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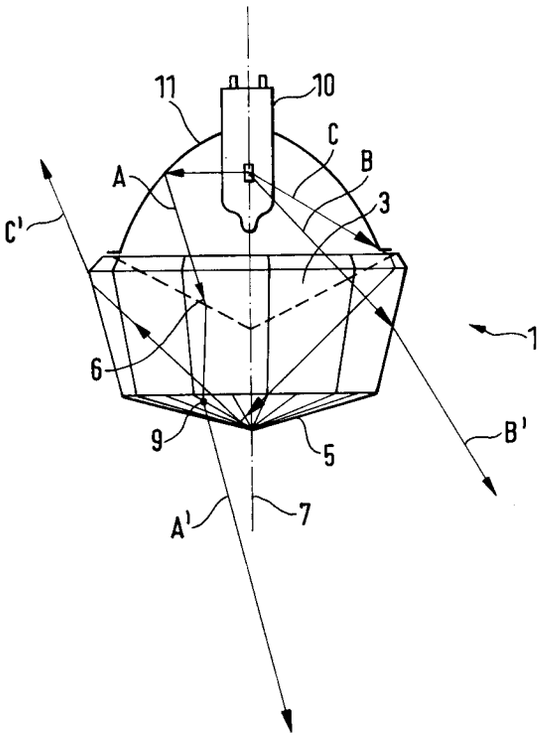
(54) A transparent element for varying the light rays from an illuminating means.

(57) The invention relates to an element (1) made of transparent material for varying the light rays from an illuminating means (10), whereby light rays (B) hitting the element at an angle of more than 45° from the optical axis of the element are deflected at least partly so as to be emitted by the element at an angle of less than 45° (B').

FIG.3



EP 0 621 440 A1

The present invention relates to an element made of transparent material for varying the light rays from an illuminating means.

Illuminating means are used to a great extent for illuminating useful architectural areas and business areas. Their design and construction are aimed essentially at obtaining high light efficiencies at a low expenditure of energy. The disadvantages of most illuminating means hitherto used are that great quantities of light cannot be utilized due to light scatter and that this light scatter furthermore has an undesirable and unfavorable dazzling effect. Reflectors of illuminating means frequently have a shield behavior that does not meet German industrial standard recommendations (DIN 5035), and corrections of the shield behavior impair the reflector's light distribution curve.

The present invention is based on the problem of providing an element for optimally correcting the shield behavior of illuminating means or reflectors, taking account of not only lighting aspects but also esthetic aspects.

The invention is based on the idea of providing the shield by a transparent body whose geometry is such that this is achieved by refraction and inner reflection.

The object of the present invention is an element made of transparent material for varying the light rays from an illuminating means, whereby light rays hitting the element at an angle of more than 45° from the optical axis of the element are deflected at least partly so as to be emitted by the element at an angle of less than 45°.

If such an element is placed before an illuminating means or a reflector one can obtain an optimal illumination of the surface to be illuminated while simultaneously suppressing the dazzling effect.

In a preferred embodiment the predominant portion of light rays are deflected so as to be emitted by the element at an angle of less than 45°.

This makes it possible to utilize the light scatter fraction optimally for illuminating a room or workplace.

It is further preferred to simultaneously deflect a portion of the light scatter such that the light rays are emitted by the element at an angle of less than 90° from the optical axis in the direction of the incident light rays.

In this embodiment a portion of the light scatter can thus be used to illuminate the ceiling, which is advantageous under certain room conditions.

The outer geometrical shape of the element is widely variable. For optical-physical reasons, however, a hemispherical, ellipsoid, truncated-cone or torus shape is preferred.

If the element has a hemispherical, ellipsoid or truncated-cone shape it advantageously has a recess on the base facing the impinging light rays. This recess is preferably formed by a spherical surface or is itself conic for optical-physical reasons.

It is particularly preferred to form the element as a truncated cone with a conic depression provided in its base.

In a further preferred embodiment an apex is formed on the cut surface of the truncated cone parallel to the base. Obviously the lateral surface of the apex is disposed at an angle to the lateral surface of the truncated cone and the truncated cone and apex are of integral design.

