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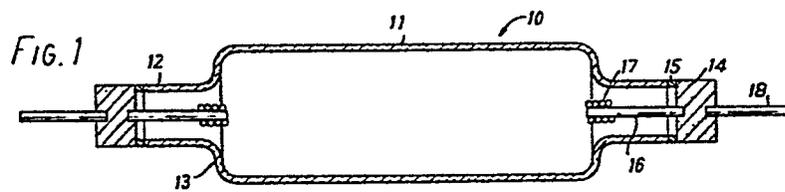
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(54) **Electric discharge lamps.**

(57) Arc tubes (10) for high pressure, metal halide, electric discharge lamps comprise a tube (11) of ceramic material, for example alumina, having end portions (12) of smaller cross-sectional area than the intermediate portion of the tube. Cermet end closures (14) of corresponding cross-section are sealed to the tube ends and carry electrodes (17) and leads (18) which are each inserted into an area of electrically conductive cermet to make connection between them. The reduced cross-section of the tube ends and closures reduces heat losses due to radiation and enables a higher 'cool spot temperature' to be maintained. It also minimizes loss of volatile substances during the operation of final sealing of the tube.

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ELECTRIC DISCHARGE LAMPS

This invention relates to electric discharge lamps and more especially to the provision of improved ceramic arc tubes for high pressure, metal halide lamps.

- Discharge lamps operating at relatively low
5. power but with high efficacy, for example low power, high pressure metal halide lamps, have of necessity a high power loading (watts per unit arc length) and a high power density (watts per unit arc tube volume). The arc tube walls consequently attain a high operating temper-
10. ature and silica is not a satisfactory material for the tube if the lamp is to have a long life. Ceramic materials, for example alumina, can withstand a high temperature, are chemically less reactive than silica, can easily be made in small sizes and are therefore
15. suitable for use in this type of lamp.

- One of the problems facing the designer of a high pressure metal halide lamp intended for operation at low power is that of achieving adequate partial pressures of the metal halides. This generally requires
20. a relatively high minimum arc tube temperature (cool spot temperature), which becomes progressively more difficult to achieve as the designed input power of the lamp is reduced. Heat conservation thus becomes increasingly more important as the desired operating power is reduced,
25. and these arc tubes are operated in evacuated outer envelopes or bulbs to reduce the loss of heat by conduction and convection from the surfaces of the tube. With these losses reduced to a minimum the main cause of heat loss is radiation from the hot arc tube.

30. The equilibrium temperature of any part of the arc tube is determined by the balance between the inflow and outflow of heat, and in regions remote from the discharge (for example, in the vicinity of the seals, where the cool spot is usually situated) heat losses are

due mainly to radiation, and increase with increasing temperature, surface area and emittance of the material employed. For example, in conventional fused silica arc tubes the large area of the pinch seals, which have

5. high emittance, limits the cool spot temperatures that can be attained. In the case of ceramic tubes, we have now found that cermet materials which may be used to seal the tube also exhibit high emittance, and notably a higher emittance than that of the ceramic materials

10. themselves.

A further problem in ceramic lamps of small dimensions is that of making the final seal without loss of volatile fill substances. Sealing involves heating parts of the arc lamp to a high temperature, perhaps

15. even above 1600°C , with the dose only about a centimetre away. We have found upon investigation that in the early stages of the sealing process the transfer of heat to the doses of volatile substances is mainly due to direct radiation from the heat region.

20. The present invention is concerned with the design of ceramic arc tubes in which heat losses from the tube ends are reduced and cool spot temperature increased. The invention is also concerned to provide arc tubes of ceramic material in which final sealing can be accomplish-

25. ed without loss of volatile substances, by reducing the transfer of heat to the substances from the heated region of the seal.

In accordance with the present invention we now provide an arc tube for a high pressure, metal halide,

30. electric discharge lamp comprising a tube of light-transmitting ceramic having end portions which are of smaller cross-sectional area than an intermediate portion and are adapted to be sealed to end closures of compatible cermet of corresponding diameter.

