(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
3 October 2013 (03.10.2013)

(10) International Publication Number
WO 2013/144005 A1

(51) International Patent Classification:
F21V 7/00 (2006.01) *F21V 7/09* (2006.01)

(21) International Application Number:
PCT/EP2013/056051

(22) International Filing Date:
22 March 2013 (22.03.2013)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
MI2012A000488 27 March 2012 (27.03.2012) IT

(71) Applicant: **FAEL S.P.A.** [IT/IT]; Via Lovanio, 5, I-20121 Milano (IT).

(72) Inventor: **SANGIORGIO, Flavio Mauro**; Via Roma, 12, I-20853 Biassono (mb) (IT).

(74) Agents: **MITTLER, Enrico** et al.; Viale Lombardia, 20, I-20131 Milano (IT).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

(54) **Title**: ROTATIONAL ASYMMETRIC PARA-ELLIPSOIDAL AND BIELLIPSOIDAL REFLECTORS FOR LIGHTING INSTALLATIONS.

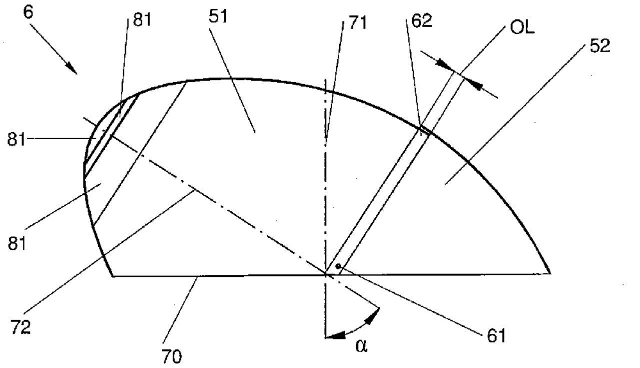


Fig. 10

(57) **Abstract**: The object of the present invention is a procedure for construction of a rotational asymmetric assembled reflector (6, 12) for projectors for lighting installations, with an angle of asymmetry, a, between an axis corresponding to a light beam of maximum light intensity and an axis orthogonal to a light output plane, comprising construction of a rotationally symmetrical solid (5, 10) symmetrical with respect to an axis of rotation (X), formed by two rotationally symmetrical solids (65, 66, 125, 126) having a same tangent plane (69, 129) at common points (68, 128) along a conjunction line (67, 127) of said rotationally symmetrical solids (65, 66, 125, 126); cutting of said rotationally symmetrical solid (5, 10) according to a cutting plane (60) inclined to an axis (Y) orthogonal to said axis of rotation (X), by an angle corresponding to the said angle of asymmetry, a, aimed at obtaining two parts (51, 52, 111, 112); rotation of about 180 ° of one (52, 112) of the two parts obtained by means of said cutting around an axis orthogonal to a plane (X, Y) containing said axis of rotation (X) and its orthogonal axis (Y); assembling of the parts (51, 52, 111, 112) thanks to connecting means (61, 121); overlapping of a quantity (OL) of one part (52, 112) with respect to the other part (51, 111); adjustment of the inclination of the parts (51, 52, 111, 112) according to a optimum light performance; assembling (62, 122) of the parts (51, 52, 111, 112). (Fig. 10).

WO 2013/144005 A1

Rotational asymmetric para-ellipsoidal and biellipsoidal reflectors for lighting installations.

* * * *

DESCRIPTION

The present invention relates to rotational asymmetric para-ellipsoidal and biellipsoidal reflectors for lighting installations.

Symmetrical projectors are provided with both trapezoidal and rotational reflectors and allow values of maximum light intensity (about 15000 candelas) to be obtained at around 0° inclination with respect to the vertical perpendicular to the glass; the light intensity of said symmetrical projectors quickly decreases moving away from 0°. Accordingly, symmetrical projectors are especially useful in sport installations with color TV shooting where a high illuminance is required and therefore, a high light intensity in a restricted area of the sport ground is desired. The reflector needs to be greatly inclined if a high light intensity in an area far away from the vertical is desired.

However, the inclination of the symmetrical reflector yields a light pollution (upward light scattering) which makes symmetrical reflectors not usable in some circumstances due to limitations set by international rules. Figure 25 shows a known symmetrical reflector SR inclined by an angle α, whose glass V is passed through perpendicularly by the maximum intensity ray MIR emitted by a lamp L. The reflector inclination β generates an upward scattered luminous flux (light pollution).

