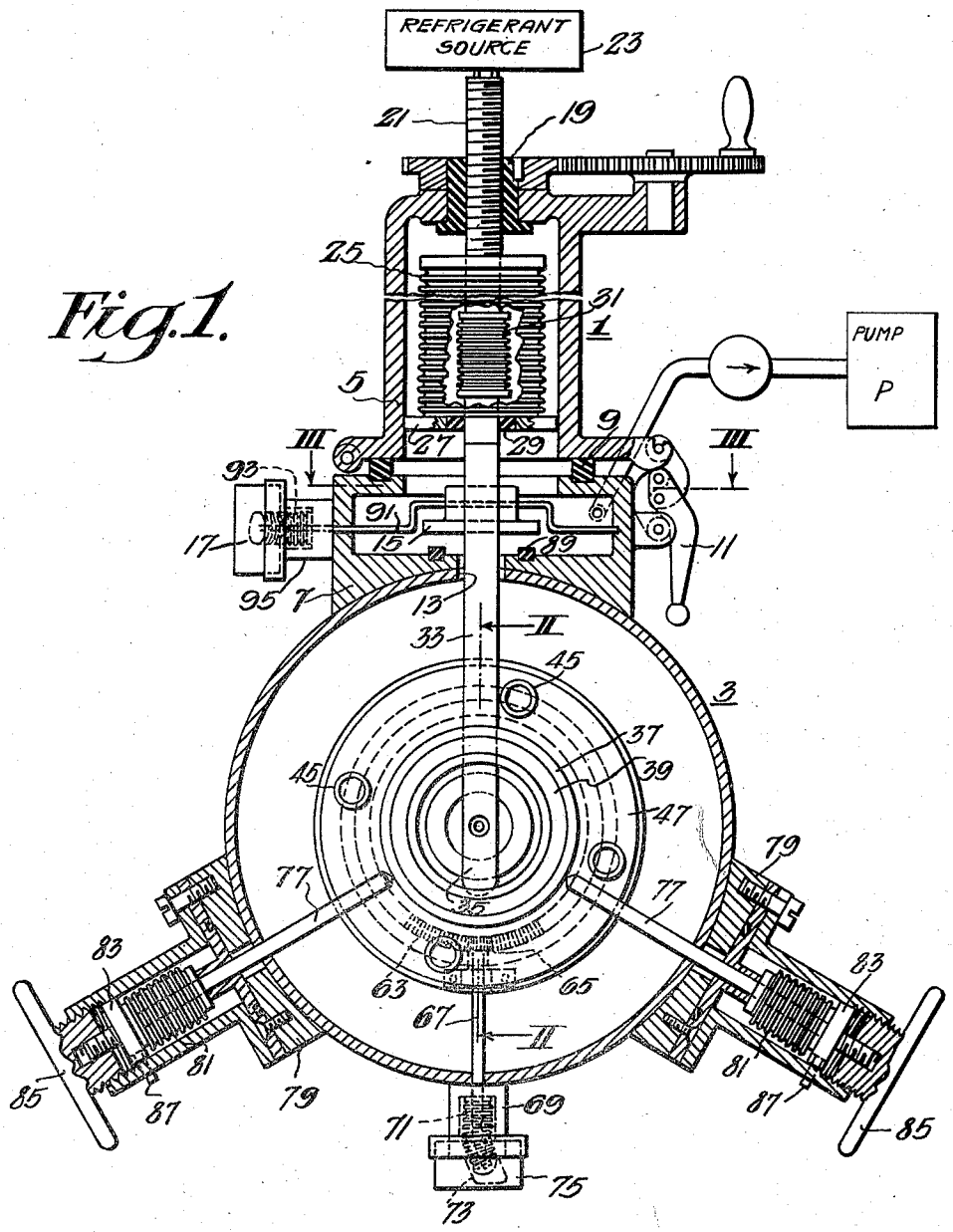
Nov. 12, 1940. L. MARTON 2,220,973

ELECTRON MICROSCOPE

Filed March 31, 1939 2 Sheets-Sheet 1

Fig. 1.



Inventor

Ladislaus Marton

By

Attorney

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Fig. 2.

