

Dec. 25, 1945.

J. HILLIER

2,391,780

ELECTRON DISCHARGE DEVICE

Filed Oct. 13, 1943

2 Sheets-Sheet 1

Fig. 4.

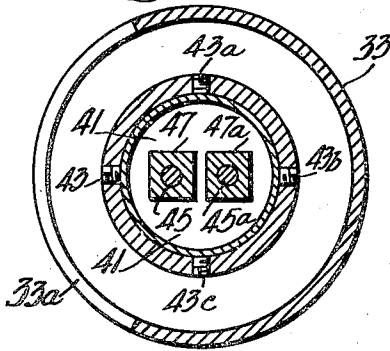


Fig. 1.

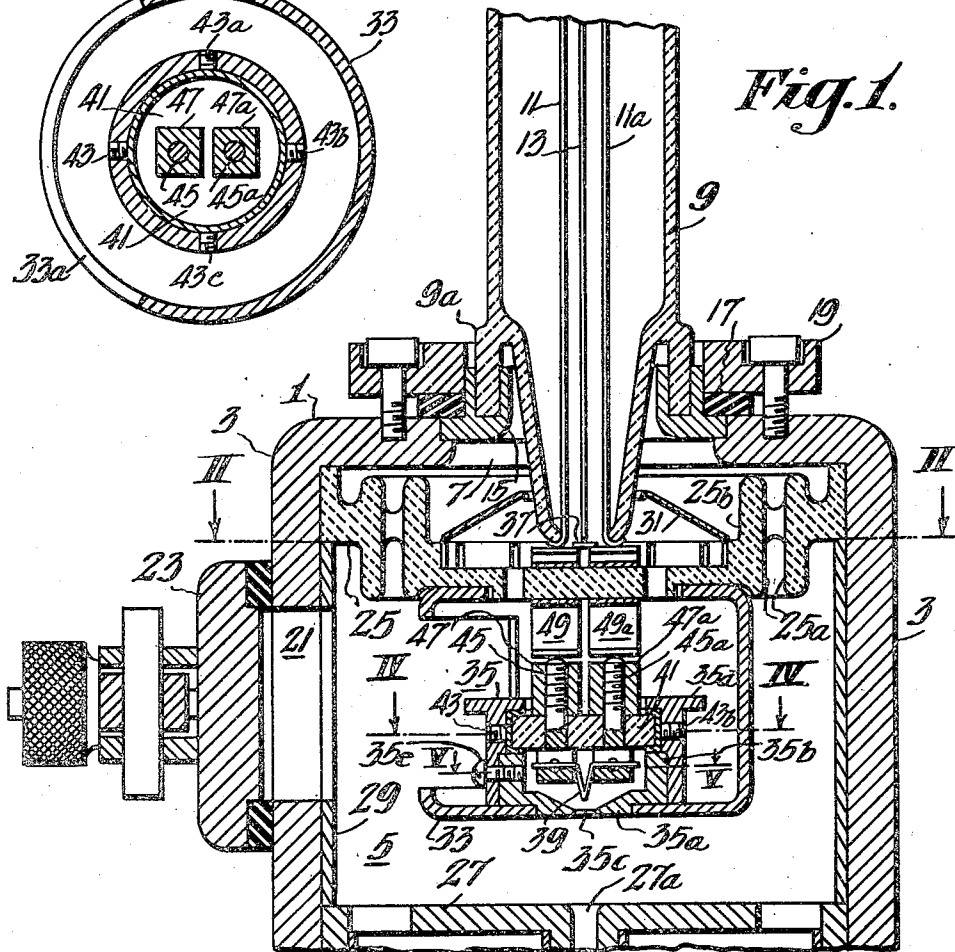
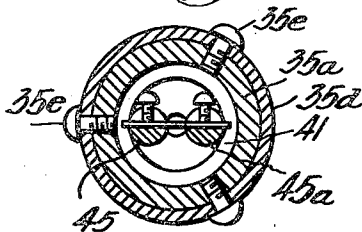


Fig. 5.



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Fig. 2.