In accordance with one preferred embodiment of the invention, the intermediate portion of the tube is substantially cylindrical, and the end portions are substantially cylindrical and of smaller diameter, and are

5. connected with the intermediate portion by respective integral shoulder portions. In arc lamps of this form it is preferred that the electrodes should be carried on conductive supports of such lengths that the electrodes are disposed in the vicinity of the shoulder portions of

10. the lamp. The reduced cross-section of the end portions and the use of cermet closure plugs or caps of correspondingly reduced cross-section permits the reduction of radiative thermal losses and maintenance of the desired high cool spot temperatures.

15. According to a second preferred embodiment of the invention, the intermediate portion has a maximum diameter in the central region of the tube and tapers inwardly in both directions respective orifices of reduced diameter at the tube ends, to which the cermet

20. closures are sealed. This tapering form of lamp tube maintains a more nearly isothermal temperature distribution along its length.

In accordance with the third preferred embodiment of the invention, the intermediate portion is

25. substantially cylindrical, and the end portions are of integral shouldered form, terminating in respective orifices of reduced diameter to which the cermet closures are sealed. With this form of tube, it is preferred that the electrodes should be carried on short supports so

30. that they are located within the shouldered end regions of the tube. This form of tube requires suitably shaped end plugs of cermet material, for example as described in our German Specification OS 26 55 726, which are preferably sealed with the application of pressure in the

35. axial direction.

The principles of this invention are applicable

to any ceramic material suitable for the fabrication of arc lamp envelopes and to any cermet material suitable for use in end closures for such tubes. Examples of suitable ceramic materials include translucent poly-

5. crystalline and single crystal alumina ceramics, such as those available under the Trade Mark "STELLOX".

The arc tubes may be made in several ways. For example, the ceramic powder can be moulded and compacted to the desired shape, using a 'lost wax' process, prior to sintering. Alternatively, a 'green-state' or partly sintered tube can be machined to shape. Yet another, and simpler, method is to assemble apertured plugs at the end of a length of tube in the green state, giving a structure which will be integrated by sintering and may subsequently be trimmed.

15. Useful cermet materials, which may be conductive or may include integral conductive and insulating regions, may be made by compacting and sintering granules of refractory oxide, such as alumina, which have been coated with a metal such as tungsten, molybdenum or tantalum, e.g. by rolling in the metal powder. These cermet materials are described in our aforesaid German Specification 26 55 721, which also describes a variety of forms and shapes of arc tube end closures. The seals between the end closure of the tubes are preferably made with the help of sealing compositions such as those described in our co-pending British Applications 35720/78 and 40991/78, the latter published under the serial number 2 008 087. The materials of the former application are ceramic materials composed of a refractory oxide, such as alumina, with minor amounts of other oxides. The materials of the latter application are halide resistant glasses based on rare earth oxides, such as lanthanum oxide, with minor amounts of boric oxide and other oxides. These materials may conveniently be preformed into elements of appropriate shape.
- 20.
- 25.
- 30.
- 35.

In the accompanying drawings:

Fig. 1 is a diagrammatic section of a discharge lamp embodying the invention;

5. Fig. 2 is a similar section of a second embodiment;

Fig. 3 is a similar section of a third embodiment;

10. Figs. 4A and 4B are fragmentary views illustrating the fabrication of the tubes of Figs. 1 and 3 respectively; and

Fig. 5 is a fragmentary view showing the location of volatile substances during sealing of a lamp embodying the invention.

15. In Fig. 1, an arc tube 10 for a low power, high efficacy, metal halide discharge lamp comprises a substantially cylindrical main portion 11, which may, for example, be up to 2 cm in length. Respective cylindrical end portions 12 are connected with the main portion
20. 11 by integral shoulders 13: The arc tube is preferably composed of translucent alumina ceramic such as the 'STELLOX' material referred to above.