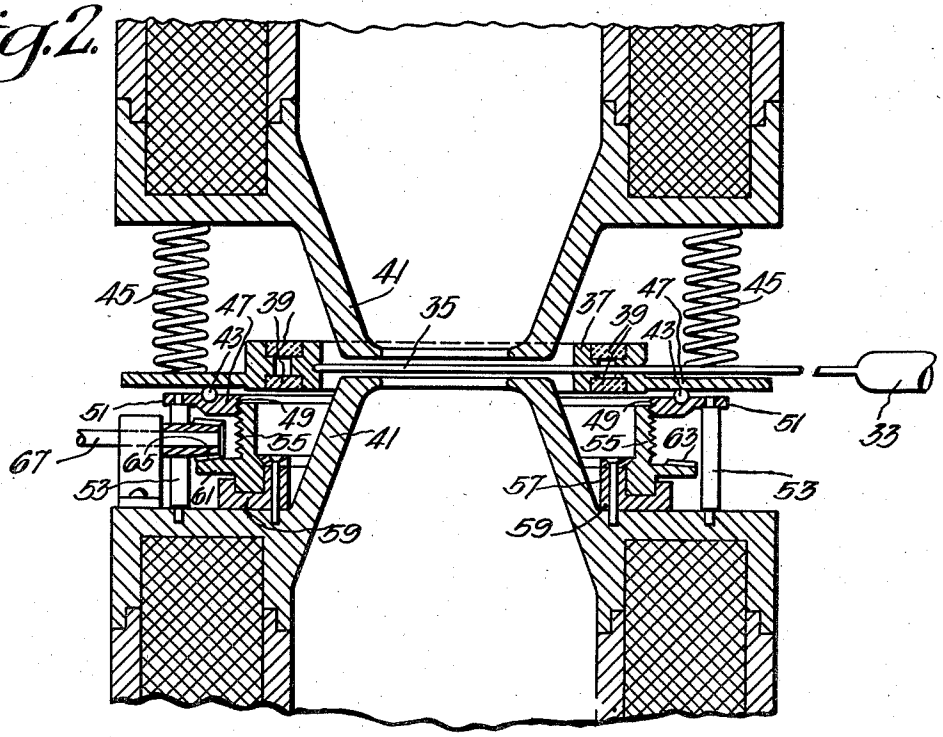


Fig. 3.

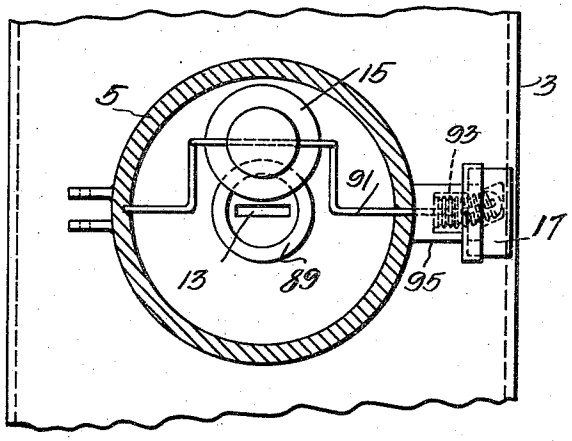
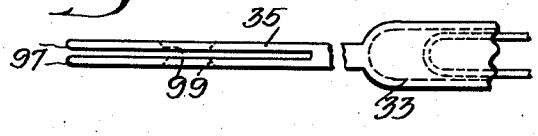


Fig. 4.



Inventor

Ladislaus Marton

By

Attorney

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UNITED STATES PATENT OFFICE

2,220,973

ELECTRON MICROSCOPE

Ladislaus Marton, Collingswood, N. J., assignor to Radio Corporation of America, a corporation of Delaware

Application March 31, 1939, Serial No. 265,375

9 Claims. (Cl. 250—160)

This invention relates to a device for inserting specimens or objects into a vacuum chamber. In one embodiment of the invention, the device is associated with an electronic microscope, which is so arranged that the vacuum of the main chamber is not disturbed when a specimen is inserted into the chamber.

In a number of instruments, such as electronic microscopes, after a main chamber has been evacuated, it is desirable to be able to insert specimens into the main chamber without destroying or reducing the vacuum. It is also desirable to provide means for moving the specimen within the vacuum so that its image may be focused.

The present invention has for one of its objects the provision of means for inserting an object into a vacuum. Another object is to provide means for moving an object within a vacuum. Another object is to provide means for cooling a specimen which has been inserted into a vacuum. An additional object is to provide an electronic microscope with an auxiliary chamber by means of which specimens may be inserted into a main evacuated chamber without impairing the main vacuum.

