Fig. 1

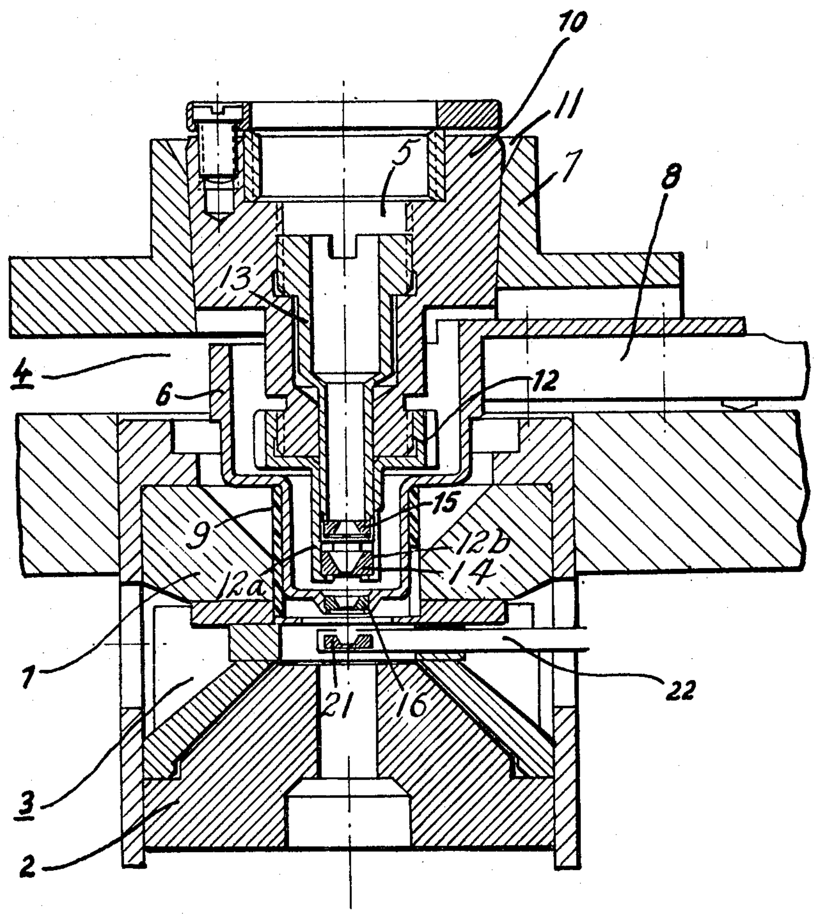


Fig.2

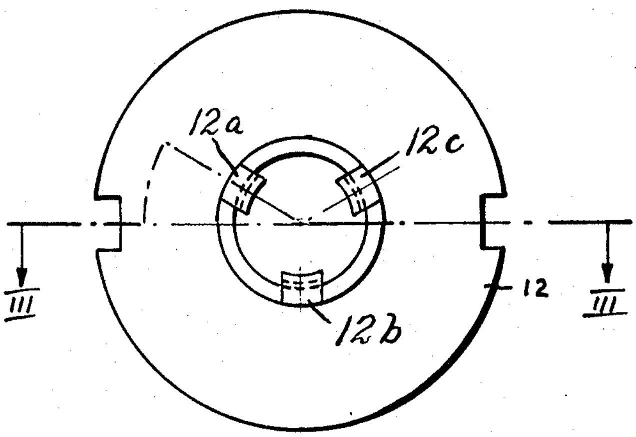


Fig.3

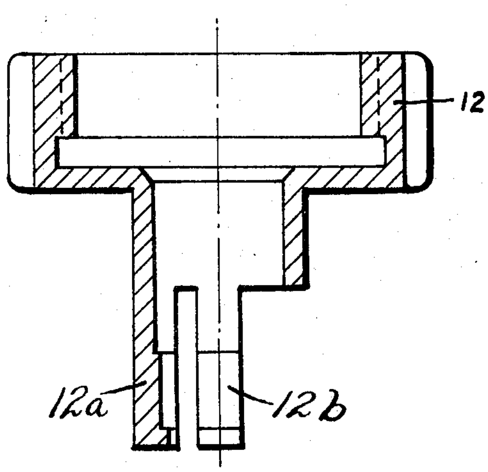
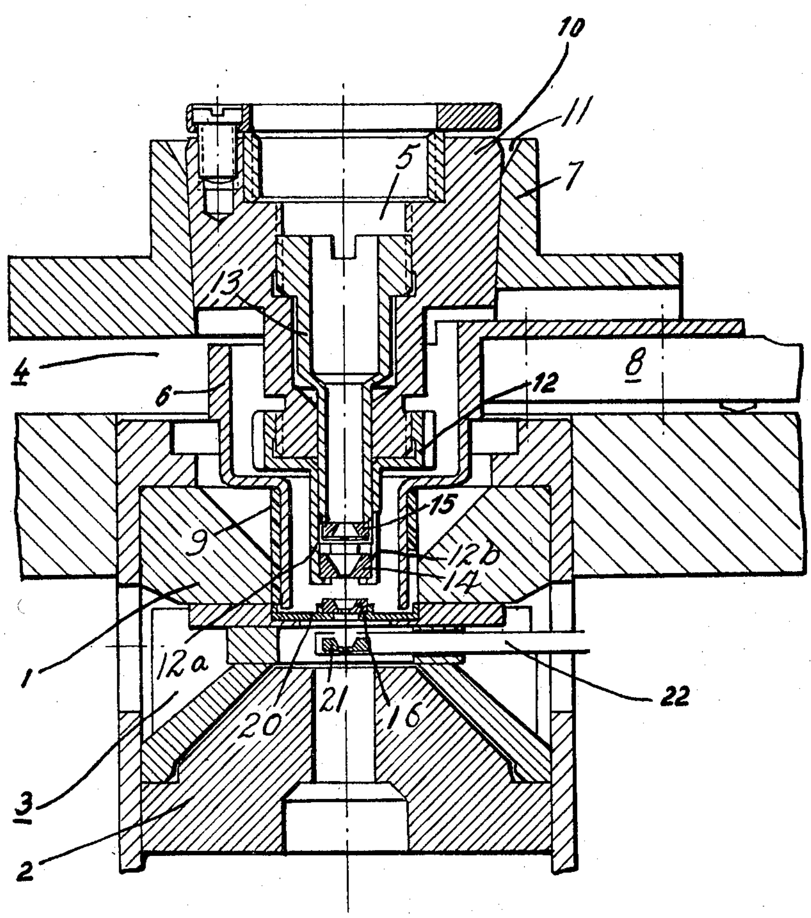


