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F. KRAUSE

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ELECTROSTATIC ELECTRON LENS

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Fig. 1.

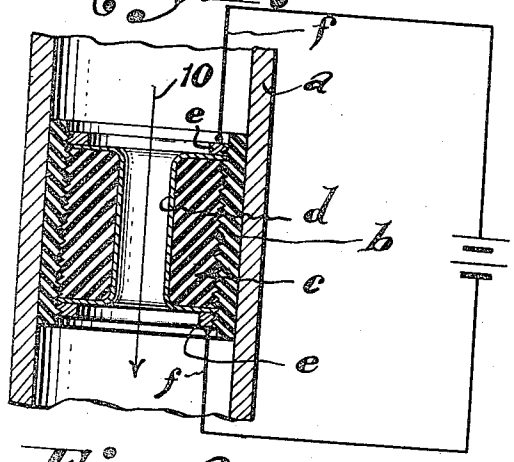


Fig. 2.

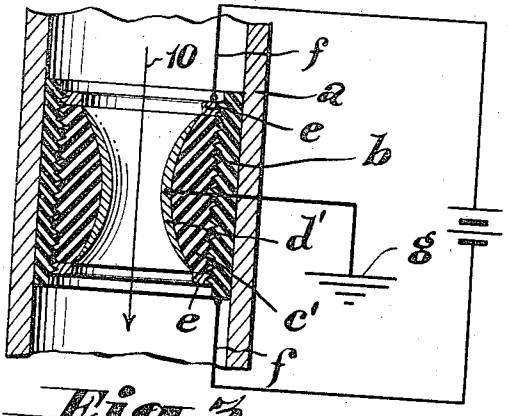
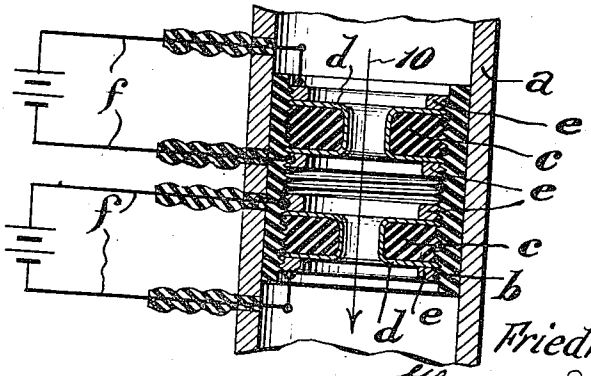


Fig. 3.



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ELECTROSTATIC ELECTRON LENS

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5 Claims. (Cl. 250—160)

The present invention relates to electron microscopes and more specifically pertains to electrostatic means for controlling the movement of electrons in such apparatus.

Electrostatic electron lens operate in such a manner that potential differences are applied to two or more insulated plates often referred to as diaphragms whereby lens-like effects are produced on electron rays passing axially through openings in the diaphragms. Such lenses are used in electron apparatus such as electrostatic electron microscopes.

An object of the present invention resides in providing an improved type of electrostatic lens for electron microscopes wherein the lens arrangement is characterized by a continuous variation of the potential fields.

Other and further features and objects of the invention will be apparent from a consideration of the following detailed description and the accompanying drawing wherein several exemplary embodiments of the invention are disclosed.

In the drawing:

Fig. 1 is a sectional view of a tube of an electron microscope showing one lens arrangement embodying the invention.

Fig. 2 is a similar sectional view of a modified arrangement.

Fig. 3 is a sectional view of an electron microscope tube showing a further modification of the electrostatic lens arrangement.

Referring to the drawing there is shown in Fig. 1 at *a*, a tube of an electron microscope. The electron rays move axially in the tube as indicated by the arrow 10. A cylindrical bushing *b* formed of suitable insulating material is provided within the tube and suitably secured therein. Another bushing *c* of insulating material is mounted within the bushing *b*. The bushing *c* may be provided with external threads for engaging internal threads of the bushing *b*. The two bushings *b* and *c* may be formed of any suitable insulating material such as phenol formaldehyde condensation products or other synthetic resins.

