

[54] **LAMP WITH TUBULAR BULB AND REFLECTOR**

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[58] Field of Search ..... 240/41, 41.35 R, 41.35 F, 240/1.3, 3, 103 R, 41.35 C, 41.36, 41.37, 41.38, 11.4 R

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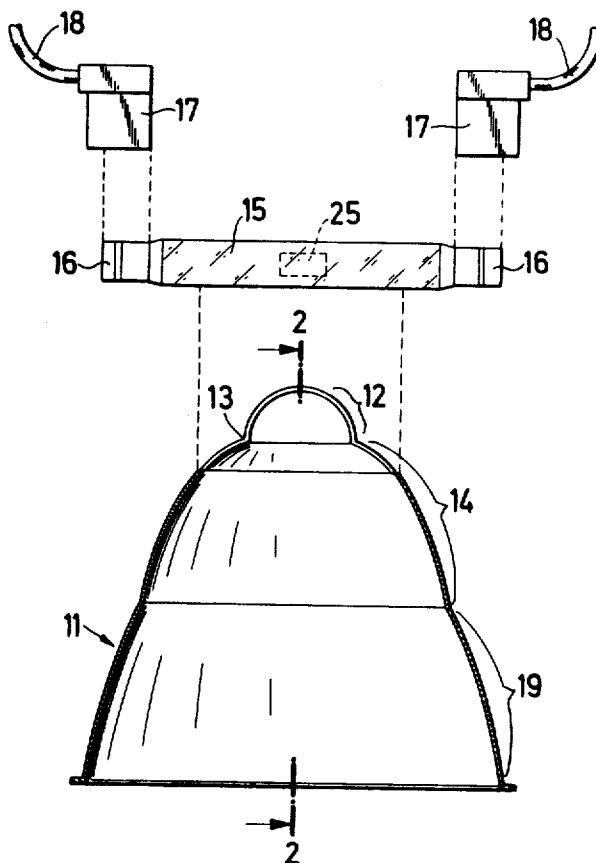
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[57] **ABSTRACT**

Disclosed is an electric lamp comprising a reflector and a tubular-shaped bulb having an illuminating arc of a length which is short in comparison to the total length of the bulb. The reflector encloses essentially only the arc portion of the bulb, thereby enhancing the performance and design of the lamp. A novel rear reflector design is also provided for maximizing the efficiency of the lamp.

**16 Claims, 6 Drawing Figures**



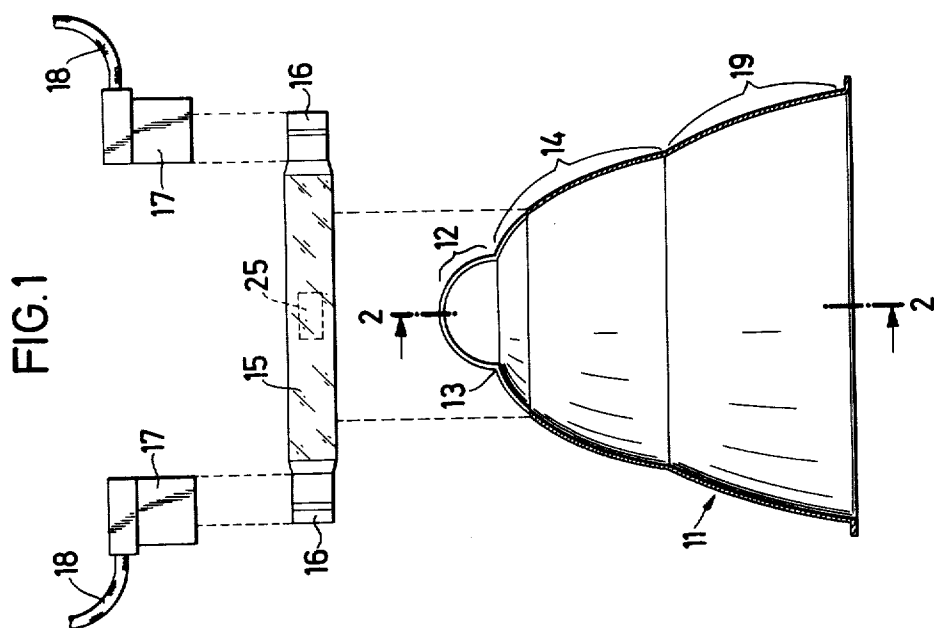
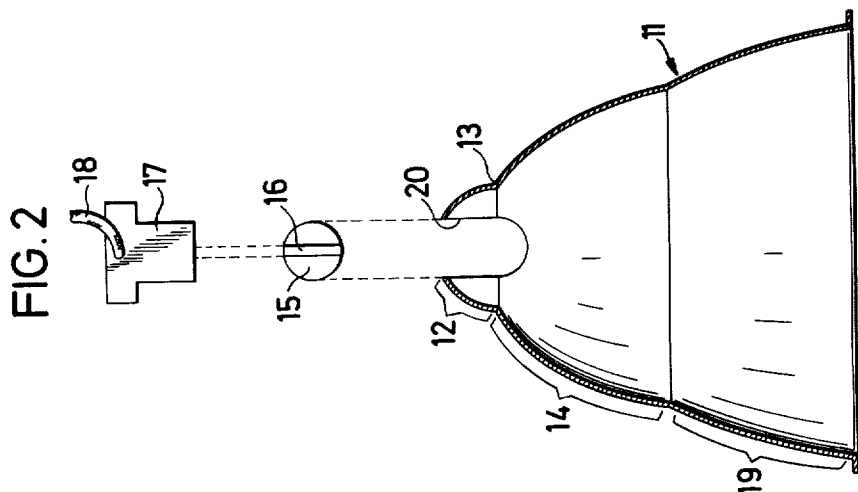
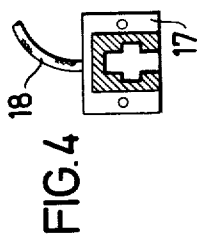
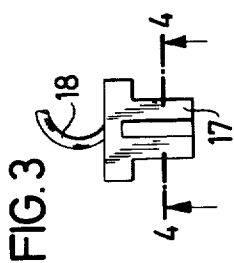


