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HIGH-TENSION ELECTROSTATIC ELECTRON LENS

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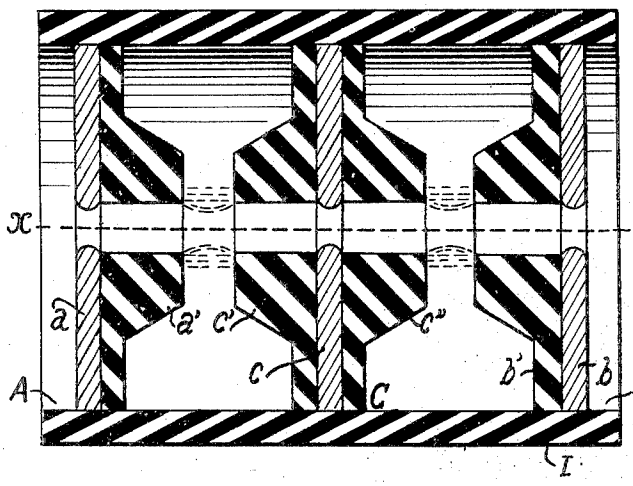

Fig. 1

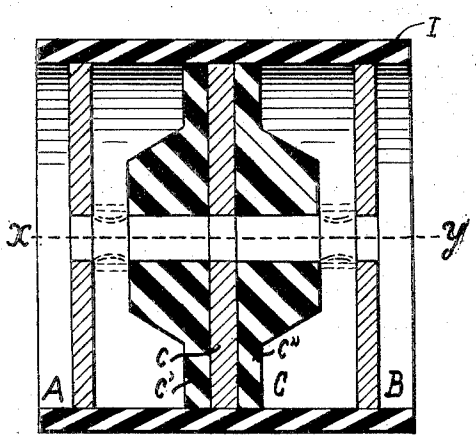

Fig. 2

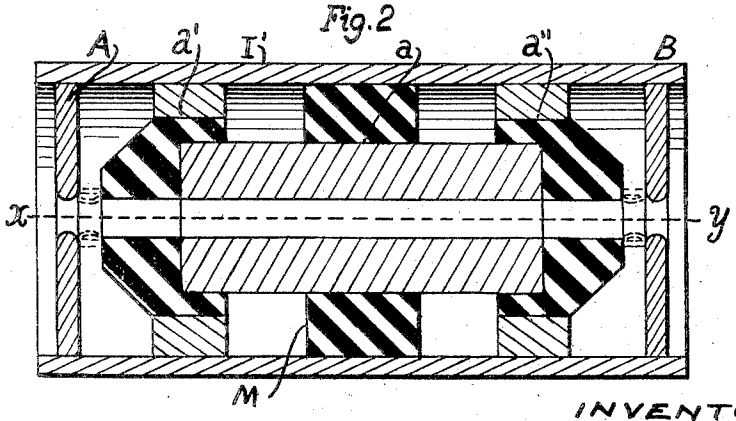

Fig. 3

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HIGH-TENSION ELECTROSTATIC ELECTRON LENS

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7 Claims. (Cl. 250—49.5)

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It is well known that the electrostatic electron lenses, such as utilized, for instance, in the electronic microscopes, are normally composed of circular metal diaphragms having a central hole and disposed along a common axis. These diaphragms are raised to suitable potentials, and so placed as to obtain, in the neighborhood of the common axis, a distribution of electric fields rotationally symmetrical (i. e. symmetrical about the common axis of the diaphragms) and exercising on the electron flow the same action as would an optical lens on a light beam.

If it is desired to operate with high speed electrons and to obtain a marked convergence, it is necessary to create very strong electric fields in very limited spaces; it is thus indispensable to apply very high tensions across the diaphragms of the lenses. Therefrom result serious dangers of breakdown as a consequence of vacuum discharges (flashing) eventually occurring between the electrodes, so that they run the risk to be damaged, and the supply sources also may simultaneously be injured.

My invention has for its object to eliminate those difficulties. The device herein proposed permits to obtain high electric fields in the useful places by means of insulating electrodes offering a high dielectric constant, the shapes of which are similar to the ones which are usually given to the ferromagnetic metal pole pieces commonly used for the distribution of the magnetic fields. Thus is readily secured the same concentration as is derived from the conventional disposition, but with the additional advantage that the tendency to flashing between the insulating pole pieces is extremely low, much lower in fact than it is between metallic pieces separated by the same distance. The danger of such discharges is, indeed, related to the dielectric strength of the insulating material for which the disruptive voltages are much higher than they are for the metals.

For a better understanding of my invention, reference will be made to the following description, together with the appended drawings, which give non-limitative instances of realization of the invention; the characteristic features of which, such as they appear from the description and from the figures, belong of course to the matter of the invention; and in which drawings:

Figure 1 shows an arrangement of electron lenses, embodying my invention;

Fig. 2 shows a modified form of an electronic lens system embodying my invention; and

Fig. 3 shows a further modified form of electronic lens system constructed in accordance with my invention.

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Figure 1 shows a lens intended for replacing the classical three-diaphragm lenses. The three circular electrodes A, B and C are seen in a sectional view, made by a plane containing the axis of revolution *xy* on which take place the respective centers of the said electrodes.