The bushing *c* is provided with a central axially extending opening through which the electron rays of the microscope are adapted to pass. The inner periphery of the bushing *c* is coated with a conducting varnish *d* having a relatively high resistance characteristic. The varnish layer covers the ends of the bushing *c* as illustrated in Fig. 1. Current is supplied to the conducting varnish layer *d* by means of wires *f* which are connected to metal rings *e*. The metal rings *e* engage the ends of the conducting varnish layer *d* and the rings *e* may be threaded in the bushing *b*. With such an arrangement if a positive voltage is applied to the upper ring *e* and a negative voltage is applied to the lower ring *e* there will take place on the entire cylindrical surface of the conducting layer *d* a voltage drop and the extent of the drop will depend on the resistance and thickness of the conducting varnish. A voltage of a few thousand volts may therefore be impressed across the end rings *e* and it is thus possible to form and continuously control the electric field within the central opening of the bushing *c*.

A modified electrostatic lens arrangement is illustrated in Fig. 2 wherein an insulating bushing *c'* is arranged within the bushing *b*. The bushing *c'* may likewise be threaded in the bushing *b*. The inner surface of the insulating bushing *c'* is preferably arched or provided with a concave shape as shown in Fig. 2. The bushing *c'* is also formed of a suitable insulating material and coated on the inner surface with a conducting varnish having a relatively high ohmic characteristic. Current is conducted to the varnish layer *d'* by means of end rings *e* and conductors *f* in a manner similar to the arrangement disclosed in Fig. 1. The conducting varnish layer *d'* may vary in thickness so that the central portion of the bushing *c'* is provided with a thicker conducting layer than the thickness of the layer adjacent the ends of the bushing *c'*. The arcuate shape of the inner surface of the conducting layer *d'* provides the advantage that the ends of the electrostatic field adjacent the rings *e* are further removed from the central axis of the microscope. Another advantage of providing a thicker coating of the conducting varnish in the center of the bushing *c'* pertains to the fact that the voltage drop varies along the length of the bushing *c'* since the resistance of the conducting coating varies with the thickness thereof.

In carrying out the invention it is possible to provide a number of electrodes for conducting current to the varnish layers. For example, the central portion of the conducting layer *d'* may be grounded as indicated at *g*.

In carrying out the invention a number of electrostatic lens arrangements such as shown in Figs. 1 and 2 may be arranged in an electron microscope tube *a* and an example of such a series of electron lens is shown in Fig. 3. In this embodiment the insulating bushings *c* are similar to

those illustrated in Fig. 1 and successively arranged along the electron microscope tube *a*.

While the invention has been described with reference to specific structural details it will be appreciated that changes may be made therein by those skilled in the art. Such modifications may be made without departing from the spirit and scope of the invention as set forth in the appended claims.

I claim:

1. In electron apparatus, an electron tube, an insulating bushing mounted within said tube and having an opening through which rays of the electron tube are adapted to pass, a layer of conducting material arranged on said bushing within said opening, means for applying a voltage across said layer, and said conducting layer having sufficient resistance to provide a voltage drop along the inner surface of the bushing so as to provide an electrostatic field for controlling the movement of the electron rays.

2. An electrostatic electron lens for electron tubes comprising, a bushing of insulating material mounted within the electron tube, said bushing being of appreciable length and having an opening therein through which electron rays are adapted to pass, a layer of conducting varnish arranged along the surface of said opening, means for impressing a voltage across said conducting layer and the resistance and thickness of said conducting varnish layer being such as to provide a voltage drop establishing an electrostatic field for controlling the electron rays.

3. An electrostatic electron lens for electron tubes comprising, a bushing of insulating material mounted within the electron tube, said bushing being of appreciable length and having an opening therein through which electron rays are adapted to pass, a layer of conducting material arranged along the surface of said opening, means for impressing a voltage across said conducting layer and the resistance and thickness of said conducting layer being such as to provide a voltage drop establishing an electrostatic field for controlling the electron rays, and said conducting layer having varying thicknesses along the inner surface of the bushing.

4. An electrostatic electron lens for electron tubes comprising, a bushing of insulating material mounted within the electron tube, said bushing having an appreciable length and an axial opening of concave shape through which electron rays are adapted to pass, a layer of conducting varnish arranged along the surface of said opening, means for impressing a voltage across said conducting layer and the resistance and thickness of said conducting varnish layer being such as to provide a voltage drop establishing an electrostatic field for controlling the electron rays.

5. An electrostatic electron lens for electron microscopes comprising, an electron tube, an insulating bushing mounted within said electron tube and having an opening of concave shape through which electron rays are adapted to pass, a layer of electrically conductive material arranged on said bushing within said opening, means for impressing a voltage across said conductive layer, and the thickness of said electrically conductive layer varying along the inner surface of the bushing so as to provide a voltage drop along the conductive layer within the opening for controlling the movement of the electrons therethrough.

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