(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 271 877 A2**

(12) EUROPEAN PATENT APPLICATION

(21) Application number: 87118580.7

(22) Date of filing: 15.12.87

(51) Int. Cl.4: **H01J 61/36**, H01J 61/02, H01J 61/18, H01J 61/22

(30) Priority: 15.12.86 US 941442

(43) Date of publication of application: 22.06.88 Bulletin 88/25

(84) Designated Contracting States: BE DE FR GB NL

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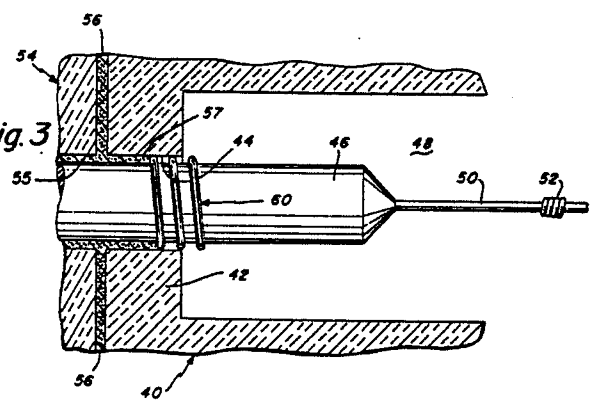
(54) Improved in-lead for sodium and metal-halide lamps.

(57) In an arc tube of a high-pressure discharge lamp, there is provided an inlead member disposed in an end aperture of the arc tube. A coiled wire is disposed about the inlead member forming a gasket between the inlead member and the arc tube at the arc tube end aperture. A sealing glass is provided for sealing between the inlead member and the arc tube end wall. The sealing glass is blocked by the coiled wire so that the sealing glass is not exposed to the constituents within the arc tube, whereby deleterious chemical reactions between the constituents of the arc tube fill and the sealing glass are avoided. In some embodiments, the coil wire also protects the inlead from chemical attack by the fill constituents. Lamps constructed in accordance with the invention may be manufactured simply and inexpensively without the necessity of close-tolerance technology. By preventing exposure of the sealing frit to the fill constituents, lamp performance characteristics are enhanced.

Fig.3



EP 0 271 877 A2

IMPROVED IN-LEAD FOR SODIUM AND METAL-HALIDE LAMPS

CROSS REFERENCE TO RELATED APPLICATIONS

Copending United States patent applications, Serial No. 557,812, filed December 5, 1983, and Serial No. 740,165, filed June 3, 1985, both assigned to the assignee hereof, contain related subject matter.

TECHNICAL FIELD

The invention relates to arc tubes for high pressure discharge lamp applications. More particularly, the invention relates to improvements in ceramic arc tubes for high pressure sodium lamps and related lamps, such as mixed metal-vapor and metal-halide lamps. Even more particularly, the invention relates to an improved end seal for arc tubes used in the high-pressure discharge lamps.

BACKGROUND PRIOR ART

An arc tube of a high pressure discharge lamp may have at each end thereof an electrical inlead to the tungsten electrode of the arc tube. In one embodiment, such as is illustrated in the prior art drawing of Fig. 1 herein, a niobium tube is sealed into the end of the arc tube with a refractory glass frit; the niobium tube functions as an electrical inlead to the tungsten electrode. Alternatively, an alumina-tungsten cermet inlead may be used, as shown in the prior art drawing of Fig. 2 herein, or as described in United States Patent No. 4,155,757, to Hing, or United States Patent No. 4,155,758, to Evans et al. Also refer to co-pending application, Serial No. 557,812, filed December 5, 1983, entitled Electrode For High Intensity Discharge Lamps. See Japanese Patent No. 59-103267, issued to Nippon Gaishi K.K., for an example of an alumina-tungsten cermet disk closing a ceramic arc tube.

In both prior art embodiments shown in Figs. 1 and 2 herein, the sealing glass is exposed to the arc tube constitutents. The extent (or area) of such exposure may be relatively large if the sealing glass flows into the arc tube chamber and spreads over the internal surface of the arc tube. Advances in glass frit formulations have been made to minimize the chemical reactions of the sealing glass with arc tube constituents during lamp operation. For example, in United States Patent No. 4,208,605, to McVey et al., a glass frit formulation of alumina-calcia-baria is taught. In related United States Patent No. 4,199,704, to Varshnevy et al., use of strontium oxide in the sealing composition is described. Refer also to United States Patent No. 4,316,939, to Hing, teaching the use of alumina-silica-magnesia-boric oxide. Further, a known sealing composition is comprises of 22% alumina, 41% silica, and 47% yttria.