To obtain an optimal shield the transparent element preferably has a certain geometry. Angle α between the surface of the recess and the optical axis is preferably selected to be between 50 and 80°. It is particularly suitable for angle α to be between 60 and 70°, in particular 65°. In the case of the spherical recess this requirement means that angle α is to be maintained between the tapering tangent on the spherical surface and the optical axis.

Angle β between the lateral surface of the element and the optical axis is preferably between 2° and 20°. It is particularly preferred for angle β to be between 8° and 13°, in particular 10.5°.

If the element is a truncated cone and an apex is formed on the truncated cone, angle γ between the lateral surface of the apex and the optical axis is preferably between 60 and 90°. It is particularly preferred for angle γ to be between 70° and 80°, in particular 75°.

If the element has a torus shape its dimensions are widely variable. However it is preferable for the torus to have three surface areas inclined at certain angles from one another. It is suitable for angle of inclination α between the side facing the incident light and a vertically extending adjacent surface to be between 10 and 15°, preferably between 12 and 14°, and in particular 13.6°. Angle of inclination β between vertical surface and underside of the torus is suitably between 9 and 14°, preferably between 10 and 15°, and in particular 12°.

The design features described above permit, singly and in combination, an extremely compact design of the shield element so that the size of the reflector to be shielded is only minimally exceeded in diameter.

The functionality of the element takes account of the following general reflection properties.

1. The lamp's direct radiation, i.e. the radiation emitted by the lamp downward to the lighting plane, is deflected to the vertical optical axis. Many illuminants have the property that the glass portions surrounding the light-emitting me-

dium (e.g. a spiral-wound filament) cause an additional light scatter due to lamp glass reflection and thus constitute an additional source of glare. This light scatter fraction is also captured by the inventive transparent element.

2. The reflector's radiation, i.e. the radiation directed to the lighting plane via the reflector, remains virtually unaffected. The transparent element according to the present invention also takes up the reflector's radiation which causes an additional light scatter through the glass portion surrounding the light-emitting medium on the reflector, and deflects it.

The optical-geometrical shape of the inventive transparent element permits it to capture all light emerging downward from the reflector, including the light scatter due to the illuminant construction.

Ultimately, only the desired reflector radiation is transmitted. The remaining light scatter from the lamp's direct radiation, the lamp glass reflection and the reflector is deflected upward to the ceiling by total reflection and/or predominantly toward the optical axis.

In further preferred embodiments the individual surfaces of the transparent element, in particular the lateral surface of the truncated cone or the lateral surface of the apex, if any, or the surface of the torus, can be faceted.

A preferred material is glass.

The faceting of the element achieves in particular a decorative effect since a certain light scatter fraction is decomposed spectrally by the facets.

In the following the invention shall be explained in more detail with reference to drawings showing exemplary embodiments.

Fig. 1 shows a schematic representation of an embodiment of the inventive transparent element,

Fig. 2 shows a top view of the element according to Fig. 1,

Fig. 3 shows an inventive element with a schematically shown path of rays, and

Fig. 4 shows another preferred embodiment of an inventive element, likewise with a path of rays.

Fig. 1 shows inventive element 1 for varying the light rays from an illuminating means in a preferred embodiment. The element is formed as a truncated cone. Apex 5 is formed on cut surface 4 of the truncated cone parallel to base 2. Lateral surface 8 of element 1 and lateral surface 9 of apex 5 are faceted. Base 2 of the truncated cone has conic recess 3 formed therein. Conic recess 3 extends centrally inward from lateral surface 8 of element 1.

Element 1 is of integral design and is preferably made of cut and polished crystal glass. However pressed glass or another transparent refractive material, such as certain plastics, can also be used.

The faceting of transparent element 1 is desirable particularly for esthetic reasons but also has an influence on the shield effect of the element.

In the embodiment shown, conic recess 3 is formed so that angle α between surface 6 of conic recess 3 and optical axis 7 shown by the dash-dot line is 65°. The inclination of the truncated cone is selected so that angle β between lateral surface 8 of the truncated cone and optical axis 7 is 10.5°. Angle γ between lateral surface 9 of apex 5 and optical axis 7 is 75°.

The position of surface 6 was fixed with consideration of the reflector's radiation and the lamp's direct radiation in such a way that the reflector's radiation is refracted to vertical optical axis 7 while the lamp's direct radiation is refracted toward lateral surface 8 of the truncated cone so that the emerging rays are deflected very sharply to the vertical optical axis or totally reflected in part thereon, thereby permitting the first step of de-glaring the reflector.