The invention will be described by reference to the accompanying drawings in which Figure 1 is a plan view, partly in section, of one embodiment of the invention; Figure 2 is a sectional view taken along the line II—II; Figure 3 is a sectional view taken along the line III—III; and Figure 4 is an elevational view of the specimen holder. Similar reference numerals are used to indicate similar elements in the several views.

Referring to Fig. 1, an auxiliary chamber 1 is attached to the main chamber 3 of an electronic microscope. Since the microscope itself is well known to those skilled in the art, it is unnecessary to show the details which, by way of example, may be found in a copending application Serial No. 243,747, entitled "Method of making electronic photographs," filed December 3, 1938, by Ladislaus Marton.

The auxiliary chamber 1 is provided with a hinged portion 5 which may be sealed to a base portion 7 by means of a gasket 9 and a lock 11. The base portion includes an opening 13 into the main chamber and a cover 15 operated by an external control 17 which will be hereinafter described.

The end of the hinged portion 5 includes a heat-insulating nut 19 which is rotatably mounted. The threaded portion of the nut 19 engages a threaded pipe 21 which may be connected to a source 23 of refrigerant used in freezing the specimen. The threaded pipe is soldered to a bellows or Sylphon 25 which is in turn soldered to a disc or plate 27 in the hinged portion 5. The disc may include a thermal insulator 29. The pipe 21 is connected through a second Sylphon 31 to a second pipe 33 terminating in a specimen holder 35. The second pipe and specimen holder extend through the opening 13 into the main chamber.

Referring to Fig. 2, the specimen holder 35 is inserted into a cutaway portion of the disc 37. The disc 37 may be made of a single piece, if a heat-insulating material is used. If non-insulating materials are employed, it is preferable to include heat-insulating rings 39 to prevent conduction losses in the refrigerant. The central portion of the disc is reduced in thickness to permit suitable spacing of the pole pieces 41 of the electronic lens of the microscope proper. The disc 37 is seated on ball bearings 43 and is held in engagement therewith by springs 45, which may bear upon the upper pole piece structure.

The ball bearings are suitably mounted on an annulus 47 whose inner portion 49 is threaded and whose outer portion 51 is slidably mounted on pins 53. The pins prevent rotation of the annulus. The threaded portion 49 engages a male thread 55 on a second annulus 57. The second annulus is mounted on a circular track 59, which may be a portion of the lower pole piece structure. The second annulus includes a skirt portion 61 on which is formed a circular rack 63. The circular rack is engaged by a pinion 65. The pinion is mounted on a shaft 67.

Referring to Fig. 1, the shaft 67 is extended through the main chamber 3 to a vacuum-tight fitting 69. A Sylphon 71 is soldered to the fitting and is closed at its free end. The shaft 67 is bent along the portion remote from the main chamber. The bent portion is included within the Sylphon 71, which terminates in an eccentric aperture 73 in a knob 75. The knob is rotatably mounted on the fitting 69. The foregoing arrangement makes a vacuum-tight connection for the shaft without the addition of stuffing boxes, or the like. The shaft is rotated by rotating the knob 75. Such rotation is permitted by the flexibility of the Sylphon 71. Rotation of the knob 75 raises and lowers the first annulus 47 and the disc 37 carrying the specimen holder 35. The flexibility of the pipe 33 and the clearance at opening 13 are designed to permit this movement.

In order that the specimen holder may be shifted with respect to the center line of the microscope or located with respect thereto, a pair of pins 77 are arranged within the main chamber opposite the opening 13. Inasmuch as the pins may be identical, only one will be described. The pin extends through a vacuum-tight fitting 79 and terminates in the far end of a Sylphon 81. The near end of the Sylphon 81 is soldered to the fitting. The elasticity of the Sylphon makes it possible to move the pin inwardly or outwardly. These movements may be effected by a plunger 83 which is threaded into an adjusting knob 85. The plunger 83 is keyed 87 to prevent rotation. The adjusting knob 85 is also threaded into the fitting 79. A different number of threads per inch is preferably used on the adjusting knob and plunger so that a differential action or vernier movement results.

The two pins 77 engage a shoulder on the disc 37. The movements of the pins are accompanied by movements of the disc because the latter is continuously pressed against the pins by virtue of the atmospheric pressure applied through the tube 21, 33 and transmitted by the second-mentioned Sylphon 31 which is interposed in the pipe line 21, 33. The clearance in the opening 13 prevents interference with movements of the disc. It should be understood that a careful fit of the specimen holder 35 within the disc ensures not only an accurate location of the specimen but also that movements of the disc are accompanied by corresponding movements of the specimen holder.

