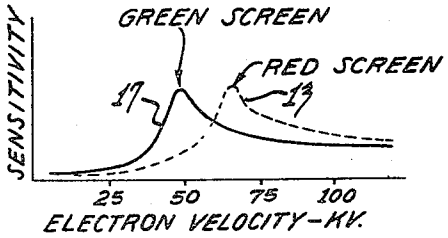


Fig. 3



INVENTOR
Edward G. Ramberg
BY C. D. Lucke
ATTORNEY

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ELECTRON SENSITIVE COLOR PHOTOGRAPHIC PLATE

Edward G. Ramberg, Feasterville, Pa., assignor to Radio Corporation of America, a corporation of Delaware

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12 Claims. (Cl. 250—65)

1

This invention relates generally to electron photography and more particularly to electron color photographic plates responsive to variations in the velocity of electrons impinging thereon.

Frequently it is desirable to record differences in the velocity of electrons impinging upon the photographic plate employed in electron optical systems such, for example, as an electron microscope. 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 instant invention contemplates the use of a color photographic plate capable of recording differences in the velocity of electrons impinging thereon in terms of the color or colors of the developed and fixed plate when viewed by light transmission.

The color plates according to the invention essentially are similar to the Paget color process plates comprising a plurality of mosaics having different photographic color properties such, for example, as complementary fine checkerboard patterns of alternate red and green dye patches covering a supporting plate. The essential difference between conventional color process plates and the photographic color plate of the instant invention is that a thin, uniform-thickness, metallic film is deposited over all of the rectangular dye patches of one of the color mosaics, and then the second color mosaic is deposited over the thin metallic film.

In the U. S. Patent 2,372,170 granted to Richard F. Baker on March 27, 1945, it is shown that various photographic materials have maximum sensitivity to irradiating electrons of a predetermined electron velocity. Electron velocities greater or less than the optimum value provide reduced exposure of the photographic film. This principle is utilized in the instant invention by selecting electron velocities in the minimum range which will provide efficient exposure of the outer color film, and thence selecting the character and thickness of the metallic film between the color films to provide the desired optimum electron velocity difference for exposure of the second color photographic film under the metallic film. Thus if both photographic films have maximum electron sensitivity at 50 kilovolt electron velocity, and the thickness of the metallic deposit is sufficient to reduce the velocity of 70 kilovolt electrons to an effective value of 50 kilovolts, then the outer color film will provide maximum sensitivity for 50 kilovolt electrons while the inner color film will have maximum sensitivity to 70 kilovolt electrons.

2

Portions of the photographic plate exposed to 50 kilovolt electrons will be blackened most at the squares of the mosaic comprising the outer color film. Similarly portions of the plate exposed to 70 kilovolt electrons will be blackened most at the complementary squares of the mosaic comprising the inner photographic film. When viewed by light transmission, the photographic plate thus will provide distinguishing color characteristics depending upon the velocities of the electrons which impinged upon the plate.

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 recording differences in electron velocity. An additional object is to provide an improved method of and means for producing a color record of differences in the velocity of electrons impinging upon a color plate. A further object is to provide an improved color plate for electron optical photography for indicating differences in the velocity of electrons exposing said plate. A still further object of the invention is to provide an improved color plate for electron optical photography comprising complementary mosaics of electron sensitive materials having different electron-velocity sensitive characteristics, or providing distinguishing color characteristics for different impinging electron velocities. Another object is to provide an improved method of and means for indicating photographically the composition of microspecimens in an electron microscope or other electron optical device.

The invention will be described in further detail by reference to the accompanying drawing of which Figure 1 is a plan view of a color plate in accordance with the invention, Figure 2 is a side elevational schematic view of the basic combination of such a color plate with an irradiating electron source, and Figure 3 is a family of graphs illustrating the electron velocity-sensitive characteristics of a typical pair of electron sensitive films according to the invention. Similar reference characters are applied to similar elements throughout the drawing.

Referring to Figures 1 and 2 of the drawing, the electron-sensitive color plate according to the invention includes, for example, a glass support 1 upon which is deposited a large number of rectangular red dye patches forming a red screen 3 and arranged in a checkerboard pattern

as shown in Figure 1. Over the layer of red dye patches 3' is deposited a thin metallic film 5, such as magnesium, which reduces the velocity of 70 kilovolt electrons to an effective velocity of 50 kilovolts. Over the metallic film 5, a second electron-sensitive color screen 7 is deposited in a similar fine checkerboard pattern of alternate green dye patches 7' wherein the green patches coincide with the spaces between the red dye patches 3' of the red screen 3.

It should be understood that any other combination of electron-sensitive color screens may be employed and that the arrangement and orientation thereof may be varied in any desired manner. For example, instead of rectangular checkerboard patterns, the screens may comprise circular, hexagonal, or other shaped dye patches alternately or randomly arranged, or they may comprise alternately spaced color lines of any desired color arrangement. Furthermore more than two such screens may be superposed, and the metallic film 5 may or may not be interposed between each of the screens. Also the screens and the metallic film may be applied in any known manner such as by evaporation, electrodeposition or by conventional coating processes, including or excluding the use of masking screens.

In a typical example, red and green checkerboard electron-sensitive color screens separated by a thin magnesium deposit are employed as shown in the drawing. The color screens 3 and 7 have maximum electron photosensitivity for electron velocities of 50 kilovolts. The thickness of the metallic deposit 5 is selected to require an electron velocity of 20 kilovolts for penetration thereof. Preferably, the electron decelerating deposit 5 should be substantially transparent to light transmission. However, if desired, it may be dissolved away during development of the color screens.