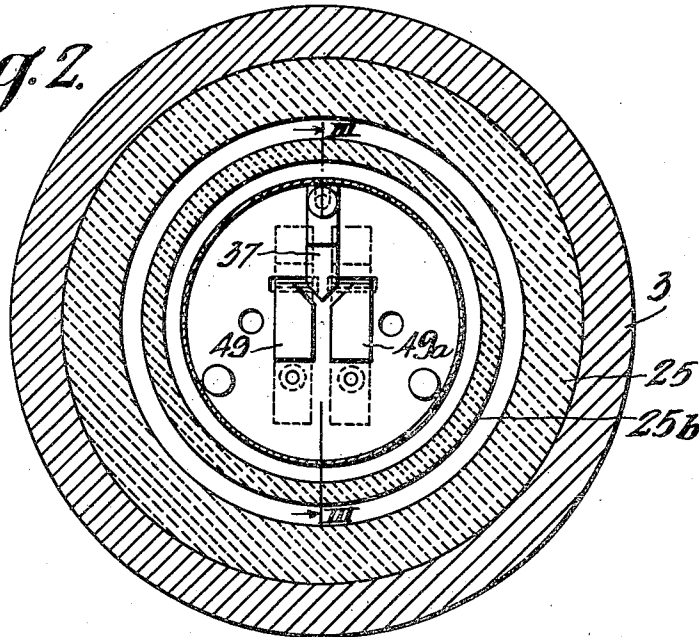
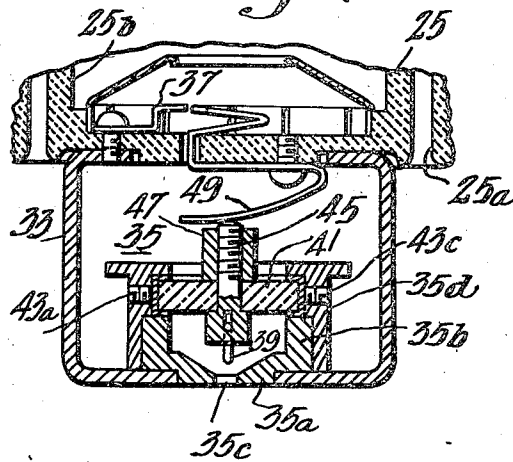


Fig. 3.



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2,391,780

ELECTRON DISCHARGE DEVICE

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Application October 13, 1943, Serial No. 506,035

5 Claims. (Cl. 250—27.5)

This invention relates to electron discharge devices, particularly to improvements in so-called "ray tubes," and has for its principal object to provide an improved electrode assembly and sub-assembly for electron microscopes and other electron discharge devices wherein the filament or other source of electrons must be aligned with a high degree of accuracy with respect to a reference line or to one or more apertured electrodes or lens elements.

In electron discharge devices of the general character described, and especially in electron optical instruments wherein an image of high resolution is required, it is customary to employ a "point type" cathode as the primary source of electrons. Such cathodes may comprise a needle-like element, such for example as the one shown in U. S. Patent 2,271,990 to Edward G. Ramberg or, more conventionally, a hairpin filament wherein the bend is not rounded, but pointed. When, as is usually the case, the cathode is constituted of tungsten, difficulties arise in maintaining the point-source in alignment with the grid, anode and lens apertures. This is so principally because of the well known tendency of tungsten to warp when first subjected to heating currents. It has accordingly been the practice to provide the microscope or other device, in which such cathodes are used, with a flexible coupling intermediate the cathode and lens chambers and to move the cathode chamber, in its entirety, with respect to the lens chamber in order to orient and align the electron beam with the apertured electrodes within the said chambers. (As to this see U. S. Patent 2,319,061 to the same inventor.) While such flexible mountings correct for certain inaccuracies of alignment they cannot correct for those due to decentering of the filament relative to the other parts of the cathode. Moreover, such flexible mountings and adjusting means complicate the construction and contribute materially to the cost of the instrument.

Accordingly, another and important object of the present invention is to provide a simple, inexpensive and trouble-free adjustable electrode assembly, and one which may be adjusted without resorting to the use of flexible couplings and other more or less complicated auxiliary devices.

Certain preferred details of construction together with other objects and advantages will be apparent and the invention itself will be best understood by a reference to the following specification and to the accompanying drawings, wherein

Figure 1 is a sectional elevational view of the

cathode chamber of an electron microscope showing a removable adjustable electrode assembly constructed in accordance with one embodiment of the invention.

Figure 2 is a horizontal sectional view taken on a line II—II of Figure 1,

Figure 3 is a fragmentary sectional view, rotated 90°, of the cathode-grid assembly shown in Figure 1,

Figures 4 and 5 are horizontal sectional views, respectively, on the lines IV—IV, V—V of Figure 1.

