



EUROPEAN PATENT APPLICATION

Application number : **92308649.0**

Int. Cl.⁵ : **H01J 61/56, H01J 61/52**

Date of filing : **23.09.92**

Priority : **26.09.91 US 766608**

Date of publication of application :
31.03.93 Bulletin 93/13

Designated Contracting States :
DE FR GB NL

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54 Compact discharge lamp with thermal management characteristics.

57 A discharge lamp having improved thermal management properties includes a housing base (12) in which the ballast circuit (26) utilized for driving the discharge lamp (20) at an appropriate operating frequency is located. The ballast circuit (26) is disposed on a circuit board (22) which is mounted in a vertical orientation within the housing base (12) relative to the discharge lamp (20) being mounted in an upright position. The space along either side of the circuit board (22) on which the components (28,32) of the ballast circuit (26) are mounted allows for the flow of thermal convection currents thereover. Additionally, the circuit board (22) extends into the lowermost portion of the housing base (12) to the point where the screw base (14) attaches and is disposed in thermal connection to the screw base (14) such that the screw base (14) acts as a heat sink for the components (28,32) disposed on the circuit board. Selective placement of the components (28,32) of the ballast circuit (26) is made such that the components capable of generating the most heat are located toward the bottom (22a) of the circuit board (22) in closer proximity to the screw base (14) than those components which generate less heat.

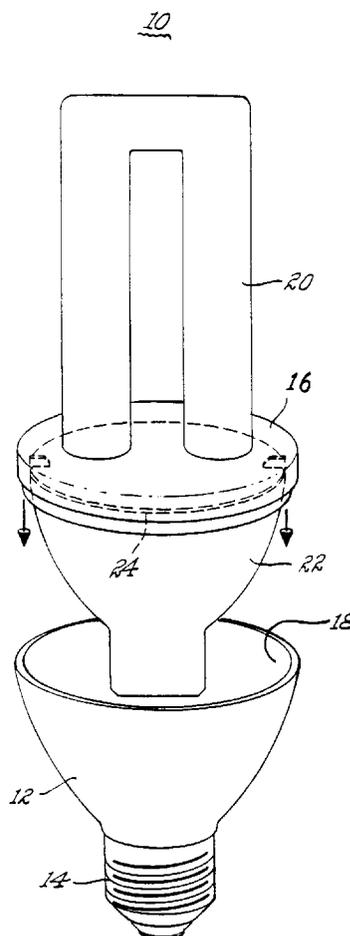


Fig. 1

The present invention is related to co-filed European Patent Application No. (Our ref: L.10276) "Electronic Ballast Arrangement for a Compact Fluorescent Lamp".

FIELD OF THE INVENTION

This invention relates to a compact discharge lamp which exhibits improved thermal management properties.

In the field of discharge lamps and their associated ballast circuits which are used to convert a line current into a high frequency operating signal for the discharge lamp, there have been significant design advances made in the use of electronic circuitry for developing such high frequency operating signal. The advantage of providing a high frequency operating signal is significant because it is known that a discharge lamp exhibits greater efficacy when operated by a high frequency signal rather than one that is merely at the line current frequency of 60 hz. An example of such an electronic ballast circuit can be found in the copending application referenced above in which an operating frequency of between 40 and 100 khz can be achieved by use of power MOSFET switching devices.

Along with the benefits that such a high frequency operation provides, one must consider the certain side effects, most notably, that such an electronic circuit that achieves a high frequency operation inherently generates an amount of heat that must be dissipated in order to allow the discharge lamp to operate efficiently. Of course, thermal considerations are of significance to any ballast circuit arrangement whether electronic or magnetic devices such as an auto-transformer device for instance are utilized. Moreover, it can be appreciated that although the thermal management properties of any type of discharge lamp ballast arrangement play a significant role in the overall lighting design in which the discharge lamp is intended for use, in the field of a compact fluorescent type of discharge lamp in which the ballast circuit is disposed within a plastic housing having a standard Edison screw base for insertion in a typical light socket, temperature performance is a major concern. Given the structural considerations such as size and materials utilized for a compact fluorescent product and the fact that such a product can be used in most standard light sockets as a replacement for an incandescent lamp, it is important that the temperature generated by the ballast circuit be controlled such that lamp efficiency is maintained and product integrity is not compromised. It is known that for a compact fluorescent product utilizing an electronic ballast circuit, the circuit board can be mounted horizontally relative to an upright mounted lamp and that such board mounting occurs at the topmost portion of the housing base, that is, such mounting occurs at the point furthest

