United States Patent [19]

Vause

[11] **3,885,186**

[45] **May 20, 1975**

[54] **LAMP CAP CONNECTIONS USING SUPERPLASTIC ALLOY**

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[22] Filed: **Apr. 1, 1974**

[21] Appl. No.: **457,064**

Related U.S. Application Data

[62] Division of Ser. No. 366,739, June 4, 1973, Pat. No. 3,818,558.

[52] **U.S. Cl.** ..... **313/318**; 339/275 T; 228/56

[51] **Int. Cl.** **H01j 5/54**; B23k 35/24

[58] **Field of Search** ..... 313/318; 339/275 B, 275 T; 29/628; 228/56

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[57] **ABSTRACT**

Electric lamps are disclosed having lead-in wires which extend out of the lamp envelopes and are connected to external electrical terminals, the terminals including hollow metal sleeves receiving the wires and the wires being joined thereto using alloys which exhibit superplastic behaviour, the alloys being heated, without melting, and caused to flow or creep superplastically into the sleeves and around the wires.

9 Claims, 4 Drawing Figures

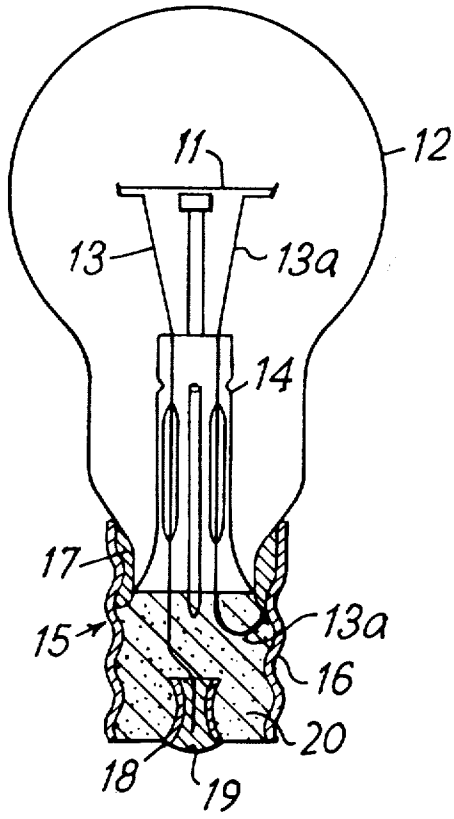


FIG. 1.

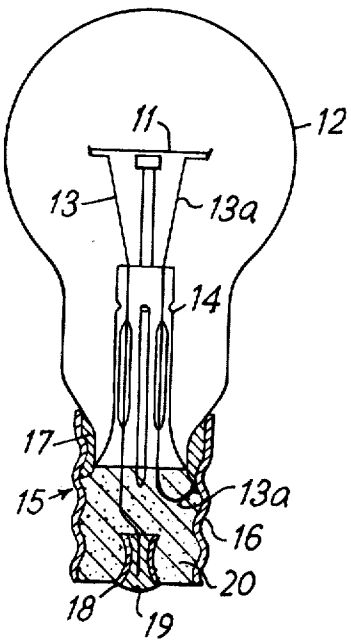


FIG. 2.

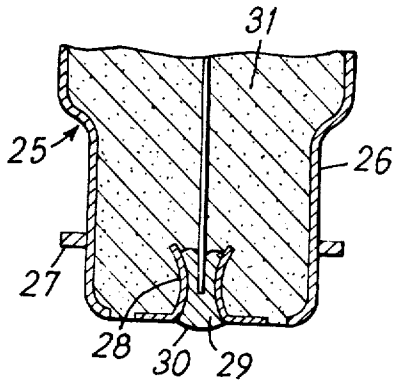


FIG. 3.

