Oct. 27, 1936. W. C. WHITE ET AL 2,059,072

ELECTRON DISCHARGE DEVICE

Filed July 31, 1935

Fig. 2

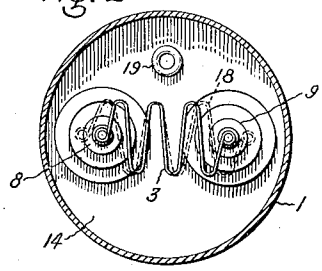


Fig. 5.

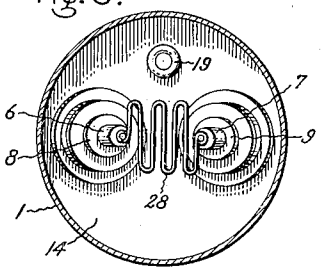


Fig. 1.

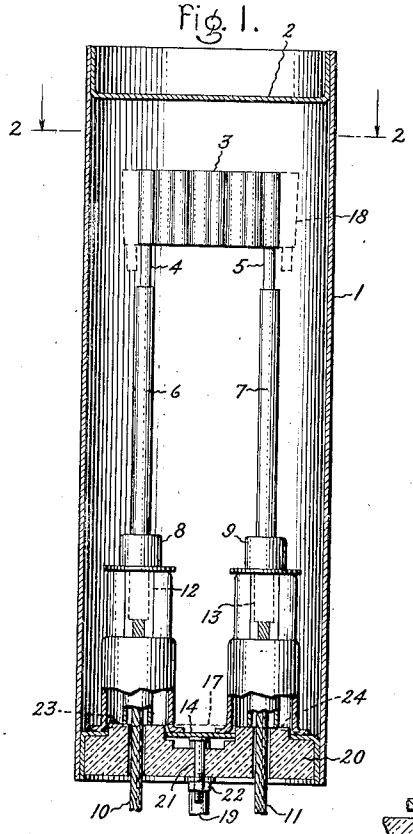


Fig. 4.

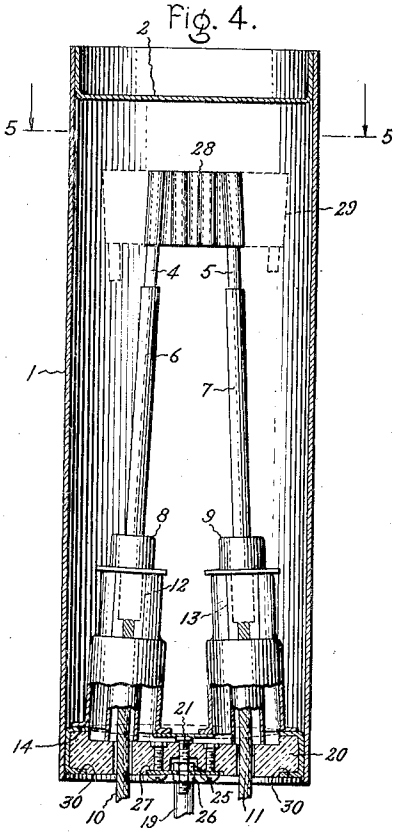


Fig. 7.

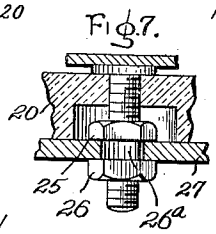


Fig. 3.

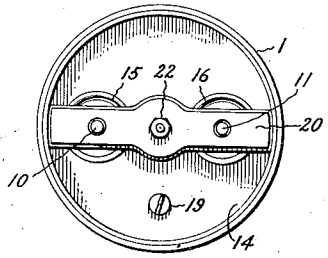
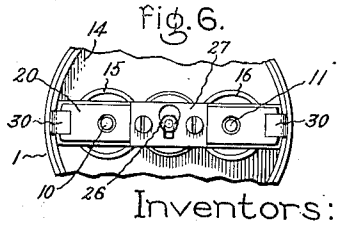


Fig. 6.



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2,059,072

ELECTRON DISCHARGE DEVICE

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Application July 31, 1935, Serial No. 33,990

7 Claims. (Cl. 250—27.5)

The present invention relates to electron discharge devices, and more particularly to an improved cathode mounting for such devices.