FIG. 6

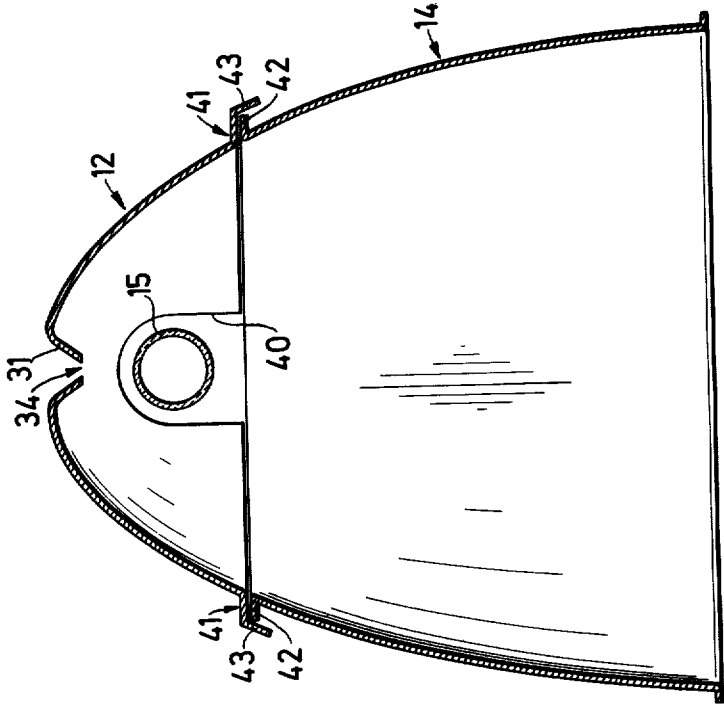
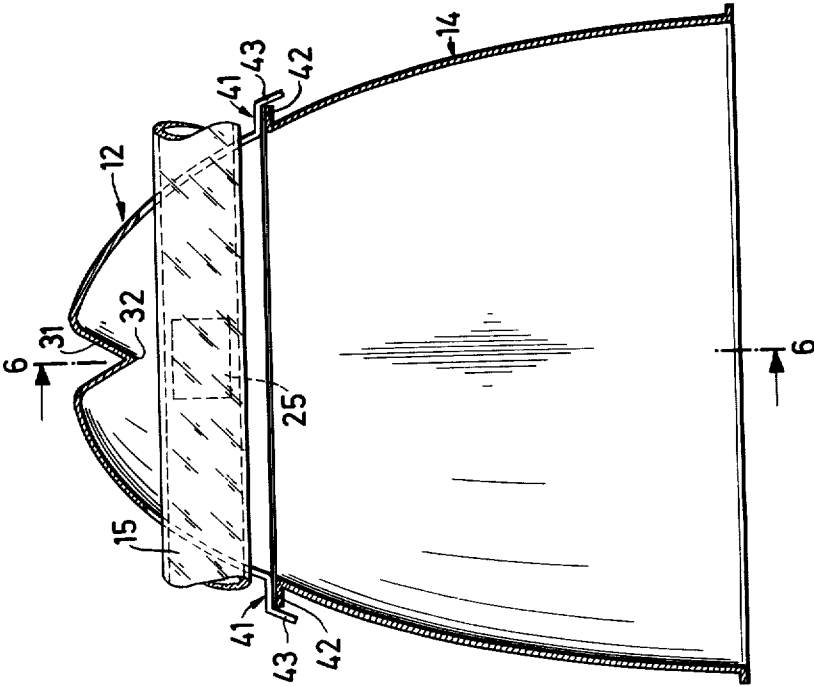


