June 2, 1942. V. K. ZWORYKIN ET AL 2,284,710

VACUUM PLUMBING

Filed June 1, 1940

Fig. 1

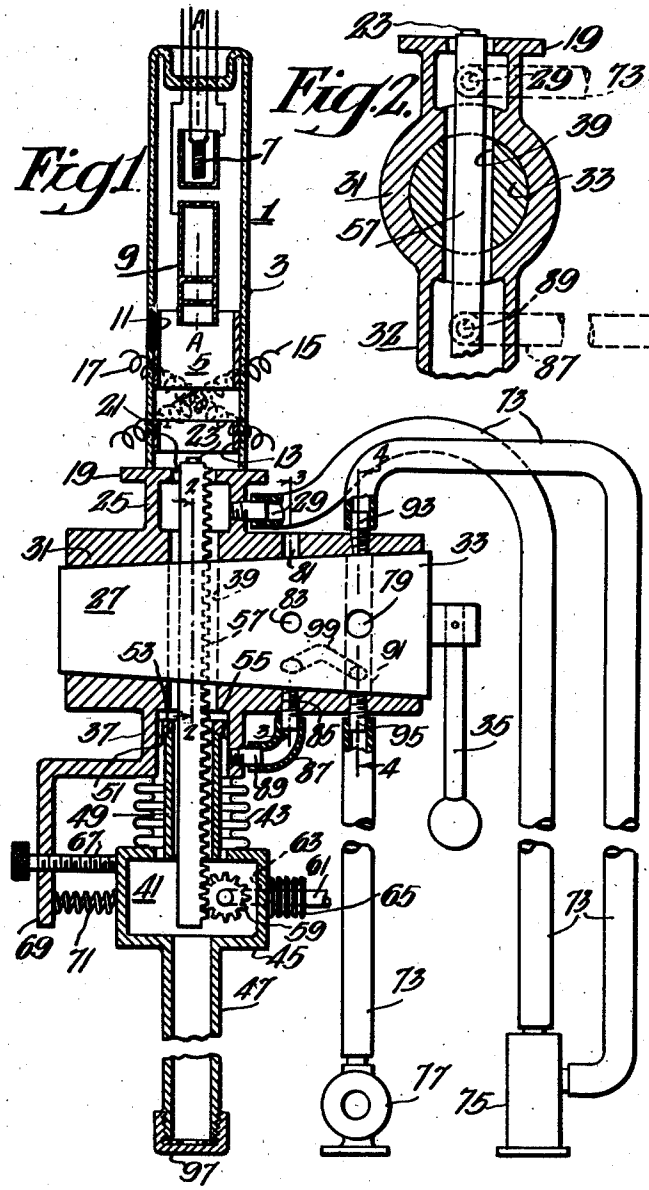


Fig. 2.

Fig. 3.

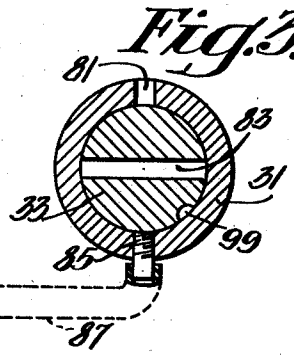
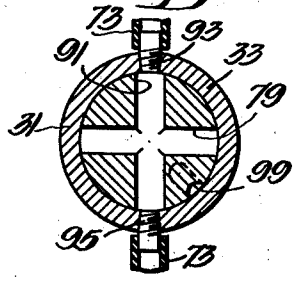


Fig. 4.



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VACUUM PLUMBING

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10 Claims. (Cl. 250—49.5)

This invention relates to improvements in vacuum plumbing and has for its principal object to provide means for inserting an object into a vacuum chamber without destroying its vacuum.

Another and important object of the present invention is to provide a convenient means for removably inserting a specimen or other article into the specimen chamber of an electron microscope, electron diffraction camera, and analogous instruments, without destroying the high vacuum in said chamber, said means comprising a mount for the specimen and being movable to permit the manipulation or orientation of the specimen within said chamber during and subsequent to its entry therein.