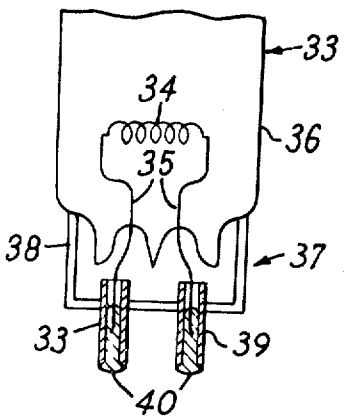
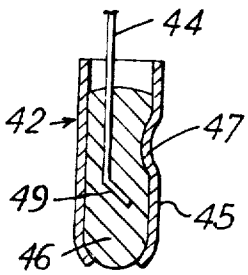


FIG. 4.



LAMP CAP CONNECTIONS USING SUPERPLASTIC ALLOY

This is a division of application Ser. No. 366,739, filed on June 4, 1973 now U.S. Pat. No. 3,818,558.

The present invention relates to improved lamps and particularly to improvements in lamp cap connections to lead-in conductors.

At some stage during the manufacture of an electric lamp it is necessary to make permanent electrical connections between a lamp cap or base and one or more lead-in conductors such as wires which extend into the interior of the lamp. The lead-in wire or wires may be connected to the shell of the cap, or to contact pads or to pin terminals with which the cap is provided, depending upon the form of the cap and the type of electrical socket which the lamp is intended to fit. The normal method of connecting lead-in wires to cap contacts involves soldering.

Soldering is not entirely satisfactory, however, and presents various problems both during manufacture and use, and can also impose limitations on the design of lamps and associated fittings. It can be extremely difficult to arrange that only just that quantity of solder needed to cover the lead-in wires and to form adequate connections is dispensed by automatic soldering machines. Furthermore, a flux normally has to be used when soldering. Fluxes are frequently corrosive and, when cold, may be in the form of hard, glassy substances. These characteristics of fluxes makes it relatively difficult and time consuming to maintain soldering machinery properly.

When in use, a lamp may be subjected to high temperatures which can cause softening of soldered connections. In turn, softening can lead to connections breaking and possibly to a lamp becoming soldered to the electrical socket itself. Another possible fault arising from the use of solder is that arcing between the socket and the lamp cap may arise, with consequent damage to both the socket and the lamp. The onset of arcing is encouraged by irregularities on the solder surface, and the occurrence of irregularities such as spikes of solder is difficult to prevent during automated manufacture.

The shells of lamp caps which form part of the conductive paths between the lamps and their sockets are commonly made of brass because it is easy to make soldered connections thereto. An example of such a lamp is one having an Edison screw-cap. Brass is expensive, however, and for this reason it would be preferable if aluminium could be substituted instead. Unfortunately, aluminium does not adequately lend itself to soldering in a simple and economical manner. There are many problems standing in the way of making intimate and durable electrical connections to aluminium lamps caps on high speed automated lamp-making machines.

In accordance with the present invention therefore, there is provided a method of finishing an electrical lamp which has a lead-in conductor sealed through the envelope of the lamp and terminating outside the envelope, wherein an electrical terminal is made by threading the outer end of the conductor into a hollow member which forms a well around the conductor, the lamp is inverted such that the well is uppermost, and an alloy capable of exhibiting the phenomenon of superplasticity is placed in the well and heated to a temperature,

below its melting temperature, at which it behaves superplastically to cause it to flow into a compact mass in intimate contact with the conductor. No flux is needed when carrying out the method source no melting is involved, and hence contamination of machinery and consequent difficult maintenance is avoided. Preferably, the hollow member forming the well has a reentrant portion serving to ensure that the mass of alloy is securely retained therein. If the method is applied to a general lighting service lamp bulb, the well can be formed directly in the body of insulation contained within the shell of an Edison screw or bayonet-type lamp base. Alternatively, the well is formed by a shaped metal ferrule which is embedded in the insulation. In lamps having post or pin terminals, the well is formed by a hollow metal sleeve element.