The tube may be fabricated by machining to shape a 'green' or partly sintered tube, or by a 'lost
25. wax' type of moulding technique in which the ceramic powder is compacted round a former which is subsequently removed by heating, burning or oxidation, as described in British Patents 1 360 340 and 1 443 741.

A simpler method of fabrication is illustrated
30. by Fig. 4A and involves the insertion of shouldered plugs 40 of partly sintered ceramic material powder into each end of a green-state parallel tube 11. The powders from which the plugs are made are chosen to ensure that the tube shrinks onto them during the final sintering process
35. and gives a vacuum tight join, as described in British Patent 1 196 899. The excess 41 at the ends of the tube can be trimmed off after the final sintering.

End caps 14 are sealed to the respective end portions 12 through the intermediary of a sealing composition 15. The caps carry conductive electrode supports 16 terminating in arc tube electrodes 17, which may be
5. of conventional type but preferably have a double overwind of tungsten wire (see Fig. 5), located in shouldered portions 13. The end closures 14 carry external electrical leads 18 which are preferably connected electrically to the supports 16 through conductive cermet material constituting or included in the end closure 14 as described in
10. our German Specification 26 55 726.

The sealing composition 15 may be a halide resistant sealing glass, in which case the cermet closure, the intermediary sealing material and the end of the tube
15. are heated to a temperature sufficient to cause the glass to soften and flow over the surfaces to be sealed. Application of light pressure helps to seal the cermet squarely on the tube end. Alternatively, the sealing composition may be a ceramic material based, for example,
20. on an oxide such as alumina, which can be fired, ground and pressed to form an annular sealing element for application to the tube ends, as described in the British Applications referred to.

In either case, the lower end of the arc tube
25. may be supported in a metallic holder, for example of copper, during the sealing process, which has the effect of conducting heat away from the tube end and thereby further reducing heating of the doses of volatile substances. The position of these doses in the tube end is
30. shown in Fig. 5, where the reference numerals correspond to those in Fig. 1. The cermet closure 14 differs from that in Fig. 1 in having a boss 42, on which the doses 43 rest during the operation of sealing the second tube end. The electrodes 17 have the double tungsten overwind
35. already referred to.

The end portions 12 of reduced cross-section and more especially the closures 14 of corresponding reduced cross-section reduce the radiative thermal losses from the tube ends and enable a relatively high spot temperature to be maintained. Furthermore, this structure of arc tube reduces the transfer of heat to dosed materials within the tube during the operation of sealing on the final end closure 14.

The arc tube 20 of Fig. 2 includes a central portion 21 of enlarged diameter which tapers towards both ends in regions 22 to terminal orifices 23 of reduced diameter. The ends are closed by cermet end caps 24 with the help of sealing material 25 and are provided with electrodes 26 and external electrical connections 27 as in the lamp of Fig. 1. The materials and techniques employed in the manufacture of this lamp may be the same as for the lamp of Fig. 1, and the tube may be either machined from a solid piece or moulded by the 'lost wax' process.

The shape of the arc tube shown in Fig. 2 enables a more nearly isothermal temperature distribution to be maintained along the length of the tube during lamp operation. The reduced diameter of the ends 23 and closures 24 have the same advantages as in the lamp of Fig. 1.

In Fig. 3, an arc tube 30 is substantially cylindrical throughout the greater part of its length but at its ends has shouldered regions 31 providing terminal orifices 32 of reduced diameter. The tube is closed by suitably shaped end plugs 33 which are sealed to the orifices 32 with the help of sealing material 34. Electrodes 35 are carried on very short supports or shanks and external electrical connections 36 are provided.

The tube 30 together with the shouldered regions 31 can be made by the 'lost wax' moulding process or, more simply, by inserting shaped and apertured end plugs

44 into the ends of a green-state tube prior to final sintering, as shown in Fig. 4B. After sintering, the ends can be trimmed and the external shoulder ground to a radius to follow the internal curvature.