FIG. 5



**LAMP WITH TUBULAR BULB AND REFLECTOR**

This is a continuation of application Ser. No. 358,104 filed May 7, 1973, now abandoned.

**BACKGROUND OF THE INVENTION**

The present invention relates to a lamp with a tubular bulb and a reflector.

Such a lamp is known from German Auslegeschrift No. (DAS) 1,223,327. There, a tubular high-performance bulb of small size is disposed in the focal line of a channel-like portion of a reflector. The ends of the channel-like portion, which is of parabolic section, are closed by reflecting end portions which are portions of a paraboloid of revolution.

This lamp has the disadvantage of requiring a very large reflector. Measured along the crest line, it is about twice as long as the tubular bulb, and the forward distance of the end portions is even three to four times as long as the bulb (of FIGS. 1 to 3 of DAS 1,223,327). This reflector, which is huge in comparison with the bulb, increases the manufacturing costs of the entire lamp because of the material required as a result of its size, particularly if the reflector is placed into a lamp housing of suitable size. In addition, the necessary minimum size of the reflector limits the possibilities of designing the lamp in a pleasant manner.

This known lamp has another disadvantage in that it has a wide angle of radiation in spite of the large reflector, i.e., it glares over a very wide range, particularly in the longitudinal direction of the tubular bulb. This is particularly disadvantageous because the screens commonly used in bulbs with low luminance cannot be used in bulbs with high luminance. The side angle of radiation also means that the light cannot be directed well with this lamp because a great deal of the light is not incident on the reflector but leaves the lamp directly, obliquely towards the front. Thus, this reflector is quite unsuitable for use in a spot lamp.

To slightly mitigate this latter disadvantage, it may first appear appropriate to shorten the reflector so that the crest line of the channel-like portion is only slightly longer than the bulb and the associated base, while the other dimensions are maintained. This actually makes the angle of radiation in the longitudinal direction smaller and reduces the range of glare in this direction. However, any reduction in size of the reflector inevitably entails the disadvantage that the bulb bases, whose size remains the same, occupy a relatively greater portion of the reflector's interior space. These bulb bases reduce the reflector's efficiency considerably because they partly absorb the light incident on them and partly reflect it in the wrong direction or scatter it. The smaller the reflector, the greater this unwanted shading effect.

On the other hand, in order to reduce the range of glare and achieve better light-directing characteristics, one might think of enlarging the reflector in the direction of projection. In that case, however, an even greater reflector and an even greater lamp are obtained, which lamp, in addition to requiring a large amount of material, has the disadvantage of being simply too big for most applications.

**SUMMARY OF THE INVENTION**

It is the object of the present invention to provide a lamp with a tubular bulb and a reflector which does not have the disadvantages of the known lamps, is opti-

mally designed from the point of view of illumination engineering, and permits accurate directing of the light.

The invention is characterized in that the reflector encloses only the arc or the luminous portion of the tubular bulb.

