HEAT DISSIPATING ELECTRIC LAMP ASSEMBLIES

Filed Feb. 3, 1966 3 Sheets-Sheet 1

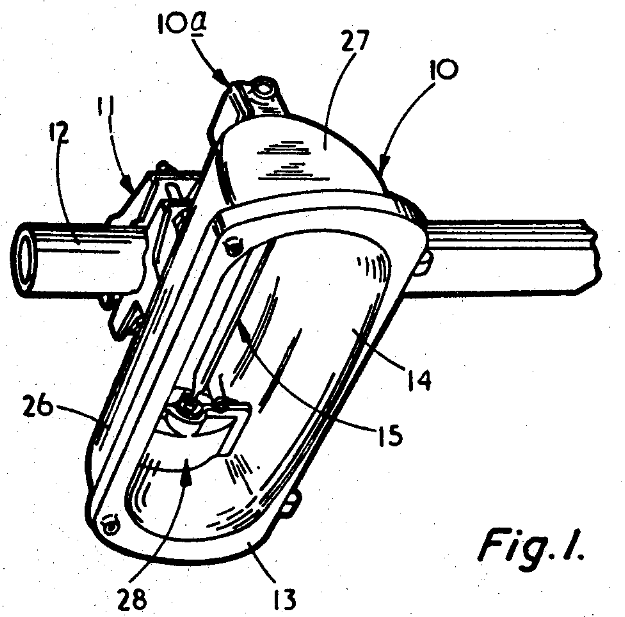

Fig. 1.

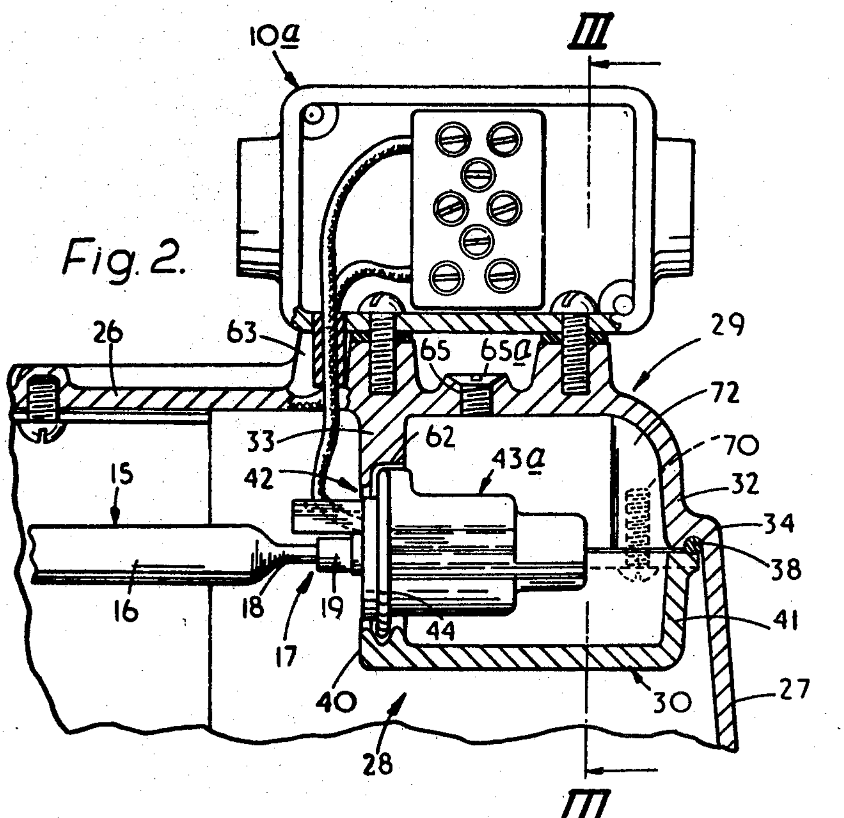

Fig. 2.

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HEAT DISSIPATING ELECTRIC LAMP ASSEMBLIES

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Fig. 3.