5. In sealing the end plugs 33 to the ends of the arc tube 30, considerably greater pressure has to be applied to the cermet. However, the end plugs are preferably sealed to the tube 30 with the help of the ceramic sealing materials and techniques described in
10. Application 35720/78 which enable a lower sealing temperature to be employed, for example about 1200°C, while pressure is applied in the axial direction between the end plug and the arc tube. The lower temperatures employed help further to reduce the transfer of heat
15. from the region of the seal to dosed materials within the arc tube during final sealing.

- The invention is eminently suitable for use with lower power, high efficacy, metal halide lamps. The vapour fill for such lamps may be of a conventional
20. character and thus comprise an inert gas, such as argon, mercury and at least one metal halide, as well known in the art, to provide a modified or broadened emission spectrum. For example, the halides may comprise sodium and tin halides as described in our British Patent
25. 1 541 437 or, as an alternative, sodium and aluminium halides as described in our British Patent 1 444 023. The invention is of especial interest in the production of lamps of less than 250 watts power, for example, for domestic use and more particularly below 150 watts, for
30. example, about 100 watts.

CLAIMS

1. A high pressure metal halide electric discharge lamp having a ceramic arc tube characterized in that the end portions of the tube and cermet end closures sealed thereto are of smaller cross-sectional area than an intermediate portion of the tube.
- 5.
2. A lamp according to claim 1 characterized in that the intermediate portion of the arc tube is substantially cylindrical and the end portions are substantially cylindrical and of smaller diameter and are connected with the intermediate portion by respective integral shoulder portions.
- 10.
3. A lamp according to claim 2 characterized in that the electrodes are disposed in the vicinity of the shoulder portion at each end of the lamp.
- 15.
4. A lamp according to claim 1 characterized in that the intermediate portion has a maximum diameter in its central region and tapers inwardly in both directions to respective orifices of reduced diameter to which the end closures are sealed.
- 20.
5. A lamp according to claim 1 characterized in that the intermediate portion is substantially cylindrical and the end portions are of integral shouldered form and terminate in respective orifices of reduced diameter to which the end closures are sealed.
- 25.
6. A lamp according to claim 5 characterized in that the electrodes are disposed within the shouldered end portions of the tube.
- 30.

7. A lamp according to any preceding claim characterized in that the end closures are formed at least in part of electrically conductive cermet and the electrodes are mounted on supports which are fixed in
5. but do not extend completely through the conductive regions of the closures.
8. A lamp according to claim 7 characterized in that the conductive cermet contains tungsten and aluminium oxide in a volume ratio ^{of metal} not exceeding 0.076 and substantially matches the ceramic of the arc tube in thermal expansion properties.
9. A lamp according to claim 2 or 3 characterized in that the shoulder and end portions at each end of the lamp are constituted by respective integral ceramic disc and tube elements inserted and sintered into the intermediate portion tube.
10. 10. A lamp according to claim 5 or 6 characterized in that the shouldered portions are constituted by internally concave plug elements inserted and sintered into the ends of the tube.
25. 11. A ceramic arc tube for an electrical discharge lamp characterized in that the end portions of the tube are of smaller cross-sectional area than an intermediate portion and are adapted to be sealed to end closures of compatible cermet.