Certain details of construction, together with other objects and advantages will be apparent and the invention itself will be best understood by reference to the following specification and to the accompanying drawing, wherein

Figure 1 is an elevational view partly in section showing an electron microscope including an exhaust system therefor and embodying a stop-cock and other elements of a vacuum plumbing system which is designed, positioned and arranged in accordance with the principle of the invention.

Figures 2, 3 and 4 are sectional views taken on the similarly designed sectional lines of Fig. 1 and show, schematically, the relative arrangement of the stop cock and its flow openings in the plumbing system.

The electron microscope 1 which has been selected for purposes of illustration is a so-called "scanning microscope" and comprises a glass or metal envelope 3 which defines a "main" chamber 5 containing a more or less conventional arrangement of electrodes including a source of electrons, exemplified by a thermionic cathode 7, an electron lens system comprising two or more focusing cylinders 9 and 11 and a collector electrode 13 arranged in the order named along a central axis A—A of the chamber. A pair of deflecting coils 15 and 17 surround the envelope in the vicinity of the lens system. The otherwise open end of the envelope adjacent the collector electrode is seated upon a base 19 which is provided with an opening 21 through which the specimen 23 is to be examined is introduced into the main chamber 5 in a position to be scanned by the electron beam (not shown) in said chamber.

The mode of operating an electron scanning microscope of this general construction is now well known. However, in the interest of completeness, it may here be said that electrons emanating from the cathode 7 are formed into a beam of the desired sharpness by the electron-lens system 9, 11. As the beam emerges from the last lens cylinder 11 it is moved repeatedly across the specimen 23 and "scans" it under the control of the deflecting coils 15 and 17. The impact of the electron beam upon the specimen releases secondary electrons therefrom. The secondary electrons are collected upon the electrode 13, and the resulting current utilized (usually after amplification) to control the intensity of the beam of a kinescope or other viewing device (not shown) employing a scanning system which moves in synchronism with the beam of the microscope.

The base 19 upon which the envelope 3 of the microscope 1 is fixed is preferably of rugged construction and has a dependent collar 25 which surrounds the opening 21 in the said base and constitutes a support for a stop cock 27. A radially extending port 29 in the collar comprises an opening through which the envelope or main chamber 3 of the microscope is evacuated.

The stop cock 27 preferably comprises a tapered cylindrical bearing 31 in which a turning plug or stopper 33 having a handle 35 is seated. Grease or other packing material (not shown) having a low vapor pressure may be interposed between the bearing 31 and the stopper 33 of the cock to ensure a hermetic seal between these two parts.

There is a second collar 37 on the opposite side of the stop cock in line with the upper collar 25. The openings in these collars 25 and 27 and the opening 21 in the base 19 of the microscope are coaxial and are adapted to be connected by a straight flow opening 39 in the cock when the stopper 33 is turned by means of its handle 35. This second or lower collar 37 communicates with or forms part of on auxiliary chamber 41 the walls of which are defined by a metal bellows or other flexible cylinder 43, and a housing 45 which has a dependent neck portion 47. An upwardly extending neck 49, forming a continuation of the housing 45, is encompassed by the bellows 43 and terminates in a curved end 51 contiguous a spherical bearing surface 53 which is mounted within the collar 37 adjacent that portion 55 of the outer surface of the stop cock which is surrounded by the lower collar 37.

The inner surface of the oppositely extending neck portions 47 and 49 of the housing 45 comprise a guide for a rack 57, the driving pin 59 of

which is conveniently mounted for rotation within the housing 45. A crank comprising a flexible rod or drill shaft 61 which extends through an aperture 63 in the housing 45 comprises a convenient means for imparting a driving force to rack through the pinion 59. A narrow flexible bellows 65 which extends around the crank 61 and is sealed to the housing 45 forms an effective air tight seal about the aperture 63.