The portions of the color plate bombarded by 50 kilovolt electrons derived from an electron source 9 will be blackened most (after development and fixing), at the green squares 7' on the green color screen 7. Similarly, electrons having a velocity of 70 kilovolts will provide maximum blackening of the red color patches 3' of the red screen 3, since such 70 kilovolt electrons will be decelerated by 20 kilovolts in passing through the metallic deposit 5 between the color screens. The blackening of the red dye patches by 50 kilovolt electrons therefore will provide an apparent increase in the green transmission of the color plate when viewed by light transmission. Similarly the blackening of the green dye patches by 70 kilovolt electrons will apparently increase the red light transmission of the color plate.

For a certain electron velocity between 50 and 70 kilovolts, the color screen passes from a greenish to a reddish coloration when viewed by light transmission. For electron velocities below 50 kilovolts, the color screen will have more pronounced red transmission, while for electron velocities above 70 kilovolts the screen will appear to have somewhat less pronounced green light transmission characteristics. As explained heretofore other dye patch arrangements or combinations will provide different color properties in response to different bombarding electron velocities.

In Figure 3 the electron photosensitivity of the green and red screens 7 and 3, respectively, is illustrated in the graphs 17 and 13.

The color screen thus described may be employed for velocity analysis of an electron image as in an electron microscope, (not shown), wherein substantially constant velocity electrons irradiate a microspecimen, and the variations in velocity of electrons transmitted by the specimen may be employed to determine the molecular composition or the thickness of the various portions of the imaged specimen. Color plates of the type described also may be employed for any other purpose wherein measurements of electron velocity are desired over predetermined velocity ranges. The exposed color screen may be observed by light transmission in any desired manner.

It should be understood that if the outer color screen 7 provides appreciable electron deceleration through the portions of the screen between the dye patches, the metallic deposit 5 may be omitted since the additional deceleration provided thereby may not be required. Various combinations of color screens and decelerating films or deposits may be employed to provide additional color differentiation for indicating more extended electron velocity ranges.

I claim as my invention:

1. A photosensitive plate for electron-optical photography comprising a pair of complementary mosaics of electron photosensitive materials having different electron-velocity photosensitivity characteristics and disposed in parallel complementary relation, whereby contrasting exposure of said mosaics is provided by irradiating electrons of predetermined different velocities.

2. A photosensitive plate for electron-optical photography comprising a pair of complementary mosaics of electron photosensitive materials having different electron-photosensitivity characteristics and disposed in parallel complementary relation, and an electron decelerating element disposed between said mosaics whereby contrasting exposure of said mosaics is provided by irradiating electrons of predetermined different velocities.

3. A photosensitive plate for electron-optical photography comprising a pair of complementary mosaics of electron photosensitive materials having different electron-photosensitivity color characteristics and disposed in complementary interleaved relation, and an electron decelerating element disposed between said mosaics whereby contrasting exposure of said mosaics is provided by irradiating electrons of predetermined different velocities.

4. In a system utilizing a photosensitive plate for electron-optical photography comprising a pair of complementary mosaics of electron photosensitive materials having different electron-photosensitivity characteristics and disposed in parallel complementary relation, and an electron decelerating element disposed between said mosaics whereby contrasting exposure of said mosaics is provided by irradiating electrons of predetermined different velocities, the method comprising irradiating said mosaics simultaneously by electrons of predetermined different velocities to provide contrasting exposures of said mosaics as a function of said irradiating electron velocities, and developing said exposed mosaics to provide color contrast therein.

5. The method according to claim 4 including the step of removing said decelerating element subsequent to electron exposure of said mosaics.

6. In a system of the type described in claim 4 wherein said decelerating element is deposited between said mosaics, and including the step of

removing at least portions of said deposited element subsequent to electron exposure of said mosaics.

7. In combination, a photosensitive plate for electron-optical photography comprising a pair of complementary mosaics of electron photosensitive materials having different electron-photosensitivity color characteristics and disposed in parallel complementary relation, and an electron decelerating element disposed between said mosaics, and means for irradiating said mosaics simultaneously by electrons of predetermined different velocities to provide contrasting color exposure of said mosaics.

8. In combination, a photosensitive plate for electron-optical photography comprising a pair of mosaics of electron photosensitive materials having different electron-photosensitivity color characteristics and disposed in parallel complementary registry, and an electron decelerating element disposed between said mosaics, and means for irradiating said mosaics simultaneously by electrons of predetermined different velocities to provide contrasting color exposure of said mosaics.

9. In combination, a photosensitive plate for electron-optical photography comprising a pair of checkerboard mosaics of electron photosensitive materials having different electron-photosensitivity color characteristics and disposed in parallel complementary registry, and an electron decelerating element disposed between said mosaics, and means for irradiating said mosaics simultaneously by electrons of predetermined different velocities to provide contrasting color exposure of said mosaics.

10. A photosensitive plate for electron-optical photography comprising a pair of complementary mosaics of electron photosensitive materials having different electron-photosensitivity characteristics and disposed in parallel complementary relation, and a substantially optically transparent electron decelerating element disposed between said mosaics whereby contrasting exposure of said mosaics is provided by irradiating electrons of predetermined different velocities.

11. A photosensitive plate for electron-optical photography comprising a pair of complementary mosaics of electron photosensitive materials having different electron-photosensitivity characteristics and disposed in parallel complementary relation, and a thin metallic electron decelerating element disposed between said mosaics whereby contrasting exposure of said mosaics is provided by irradiating electrons of predetermined different velocities.

12. A photosensitive plate for electron-optical photography comprising a pair of complementary mosaics of electron photosensitive materials having different electron-photosensitivity characteristics and disposed in parallel complementary relation, and a thin magnesium film comprising an electron decelerating element disposed between said mosaics whereby contrasting exposure of said mosaics is provided by irradiating electrons of predetermined different velocities.

EDWARD G. RAMBERG.