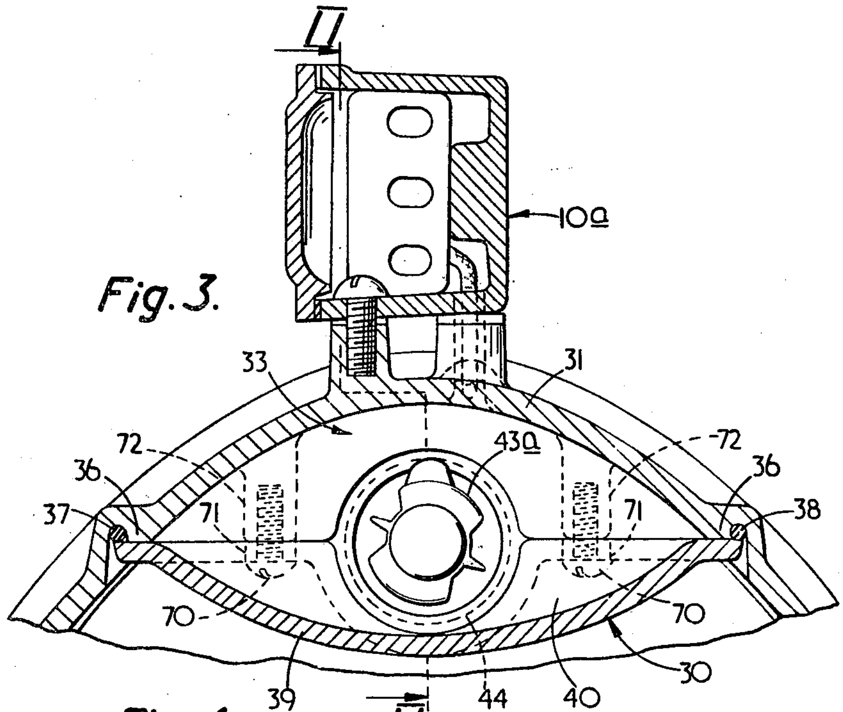
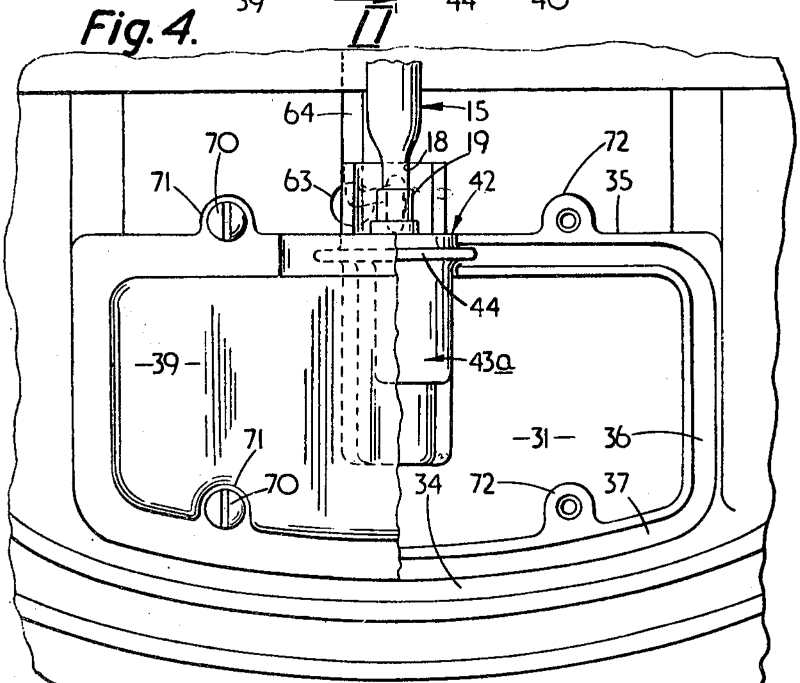


Fig. 4.



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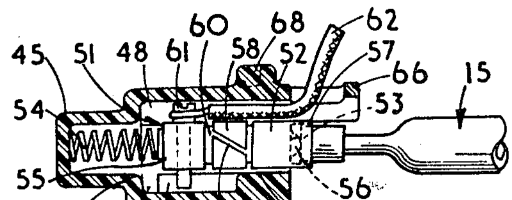

Fig.5d.

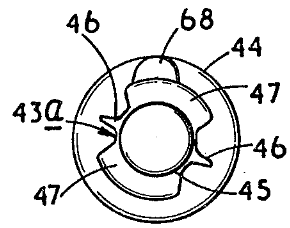

Fig.5a.

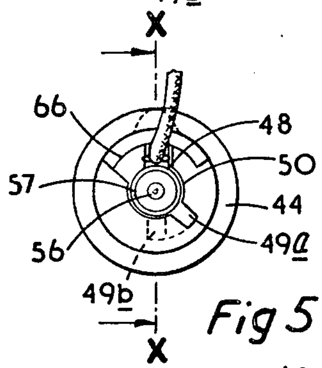

Fig 5.c.