Asymmetric projectors, normally with trapezoidal reflector, allow to obtain a maximum light intensity far away from 0°, but it is significantly inferior (at most 1000-1400 candelas at an angle of asymmetry of 40°-60°).

Therefore, trapezoidal asymmetric projectors solve the light pollution problem as they have the glass parallel to the ground, but they provide a much lower light intensity (10 times lower) than symmetrical projectors. This creates considerable problems when large spaces such as sport grounds or the like need to be illuminated. Figure 26 shows a known asymmetric reflector AR with an angle of asymmetry α, whose horizontal glass V is passed through by the maximum intensity ray MIR emitted by a lamp L, inclined according to said angle of asymmetry α with respect to the vertical. Note the absence of upward scattered luminous flux (light pollution).

If asymmetric projectors are used to limit the light pollution, their number must be increased in order to obviate the low light intensity of each reflector, thereby increasing the installation costs and difficulties.

Moreover, asymmetric projectors have a non negligible light intensity value at 0° degrees (e.g. about 250 candelas), which causes a non ideal illuminance on the ground, for example on football fields.

International standards exist which define the uniformity of illuminance U1 and U2 the manufacturers must comply with. In particular, E being the illuminance value, the following is defined:

U1 = E minimum / E average;

U2 = E minimum / E maximum;

E minimum = minimum illuminance of the field;

E maximum = maximum illuminance of the field;

E average = average illuminance of the field.

According to the rules, U1 must be greater than or equal to 0.7 whereas U2 must be greater than or equal to 0.5.

If a plurality of asymmetric projectors is mounted on a single pole, the overall maximum intensity increases at the angle of asymmetry (e.g. 40°) but the light intensity increases even more beneath the pole, i.e. the increasing of theE average and the E maximum as a result decreases the values of U1 and U2 till to reach values below the thresholds required by the rules.

This means that if an international football field needs to be illuminated, with the need of having high light intensity values, it is necessary to use inclined symmetrical projectors that greatly increase the light pollution as a result. Only international exceptions to the rules allow the use of said symmetrical projectors of high light pollution level in sport grounds with color TV shooting, due to the impossibility of having high light intensities and high angles without upward scattered light.

In order to illuminate smaller football fields, where said exception is not applicable, the manufacturer is forced to use asymmetrical projectors, increasing the number thereof and increasing the pole height in order to compensate the lack of uniformity of illuminance. As a consequence, costs also increase by 60%.

Assembled asymmetric reflectors of circular shape are known which reproduce an optical pattern given by the composition of different curvatures. In particular, said curvatures are overlapping conical sections reciprocally connected to reflect the light energy irradiated by the lighting installations in an optimum and continuous manner.

The prior art of assembled asymmetric reflectors, both of circular and of rectangular shape, is represented by various patents.

Document WO0077445 describes an assembled asymmetric reflector generated by a series of hyperboles that allow the elimination of shadows, energy saving and a pleasant lighting to be provided. The assembled asymmetric reflector is formed of: a first section constructed along the curvature of a first hyperbole; a second section constructed along the curvature of a second hyperbole; a third section constituting an arch. Said three sections are reciprocally inclined in order to generate contiguous schemes of reflected light on a illuminated surface.

Document EP2093482 describes a reflector comprising a light source, of the type formed of three zones: the reflector base is occupied by a parabolic surface; the end ends with an elliptical surface; a transition zone exists between the two zones. The reflector thus assembled allows the amount of reflected light combined with direct light to be controlled.

Document EP2019255 describes a reflector formed by the combination of parabolic and elliptical sections that allow direct light and reflected light to be combined.

Document US4942507 describes a reflector having an elliptical shape in a plane $Y = 0$ and a parabolic shape in a plane $Z = 0$, Y and Z belonging to a

Cartesian space having coordinates x, y and z, generating a rectangular light field and a uniform light density. The reflector shape is obtained by means of a geometrical formula based on the hyperbole and parabola parameters.

Document EP1126210 describes a reflector of an automotive light wherein a first elliptical reflecting surface has the focus coinciding with that of a second elliptical reflecting surface, the optical axis of the first reflecting surface being inclined by a right angle with respect to that of the second reflecting surface. A parabolic reflecting system has the focus coinciding with the second focus of said second elliptical reflecting surface, the optical axis coinciding with the illuminance direction.

Document GB1183481 describes a reflector of which the surface is composed of a parabola inclined so as to intersect axis Y of a hyperbole at the common focus, and thus rotated according to its axis so as to generate a paraboloid. In particular, the finding is adapted to be configured in various combinations with surfaces having paraboloid, hyperboloid, cylindrical parabolic, cylindrical hyperbolic or flat shape.