Fig. 4



PARTICLE BEAM APPARATUS WITH A CRYOGENICALLY COOLED SPECIMEN CARTRIDGE THAT IS BELOW THE SPECIMEN HOLDER TEMPERATURE

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Fig. 5

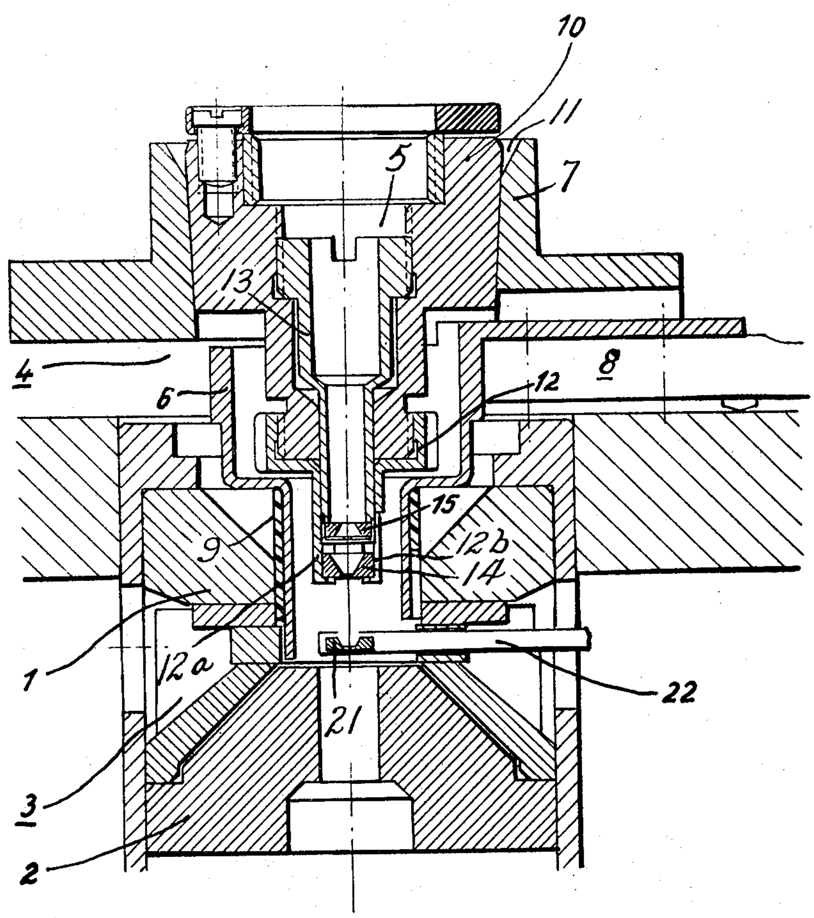


Fig. 6

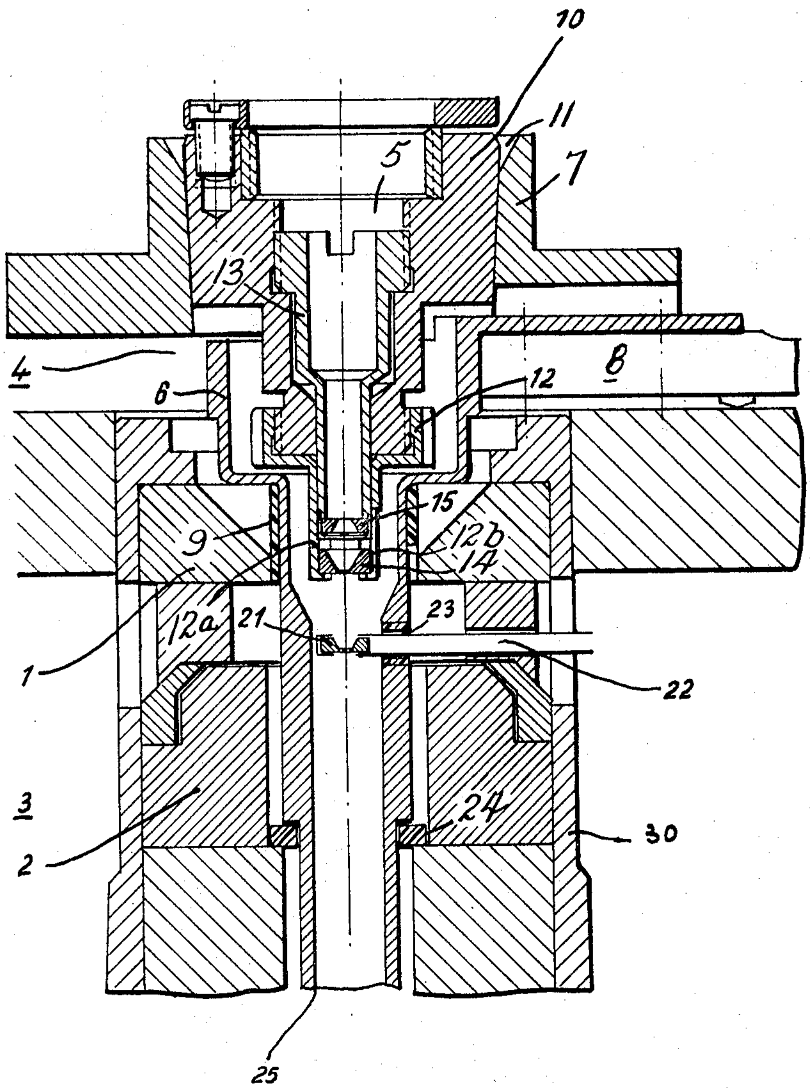
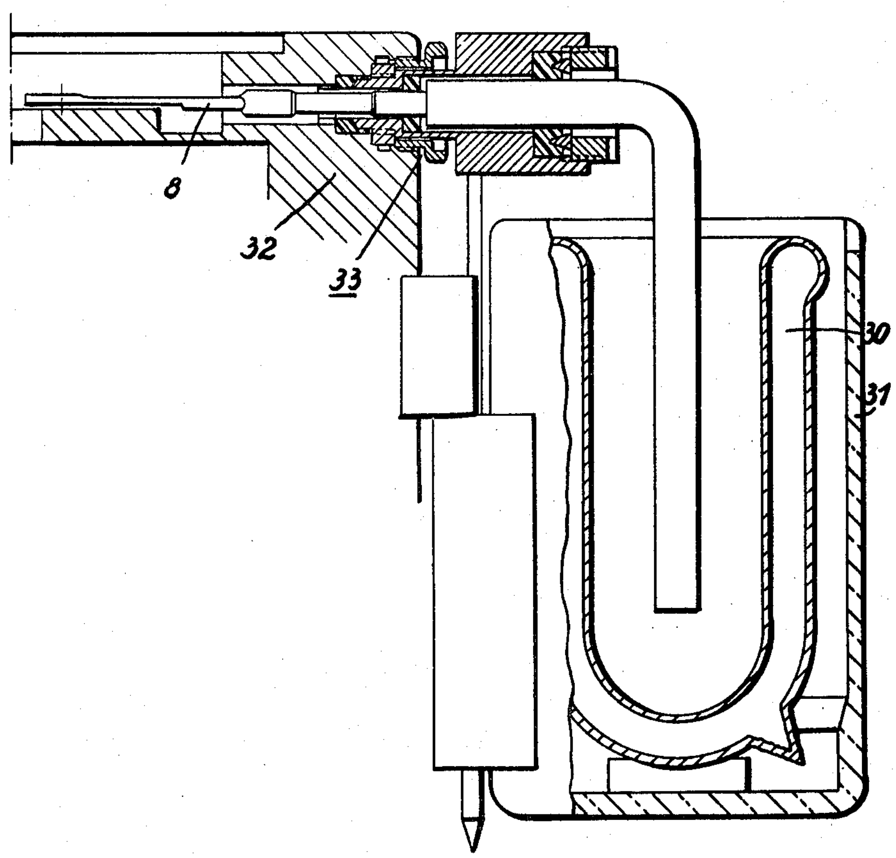


Fig. 7



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PARTICLE BEAM APPARATUS WITH A CRYOGENICALLY COOLED SPECIMEN CARTRIDGE THAT IS BELOW THE SPECIMEN HOLDER TEMPERATURE

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Claims priority, application Germany, Sept. 9, 1963, S 87,171
15 Claims. (Cl. 250—49.5)

ABSTRACT OF THE DISCLOSURE

In a particle beam apparatus having wall structure forming a chamber, the wall structure being at the temperature of the surrounding atmosphere when the apparatus is in operation and having a vacuum space in the chamber; a cartridge assembly mounted in the chamber and having two coaxial and axially apertured cartridge portions, a first one of the cartridge portions being in thermally conductive connection with the chamber so as to be substantially at the temperature of the wall structure; cryogenic means connected with a second one of the cartridge portions for cooling it during the operation to a temperature below the temperature of the wall structure; a specimen holder and diaphragm means mounted on the first cartridge portion in coaxial relation thereto, the diaphragm means being axially spaced from the specimen holder on one side of the holder and being in thermally conductive connection with the first cartridge portion so as to be approximately at the temperature of the wall structure; and means for directing a particle beam through the first apertured cartridge portion onto a specimen held in the specimen holder, the second cartridge portion extending around the first cartridge portion in the region where the specimen holder is axially spaced from the diaphragm means, and the first cartridge portion having openings in the region, whereby the low temperature of the second cartridge portion is effective through the openings to reduce specimen soiling.