In spite of such advances in glass frit formulations, reactions of the sealing glass with constituents of the light-emitting plasma continue to cause substantial deterioration in lamp performance and premature lamp failure. These reactions are aggravated by high inlead and seal temperatures which are required, e.g., for improved color rendering at high luminous efficacies. These deleterious reactions constitute a barrier to the performance and life of these lamps.

In summary, a serious problem with arc tube seals utilizing glass frits is that the temperature of the polycrystalline aluminium oxide (PCA) arc tube end is limited to an operating temperature of about 800° Celsius, which is below the capability of the PCA tube. A PCA arc tube may be operated at temperatures up to 1200°C or even higher in the central region of the arc tube. This temperature limitation applying to the end portions of the arc tube is largely due to the aggressive corrosion of the sealing glass by sodium, metal halides, and other fill constituents, including such metals as thalium, cadmium, and zinc, such corrosion occurring at higher temperatures. This corrosion results in the progressive loss of sodium or other plasma discharge constituents by chemical reaction with the glass frit which leads to eventual failure of the seal and, consequently, the lamp. Thus, the life of the lamp and the quality of light are thereby limited. On the other hand, if higher operating temperatures could be used without increased corrosion, then correspondingly higher metal vapor pressures would be attained within the arc tube. Additives such as sodium, scandium iodide, cadmium, thallium, and zinc could be utilized at higher pressures to improve luminous efficacy and color rendering in these lamps.

Reference is now made to United States Patent No. 4,560,903, to Sneijers et al., describing an arc tube in which the inlead member has a protuberance around it which screens the sealing glass from the arc tube constituents. A problem with this technique is that the inlead with the protuberance must be manufactured to extremely close tolerances which incurs significant expense.

Reference is made to co-pending application, Serial No. 740,165, filed June 3, 1985, entitled High

Temperature Tapered Inlead For Ceramic Discharge Lamps. This application describes an improved form of the sealing joint to prevent exposure of the glass frit to the arc tube fill. This particular technique also had the disadvantage of requiring close mechanical tolerances between components.

It is believed, therefore, that an arc tube end structure used to seal the ends of a ceramic arc tube which can be manufactured without the need for close-tolerance techniques would constitute a significant advancement in the art.

DISCLOSURE OF THE INVENTION

It is, therefore, an object of the invention to obviate the deficiencies of the prior art. Another object of the invention is to the provide an improved technique for sealing an arc tube of a high-pressure discharge lamp in a manner to prevent the glass sealing frit from flowing into the arc chamber.

Yet another object of the invention is to provide, in an arc tube of a high-pressure discharge lamp, a means for limiting the chemical reactions between the sealing joints and constituents of the fill of the arc tube.

Still another object of the invention is to provide, in an arc tube of a high-pressure discharge lamp, a means for protecting all or substantially all of the inlead from chemical reaction with the constituents of the fill of the arc tube.

A further object of the invention is to provide an improved seal for an arc tube of a high-pressure discharge lamp in which the sealing technique does not require costly close-tolerance technology and procedures.

In accordance with one aspect of the invention, there is provided a high-pressure lamp comprising an arc tube having at least one end thereof formed with an aperture and an inlead member adapted to be received by the arc tube at the aperture. The inlead member supports electrode means. A coiled wire is disposed about the inlead member forming a gasket between the inlead member and arc tube end aperture. A sealing glass is provided for sealing between the inlead member and the arc tube end. The sealing glass is subject to reacting chemically with the constituents of the fill within the arc tube, when and if the sealing glass is exposed to the fill. The coiled wire is positioned such that the sealing glass is shielded from the fill. The structure prevents a chemical reaction from occuring between the sealing glass and the constituent of the fill.

In accordance with another aspect of the invention, a disk is mounted on the end of the arc tube. The disk has a second aperture for receiving the inlead member. The disk is sealed to the arc tube end and inlead member by the sealing glass. In one embodiment of this aspect of the invention, the coiled wire extends about the inlead member from a position at the arc tube aperture to a position covering substantially all of the inlead member located within the internal chamber of the arc tube. Further protection of the inlead member may be attained by coating it with a material, e.g., tungsten by sputtering or by chemical vapor deposition. In another embodiment, the coiled wire extends about the inlead member substantially at the aperture of the sealing disk. In still another embodiment, the coiled wire extends about the inlead member at both the sealing disk aperture and the arc tube end aperture. In yet another embodiment of the invention, the arc tube end aperture is tapered to prevent the coiled wire from protruding into the interior of the arc tube. In still a further embodiment, the arc tube end aperture is provided with an internal annular channel for receiving the coiled wire and preventing the coiled wire from protruding into the interior of the arc tube.