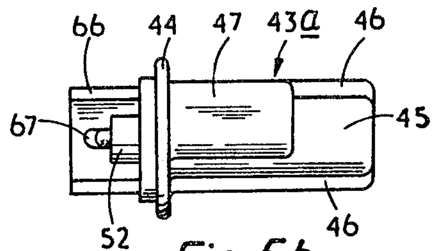

Fig.5b.

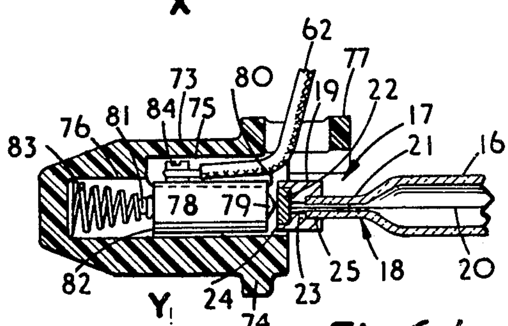

Fig.6d.

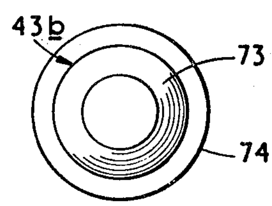

Fig.6a.

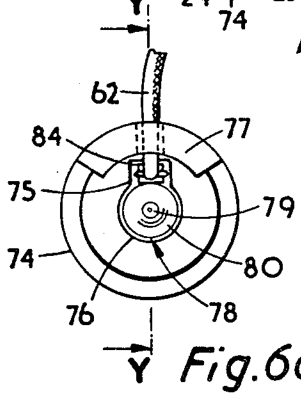

Fig.6c

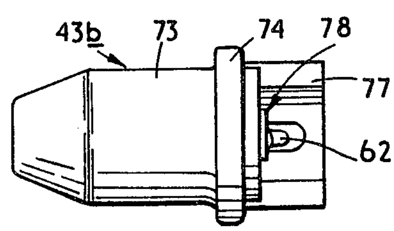

Fig.6b.

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3,390,373
HEAT DISSIPATING ELECTRIC LAMP ASSEMBLIES

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Claims priority, application Great Britain, Feb. 11, 1965, 5,896/65
4 Claims. (Cl. 339—112)

ABSTRACT OF THE DISCLOSURE

A heat dissipating lamp assembly wherein, to provide for dissipation of heat from the lamp proper, an electric contact member which co-operates with a contact of the lamp proper, is slidably disposed in a sleeve and maintained in good thermal contact therewith by a resilient metal element acting between the contact member and the sleeve, the sleeve itself being disposed within a chamber defined by a housing having a greater surface area than the contact member and containing a heat transfer substance which is liquid at least at the operational temperature of the assembly to maintain good thermal contact between the sleeve and the housing.

This invention relates to electric lamp assemblies (herein referred to as being of the kind specified) comprising an electric lamp proper having a transparent envelope and an electrically energised light producing medium therein and connector means including conductors emergent from the envelope at one or more positions thereon, and an appropriate number of lamp holders including connector means which co-operate with that or those of the lamp proper to enable electric current to be supplied to the light producing medium.

The invention has been developed in relation to, and is applicable primarily but not exclusively to, lamp assemblies of the kind specified which are required to be operated at not less than a predetermined temperature, and wherein the light producing medium of the lamp proper includes a metal filament and a gaseous or vapourised substance contained in the envelope which in combination establish a light source when the filament is energised by electric current. Because of this minimum temperature condition, which inevitably sets up a high temperature in the envelope and connector means, special problems are created in maintaining a satisfactory seal between the conductors of the connector means on the lamp proper and the envelope thereof. In one such form of lamp, having a tungsten filament in an envelope containing iodine vapour, the predetermined minimum temperature of operation is about 200° C. Under operating conditions the surface temperature of the envelope of this lamp is appreciably higher than this value and may be in the region 450° C. However, at the latter temperature failure of the envelope can occur where the conductors of the connector means emerge through the envelope. In practice, for satisfactory working life, the envelope is required to be maintained at a temperature not substantially exceeding 300° C., in the regions surrounding the emergent conductors. Another type of lamp in connection with which the invention may advantageously be used is the "discharge" type, which also reach high temperatures during prolonged operation.

The object of the invention is to avoid or reduce these difficulties in lamp assemblies of the kind specified.