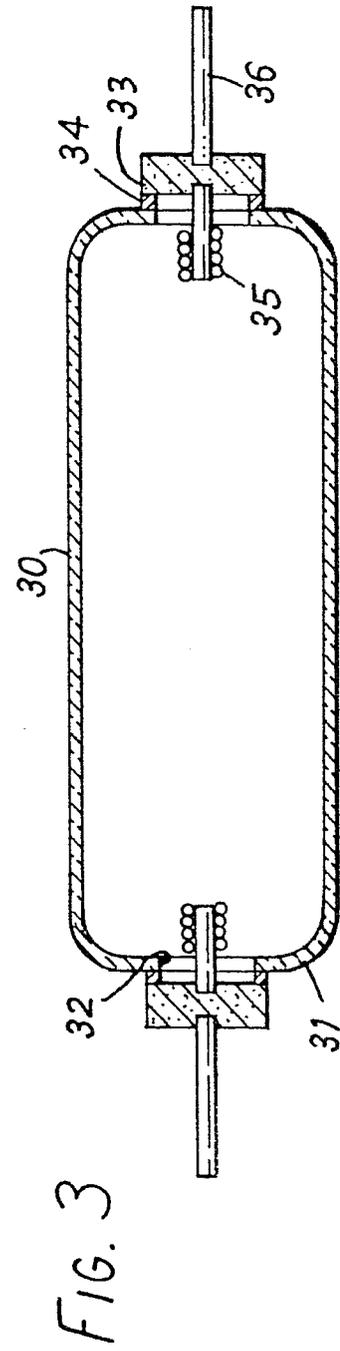
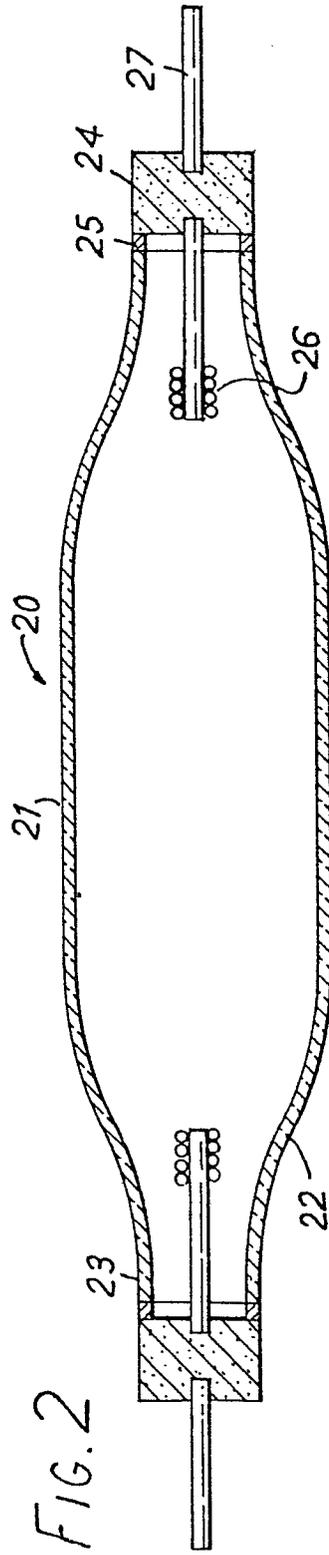
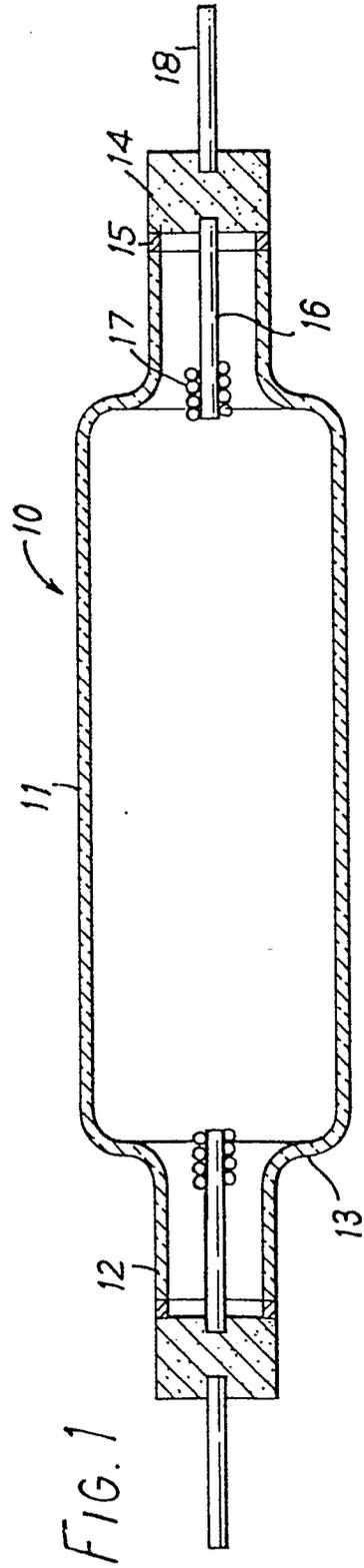