The development of improved glass to metal seals has now made it practical to construct sealed envelopes for discharge tubes consisting wholly, or in part, of relatively thin sheet metal. Due to the great flexibility of such materials as compared with glass, envelopes constructed in this manner may be subject to considerable distortion upon evacuation or changes in heat distribution throughout the tube. As a result of such distortion there is a tendency for electrode parts rigidly fixed with respect to the metal walls to be displaced from one another in accordance with any flexure of the walls. This is particularly noticeable in connection with cathode structures in which the heating element is supported at some distance from the tube wall. In such a case any deflection of the tube wall is greatly magnified in being transmitted to the cathode due to the great length of the cathode supporting elements, thus resulting in an increase or decrease in the cathode position or dimensions. In tubes of the type with which our invention is chiefly concerned these variations are of considerable importance since they may result in a change in the heating current required by the cathode beyond the limits considered permissible for satisfactory operation.

It is, therefore, an object of our invention to provide a practical bracing means which will prevent objectionable displacement of the electrodes. For attaining this object we provide a rigid member in the nature of a fixed beam having an externally accessible force-transmitting connection with the portion of the flexible envelope wall on which the electrodes are supported. By this means it is possible not only to prevent undesired displacement of the parts due to pressure variations, but also to produce a corrective adjustment in the nature of an artificial displacement where such an effect is desirable.

The novel features which we consider to be characteristic of our invention will be pointed out with particularity in the appended claims. Our invention itself, however, will best be understood by reference to the following specification taken in connection with the drawing, in which Fig. 1 represents a sectionalized view of a tube structure which we consider suitable for the practice of our invention; Fig. 2 is a horizontal section taken on line 2—2 of Fig. 1, while Fig. 3 is a plan view of the tube shown in Fig. 1. Fig. 4 illustrates in section a somewhat modified tube structure embodying another aspect of our invention, while Fig. 5 is a section taken on line 5—5 across the tube shown in Fig. 4, Fig. 6 being a partial plan view of the tube. Fig. 7 is a fragmentary detail view of the force-transmitting connection of Fig. 4.

Referring more particularly to Fig. 1, we have illustrated a discharge device comprising a cylindrical envelope 1 which may conveniently consist of a section of seamless steel tubing. This may be sealed at the top by a flanged diaphragm 2, line-welded or otherwise hermetically sealed to the interior surface of the cylinder. In view of the conducting nature of these parts, it is considered practical to use the envelope itself as the positive electrode or anode of the discharge path although separate electrode structure may be alternatively provided for that purpose. The envelope may either be highly evacuated or provided with a quantity of an ionizable medium such as an inert gas or mercury, depending on the purposes for which the device is to be employed.

Supported between the ends of the cylinder 1 and spaced from its walls we have illustrated a directly heated cathode 3 shown as consisting of a convoluted or pleated expansible metal ribbon. Numerous materials may be used for the construction of the cathode, but we prefer to use a base metal such as nickel or tungsten suitably coated with an alkaline earth metal oxide or other electron emissive substance. The cathode 3 is directly mounted on a pair of supports 4 and 5 which may be of heat-resisting conducting material such as nickel. These in turn are further supported on heavy conducting copper or steel rods 6 and 7, silver soldered, brazed or welded at their lower extremities to a pair of inverted thimbles 8 and 9. The thimbles should be of a material capable of being fused directly to glass and suitable for the formation of a gas-tight glass to metal seal. A seal of this type and material suitable for its manufacture is fully described and claimed in application, Serial No. 716,111 to H. J. Nolte, filed December 26, 1933, and assigned to the same assignee as the present invention. The nature of the seal not being material to the structure of our invention, it is not considered necessary to describe it with greater particularity herein.

Connections to external lead-in conductors 10 and 11 are made by suitably affixing their ends to the under surfaces of the thimbles 8 and 9, respectively. For the purpose of increasing the arc-over resistance of these connections insulat-

ing cylinders 12 and 13 are loosely placed over the lead-in wires. These may conveniently consist of glass or equivalent vitreous material and serve to minimize the danger of random contacts or corona discharge.

The lower end of the envelope 1 is closed by a flanged diaphragm 14 suitably sealed at its outer periphery to the interior of the main cylinder and so positioned that a portion of the cylinder projects substantially beyond the diaphragm. For bringing the lead-in conductors to the interior of the seals a pair of apertures 15 and 16 are formed having their centers on a diameter of the diaphragm 14 in such a position as to be aligned with the supporting rods 6 and 7. A depending tubulation 19 serves as a convenient means for exhausting the tube and also as a condensation reservoir in case the tube is desired to be operated with a mercury vapor filling.