The invention resides in the provision of a lamp holder for use in a lamp assembly of the kind specified, such holder comprising the combination of an inner member

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formed of an electrically conductive material for engaging the connector means of the lamp proper, an outer member affording a larger surface area than the inner member to promote dissipation of heat, and a heat transfer substance which is in liquid form, at least at the temperature of operation of the assembly, disposed between the inner and outer members to provide a heat conducting path from the former to the latter.

Preferably, the outer member comprises a hollow housing which defines a chamber in which the heat transfer substance is disposed, and the inner member is disposed in the interior of an open-ended cavity or recess formed in a sleeve which extends from one side of the housing into the chamber and is open at its outer end, the inner member being maintained in contact with the inner surface of the sleeve so as to conductively transmit heat to and through the latter, to the heat transfer substance and thence to the housing which forms the outer wall of the chamber.

The sleeve may be made of a ceramic material so as to be capable of withstanding the temperature involved and preferably the material is chosen to have a relatively high thermal conductivity, a suitable material being an alumina ceramic. This provides the requisite electrical insulation between the inner member and the housing which forms the outer member of the holder and has a higher thermal conductivity than many ceramic materials commonly used as electrical insulators. Alternatively, a plastics material having generally similar properties may be employed, for example a moulded or fabricated polytetrafluoroethylene (such as I.C.I. "Fluon") or a high silicone content heat resistant plastic. Moulded borosilicate or silica-quartz glass could also be used.

The heat transfer substance is selected to exist in liquid phase at the temperature of operation so that despite fairly wide dimensional tolerances which are inherent in the sleeve when the latter is made of a ceramic material, and/or despite intricacies of shape which it may be convenient to impart to the outer member to facilitate its combination or assembly with other components such as a reflector extensive physical contact will be maintained between the heat transfer substance on the one hand and the sleeve and housing on the other hand. It will be appreciated that the use of a heat transfer substance which is liquid at the operating temperature avoids voids or air spaces which would form barriers to the outward transmission of heat and which are inevitably present in particulate solids.

The heat transfer substance is preferably characterised by having a freezing or crystallisation point which is lower than the normal minimum ambient temperature to which the lamp assembly is to be exposed in use and a boiling point which is appreciably higher than the highest working temperature attained by this substance during the operation of the lamp. The substance is also selected to be chemically and physically stable throughout this range of temperature and to be inert with respect to other materials required to be utilised to form the sleeve and the housing, namely ceramic or plastic materials, and suitable metals for the housing such as aluminium and alloys thereof.

One heat transfer substance which meets these requirements is that manufactured and sold by I.C.I. Limited under the designation "Ether 710," this being a mixture of branched-chain dialkyl ethers which exists in liquid phase between −60° C. and +260° C. and has the requisite physical and chemical stability and inertness with respect to the materials previously mentioned. A second suitable substance, also manufactured and sold by I.C.I. Limited, is that designated "Thermex." This is an eutectic mixture of diphenyl oxide and diphenyl, which exists in liquid phase from 12° C. to 260° C.

A third substance, also manufactured and sold by I.C.I. Limited, which is suitable although less advantageous in view of its higher cost, is that designated "Silicone Fluid DP. 190." This contains methyl phenyl silicones and exists in liquid phase from 16° C. to approximately 600° C. In spite of its higher cost, this has the additional advantage that its boiling point is very much higher than the highest temperature likely to be obtained in the housing even if the lamp is misused. Thus there is a wide safety margin before the vapour pressure of this substance attains a value which is likely to disturb the seal between the sleeve and the housing.

A further suitable substance is that manufactured and sold by I.C.I. Limited under the designation "Cassell TR. 155 Heat Transfer Salts." This is a eutectic mixture of sodium nitrite, sodium nitrate and potassium nitrate which "melts" at 143° C. and is effective from 155° C. to 540° C.

The invention will now be described by way of example with reference to a specific construction in accordance therewith as shown in the accompanying drawings wherein:

FIGURE 1 shows a perspective view of a lamp assembly incorporating a lamp holder in accordance with the invention.

FIGURE 2 shows a part sectional elevation of the lamp holder on the line II—II of FIGURE 3.

FIGURE 3 shows a transverse section on the line III—III of FIGURE 2.

FIGURE 4 shows a partially cut-away underneath plan view of the lamp holder.

FIGURES 5*a* to *d* show respectively a sleeve incorporated in the holder in rear elevation, underneath plan view, front elevation and, longitudinal cross section on the line X—X of FIGURE 5*c*, and

FIGURES 6*a* to *d* show a modified form of sleeve in views similar to those of FIGURES 5*a* to *d*.

