June 27, 1950 J. B. LE POOLE ET AL 2,512,947

ELECTRON-MICROSCOPE

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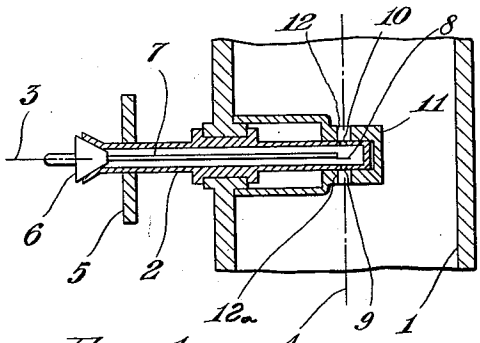


Fig. 1.

Fig. 3.

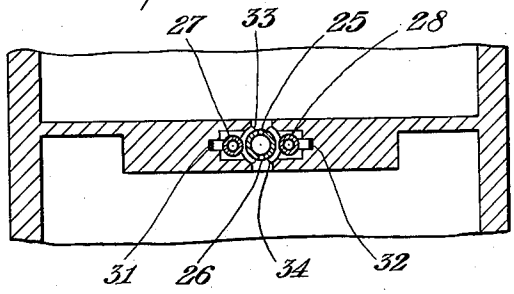


Fig. 2.

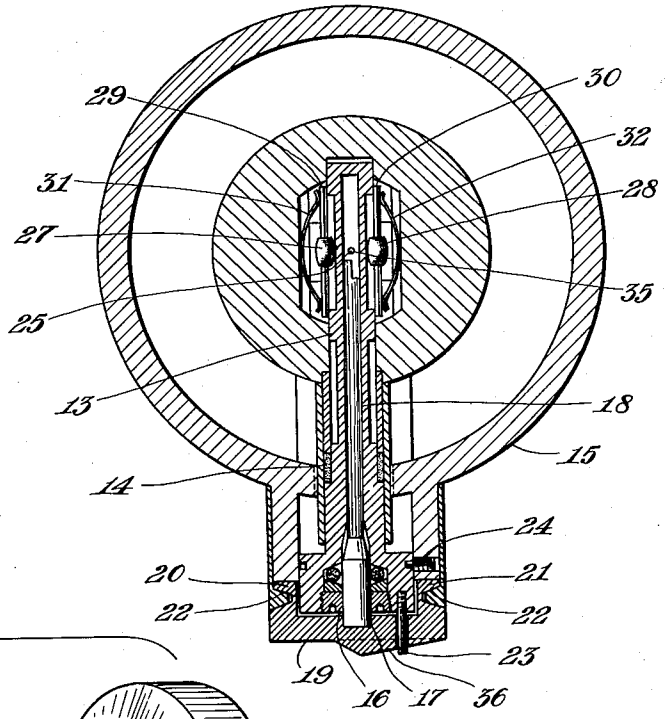
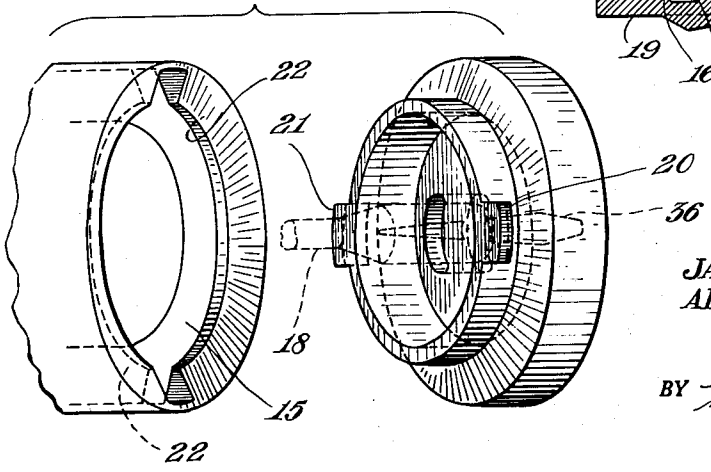


Fig. 4.



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ELECTRON MICROSCOPE

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9 Claims. (Cl. 250—49.5)

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The invention relates to electron microscopes and more particularly to an electron microscope structure for the introduction of specimens to a vacuum chamber of a discharge vessel of a microscope.

It is an object of the present invention to provide a new and novel specimen-holder arrangement for an electron microscope.

It is another object of the invention to provide a specimen-holder arrangement which will permit a rapid and easy change of specimens by simple manipulations.