from the electrical connection to the screw base. It can be appreciated that with this illustrated orientation of the circuit board within the housing base, the thermal performance characteristics of the ballast will be affected by spacing around the circuit board as well as the placement of the board relative to bottom portion of the housing base. An example of a horizontal ballast mounting arrangement for a compact fluorescent lamp can be found in U.S. Patent No. 4,695,767 issued to Wittmann on September 22, 1987. Accordingly, it would be advantageous if an arrangement for controlling the temperature performance characteristics of an electronic or electrical ballast circuit for a discharge type of lamp were provided.

For the particular application of an electronic ballast circuit in the housing base of a compact fluorescent discharge lamp, in addition to the requirement of managing the thermal performance characteristics of the ballast circuit in view of the fact that the device operates at a high frequency, one must also consider the space limitations that must be met in order for the ballast circuit to actually fit within the housing base. In fact, component placement within the housing base not only impacts the overall size consideration of the compact fluorescent lamp but, if in laying out components within the size constraints of the housing base, one were to look primarily to using any space within the housing base, the resultant arrangement would leave little space if any for the purpose of improving thermal convection currents within such housing base. Accordingly, it would be advantageous that in a compact fluorescent type of discharge lamp having an electronic ballast circuit disposed in a housing base adaptable for insertion in a standard light socket, that the electronic components that comprise the ballast circuit are arranged in as compact a space as possible and yet still allow for space around such components to achieve adequate flow of thermal convection currents.

SUMMARY OF THE INVENTION

The present invention provides in one aspect a discharge lamp having a lamp base and being operable using power line current, said discharge lamp comprising: a lamp member extending from said lamp base; a ballast circuit disposed within said lamp base and having circuit means including a group of circuit elements effective to energize said lamp member to a discharge state; and mounting means disposed within said lamp base and having mounted thereon, at least two of said group of circuit elements, said mounting means contacting said lamp base in a manner such that said lamp base acts as a heat sink for said ballast circuit.

The present invention provides in a further aspect a compact fluorescent discharge lamp having an

electronic ballast disposed within a housing base and operable using power line current, said compact fluorescent discharge lamp comprising: a tubular lamp member extending from said housing base; circuit means including a group of circuit elements for driving said tubular lamp member to a discharge state; and means for mounting said circuit means within said housing base in a vertical orientation relative to said discharge lamp being mounted in an upright position.

The present invention provides in a further aspect a discharge lamp operable using power line current, comprising: a discharge lamp member; a housing base from which said discharge lamp extends on one end and further having secured thereto, means for connecting to said power line current; a ballast circuit having elements effective so as to produce a resonant operating signal for driving said discharge lamp member to a discharge state; and mounting means disposed within said housing base and being effective for supporting thereon, at least some of said elements of said ballast circuit, said mounting means further being in thermal contact with said connecting means of said housing base such that heat generated by said ballast circuit can be at least partially dissipated by said connecting means.

The present invention provides for a thermal management arrangement for the ballasting circuit of a discharge lamp, particularly when such discharge lamp is a compact fluorescent type in which an electronic ballast is disposed within a housing base adaptable for use in a standard type of light socket and wherein the electronic ballast circuit is designed so as to operate at a high operating frequency. The thermal management properties of the present invention further allow for the spacing of the necessary components of the ballast circuit in an arrangement that provides as compact a profile for the housing base as possible and at the same time provides necessary spacing within the housing base so that thermal convection currents can flow around the components of the ballast circuit.