In this construction the lamp assembly comprises a casing **10** provided with a clamp **11** for attachment to a suitable supporting member **12**, and a hinged front frame **13** having a window **14** of toughened boro-silicate glass. A terminal box **10***a* is also provided. Inside the casing there is a lamp proper **15** having a transparent envelope **16** formed from silica, silica quartz or boro-silicate glass, such envelope being of tubular form and containing an axially extending tungsten filament **20** connected at each end to a connector means **17** including an axial conductor wire **21** emergent through the end of the envelope **16**. At each end the envelope is pinched in to produce a flat plate-like portion **18** through which the conductor extends, such conductor being connected electrically at the end of the envelope to a metal end cap **22** forming a contact.

The flat plate-like portion **18** at each end of the envelope is protected by an overlying thimble **19** of a ceramic material such as porcelain. The thimble **19** (see FIGURE 5*d*) is of cylindrical shape externally and has part of its length of an internal cross sectional shape corresponding to the external cross section shape of the flat plate-like portion **18** of the envelope so as to provide a recess **25** which fits closely thereon. The remaining part of the thimble **19** which projects axially beyond the envelope **16** incorporates a smaller axially extending bore **23** for the passage of the conductor **21** terminating in a larger diameter cylindrical recess **24** in the outer end face of the thimble **19** in which is accommodated the metal end cap **22** forming the contact.

The lamp **15** is of the type containing iodine vapour which in combination with the tungsten filament **20** provides exceptionally high intensity illumination source at temperatures of above 200° C. It is necessary however, for the flat plate-like portions **18** of the envelope **16** to be maintained at a temperature not exceeding about

300° C. in order to avoid failure of the hermetic seal formed between the material of the envelope and the axially projecting conductor wires **21** leading to the contacts **22** of the lamp at each end thereof.

The casing **10** of the lamp assembly comprises a trough-like body made of a suitable metal such as aluminium alloy, having a curved wall **26** integrally joined to end walls **27**, the assembly normally being positioned with the open side of the trough-like body downward when the lamp assembly is suspended from a ceiling or other member as in FIGURE 1.

The lamp proper **15** is disposed in this body with its longitudinal axis extending longitudinally of the longer dimension of the body and with the lamp situated centrally near the curved wall **26** of the body, the lamp proper **15** being supported at each of its ends from holders **28** constructed in accordance with the invention as now described.

Each of these holders **28** comprises an outer member formed in two parts one of which **29** is integral with the body and is disposed uppermost when the body of the assembly is in its normal working position with the mouth presented downwardly and the other of which is a structurally separate cover part **30**.

The part **29** of the housing is constituted by a generally rectangular portion of the trough-shaped body as seen in underneath plan view (FIGURE 4), typically occupying about one half of the width thereof or rather more. This part **29** is bounded laterally by a part **31** of the curved wall **26** of the body, a part **32** of the end wall **27** of the body and an inner wall **33** projecting downwardly from the curved wall **26** and extending generally parallel to the end wall **27**. The part **32** of the end wall **27** of the body at its lower edge presents a step or ledge **34** on the same level as the lower edge **35** of the inner side wall **33**.

The ledge **34** is continued at each end along the curved wall **26** at the same level to form ledges **36** and the ledges **34**, **35** and **36** are formed with a groove **37** in which a sealing ring **38** or a sealing compound is seated.

The cover part **30** of the housing is of similar shape and dimensions to the part **29** as viewed in plan and is generally part cylindrical in form, comprising a curved wall **39**, inner end wall **40** and an outer end wall **41**. The upwardly presented edge faces of these walls **39**, **40**, **41** abut the ledges **34**, **35** and **36**. The two parts of the housing **28** are secured together by means of screws **70** passing through apertures in projecting lugs **71** around the cover part **30** into corresponding bosses **72** formed on the other part **28**.

The depth or height of the housing may vary as required, but typically it is about one-third the total depth of the trough-shaped body whilst longitudinally each housing may occupy about one-fifth or rather less of the total length of the trough-shaped body.

The inner side walls **33** and **40** of each housing define in combination a wall presented towards the centre of the trough-shaped body and are each formed with semi-circular cut-outs which together provide an aperture **42** to receive an open-ended sleeve **43***a* or **43***b* which is closed at its inner end. The aperture **42** which is formed partly in the part **29** of the housing and partly in the cover part **30** has the groove **37** hereinbefore referred to extending around its boundaries so that the sealing ring is in contact peripherally with the sleeve. The latter may, as shown in FIGURES 1 to 5, incorporate a radially projecting rib **44** which engages in the groove to some extent so as to provide cantilever support for the sleeve so that the latter is supported securely within the chamber afforded by the housing in spaced relation to the upper and lower walls **31** and **39** thereof with its inner end spaced from the end walls **32**, **41** of the housing.