In practice, the superplastic material is given a preliminary heat treatment involving annealing and rapid quenching, to ensure that the material is in a condition in which it will be able to exhibit superplasticity. The material is then placed in contact with the two surfaces to be joined, i.e. a lead-in conductor and the well, and is then reheated. During this reheating, the material becomes superplastic and can then flow into intimate contact with the two surfaces. Thereafter, the temperature is reduced to ambient and it is found that a rigid joint is obtained possessing good electrical characteristics.

It is preferred to use an alloy consisting of 22% Aluminium and 78% Zinc for the bonding material. This alloy can be obtained from the Imperial Smelting Corporation (N.S.C.) Limited, Avonmouth and is Known by the terms "S.P.Z." and "Prestal." The alloy exhibits free flowing superplastics behaviour when its temperature is in the range of 250° to 275°C. After cooling from this temperature range, the alloy can only recover superplasticity if heated to a somewhat higher temperature range and then quenched rapidly. The higher temperature range is approximately 275° to 375°C. Accordingly, if a lamp embodying the invention is operated normally in a hot environment, the joint is not adversely affected. The reason is that once the material has been cooled from its superplastic condition during manufacture, it loses its superplasticity and this is not normally regained later under the usual heating conditions which the lamp in service undergoes. Superplasticity can only return after the material has been heated to a critical temperature range and then rapidly quenched — a thermal treatment which is not duplicated in service.

It has been found that the above alloy is capable of making strong, durable bonds to clean aluminium as well as brass. Aluminium is the preferred lamp cap material not only on the grounds of cost, but also because aluminium and the above alloy have similar thermal coefficients of expansion.

The invention will now be described by way of example with reference to the accompanying drawings, in which:

FIG. 1 is an elevational view, with parts in cross section, of a general lighting service lamp bulb,

FIG. 2 is a partial cross sectional view of a bayonet type lamp cap,

FIG. 3 is a fractional view of a fluorescent lamp with part shown in cross section, and

FIG. 4 is a cross section through a pin-type lamp terminal.

The invention is equally applicable to the manufacture of incandescent lamps and arc discharge lamps. A selection of lamps and lamp end fittings embodying the invention are shown in the drawings.

In FIG. 1, an incandescent filament lamp **10** is shown, having a filament **11** within an enclosing envelope **12.** The filament **11** is supported upon conductors **13, 13***a* embedded in a neck **14** which is sealed to an end portion of the envelope **12.** The conductors **13, 13***a* serve as lead-in wires for connecting the filament electrically to a supply, and are electrically connected to the two poles of an Edison screw lamp base **15.** The base **15** includes a metallic shell **16,** e.g. of brass or aluminium, which is bonded to the end portion of the envelope **12** with cement **17.** In this instance, one lead-in conductor, **13***a* is electrically connected to the shell **16** by being trapped between the upper rim thereof and the outside of the envelope **12.** The other lead-in conductor **13** is electrically connected to a metal ferrule **18,** e.g. of brass or aluminium, which is centred in the end of the lamp base **15.** The ferrule **18** can be an integral part of a sole plate. The electrical connection is way of a mass of superplastic alloy **19** filling the ferrule **18,** the conductor **13** being embedded in the alloy **19.** Instead of connecting the conductor **13***a* to the shell **16** as shown, it could be connected by means of superplastic alloy. In that case, the shell **16** would be provided with a cupped opening — similar in shape to the ferrule **18.** The conductor would then be threaded into the opening and secured thereto with a mass of the superplastic alloy. The lamp cap **15** is completed by a filling of a heat-resistant insulating material **20.** The material **20** can be a ceramic cement or a material such as "Vitrite," and serves to isolate the ferrule **18** electrically from the cap shell **16.**

It will be appreciated that the Edison screw lamp base **15** can be applied to other types of lamp, such as high performance, metal halide discharge lamps.