The inclination of lateral surface 8 of the truncated cone was fixed at 10.5° with consideration of surface 6 of conic recess 3. However, for an optimal shielding effect lateral surface 8 must simultaneously take account of the so-called Fresnel reflection, i.e. the light fraction reflected on the boundary surface between optically denser medium and optically thinner medium, although no total reflection exists, so that no rays can emerge in the shield area on the opposite surface. This is achieved by coordinating the inclination of surface 8 with lateral surface 9 of apex 5, if any, and, if there is no apex, with cut surface 4 of the truncated cone so that all Fresnel reflection of lateral surface 8 hits surface 9 or 4. There it is totally reflected and leaves the shield body toward the ceiling so that this fraction of glare is also eliminated and put to good use for lighting up the ceiling.

Lateral surface 9 of apex 5 is related to surface 6 of conic depression 3 in that the rays of the reflector's light cone slightly refracted there to the vertical optical axis are refracted again approximately into their original position when emerging from the shield body. Virtually the same light distribution as originally caused by the reflector thus arises on the collecting plane, i.e. the useful plane.

In the embodiment of the inventive transparent element shown, wherein angle α is 65°, angle β is 10.5° and angle γ is 75°, height *a* of the truncated cone is fixed at 25.1 mm, and overall height *b* including the formed apex is 31.85 mm. Diameter *c* of the element is 59.3 mm° Obviously these dimensions can vary within wide limits in various designs and be coordinated with one another in accordance with the light source and other requirements.

The inventive element can be a pressed glass body but its surface should be polished, e.g. acid-polished, to ensure optical functionality. However the element is preferably made of cut and polished crystal glass.

To increase the decorative effect it is recommendable to give the lateral surface of the truncated cone a faceted design. The faceting should be provided in an odd number, e.g. elevenfold, so that the unavoidable light scatter reflection and light scatter refraction are radially offset. In other words, the odd number of facets means that when one looks into the shield element via one of the facets on lateral surface 8 of the truncated cone no facet is visible on the opposite side whose light scatter reflection could be reflected into the shield area, but rather two facets offset at an angle whose light scatter reflection is deflected. This is apparent from Fig. 2.

Conic surface 6 of conic recess 3 and lateral surface 9 of apex 5 can be unfaceted. But faceting is advantageous for heightening the decorative effect.

Fig. 2 shows the inventive element according to Fig. 1 in a top view. Lateral surface 8 of element 1 is faceted, as is lateral surface 9 of formed apex 5.

Fig. 3 shows schematically three paths of rays through inventive element 1 according to Figs. 1 and 2. Element 1 is placed here before illuminant 10 in reflector 11. Light ray *A* incident substantially parallel to optical axis 7 of the element (the reflector ray) is deflected on surface 6 of conic recess 3 and on lateral surface 9 of apex 5 and leaves the element at an angle of less than 45° to optical axis 7 as ray *A'*.

Obliquely incident light ray *B*, which is incident at an oblique angle of more than 45° from optical axis 7, is refracted on surface 6 of conic recess 3 toward the vertical, passes through element 1 and is refracted again on lateral surface 8. Element 1 thus emits this lamp ray *B* as ray *B'* at an angle of less than 45°.

Lamp ray *C*, which is incident at an even more oblique angle (about 60°), is refracted on surface 6 of recess 3, hits lateral surface 8 of the truncated cone, is reflected there away from the vertical in the interior of the element, hits lateral surface 9 of apex 5, is again reflected away from the vertical in the interior, again hits lateral surface 8 where it leaves element 1 at an angle of less than 90° from optical axis 7 toward the ceiling. This light ray from the lamp, which otherwise forms a light scatter fraction, is thus used partly to illuminate the element itself and to light up the ceiling (as ray *C'*).

Fig. 4 shows a further embodiment of inventive element 1 in the form of a torus. The torus made of transparent material preferably bears facets 13 both on the outer side and on the inner side.