It can be seen that A, B and C are not homogeneous, A and B respectively comprise conducting parts *a* and *b*, and insulating parts *a'* and *b'*, those latter being separate parts mounted on the former. In the same way the electrode C comprises a central component piece *c*, which is conducting, and two insulating side pieces *c'* and *c''*. The components *a* and *b* are intended, for instance, for being carried to the potential U of the cathode, while *c* will be given a potential U1, intermediate between the anode voltage and the cathode potential.

It can also be seen that the insulating components *a'*, *b'*, *c'* and *c''* have a section shaped as spreading polar extensions (or pole-shoes), in order to favor such a distribution of the electrical field as to avoid the dangers of starting a discharge across the electrodes; they exercise the same action as would do concentrating or focusing electrodes.

Fig. 2 shows another embodiment of the invention, in which the construction is of a mixed character. The three electrodes A, B and C are still shaped as volumes of revolution around the axis *xy* passing through their central perforations; A and B are single non-composite electrodes and entirely conducting; on the contrary C comprises a conducting piece *c* and two insulating parts *c'* and *c''*, the section of which is shaped as spreading pole pieces. Such a construction is to be recommended in the case that certain electrodes only, such as electrode C in the present instance, would be liable to get coated with negative charges in the course of operation.

Fig. 3 shows the disposition of two lenses made according to the invention. They can be called to assume the functions of the objective and of the projecting lens of an electronic microscope at the same time. Between the lenses A and B takes place a conducting sleeve *a* connected, for instance, with the negative pole of the high tension supply; the said sleeve carries at its extremities two insulating expanded terminals *a'* and *a''*. It could be of advantage, for certain applications, to similarly fix up insulating pieces on the electrodes A and B.

For composing the various above-described in-

sulating pieces, a choice may be made between all materials possessing a high dielectric strength together with a high dielectric constant. For instance particularly good results have been secured with ceramic compositions containing rutile or derived therefrom as a base (the dielectric constant of which can reach a value of 100), or with ceramic compositions containing some titanates, for which the dielectric constant exceeds 1000, while the dielectric strength possessed by the same materials is entirely satisfactory.

The electrodes as well as the insulating parts forming the dielectric poles are fastened in a cylindrical mounting I of insulating material, as shown in Figs. 1 and 2. The latter may be replaced by a metal mounting, as shown in Fig. 3, on condition that the central electrode is insulated. In Fig. 3, the attachment of the central electrode a is achieved by means of the insulating partition M disposed between the electrically conducting cylinder I' and the central electrode.

It must be understood, however, that the instance given for the composition and the constructive features of the above described devices are to be taken as non-limitative. Detailed modifications could be effected in the said devices without in any way deviating from the scope of the invention. In what particularly regards the number and the shape of the above-described insulating components, they could readily be varied according to the desired results and the electric field distribution to be aimed at. It could even be proceeded to the production of the said pieces by means of other materials than the ones which have been mentioned in connection with the above given instances of application of the invention.

What I claim is:

1. In an electrostatic aperture lens, such as used in the electronic microscope, at least two electrodes of a good conducting material maintained at a high potential difference and spaced apart in the line of the lens axis and a piece of an insulating substance of a relatively high dielectric constant introduced between these electrodes, one of the faces of this piece being in a tight contact with the surface of one of the said electrodes, and its other opposite face being located at a substantial distance from the face of the other electrode, a hollow channel being provided in all these elements in the line of the lens axis for the passage of an electronic ray.

2. In an electrostatic lens of the aperture type,

such as used in the electronic microscope, at least two metallic electrodes with flat surfaces transverse to the lens axis maintained at a high potential difference and spaced apart face to face in the line of the lens axis, and a piece of an insulating substance of a high dielectric constant offering two opposite flat surfaces transverse to the lens axis, introduced between these electrodes, one of its flat faces being in a tight contact with the surface of one of the said electrodes, and its other face being at a substantial distance from the face of the other electrode, this distance being substantially less than the insulator thickness in the line of the axis, and an aperture in all these parts for the passage of an electronic ray.

3. An electrostatic lens of the aperture type as set forth in claim 2 in which the piece of insulating substance has a conotruncate form fastened with its large base on one of the electrodes and having its small base facing the gap adjacent the other electrode.

4. An electrostatic lens of the aperture type as set forth in claim 2 in which the piece of insulating substance is of circular formation about the axis of the lens.

5. An electrostatic lens of the aperture type as set forth in claim 2 in which the apertures in all of said electrodes and in said piece of insulating substance have substantially the same section.

6. An electrostatic lens of the aperture type as set forth in claim 2 in which the apertures in all of said electrodes and in said piece of insulating substance are of circular form of substantially the same internal diameter.

7. In an electrostatic aperture lens for use in an electronic microscope, three electrodes in the form of flat plates including a central electrode and a pair of transverse opposite electrodes, conotruncate pieces of circular section fastened with their large bases on the central electrode and with their smaller bases directed toward said extreme opposite electrodes.

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The following references are of record in the file of this patent:

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