In accordance with the principles of the present invention, there is provided herein a discharge lamp having a ballast circuit associated therewith which during operation, generates heat that is dissipated in a more efficient manner as a result of the improved thermal management properties of the present invention. The discharge lamp includes an electronic ballast circuit arrangement which is disposed on a printed circuit board positioned within the ballast housing in a manner whereby the ballast housing itself, and more particularly, the portion of the ballast housing furthest from the lamp is utilized for purposes of dissipating heat. Additionally, the printed circuit board is configured in substantially the same design as a crosswise section of the housing base such that the printed circuit board contacts and is supported by the sides of the housing base when the printed circuit

board is mounted in a vertical orientation relative to the discharge lamp being installed in an upright manner. The crosswise design of the circuit board further includes a bottom extending portion which conforms in shape to the portion of the housing base on which the screw base is disposed.

In a variation of the present invention, it is possible to specify that the positioning of the highest heat generating components occur at the lowermost portion of the circuit board and gradually spacing the next highest heat generating components in a hierarchical manner further up on the circuit board. It is also possible that, although the previous discussion has been directed to the use of the thermal properties improvements of the present invention being applied in a compact fluorescent product situation, the present invention in its basic-format can be applied to any ballast circuit for a discharge lamp in which it is desirable to control the thermal performance characteristics in a close quartered environment.

BRIEF DESCRIPTION OF THE DRAWINGS

In the following detailed description of the invention, reference will be made to the attached drawings in which:

Fig. 1 is an elevational view partly in sectional form of a discharge lamp exhibiting improved thermal properties and constructed in accordance with the present invention.

Fig. 2 is an elevational view of a circuit board configuration on which an electronic ballast circuit can be mounted for improved thermal management purposes according to the present invention.

Fig. 3 is a sectional view of a discharge lamp and circuit board arrangement achieving the improved thermal management properties of the present invention.

DESCRIPTION AND OPERATION

As seen in figure 1, the discharge lamp having improved thermal management properties is shown in the form of a compact fluorescent type of discharge lamp 10 having a housing base 12 in which a ballast circuit (not shown) is disposed. Although shown in the form of a compact fluorescent discharge product, the subject matter disclosed and claimed as follows applies equally as well to other types of discharge lamps utilizing ballast circuits for which thermal management is an important design consideration. Moreover, the actual circuit and operation of the lamp ballast for which the improved thermal management properties of the present invention are directed can be achieved by a variety of techniques one of which is the above cross-referenced co-filed application No.

(L10276). Additionally, for a detailed discussion of the operation of a high frequency discharge

lamp ballast circuit, which, in operation generates an amount of heat that must be dissipated, reference is hereby made to Application Note AN-973 entitled "HEXFETs, Improve Efficiency, Expand Life of Electronic Lighting Ballasts" written by Peter N. Wood and published by International Rectifier of E1 Segunda, CA. In this ballast circuit arrangement, MOSFETs are switched at a very high speed in response to a speed-up pulse injected to the gate terminals of the respective MOSFETs. It can be appreciated that high speed switching ballasts which are effective for achieving the higher frequency of operation that a discharge lamp operates best under, inherently generate an amount of heat that, given the small confines of a compact fluorescent housing base, must be thermally managed such that a thermal runaway condition does not occur.

The housing base 12 for the compact discharge lamp 10 is in a generally conical shape which is of a general size and configuration that allows for the insertion of the compact fluorescent lamp 10 into a standard light socket; other shapes such as a tapered cylindrical configuration would also be appropriate. Disposed at the bottom portion of the housing base 12 is a standard Edison type screw base 14. Because of the manufacturing advantages of using an automated injection molding process, the housing base 12 will be constructed typically of a plastic material. A top cap member 16 made of the same material as the housing base 12 secures to the housing base 12 by means of a snap or other type of closure arrangement and is further effective for closing off the inner cavity region 18 of the housing base 12. The top cap member 16 also serves to support the tubular lamp member 20 which extends upward therefrom. Although illustrated as a two-axis lamp 20 in fig. 1, it can be appreciated that any multiple axis compact fluorescent lamp can be utilized such as for instance, a quad (4-axis) or hex (6-axis) product.