It is a further object of the invention to provide a specimen holder arrangement which will permit change of specimens while maintaining a high degree of vacuum in the vacuum chamber.

Other objects, advantages and novel features of the invention will become apparent as the specification progresses.

In the electron microscope with which the present invention is concerned, a tube having a closed bottom and passing hermetically through the wall of the discharge vessel serves to accommodate an object holder. The axis of this tube intersects the major axis of the microscope at substantially right angles. The tube is rotatable about its axis by means provided on the outside of the device and the open end may be closed by a stopper which carries the object holder. Along the wall of this tube are provided diametrical apertures through which the electron beam of the microscope may pass in a given position of the tube. When the tube is rotated from the given position these apertures are hermetically closed by means of a solid body bearing against the tube at the apertures.

According to the invention, the removal of the object-holder which supports the specimen to be examined, is only possible when the tube occupies a position in which the diametrical apertures provided to permit the passage of the electron beams are closed. Thus protection against ingress of air to the vacuum chamber during the change of specimens is obtained. Accordingly, when the tube is so positioned the stopper may be withdrawn in the direction of the tube axis and it is then possible to lift a stopper from the tube to introduce a new preparation or specimen for observation.

A suitable embodiment of such a construction is obtained by securing to the stopper a handle which serves not only to lift the stopper with the object holder from the tube but also to turn the tube. Moreover a bayonet joint may be provided which locks the said handle in an open position, a position in which the beam apertures are so placed that the electron beam passes through the specimen or the object holder. A turn of the bayonet then permits closing of the apertures thus preventing passage of the electron beam.

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It may be desirable in some circumstances to be able to displace the object slightly without immediately moving the beam apertures out of the axis of the microscope, for it is sometimes desired to cause the electron beam to fall on the object in different directions, for example, when making stereoscopic exposures. It is therefore advantageous that the handle have a certain freedom of movement (for example 30°) with respect to the tube.

According to the invention it is also possible to obtain a good seal between the tube and the vacuum chamber by means of valves made of rollers which resiliently bear against the tube and the axes of which rollers are parallel to the tube axis. Notwithstanding the spring pressure required for closing the beam apertures when using these rollers very little frictional resistance is experienced when the tube is turned since the rollers are rotatable about their only axes. Perfect sealing is ensured in this case if the rollers are made of elastic material such as rubber. Unfortunately the use of rubber entails the disadvantage of wear which makes an exchange of rollers necessary from time to time. Moreover, the specimen under observation is likely to become contaminated by scraps of material ground off the rollers. According to the invention, this disadvantage may be obviated by mounting the rollers on metal spindles and by giving the tube a profile such that in the open position when the electron beam may pass through the apertures these spindles bear against the tube and the rollers are clear thereof whereas in the closed position in which passage of the electron beam is prevented, the spindles are positioned in depressions of the tube and the rollers are pressed against the apertures to close them.

The invention will be explained more fully with reference to the accompanying drawing wherein

Fig. 1 diagrammatically represents, by way of example, one embodiment of the sluicing device in an electron microscope.

Figs. 2, 3, and 4 show a further embodiment of such a device according to the invention.

Fig. 1 is a cross-sectional view through the axis of the electron microscope and represents

a small portion of the discharge vessel which, in the neighborhood of the sluicing device, has a cylindrical metal wall 1. Through an aperture provided in this wall passes a metal tube 2 which is rotatable about its axis 3 which intersects the axis 4 of the discharge vessel at right angles. In order to facilitate this rotation the tube is provided with a hand wheel 5.

The tube is closed by a stopper 6 having secured to it an object-holder 7 which extends within the tube 2 over a length such that the specimen 8 provided at the end of the holder is located in the centrally passing electron beam. In the wall of the tube 2, in alignment with the axis 4, two diametrical apertures 9 and 10 are provided which allow the electron beam to pass through the tube wall. A metal body 11 secured to the wall 1 and having provided in its apertures 12 and 12*a* corresponding with the apertures 9 and 10 of the tube, and the tube itself form together a plug cock. Hermetical sealing may be favoured by providing on the tube a thin layer of the packing material known under the name of "cockfat."