The main advantage achieved through the invention is that neither the bases of the bulb nor any other holders, which would absorb or scatter light, are located in the interior space of the reflector. This permits the reflector to be designed optimally from the point of view of illumination engineering and to direct and project the light of the lamp in the desired form. The invention permits the manufacture of wide-angle lamps or floodlights in which the light is directed with high accuracy and which have a high efficiency. Furthermore, the invention, for the first time, permits spot or narrow-angle lamps with a symmetrical cone of light and high efficiency to be manufactured using a tubular bulb. This advantage of the invention has a particularly favorable effect in the case of tubular bulbs, the arc, i.e., illuminating electric arc, length of which is short compared with the bulb length, as is the case, for example, in the HQI-TS 400 W and HQI-TS 250 W halogen-metal vapor lamps, which are known from the journal "Licht-technik", Volume 23, No. 8/1971, pp. 447-449. The characteristics of these two discharge bulbs are as follows:

| Measurements            | HQITS 400W | HQITS 250W |
|-------------------------|------------|------------|
| length                  | 205 mm     | 162 mm     |
| diameter                | 30 mm      | 23 mm      |
| arc length              | 48 mm      | 25 mm      |
| <u>Electrical Data</u>  |            |            |
| line voltage            | 220 V      | 220 V      |
| bulb voltage            | 120 V      | 105 V      |
| bulb current            | 3.5 AMP    | 2.9 AMP    |
| power                   | 360 W      | 250 W      |
| <u>Photometric Data</u> |            |            |
| light intensity         | 25,000 lm  | 20,000 lm  |
| light efficiency        | 68 lm/w    | 80 lm/w    |

The invention has other advantages in that it permits the manufacture of a relatively small reflector, that the manufacturing costs are proportionately lower, and that it does not limit the scope for designing the lamp.

The reflector's rear section, which encloses the bulb, preferably has a greater curvature than the front section. This feature of the invention is particularly advantageous in the case of bulbs with a very small arc.

Between the rear and front sections, the reflector may have a constriction. This permits the rear section of the reflector to be given a geometrical form quite different from that of the front section.

In one embodiment of the invention, the rear section of the reflector has two diametrically opposed holes for inserting the lamp. This embodiment is particularly suitable for use with bulbs having a base on one side only because it permits the bulb to be replaced from one side without the reflector first having to be taken off of the lamp housing.

In another embodiment, the rear section of the reflector has a slot whose width and depth are greater than the diameter of the bulb. This embodiment of the invention is particularly suitable for the manufacture of a lamp with a tubular bulb having a base on either side. It permits the bulb to be taken out of the slot toward the rear or to remove the reflector forwards, to replace

the bulb, and to put the reflector over the bulb again from the front.

The reflector's rear section, which encloses the bulb, is preferably spherical in shape. The front section of the reflector is advantageously shaped approximately like a paraboloid. In a particularly advantageous embodiment, the front section of the reflector passes in front into a rim section which is shaped as part of an inversely put-on paraboloid. This reflector shape according to the invention permits the classic, basic principle of reflection to be applied so that one can look into the reflector without being dazzled as long as one does not look directly into the arc.

The reflector may consist of several separate parts which are each shaped like the sections described above. This particularly advantageous feature of the invention permits the rear section of the reflector to be securely mounted in the lamp housing and to simultaneously use a tubular bulb having a base on either side. The separating line between the rear and front sections may lie on a level with the lamp axis. In this case, it would be sufficient to provide half-holes for receiving the tubular bulb in both the rear section of the reflector and the adjacent section of the reflector at diametrically opposed points. This offers the particular advantage that the rear section of the reflector can be completely closed at the back. To replace a defective bulb, it would only be necessary in this embodiment to first take the front part(s) out of the lamp housing. According to a further feature of the invention, a back-up reflector is disposed behind the slot of the reflector's rear section. This additional back-up reflector reflects the light radiated rearwardly by the lamp back into the main reflector.

This lamp operates excellently in connection with the well-known tubular bulbs and particularly with those the arc of which is short as compared with the length of the entire bulb. This lamp in particular is distinguished by two properties: on the one hand, by its ability to direct light well, both as a narrow-angle lamp and as a wide-angle lamp; on the other hand, by its high illuminating efficiency. In one embodiment, an efficiency of more than 80% was measured.

In this lamp it may happen — depending on the dimensions of the luminous portion of the tubular bulb and on those of the reflector and on the precise location of the bulb's luminous portion in relation to the rear section of the reflector — that part of the light reflected from the rear section of the reflector passes through the arc of the bulb.