In this embodiment the central light cone passes through element 1 without hindrance. The light scatter, which is incident at an angle of more than 45°, is deflected at an angle of less than 45° and/or reflected upward. Light rays (*D*, *E*, *F*) from spiral-wound filament 10 or reflector 11 are deflected or refracted by the same laws as described in Fig. 3. Light rays radiating from above at an angle of less than 45° pass without hindrance through bore 12 in the torus as a so-called reflector light cone (ray *D*, *D'*). Light rays radiated at an angle of more than 45° from the optical axis hit upper surface 8.1 on the torus and, depending on the obliqueness of the angle, are either refracted toward the axis of incidence, i.e. fed to reflector light cone *D'* as ray *E'*, or multiply reflected in the interior of the torus and refracted upward. These light rays again serve to light up the ceiling and illuminate the torus itself.

An inventively used torus has three surfaces (8.1, 9.1 and 10') inclined at certain angles from one another. Its overall height is preferably 16.5 mm, the diameter of bore 12 preferably 60 mm. The diameter of the total element is then preferably 127 mm. Obviously these dimensions are freely variable depending on the application.

Angle of inclination α between surface 8.1 and surface 9.1 is suitably between 10 and 15°, preferably 13.6°. Angle of inclination β between surfaces 9.1 and 10' is suitably between 9 and 14°, preferably 12°.

In all cases and embodiments it is further expedient to design element 1 so that it is adapted to be displaceable along optical axis 7 relative to the light source.

The inventive elements are particularly intended for cold-light reflector lamps and are preferably dimensioned so that all ray distributions (from narrow- to wide-angle) can be captured optimally by the element.

Claims

1. An element made of transparent material for varying the light rays from an illuminating means, **characterized** in that light rays hitting the element (1) at an angle of more than 45° from the optical axis (7) of the element are deflected at least partly so as to be emitted by the element at an angle of less than 45°.

2. The element of claim 1, **characterized** in that the predominant portion of light rays are deflected so as to be emitted by the element (1) at an angle of less than 45°.

3. The element of claim 1 or 2, **characterized** in that the light rays are deflected in part so as to be emitted by the element (1) at an angle of less than 90° from the optical axis (7) in the direction of the incident light rays.

4. The element of any of claims 1 to 3, **characterized** in that the element (1) has a hemispherical shape.

5. The element of any of claims 1 to 3, **characterized** in that the element (1) has an ellipsoid shape.

6. The element of any of claims 1 to 3, **characterized** in that the element (1) has a truncated-cone shape.

7. The element of any of claims 1 to 3, **characterized** in that the element (1) has a torus shape.

8. The element of any of claims 1 to 6, **characterized** in that the element (1) has a recess (3) on the base (2) facing the impinging light.

9. The element of claim 8, **characterized** in that the recess (3) is formed by a spherical surface.

10. The element of claim 8, **characterized** in that the recess (3) is conic.

11. The element of claim 6, **characterized** in that an apex (5) is formed on the cut surface (4) of the truncated cone parallel to the base (2).

12. The element of any of claims 1 to 6 and 8 to 11, **characterized** in that angle α between the surface (6) of the recess (3) and the optical axis (7) is between 50° and 80°.

13. The element of claim 12, **characterized** in that angle α is between 60° and 70°.

14. The element of any of claims 1 to 5 and 8 to 13, **characterized** in that angle α between the lateral surface (8) of the element (1) and the optical axis (7) is between 2° and 20°.

15. The element of claim 14, **characterized** in that angle β is between 8° and 13°.

16. The element of claim 11, **characterized** in that angle γ between the lateral surface (9) of the apex (5) and the optical axis (7) is between 60° and 90°.

17. The element of claim 16, **characterized** in that angle γ is between 70° and 80°.

18. The element of any of claims 1 to 6 and 8 to 17, **characterized** in that the lateral surface (8) of the element (1) is faceted.

19. The element of claim 11, **characterized** in that the lateral surface (9) of the apex (5) is faceted.

20. The element of claim 7, **characterized** in that the torus has surfaces (8.1, 9.1 and 10') that are inclined toward one another.

21. The element of claim 20, **characterized** in that angle of inclination α between the surface (8.1) and the surface (9.1) is between 10° and 15°.

22. The element of claim 20 or 21, **characterized** in that angle of inclination β between the surface (9.1) and the surface (10') is between 9° and 14°.

