

UNITED STATES PATENT OFFICE

2,410,658

LIMITING APERTURE FOR ELECTRON
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Application July 16, 1943, Serial No. 495,024

9 Claims. (Cl. 250—49.5)

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This invention relates generally to electron image apparatus and more particularly to the use of an apertured diaphragm with such apparatus for limiting the electron irradiation to a specimen under observation while preventing electron irradiation of the specimen support.

The intensity of electron bombardment of an electron microscope specimen is intrinsically very high, and often is of the order of 1 to 10 kilowatts per square millimeter. Even if only a small portion of this energy is absorbed by the specimen, extremely high temperatures may be reached therein, resulting in damage or complete destruction of the specimen. Normally, an electron microscope specimen is so thin that the energy absorbed thereby due to electron bombardment is substantially negligible. However, such thin specimens must necessarily have relatively strong means of support which necessarily will absorb a large proportion of the electron energy of the portion of the electron beam which impinges upon the support. If the rate at which this energy is absorbed by the supporting means is greater than the rate at which the supporting means can conduct it to cooler portions of the microscope, the temperature of the support will rise to a value where the specimen will be destroyed along the line of adhesion between it and its support.

Heretofore, this difficulty has been at least partially avoided in a number of ways. One method comprises reducing the intensity of the irradiating electron beam. A second method comprises reducing the time of exposure of the specimen and its support to the irradiating electron beam. A third method includes the use of a condenser lens intermediate the electron source and the specimen, which focuses an extremely minute image of the electron source only on that portion of the specimen under observation. Destruction of the specimen is substantially avoided in the latter instance even if a portion of the irradiating beam strikes the specimen supporting means, since the total energy content of the beam is extremely small and the area bombarded is also extremely small. Large temperature gradients are therefore set up within the specimen and the specimen support, which provide rapid conduction of heat generated therein to cooler portions of the microscope. While the third method is satisfactory from the standpoints of economy and compactness, it is sometimes found desirable to eliminate the condenser lens normally employed with larger electron microscopes.

The present invention comprises a relatively simple and efficient means of protecting an electron microscope specimen wherein a relatively large, heavy metallic diaphragm having an extremely minute aperture therein is disposed im-

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mediately adjacent the specimen and intermediate the specimen and the electron source. The diaphragm should be sufficiently large to screen effectively all portions of the specimen support with the exception of the portions immediately adjacent the specimen. It will be seen that this arrangement permits extremely high irradiation intensity of the specimen, while limiting the total heat generated in the specimen and specimen support to a minimum value. Preferably, some means of adjustment should be provided for the apertured diaphragm in order that the aperture therein may coincide substantially with the microscope electron beam axis.

Among the objects of the invention are to provide an improved method of and means for irradiating electronically specimens in electron image apparatus. Another object is to provide an improved method of and means for limiting the electronic irradiation of a specimen in an electron microscope to the area immediately adjacent to and including the specimen to be observed while effectively screening other portions of the specimen support from electronic irradiation. A further object of the invention is to provide an improved method of and means for limiting the electronic irradiation of a specimen and its support in an electron microscope wherein a relatively heavy metal diaphragm having a minute aperture therein is interposed between the electron source and the specimen support whereby high intensity irradiation of the specimen is provided while the major portion of the specimen support is screened effectively from the electron source.

The invention will be further described by reference to the accompanying drawing of which the single figure is a schematic diagram of a typical embodiment thereof.

Referring to the drawing, an electron microscope or other electron image device having a frame 1 includes a cathode 2 which is maintained at a relatively high negative potential with respect to the grounded frame 1 of the image device. The cathode 2 may be heated either directly or by means of a conventional heater element 3. If desired, the cathode 2 may be surrounded by a conventional apertured Wehnelt cylinder 4. An apertured anode 5, maintained at ground potential, is disposed adjacent the apertured end of the Wehnelt cylinder 4, thereby providing an electron gun which generates a beam of electrons substantially defined by the dash lines *a, a'*.