In general, this is not disadvantageous. It is, however, conceivable that tubular bulbs with a short arc are put on the market in which this effect is undesirable. It is known, for example, that the discharge column of the sodium-vapor bulb is impervious to light of its own wavelength. If a sodium-vapor bulb were used in a lamp as disclosed herein, this effect could result in a reduction — perhaps only small — in the lamp efficiency.

It is therefore another object of the invention, to improve the lamp so that it can be used for all tubular bulbs having a luminous portion which is short in relation to the bulb without any reduction in lamp reflection.

This object is attained by making the reflector substantially axially symmetrical and indenting or impressing the rear section of the reflector in the region of its

central axis toward the front in the direction of the central axis.

In an improved embodiment of the invention, the forwardly indented portion of the rear section of the reflector is formed into a tip in front.

This shape of the reflector causes almost all the light which is radiated by the lamp into the rearward space and is reflected forward by the rear section of the reflector to be guided around the luminous portion of the bulb. Since almost no reflected light passes through the discharge column, the invention offers the advantage that the high efficiency of the lamp is independent of the kind of tubular bulb used as long as the dimensions of the bulb and the light column are comparable. The efficiency would not be decreased even if the lamp were operated with a tubular sodium-vapor bulb.

In another improved embodiment of the invention, the tip of the indented portion of the reflector is cut off. The rear section of this embodiment has, in the indented portion, a hole concentric with the central axis of the reflector. This embodiment of the invention is advantageous particularly if the shaping of the tip, which should be as fine as possible, entails an undesirably great expense, e.g., because of the properties of the material used for the reflector. This embodiment not only has the advantage that it can be manufactured at a lower cost; it has a special advantage in that no light at all is thrown back through the arc. The light, which is radiated by the light column approximately along the reflector's rotational axis toward the rear and which would be reflected from a slightly blunt tip of the indented portion toward the arc, instead passes through the hole and leaves the reflector toward the rear.

It must be taken into account that the arc of a tubular bulb is generally longer than wide. The curvature of the indented portion and the diameter of the hole should be dimensioned so that all light radiated toward the rear is directed forward in a path outside the ends of the arc.

Through this hole, the ambient temperature around the bulb can be influenced.

During the installation or insertion of the bulb, this hole can be used in a particularly advantageous manner to adjust the bulb, both by hand and automatically with the aid of one or more light-sensitive cells.

The light passing through the hole toward the rear only amounts to a very small percentage of the total light of the bulb. Therefore, its effect on the efficiency of the lamp is negligible.

Finally it should be noted that the light passing through the hole can also be used for purposes of illumination, e.g., to slightly brighten a ceiling or a back-ground.

Another improved embodiment of the invention is characterized in that the rear section of the reflector is separable from the adjoining section of the reflector, and that its front edge is provided with a slot at two diametrically opposed points, the width of which slot is greater than the diameter of the bulb. This embodiment of the invention permits the bulb to be inserted into the rear section of the reflector from the front after the front section of the reflector has been removed. In this embodiment, the rear section of the reflector may be permanently connected with the lamp housing. This rigid connection is advantageous particularly because the exact alignment of the reflector's rear section, which has a greater curvature than the front section, is

particularly important to an accurate guidance of the light.

The front edge of the reflector's rear section and the rear edge of the reflector's adjoining section advantageously have outwardly projecting, circumferential ledges of complementary shape. These ledges permit the front section of the reflector to be guided, e.g., in special guides, close to the rear section of the reflector after the bulb has been inserted. The ledges of complementary shape cause the optical axis of the reflector's front section to be aligned in a direction parallel to the optical axis of the reflector's rear section.

A circumferential skirt, which guides the adjoining front section of the reflector during its insertion, may project downwardly from the outwardly projecting ledge of the rear section of the reflector. If the inside diameter of this skirt is, at least in its rear portion, equal to the outside diameter of the ledge provided on the front section of the reflector, this skirt simultaneously forms a locking device which prevents the front section of the reflector from being laterally displaced in relation to the rear section of the reflector.

The reflector may be attached to a lamp housing of sheet metal, cast metal, or plastic, but may also form an integral part of the lamp housing. The inside of the reflector may be provided with a highly polished mirror coating, but the reflector may also have a granular surface.

Further advantages and features of the invention will become apparent from the claims and the following description taken in conjunction with the accompanying drawings.