In the drawing the rack 57 is shown in its extended position, i. e., in a position whereat it has been raised through the flow opening 39 in the turning plug 33 to present the specimen 23 to the electron beam within the main chamber 5 of the microscope. Since that part of the auxiliary chamber which is below or beyond the collar 37 is flexibly supported by the bellows 43 it is apparent that any transverse movement imparted to the housing 45 will be imparted to the rack 57 (the diameter of the openings 19, 39 being sufficient to permit such movement) so that the specimen 23 thereon may be moved within the microscope and orientated with respect to the electron beam. For the purpose of imparting such movement to the rack 57 an adjusting screw 67 supported at a fixed point (which in this case comprises a dependent extension 69 on the collar 37) is brought to bear against the outer surface of the housing 45, as by means of a biasing spring 71. More than one adjusting screw 67 may be employed where necessary or desirable.

When the specimen is correctly positioned within the microscope the auxiliary chamber 41 communicates with the main chamber 5, hence the vacuum in both chambers can be maintained or augmented through the port 29 from which a hose 73 extends to a diffusion pump 75 and a series connected for pump 77. The path of evacuation in such case is indicated by the arrows and extends through a second flow opening 79 in the stop cock 27.

When it is desired to change a specimen the rack is lowered by turning the crank 61. The handle 35 of the stop cock is then given a quarter turn to close the passageway 39, through the stopper 33, between the main chamber 5 and the auxiliary chamber 41. There is a vent 81 in the bearing or cylinder 31 of the stop-cock and a complementary flow opening 83 in the stopper or turning plug 33. When the vent 81 and the flow opening 83 (which in Fig. 1 is perpendicular to the plane of projection) are aligned, air entering the vent passes through the said opening 83 in the turning plug to a port 85 in the bearing 31. This port 85 in turn is connected as by a short hose 87 to a port 89 in the collar 37 in the auxiliary chamber 41; hence air may enter this chamber. Since the passageway 39 connecting the auxiliary chamber 41 and the main chamber 5 is now closed, there can be no leakage of air therebetween. It is usually convenient, however, to keep the main chamber "on the pump" during the period when air is being admitted to the auxiliary chamber. During this period it is desirable to maintain the series connection 73 between the fore pump 77 and the diffusion pump 75. To this end the stop cock is provided with a fourth flow opening 91 and a pair of ports 93 and 95. The flow opening 91 extends at a right angle to (and communicates with) the flow opening 79. The ports 93 and 95 are connected by the flow opening 91 when the main and auxiliary chambers 5 and 41 are connected by the flow opening 39 through which the rack 57 extends.

When the auxiliary chamber 41 reaches atmospheric pressure it may be opened by removing a cap 97 or other closure element on the lower extremity of the dependent neck 47, and the rack removed from its housing so that the specimen 23 on its leading or inner end may be changed, if desired. When the rack 57 is returned to the auxiliary chamber 41 and the cap 97 has been resealed in place, the auxiliary chamber should preferably be at least partially evacuated before the flow opening 39, which communicates with the main chamber 5 and the port 29 to the diffusion pump 75 is opened. Such a "low" vacuum can be achieved in the auxiliary chamber 41 if the port 89 therein is connected to the fore pump 77. For the purpose of establishing such a connection the turning plug 33 is provided with a fifth flow opening 99 the terminals or ends of which are arranged to register with the ports 85 and 95.

Various modifications of the invention will suggest themselves to those skilled in the art. Accordingly, it is to be understood that the foregoing description of a preferred embodiment and useful application of the invention is to be interpreted as illustrative and not in a limiting sense except as required by the prior art and by the spirit of the appended claims.

What is claimed is:

1. Vacuum apparatus comprising a main chamber and an auxiliary chamber having aligned openings therein, a stop cock having a flow opening adapted to connect said chamber openings, a support for an object mounted for longitudinal and tiltable movement in said auxiliary chamber, means for moving said support into said main chamber through said openings, said openings and said main chamber being of a diameter greater than is required to accommodate said support whereby said support may be entered into said main chamber through said openings and tilted therein, and means for tilting said support within said openings and relative to said main chamber, whereby to orient said object within said chamber.