An alternative lamp base **25** is shown in FIG. **2.** This base **25** is a bayonet type, having a brass or aluminium shell **26** and bayonet studs **27.** Each of the two lead-in conductors **13** extends through the interior of the shell **26** and terminates inside a ferrule **28** at the outer end of the base **25.** The ferrule **28** is filled with superplastic alloy **29** and the conductor **13** is embedded therein. As shown, the surface **30** of the alloy **29** presents a smooth convex bulge for making contact with an associated sprung terminal inside a bayonet lamp socket. It will be realised that the second lead-in conductor and alloy-filled ferrule are located behind those shown in the sectional view of FIG. **2.** The conductors **13,** ferrules **28** and shell **26** are insulated from one another by a filling of temperature resistant insulating material **31.**

A discharge lamp embodying the invention is shown in FIG. **3.** The lamp **33** can be a metal halide arc discharge lamp or a fluorescent lamp. The exact form of the discharge electrode **34** will depend upon the design of the lamp, as is known, and does not form part of this invention. In this instance, the electrode **34** takes the form of a heater filament and is coated with an electron-emissive compound. It is supported on lead-in conductors **35** which are sealed through the end of an envelope **36** and enter a base or cap **37.** The cap **37** has a shell **38** and a pair of pin terminals **38** suitably secured thereto and insulated from one another. Each pin terminal consists of a hollow sleeve within which one of the conductors **35** terminates. The sleeve is filled with superplastic alloy **40** which surrounds the conductor **35** and joins it mechanically and electrically to the sleeve. To assist entry of the alloy **40** into the sleeves during manufacture, the free, lower ends of the sleeves have internally-flared mouths as shown.

A rather differently formed pin or post terminal **42** is shown in FIG. **4.** Such a terminal is suitable for use in automobile lamps, projector lamps and high power incandescent or discharge lamps. The lead-in conductor **44** enters and terminates in a hollow metal sleeve **45,** the interior of which is filled with superplastic alloy **46.** As shown, the wall of the sleeve **45** has a dimple forming a re-entrant portion **47.** This re-entrant portion is similar to the concavely-shaped ferrules **18,28** shown in FIGS. **1** and **2,** and likewise serves to key the alloy firmly inside the sleeve. The strength of the joint is enhanced by forming a bend, kink or similar irregularity **49** at the end of the conductor **44.**

Manufacture of lamps embodying the invention is as follows. The filaments or discharge electrodes are attached to lead-in conductors and are then sealed into their lamp envelopes using standard techniques. Gas-filling and exhaustion of the envelopes likewise is carried out using well known techniques. The outer ends of the lead-in conductors are then threaded through hollow metal elements **18,28, 39,45** which are preferably so shaped as to provide mechanical keying of the superplastic alloy which is subsequently admitted into the hollow metal elements. The inner ends of these elements **18,28, 39,45** are preferably closed, either by Vitrite **20,** as in FIGS. **1** and **2,** or by being sealed directly into the envelope. The partially-finished lamps are then inverted from their positions shown in the accompanying drawings, and the superplastic alloy is then inserted into the said hollow elements **18,28,39,45** which form wells surrounding the conductors. The alloy is introduced in the form of wire, strip or pellets, and sufficient is used to ensure that it just fills or slightly overfills the space around the lead-in conductor. The hollow element and alloy are then heated to the temperature at which the alloy exhibits superplasticity, whereupon it flows or creeps into intimate contact with the conductor and the inner contour of the hollow element, thereby forming a secure joint.

The preferred alloy consists of 22% aluminium - 78% zinc. This alloy is able to exhibit superplasticity after an initial heat treatment or anneal between 275° and 375°C, followed by rapid quenching. This treatment results in a very fine-grained duplex microstructure. When the alloy is in this state, subsequent heating to 250° to 275°C (in the neighbourhood of the eutectoid transformation) results in easy viscous flow. Upon slow cooling to room temperature, e.g. in air, the microstructure coarsens with gram growth. Subsequently no superplastic behaviour is observed, unless the alloy is reheated to 275° to 375°C followed by rapid quenching.