23. The element of any of claims 20 to 22, **characterized** in that the surfaces (8.1, 9.1, 10') have facets (13).

24. The element of any of claims 1 to 23, **characterized** in that the element (1) is made of cut glass.

25. The element of claim 24, **characterized** in that it is made of colored glass.

26. The element of any of the above claims, **characterized** in that it is adapted to be displaceable along the optical axis (7).

FIG.1

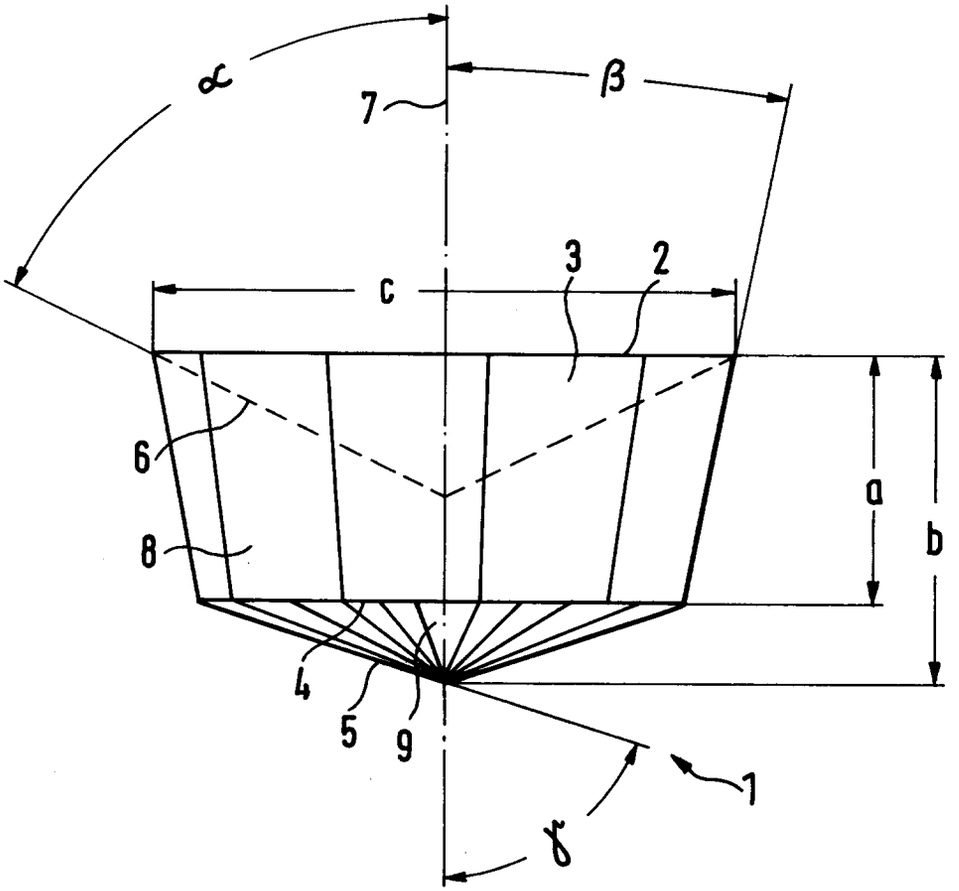