Document WO2011107901 describes an optical device comprising an area formed of a first surface having a first Bezier curve and a second surface having a second Bezier curve, said Bezier curves being arranged so that the optical device is rotational asymmetric with respect to its central axis, causing a homogeneous light distribution in horizontal and vertical direction on a predefined lighting area subtended by a certain angle.

Document WO2010146494 describes a lighting device comprising a reflector constructed about a main axis, wherein the rear part comprises a portion rotated with respect to an axis perpendicular to said main axis, obtaining an asymmetric distribution of the light at the outlet of said rear part. As an alternative, the rear part is of conical or of parabolic shape.

Therefore, the prior art of asymmetric reflectors knows the composition technique of surfaces generated by different conical curves for optimizing the light intensity and efficiency.

A problem at the basis of the use of asymmetric reflectors is represented by the difficulty to control the direction and distribution of the light intensity in space, i.e. the practical implementation of the angle of asymmetry in project.

This problem is mainly felt in rotational asymmetric reflectors due to the onset of multiple reflections of the optical path, observed on most planes passing by the main optical axis of the reflector. For this reason, the prior art of asymmetric reflectors is concentrated on the development of rectangular projectors, provided with an optical path easier to control, leaving the problem of the efficiency of rotational asymmetric projectors almost unsolved.

According to the prior art, the architecture of a rotational asymmetric reflector is based on: the construction of a combined curve by means of different conical sections; the rotation of the combined curve by a round angle with respect to the optical axis of the reflector; the generation of a spatial figure; the edging of the spatial figure. From the construction viewpoint, a circular asymmetric reflector requires: a forming machine of a three-dimensional solid capable of reproducing the outline of the spatial figure; three-dimensional connection and cutting means. The device finish is based on the choice of materials having strong reflecting features and on the application of metal coatings on the reflecting surfaces.

The object of the present invention is to define a procedure for the construction of a projector with rotational asymmetric reflector by which the angle of asymmetry is easily controlled, i.e. constructing the reflector with the project asymmetry angle is easy.

A second object of the present invention is to provide a projector with rotational asymmetric reflector which has maximum light intensity values similar to symmetrical projectors, and at least with the same efficiency.

A further object of the present invention is to allow the lighting of important sport facilities and color TV shooting with distributed lighting only with asymmetric reflectors without generating light pollution, where by distributed lighting it is meant the distributed positioning of the projectors above or below the coverage of the tribunes of the stadium.

Yet a further object of the present invention is to provide a projector with rotational asymmetric reflector with values of uniformity of illuminance complying with the rules in low and medium level football fields without increasing the height of poles and without generating light pollution.

According to the invention, such object is achieved with a procedure for the construction of a rotational asymmetric assembled reflector for projectors for lighting installations according to claim 1.

According to the invention, such further objects are achieved with a procedure for the construction of an assembled rotational asymmetric reflector for projector for lighting installations according to claim 4.

The present invention will be described through some preferred embodiments thereof, given by way of a non-limiting example, with reference to the accompanying drawings, in which:

FIG. 1 shows a geometrical figure in a plane X, Y, in a Cartesian space delimited by three axes X, Y, Z, composed of an ellipse, symmetrical with respect to the Cartesian axes, and of two identical parabolas, symmetrical with respect to axis Y and tangent to the ellipse, related to the present invention;

FIG. 2 shows the geometrical figure of FIG. 1 without the half constructed along the positive stretch of axis 0-X;

FIG. 3 shows a sectional area obtained from the geometrical figure of FIG. 2 without the half constructed along the negative stretch of axis 0-Y, provided with a thickness of a sheet of material used for forming a reflector, according to the present invention;

FIG. 4 and FIG. 5 show axonometric views of a rotationally symmetric solid obtained by rotating the sectional area of FIG. 3 about axis X, according to the present invention;

FIG. 6 and FIG. 7 show a projection view in plane X, Y and an axonometric view of the solid of FIG. 4 and FIG. 5, respectively, divided into two parts according to a plane, parallel to axis Z, inclined by an angle α with respect to axis

Y and translated by a height Y=Y0, according to the present invention;

FIG. 8 shows a projection view in plane X, Y of the two parts of solid of FIG. 6 and FIG. 7, the second part of said solid being rotated by a flat angle with respect to the axis parallel to axis Z and with trace Y=Y0, according to the present invention;

