July 7, 1942. W. W. WATROUS, JR 2,288,861

PROTECTOR TUBE

Filed Feb. 27, 1941

Fig. 1.

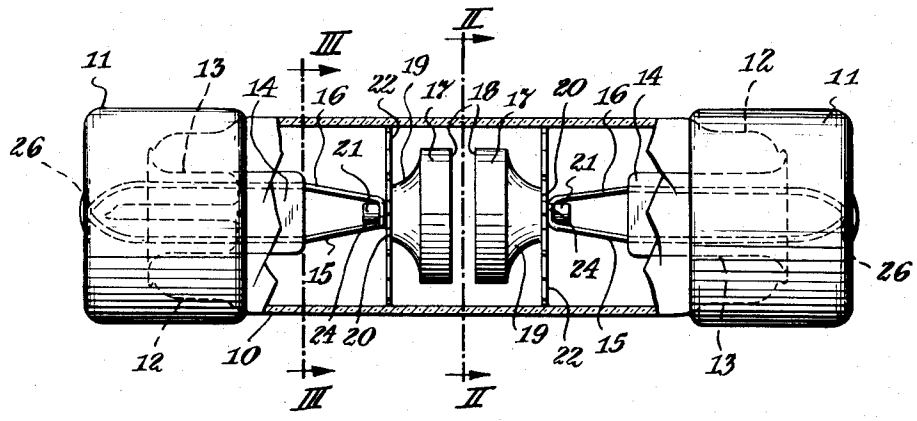


Fig. 2.

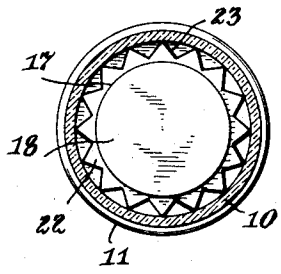


Fig. 6.

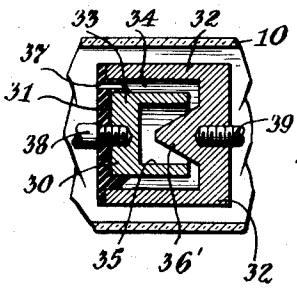


Fig. 3.

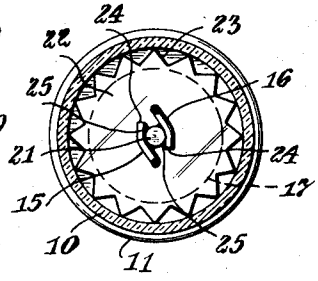


Fig. 4.

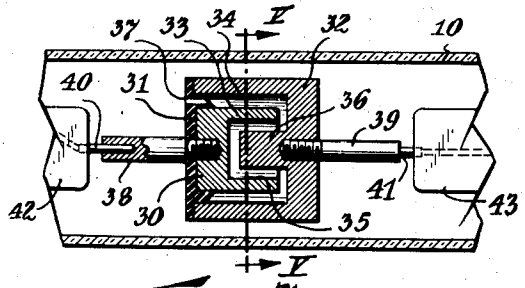


Fig. 5.

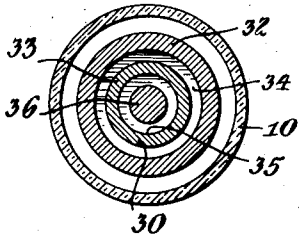
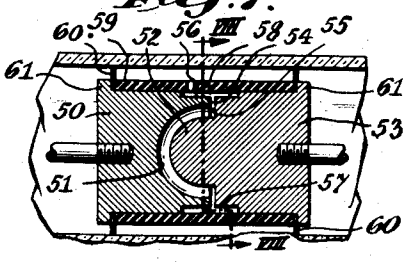


Fig. 7.



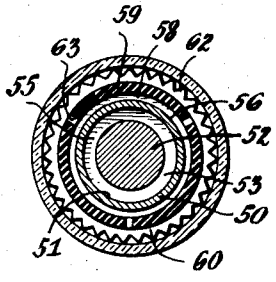


Fig. 8.

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PROTECTOR TUBE

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Application February 27, 1941, Serial No. 380,750

15 Claims. (Cl. 250—27.5)

My invention relates to tubes and especially to the type of tube known as a gas-filled protector tube.

An object of the invention is to provide a simplified protector tube that is inexpensive to manufacture.

Another object of the invention is to reduce the erratic operation that is characteristic of the protector tubes of the prior art.

Still further objects are to properly protect the arc discharge space between the discharge electrodes in a protector tube.

