May 27, 1947. C. H. BACHMAN 2,421,234

ELECTRON LENS ASSEMBLY

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Fig. 1.

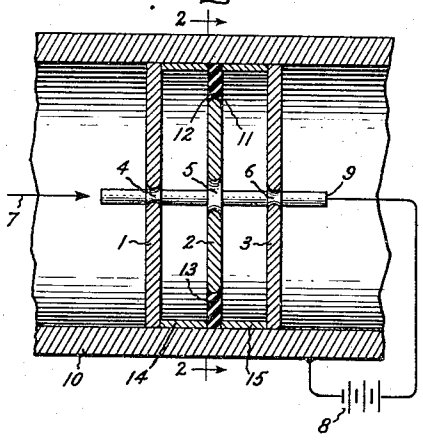


Fig. 2.

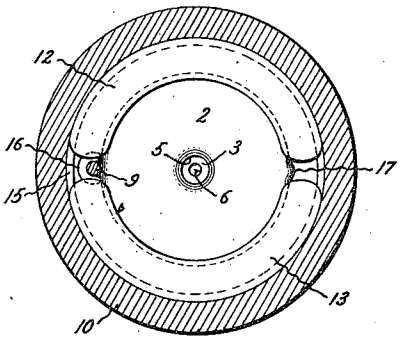
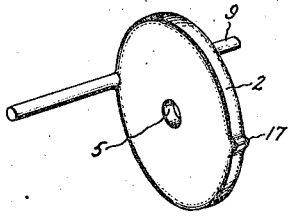


Fig. 3.



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ELECTRON LENS ASSEMBLY

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3 Claims. (Cl. 250—162)

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The present invention relates to electron lens systems such as are used in cathode ray tubes and has for its object to provide a new and improved electron lens assembly of the electrostatic type.

In a cathode ray device, such as an electron microscope in which a visible image is formed by the action of an electron beam, it is customary to use an electrostatic lens system in the form of a plurality of apertured metallic disks axially aligned and spaced. For a given electron beam velocity the focal action is determined by the spacings, aperture sizes, and the potentials applied to the disks. One type of such lens consists of three such disks, the center one operating at a potential differing from that of the outer ones which are usually at ground potential. The lens system is supported within a metallic enclosure or envelope of the device and a high operating potential for the central electrode, which operates at a considerable potential difference with respect to the envelope, is supplied by means of a rod which contacts one edge of the center electrode and which passes through clearance holes in the outer lens elements. The center electrode is supported by insulators interposed between the edges of the electrode and the envelope. It has been found that, in continued operation due to vibrations and jarring, the center electrode tends to rotate in its insulator support and to cause either a short-circuit between the potential supplying rod and the outer electrodes or to induce a lower breakdown voltage of the lens system. It is an object of the present invention to provide means for more securely supporting the center electrode in an electrostatic lens system to obtain improved operating characteristics of the system.

The foregoing object is accomplished in accordance with one embodiment of the invention by providing insulators which extend around substantially the entire periphery of the central electrode of an electrostatic lens operating at high potential with respect to the enclosing envelope and which is grooved to engage the outer edges of the central electrode. The central electrode has a built-up area or protuberance on its outer edge which permits the supporting insulators to be rotated and wedged thereon. It is found that, in the use of the invention in an electron microscope, not only is the task of assembling the lens system in the microscope reduced, but the operating characteristic of the lens system is maintained substantially constant over a long period of use.

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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 is a longitudinal cross-sectional view of a lens system of the type considered in the present invention; Fig. 2 is a cross-sectional view of the electrostatic lens system of Fig. 1 taken along the line 2—2; and Fig. 3 is a perspective view of the central electrode of the lens system of Fig. 1.

In Fig. 1, there is shown an electron lens system of the electrostatic type comprising three apertured metallic disks 1, 2, and 3 axially aligned and spaced. The disks are provided, respectively, with central apertures 4, 5, and 6 through which is projected a cathode ray beam represented by the arrow 7 and which is to be deflected by the electron lens system. To this end, the outer disks 1 and 3 are connected to the positive terminal of a source of unidirectional potential, such as the battery 8, while the central disk 2 is connected to the negative terminal of this battery by means of a conductor or rod 9 attached to the outer edge of the disk. In such an electron lens system, the stream of electrons 7, after passing through the aperture 4, are made to converge through the action of the highly repellent electrostatic field created by the lens member 2.

