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ELECTRON MICROSCOPE

Filed Aug. 12, 1939

Fig. 1

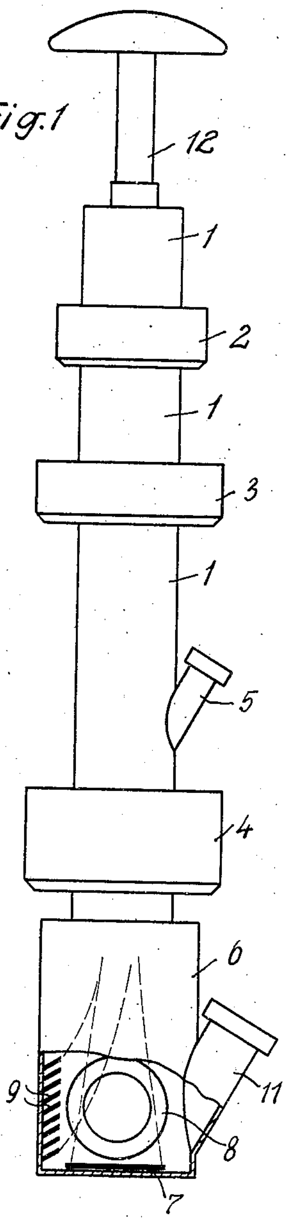
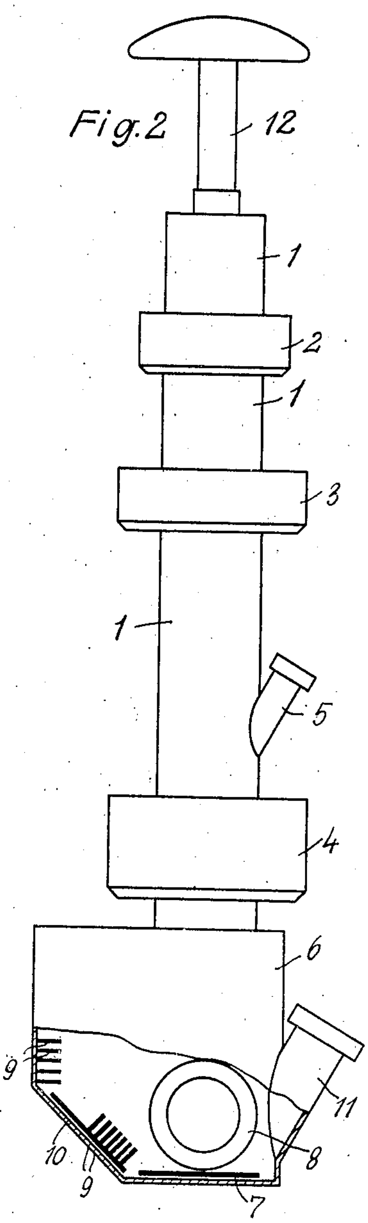


Fig. 2



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ELECTRON MICROSCOPE

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5 Claims. (Cl. 250—49.5)

This invention relates to an electron microscope and a method of photographically recording electron-microscopic images.

The photographic recording of images by means of electron microscopes is well known in the art. To this end, a photographic plate is introduced at the lower part of the microscope. Directly in front of the photographic plate is arranged a fluorescent screen with the aid of which the image may be focussed. After focusing the image, the fluorescent screen is mechanically moved aside so that the electron ray impinges upon the photographic plate. It has been found that fuzzy images are often obtained when proceeding in the above manner, probably because the vacuum conditions in the microscope are altered by the movement of the fluorescent screen or because of charges of the fluorescent screen brought about by the electrons of the ray.

The above-mentioned drawback may be removed according to the present invention by laterally deviating the electron ray in the space between the projection lens and the photographic layer, preferably in the immediate neighborhood of the latter, after introducing the object and the photographic plate into the vacuum chamber and before the exposure proper of the plate. The electron ray may be laterally deviated with the aid of any known means for deflecting electron rays. Solenoids, vacuum-tightly embedded in insulating material to prevent the escape of occluded gases during the operation are particularly suitable. These solenoids, for instance, may be vacuum-tightly sealed with the aid of a glass flux into an inorganic insulating substance. This insulating and vacuum-tight substance may consist of the known ceramic materials which contain magnesium silicates or aluminum silicates, and which are formed by a dry pressing method from such materials as soapstone (steatite), talc, or sericite.

These ceramic substances may easily be provided, according to a known method, with a metallic coating which permits the ceramic body to be soldered to the metallic parts of the microscope structure. If the soldered joints are apt to be exposed to high temperatures, the metallic coating of the ceramic insulating body is preferably made of a high-melting base metal, for instance iron, and the soldering is effected by means of a relatively heat-resistant hard solder. The iron coating may be produced by covering the surface portion, to be coated, with a layer of powdered iron, and sintering it on the ceramic body in an atmosphere free of oxygen. The just-mentioned specific methods of coating and soldering ceramic bodies, in order to obtain a vacuum-tight structure, are described more in detail in U. S. patents to H. Vatter, Nos. 2,129,892, 2,133,492, 2,137,069 and 2,139,431, and do not form a feature of the present invention proper. The solenoids for deflecting the electron beam may also be vacuum-tightly sealed in any other suitable manner, for instance by enclosing them in a vacuum-tight metal housing.

While according to a preferred embodiment of the invention the lateral deflection of the electron beam is effected between the microscopic lens system and the photographic layer; i. e. after the beam has passed through, and has been electron-optically biased by, the lens system, it is also possible to deflect the electron beam in an intermediate stage of the lens system, for instance in the neighborhood of an intermediate diaphragm. It has been found, however, that the beam, if thus deflected, is liable to produce disturbing electric charges of the intermediate diaphragm, which result in a displacement of the intermediate image. This displacement is considerably increased by the projection lens. This drawback is avoided if the deflection of the beam is effected directly in front of the photographic plate. This has the further advantage that the image may be inspected and its focusing checked to a certain extent while the beam is in deflected condition. To this end, a fluorescent screen is arranged adjacent to the photographic plate, as well be described in the following.