Other objects and advantages of the invention will be apparent from the following description and drawing in which:

Fig. 1 is a view of a protector tube embodying my invention with certain portions of the casing broken away.

Fig. 2 is a view on lines II—II of Fig. 1.

Fig. 3 is a view on lines III—III of Fig. 1.

Fig. 4 is a modification of the structure of Fig. 1.

Fig. 5 is a view on lines V—V of Fig. 4.

Fig. 6 is a modification of the electrode structure of Fig. 4.

Fig. 7 is a still further modification of Fig. 4.

Fig. 8 is a cross section on lines VIII—VIII of Fig. 7.

Gas-filled protector tubes of the prior art have inherent disadvantages which include their high cost, erratic operation, inconvenient mounting, awkward shape, and relatively fragile construction. It is first of all an object of my invention to simplify the construction of a protector tube and to make one that is both compact and of sturdy construction. Another object of the present invention is to provide a simplified structure which eliminates the erratic operation present in prior art tubes of this type.

In Fig. 1 I have disclosed a preferred embodiment of my invention, which has a casing 10 of glass, preferably of cylindrical shape, with closed ends fitting into suitable metal caps 11. The cylindrical casing 10 and the shape of the metal caps 11 may be of such a size as to conveniently fit into the ordinary fuse clip type of mounting. The two ends 12 of the glass casing may conveniently take the form of a glass reentrant portion 13 terminating in a glass press 14 through which are sealed one, and preferably two, standards or conductors 15 and 16 of nickel or tungsten wire.

At the center portion of the casing 10 are two closely spaced electrodes 17, preferably in the shape of cylindrical disks, with their opposed faces 18 exactly parallel with one another. These disks have a projecting reduced portion 19 terminating in a flat face 20 to which is attached, as by a screw threaded joint, a stud 21, preferably of nickel holding a disk or sheet of thin flexible insulation 22 preferably of mica, against the flat face 20 of the electrode. This disk has preferably a saw-tooth edge 23, illustrated in Figs. 2 and 3, in tight frictional fit against the inner wall of the casing 10.

The two conductors 15 and 16 sealed through the press have their ends 24 bent over and may press against the mica disk to also help keep this disk flat against the face 20 of the electrode, as illustrated in Fig. 3. These conductors are soldered or welded at 25 to a stud 21 preferably of nickel. The ends of the conductors 15 and 16 that extend through the press 14 are connected at 26 to the interior of the cap 11.

It will be noted that this construction is a very economical one because the glass portion of the casing, including the cylindrical housing 10, the glass ends 12, reentrant portion 13 and press 14 with the two conductors extending therethrough, are standard glass lamp forms and materials produced by automatic machines. The method of assembling this glass structure is accordingly familiar to a large body of workers in the lamp art.

While the two conductors through each press are not absolutely necessary, yet the double support bearing against the mica disk and welded to the stud 21 helps maintain the electrode exactly in the place desired for it. The mica disks help to space the electrodes exactly on the axis of the device and help confine the discharge to the surface of the electrodes.

In Fig. 4 I have illustrated a still further modification of my invention in which I have increased the arcing area between the electrodes and yet have prevented any long path of breakdown therebetween. It is known, of course, that in the protector tubes of the prior art that the arc may travel to the back surface of the electrodes and fuse the supports and the protective insulation. Where the possibility exists of a long path breakdown between the electrodes, the glass envelope may craze or crack because of this long arc.

Accordingly, I modify the electrode structure by reducing the diameter of one of the electrodes, such as 30 in Fig. 4, and form a disk of insulation 31 as a cover to the other electrode 32 which will enclose the first electrode 30. This insulation cover 31 may be of a suitable ceramic ma-

terial. The smaller electrode 30 has a cylindrical extension 33 extending into a hollowed space 34 enclosing electrode 30. This cylindrical extension 33 has central hollow space or depression 35 in turn, into which extends a projecting portion 36 from the enclosing electrode 32. The result is that the two electrodes have large interfitting surfaces slightly spaced from one another across which the arc discharge may take place. The shape of these interfitting projections may be cylindrical, although in Fig. 6 the central projection 36' from the electrode 32 may have a conical formation. This conical projection provides a space of continuously varying distance which permits the discharge to start at the most favorable spacing for the gas pressure, and then the arc transfers to another region, thus keeping the starting surface from rapid erosion in operation. The cover 31 may have a suitable vent 37 to prevent any disruptive explosion because of the confined gases. A suitable support 38 is attached to the electrode 30, and another suitable support 39 is attached to the other electrode 32. These may be connected in turn to conductors 40 and 41 sealed through the opposite presses 42 and 43. The supporting structure of Fig. 1 could, of course, be utilized with that of Figs. 4, 6 and 7.