FIG. 9 shows a projection view in plane X, Y of the two parts of solid of FIG. 8, the second part of said solid being translated along the plane, parallel to axis Z and inclined by an angle α, according to the present invention;

FIG. 10, FIG. 11 and FIG. 12 respectively show a projection view in plane X, Y and two axonometric views of the solid of FIG. 9 assembled with hinge fixing elements;

FIG. 13 shows a geometrical figure in a plane X, Y', composed of a first ellipse, symmetrical with respect to the Cartesian axes, tangent to a second ellipse, inscribed to the first ellipse, related to the present invention;

FIG. 14 shows the geometrical figure of FIG. 14 without the half constructed along the positive stretch of axis 0-X;

FIG. 15 shows a sectional area obtained from the geometrical figure of FIG. 14 without the half constructed along the negative stretch of axis 0-Y, provided with a thickness of a sheet of material used for forming a reflector, according to the present invention;

FIG. 16 and FIG. 17 show axonometric views of a rotationally symmetric solid obtained by rotating the sectional area of FIG. 15 about axis X, according to the present invention;

FIG. 18 and FIG. 19 show a projection view in plane X, Y and an axonometric view of the solid of FIG. 16 and FIG. 17, respectively, divided into two parts according to a plane, parallel to axis Z, inclined by an angle α with respect to axis Y and translated by a height Y=Y0, according to the present invention;

FIG. 20 shows a projection view in plane X, Y of the two parts of solid of FIG. 18 and FIG. 19, the second part of said solid being rotated by a flat angle with respect to the axis parallel to axis Z and with trace Y=Y0, according to the present invention;

FIG. 21 shows a projection view in plane X, Y of the two parts of solid of FIG. 20, the second part of said solid being translated along the plane, parallel to axis Z and inclined by an angle α, according to the present invention;

FIG. 22, FIG. 23 and FIG. 24 respectively show a projection view in plane X, Y and two axonometric views of the solid of FIG. 21 assembled with hinge fixing elements;

FIG. 25 shows a known symmetrical reflector;

FIG. 26 shows a known asymmetric reflector.

With reference to figure 1, a shape of a rotational asymmetric reflector for projector for lighting installations according to the present invention derives from a geometrical figure in a plane X, Y composed of an ellipse E symmetrical with respect to the Cartesian axes and of a pair of identical parabolas P, symmetrical with respect to axis Y and tangent to ellipse E in points PE1, PE2, PE3 and PE4.

A closed curvature 1 is formed by stretches of parabola P and by stretches of ellipse E, jointed at points PE1, PE2, PE3 and PE4.

Let's call the outer profile of the flat geometrical figure thus generated "Para-ellipse".

An open curvature 2 is formed by curvature 1 without the half constructed along the positive stretch of axis 0-X. It is noted that said open curvature 2 (figure 2) consists of a parabola P with a known focus suitable for the type of light source tangent in points PE2 and PE3 to an ellipse E. Mathematically, such ellipse E is the only one to be tangent in those points once a focus F1E thereof has been set. The determination of points PE2 and PE3 and of a focus F1E of the ellipse is dictated by the value of the maximum light intensity to be obtained and by allowing the whole light reflected by parabola P to directly exit from the final reflector with a single reflection.

A curve 3 is obtained from the open curvature 2 after the latter has been deprived of the half constructed along the negative stretch of axis 0-Y, provided with a thickness *th* of a sheet of malleable material used to form a reflector, according to the present invention.

A rotationally or revolution symmetrical solid 5 is obtained by rotating curve 3 about axis X (figures 4 and 5).

The flat curve 1 is just the intersection of plane X, Y (or of any other plane containing the axis of rotation X of the rotationally symmetrical solid 5) with the rotationally symmetrical solid 5.

In the practice, said rotationally symmetrical solid 5 is obtained by sheet turning, using especially designed turning molds.

The rotationally symmetrical solid 5, obtained as said by sheet turning, is divided into two parts, 51 and 52, by 3D laser cutting along a cutting plane 60 which is parallel to axis Z and is inclined by an angle α with respect to axis Y (figures 6 and 7).

Said angle α corresponds to the asymmetry angle of the maximum light intensity of the projector, which is normally in the range between 40° and 60°.

Looking at figure 6 it may be seen that the cutting plane 60 does not contain axis Z, but is displaced in the positive direction of axis Y by a stretch Y0 of few millimeters, useful for overlapping parts 51 and 52 as will be clearer hereinafter (figures 8-10).