The cover 15 arrangement is illustrated in Fig. 3. The opening 13 is surrounded by a suitable gasket 89. The cover 15 is mounted on a crank shaft 91. The crank shaft is supported by bearings in the hinged portion 5 of the auxiliary chamber. One end of the crank shaft extends through the wall of the hinged portion 5 and is bent. The bent portion is surrounded by a Sylphon 93. The Sylphon is sealed at one end and is soldered at the other to a fitting 95. The fitting is soldered to the wall of the hinged portion 5. The sealed end of the Sylphon 93 engages an aperture in the knob 17. It should be understood that other types of cover may be used as for example described in United States Patent No. 2,200,095 which issued May 7, 1940 on application Serial No. 258,887, filed February 28, 1939 entitled "Photographic device for vacuum apparatus."

While any type of specimen holder may be used, a preferred type has been illustrated in Fig. 4. The second pipe 33 is soldered or otherwise secured to the holder 35. The second pipe may be appropriately guided within the second Sylphon to maintain alignment with the first pipe. Stops may be used to limit the Sylphon deflection. The holder may be made of a pair of spring metal strips 97. A hole 99 is made through the strips 97. The specimen may be clamped between the strips and aligned with the hole.

The operation of the device is as follows: We shall assume that the main chamber has been closed by clamping the cover 15 over the opening 13, and that the main chamber has been evacuated. It follows that the specimen holder 35 has been withdrawn from the main chamber by withdrawing the pipe portion 33. Suitable clearance for such movement has been noted by the breaks in the hinged portion of the auxiliary chamber. Air may be admitted into the auxiliary chamber, which may be opened to make the specimen holder accessible.

A specimen is inserted within the holder and is aligned with the aperture 99. The specimen may be cooled or frozen by admitting the refrigerant which may be circulated through the pipes 21, 33. The auxiliary chamber 1 is closed and the hinged portion 5 is clamped securely 11. The auxiliary chamber is then evacuated by a pump P. After or during evacuation, the cover 15 may be removed from the opening 13 to permit the insertion of the specimen holder 35 into the disc 37. The insertion is accomplished by turning the nut 19 which advances the threaded pipe 21. After the specimen holder has reached its seat in the disc, an image of the specimen may be focused by raising or lowering the disc by means of knob 75. Such movements are possible because of the elasticity of the relatively long pipes 21, 33. Furthermore, the guiding means within the second Sylphon 31 is also designed to permit movements. It should be realized that the movements are of the order of a few hundredths of an inch. The specimen holder may be moved with respect to the central axis of the microscope by means of the adjusting knobs 85.

Thus, the invention has been described as a device for inserting a specimen into a vacuum. The device includes an auxiliary chamber, connected to a main chamber, through a coverable opening. This arrangement makes it practical to insert an object or specimen without impairing the vacuum of the main chamber. Means external to the main chamber are disclosed for shifting the specimen with respect to the axis of the chamber and for moving the specimen with respect to a focal point. The several adjusting means are operable without the use of stuffing boxes. While the device has been described in connection with an electronic microscope, it should be understood that the invention may be applied to other vacuum-operated instruments.

I claim:

1. In an electronic microscope, a main vacuum chamber, an auxiliary chamber, said auxiliary chamber being independently evacuated, means for evacuating said chambers, a wall including an opening between said chambers, said wall being located between said chambers, a vacuum tight cover for said opening, a holder for supporting a specimen to be examined within said electronic microscope, movable means for inserting said specimen holder from said auxiliary chamber through said opening without impairing the vacuum of the main chamber, and supplemental adjusting means external to both chambers for moving said specimen holder.

2. In an electronic microscope a main vacuum chamber, an auxiliary chamber, said auxiliary chamber being independently evacuated, means for evacuating said auxiliary chamber, a passageway between said chambers, a vacuum tight cover for closing said passageway, mechanical means external to said chambers for opening and closing said cover, a holder supported partly within said auxiliary chamber and arranged to support a specimen to be examined within said electronic microscope, movable means for inserting said holder through said passageway into said main chamber, and supplemental adjusting means external to said chambers for moving said holder laterally with respect to the axis of the main chamber.