Without limiting the foregoing, the arc tube and the disk may be formed from polycrystalline alumina. The inlead member may be an inlead tube, such as a niobium tube, supporting a tungsten electrode. The coiled wire may be a helical coil of tungsten wire. The coiled wire has a preferred wire diameter in a range on the order of 3.0 to 5.0 mils, for ease of construction. In alternate embodiments of the invention, the inlead member may be a cermet inlead and the coiled wire may be formed from a material selected from a group consisting of molybdenum, tantalum, niobium, tungsten, and rhenium.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a partial cross-sectional view of a prior art construction of an arc tube illustrating the sealing of the inlead member at an end of the arc tube;

FIG. 2 is a partial cross-sectional view of a prior art construction of an arc tube illustrating the sealing of a cermet inlead at the end of the arc tube;

FIG. 3 is a partial cross-sectional view of an arc tube end illustrating one embodiment of the invention employing a coiled wire between the inlead member and arc tube end wall;

FIG. 4 is partial cross-sectional view of an alternate embodiment of the invention in which the coiled wire extends to cover substantially the entire inlead member along the portion located inside the arc tube chamber;

FIG. 5 is a partial cross-sectional view of another embodiment of the invention employing a channeled aperture in the arc tube end wall in combination with a sealing button or disk and glass sealing frit;

FIG. 6 is partial cross-sectional view of an arc tube end and sealing disk wherein the diameter of the aperture of the arc tube is smaller than the diameter of the disk in order to prevent the coiled wire from protruding into the arc tube chamber.

FIG. 7 is a partial cross-sectional view of an arc tube end having a tapered aperture which prevents the coiled wire from protruding into the arc tube member.

BEST MODE FOR CARRYING OUT THE INVENTION

For a better understanding of the invention together with other and further objects, advantages, features, and capabilities thereof, reference is made to the following disclosure and appended claims in connection with the above described drawings.

FIGS. 1 and 2 show typical prior art constructions for sealing the end of an arc tube. FIG. 1 illustrates the end portion of a ceramic arc tube 10, typically formed from polycrystalline alumina for a high-pressure sodium lamp. Arc tube 10 includes end wall 12 having defined therein an end wall aperture 14. An inlead member 16 is disposed in aperture 14 and extends from an external position at one end 16A an internal position within chamber 18 of arc tube 10. Inlead member 16 may be in the form of a niobium tube which supports electrode wire 20 and electrode turns 22 within chamber 18.

FIG. 1 shows use of a separate sealing disk or button 24 having aperture 15 formed therein. Both arc tube 10 and sealing disk 24 may be formed of PCA, or they may be formed from different materials having coefficients of thermal expansion which are sufficiently matched. FIG. 1 also shows glass sealing frit at 26. The glass sealing frit may comprise, for example, alumina, calcium, magnesia, and barrium oxide, frequently used for sealing purposes. See, for example, United States Patent No. 4,208,605, to McVey et al. The sealing frit extends between disk 24 and end wall 12, and between apertures 15 and 16 and inlead member 16. Note, sealing frit 26 extends about inlead member 16 where it is exposed at 28 to the constituents with chamber 18.

FIG. 2 show an alternate inlead member in the form of alumina-tungsten cermet inlead 36 disposed in aperture 34 of end wall 32 of arc tube 30. In this embodiment of the invention, arc tube 30 may also be constructed to PCA. FIG. 2 illustrated the end portion of a ceramic arc tube which may be employed in metal-halide or metal-vapor lamps.

In FIG. 2, cermet inlead 36 is maintained and sealed in position by glass sealing frit 38. Cermet inlead 36 may have associated therewith an electrode and associated light-emitting material. The cermet and electrode combination may be sealed by a sealing frit typically comprising silica, alumina, and yttria or magnesia. As with the embodiment of FIG. 1, glass sealing frit 38 in FIG. 2 extends about the inlead member 36 where it is exposed at 39 to constituents within the chamber of arc tube 30.

Cermets, such as cermet 36, are electrically conductive; they are refractory composites, typically comprising an interconnected network of molybdenum or tungsten within a matrix of dense, polycrystalline aluminum oxide.

In both embodiments of FIGS. 1 and 2 there is a substantially annular surface of glass frit at the sealing joint wherein inlead emerges from the end wall into the arc tube chamber. This ring of frit is in contact with constituents of the fill of the arc tube. This sealing joint frequently reacts chemically with the fill constituents during operation of the lamp leading to eventual loss of the hermetic seal and lamp failure.

Reference is now made of FIG. 3, illustrating a first embodiment of the invention. Means are provided, in the form of a helical coil tightly wound around the inlead member, to prevent reaction of the sealing glass with constituents of the light-emitting plasma within the arc chamber. Such reactions cause substantial deterioration of lamp performance and premature lamp failure. The helical coil shields the glass sealing frit from exposure to the fill.