The sleeves **43***a* and **43***b* are formed of a ceramic material having good electrically insulating properties and good thermal conductivity preferably an alumina ceramic.

A typical alumina ceramic suitable for the purpose is that known as Mazalumina manufactured and sold by Ferranti Porcelain Company Limited. This material has a dielectric strength of 490 k.v. per cm. impulse at 50 cycles per second, a volume resistivity of between 4×10^{14} ohm-cm. at 200° C. to 3×10^{13} ohm-cm. at 300° C. The approximate thermal conductivity is 0.045 cal. cm./sec. $cm.^2$ ° C. Other ceramics or plastics having similar properties could be used if desired.

The sleeve, in one form (shown in FIGURES 1 to 4 and more particularly in FIGURES *5a* to *5d*) incorporates a portion **45** of generally cylindrical cross section externally and internally. At diametrically opposed positions on its external face it incorporates radially projecting fins **46** extending the surface area presented externally of the sleeve.

For approximately two-thirds of its length from the open end the sleeve **43*a*** also incorporates, at two diametrically opposed positions centered on a diameter at right angles to that on which the external ribs **46** lie, radial enlargements **47** of its cross section, these being of generally sector shape externally as can best be seen in FIGURE *5a*. Internally the enlargements **47** are each formed with axially extending grooves **48** and **49** respectively which open out internally into a main cylindrical bore **50** which extends from the mouth or open end of the sleeve. One of the grooves, that indicated by the reference numeral **48**, is wider than the other measured circumferentially of the sleeve-like member, and is of simple parallel sided form from end to end. The other, narrower, groove **49** comprises two legs **49*a*** and **49*b***, of which one (**49*a***) extends for the whole length of its radial enlargement **47** and opens at one end into the mouth or open end of the sleeve **43*a***. The other leg **49*b*** is shorter and parallel to the first leg **49*a*** and is connected to it at its inner end remote from the open end or mouth of the sleeve so that the two legs form one component of a bayonet type fastening.

Disposed within the sleeve **43*a*** is an inner body **51** of composite form comprising a generally cylindrical contact block **52** formed of a copper alloy capable of withstanding the working temperature attained in the housing **28** and arranged with its forward end face **53** coincident or approximately coincident with the mouth of the sleeve **43*a*** and engaged with the metal contact **22** of the lamp proper. A coiled cylindrical compression spring **54** disposed in the rear portion of the sleeve adjacent to its closed or blind end acts between this end and the inner end **55** of the contact block **52** to urge the latter towards the mouth of the sleeve. A suitable metal for the contact blocks is a cadmium-copper alloy.

The forward end face **53** of the contact block **52** includes a central axially extending projection **56** of cross sectional dimensions equal to or slightly less than those of the metal contact **22** of the lamp **15**. Such projection **56** is surrounded by an axially projecting flange **57** integral with the contact block and embracing externally an end portion of the thimble **19** on the lamp in order to provide support and location for the lamp relative to the holder as a whole.

The external diameter of the contact block **52** is such that it is a sliding fit in the bore **50** of the sleeve so that the exterior surfaces of the contact block come into contact loosely with those parts of the interior surface of the sleeve which intervene circumferentially between the two grooves **48** and **49**.

In order to maintain axial sliding between the contact block **52** and the sleeve **43*a*** under the influence of the coiled compression spring **54** for the purpose of maintaining proper electrical contact between the contact block and the contact **22** on the lamp proper, and also to avoid too tight a fit between the contact block and the sleeve which could cause fracture of the latter due to differential thermal expansion and contraction under operating conditions as between the sleeve and the contact

block, an intermediate sleeve is in this case used to establish, at least partially, thermal communication between the contact block **52** and the interior surface of the sleeve **43*a***.

Such intermediate sleeve is in the form of a ring **58** of resilient metal, for example the copper alloy previously mentioned, such ring being split at one position around its circumference with the gap or slit **59** extending axially for the whole length of the ring.