Specification

Our invention relates to particle beam apparatus, also known as corpuscular-ray apparatus, particularly electron microscopes, which during operation are continuously connected to a vacuum pump and have a specimen holder accommodating cartridge connected with a cryogenic cooling device.

The connection of the specimen cartridge with the cryogenic device serves to reduce soiling of the object or, more accurately, to minimize the rate of soiling substantially down to zero. Such soiling is caused by the specimen being coated with deposits stemming from residual hydrocarbon gases contained in the vacuum space of the corpuscular-ray apparatus and growing on the specimen under the effect of the corpuscular ray. The coatings become troublesome, for example in electron microscopes, because they reduce the contrast of the microscopic image, tend to blur the contours of the electron-optical image, and to darken the image, thus aggravating the work to be done with the apparatus and often also prevent utilizing the degree of resolution otherwise attainable.

In view of the significance of this soiling problem there have been various proposals towards its solution. Among these the following two are typical.

According to one of the known devices for reducing soiling of the specimen in electron microscopes, the specimen holder is accommodated within a cartridge which is

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located in a cooling chamber formed of good heat-conducting walls heat-conductively connected with a low-temperature cooling device. In the cartridge, the vicinity of the specimen as well as the specimen itself are cooled down to temperatures near −80° C. This known device thus operates to cool the specimen as well as its environment.

Such a device indeed affords a reduction in the rate of soiling down to the zero value. In operation, however, difficulties are often encountered because an excessive cooling is accompanied in most cases by greatly undesirable deterioration of the specimen, manifested essentially by removal of material therefrom. Measurements have shown that there is a given temperature, dependent upon the particular specimen and the particular investigating conditions obtaining in the corpuscular-ray apparatus, at which the rate of soiling as well as the deterioration of the specimen will vanish. This temperature can be adjusted only with great difficulty, not only on account of its dependency upon the particular specimen, but also because the rate of soiling and the specimen deterioration are not uniformly distributed over the specimen surface but are dependent upon the particular locality of the specimen surface under observation. Furthermore, undesired movements of the specimen due to thermal contraction of the cooled parts may occur.

A second known device for reducing the rate of soiling affords the advantage that no, or at least no appreciable, reduction of material from the specimen takes place and that no difficult temperature conditions are to be maintained. In departure from the known device first-described above, the second device operates by cooling only the environment of the specimen down to a temperature beneath the approximate value of −130° C., whereas the specimen remains, at least approximately, at normal room temperature. The favorable performance of this device can be explained by considering that the rate of soiling depends upon the atoms and molecules of hydrocarbons still contained in the residual gases within the vacuum space of the corpuscular-ray apparatus, whereas the reduction of the specimen is caused by molecules of water vapor. With a relatively warm specimen, the dwell time of the water molecules on the specimen is considerably shorter than on the surrounding surface areas, so that the latter have a pumping effect and greatly eliminate the danger of water molecules acting upon the specimen.

This second known device affords considerable advantages in practical operation because, below a temperature of the specimen environment of approximately −130° C., the reduction of the specimen is negligibly slight within a wide range of temperature. Consequently, cooling of the specimen environment to a temperature within a certain range affords keeping any soiling as well as any deterioration of the specimen in negligible limits.

In the last-mentioned known device, the specimen holder accommodating cartridge consists of two mutually heat-insulated portions of which one contains the specimen holder and is in good heat-conducting connection therewith and also with parts of the corpuscular-ray apparatus that are at least approxmately at normal room temperature. The second cartridge portion is heat-insulated from the specimen holder, surrounds the holder, and is in good heat-conducting connection with the cryogenic cooling device. The specimen holder is located between at least two diaphragms which are in good heat-conducting connection through the second cartridge portion with the cryogenic device. This requires that the second cartridge portion be given a particular construction. It consists of a cup-shaped piece and a cover piece. The cup-shaped piece is connected with the cryogenic device, surrounds the specimen holder and also carries the assembly of diaphragms. The cover piece matches the not cryogenically cooled first cartridge portion and is in interruptible heat-conducting contact with the cup-shaped piece. The possibility of interrupting or eliminating the heat-conducting contact between the cup-shaped piece and the cover piece is necessary because, when the specimen is to be exchanged and hence to be sluiced out of the vacuum chamber, the first cartridge portion and the correlated cover piece of the second, cooled cartridge portion must both be taken out of the corpuscular-ray apparatus.

The reason for this particular design of the second cartridge portion is the fact that the diaphragms mounted on opposite sides respectively of the specimen holder must also be cooled in order to realize the chamber principle, i.e., for providing a chamber having cryogenically cooled walls surrounding on all sides the specimen whose temperatures is substantially equal to normal room temperature. This is achieved in the known device by having on the one hand the diaphragms mounted on the cup-shaped piece in heat-conducting connection therewith, and, on the other hand, by providing the cover piece with a heat-conducting extension which reaches into the region of the specimen holder and holds the diaphragms on the other side of the specimen holder so as to connect them heat-conductively with the cryogenic cooling device.

The application of the chamber principle in the known device thus makes it necessary to provide for a mutual geometric penetration of the first cartridge portion, being substantially at room temperature, relative to the second cartridge portion which is in heat-conducting connection with the cryogenic device. This is a difficult structural design requiring assembling and adjusting work of extremely high precision.

Furthermore, the described known device involves the danger that the cooled diaphragm arrangement which constitutes a covering of the cartridge space may be subjected to icing, which due to the proximity of the diaphragm arrangement to the lens field may result in disturbing astigmatism.