In the accompanying drawings wherein like reference characters designate the same parts in all figures, 1 designates an end wall and 3 the side wall of a cylindrical casing surrounding the "cathode chamber" 5 of an electron microscope or other "cathode ray device." The end wall 1 is provided with a centrally located aperture 7 through which a glass or other insulating conduit 9 extends. This conduit contains two cathode leads 11, 11a and a third lead, 13. As shown in Figure 1, the conduit 9 is of a reduced diameter adjacent to its leading end and cathode leads 11, 11a are fixed thereto as by bending them over the said end. A circular flange 9a, a complementarily shaped seat 15 for the said flange, and a gasket 17 and clamping ring 19 on the end wall 1 of the casing serve as a vacuum-tight support for the conduit 9. The side wall 3 of the casing 1 contains one or more apertures 21 through which access may be had to the interior of the cathode chamber when a vacuum-tight door 23 is opened.

Referring particularly to Figs. 1 and 2, an insulator in the form of an annulus 25 is held within the chamber 1 adjacent to the end wall 1 by means of a clamp, not shown but which will be understood to be so arranged at the opposite end of the chamber that it exerts its force upon the said insulator through an anode structure 27, and a cylindrical spacer 29 which has a sliding fit within the bore of the outer cylinder 3. Ordinarily the anode 27 and the outer casing 3 are maintained at ground potential and the cathode and cathode focusing electrode at potentials of the order of 30 kilovolts negative with respect to ground. Accordingly, in order to prevent corona discharge between the leads 11, 11a and 13 and the grounded casing 1, 3 it is preferable to provide the insulator 25 with a ribbed or other extended surface 25a and having a central depression 25b which accommodates a conical corona shield 31 within which the end of the conduit 9 is received.

The central portion of the inner surface of the insulator 25 serves as a support for a circular metal shell or box 33 which has an opening 33a (see Fig. 4) in its side wall in register with one of the vacuum-tight doors 23 so that a capsule 35 containing an adjustable cathode assembly (later described) may be entered therein. It will be observed upon inspection of Figs. 2 and 3 that the metal box or support 33 is connected to the lead 13 by means of a leaf spring 37 which is biased to bear against the end of the said lead 13. It will also be observed that the box 33 is provided with a circular aperture at the center of its "bottom" surface and that this aperture serves as a seat for a similarly shaped apertured protuberance 35a on the bottom of the capsule 35 which contains the cathode assembly. This protuberance 35a and the cup shape portion 35b of the capsule from which the part 35a protrudes may be said to comprise the "grid" of the device. The conductive supporting shell 33 in which the said grid is mounted is sufficiently rigid and is so carefully oriented with respect to the long (vertical) axis of the chamber 5 that when the protuberance 35a is seated within the shell the grid aperture 35c will be in perfect alignment with the aperture 27a in the anode 27.

As previously indicated, the removable capsule 35 serves not only as a grid, or focusing electrode, but also as a container for the filament 39 of the device and for an adjusting mechanism (later described) for orienting the filament with respect to the grid aperture 35c. Since the seating of the grid protuberance 35a within the shell 33 brings the grid aperture 35c into alignment with the anode aperture 27a (Fig. 1) it will be apparent that when the filament 39 is properly aligned with the grid aperture 35c it is also in alignment with the aperture 27a in the anode.

Referring now in detail to the adjustable support for the filament 39, as shown more clearly in Figs. 1 and 3, the apertured cup-shape base 35b of the capsule 35 is provided with an inverted cup-shape cover 35d which fits over the said base and is secured to the side wall thereof as by screws 35e (Figs. 1 and 5). The inner surface of the cover 35d is cut away adjacent to the top of the lower cup 35b to provide a retaining groove for a circular insulating plate 41 which is freely mounted for movement on and about the rim of the said lower cup under control of three or more screws 43, 43a, etc. (see Fig. 4), which extend through the side wall of the capsule 35. The filament 39 is supported at its opposite ends by two parallelly arranged screws 45, 45a which extend through the movable insulating plate 41 and through a relatively large opening of the lid or cover 35d of the capsule 35. Insulating grommets 47 and 47a surround these screws throughout the greater portion of their length. The ends of the screws, however, are exposed in line with two leaf springs 49 and 49a, respectively, through which contact is made with the filament leads 11 and 11a, respectively.

