Aug. 14, 1956 H. J. HASBROUCK 2,759,117

ELECTRON LENS

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Fig. 1.

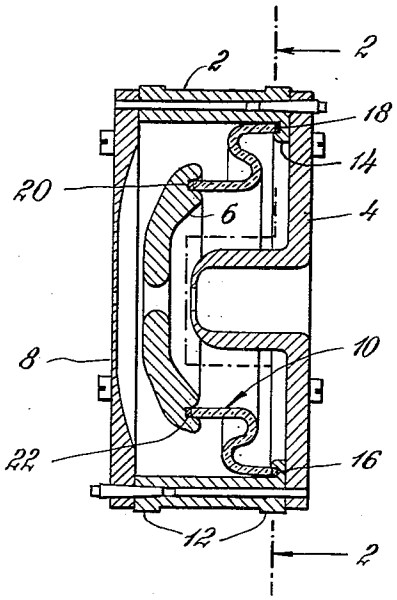
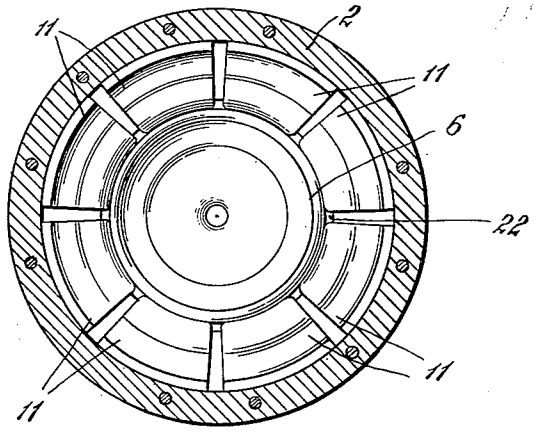


Fig. 2.



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ELECTRON LENS

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7 Claims. (Cl. 313—82)

This invention relates to electron lenses, and more particularly to electron lenses of the electrostatic type in which a plurality of apertured diaphragm electrodes, usually three in number, are supported in coaxial relation, with one or more of the electrodes, usually the central electrode, electrically insulated from the others such as the outer or end electrodes. Such lenses are useful in electron microscopes and similar apparatus.

When three electrodes are employed it is customary for the end electrodes to be connected together electrically and for the middle electrode to be insulated therefrom, to produce what is called a unipotential lens.

The invention will be hereinafter described in terms of its application to unipotential lenses, although it is applicable to any type of electrostatic electron lens, including electron mirrors, in which two or more electrodes of diaphragm type are to be supported together coaxially with one or more electrodes in electrical insulation from one or more other electrodes.

The invention provides an electron lens of the electrostatic type having an improved form of insulating support for the central electrode. According to the invention, the central electrode is supported from a metallic sleeve or barrel, to which the end electrodes are removably affixed, by means of a multi-section ceramic insulator, made of glass for example. The insulator sections are affixed to the barrel by soldering at suitably metalized surfaces on the sections, and the central electrode is similarly affixed to the sections at other metalized surfaces on the sections. The ceramic insulator provides good insulation and high mechanical, dimensional stability, while the plural nature of the sections into which it is divided permits the insulator to withstand the thermal stresses incident to assembly by means of soldering.

The invention will now be further described in terms of a preferred embodiment by reference to the accompanying drawings in which

Fig. 1 is an axial section through a lens according to the invention; and

Fig. 2 is a sectional view taken along the line 2—2 of Fig. 1.

The lens of Figs. 1 and 2 includes a generally cylindrical lens barrel or sleeve **2**, front, middle and rear diaphragm electrodes **4**, **6** and **8**, respectively, and an insulator generally indicated at **10** for support of the central electrode. The front and rear electrodes are fastened to the barrel by means of screws and locating dowels which permit disassembly of the lens for cleaning and its reassembly without change in the relative circumferential positions of the electrodes. The barrel is provided on its outer surface with annular rails or mounting surfaces **12** which are accurately coaxial with the electrode apertures, for proper alignment of the lens in the finished microscope. The barrel and electrodes are advantageously made of aluminum, since this metal can be machined to a perfect finish directly on a lathe without subsequent polishing operations. This makes it possible to generate the apertures in all three electrodes together with the rails on the barrel while the lens elements so operated on are mounted on a lathe, thus insuring an accurate coaxial relation of the three apertures together with the mounting rails of the lens.

For support of the central electrode **6**, the barrel is provided with an inwardly extending annular shoulder **14** in which is formed a groove **16**, extending generally axially of the barrel. The groove **16** accommodates a brass ring **18** provided for soldering to the metalized surfaces on the sections of the insulator **10**. The brass ring is provided so that a low temperature solder may be used on the insulator sections. The ring **18** on the other hand may be soldered to the aluminum barrel with the high temperature solder necessary for bonding to that metal, before the insulator is assembled to the lens.

The electrode **6** contains a similar groove **20** and brass ring **22**.