Disposed within the cavity 18 of the housing base 12 is a ballast circuit mounting member 22 which is configured in a shape substantially in conformance with the shape of the housing base 12. The ballast circuit mounting member 22, or circuit board 22 as it will be described in the discussion of fig. 2, includes a bottom extending portion 22a which is essentially square shaped and is sized so as to fit securely within the bottom portion of the housing base 12 on which the screw base 14 is secured. In this manner, the circuit board extends down into the bottommost portion of the housing so as to be in thermal contact with the screw base thereby allowing the screw base to act as a heat sink for the electronic ballast circuit of the present invention. In order to achieve the maximum dimension of the circuit board within the housing when such circuit board is disposed in a vertical manner, it is necessary to place such board at or near the diameter of the housing base given that such housing base

is of a circular configuration. By so disposing the circuit board centrally of the housing base, the amount of space on the circuit board that can be allocated for the mounting of the electrical components of the ballast circuit are maximized. Additionally, if centrally disposed, the amount of space on either side of the circuit board that could be utilized for purposes of allowing the flow of thermal convection currents thereover, has also been maximized. Moreover, in addition to the thermal advantages that the present circuit board presents, there are benefits gained in terms of the support of the circuit board within the housing base. For instance, the vertically oriented printed circuit board can be supported on its side periphery by contacting the inside portion of the housing base and on its top portion as well by way of a circular support member secured in a horizontal manner within the housing base. Of course, it can be appreciated that the support of the circuit board in the horizontal direction can be accomplished by attaching the circuit board to the upper portion of the housing base thus avoiding the need for the separate circular support member.

It will be noted that during the discussion of the thermal management properties of the present invention, reference will be made to the orientation of the ballast circuit mounting member 22 as it is mounted within the housing base 12. Such orientation is made relative to the discharge lamp 10 being mounted in an upright position; that is, the discharge lamp 10 will be mounted such that the tubular lamp member 20 will extend upright and the screw base 14 will be disposed in the downward direction. Of course, it can be appreciated that the discharge lamp 10 can be oriented in other directions rather than merely an upright one, in such an instance, the ballast circuit mounting member 22 will change in orientation along with the discharge lamp 10.

In order to attain the vertical orientation of the circuit board 22, it is desirable to support the circuit board 22 in a horizontal direction as well as merely a vertical one. As seen in fig. 1, a circularly shaped support member 24 is disposed in the top cap member 16 of the housing base 12 and the circuit board 22 is attached thereto for such horizontal support. Once the lamp electrodes (not shown) are electrically connected to the ballast circuit (not shown), top cap member 16 is inserted into the housing base 12 so that the circuit board 22 will then be in contact with the inner wall of the cavity 18. In this manner, the circuit board 22 is supported both in the vertical direction by contacting the housing base 12 and in the horizontal direction by the support gained in the connection to the circular support member 24. Of course, it can be appreciated that the horizontal support provided to the circuit board 22 by way of the circular support member 24 can also be provided by a direct connection of the circuit board 22 to a portion of the top cap mem-

ber 16 and thereby preclude the need for a separate support member 24.

Additionally, by the vertical orientation of the circuit board 22 within the housing base, it can be further appreciated that the manufacturing step of connecting the lamp 20 to the circuit board 22 and then the circuit board 22 to the screw base 14 has been simplified. For an automated manufacturing process, it would be advantageous to achieve these two connections using inlead wires which are bare thereby avoiding the step of stripping a portion of insulation from these wires. In a horizontally disposed circuit board arrangement, it can be appreciated that a significant length of bare wire would be needed to connect the circuit board to the socket and such an arrangement may be prone to experiencing a short circuit condition when the lamp is finally assembled. With a vertically disposed circuit board 22, it is possible to use short lengths of bare inlead wires to make the connection from the circuit board 22 to the lamp 20 and from the circuit board 22 to the screw base 14 thereby avoiding the risk of experiencing a short circuit condition during final lamp assembly.