In FIG. 3, there is shown arc tube 40 having an end wall 42 with aperture 44 centrally disposed therein. The inlead member, which may be in the form of a niobium tube 46, is disposed in aperture 44. Sealing disk 54 similarly has centrally disposed aperture 55 for receiving niobium tube 46. Niobium tube 46 supports a tungsten electrode wire 50 and associated wire turns 52. A glass sealing frit 56 is disposed between the inlead member 46, sealing disk 54, and end wall 42 of the arc tube.

In accordance with the invention, FIG. 3 illustrates helical coil 60 would about the inlead member 46. In this embodiment, coil 60 is an open coil, meaning that there are spaces between turns. Coil 60 forms a gasket preventing glass sealing frit 56 from flowing into the arc chamber 48. Accordingly, glass sealing frit 56 extends only to the edge of the left-most turn of coil 60, such as at location 57.

In the embodiment of FIG. 3, the diameter of niobium tube 46 may be approximately 0.125 inch while the diameters of aperture 44 and aperture 55 each may be approximately 0.130 inch. The diameter of wire 60 should be equal to or slightly less than the space between inlead member 46 and aperture 44. In FIG. 3, the diameter of the wire of the coil 60 may be 0.005 inches (5.0 mils) or slightly less. It is preferred that the diameter of the wire of helical coil 60 be in a range of approximately 3.0 to 5.0 mils. A wire diameter substantially less than 3.0 mils is fragile for manufacturing assembly. A wire diameter substantially greater than 5.0 mils may not provide sufficient flexibility for insertion of the inlead member and positioning in the arc tube end wall.

In the manufacturing process, the wire coil is disposed about he inlead member; thereafter, the inlead member with the coil attached is inserted and centered within the arc tube aperture. The sealing frit is then introduced along the sealing button (if used in a particular embodiment).

FIG. 4 shows an alternate embodiment of the invention. In FIG. 4, the same reference characters are used to identify like parts of the arc tube previously referred to in FIG. 3. In FIG. 4, there is provided an arc tube 40 having an end wall 42 and having associated therewith a sealing disk 54. Both the sealing disk 54 and the arc tube end wall 42 have centrally disposed apertures 44 and 55 for receiving niobium tube 46. Niobium tube 46 in turn supports tungsten electrode wire 50 and associated turns 52.

FIG. 4 illustrates the use of a helical coil 60A, preferably of tungsten wire in the range of approximately 3.0 to 5.0 mils wire diameter. The left-most end of helical coil 60A is disposed in aperture 44 such that a gasket is formed to prevent the glass sealing frit, such as at location 57, from extending into arc tube chamber 48. The remainder of helical coil 60A extends to cover substantially the length of niobium tube 46 within chamber 48 to shield the niobium inlead tube from attack by the arc constituents.

In FIG. 4, the coil turns are closed, i.e., adjacent turns of the coil touch each other. This is advantageous in the embodiment of FIG. 4 where protection of the niobium tube from chemical reaction with fill constituents is desired. Further protection of the niobium tube can be achieved by coating the tube with tungsten, such as by sputtering or chemical vapor deposition directly on the tube. Such a coating may be used in the embodiment of FIG. 3 for providing protection to the niobium tube.

FIG. 5 illustrates an alternate embodiment of the invention employing arc tube 64 having end wall 66 with a centrally disposed aperture having an annular channel therein. The aperture in end wall 66 is formed by two separate bores of respective diameters D1 and D2. Diameter D1 is larger than diameter D2 providing a shoulder in the bore at location 68. The helical tungsten coil 70, shown in cross section in the drawing, sits within the D1 bore against shoulder 68 and is wound about niobium tube 72, as illustrated in FIG. 5.

The bore in end wall 66 at diameter D2 may be but slightly larger, say, approximately .001 inches or less, than the outer diameter of the niobium tube so that there is only a slight clearance space between the niobium tube and the end wall. Tungsten coil 70 provides a gasket for blocking sealing glass 74 and preventing sealing glass 74 form flowing into the arc tube chamber. The embodiment of FIG. 5 includes alumina button 76. Sealing frit 74 extends into the channel defined by diameter D1 and extends to, but is blocked by, the left-most turn of helical coil 70.

Additional embodiments of the invention are described in FIGS. 6 and 7. In FIGS. 6 and 7, the same reference characters are used to identify parts previously identified in FIG. 4.

In FIG. 6, there is shown arc tube 40 with end wall 42 having aperture 44 for receiving niobium tube 46. Sealing disk 54 has centrally disposed aperture 55. In the embodiment of FIG. 6, diameter D3 represents the inner diameter of aperture 44, and dimension D4 represents the inner diameter of aperture 55. Diameter D3 is smaller than diameter D4 so that a shoulder at 45 is formed. Helical coil 80, shown in cross section in the drawing, is urged at one end against shoulder 45 and extends at the other end to the outside surface of sealing disk 54. Coil 80 may be a closed coil as shown.