It will be apparent that with the structure so far described a considerable degree of flexibility is available due to the relative thinness of the diaphragm 14. For this reason when the envelope 1 is subjected to a high vacuum exhaust the effect of the decrease in internal pressure is to cause an initial flexure of the diaphragm wall to a position such as that shown in dotted outline at 17. The direct result of this displacement is to destroy the parallelism supposed to exist between rods 6 and 7 and to increase the degree of extension of the cathode 3, causing it to assume a new form such as is shown at 18. Since the operating characteristics and particularly the temperature of a cathode ribbon such as that illustrated depends largely upon the degree of mutual shielding provided by adjacent convolutions, it will be obvious that a considerable change in these factors may be occasioned by the displacement indicated. Very frequently the magnitude of the change thus brought about will be so great as to render the tube unsuitable for the circuits for which it is designed.

To overcome this difficulty and to permit regulation of the cathode extension our invention provides a bracing structure associated with the cathode supports for preventing flexure of the diaphragm 14. For this purpose we prefer to use a bar of insulating material 20 positioned within the confines of the projecting cylinder portion and diametrically traversing the exterior surface of the diaphragm in such a way as to pass under the horizontal projections of the rods 6 and 7. The outer ends of the bar 20 should be either in contact with the diaphragm 14 near its outer periphery or kept in fixed relation thereto by a suitable spacing means. The central portions of the bar and diaphragm should, however, be appreciably spaced to allow relative motion between them.

In view of the above description it will be seen that the bar 20 is in effect a beam supported at its ends. For utilizing this structure as a means of adjusting the displacement of the cathode supports we provide a force-transmitting connection in the form of a bolt 21 which passes through the beam at the central portion thereof and is affixed at one end to the diaphragm 14 by a butt-weld, or other rigid connection. The outer extremity of the bolt is threaded and furnished with a nut 22 which may be alternatively tightened or loosened to vary the amount of force exerted on the diaphragm.

It will be understood that if the condition of the tube after exhaust is such as to cause the cathode to tend to assume the position shown at 18, it may be restored to a proper displacement simply by tightening the nut 22. The tightening may be accomplished before exhaust, in which case the beam 20 and the bolt 21 act as an anchoring means, or it may be tightened after exhaust, the tightening operation then being in the nature of an adjustment. If the latter method is used the proper adjustment may be obtained either by observing the actual positioning of the parts as by means of an X-ray equipment or other convenient observation mechanism, or by noting the variations of the current drawn by the cathode at a constant voltage. Since this last value is in effect proportional to cathode resistance and, hence, to the degree of cathode extension extremely accurate regulation may be accomplished in this way.

The beam 20 may be constructed of any material having good mechanical strength and insulating properties. We have found it convenient to use for this purpose refractory material comprising a mixture of from 70 to 80 per cent of magnesium silicate, or talc with a complementary portion of clay and feldspar. When properly mixed, compressed and fired, this composition yields a product having a tensile strength of approximately 10,000 pounds per square inch. In addition, it is of high insulating quality, nonhygroscopic and eminently suited to the purposes of our invention.

In order to prevent rotation of the beam 20 when torque is applied to the nut 22, it is advisable to provide upset projections such as those shown at 23 and 24 to engage the diaphragm apertures 15 and 16. We have also found it convenient to provide holes in the beam structure to permit the passage therethrough of the lead-in conductors 10 and 11. In this way besides the functions described above, the beam is made to serve as an insulator for maintaining the bare conductors in appropriately spaced relation.

For some purposes it may be desirable to provide means for exerting both an expanding and a contracting force on the cathode 3. The value of such an arrangement might be realized, for example, in cases where the conditions of manufacture are such that the cathode ends tend to assume too close a displacement. To allow for this possibility and to make possible an even greater degree of adjustment than is permissible with the structure already described, we have illustrated a modification of which our invention is capable. This is shown in detail in Figs. 4, 5 and 6 in which parts corresponding to those illustrated in Fig. 1 are identically numbered.