The insulator **10** seen in section in Fig. 1 is seen in elevation in Fig. 2 and is made of glass or of a ceramic material. It conforms generally to a solid of revolution whose figure contains a reverse bend or S-curve to provide additional elasticity for resistance to thermal stress. The insulator is sawn along meridian planes into a plurality of equal sections or sectors, to provide a plurality of sections fitting with clearance from each other. Eight sections have proved to be a satisfactory degree of subdivision of the complete insulator.

In manufacture, the sections **11** are metalized on their end surfaces which are to join with the brass rings **18** and **22**, by evaporation of suitable metals thereon such as silver and chronium, the other surfaces of the sections being protected by a lacquer mask. The surfaces of the insulator sections so metalized and the rings **18** and **22** are then further tinned with a low temperature solder for bonding together. For assembly of the barrel and central electrode, the barrel is set with its axis upright, and the sections **11** are supported on the ring **18** and evenly spaced from each other by means of a fixture. The entire insulator is then warmed to reduce stresses in the insulator sections and the sections are soldered to the ring **18** by the application of heat. After the sections have been soldered to the barrel at the ring **18**, the barrel is inverted and the insulator sections are similarly soldered to the central electrode at its ring **22**.

After cleaning of any soldering flux and excess particles of solder from the insulator and from the spaces between its sections **11**, the end electrodes may be assembled to the lens.

The lens of the invention is preferably manufactured according to the method described and claimed in the copending application of Clair L. Farrand, Serial No. 296,674, filed July 1, 1952, assigned to the assignee hereof. According to this method, the electrode apertures and the lens mounting surfaces are formed in boring and turning operations which are performed while the lens elements which are to bear these aperture and mounting surfaces are mounted on a lathe. Before the aperture and lens mounting surfaces are formed, the central electrode is permanently fastened to the barrel and the end electrodes and lens barrel are mounted together with screws and dowels which define a unique relation in which the lens elements can be assembled together. One end electrode is then fastened to the lathe, defining an axis of rotation for the entire lens. All lens aperture and lens mounting surfaces are then formed on the appropriate lens elements without removing this axis-defining electrode from the lathe, the other lens elements being fastened to each other and to this axis-defining end electrode in the proper spatial order or removed therefrom, as required to give to the operator access to the lens elements to be operated on.

While the invention has been described in terms of a preferred embodiment, various modifications may be made

in the lens illustrated without departing from the invention as defined in the appended claims.

I claim:

1. An electrostatic electron lens comprising a metallic barrel, apertured diaphragm and electrodes affixed to said barrel, a central apertured diaphragm electrode, and a multisection glass insulator whose sections conform to portions of a figure of revolution limited by meridian planes of said figure, said sections supporting said central electrode from said barrel, said insulator sections being soldered to said barrel and to said central electrode.

2. In an electrostatic electron lens, a metallic electrode support of annular shape, an apertured diaphragm electrode, and a multisection ceramic insulator supporting said electrode from said support, said insulator comprising a plurality of sections of a solid of revolutions bounded in part by meridian planes of said solid, said sections having each two metalized surfaces of which one is soldered to said support and the other to said electrode.

3. An electrostatic electron lens comprising front, middle and rear apertured diaphragm aluminum electrodes, an aluminum lens barrel, annular grooves in said middle electrode and said barrel, brass rings in said grooves, a glass insulator including a plurality of sections conforming to portions of an annular solid of revolution bounded by meridian planes of said solid, said solid having end faces equal to the diameters of said rings respectively, said sections having metal coatings on their surfaces belonging to said end faces, said surfaces being soldered to said rings.

4. An electrostatic electron lens comprising a generally cylindrical metallic lens barrel, a first brass ring affixed to said barrel, a plurality of ceramic insulator elements soldered to said first brass ring, a central electrode, a second brass ring affixed to said central electrode, said second brass ring being soldered to said elements, and front and rear electrodes affixed at the ends of said barrel.

5. An electrostatic electron lens comprising a metallic barrel having a grooved shoulder formed on the inner surface thereof, a brass ring secured in the groove of said shoulder, a central diaphragm electrode having a peripheral groove therein, a brass ring secured in the groove of said electrode, a multisection glass support conforming generally to a solid of revolution having end faces of the diameters of said rings, metal coatings on said end faces, and soldered joints between said end faces and said rings.

6. An electrostatic electron lens comprising an aluminum barrel of annular shape, an aluminum central electrode of apertured diaphragm shape, metallic inserts capable of bonding to low temperature solder affixed to said barrel and electrode, and a multisection ceramic insulator conforming to a solid of revolution divided along meridian planes into a plurality of sections, each of said sections having two metalized surfaces soldered one to each of said inserts.

7. An electrostatic electron lens comprising an aluminum barrel, apertured diaphragm end electrodes secured to said barrel in electrically conductive relation therewith, an aluminum apertured diaphragm central electrode, brass rings secured to said barrel and central electrode, and a multisection glass insulator having metalized surfaces soldered to said rings to support said central electrode coaxially of said barrel.

References Cited in the file of this patent

UNITED STATES PATENTS

2,452,893	Bachman	Nov. 2, 1948
2,507,531	Bertein et al.	May 9, 1950
2,536,878	Fleming	Jan. 2, 1951