FIG. 4

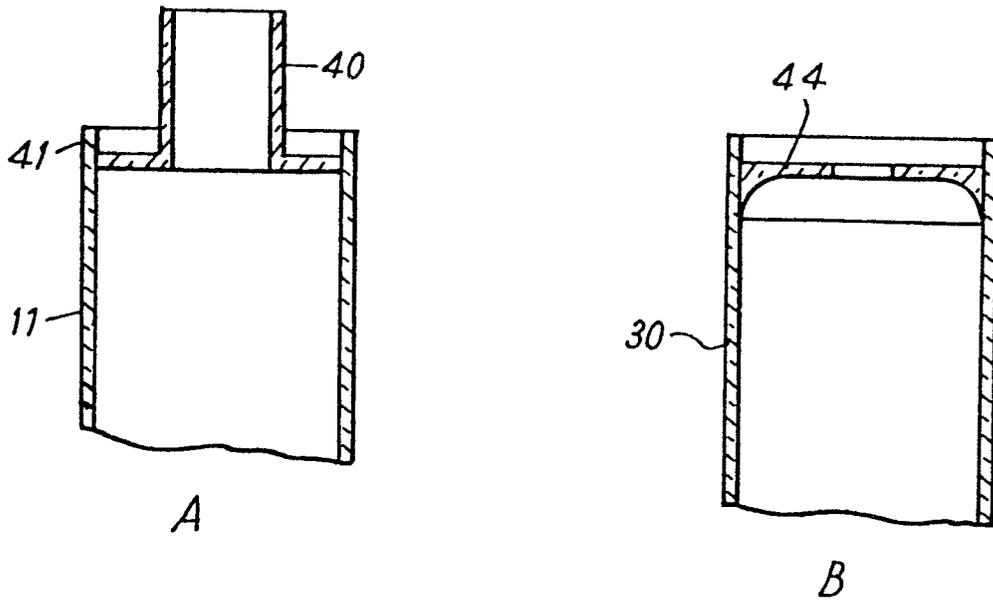
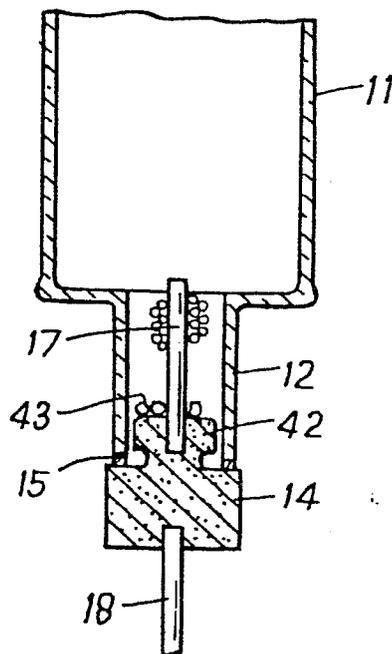


FIG. 5





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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim
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The present search report has been drawn up for all claims		TECHNICAL FIELDS SEARCHED (Int.Cl. 3) H 01 J 61/30 H 01 J 61/32 H 01 J 61/33 H 01 J 61/36 H 01 J 9/24 CATEGORY OF CITED DOCUMENTS X: particularly relevant A: technological background O: non-written disclosure P: intermediate document T: theory or principle underlying the invention E: conflicting application D: document cited in the application L: citation for other reasons &: member of the same patent family, corresponding document
Place of search	Date of completion of the search	Examiner
The Hague	15-02-1980	MAUGAIN



DOCUMENTS CONSIDERED TO BE RELEVANT		CLASSIFICATION OF THE APPLICATION (Int. Cl. ³)	
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
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