May 14, 1946. C. H. BACHMAN 2,400,331

ELECTRON LENS SYSTEM

Filed Oct. 25, 1943

Fig. 1.

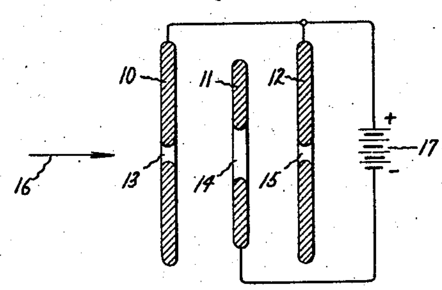


Fig. 2.

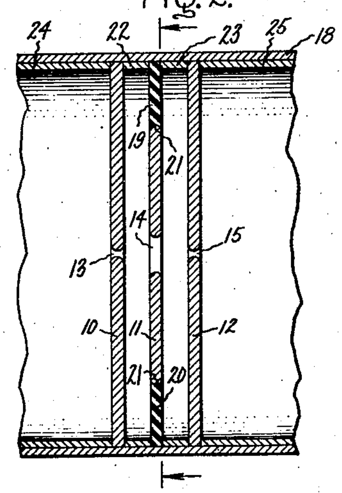


Fig. 3.

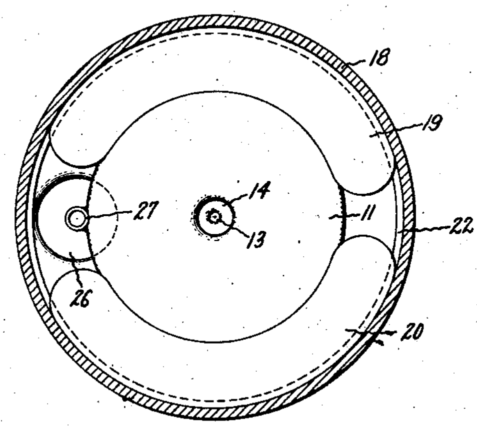


Fig. 4.

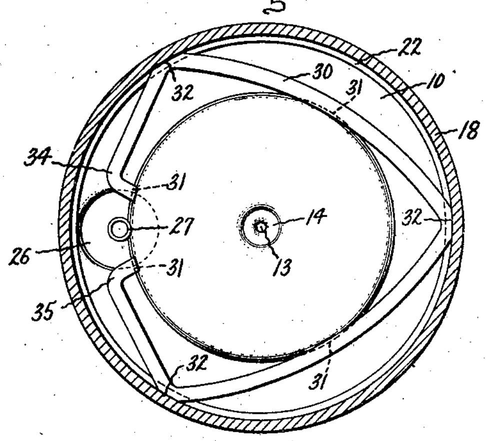
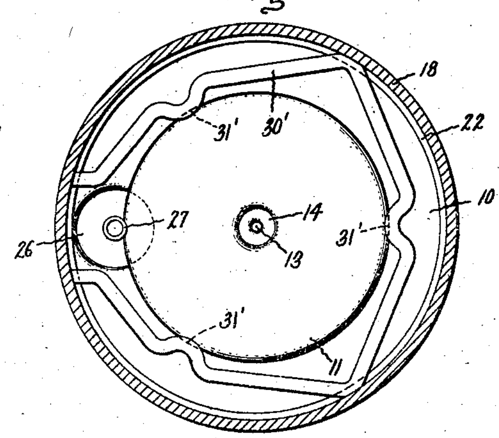


Fig. 5.



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2,400,331

ELECTRON LENS SYSTEM

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4 Claims. (Cl. 250—162)

The present invention relates to a cathode ray tube and it has for its object to provide an improved electron lens system for such a tube.