Referring now to fig. 2, it can be seen that the ballast circuit shown generally as reference 26, is disposed on the circuit board 22 in a manner such that the various components 28 are all electrically interconnected by circuit board runs 30. It is to be understood that the component representation 28 of fig. 2 is of a general nature and is meant to include as being covered thereby, an electronic ballast arrangement using high frequency switching devices, a rectifier circuit, a resonance circuit and a circuit for generating the control signal which controls the switching operation of the high speed switching devices. The high speed switching devices, for purposes to be discussed hereinafter in further detail, are designated reference 32 and can be disposed on the opposite side of the circuit board 22 as other components 28.

It is significant to note that by disposing the circuit board 22 in a vertical orientation within the housing base 12, there is sufficient space on either side of the circuit board for mounting ballast circuit components 28. As such, the need to interconnect various components by means of an inlead wire arrangement wherein the component is disposed off of the circuit board and an inlead wire is added to couple that component into the ballast circuit 26, is largely avoided. Additionally as seen in fig. 2, with some components 28 mounted on one side of the circuit board 22, it is possible to mount other components 32 (shown in phantom) on the opposite side of the board and still maintain the ability to interconnect all components 28 and 32 without the need for lengths of inlead wire within the housing base and yet, still maintain the space around the various components 28 and 32 through which thermal convection currents can flow. Extending from the bottom portion of the circuit board 22 and

from along the side of the bottom portion 22a of the circuit board 22, are connectors 34 which connect to the screw base 14 so that power line current can be coupled to the ballast circuit 26. Circuit board 22 has formed at the upper or widest portion thereof, respective tab members 36 which can contact either the circular support member 24 or a portion of the top cap member 16 so that the horizontal support of the circuit board 22 as previously discussed, can be accomplished.

In addition to the improved thermal management characteristics achieved by the vertical orientation of the circuit board 22 within the housing base 12, which orientation allows for sufficient space along either side of the circuit board 22 to accommodate thermal convection currents to flow over such components 28, it is of further significance that the components 28 which comprise the ballast circuit 26 can be selectively located in a hierarchical manner on the circuit board 22 according to the heat generating capabilities of the specific components. In other words, with a vertically oriented circuit board 22, given that certain components 28 of the ballast circuit 26 are higher heat generating devices which require more dissipation capabilities than other components and because heat can be more readily dissipated at the lowermost portion of the housing base 12, it would be thermally advantageous to place the highest heat generating components 28 at the bottom of the circuit board 22. Similarly, it is possible to assign the positions of the various components 28 and 32 on the circuit board in order of their respective heat generating characteristics wherein the highest heat generating components are disposed in descending order from the lowermost portion of the circuit board 22 to the topmost portion of the circuit board 22. For instance, it is known that a typical resonance circuit for a discharge lamp will employ a relatively large electrolytic capacitor and that such device generates an amount of heat that requires additional consideration. By placing such element at the bottom portion 22a of the circuit board 22, the heat sinking capabilities of thermally connecting the circuit board 22 to the screw base 14 are efficiently utilized.

A further thermal management consideration is achieved by the present invention in that, as previously noted, certain electronic ballast circuits for discharge lamps employ high speed switching devices which can generate a noticeable amount of heat, noise or other interference that affects other components in the ballast circuit 26. The present invention, by allowing the placement of some components on opposite sides of the circuit board 22 as other components, allows an amount of isolation between such noise or interference generating components and those components which may be adversely affected by such noise/interference. As shown by the phantom representation of a component 32 of the ballast circuit

26 being disposed on opposite sides as components 28, a further thermal advantage is attained.