The electron lens is adapted to be supported within the envelope 10 of a cathode ray tube, the members 1 and 3 having a diameter equal to the inner diameter of the cylindrical envelope so that they fit securely therein. The central lens member 2 has a rounded outer edge which fits into grooves 11 in a pair of segments 12, 13 of a ring insulator constituted of any suitable dielectric material, such as for example glass or Micalex. The grooves 11 are carefully machined so that, with the apertured disk 2 in place, the combination of the disk 2 and the insulator segments 12, 13 forms a large disk which can be held firmly in place in the envelope 10 by means of a pair of metallic spacing rings 14, 15 positioned between the inner electrode assembly and the outer electrodes 1, 3, respectively. In an electron microscope, for example, a plurality of such electron lenses may be used and are spaced apart within th envelope 10, high operating potential for the central electrode 2 of the respective lens assembly being supplied thereto by means of the side rod 9 which passes through clearance holes 16 (shown in Fig. 2) in the outer lens elements 1, 3.

It has been observed that one of the difficulties encountered in such an electrostatic lens structure is obtaining a tight friction fit between the center electrode 2 and the insulators 12, 13. Due to vibrations, jarring, or even gravity, the whole high potential structure consisting of the rod 9 and the center electrode 2 tends to shift or slide around in the grooves 11 of the insulator. Such shifting may cause a short-circuit between the side rod 9 and the grounded electrodes 1, 3, or may merely disturb the centering of the side rod system and induce a lower breakdown voltage, because the side rod 9 is not centrally positioned within the clearance holes of the lens elements 1, 3. With continued operation, such looseness may cause aberrations in the lens insulator and faulty operation of the cathode ray device. In this respect, it is noted that the insulators 12, 13, the spacers 14, 15, and the outer lens elements 1, 3 form a line-up in the envelope 10 which, after assembling in place, is customarily clamped by pressure from the ends of the envelope. After such clamping, the insulators 12, 13 are not free to turn. The center electrode 2 nonetheless tends to rotate in the insulators, even though the mechanical fit of the electrode within the grooves 11 is machined accurately to a very small fraction of an inch.

In accordance with the invention, the tendency of the center electrode to rotate is eliminated by providing a small built-up area or protuberance 17, shown in Figs. 2 and 3, on the outer periphery of the center electrode 2 at a desired position. Where an insulator consisting of two segments 12, 13 is used, the built-up area 17 is arranged diametrically opposite the point of connection of the side rod 9 to the electrode 2. The built-up area preferably increases the radius of the electrode by a few mils and is so formed that the two insulator segments 12, 13 can be slid around within the tube 10 along the outer edge of the electrode 2 until the grooves 11 run up on the protuberance 17 wedging the insulators between the electrode 2 and the envelope 10. This wedging preferably is made during final assembly of the cathode ray device before the insulators are clamped in position. When the built-up area has been symmetrically placed on the electrode rim, the lens system is not only protected from sliding of electrode 2 in the insulator, but the electrode is held rigid against vibrations as well. The resultant electrostatic lens assembly provides a maximum breakdown characteristic which is maintained over a long period of use of the cathode ray device.

Numerous 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. In an electron lens system, the combination of a disk electrode, a cylindrical envelope concentrically surrounding said electrode, a plurality of insulators positioned between said electrode and said envelope, said insulators having a groove adapted to fit over the edge of the said electrode, and said electrode having a built-up portion on the outer edge thereof for wedging said insulators between said electrode and said envelope.

2. The combination, in a cathode ray device having a cylindrical envelope portion, of an electrostatic lens assembly positioned with said envelope comprising three longitudinally spaced disk members, the central one of said disk members having a diameter substantially less than the inner diameter of said cylindrical member, a pair of insulators positioned between said central disk member and said envelope, said insulators having grooves adapted to engage the outer edge of said central disk member and said central disk member having a built-up portion for wedging said insulators between said central disk member and said envelope to prevent rotation or vibration of said central disk member in said grooves.

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 positioned between said envelope and said member, said insulator having a groove adapted to engage the outer edge of said member, and means for preventing movement of said member in said groove comprising a protuberance on said outer edge for wedging said insulator between said member and said envelope.

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