FIG.2

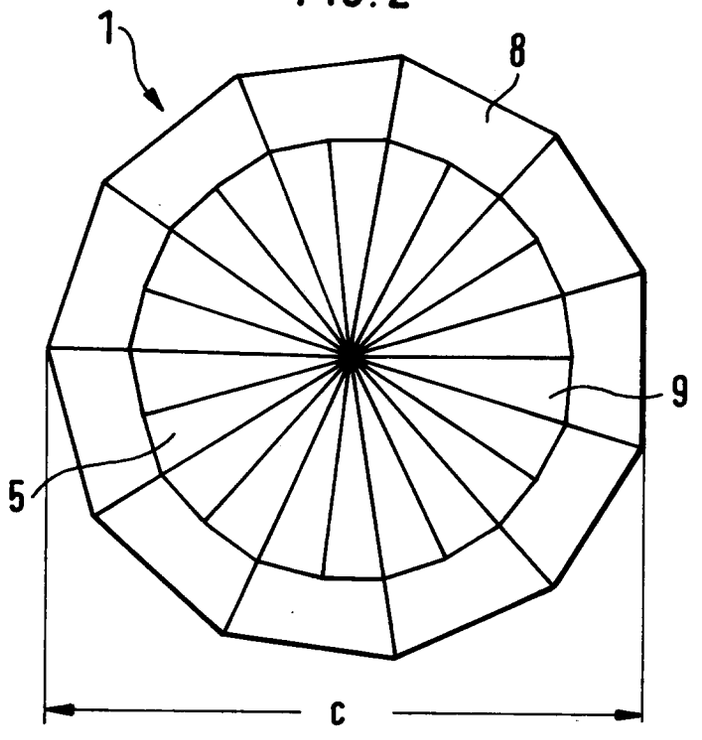


FIG.3

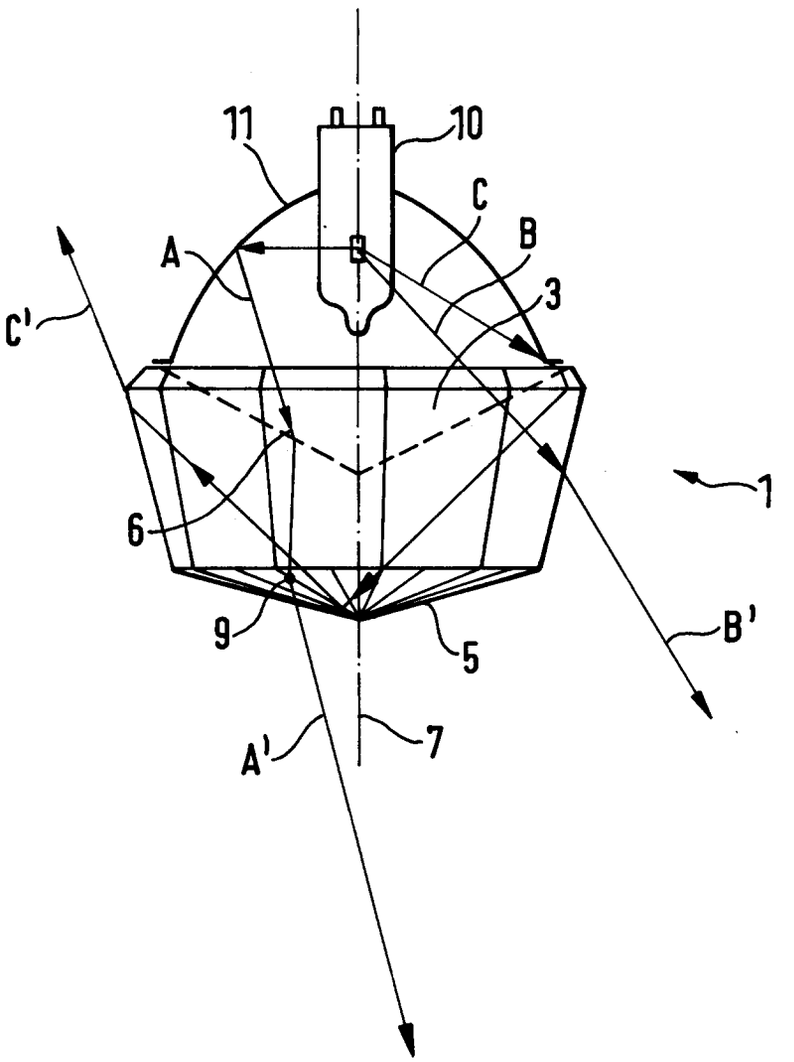
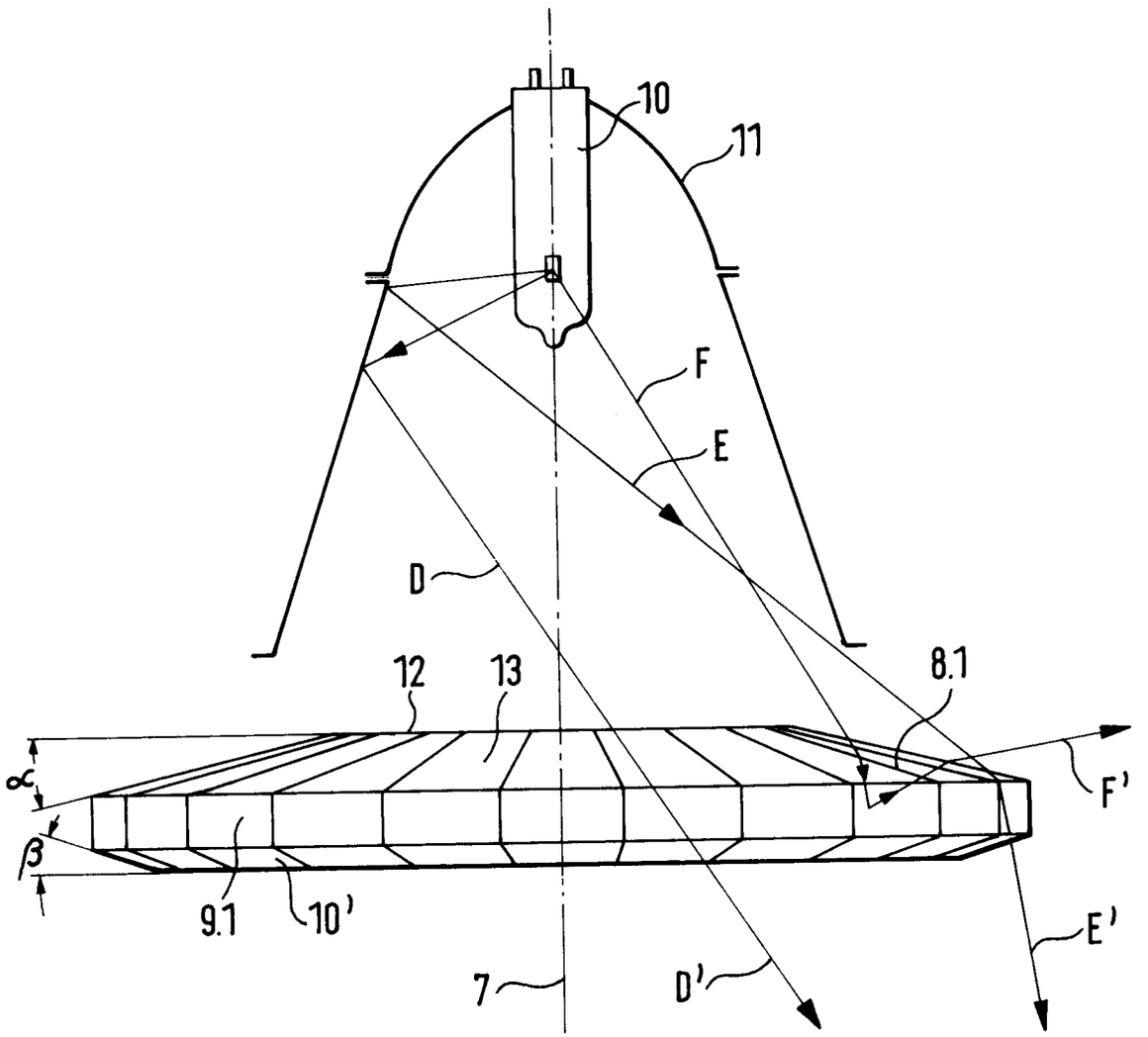


FIG. 4



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EUROPEAN SEARCH REPORT

Application Number
EP 93 11 7832

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	FR-A-817 059 (FORGES ET ATELIERS DE CONTRUCTIONS ELECTRIQUES DE JEUMONT) * the whole document *	1,2	F21V5/04 F21V5/02
X	EP-A-0 380 663 (NAUCHNO-PROIZVODSTEVENNOE OBIEDINENIE PO AUTOELEKTRONIKE...) * page 6, line 21 - page 19, line 10; figures *	1,2	
X	US-A-5 173 810 (YAMAKAWA) * column 2, line 66 - column 5, line 12; figures *	1,2,4,8	
A	DE-B-10 34 116 (HENSOLDT & SÖHNE) * figures *	1	
A	US-A-4 969 074 (DAVIS)		
A	US-A-3 711 704 (SPITERI)		

TECHNICAL FIELDS SEARCHED (Int.Cl.5)

F21V

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	22 July 1994	Mouton, J

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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