#### BRIEF DESCRIPTION OF THE DRAWINGS

The invention will now be explained in more detail with reference to several embodiments thereof and in connection with the accompanying drawings, in which:

FIG. 1 is an exploded side view of a reflector according to the invention, of an associated tubular bulb, and of the latter's sockets;

FIG. 2 is a side view taken along the line 2—2 of FIG. 1;

FIG. 3 shows a bulb socket as viewed from the middle of the bulb;

FIG. 4 is a sectional view taken along the line 4—4 of FIG. 3;

FIG. 5 is a sectional view of a reflector, with bulb inserted, according to the invention; and

FIG. 6 is a section through a reflector according to another embodiment of the invention, taken along a direction parallel with the longitudinal axis of the bulb.

#### DETAILED DESCRIPTION OF THE INVENTION

The drawings show only the essential elements of the lamp according to the invention. The bulb housing, the ignition devices, and the individual holders are not shown for purposes of clarity.

Referring to FIG. 1, there is shown a reflector 11, which has a constriction between its rear section 12 and its front section 14. The rear section 12 is spherical in shape, while the front section 14 is approximately paraboloid-shaped. In front, the front section 14 of the reflector 11 passes into a rim section 19, which is formed as part of an inversely installed paraboloid. Shown above the reflector 11 is a tubular bulb 15, which, at its two ends, has flat pinched portions 16. Shown above the lamp 15 are two sockets 17, which re-

ceive the pinched portions 16. The conductors 18 lead to the electrical source for the lamp.

In FIG. 2, the elements shown in FIG. 1 have been turned through an angle of 90°. This representation shows the slot 20, which is provided in the rear section 12 of the reflector.

FIGS. 1 and 2 are exploded views. In the finished lamp, the sockets 17 have been slipped downwardly over the pinched portions 16 of the bulb 15, and the reflector 11 has been slipped upwardly over the bulb 15, so that the arc 25 is located within the reflector. As can be seen from FIG. 1, the non-luminous portions of the bulb 15 and the bases are located outside the reflector. The latter can, therefore, reflect virtually all light emerging from the arc and direct it with any accuracy desired.

FIG. 3 shows a bulb socket 17 as viewed from a point between the two bases. That portion of the socket 17 which receives a pinched portion 16 of the lamp 15 is of U-shaped section as shown in FIG. 4, which is a section taken along line 4—4 of FIG. 3. This socket 17 may contain grooves for guiding the bulb ends 16 and springs for holding these bulb ends in place.

In one embodiment, the light source is a HQI-TS 250 W halogen-metal vapor bulb, which is known from the journal referred to hereinabove. This bulb measures 16.2 cm in length, and its arc is 2.5 cm long. In such bulbs, in which the arc length is only a fraction of the overall length, the invention is used with particular advantage.

FIG. 5 shows a reflector which consists of two separate sections, namely, of a rear section 12 and a front section 14. The rear section 12, which has a greater curvature than the front section 14, encloses substantially only the arc or the luminous portion 25 of the bulb 15, which is shown only fragmentarily. Both sections of the reflector are substantially axially symmetrical. In the region of its central axis, the rear section 12 of the reflector is indented or pressed in forward in the direction of the central axis. This indented portion 31 is completely symmetrical about the central axis of the reflector. Toward the front, the indented portion 31 tapers to a tip 32.

As can be seen from this figure, all the light which is radiated by the arc 25 of the bulb 15 into the rearward space behind the bulb is directed by the reflector's rear section around the arc 25.

Provided at the front edge of the rear section 12 of the reflector is an outwardly projecting, circumferential ledge 41. A skirt 43 projects from the outer edge of this ledge 41 obliquely toward the front. The rear edge of the front section 14 of the reflector also has an outwardly projecting, circumferential ledge 42. The outside diameter of this ledge 42 is exactly equal to the inside diameter of the skirt 43 in its rear portion. In this way, the skirt 43 acts as a locking device which prevents the front section 14 of the reflector from being laterally displaced in relation to the rear section 12. The two ledges 41 and 42 are shown as flat rings. However, they may also have concentric depressions and protuberances, with the shape of the ledge 42 being always complementary to that of the ledge 41.