The contact block **52** includes intermediate its ends a portion **60** of reduced diameter in which the ring is received, the depth of the annular recess afforded by this portion being such that the outer surface of the ring **58** when in its unstressed state projects radially to a slight extent beyond the outer surface of the remaining end portions of the contact block and presents a diameter slightly exceeding the internal diameter of the bore **50** in the cylindrical portion **45** of the sleeve **43*a***. Upon insertion of the contact block **43*a*** with its ring **58** into the sleeve the ring is thus caused to be radially contracted to some extent.

Over part of the axial length of the ring **58** a radial clearance is established between its internal surface and the external surface of the annular recess in which it is seated, thereby permitting radial compression of the ring by contact with the internal surface of the sleeve, whilst over a remaining axially spaced portion of the ring contact is maintained between the internal surface of the ring and the external surface of the annular recess of the contact block, and a radial clearance is maintained over this portion between the external surface of the ring and the internal surface of the sleeve-like member. Such clearance may be established in any of various ways. For example, the ring may be formed with different internal diameters over two axially spaced portions and/or different external diameters. Alternatively, part of the clearance may be effected by forming the annular seating with different external diameters. In either case, continuous contact can be maintained between the contact block, the ring and the sleeve-like member whilst allowing for differential thermal expansions and contractions.

A heat conducting path is thus established from the contact block **52** to the portion of the ring **58** in pressure contact therewith then axially through the ring to the axially spaced portion thereof which is in pressure contact with the internal surface of the sleeve and thence to the latter.

The pressure of contact is of course not so great that the assembly comprising the contact block and ring is unable to slide under pressure of the coiled compression spring **54**.

The innermost portion of the contact block is bored transversely to receive a terminal screw **61** arranged with its head lying in the groove **48** and its opposite end projecting into the groove **49** so as to form the other component of a bayonet fitting in co-operation therewith. This arrangement permits a conductor wire **62** to enter the sleeve through the groove **48** for connection with the terminal screw head.

The chamber formed between the sleeve and the housing contains one of the heat transfer substances previously mentioned, preferably the first of those specifically mentioned. If, however, the mixture of salts is used, the metal parts which come into contact with the substance should be formed of mild or stainless steel.

The chamber is filled via a screw tapped bore **65** having a closure screw **65*a*** and is either filled completely or filled except for a small air or vapour space to allow of some thermal expansion.

A terminal block is provided in the terminal box **10*a*** mounted externally of the trough-shaped body, adjacent to one of the housings **28**. Conductor wires emerging from the box pass through a hole **63** in the body and one wire leads directly to the mouth of the sleeve nearest to the terminal block, whilst the other wire is lead to the other sleeve along a channel **64** formed for this purpose.

The external face of the trough-shaped body over those parts which also form part of the housing **28**, may be formed with ribs or fins to extend the surface area in contact with the air to facilitate dissipation of heat.

Heat is transmitted from the thimble **19** and metal contact **22** of the lamp proper firstly by conduction to the contact block **52** which is of a sufficient mass to act as a heat sink. Secondly heat is transferred conductively through the split ring **58** to the sleeve **43***a*, and thirdly heat is carried conductively through the compression spring **54** at the rear of the contact block to the end of the sleeve.

The compression spring **54** may alternatively be formed of strip or plate material in order to present as big a contact surface as possible for engagement with the end of the contact block and with the end wall of the sleeve so as to provide maximum heat transmission to this part of the sleeve-like member from the contact block.

Heat is transmitted conductively through the walls of the sleeve and then by the heat transfer substance to the walls of the housing from which it is dissipated to the ambient atmosphere. Heat transfer is effected through the heat transfer substance partly by conduction and also to some extent by convection.

The sleeve **43***a* includes an axially projecting extension **66** at its mouth above the thimble **19** of the lamp proper so as to act as a shield intercepting radiant energy reflected from the downwardly presented inner surface of the trough-shaped body and hence assisting further in maintaining the operating temperature of the flat plate-like portion **18** of the lamp envelope below that at which damage would result. A slot **67** is provided in the extension **66** for passage of the conductor **62** to the contact block.

A projection **68** is provided on the sleeve **43***a* behind the radial rib **44** to co-operate with a recess **69** formed in the housing to ensure correct location of the sleeve in the latter.