As seen in fig. 3, the discharge lamp 10 of the present invention which exhibits improved thermal management properties is illustrated wherein the circuit board 22 is in thermal contact with the screw base 14. In this manner, the heat sinking capabilities of the metallic screw base 14 are utilized more directly than would a circuit board arrangement disposed in a circumferential manner near the top portion of a housing base for a compact fluorescent or other type of discharge lamp.

Although the previously described embodiment of the invention constitutes a preferred embodiment, it should be understood that modifications can be made thereto without departing from the scope of the invention as set forth in the appended claims. For instance, the principles of the present invention apply equally as well to a discharge lamp ballast configuration that is disposed in a housing separate from but in close proximity to the actual discharge lamp.

Claims

1. A discharge lamp having a lamp base and being operable using power line current, said discharge lamp comprising:
 - a lamp member extending from said lamp base;
 - a ballast circuit disposed within said lamp base and having circuit means including a group of circuit elements effective to energize said lamp member to a discharge state; and
 - mounting means disposed within said lamp base and having mounted thereon, at least two of said group of circuit elements, said mounting means contacting said lamp base in a manner such that said lamp base acts as a heat sink for said ballast circuit.
2. A discharge lamp as set forth in claim 1 wherein said mounting means includes a circuit board and said circuit board is disposed within said lamp base so as to allow space on either side thereof for mounting said group of elements and for air flow thermal management purposes.
3. A discharge lamp as set forth in claim 2 wherein said lamp base includes a metallic screw base portion and said circuit board is mounted vertically within said lamp base in relation to said lamp base being mounted in an upright position.
4. A discharge lamp as set forth in claim 3 wherein said circuit board is attached at its topmost portion to a support member mounted horizontally within said lamp base, said circuit board thereby being supported in three dimensions by way of attachment to said horizontally disposed support member and by said vertically mounted circuit board contacting and being supported by an inner portion of said lamp base.
5. A discharge lamp as set forth in claim 3 wherein said group of elements mounted on said mounting means are mounted on said circuit board in a manner such that those elements of said group capable of generating the highest amount of heat are mounted closest to said metallic screw base.
6. A compact fluorescent discharge lamp having an electronic ballast disposed within a housing base and operable using power line current, said compact fluorescent discharge lamp comprising:
 - a tubular lamp member extending from said housing base;
 - circuit means including a group of circuit elements for driving said tubular lamp member to a discharge state; and
 - means for mounting said circuit means within said housing base in a vertical orientation relative to said discharge lamp being mounted in an upright position.
7. A compact fluorescent discharge lamp as set forth in claim 6 wherein said mounting means is a circuit board mounted within said housing base in a manner such that said circuit board is thermally coupled to a metallic screw base portion of said housing base thereby allowing said screw base portion to act as a heat sink for said circuit board and any elements mounted thereon.
8. A compact fluorescent discharge lamp as set forth in claim 7 wherein said circuit means includes at least two power transistor switching devices and wherein said power transistor switching devices are mounted on one side of said circuit board in an isolated manner from other components of said ballast circuit.
9. A discharge lamp operable using power line current, comprising:
 - a discharge lamp member;
 - a housing base from which said discharge lamp extends on one end and further having secured thereto, means for connecting to said power line current;
 - a ballast circuit having elements effective so as to produce a resonant operating signal for driving said discharge lamp member to a discharge state; and
 - mounting means disposed within said housing base and being effective for supporting thereon, at least some of said elements of said

ballast circuit, said mounting means further being in thermal contact with said connecting means of said housing base such that heat generated by said ballast circuit can be at least partially dissipated by said connecting means.

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10. A discharge lamp as set forth in claim 9 wherein said mounting means is a circuit board and said ballast circuit is comprised primarily of electronic components which are secured to said circuit board, and further wherein said circuit board is disposed in said housing in a vertical orientation relative to said discharge lamp being mounted in an upright position.