FIG. 6 shows another embodiment of the reflector according to the invention which has been turned through an angle of 90° in relation to the reflector of FIG. 5. The reflector of FIG. 6 has its indented portion 31 cut off in front. The portion 31 therefore has a hole

34, which is concentric with the central axis of the reflector. This hole 34 also permits the bulb to be adjusted in a particularly simple and quick manner.

The front edge of the reflector's rear section 12 has a slot 40 at two diametrically opposed points. The width of this slot 40 is greater than the diameter of the bulb 15.

If the bulb 15 is to be replaced, the front section 14 of the reflector is first removed, and the bulb 15 is then taken out from the front and replaced by another bulb.

The reflector 11 may be fastened to a lamp housing of sheet metal, cast metal, or plastics, but it may also form an integral part of the lamp housing. Its inside surface may be provided with a highly polished mirror coating, but it may also advantageously be granular. This reflector 11, which, except for the slot 20 for receiving the bulb 15, is rotationally symmetrical and produces a completely symmetrical cone of light. It is deep drawn, so that it does not glare even if one looks directly into it as long as one does not look directly into the arc of the bulb 15. With the described form of the reflector 11, a lamp efficiency is achieved which is considerably higher than has been possible thus far.

While the invention has been described with reference to certain specific embodiments thereof, it is evident that various modifications and/or substitutions may be made to the subject lamp assembly without departing from the spirit of the invention. Therefore, it is intended that the invention be limited only by the scope of the claims appended hereto.

What is claimed is:

1. An electric lamp which produces a rotationally symmetric light beam with a very high illuminating efficiency, comprising a reflector having two diametrically opposed apertures, said reflector being rotationally symmetric about an axis parallel to the light beam of the lamp and a tubular-shaped discharge bulb extending through said apertures and having an illuminating arc of a length which is short in comparison to the total bulb length, said opposed apertures being of a size greater than the diameter of said bulb, said apertures terminating immediately forward of said bulb in the direction of the light beam and being located so that said reflector encloses essentially only said short illuminating arc portion of the bulb, the residual major portion of said bulb extending on the outside of said reflector.

2. An electric lamp according to claim 1, wherein said reflector has a rear section and a front section, said rear section being adapted to enclose said bulb and being of greater curvature than the front section.

3. An electric lamp according to claim 2, wherein there is a constriction between the rear section and the front section.

4. An electric lamp according to claim 1, wherein each of said apertures extends from immediately for-

ward of said bulb rearwardly along the entire length of the reflector to a point where said apertures meet one another, thereby forming a single slot the width and depth of which are greater than the diameter of the bulb, whereby the reflector may be removed from said lamp and said bulb replaced along the direction of said reflector axis.

5. An electric lamp according to claim 2, wherein the rear section of the reflector is spherical in shape.

6. An electric lamp according to claim 2, wherein the front section of the reflector is approximately paraboloid-shaped.

7. An electric lamp according to claim 6, wherein the front section of the reflector further comprises a rim section which is shaped as part of an inversely applied paraboloid.

8. The electric lamp as defined by claim 1, wherein the length of the illuminating arc portion of said bulb in relation to the total length of the bulb is in a ratio of about 48:205.

9. The electric lamp as defined by claim 1, wherein the length of the illuminating arc portion of said bulb in relation to the total length of the bulb is in a ratio of about 25:162.

10. The electric lamp as defined by claim 1, wherein the length of the illuminating arc portion of said bulb is less than about 25% of the total length of the bulb.

11. An electric lamp according to claim 1, wherein said reflector comprises separable front and back sections, said back section having at its front edge the said two diametrically opposed apertures, whereby upon separation of said front section from said back section, the bulb may be replaced along the direction of said reflector axis.

12. An electric lamp according to claim 11, wherein the reflector is substantially axially symmetrical, and in the rear in the region of its central axis the reflector is indented toward the front in the direction of said central axis.

13. An electric lamp according to claim 12, wherein the indented portion of the reflector is formed into a tip in front.

14. An electric lamp according to claim 13, wherein the tip of the indented portion is cut off, thereby forming an aperture.

15. An electric lamp according to claim 11, further comprising outwardly projecting, circumferential ledges of complementary shape at the front edge of the rear section of the reflector and at the rear edge of the front section of the reflector.

16. An electric lamp according to claim 15, further comprising a circumferential skirt projecting downwardly from the outwardly projecting ledge of the rear section of the reflector.

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