A specimen support including a wire mesh frame comprising the wires 6, 6', 6'', 6''' includes an extremely thin membrane 7 of collodion, for example, which supports a specimen 8 on the reverse side thereof. This type of specimen support is commonly used in electron microscope

work since it provides an extremely strong thin supporting membrane immediately adjacent the specimen. However, electronic bombardment of the wires 6', 6'' immediately adjacent the specimen 8 would normally provide extremely high temperatures in the wires 6', 6'' which would damage the supporting membrane 7. Therefore, a limiting apertured diaphragm 9, having an aperture 10 therein, is interposed between the anode 5 of the electron gun and the specimen support. The aperture 10 should preferably be extremely minute, and the diaphragm 9 should be as close as practicable to the specimen support. The limited electron beam provided by the limiting aperture 10 is indicated by the dash lines b, b'. It will be seen that the electronic irradiation is substantially limited to the specimen 8 and the portion of the supporting membrane 7 immediately adjacent thereto. Since these elements normally are extremely thin, negligible heat is generated therein due to electron bombardment thereof. It should be understood that the irradiation field may be limited to a somewhat larger area which may even include the wire supports immediately adjacent the specimen, providing sufficient heat dissipation is provided to prevent damage to the supporting membrane and the specimen proper.

The limiting apertured diaphragm 9 should preferably be adjustable transversely of the axis of the electron microscope 1 to provide for centering of the aperture 10 on the electron beam axis. Any well known method of centering electron microscope components may be employed, or the adjustment of the diaphragm may be accomplished by means of a threaded member 11 pivoted on the diaphragm 9 and threaded to the side of the microscope frame 1. A control knob 12 may be provided on the threaded member 11 externally of the microscope frame 1, for facilitating adjustment of the position of the diaphragm 9.

The remainder of the electron image device, or electron microscope, may be of conventional design. It may, for example, include an electron objective lens 13, centered on the microscope axis, at a predetermined distance from the specimen 8 which will depend upon the focal length of the lens 13. Likewise, a conventional electron projection lens 14 may be employed to enlarge and project the image derived from the objective lens 13 upon a fluorescent screen, or other image device, 15. The electron objective and projection lenses 13, 14 may be either electrostatic or electromagnetic and may of conventional design depending upon the particular optical requirements of the apparatus.

Thus the invention described comprises a simple and efficient means of limiting the electronic irradiation of a specimen in an electron image device to the portion of the specimen support immediately adjacent to and including the portion of specimen to be observed, while effectively screening the remainder of the specimen support to prevent heating thereof due to electron bombardment.

I claim as my invention:

1. In combination, an electron image device including an electron source, a specimen, a specimen support, and means including a heat conductive diaphragm having a minute aperture therein interposed between said source and said specimen and in close proximity to said specimen support

for electronically irradiating said specimen and for screening said specimen support.

2. Apparatus of the type described in claim 1 including means for adjusting externally of said device the position of said diaphragm to provide coincidence of said aperture with the common axis of said source and said specimen.

3. In combination, an electron image device including an electron source, a specimen, a specimen support, and means including a heat conductive metallic diaphragm having a minute aperture therein interposed between said source and said specimen and in close proximity to said specimen support for electronically irradiating said specimen through said aperture and for screening the balance of said specimen support.

4. An electron microscope including an electron source, a specimen, a specimen support, means including a metallic diaphragm having a minute aperture therein interposed between said source and said specimen and in close proximity to said specimen support for electronically irradiating said specimen through said aperture and for screening the balance of said specimen support, means for forming an electronic image of the irradiated portion of said specimen, and electron lens means for providing an enlarged image of the irradiated portion of said specimen.

5. Apparatus of the type described in claim 4 including means for adjusting externally of said microscope the position of said diaphragm to provide coincidence of said aperture with the common axis of said source and said specimen.

6. In an electron image device comprising an electron source and a specimen support including a specimen, a device for minimizing heating of said support upon electronic irradiation of said specimen comprising a metal diaphragm having a minute aperture therein coaxial with said source and said specimen interposed between said source and said specimen and in close proximity to said specimen support.

7. In combination, an electron source, a specimen, a specimen support and means for minimizing heating of said support upon electron irradiation of said specimen comprising a limiting aperture device interposed between said source and said specimen support and in close proximity to said support for preventing electron irradiation of said support.

8. In combination, an electron image device including an electron source, a specimen support for positioning a specimen, and means including a heat conductive diaphragm having a minute aperture therein interposed between said source and said specimen support and in close proximity to said support for electronically irradiating said specimen and for screening said specimen support.

9. An electron microscope including an electron source, a specimen support for positioning a specimen, means including a metallic diaphragm having a minute aperture therein interposed between said source and said specimen support and in close proximity to said support for electronically irradiating said specimen through said aperture and for screening the balance of said specimen support, means for forming an electronic image of the irradiated portion of said specimen, and electron lens means for providing an enlarged image of the irradiated portion of said specimen.

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