Coil 80, contacting shoulder 45, forms a gasket to prevent sealing frit 56 from extending into aperture 44 at end wall 42. There is also glass sealing disk 54 and niobium tube 46. In the embodiment of FIG. 6, there are essentially two separate glass sealing frits 56 and 57 separated by coil 80. Frit 56 seals between end wall 42 and sealing disk 54, and frit 57 seals between sealing disk 54 and niobium tube 46.

FIG. 7 illustrates still a further embodiment of the invention also employing an arc tube 40, an end wall 42, an associated sealing disk 54, and glass sealing frit 56. Niobium tube 46 extends through apertures in both end wall 42 and sealing disk 54. Coil 82, shown in cross section in the drawing, extends the width of sealing disk 54 and further partially into the aperture in end wall 42. The aperture in end wall 42 is tapered at 43 so as to limit the inner position of the coil 82 within the aperture of end wall 42.

Glass frit 56 provides a seal between end wall 42 and sealing disk 54. Glass frit 57 provides a seal between the sealing disk 54 and niobium tube 46. The aperture in sealing disk 54 may be of a diameter to leave sufficient clearance space between the aperture and coil 82 so that some of the glass sealing frit extends into the aperture in sealing disk 54. The dimensions may be chosen so that there is a continuous glass sealing frit between locations 56 and 57. Because of the taper on the aperture at 43 in the end wall 42, the glass sealing frit will not extend beyond the right-most turn of coil 82. Thus, no sealing frit extends into the arc tube chamber.

While there have been shown and described what are at present considered the preferred embodiments of the invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the scope of the invention as defined by the appended claims.

Claims

1. A high-pressure discharge lamp comprising:

(a) an outer envelope:

(b) an arc tube mounted within said outer envelope hermetically enclosing an interior, said arc tube having a body and at least one end, said end being formed with an aperture;

(c) an inlead member adapted to be received by said arc tube end, said inlead member being mounted in said aperture and supporting electrode means within said interior;

(d) a fill within said interior, said fill being capable of sustaining an electrical arc therethrough;

(e) sealing glass disposed between said inlead member and said arc tube end such that a hermetic seal is attained, said sealing glass being subject to react chemically with said fill when exposed to said fill;

(f) a coiled wire disposed about said inlead member forming a gasket between said inlead member and said arc tube end aperture such that said sealing glass is shielded from said fill and from reacting with said fill; and

(g) means for structurally and electrically completing said lamp.

2. A high-pressure discharge lamp as described in Claim 1 wherein said arc tube is formed from polycrystalline alumina.

3. A high-pressure discharge lamp as described in Claim 1 wherein the inlead member comprises an inlead tube.

4. A high-pressure discharge lamp as described in Claim 3 wherein said inlead member is a niobium tube supporting a tungsten electrode.

5. A high-pressure discharge lamp as described in Claim 1 wherein said coiled wire comprises a helical coil of tungsten wire.

6. A high-pressure discharge lamp as described in Claim 1 wherein said coiled wire has a wire diameter of approximately 3.0 to 5.0 mils.

7. A high-pressure discharge lamp as described in Claim 1 wherein said coiled wire is wound with open turns.

8. A high-pressure discharge lamp as described in Claim 1 wherein said coil wire is wound with closed turns.

9. A high-pressure discharge lamp as described in Claim 1 wherein said inlead member comprises a cermet inlead.

10. A high-pressure discharge lamp as described in Claim 1 wherein said coiled wire is constructed of a material selected from as group consisting of molybdenum, tantalum, niobium, tungsten, and rhenium.

11. A high-pressure discharge lamp as described in Claim 1 including a protective coating deposited over said inlead member.

12. A high-pressure discharge lamp as described in Claim 1 including a disk mounted on said end of said arc tube, said disk having a second aperture for receiving said inlead member, said disk being sealed to said arc tube end and said inlead member by said sealing glass.

13. A high-pressure discharge lamp as described in Claim 12 wherein said coiled wire extends about the inlead member from a position at the arc tube aperture to a position covering substantially all of the inlead member extending into said interior of said arc tube.

14. A high-pressure discharge lamp as described in Claim 12 wherein said coiled wire extends about said inlead member substantially at said sealing disk aperture.

15. A high-pressure discharge lamp as described in Claim 12 wherein said coiled wire extends about said inlead member at both said sealing disk aperture and said arc tube end wall aperture.

16. A high-pressure discharge lamp as described in Claim 15 wherein the arc tube end wall aperture is tapered to prevent said coiled wire from protruding into said interior of said arc tube.

17. A high-pressure discharge lamp as described in Claim 15 wherein said arc tube end wall aperture has an internal annular channel for receiving said coiled wire and preventing said coiled wire from protruding into said interior of said arc tube.

