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MEANS FOR IMPROVING THE ELECTRONIC EXPOSURE
OF PHOTOGRAPHIC EMULSIONS
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Fig. 1.

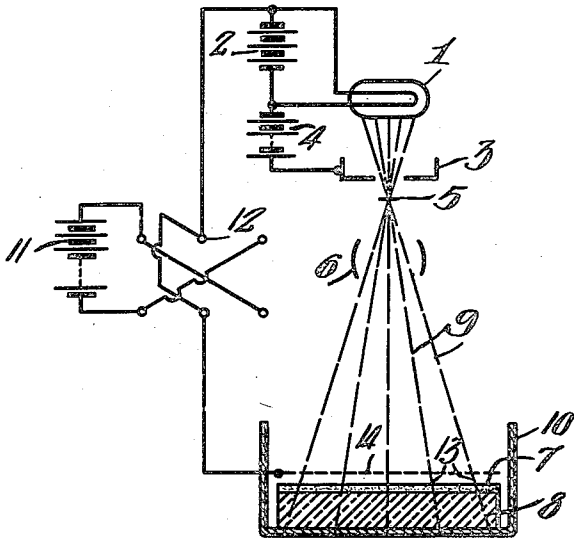
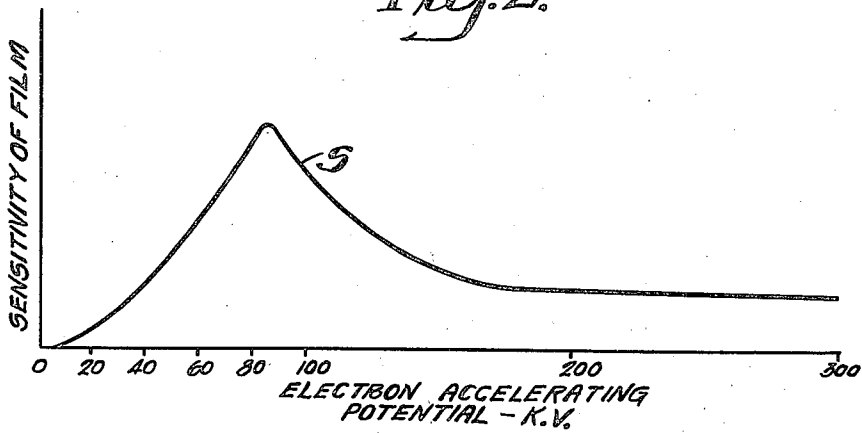


Fig. 2.



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MEANS FOR IMPROVING THE ELECTRONIC
EXPOSURE OF PHOTOGRAPHIC EMULSIONSJames L. Whittaker, Woodbury, N. J., assignor to
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13 Claims. (Cl. 250—49.5)

This invention relates generally to means for controlling electron velocity and particularly to methods of and apparatus for controlling the velocity and scattering electrons in electronic apparatus for the purpose of obtaining optimum electron velocity and diffusion for the exposure of sensitized emulsions or for forming electronic images.

It has been customary to accelerate the electrons irradiating the object in an electron microscope to velocities at which the electrons pierce the object. In many instances such velocities require accelerating voltages in excess of 100 kilovolts. Experiments indicate that such velocities are inefficient for exposure of photographic emulsions since the optimum velocity for this purpose is produced by accelerating voltages of approximately 80 to 100 kilovolts, depending upon the emulsion characteristics. Velocities substantially above or below this critical value produce less effect upon photographic emulsions and therefore require longer exposure for a given image density. Therefore, it is desirable to irradiate the object or otherwise utilize the electron beam at the most advantageous velocity and then alter the velocity to the optimum value for exposure of the sensitized emulsion.

The apparatus described in this application is disclosed but not specifically claimed in the co-pending application of Richard F. Baker, Serial No. 435,827, filed March 23, 1942, and assigned to the same assignee.

An object of this invention is to provide a method of and means for changing the velocity of an electron beam in an electron microscope or other electronic device prior to the impingement of the electrons on a photographically sensitized emulsion. Another object is to provide means for changing the velocity of electrons to the optimum value required for exposure of a sensitized emulsion or for forming electronic images. Another object is to provide in an electron microscope, or similar electronic device, a velocity controlling electrode for altering the velocity of electrons impinging on the sensitized emulsion of a photographic target.

Another object is to provide a screen electrode having predetermined electron scattering characteristics. An additional object is to provide selective means for accelerating or decelerating electrons to a predetermined value for the exposure of a sensitized emulsion or a fluorescent screen.

The invention will be described with reference to the drawing of which Figure 1 is a schematic

diagram of the invention, and Figure 2 is a graph of the electron sensitivity characteristics of a typical photographic emulsion.

Referring to the drawing, Fig. 1 is an electronic device in which an electron beam is caused to expose a photographic emulsion. An electron source 1 is supplied with power from a battery or any suitable source 2. Electrons emitted by the source 1 are drawn toward the accelerating electrode 3 which is supplied with a high positive potential from the battery or other power source 4. The accelerating electrode causes the electron beam to penetrate the object or specimen 5. An electrostatic or a magnetic electron focusing means 6 causes the electron beam to be focused upon the photographically sensitized surface 7 of the base 8. Since the velocity of the electrons 9 required for penetration of the object 5 is considerably higher than the optimum electron velocity for exposure of the photographic emulsion, the electrode 10 is supplied with a negative potential, from the battery or other source 11 through the switch 12, to reduce the electron velocity to the optimum exposure value in the vicinity 13 of the image upon the sensitized emulsion surface.