The arc discharge may be confined in other ways and the shape of the interfitting electrodes may also be varied as illustrated in Fig. 7. In Fig. 7 the electrode 50 has a hemispherical depression 51 into which extends a hemispherical projection 52 from the opposite electrode 53 with the desired spacing between the two surfaces. The surrounding circular edge 54 of this hemispherical depression in 51 is placed closer to the adjoining circular face 55 of the electrode 53 than the rest of the spacing between the two electrodes. The outside edge 56 and 57 adjoining these two faces 54 and 55 is reduced in diameter to make a small chamber 58.

A cylinder of insulation 59, such as alumina or magnesia surrounds the two electrodes and maintains the desired spacing between the two adjacent surfaces of these electrodes. The two electrodes are centered in the container wall 10 by having two mica rings 60 preferably bound between the insulation 59 and an exterior flange 61 at each end of the electrodes. These mica rings 60 preferably have a frictional saw-tooth edge 62 bearing against the inner surface of the container wall 10. The tube of insulation 59 has a suitable vent 63 to permit gas interchange between the electrode cavity and the bulb space.

In Fig. 7 the spacing and gas pressure can be so proportioned that the arc will start across the spacing between the two annular faces 54 and 55. It will then transfer to the large hemispherical surface of each electrode. In this figure the carbon sputtered from the electrodes can only be deposited on a very limited area of the cylinder 59 opposite the small space between the edge 54 of the electrode 50 and the adjacent face 55 of the electrode 53. Because of this limited deposition of carbon there will not be a complete leakage path across the insulation 59 spacing the two electrodes.

It will be noted that the construction of my gas-filled protector tubes is simple yet rugged. The spacing between the two electrodes can be made very accurately. The electrodes, especially in Figs. 4 and 7, have a large arcing area which decreases erosion and provides a multitude of points in parallel so that in a series of successive breakdowns, the deviation from the mean voltage breakdown is greatly lowered.

The enclosed electrode structure of Figs. 4 and 7 makes impossible any breakdown over a long path thus preventing erratic operation and damage to the electrode connections.

It is apparent, however, that many modifications may be made in the form and arrangement of my preferred embodiments, and accordingly I desire only such limitations to be imposed upon my invention as are necessitated by the spirit and scope of the following claims.

I claim:

1. A protector tube comprising two closely spaced electrodes having opposed parallel discharge faces, and having each another face distinct from said discharge faces and constituting insulation-attaching faces, an insulating casing surrounding said electrodes, and insulation means attached to said electrodes with surface areas of said means in tight coextensive engagement with said insulation-attaching faces and cooperating for both retaining said electrodes spaced from the insulating casing and for retaining said discharge faces parallel.

2. A protector tube comprising two closely spaced electrodes having opposed parallel discharge faces, and having each another face distinct from said discharge faces and constituting insulation-attaching faces, an insulating casing surrounding said electrodes, and insulation means attached to said electrodes with surface areas of said means in tight coextensive engagement with said insulation-attaching faces and cooperating for both retaining said electrodes spaced from the insulating casing and for retaining said discharge faces parallel and said means having contact at evenly spaced intervals around their entire outer periphery with said insulating casing, and said means being attached at the center part thereof to said electrode and the said means, electrodes and the said insulating casing being symmetrical about a common central axis whereby the said means centralizes the electrodes with respect to the casing and confines the discharge to the electrodes.

3. A protector tube comprising two closely spaced electrodes having opposed discharge faces, an insulating casing surrounding said electrodes, and insulating means in contact with said casing and secured tightly to said electrodes to centralize the electrodes and confine the discharge to the electrodes comprising a complete ring of flexible insulation clamped to parts of said electrodes remote from said discharge faces and in frictional contact at closely spaced intervals throughout the peripheral edge thereof with the interior wall of said container.

4. A protector tube comprising two closely spaced electrodes having opposed discharge faces, an insulating casing surrounding said electrodes, and insulating means in contact with said casing and said electrodes to centralize the electrodes and confine the discharge to the electrodes comprising a complete ring of mica clamped at a middle part thereof to said electrodes remote from said discharge faces and having a continuous saw-toothed edge in contact with the inner wall of said container.