18. A high-pressure discharge lamp as described in Claim 12 wherein said second aperture receives said inlead member, said coiled wire, and said sealing glass.

Fig. 1
(PRIOR ART)

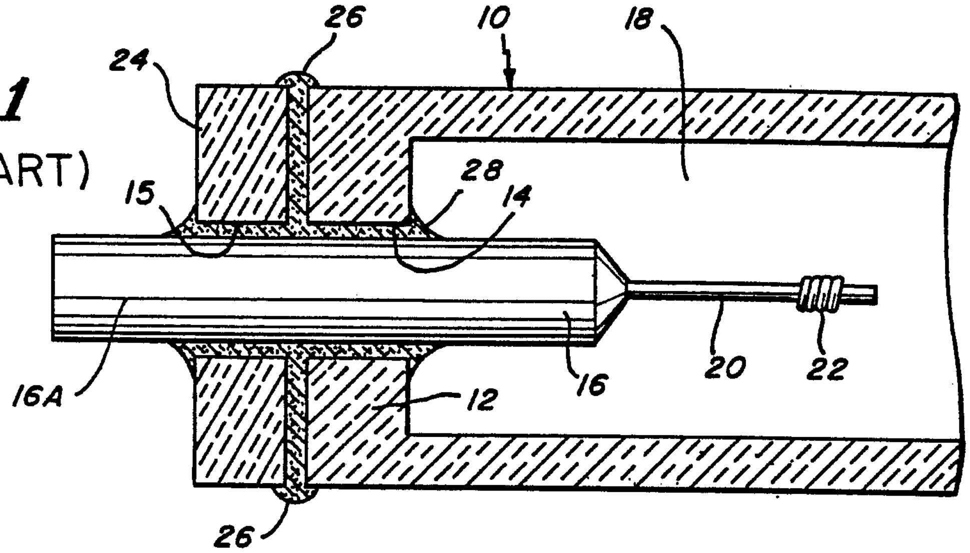


Fig. 2
(PRIOR ART)