Our invention more particularly relates to a corpuscular-ray apparatus of the type last described, having a specimen cartridge formed of two mutually heat-insulated portions of which one contains the specimen holder and is in good heat-conducting connection therewith and with parts of the corpuscular-ray apparatus which are approximately at normal room temperature, whereas the second cartridge portion surrounding the specimen holder is heat-insulated therefrom and in good heat-conducting connection with a low-temperature cooling device, and the specimen holder being located between at least two diaphragms.

Relating to corpuscular-ray devices of this type, it is an object of our invention to avoid the above-mentioned difficulties and deficiencies of the known devices by providing a considerably simplified design capable of performing the same functions and also avoiding the danger of icing at the diaphragms.

Another object of the invention is to devise a specimen cartridge generally of the above-mentioned kind that facilitates exchanging a specimen by permitting the specimen-holder accommodating cartridge portion to be removed as a unit from the corpuscular-ray apparatus without affecting the mounting of the second cartridge portion in the apparatus.

Still another object of the invention is to provide for structural separation between the cryogenically cooled cartridge portion and the other cartridge portion so as to prevent occurrence of undesired displacements of the specimen.

According to the invention, a first cartridge portion, aside from accommodating the specimen holder, also receives heat-conductively the diaphragm means located at one side of the specimen holder so that these diaphragm means are also at a temperature approximately corresponding to normal room temperature. Furthermore, the first cartridge portion possesses lateral openings between these diaphragm means and the specimen holder, the openings being located in a region where the second cartridge portion surrounds the first cartridge portion. Through these openings, the second, cooled cartridge portion can be effective to exhaust any atoms or molecules of gases or vapors as may be present between the diaphragm means and the specimen holder.

In a corpuscular-ray apparatus according to the invention, therefore, the chamber principle, heretofore considered indispensable for effective reduction of specimen soiling, is done away with, and the cryogenic cooling of the diaphragm means located on one side of the specimen holder is likewise eliminated. As will be explained hereinafter, this results in a considerable structural simplification of the specimen cartridge. Although a diaphragm kept at room temperature does not retain atoms or molecules moving in the region of the diaphragm opening, the danger of specimen soiling is nevertheless avoided by virture of the fact that the first cartridge portion in its region between the diaphragms and the specimen holder within the cooled second cartridge portion possesses the above-mentioned openings. Due to these openings, the surface of the specimen holder facing the room-temperature diaphragm is opposite the cooled inner surfaces of the second cartridge portion, so that the latter exhaust any atoms and molecules as may have penetrated into the interspace between the above-mentioned diaphragm means and the specimen holder.

According to a preferred embodiment of the invention, the second cartridge portion is fastened to the objective lens of the corpuscular-ray apparatus such as an electron microscope, and the first cartridge portion is inserted into a specimen holder table and protrudes into the second cartridge portion within the region where the specimen holder and the above-mentioned openings are located. The second cartridge portion, connected with the cryogenic device, may remain in the apparatus without eliminating this connection, even during exchange of a specimen.

If the apparatus is equipped with a specimen holder table which permits being displaced transversely of the ray axis, the distance between the two cartridge portions are preferably made only as large as needed to permit the first cartridge portion to pass by the second cartridge portion during table displacing movement. In this manner, the penetration of atoms and molecules into the region of the specimen, as may result in soiling or deterioration of the specimen, is minimized or substantially prevented.

In a lens having cooled, particularly superconducting parts, the second cartridge portion may be formed by the cooled parts of the lens, due to the fact that the second cartridge portion is permanently and fixedly arranged in the corpuscular-ray apparatus. These lens parts may be constituted, for example, by one or both of the cooled pole shoes of a magnetic lens.

The lateral openings in the first cartridge portion between the diaphragms and the specimen holder may be provided, for example, by fastening the specimen holder to the first cartridge portion with the aid of a wire mesh having a suitable mesh width. A simpler, more effective and often more stable way of providing for the openings is to fasten the specimen holder by means of heat-conducting legs or struts to the first cartridge portion so that the specimen holder is virtually freely suspended within the second cartridge portion. The openings are then constituted by the free spaces between the individual struts. The struts may consist of wire or may be directly machined out of the material from which the first cartridge portion is formed.

In the foregoing, reference is made to the diaphragms located on one side of the specimen holder. Relative to the arrangement and temperature of the diaphragms located on the other side and facing the objective lens, the invention offers various possibilities. For example, the diaphragms on the other side of the specimen holder may be heat-conductively mounted in the second cartridge portion so that they are in good heat-conducting connection through the second cartridge portion with the low-temperature cooling device, as in one of the above-described known arrangements. With this choice of the diaphragm temperature, however, there exists the above-mentioned danger of ice formation at the diaphragms. It is preferable, therefore, not to subject these diaphragms to cryogenic cooling and to heat-insulate them from the second cartridge portion, for example by heat-insulating inserts. With such a choice of the diaphragm temperature, some amount of soiling, although to an only slight extent, may occur at the specimen due to ingress of organic molecules or atoms into the immediate vicinity of the object. This danger is reduced somewhat if the diaphragm on the other side of the specimen holder is constituted by the lens-aperture diaphragm which is approximately at room temperature and axially spaced from the specimen holder, and if the second cartridge portion extends at least to the vicinity of this aperture diaphragm.