3. In an electronic microscope, a main vacuum chamber, an auxiliary chamber, said auxiliary chamber supporting a vacuum independent from said main chamber, means for evacuating said

auxiliary chamber, a passageway between said chambers, a vacuum tight cover for closing said passageway, means external to said chambers for operating said cover, a holder supported partly within said auxiliary chamber and arranged to support a specimen to be examined within said electronic microscope, movable means for inserting said holder through said passageway into said main chamber, means external to said chambers for moving said holder with respect to the axis of the main chamber, and supplemental adjusting means external to said chambers for moving said holder along said axis.

4. In an electronic microscope, a main vacuum chamber, an auxiliary chamber, said auxiliary chamber being constituted to support a vacuum independent of said main chamber, means hinging said auxiliary chamber on said main chamber, a clamp for securing said auxiliary chamber to said main chamber so as to sustain said vacuums, a holder supported partly within said main chamber and adapted for supporting a specimen to be examined electronically, movable means for inserting said specimen holder into said main chamber through an opening therein, a vacuum tight cover for closing said opening, mechanical means external to said chambers for operating said cover, and means for evacuating said auxiliary chamber so that the vacuum of the main chamber is not impaired during the insertion of said holder.

5. In an electronic microscope, a main vacuum chamber, means located within said chamber for receiving a specimen holder, means external to said chamber for raising or lowering said first-named means, means external to said chamber for moving said first-named means with respect to the axis of said chamber, said last-named means being operable through vacuum-tight connections, a holder for supporting a specimen to be examined, an auxiliary vacuum tight chamber partly supporting said holder, a common wall for said chambers including an aperture permitting said holder to be inserted through said wall and into engagement with said first-named means, means for evacuating said auxiliary chamber independently of said main chamber, and movable means external to said chambers for inserting said holder into said main chamber.

6. In an electronic microscope, a main vacuum chamber, an auxiliary chamber, said auxiliary chamber being constituted to support a vacuum independent of said main chamber, means hinging said auxiliary chamber on said main chamber, a clamp for securing said auxiliary chamber to said main chamber so as to sustain said vacuums, a holder supported partly within said main chamber and adapted for supporting a specimen to be examined electronically, movable means for inserting said specimen holder into said main chamber through an opening therein, a vacuum tight cover for closing said opening, mechanical means external to said chambers for operating said cover, means for evacuating said auxiliary chamber so that the vacuum of the main chamber is not impaired during the insertion of said holder, means for raising or lowering said holder with respect to a point within said main chamber, and means external to the main chamber for operating said raising or lowering means.

7. In an electronic microscope, a main vacuum chamber, an auxiliary chamber, said auxiliary chamber being constituted to support a vacuum independent of said main chamber, means hinging said auxiliary chamber on said main chamber, a clamp for securing said auxiliary chamber to said main chamber so as to sustain said vacuums, a holder supported partly within said main chamber and adapted for supporting a specimen to be examined electronically, movable means for inserting said specimen holder into said main chamber through an opening therein, a vacuum tight cover for closing said opening, mechanical means external to said chambers for operating said cover, means for locating said holder with respect to the axis of said main chamber, and means external to the main chamber for operating said locating means.

8. In an electronic microscope, a main vacuum chamber, an auxiliary chamber, said auxiliary chamber being independently evacuated, means for evacuating said chambers, a wall including an opening between said chambers, said wall being located between said chambers, a vacuum tight cover for said opening, a holder for supporting a specimen to be examined within said electronic microscope, movable means for inserting said specimen holder from said auxiliary chamber through said opening without impairing the vacuum of the main chamber, supplemental adjusting means external to both chambers for moving said specimen holder, means external to said chambers and connected to said specimen holder for cooling said specimen within said main chamber, and means intermediate said support and said chambers for heat insulating said specimen holder from said chambers.

9. In an electronic microscope, a main vacuum chamber, means located within said chamber for receiving a specimen holder, means external to said chamber for raising or lowering said first-named means, means external to said chamber for moving said first-named means with respect to the axis of said chamber, said last-named means being operable through vacuum-tight connections, a holder for supporting a specimen to be examined, an auxiliary vacuum tight chamber partly supporting said holder, a common wall for said chambers including an aperture permitting said holder to be inserted through said wall and into engagement with said first-named means, means for evacuating said auxiliary chamber independently of said main chamber, movable means external to said chambers for inserting said holder into said main chamber, a vacuum tight cover for closing the aperture in said common wall, and mechanical means external to said chambers for moving said cover into and out of place.

LADISLAUS MARTON.