2. Vacuum apparatus comprising a main chamber and an auxiliary chamber, a stop cock between said chambers, a flexible mounting upon which said auxiliary chamber is supported, said chambers having normally aligned openings and said stop cock having a flow opening adapted to connect said chamber openings, a support for an object mounted for longitudinal and tiltable movement in said auxiliary chamber, means for moving said support into said main chamber through said openings, said openings being of a diameter greater than is required to accommodate said support whereby said support may be tilted within said openings, and means for tilting said flexibly mounted auxiliary chamber and hence said object support, relative to said main chamber, whereby to orient said object within said main chamber when said object support is entered therein.

3. Vacuum apparatus comprising a main chamber and an auxiliary chamber having aligned openings therein, a vacuum tight stop cock mounted between said chambers and comprising a turning plug having a flow opening adapted to connect and disconnect said chamber openings, a support for an object mounted for movement in said auxiliary chamber, means for moving said support into and out of said main chamber through said openings, a port in said auxiliary chamber, means responsive to move-

ment of said turning plug to the disconnect position for connecting said port to said pump, and means for evacuating said auxiliary chamber when said object support is confined therein.

4. The invention as set forth in claim 3 and wherein means are provided for simultaneously evacuating said main and auxiliary chambers when said support extends through said flow opening into said main chamber.

5. Vacuum apparatus comprising an evacuated main chamber and an evacuated auxiliary chamber having aligned openings therein, a vacuum tight stop cock mounted between said chambers and having a flow opening adapted to connect said chamber openings, a support for an object mounted for movement in said auxiliary chamber, means for moving said support into said main chamber through said openings, a vent in said stop cock and a port in said auxiliary chamber, means for connecting said port to said vent when said flow and chamber openings are unencumbered, and a closure in said auxiliary chamber permitting access to said object support.

6. Vacuum apparatus comprising a main chamber and an auxiliary chamber having aligned openings therein, a stop cock having a flow opening adapted to connect said chamber openings, a diffusion pump and a fore pump, a permanent connection between said main chamber and said diffusion pump for creating a high vacuum in said chamber, means for connecting said fore pump to said auxiliary chamber through said stop cock when said flow opening is closed whereby to create a low vacuum in said auxiliary chamber, and means for connecting said diffusion pump to said auxiliary chamber when said flow opening is open, whereby to increase the vacuum in said auxiliary chamber to a value of the order obtaining in said main chamber.

7. In vacuum apparatus, a main chamber and an auxiliary chamber having aligned openings therein, a stop cock having a flow opening adapted to connect said chamber openings, a diffusion pump and a fore pump, a permanent connection between said main chamber and said diffusion pump for creating a high vacuum in said chamber, means responsive to movement of said stop cock when said flow opening is closed for connecting said fore pump to said auxiliary chamber whereby to create a "low" vacuum therein, means responsive to rotation of said stop cock to a position whereat said main and auxiliary chamber openings are connected to said flow opening for connecting said diffusion pump to said auxiliary chamber whereby to increase the vacuum therein to a value of the order obtaining in said main chamber, a support movably mounted in said auxiliary chamber, and means operable when said main and auxiliary chamber openings are connected by said flow opening for moving said support into said main chamber through said chamber and flow openings.

8. Vacuum apparatus comprising main and auxiliary chambers provided with an interconnecting opening, movable closure means for said opening, a support movably mounted within said auxiliary chamber, means for moving said support through said opening into said main chamber when said closure is moved to its open position, and means exterior to said chambers for orienting said support within said main chamber.

9. The invention as set forth in claim 8 and wherein said auxiliary chamber is defined at least in part by a bellows.

10. The invention as set forth in claim 8 and wherein means are provided for maintaining said main chamber at a relatively high vacuum during the insertion and removal of said support.

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