It will now be apparent from an inspection of Figs. 1 and 3 that the capsule 35 may be removed from the chamber 5 through the port 21 by first lifting it (against the biasing force of the leaf springs 49, 49a and 37) from its seat in the base of its support 33. To mount a new filament within the capsule 35 the screw or screws 35e are unscrewed from the side wall of the capsule; the cover 35d is then removed and the insulating plate together with the filament supporting screws 45, 45a and grommets 47, 47a are lifted

from the rim of the bottom cup 35a, whereupon the old filament may be removed and a new filament mounted in place by inserting its opposite ends in the heads of the parallelly arranged supporting screws 45, 45a.

If, instead of the filamentary cathode here shown, a needle-like cathode (e. g. similar to the one shown in U. S. Patent 2,271,990 to Ramberg) is employed as the "point source" of electrons, a single centrally located supporting screw and contact spring can be substituted for the paired screws and springs shown in the drawings. In either event, when the cathode and its supporting plate 41 are mounted within the capsule and the cover 35d screwed on, the cathode may be permanently aligned with the aperture 35c in the base 35a of the capsule in the following manner: The point or apex of the cathode is first more or less accurately aligned within the closed capsule by means of the four adjusting screws 43, 43a, 43b, 43c which control the movement of the insulating plate upon which the cathode is supported. The capsule is entered through the port 21, and seated in the shell 33, then the door is closed and the chamber 5 evacuated. The cathode is then energized, preferably at its normal operating current, for a period sufficiently long for the cathode to assume its ultimate shape. When the cathode is constituted of tungsten, a pre-heating period of about thirty seconds will usually suffice. The vacuum is then broken, the capsule removed and the cathode realigned in the same manner as before, i. e., laterally, by means of the adjusting screws 43, 43a, etc. and without removing the cover 35d and preferably without jarring the capsule. The adjustment may be observed, preferably with the aid of a magnifying glass, through the aperture 35c in the base of the capsule. When the point or apex of the cathode is aligned with the desired high degree of accuracy with respect to the grid aperture 35c the capsule is re-inserted in its supporting shell or box 33 within the cathode chamber 5. As previously set forth, the box 33 is so rigid and so carefully mounted with respect to the central axis of the chamber 5 that when the protuberance 35a on the bottom of the capsule is seated on the base of the box the grid aperture 35c is in perfect alignment with the aperture 27a in the anode 27.

What is claimed is:

1. The combination with an electron discharge device comprising an evacuable chamber containing an apertured anode, a port in a wall of said chamber, a rigid support for an electrode sub-assembly mounted within said chamber and accessible from said port, an electrode sub-assembly comprising a capsule having an aperture therein and adapted to be passed through said port and seated within said support with said aperture in register with the aperture in said apertured anode, an electron source mounted to permit lateral movement within said capsule, and means for moving said electron source laterally within said capsule with respect to said registered capsule and anode apertures.

2. An electrode sub-assembly for an electron discharge device having an evacuable envelope, said sub-assembly comprising a capsule having an aperture therein and adapted to be received within said evacuable envelope, an electron source mounted to permit lateral movement within said capsule, and means accessible from the exterior of said capsule for moving said

electron source laterally within said capsule and with respect to said aperture.

3. The invention as set forth in claim 2 and wherein said capsule is constituted of metal and said source of electrons is insulatingly supported within said metal capsule, whereby said capsule and said electron source may be separately energized.

4. The invention as set forth in claim 2 and wherein the mount for said electron source comprises an insulating member supported for movement in all directions in a plane normal to the axis of said aperture.

5. An electrode sub-assembly comprising a capsule comprising a cup-shape metal base having a centrally located aperture in the bottom thereof, a similarly shaped cover within which

said base is adapted to be fitted, the rim of said cup-shape base and the adjacent portion of said cover being cut away to provide a circular groove on the interior of said capsule, a circular insulating plate of a diameter smaller than that of said circular groove supported upon said rim within said groove for movement in all directions in the plane of said rim, a point-source of electrons supported on said insulating plate on the side thereof facing the said aperture, and a plurality of adjusting members spaced apart about said circular groove and extending radially outwardly to the exterior of said cover for orienting said insulating plate and hence said point source of electrons with respect to said aperture.

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