To cause the diverted electron beam to return momentarily on the photographic plate, i. e. to prevent a slow wandering of the ray over the photographic plate as compared with the exposure time, special means must be provided which cause an extremely rapid dying out of the current of the solenoids to the zero value.

The above-explained method and means according to the invention will be more readily understood from the following description of the two electronic microscopes shown diagrammatically in the drawing in which Figs. 1 and 2 represent two different embodiments in part-sectional side views. Like reference numerals designate similar elements. **1** denotes the vacuum vessel of the microscope, and **12** an auxiliary discharge tube which serves as an electron source. **2**, **3** and **4** represent schematically the condenser coil, the objective coil and the projection coil respectively. The inspection window, as indicated at **5**, permits an inspection of the intermediate image produced in the neighborhood of the window. The photographic plate 7 is arranged in the lower part 6 of the microscope vessel. For the sake of clearness the devices for introducing the object (object carrier) and photographic plate (magazine or the like) into the vacuum chamber are not shown. In the immediate neighborhood of the photographic plate 7 are arranged the solenoids which serve to laterally deflect the electron beam, of which one is shown as indicated at 8. To prevent the photographic plate 7 from being influenced by the laterally deflected beam, protective metal screens or baffles 9 are provided. To afford an inspection of the image while the beam is deflected, a fluorescent screen 10 may be arranged according to the invention close to the photographic plate 7, as is shown in Fig. 2. In this case it is advisable to provide, for the purpose mentioned above, protective baffle screens 9 on a portion of the fluorescent screen 10 as well as on the side wall of the lower vessel portion 6. 11 denotes an inspection window by means of which the photographic plate and the fluorescent screen 10 may be inspected. The solenoids 8 have their coils enclosed in a vacuum-tight casing which is connected with the wall of the vacuum vessel 6 in the manner previously described. The electric circuit means for energizing the coils are preferably of such nature as to reduce the energizing current practically instantaneously to zero so that the deflected beam returns into its normal position with an extremely rapid speed as compared with the exposure time.

The microscopes are operated as follows. At first the object, or its carrier, and the photographic plate in its holder or magazine are adjusted in their accurate position relative to the undeflected electron beam. Then the coils 8 are energized thereby, diverting the beam from the plate. Now the plate is uncovered and the coils 8 are deenergized, thereby exposing the plate to the beam.

What is claimed is:

1. An electron microscope having a vacuum vessel, an electron source for producing a beam of electrons in said vessel, a carrier for holding an object in the path of said beam, means for holding a photosensitive layer, a set of electron-optical lenses concentrically surrounding said beam for causing said beam to produce a magnified image of the object, means for producing a beam-deflecting field arranged laterally of the beam axis between said object carrier and said holding means for shifting said image from said layer to a lateral wall portion of said vessel, a luminescent screen arranged on said wall portion for visualizing said image, said screen and said layer being disposed relatively to each other so that said image when focused on one of them is also in focus when deflected onto the other.

2. An electron microscope having a vacuum vessel, an electron source for producing a beam of electrons in said vessel, a carrier for holding an object in the path of said beam, means for holding a photosensitive layer, a set of electron-optical lenses concentrically surrounding said beam for causing said beam to produce a magnified image of the object, means for producing a beam-deflecting field arranged laterally to the beam axis between said object carrier and said holding means for shifting said image from said layer to a lateral wall portion of said vessel, a luminescent screen arranged on said wall portion for visualizing said image, and protective baffles arranged between said screen and said layer to prevent said layer from being affected by said beam when the image is shifted onto said screen.

3. An electron microscope having a vacuum vessel, an electron source in said vessel for producing an electron beam, a carrier for holding an object in the path of said beam, an electron-optical lens system concentrically surrounding said beam for causing said beam to produce a magnified image of said beam, a luminescent screen disposed in said vessel for visualizing said image when focusing said beam, photographic means in said vessel for recording said image, said screen being arranged laterally to said photographic means relative to the axis of said lens system, and an exposing device having beam-deflecting field means for laterally shifting said beam so as to place said image selectively on said screen and said photographic means, said deflecting means being arranged laterally to said beam between said lens system and said photographic means.

4. An electron microscope having a vacuum vessel, an electron source in said vessel for producing an electron beam, a carrier for holding an object in the path of said beam, an electron-optical lens system concentrically surrounding said beam for causing said beam to produce a magnified image of said beam, a luminescent screen disposed in said vessel for visualizing said image when focusing said beam, photographic means in said vessel for recording said image, said screen being arranged laterally to said photographic means relative to the axis of said lens system, and an exposing device having beam-deflecting field means arranged laterally to the beam axis between said lens system and said photographic means for laterally shifting said beam so as to place said image selectively on said screen and said photographic means, and baffle means disposed between said screen and said photographic means for preventing the latter from being affected by said beam when said image is shifted onto said screen.

5. An electron microscope having a vacuum vessel, an electron source in said vessel for producing an electron beam, a carrier for holding an object in the path of said beam, a system of electron-optical lenses concentrically surrounding said beam for causing said beam to produce a magnified image of the object, a luminescent screen in said vessel for visualizing said image, means for accommodating a photographic layer disposed in said vessel for recording said image, said screen and said means being disposed laterally to each other at the side of said system opposite to said carrier, and a magnetic deflecting coil disposed laterally relative to the normal direction of said beam and arranged between said lens system and said photographic layer for selectively deflecting said beam from said layer onto said screen.

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