In a cathode ray device, such as an electron microscope in which a visible image is formed by the action of an electron stream, it is customary to use an electrostatic lens system in the form of a plurality of apertured metallic disks, axially aligned and spaced, and the center disk operating at a potential differing from that of the outer ones. One of the problems in the construction of an electron lens of this type is that of maintaining very accurate alignment of the elements and, at the same time, insulating one or more elements from the rest. In particular, in lens systems of this type where the central disk operates at a high voltage with respect to the remaining disks and their enclosing envelope, the problem of suitably insulating the system assumes major proportions. Factors which must be considered in insulating such a lens are the surface of the insulator and its volume leakage, the character of the surface from the standpoint of the charges building up on it, and the gas evolution, the dielectric structure of the insulator, and its ease of assembly in the cathode ray device. It is an object of the present invention to provide an improved insulating means for an electrostatic lens system.

The foregoing object is accomplished in accordance with one embodiment of the invention by providing a vitreous insulator which extends around substantially the entire periphery of the lens member operating at a high potential with respect to the enclosing envelope, but which contacts said member and the enclosing envelope at a minimum number of spaced points to increase the length of the insulating path while reducing the insulator area. It is found that, in the use of the invention in an electron microscope, the operating potential of the lens system may be increased substantially, while the task of assembling the lens system in the microscope is reduced.

The features which I desire to protect herein are pointed out with particularity in the appended claims. The invention itself may best be understood by reference to the following description taken in connection with the accompanying drawing, in which Fig. 1 shows schematically a lens system of the type considered in the present invention; Figs. 2 and 3 are cross-sectional and end views, respectively, of an electron lens system embodying certain features of the invention; and Figs. 4 and 5 illustrate other embodiments of the invention.

In Fig. 1, there is shown an electron lens system comprising three apertured metallic disks 10, 11, 12, axially aligned and spaced. The disks are provided, respectively, with central apertures 13, 14, 15 through which is projected a cathode ray beam represented by the arrow 16 and which is to be deflected by the electron lens system. To this end, the outer disks 10 and 12 are connected to the positive terminal of a source of unidirectional potential, such as the battery 17, while the central disk 11 is connected to the negative terminal of this battery. In such an electron lens system, the stream of electrons 16, after passing through the aperture 13, are made to converge through the action of the highly repellent electrostatic field created by the lens member 11.

In Figs. 2 and 3, there is shown a portion of an electron microscope employing an electron lens system of the type illustrated in Fig. 1. The electron microscope includes a cylindrical metallic envelope 18 in which the disks 10—12 are supported. The two outer disks 10, 12 are machined to fit snugly within the envelope 18. The central electrode 11 is held between two parts 19, 20 of a ring insulator constituted of any suitable dielectric material, such as for example glass or Micalex. The parts 19 and 20 are machined on their outer edges to conform to the inner diameter of envelope 18 and are provided on their inner edges with grooves 21 for engaging the outer edge of electrode 11.

In assembly of the electron lens system within the envelope 18, a pair of cylindrical spacers 22 and 23 are interposed, respectively, between the parts 19 and 20 and the disks 10 and 12. An additional pair of cylindrical metallic spacers 24, 25 engage the opposite faces of disks 10 and 12 to maintain these disks in spaced relation with other elements of the electron microscope. In this composite electron lens structure, the insulating parts 19, 20 maintain the electrode 11 centrally aligned within envelope 18, as well as insulate this electrode from the envelope and the electrodes 10 and 12 so that electrode 11 may be operated at a high negative potential. At the same time, the spacers 22, 23 maintain the electrodes in a desired axial spacing. As shown in Fig. 3, the electrode 10 is provided with aperture 26 through which extends a tubular conductor 27 connected to the outer edge of disk 11 to supply this disk with the high negative potential at which it operates.