While the specimen is thus protected, there is some danger that the aperture diaphragm of the lens may become soiled. According to another feature of our invention, therefore, the second cartridge portion is extended beyond the aperture diaphragm to an area of slight post-enlargement of the image in the apparatus, the second cartridge portion being provided with a lateral opening for the heat-insulated passage of the carrier for the aperture diaphragm. This has the advantage that the cooled second cartridge portion not only prevents soiling of the specimen but also soiling of the lens-aperture diaphragm. Furthermore, the extension of the second cartridge portion to an area of slight subsequent image enlargement obviates detrimental effects of any ice formation at the end of the second cartridge portion upon the quality of the image produced.

It will be understood that the first cartridge portion can be taken out of the apparatus through a vacuum lock or similar device of conventional design for the purpose of exchanging a specimen. This also applies to the low-temperature cooling device which is in good heat-conducting connection with the second cartridge portion. We have found it particularly advisable to employ a cryogenic device comprising in known manner a coolant vessel filled with liquid air or the like and having a cooling rod pressed against the second cartridge portion to maintain a good heat-conducting connection between the cryogenic medium and the second cartridge portion. The cooling rod may be pressed elastically by spring means against the second cartridge portion. However, a fixed or screw-thread connection is also applicable because in the preferred embodiment of the invention the second cartridge portion remains fixedly mounted within the corpuscular-ray apparatus.

A thermocouple may be mounted in known manner on the second cartridge portion to provide a voltage which is passed to the outside by means of leads extending along the cooling rod, thus affording an indication of the temperature of the second cartridge portion.

The invention will be further described with reference to embodiments of corpuscular-ray devices illustrated by way of example on the accompanying drawings. The devices are represented by electron microscopes of which only portions essential to the invention as shown, the microscopes being in other respects in accordance with prior art.

FIG. 1 shows an axial section of part of an electron microscope comprising an objective lens assembly with a specimen cartridge.

FIG. 2 is a view from below onto a carrier for the specimen holder in a lens assembly according to FIG. 1.

FIG. 3 is a section along the line III—III— in FIG. 2.

FIGS. 4 to 6 are axial sectional views of three other objective lens assemblies embodying the invention.

FIG. 7 shows partly in section a cryogenic device which forms part of any one of the electron microscope devices illustrated in FIG. 1 or in FIGS. 4 to 6.

The same reference characters are used in all illustrations for denoting respectively corresponding components.

Referring to FIG. 1, it will be understood that the illustrated assembly of components is located in a vacuum vessel of an electron microscope having a vacuum pump in continuous operation to maintain the necessary vacuum during use of the microscope. The assembly comprises circular pole shoes **1** and **2** of an objective lens systems **3** of the magnetic type. The specimen cartridge **4** according to the invention is mounted above the lens **3** and comprises two cartridge portions **5** and **6**. The first cartridge portions **5** is approximately at normal room temperature, i.e., about 20 C., being inserted in a supporting table structure **7** of metal and in good heat-conducting contact therewith. The table structure **7** is joined with the metallic wall of the vacuum vessel (not shown) thus maintaining the cartridge portion **5** approximately at ambient room temperature. The second cartridge portion **6** is in good heat-conducting connection with a cooling rod **8** which extends laterally away from the illustrated assembly and has a portion **8'** (FIG. 7) immersed in cryogenic medium, such as liquid air, contained in a coolant vessel as will be more fully described hereinafter. The cooled cartridge portion **6** is fastened to the lens system **3** with the aid of heat-insulating inserts **9** (FIG. 1) consisting of sleeves of synthetic plastic, for example.

The first cartridge portion **5** comprises a conical top part **10** and two parts **12** and **13** which are coaxially fastened to the top part **10**, being in threaded engagement therewith in the exemplified embodiment. The part **12** constitutes the carrier proper for the specimen holder **14**. The part **13**, inserted into the top part **10**, serves as a holder for centrally apertured diaphragm **15**.

The carrier **12** forms downwardly extending legs or struts **12*a***, **12*b*** and **12*c*** (FIGS. 1, 2, 3) whose lower ends have respective inwardly directed lugs for supporting the disc-shaped and centrally apertured specimen holder **14**. While three struts are shown, a larger number of struts may be provided.

The diaphragm **15** located above the specimen holder **14** and being in good heat-conducting connection with the table structure **7** through the insert **13** and the conical part **10**, is kept approximately at normal room temperature. A second, centrally apertured diaphragm **16** on the opposite side of the specimen holder **14** is mounted on the second cartridge portion **6** and is approximately at the low temperature of the second cartridge portion which is in heat-conducting connection with the cooling rod **8**.

It will be recognized that by discarding the principle of receiving the specimen in a chamber cryogenically cooled from all sides, there is provided a relatively simple construction which affords designing the first cartridge portion **5**, normally at room temperature on the one hand, and the low-temperature second cartridge portion on the other hand, as respective structural units and in such a manner that only the room-temperature unit of cartridge portion **5** need be removed from the corpuscular-ray apparatus for the purpose of exchanging the specimen or or cleaning the diaphragm **15**. This advantage is not accompanied by increased soiling of the specimen or impairment of the specimen because, due to the use of the struts **12*a***, **12*b***, **12*c*** for carrying the specimen holder **14**, the latter is exposed on all sides to cryogenically cooled surfaces.

The above-described embodiment further makes apparent that, by virtue of the invention the structural unit of the first cartridge portion, containing the specimen holder, can be removed from the corpuscular-ray apparatus for exchanging the specimen—an operation preferably performed by sluicing the first cartridge portion through a vacuum lock—without affecting the second cartridge portion which may remain undisturbed inside the apparatus.