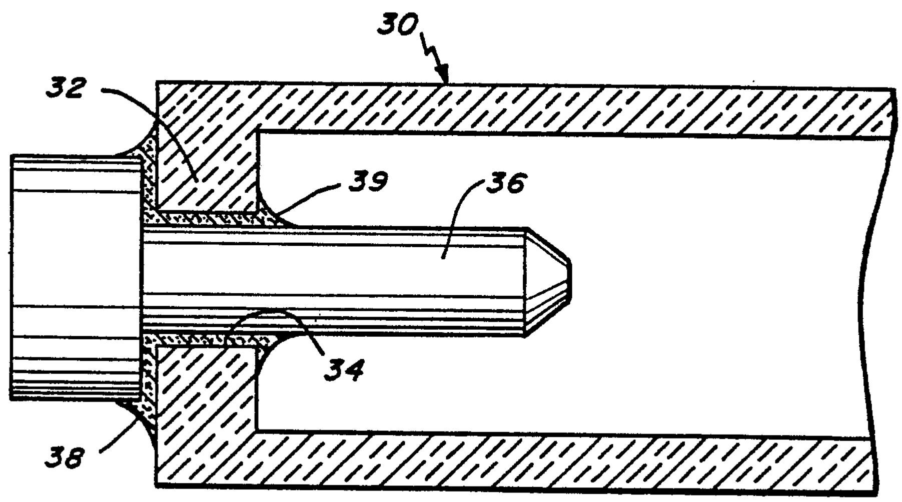


Fig. 3

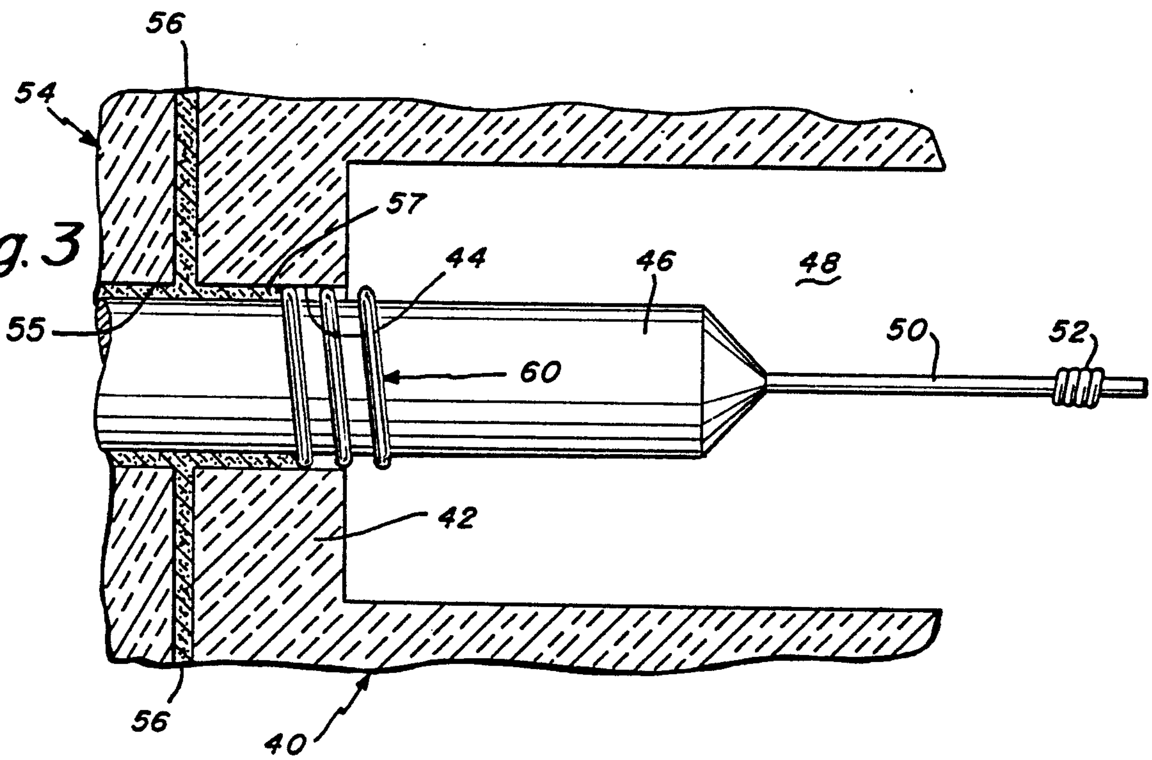


Fig. 4

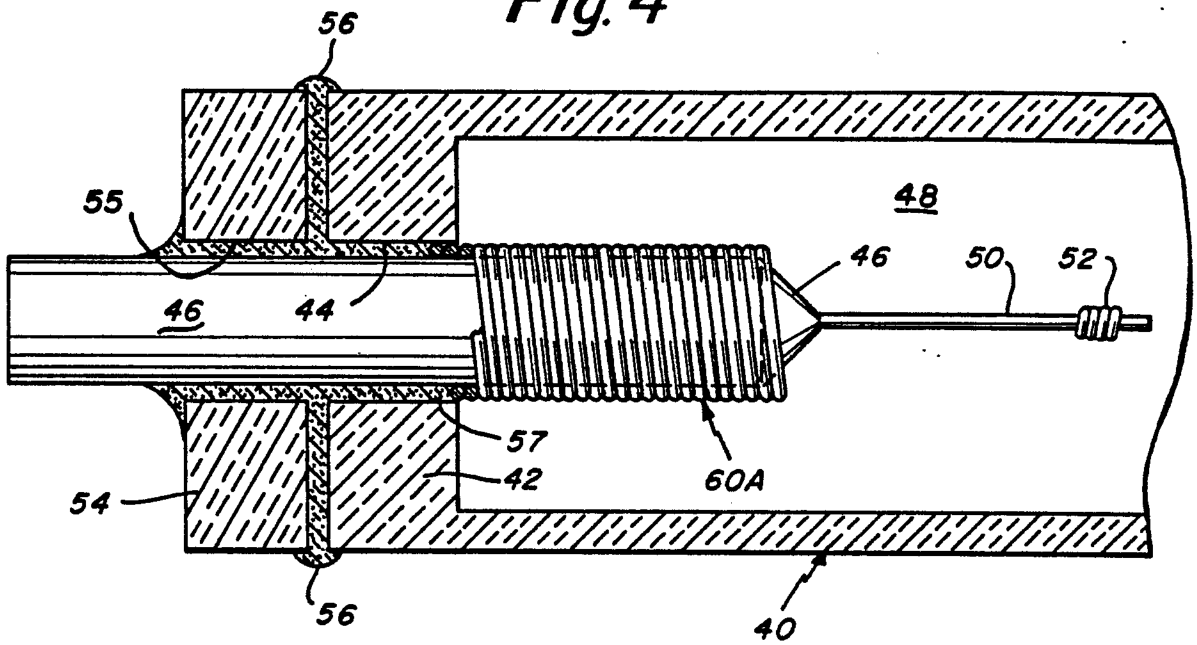

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