An alternative type of sleeve **43***b* is shown in FIGURES 6*a* to *d*. This sleeve comprises a generally cylindrical body part **73** which tapers at its rear end and is formed with a radially projecting rib **74** at its forward end. In this case, the axial width of the rib **74** is rather greater than that of the corresponding rib **44** on the other type of sleeve **43***a*, thus requiring a rather wider groove for its seating. No fins or radial enlargements are provided as in the case of the other type of sleeve **43***a* and there is only one axially extending groove **75** opening into the main bore **76**. The sleeve **43***b* is also formed with an extension **77** similar to the extension **66** and serving the same purpose. Thus the sleeve **43***b* is considerably simplified as compared with the sleeve **43***a*, thereby achieving some economy as regards production costs without loss of efficiency of operation.

The contact block is also considerably simplified. It comprises a body **78** which is a sliding fit in the bore **76** and which is formed with a central projection **79** extending axially forwardly from its forward end face **80** and a knob-like projection **81** extending axially rearwardly from its rear end face **82**. The projection **81** serves to anchor one end of a tapering compression spring **83**, the other end of which in its natural state being of slightly greater diameter than that of the bore **76**. Thus, when the spring **83** and body **78** are inserted into the sleeve **43***b*, the rear or large diameter end of the spring **83** is compressed radially to a sufficient extent to retain the spring and body in the bore.

The conductor **62** in this case is led along the groove **75** to the head of a terminal screw **84** which is inserted into a transverse bore in the rear end of the body **78** so as not to project from the other side of the body.

In this case the spacing of the two sleeves in their respective housings **28** in the casing **10** in such that when the lamp proper is in position (FIGURE 6*d*) the contacts **22** of the latter are disposed just within the bores **76** of the sleeves. This enables the form of the body **78** to be simplified in that no axial flange member corresponding to the flange **57** is necessary.

Whilst the exterior dimensions of the outer member, namely the outer surface of the housing may be varied according to the rate at which heat is required to be dissipated therefrom, a surface area in the range 30 sq. ins. to 70 sq. ins. (a preferred value being 50 sq. ins.) will be satsfactory for use when two such housings are employed in lamp holders at opposite ends of a lamp having a power dissipation of 1 kw. A proportionally greater surface area may be employed for higher power dissipations if necessary.

What I claim then is:

1. A lamp holder comprising:
(a) an inner contact member formed of electrically conductive material,
(b) an outer member affording a larger surface area than said inner member and defining a chamber,
(c) a sleeve in which said inner contact member is disposed, said sleeve having an open end and a closed end and being supported at its open end by said outer member with its closed end within said chamber
(d) a heat transfer substance which is in liquid form, at least at the temperature of operation of the assembly, contained within said chamber to provide a heat conducting path from said sleeve to said outer member, and
(e) a resilient metal member having a part maintained in pressure contact with said sleeve and another part maintained in pressure contact with said inner contact member.

2. A lamp assembly comprising:
(a) a body,
(b) an electric lamp proper having,
 (i) a transparent envelope,
 (ii) an electrically energised light producing-means, and
 (iii) conductors emerging from said envelope, and
(c) a lamp holder for each conductor mounted in said body comprising,
 (iv) an inner contact member formed of electrically conductive material,
 (v) an outer member affording a larger surface area than said inner member and defining a chamber,
 (vi) a sleeve in which said inner contact member is disposed, said sleeve having an open end and a closed end and being supported at its open end by said outer member with its closed end within said chamber,
 (vii) a heat transfer substance which is in liquid form, at least at the temperature of operation of the assembly, contained within said chamber to provide a heat conducting path from said sleeve to said outer member, and
 (viii) a resilient metal member having a part maintained in pressure contact with said sleeve and another part maintained in pressure contact with said inner contact member.

3. A lamp assembly as claimed in claim **2** wherein said outer member comprises,
(a) a first part formed integrally with said body, and
(b) a second part which is connectable to and releasable from said first part.

4. A lamp assembly as claimed in claim **3**, wherein,
(a) said inner contact mmeber is formed from a cadmium copper alloy,
(b) said sleeve is formed from an alumina ceramic material, and
(c) said heat transfer substance is characterized by having a freezing point which is lower than the nor-

mal minimum ambient temperature to which the lamp assembly is to be exposed in use and a boiling point which is appreciably higher than the highest working temperature attained by this substance during the operation of the lamp.

References Cited

UNITED STATES PATENTS

2,515,672	7/1950	Sowa	165—104
2,829,271	4/1958	Boucher	165—104
2,860,236	11/1958	Moore	240—47 X
3,091,750	5/1963	Long et al.	339—112 X
3,097,903	7/1963	Moore	339—112 X
3,192,379	6/1965	De Garmo	240—47 X

FOREIGN PATENTS

666,277	2/1952	Great Britain.
785,625	10/1957	Great Britain.

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