The structural separation of the cooled and noncooled cartridge portions affords the further advantage that disturbing movements of the specimen cannot occur.

In the device shown in FIG. 1, however, the cooling of a diaphragm **16** entails some danger of ice formation due to precipitation of water vapor. Since this diaphragm is located in the gap between the two pole shoes **1** and **2** of the objective lens **3**, such icing may be detrimental in causing or increasing astigmatism of the objective lens. For this reason, it is generally preferable that this diaphragm be no subjected to cryogenic cooling.

Accordingly in the embodiment shown in FIG. 4, the diaphragm **16** is mounted on the second cartridge portion **6** with the aid of a thermally insulating insert plate **20**. As a result, the diaphragm **16** is virtually kept at room temperature and the specimen holder **14** is located between two diaphragms **15** and **16** which are both at least approximately at normal room temperature. In this case, however, some slight residual soiling of the specimen may have to be taken into account because a warm surface, constituted by the diaphragm **16**, is located in proximity to the specimen.

In all other respects the device according to FIG. 4 corresponds to the one described above with reference to FIGS. 1 to 3.

The above-mentioned danger of some residual soiling occurring at the specimen is prevented in the device shown in FIG. 5 which in other respects also corresponds to the one described with reference to FIGS. 1 to 3. According to FIG. 5, the aperture diaphragm **21** which normally forms part of the objective-lens system is used as a protective diaphragm on its side of the specimen holder **14** and the second cartridge portion **6** is downwardly extended into the region of the apertured diaphragm **21** so as to surround this diaphragm. Due to the fact that the slider **22** in which the apertured diaphragm **21** is in heat-conducting connection with the wall structures of the corpuscular-ray apparatus, the diaphragm **21** is substantially at room temperature. Since it is spaced a larger distance from the object holder **14** than is the diaphragm **16** in FIG. 4, any remaining danger of the object becoming soiled is greatly reduced.

The embodiment shown in FIG. 6 fully eliminates the danger that the specimen and the lens-aperture diaphragm may become soiled and also virtually eliminates any detrimental effect of ice formation at the cooled diaphragm upon the image-forming quality of the lens. To the extent the embodiment of FIG. 6 corresponds to those shown in the preceding illustrations it need not be again described. The lens-aperture diaphragm **21** with its supporting slider **22** is at least approximately at room temperature, but the second cartridge portion **6** is downwardly extended a much greater distance than in the embodiment of FIG. 5, so that the aperture diaphragm **21** is surrounded by the cartridge portion **6** in substantially the same manner as the object holder **14**. Consequently any soiling of the apertured diaphragm as well as any soiling of the specimen is prevented.

The passage **23** for the diaphragm slider **22** is designed and preferably provided with additional heat-insulating inserts for the purpose of preventing a heat-conducting connection between the second cartridge portion **6** and the aperture diaphragm **21**.

Another heat-insulating insert **24** of annular shape surrounds the lower extension of the cartridge portion **6** also for the purpose of preventing a heat-conducting connection between the cartridge portion **6** and the surrounding wall structure **32** of the corpuscular-ray apparatus.

The extension of the cartridge portion **6** has such a length beyond the location of the aperture diaphragm **21** that the end **25** of the cartridge portion is located in a region of a slight post-enlargement of the image. For example, the end **25** may be located at the place where the

first intermediate image in an electron microscope is formed. Any icing of the end **25** occurring in this region would no longer have a detrimental effect upon the quality of the image produced. This is predicated upon the requirement that the second cartridge portion **6** has a large cross section at its end **25** for the passage of the corpuscular ray. This, however, is in no way detrimental to the desired reduction in specimen soiling because the end **25** is too far remote from the specimen holder **14**.

The cooling rod **8**, according to all of the embodiments described in the foregoing, establishes a connection of the cooled cartridge portion with a cryogenic vessel. This is exemplified by the cryogenic device shown in FIG. 7. The left end of the cooling rod **8** presses against the second cartridge portion **6** (not shown in FIG. 7). The right hand portion **8'** of the cooling rod extends downwardly into a vessel **30** containing the cryogenic medium such as liquid air, liquid nitrogen or the like. The vessel **30** is mounted in an insulating container **31** which is fastened to the wall **32** of the corpuscular-ray apparatus. The cooling rod **8** passes through the wall **32** with the aid of suitable sealing and heat-insulating means such as shown at **33**.

The invention is not limited to the particular embodiments illustrated. It is applicable with corpuscular-ray or particle beam apparatus other than electron microscopes and is not predicated upon providing the particular cryogenic device shown in FIG. 7. Instead of a specimen holder in form of a diaphragm as shown on the drawing, a mesh work or other support for the specimen may be used. In some cases it is desirable or necessary to provide for good heat conductance between the table structure and/or the diaphragm slider, on the one hand, and such other parts of the corpuscular-ray apparatus as are substantially at room temperature, on the other hand, by using additional heat-conducting means which do not interfere with the necessary displacing motion of the table structure or diaphragm slider. Suitable for this purpose, for example, are braided metal connectors. If necessary, such heat-conducting connector means may also be in connection with additional heating devices.

To those skilled in the art, it will be obvious upon a study of this disclosure that the above-mentioned and other modifications are applicable and that the invention may be given embodiments other than described herein, without departing from the essential features of the invention and within the scope of the claims annexed hereto.