Where it is desired to operate the electrode 11 at very high potential with respect to the remaining parts of the electron system, the surface and volume leakage of the insulating means employed must be considered. One manner in which the insulating path may be increased, while the insulator area is reduced, is illustrated in Fig. 4 in which a rod-like insulator 30 of a vitreous material, such as Pyrex, extends about substantially the entire periphery of the lens member 11 and is bent into a shape such that it contacts the envelope 18 and the lens member 11 at a plurality of spaced points 31, 32. The portions of the insulator member 30 adjacent the points 31 are grooved to engage the outer edge of lens member 11 in the same manner as the grooves 21 of the insulators 19 and 20 in the structure of Fig. 2. The insulator 30 is machined at the points 32 to conform to the inner diameter of envelope 18.

In one method of constructing the insulator 30, an ordinary cane glass rod is used and is bent on a flat surface or plate around spaced pegs set in the plate to obtain a desired configuration of the insulator. With this construction, the insulator path between the points of contact 31 and 32 with the electrode 11 and the envelope 18 is increased to permit the use of higher voltages between these elements of the lens. Moreover, since the glass insulator 30 possesses a certain amount of resiliency, the open ends 34, 35 may be sprung apart slightly to permit insertion of lens 11 into the grooves at points 31 prior to assembly into the envelope 18. This type of insulation may also be molded or machined to the desired shape. Also, any suitable insulating material other than glass may be used, for example, porcelain or steatite.

A still further variation useful in certain cases is shown in Fig. 5, in which a configuration of the insulator 30′ differing slightly from that of insulator 30 is obtained. The insulator 30′ is shown as a small surface area in contact with the lens 11 at the points 31′, while the number of such points has been reduced, thereby permitting the use of even still higher voltages in connection with the electron lens system. In this embodiment, the insulator 30′ provides a three-point suspension of the disk 11 within the lens system.

The invention described herein may be used to advantage in cathode ray devices in permitting the employment of potentials on an electron lens system which have previously been found impossible because of the breakdown of the insulators required in such systems. Numerous additional modifications may obviously be made in my invention and I aim in the appended claims to cover all such variations as come within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. A lens system for an electron microscope of the type including a cylindrical metallic envelope, said system comprising three parallel disk-like metallic members having aligned central apertures, the outer of said members being in contact with said envelope throughout substantially their entire circumference, insulating means contacting said envelope and the third of said members at a plurality of points for supporting said third member transversely to the axis of said envelope, and cylindrical spacers interposed between said insulating means and said outer members, said insulating means contacting said third member solely at the outer edge of said member, whereby the region between said third member and said outer members may be substantially completely evacuated, said insulating means and said third member being substantially coplanar whereby said third member may be operated at a high potential with respect to both said envelope and said outer members.

2. In a cathode ray tube having a metallic envelope and a centrally apertured metallic disk-like lens member maintained at a substantial voltage with respect to said envelope, an insulator for supporting said lens member within said envelope comprising a rod member extending around substantially the entire periphery of said lens member and contacting said envelope and said lens member at a plurality of spaced points, the cross-sectional area of said rod member being substantially smaller than the distance between the outer edge of said lens member and the inner surface of said envelope to reduce the area of the insulator path between said lens member and said envelope.

3. In a cathode ray tube having a metallic envelope and a centrally apertured metallic disk-like lens member maintained at a substantial voltage with respect to said envelope, an insulator for supporting said lens member within said envelope comprising a vitreous rod extending around substantially the entire periphery of said lens member and contacting said envelope and said member at a plurality of spaced points, the cross-sectional area of said rod being substantially smaller than the distance between the outer edge of said lens member and the inner surface of said envelope, said rod being adapted at its points of contact with said lens member to engage the outer edge of said member.

4. In a cathode ray tube having a metallic envelope and a centrally apertured metallic disk-like lens member maintained at a substantial voltage with respect to said envelope, an insulator for supporting said lens member within said envelope comprising a rod of insulating material extending around substantially the entire periphery of said lens member and contacting said envelope and said member at a plurality of spaced points, said rod being adapted at its points of contact with said lens member to engage the outer edge of said member, and said rod having a pair of ends which may be spread apart to permit insertion of said lens member in said grooves.

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