The electrode 10 should preferably be dish shape in order that the emulsion 7 and support 8 may be maintained at substantially the same negative potential as the electrode. However, any form which accomplishes desired electron velocity control while maintaining the photographic medium at substantially the electrode potential, will be satisfactory. The electrode just described will decelerate the electrons without causing undesired electron scattering or diffusion inherent in other decelerating means. Freedom from excessive electron scattering is particularly important when electron images of high definition are desired.

If some degree of electron scattering is found to be advantageous in particular apparatus, this may be readily accomplished by the addition of thin metal foil or grid element 14 connected to, and preferably disposed within the electrode 10. The physical characteristics of the foil or grid will determine the degree of scattering and will also contribute to the deceleration of the electron stream.

The electrode 10, either with or without the scattering electrode 14, may be used for accelerating the electron image if the electron velocity after penetration of the object or specimen 5 is insufficient for satisfactory exposure of the photographic emulsion. Acceleration may be obtained to a desired degree by connecting the elec-

trode 10, and, if desired, the electrode 14, to a suitable positive potential from the battery 11, or other source of power, through the reversing switch 12.

Fig. 4 is a graph in which the curve S indicates the sensitivity of a typical photographic emulsion to electron velocities produced by acceleration voltages from zero to 300 kilovolts applied to the electrode 3 without no potential applied to the electrodes 10 and 14. It is apparent that the emulsion sensitivity commences at about 3 kilovolts and continues to rise to a maximum at approximately 80 kilovolts, after which it drops to a relatively low value as the accelerating voltage is increased. The optimum value of voltage varies somewhat with emulsion characteristics.

It will be seen that the means which have been described operate on an entirely different principle than typical optical filters, in that this invention controls the velocity and scattering of electrons impinging on a photographic emulsion while optical filters control either the frequency or the intensity of the light beam applied to the emulsion. Experiments indicate that the effect described is probably not due to secondary electronic emission in the velocity control element or to fluorescence or radiation from the velocity controlling element or the photographic emulsion. While no attempt has been made to explain the reasons for the relation between photographic emulsion sensitivity and electron velocity, experimental data clearly shows that the relation exists and that electron velocity can be controlled for optimum emulsion efficiency by the apparatus disclosed as this invention.

I claim as my invention:

1. Electronic image apparatus including an electron beam, electron image focusing means, and an electron responsive photographic target, electron image velocity changing means in the path of said beam adjacent said target comprising an electrode substantially transparent to said electron image and a source of potential connected to said electrode to alter said image velocity to a predetermined optimum value.

2. Electronic image apparatus including an electron beam, electron image focusing means, and an electron responsive photographic target, electron image decelerating means in the path of said beam adjacent said target comprising an open cylindrical electrode normal to said target, and a source of potential, negative with respect to said beam, connected to said electrode to alter said image velocity to a predetermined optimum value.

3. Electronic image apparatus including an electron beam, electron image focusing means, and an electron responsive photographic target, electron image accelerating means in the path of said beam adjacent said target comprising an open cylindrical electrode normal to said target, and a source of potential, positive with respect to said beam, connected to said electrode to alter said image velocity to a predetermined optimum value.

4. In electronic apparatus including an electron beam and an electron responsive target, electron velocity changing means in the path of said beam adjacent said target comprising an electrode substantially transparent to said beam and a source of potential connected to said electrode, and additional electrode means adjacent said target for scattering the electrons of said beam.

5. In electronic apparatus including an electron beam and an electron responsive target, elec-

tron decelerating means in the path of said beam adjacent said target comprising an open cylindrical electrode normal to said target, and a source of potential negative with respect to said beam connected to said electrode and additional electrode means adjacent said target for scattering the electrons of said beam.

6. In electronic apparatus including an electron beam and an electron responsive target, electron accelerating means in the path of said beam adjacent said target comprising an open cylindrical electrode normal to said target, and a source of potential positive with respect to said beam connected to said electrode, and additional electrode means adjacent said target for scattering the electrons of said beam.

7. In electronic apparatus including an electron beam and an electron responsive target, electron velocity changing means in the path of said beam adjacent said target comprising an electrode substantially transparent to said beam and a source of potential connected to said electrode to alter the electron beam velocity to a predetermined value for the exposure of said target, and additional electrode means adjacent said target for scattering the electrons of said beam.

8. Electronic apparatus including an electron beam and an electron responsive photographic target, electron velocity changing means in the path of said beam adjacent said target comprising an electrode substantially transparent to said beam and a source of potential connected to said electrode to alter the electron beam velocity to a predetermined value for the exposure of said target.

9. Apparatus of the type described in claim 8 including electrode means adjacent said target for scattering the electrons of said beam.

10. Electronic apparatus including an electron beam and an electron responsive photographic target, electron decelerating means in the path of said beam adjacent said target comprising an open cylindrical electrode normal to said target, and a source of potential, negative with respect to said beam, connected to said electrode to alter the electron beam velocity to the optimum value for the exposure of said target.

11. Electronic apparatus including an electron beam and an electron responsive photographic target, electron accelerating means in the path of said beam adjacent said target comprising an open cylindrical electrode normal to said target, and a source of potential, positive with respect to said beam, connected to said electrode to alter the electron beam velocity to the optimum value of the exposure of said target.

12. Electronic apparatus including an electron beam and an electron responsive photographic target, electron velocity changing means in the path of said beam adjacent said target comprising an open cylindrical electrode, substantially transparent to said beam, and normal to said target, and a source of potential connected to said electrode.

13. In an electron image device including electron image focusing means, the method of controlling an electron image impinging upon an electron responsive photographic target comprising focusing said image upon said target and electrically controlling the velocity of said image intermediate said focusing means and said target to provide optimum electron velocity for photographic exposure of said target.