We claim:

1. In a particle beam apparatus having wall structure forming a chamber, said wall structure being at the temperature of the surrounding atmosphere when the apparatus is in operation and having a vacuum space in said chamber; a cartridge assembly mounted in said chamber and having two coaxial and axially apertured cartridge portions, a first one of said cartridge portions being in thermally conductive connection with said chamber so as to be substantially at the temperature of said wall structure; cryogenic means connected with a second one of said cartridge portions for cooling it during said operation to a temperature below the temperature of said wall structure; a specimen holder and diaphragm means mounted on said first cartridge portion in coaxial relation thereto, said diaphragm means being axially spaced from said specimen holder on one side of said holder and being in thermally conductive connection with said first cartridge portion so as to be approximately at the temperature of said wall structure; and means for directing a particle beam through said first apertured cartridge portion onto a specimen held in said specimen holder; said second cartridge portion extending around said first cartridge portion in the region where said specimen holder is axially spaced from said diaphragm means, and said first cartridge portion having openings in said region, whereby the low temperature of said second cartridge portion is effective through said openings to reduce specimen soiling.

2. In apparatus according to claim **1**, said first and second cartridge portions forming respective structural units, said unit of said first cartridge portion being removable from the apparatus for specimen exchange independently of said other unit.

3. Apparatus according to claim **1**, comprising a magnetic lens mounted in coaxial relation to said cartridge assembly and connected with said cryogenic means to be cooled thereby, said lens forming part of said second cartridge portion.

4. In apparatus according to claim **1**, said first cartridge portion having a main body and having mutually spaced heat-conducting struts extending from said main body, said specimen holder being suspended by said struts from said main body, and said openings being constituted by the interspaces between said struts.

5. Apparatus according to claim **1**, comprising further diaphragm means coaxially located on the other side of said specimen holder from said diaphragm means on said first cartridge portion in axially spaced relation thereto and heat-conductively mounted on said second cartridge portion to be cooled by said cryogenic means.

6. Apparatus according to claim **1**, comprising further diaphragm means coaxially located on the other side of said specimen holder from said diaphragm means on said first cartridge portion in axially spaced relation thereto, said further diaphragm means being thermally insulated from said second cartridge portion.

7. Apparatus according to claim **1**, comprising further diaphragm means coaxially located on the other side of said specimen holder from said diaphragm means on said first cartridge portion in coaxially spaced relation thereto and mounted on said second cartridge portion, and heat-insulating means inserted between said further diaphragm means and said second cartridge portion.

8. Apparatus according to claim **1**, comprising a lens having two annular pole shoes coaxialy spaced from each other, said first and second cartridge portions extending coaxially in one of said pole shoes, and said specimen holder and diaphragm means being located in the bore of said one annular pole shoe.

9. In apparatus according to claim **8**, said lens having a lens-aperture diaphragm approximately at the temperature of said wall structure, said aperture diaphragm being located between said pole shoes in axially spaced relation to said specimen holder and separated therefrom by space free of structure, and said second cartridge portion having an extension surrounding said lens-aperture diaphragm.

10. In apparatus according to claim **9**, said extension of said second cartridge portion having a lateral opening, said aperture diaphragm having a heat-conducting part passing through said opening in heat-insulated relation from said second cartridge portion, and said extension of said second cartridge portion extending beyond said aperture diaphragm to an area of slight post-enlargement of said lens.

11. In apparatus according to claim **1**, said cryogenic means comprising a vessel for liquefied gaseous medium at cryogenic temperature, and a heat conducting rod structure having one end portion in said vessel to be immersed in said medium and having the other end in heat conducting engagement with said second cartridge portion.

12. In a particle beam apparatus, comprising a table structure having the temperature of the surrounding atmosphere when the apparatus is in operation; a cartridge assembly having two coaxial and axially apertured cartridge portions, a first one of said cartridge portions being inserted in said table structure and in thermally conductive contact therewith so as to be substantially at the temperature of said table structure; a specimen holder and diaphragm means mounted on said first cartridge portion, in coaxial relation thereto, said diaphragm means being axially spaced from said specimen holder on one side of said holder and being in thermally conductive connection with said first cartridge portion so as to be approximately at the temperature of said table structure; means for directing a particle beam through said first apertured cartridge portion onto a specimen held in said specimen holder; an objective lens fixedly mounted in the apparatus in coaxial relation to said cartridge assembly, said second cartridge portion being fastened to said objective lens; cryogenic means connected with said second cartridge portion for cooling it during said operation to a temperature below the temperature of said table structure, said second cartridge portion extending around said first portion in the region where said specimen holder is axially spaced from said diaphragm means, and said first cartridge portion having openings in said region, whereby the low tempearture of said second cartridge portion is effective through said openings to reduce specimen soiling.

13. In apparatus according to claim **12**, said specimen holder and diaphragm means being removably mounted in said first cartridge portion, and said first cartridge portion being removable for specimen exchange from said table stucture independently of said second cartridge portion.

14. In apparatus according to cliam **12**, said second cartridge portion being fastened to said objective lens and having radial clearance in said region relative to said first cartridge portion so as to permit transverse displacements of said table structure and first cartridge portion relative to said objective lens and second cartridge portion.

15. In apparatus according to claim **12**, said lens having pole shoes thremally connected with said cryogenic means to be cooled thereby, at least one of said pole shoes being integral with said second cartridge portion.

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