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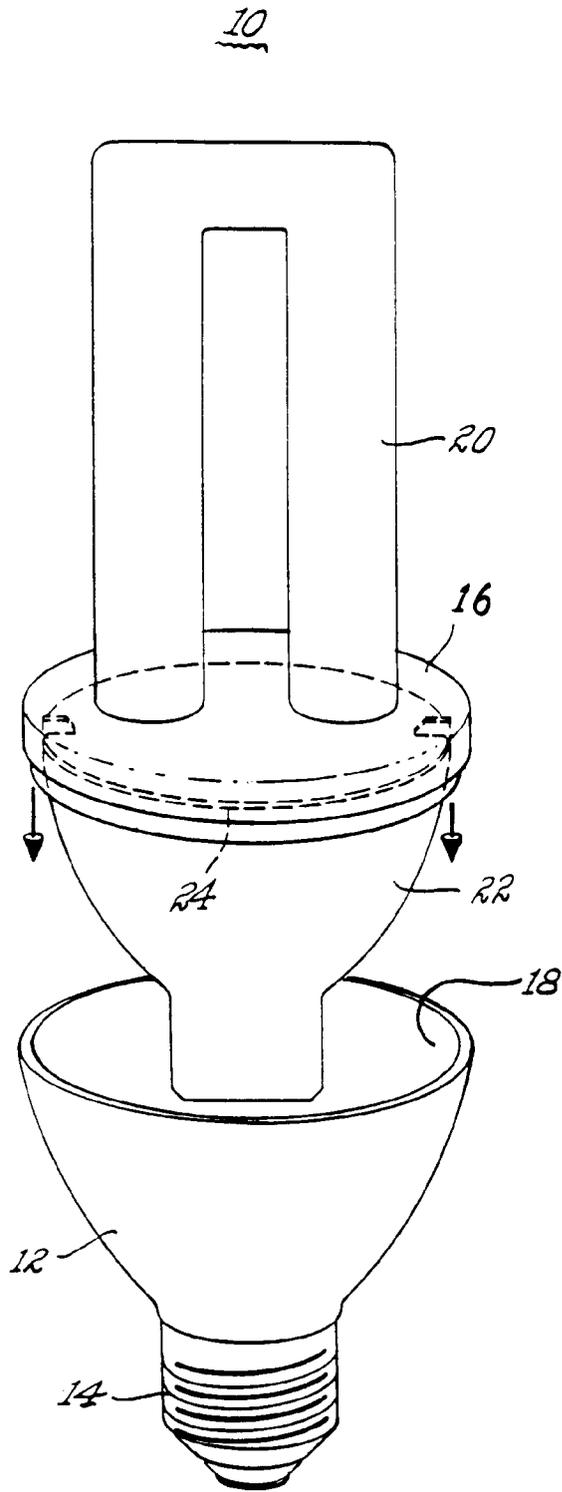