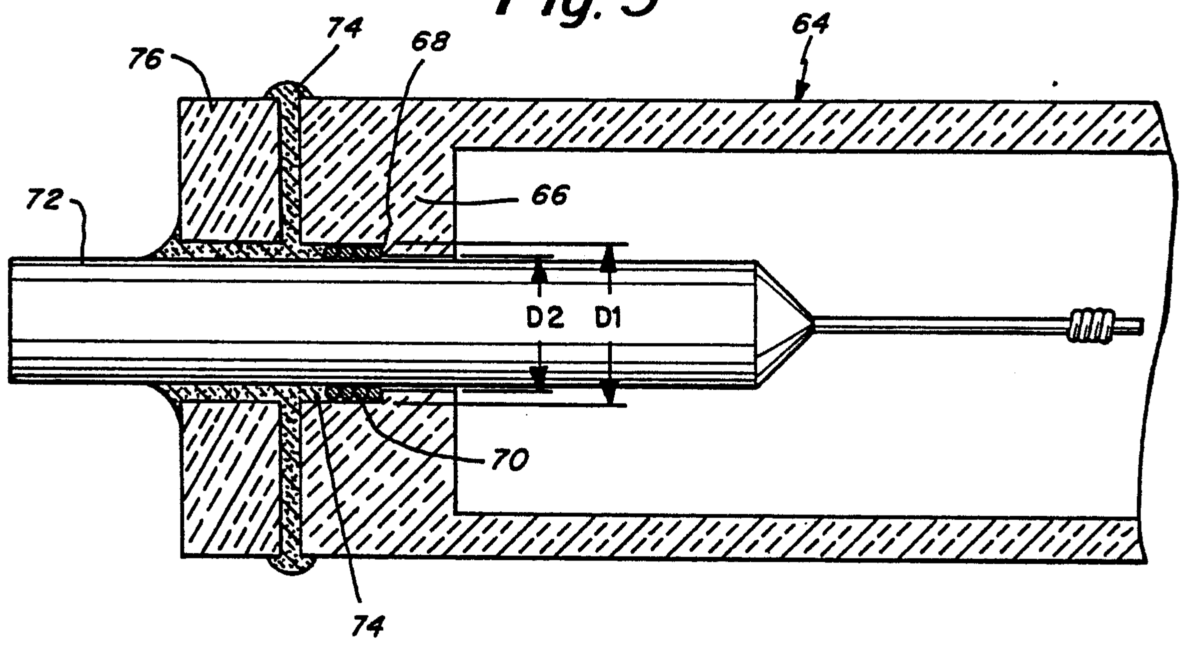
Fig. 5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D1
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Fig. 6

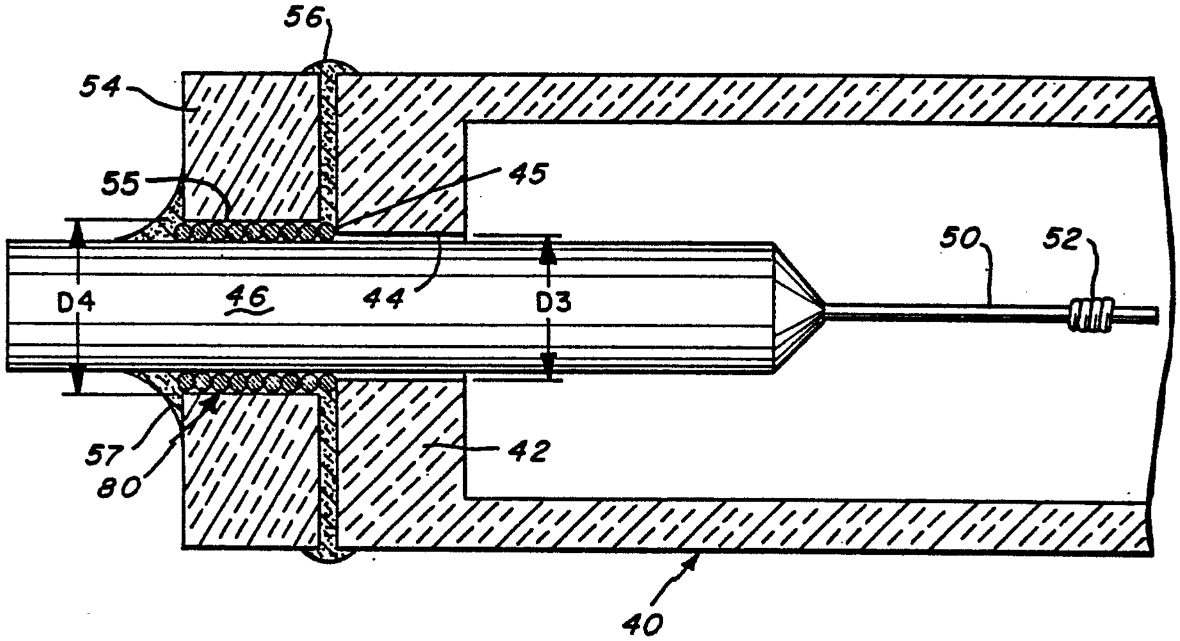

Fig. 7