When a specimen is to be removed from the micrscope it is necessary to turn the tube 2 a quarter of a turn with the aid of the handwheel 5, in which event the apertures 9 and 10 are closed by the solid portion of metal body 11 so that the electron beam is prevented from penetrating through the wall of the tube 2 into the lower section discharge vessel, penetration of air through these beam apertures 9 and 10 into the lower section of the vessel being made impossible at the same time. Without any objectionable result the stopper 6 may then be taken from the tube and with it the object holder 7 and the specimen 8 are removed. After the stopper 6 has been replaced upon the tube 2 the latter may be moved again into its previous position in which the apertures 9 and 10 are located in alignment with the apertures 12 and 12*a* and the object is transradiated by the electron beam. The air which, after the removal of the stopper 6 entered the tube 2 to fill it may now pass through the apertures 9 and 10 into the discharge vessel, this quantity being, however, so small that it may easily be removed within an extremely short time by an exhausting device which is permanently connected to the discharge vessel.

With a device constructed in accordance with Figs. 2 and 3 the quantity of air which may leak into the vessel during the change of specimens is even less than in the aforementioned construction. In this embodiment the object-holder 18 has a diameter which is substantially equal to the internal diameter of the tube 13 so that the interior of the tube 13 is filled for the major part and there remains only little space for air leakage into the vessel.

In this embodiment the sluicing device is provided on a partition of a metal portion of the wall of the discharge vessel as shown more clearly in Fig. 3. Fig. 2 is a cross-section of the vessel taken through a thicker portion of this partition and Fig. 3 is a cross-sectional view in a plane passing through the axis perpendicular to the object-holder. Fig. 4 shows in a perspective view, on a larger scale, a detail of a bayonet locking device used in this embodiment.

The tube 13 which, in accordance with the invention, serves to accommodate the object-holder 18 is rotatable in a stuffing box 14 mounted in a metal wall 15. The tube itself is closed by means of a stuffing box 16 through which passes the end 17 of an object holder 18. Thus is formed a stopper by means of which the tube 13 is closed. On the end 17 of the object holder 18 is provided a knob 19 which acts as a handle. With the aid of this knob 19 it is possible to draw the object holder 18 out of the tube 13. However in the position shown in Fig. 2 a locking device provided in the form of hooks 20 and 21 gripping behind a rim 22 of the knob 19 prevents the withdrawal of the object-holder or specimen-holder 18. When the knob 19 is turned a pin 23 secured to the tube 13 and passing through the knob 19 is carried along with it with the result that the tube 13 is rotated about its axis. The knob aperture through which the pin 23 passes has an elongated shape so that the pin has a certain freedom of movement and the object holder can be turned within the tube 13 through a certain angle. This is desirable for the making of stereoscoping exposures or if for other reasons it is desired to cause the electron beam to fall on the object at different angles.

If, after the pin 23 has been engaged, the knob 19 is further rotated, the hooks 20 and 21 slide over the rim 22 and after a rotation through an angle of approximately 90° they will be located behind recesses provided in the rim 22 (see Fig. 4). The hooks 20 and 21 now no longer prevent the object holder 18 from being removed, in which event the tube 13 itself is held in place since it is retained by screws 24 whose ends engage a circular groove in the outer wall of the tube. However, due to the rotation of the tube and the valve action to be described below, the direct communication between the interior of the tube and the discharge vessel has been interrupted.

The valve action is effected by valves in the form of rollers 27 and 28 mounted on spindles 29 and 30 which are pressed towards the tube 13 by springs 31 and 32. These rollers serve to close the beam apertures 25 and 26 of the tube 13. If, as shown in Figs. 2 and 3, the tube 13 has been turned so that the beam apertures lie in the axis of the discharge vessel, the rollers 27 and 28 are clear of the tube since as may be seen in the cross-section taken through the beam apertures the tube has a reduced external diameter so that solely the spindles bear against the tube. In the longitudinal section taken through the beam apertures the outer surface of the tube may be seen to exhibit depressions 33 and 34 at the points at which, after rotation, the ends of the spindles 29 and 30 will be located. If consequently the tube 13 is rotated from the position shown in Fig. 2 the spindles 29 and 30 are lowered into the depressions and the rollers 27 and 28 engage the tube, thus hermetically closing the apertures 25 and 26. The spindles 29 and 30 consist of metal whereas, in order to ensure a completely vacuum-tight seal the rollers 27 and 28 are made of rubber or similar elastic material. Since the rollers are normally clear of the tube and are pressed thereon only in the closed position of the tube they are substantially not subject to wear and the specimen 35 secured to the holder 18 remains free from impurities which otherwise might be present due to this wear.