Fig. 1

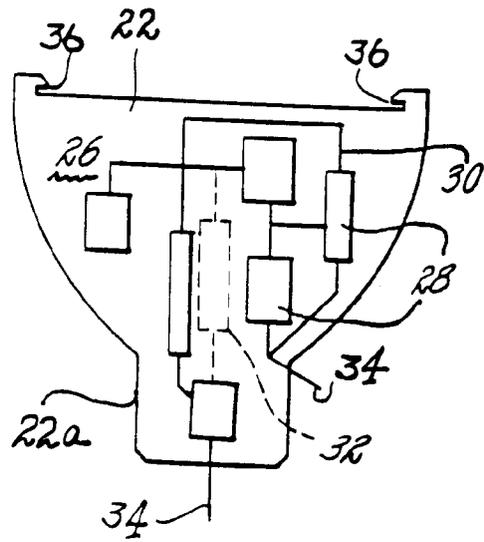


Fig. 2

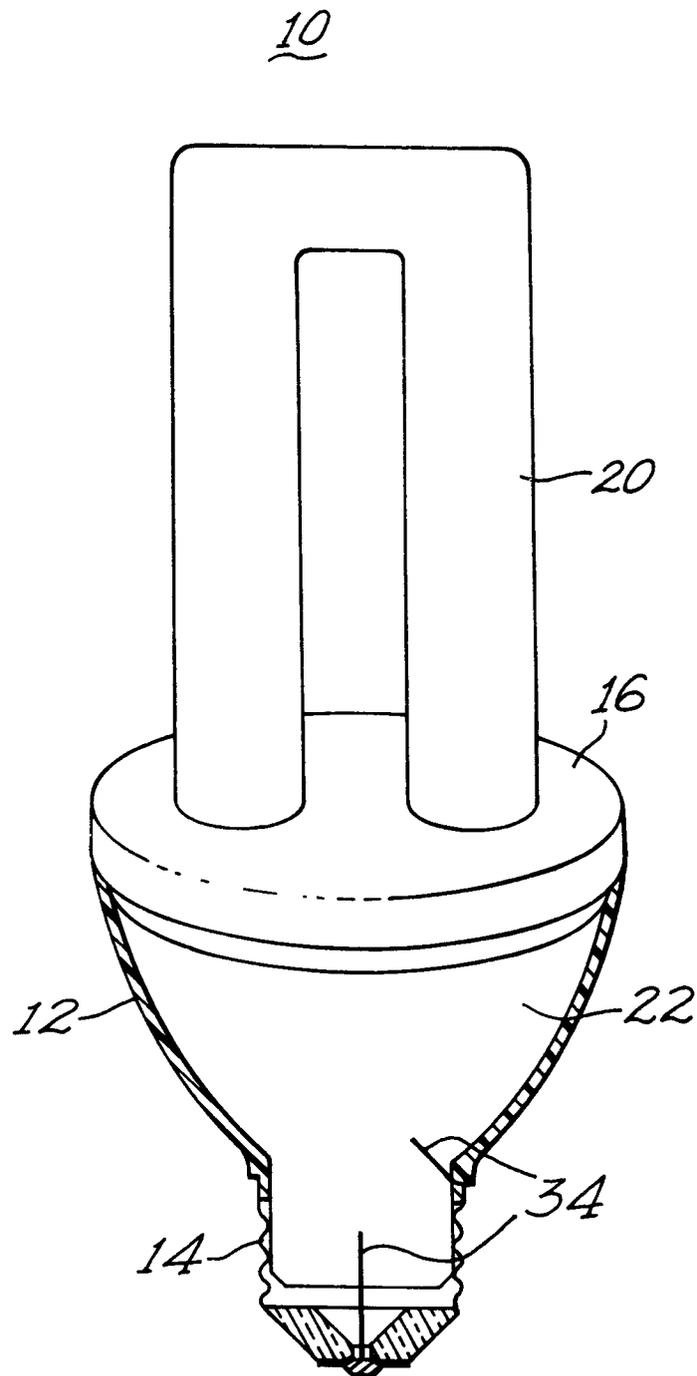


Fig. 3



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number

EP 92 30 8649

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X Y A	US-A-3 771 018 (MEDENDORP) * abstract; figure 3 * * column 1, line 36 - line 45 * * column 2, line 12 - line 16 * * column 4, line 51 * ---	1,9 9,10 3	H01J61/56 H01J61/52
X Y A	EP-A-0 349 083 (N.V. PHILIPS' GLOEILAMPENFABRIEKEN) * abstract; figure 1 * * column 2, line 24 - line 34 * ---	6 9,10 1-4	
A	EP-A-0 191 742 (LUMALAMPAN AKTIEBOLAG) * abstract; figures 1,4 * ---	1-3,5-7, 9,10	
A	WO-A-8 803 702 (DUMAS) * abstract; figure 1 * ---	1,3,5,7	TECHNICAL FIELDS SEARCHED (Int. Cl.5)
A	DE-A-4 021 420 (NARVA BERLINER GLÜHLAMPENWERK GMBH) * abstract; figure 1 * * paragraph 1 * -----	3,4,6,7, 10	H01J
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 26 JANUARY 1993	Examiner MARTIN Y VICENTE M.
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application I : document cited for other reasons ----- & : member of the same patent family, corresponding document	

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