5. A protector tube comprising two closely spaced electrodes, an insulating casing surrounding said electrodes and insulating means in contact with said casing and said electrodes to centralize the electrodes and confine the discharge to the electrodes, one of said electrodes having a

projection and the other electrode having a portion enclosing said projection.

6. A protector tube comprising two closely spaced electrodes, an insulator enclosing the discharge space between said two electrodes, said insulator being also closely spaced to the electrodes at the edge of the discharge space but attached to said electrodes at a place removed from said discharge space whereby sputtered material will not form a leakage path from one electrode to the other across said insulator.

7. A protector tube comprising two closely spaced electrodes, an insulator enclosing the discharge space between said two electrodes, said insulator being also closely spaced to the electrodes at the edge of the discharge space but attached to said electrodes at a place removed from said discharge space whereby sputtered material will not form a leakage path from one electrode to the other across said insulator, a container and insulating means positioning said electrodes within said container.

8. A protector tube comprising two closely spaced electrodes, an insulator enclosing the discharge space between said two electrodes, said insulator being also closely spaced to the electrodes at the edge of the discharge space but attached to said electrodes at a place removed from said discharge space whereby sputtered material will not form a leakage path from one electrode to the other across said insulator, a container and insulating means positioning said electrodes within said container comprising a ring of mica secured to the attached insulator-electrodes structure and bearing frictionally against the inner wall of said container.

9. A protector tube comprising two closely spaced electrodes, an insulator enclosing the discharge space between said two electrodes, said insulator being also closely spaced to the electrodes at the edge of the discharge space but attached to said electrodes at a place removed from said discharge space whereby sputtered material will not form a leakage path from one electrode to the other across said insulator, a container and insulating means positioning said electrodes within said container comprising two rings of mica, each of said rings being secured between said insulator and one of said electrodes and bearing frictionally against the inner wall of said container.

10. A protector tube comprising two closely spaced electrodes, an insulator enclosing the discharge space between said two electrodes, said insulator being also closely spaced to the electrodes at the edge of the discharge space but attached to said electrodes at a place removed from said discharge space whereby sputtered material will not form a leakage path from one electrode to the other across said insulator, a depression in the active face of one electrode, and a projection from the other electrode extending into said depression.

11. A protector tube comprising two cylindrical electrodes having their outside circular edges closely adjacent and exposed toward each other and forming a small discharge space therebetween, a cylinder of insulation material enclosing the circular edges of said electrodes and the discharge space therebetween and being slightly spaced from said closely adjacent circular edges, said cylinder of insulation material being secured to and having extensive surface contact with said electrodes at a position remote from said discharge space.

12. A protector tube comprising two cylindrical electrodes having their outside circular edges closely adjacent and exposed toward each other and forming a small discharge space therebetween, a cylinder of insulation material enclosing the circular edges of said electrodes and the discharge space therebetween and being slightly spaced from said closely adjacent circular edges, said cylinder of insulation material being secured to said electrodes at a position remote from said discharge space, a container and insulating rings attached to said electrodes and bearing frictionally against the interior wall of said container.

13. A protector tube comprising two cylindrical electrodes having their outside circular edges closely adjacent and exposed toward each other and forming a small discharge space therebetween, a cylinder of insulation material enclosing the circular edges of said electrodes and the discharge space therebetween and being slightly spaced from said closely adjacent circular edges, said cylinder of insulation material being secured to said electrodes at a position remote from said discharge space, a container and rings of mica attached to said electrodes and bearing against the interior wall of said container.

14. A protector tube comprising two cylindrical electrodes having their outside circular edges closely adjacent forming a small discharge space therebetween, a cylinder of insulation material enclosing the circular edges of said electrodes and the discharge space and being slightly spaced from said closely adjacent circular edges, said cylinder of insulation material being secured to said electrodes at a position remote from said discharge space, a depression in the active face of one electrode and a projection from the other electrode extending into said depression.

15. A protector tube comprising two closely spaced electrodes aligned on a common axis, an insulating cylindrical casing coaxial with and surrounding said electrodes, and disc-like means transverse to and centered on said axis and secured at the midparts of said disc-like means to said electrodes and said disc-like means making contact at the peripheries thereof with said cylindrical casing, said disc-like means and cylindrical casing forming a chamber confining the discharge between said electrodes within said chamber, one of said electrodes having a projection and the other electrode having a portion enclosing said projection for encouraging discharge between said electrodes to occur within said enclosing portion.

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