In order to be able to easily ascertain in darkness the position occupied by the specimen, the knob 19 is provided with a rib 36 in such manner that in the mid-position of the object-holder it is, with respect to the tube in alignment with the pin 23 passing through the knob. Thus it

is possible by touch to determine the position of the specimen within the tube.

What we claim is:

1. An electron microscope comprising a discharge vessel, a tube with a closed bottom extending into said vessel and intersecting the axis thereof, said tube being hermetically sealed to said vessel and having apertures for the passage of the electron beam, means for rotating said tube from the outside, an exchangeable carrier arranged in said tube and adapted to support a specimen for observation through said beam aperture, a member for closing said tube and supporting said specimen carrier, and means for closing said beam apertures when said tube is rotated to a position in which said tube closing member is ready for removal.

2. An electron microscope comprising a discharge vessel, a tube with a closed bottom extending into said vessel and intersecting the axis thereof at right angles, said tube being hermetically sealed to said vessel and having apertures for the passage of the electron beam, means for rotating said tube from the outside, an exchangeable carrier arranged in said tube and adapted to support a specimen for observation through said beam apertures, a stopper for closing said tube and supporting said specimen carrier, and a solid body bearing against the tube for closing said beam apertures when said tube is rotated to a position in which said tube closing member is ready for removal.

3. An electron microscope as claimed in claim 1, comprising a locking means for securing said tube closing member while the beam apertures are in open position.

4. An electron microscope comprising a discharge vessel, a tube with a closed bottom extending into said vessel and intersecting the axis thereof at right angles, said tube being hermetically sealed to said vessel and having apertures for the passage of the electron beam, an exchangeable carrier arranged in said tube and adapted to support a specimen for observation through said beam apertures, a stopper for closing said tube and supporting said specimen carrier, a handle adapted to rotate the tube and to lift the specimen carrier out of said tube, a bayonet locking device for securing the handle against withdrawal while the beam apertures are in open position, and means for closing the beam apertures when upon rotation of the tube the handle becomes unlocked and ready for withdrawal.

5. An electron microscope as claimed in claim 4, wherein said handle has an elongated arcuate slot and wherein a pin is secured to said tube and slidably received in the slot in said handle, whereby the handle receives a certain freedom of angular movement with respect to said tube and the specimen can be placed at different angles with respect to the electron beam.

6. An electron microscope as claimed in claim 4, wherein said handle has an arcuate slot of about 30 degrees and wherein said tube has a pin secured thereto, said pin being slidably received in said slot, whereby the handle is free to move for said 30 degrees with respect to said tube and the specimen can be placed at different angles with respect to the electron beam.

7. An electron microscope comprising a discharge vessel, a tube with a closed bottom extending into said vessel and intersecting the axis thereof, said tube being hermetically sealed to said vessel and having apertures for the passage of the electron beam, means for rotating said tube from the outside, an exchangeable carrier arranged in said tube and adapted to support a specimen for observation through said beam apertures, a member for closing said tube and supporting said specimen carrier, and valves for closing said beam apertures when said tube is rotated to a position in which said tube closing member is ready for removal, said valves being in the shape of rollers adapted to bear resiliently against said tube.

8. An electron microscope comprising a discharge vessel, a tube with a closed bottom extending into said vessel and intersecting the axis thereof, said tube being hermetically sealed to said vessel and having apertures for the passage of the electron beam, means for rotating said tube from the outside, an exchangeable carrier arranged in said tube and adapted to support a specimen for observation through said beam apertures, a member for closing said tube and supporting said specimen carrier, and valves for closing said beam apertures, said valves consisting of rubber rollers having their axes parallel to the tube axis and being adapted to engage with recesses formed on the outer wall of said tube, thereby closing said beam apertures when said tube is rotated to a position in which said tube closing member is ready for removal.

9. An electron microscope comprising a discharge vessel, a tube with a closed bottom extending into said vessel and intersecting the axis thereof, said tube being hermetically sealed to said vessel and having apertures for the passage of the electron beam, means for rotating said tube from the outside, an exchangeable carrier arranged in said tube and adapted to support a specimen for observation through said beam apertures, a member for closing said tube and supporting said specimen carrier, rubber rollers for temporarily closing said beam apertures, and metal spindles for mounting said rollers, said spindles being adapted to bear against the tube and said rollers being mounted to be clear of said tube while the beam apertures are open, said spindles being adapted to move to a position clear of the tube when said rollers are in beam aperture closing position.

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