In connection with Fig. 4 it will be noted that the beam 20 is cut away over a considerable portion of its length to permit of great relative movement of the diaphragm 14. In this embodiment as in that of Fig. 1 the force transmitting connection takes the form of a bolt 21 secured to the diaphragm at its inner end. The tightening nut, however, consists of a pair of spaced enlargements 25 and 26 interconnected by a section 26a of smaller diameter which is keyed into an anchor plate 27, this in turn being rigidly bolted or otherwise secured to the lower face of the beam 20. The details of this construction may readily be understood by an inspection of the enlarged view of Fig. 7.

With the arrangement just described above both thrust and tensile force may be transmitted to the central portion of the diaphragm 14, and the extension of the cathode varied between the extreme limits designated by the full line posi-

tion shown at **28** and the dotted line position shown at **29**. Since the cathode supports are approximately symmetrically disposed with respect to the movable portion of the diaphragm, a slight movement of the latter will produce a magnified motion of the ends of the cathode supports remote from the diaphragm. To prevent rotation and outward motion of the beam **20** during the application of the adjusting force, retaining studs **30** may be bent out of the flanged portion of the diaphragm **14** and pressed into corresponding slots in the face of the beam.

It is a particular advantage of the structural arrangements which we have described that deviations in cathode operation attributable to slight variations in material or errors in construction may be readily compensated. Thus, in a tube which is found to draw too little heating current when first tested the cathode extension may be increased even beyond the normal position in order to correct the defect. This feature makes possible a degree of manufacturing uniformity heretofore entirely unavailable in connection with glass and other tubes of more rigid construction. In testing such tubes a specimen found defective must either be rejected as imperfect or completely rebuilt. By utilizing the structure of our invention, on the other hand, a relatively simple adjustment will cause the tube characteristics to conform to the required operating standards.

While we have shown a particular embodiment of our invention, it will of course be understood that we do not wish to be limited thereto since many modifications in the structure may be made, and we contemplate by the appended claims to cover all such modifications as fall within the true spirit and scope of our invention.

What we claim as new and desire to secure by Letters Patent of the United States, is:

1. In an electric discharge device, a sealed cylindrical envelope having a flexible diaphragm closing one end thereof, electrode supports mounted on said diaphragm, a rigid beam diametrically traversing said diaphragm, said diaphragm being fixed with respect to said beam only adjacent the ends thereof and a force transmitting connection between said beam and said diaphragm at the center thereof.

2. In an electric discharge device, an extensible cathode, conductive supporting elements secured to the ends of said cathode, and means associated with said elements for varying at will the extension of said cathode, said means being accessible externally of said discharge device.

3. In an electric discharge device, a pleated extensible cathode supported at its ends, a sealed envelope enclosing said cathode and consisting in part of a flexible diaphragm, supporting connections between the ends of said cathode and said diaphragm, and means associated with said diaphragm for varying the extension of said cathode.

4. An electrode mounting comprising a flexible diaphragm having a plurality of apertures therein, gas-tight lead-in seals associated with said apertures, a rigid beam traversing said diaphragm and having upset projections engaging said apertures, said diaphragm being fixed with respect to said beam only at its ends, and a force transmitting connection between said diaphragm and said beam intermediate the ends thereof.

5. In an electric discharge, device, an extensible cathode whose operating characteristics are variable with the extension thereof, a sealed envelope enclosing said cathode and consisting in part of a flexible diaphragm, supporting connections between the ends of said cathode and said diaphragm, a bracing member mounted adjacent said diaphragm and a force transmitting connection between said member and said diaphragm for flexing the latter to vary the extension of said cathode.

6. In an electric discharge device, a sealed envelope consisting in part of a flexible diaphragm, a bracing member rigidly mounted adjacent said diaphragm, said diaphragm having a portion thereof freely movable with respect to said bracing member, a pluraltiy of electrode supports mounted on said diaphragm at positions approximately symmetrically disposed with respect to said movable portion and an adjustable force-transmitting connection between said member and said movable portion for fixing the position of the latter thereby to determine the spacing of the ends of said electrode supports remote from said diaphragm.

7. In an electrical discharge device, a sealed envelope including an elongated metal cylinder, a flexible diaphragm inset in one end of said cylinder so as to leave a portion of the cylinder projecting beyond the diaphragm, electrode supporting means mounted on the inner surface of said diaphragm, a rigid beam positioned within the confines of said projecting cylinder portion and traversing the outer surface of said diaphragm and a force-transmitting connection between said beam and a central region of said diaphragm.

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