It is found convenient to heat the alloy pellets by focussed infra-red radiation, and to press the heated alloy gently into the hollow metal element. This facilitates flowing of the alloy into the said element. Instead of pressing the alloy, one could employ suction in suitably designed lamps. The resulting joint is particularly strong, and its strength is enhanced by ensuring that the hollow element and the conductor are clean and free from grease and foreign particles.

Micrographic examination of sections through alloy-filled brass or aluminium hollow elements shows that a very smooth, continuous and intimate interface forms between the alloy and the neighbouring surface.

Other alloys which exhibit superplasticity may be used. Alloys which flow at temperatures in the range of 200°–500°C may be used, and those which flow when heated to 250°–300°C are preferred for convenience in manufacture. Examples of suitable alloys are given in the following table.

ALLOY	SUPERPLASTIC TEMPERATURE OR TEMPERATURE RANGE.
1. Al-33% Cu	445°–530°C
2. Al-12% Cu	500°C
3. Al-12% Si-4% Cu	500°C
4. Mg-33% Al	350°–400°C
5. Mg-30% Cu	450°C
6. Mg-23% Ni	450°–475°C
7. Mg-0.5% Zr	500°C
8. Mg-6% Zn-0.5% Zr	270°–300°C
9. Zn-5% Al	285°C
10. Zn-40% Al	250°C

The percentages given in this specification are percentages by weight.

In some alloys, superplasticity may re-appear after cooling, upon subsequent heating. To prevent this occurring during service, the alloy should be heat-treated after it has filled the hollow element and formed the joint. Such a treatment consists of an anneal at a temperature high enough and for a duration long enough to yield a coarse grained microstructure.

Whilst the embodiments shown in FIGS. **1** and **2** have hollow metal sleeves or ferrules **18, 28** containing the alloy, the ferrules could be omitted. Then, the ceramic or Vitrite **20** would be formed with a contoured opening to form a well for containing the alloy **19,** which would be in direct contact therewith. The contour of the opening should have a re-entrant to ensure that the bead of alloy is firmly held in place. In such a modification, it would also be desirable for the conductor **13** to possess an irregularity such as a lobe or kink.

I claim:

1. An electric lamp having an hermetically-sealed envelope through which a lead-in conductor is sealed, said conductor terminating outside said envelope and said conductor being embedded in a mass of an alloy which is capable of exhibiting superplastic properties, said alloy forming an electrical terminal.

2. A lamp according to claim **1,** wherein said alloy is contained within a well having a re-entrant wall portion.

3. A lamp according to claim **1,** wherein said well is defined by a hollow metal ferrule.

4. A lamp according to claim **1,** wherein said lamp has a base attached to said envelope, said base comprising a shell, a body of insulating material inside said shell, said conductor extending through said insulating body and entering a hollow metal ferrule defining said well said ferrule being located at the end of said base remote from said envelope, and said ferrule containing a mass of said alloy forming a joint between said ferrule and said conductor.

5. A lamp according to claim **1,** wherein said conductor enters and terminates within a hollow metal sleeve, said alloy filling said sleeve and forming a joint between said sleeve and said conductor, said sleeve constituting a pin terminal.

6. A lamp according to claim **5,** wherein said sleeve has a reentrant portion, and the end of said conductor has an irregularity therein.

7. A lamp according to claim **1,** wherein said alloy is one which is capable of exhibiting superplastic behaviour at temperatures within the range 200°–500°C.

8. A lamp according to claim **7,** wherein said alloy is one which is capable of exhibiting superplastic behaviour at temperatures within the range 250°–300°C.

9. A lamp according to claim **8,** wherein the composition of said alloy is 22 weight % aluminium - 78 weight % Zinc.

* * * * *