Part 52 is then rotated by about 180° and assembled to part 51 by means of connecting inserts 61, 62 such as rivets, inserted around the center of the three Cartesian axes and in the proximity of the upper overlapping zone, thereby obtaining an assembled rotational asymmetric para-ellipsoidal reflector 6 that is hereinafter referred to as para-ellipsoid 6 for simplicity.

Part 52 overlaps part 51 by a stretch OL of few millimeters (figure 10) so that the second reflecting part 52 is off axis with respect to the first reflecting part 51. The inserts 61, 62 also allow the inclination of part 52 with respect to part 51 to be changed approximately within a range of +/-20° with respect to the theoretical angle α. Moreover, the connecting inserts 61, 62 constitute a hold for the housing of the reflector to the bearing support structure of the reflector (not depicted).

The possibility of changing the inclination of part 52 allows to calibrate the photometric features of the reflector depending on the equation of ellipse E tangent to parabola P. For example, the relative rotation of the part 52 with respect to the part 51 allows to eliminate the multiple reflections within the geometrical profile of para-ellipsoid 6, optimizing the luminous efficiency of the para-ellipsoid 6, i.e. it allows to prevent multiple reflections between the first reflecting part 51 and the second reflecting part 52.

The determination of focus F1E of the ellipse is defined so that the rays directly exit from the complete final reflector with at most a single reflection on the concave reflecting surface of the para-ellipsoid 6.

Said cutting plane 60 is cut so that the beam reflected on the reflecting surface of the second reflecting part 52 does not intercept the reflecting surface of the first reflecting part 51, i.e. the cutting plane 60 starts from a point comprised between the tangent point PE2 between parabola P and ellipse E and the vertex of parabola V and said cut ends on a point comprised between points PE3 and PE1 as shown in Figures 1-6.

The second reflecting part 52 is advantageously off axis with respect to the first reflecting part 51 so that the rays of the light beam directly exit from the complete final reflector with at most a single reflection on the concave reflecting surface of the para-ellipsoid 6 and the rays of the light beam are reflected downwards without creating light pollution.

The same reasoning may be applied to the biellipsoid described hereinafter.

The para-ellipsoid 6 may also be seen as a solid obtained from: the combination of a paraboloid 65 and an ellipsoid 66 jointed along a line 67 formed by points 68 on which common tangent planes 69 pass (figure 4), suitable deprived of the symmetrical half parts; the division into two parts, 51 and 52, of the remaining solid by a cutting plane inclined by an angle α equal to the asymmetry angle of the maximum light intensity (figures 6 and 7); the reciprocal rotation of the two parts 51 and 52 (figure 8); the assembly by means of union means 61, 62 applied along the overlapping zone of the respective edge of the two parts 51 and 52 (figures 9 and 10).

The para-ellipsoid 6 is used in the present invention in order to implement a rotational asymmetric projector for lighting installations.

Experimental verifications, with a cutting plane inclined by about 60° corresponding to the asymmetry angle of the maximum light intensity of the projector, have proved that the assembled reflector 6, both in the case of short arch and long arch lighting, has a photometric curve with a maximum light intensity at about 60° (asymmetry angle) of about 15000 candelas, i.e. corresponding to the maximum light intensity of the symmetrical reflectors and much higher than the maximum light intensity of the known asymmetric reflectors (1000-1400 candelas).

Advantageously, said para-ellipsoid 6 at about 0° has a light intensity much lower than the traditional asymmetric reflectors, i.e. 150 candelas instead of the normal 250 candelas. This allows very low light intensity values to be obtained below the pole, with consequent advantages in terms of light uniformity.

The efficiency of the para-ellipsoid 6 is substantially similar to that of the best known asymmetric and symmetrical reflectors, i.e. between 70 and 80.

If the designer wants to reduce the maximum intensity value, for example bringing it to 4500-5000 candelas from the nominal 15000 candelas without decreasing the efficiency, he may make some facets 81 on the paraboloid. The larger is the number of said facets 81, the smaller is the reduction of the light intensity.

Para-ellipsoid 6 according to the invention therefore allows very large areas, such as football fields, to be illuminated, with high light intensities, without light pollution and high uniformity of the illuminance.

Advantageously, the cutting angle α corresponds to the asymmetry angle α between an axis corresponding to the maximum light intensity beam of the projector projected and to the angle between a vertical straight line 71, i.e. an axis orthogonal to an horizontal light emission plane 70, adapted to contain the projector glass, and the maximum light intensity ray 72 emitted by the reflector (figure 10), thus ensuring a reduction of the production faults and a consequent easiness of serial production of the reflectors.

The above-described construction procedure is advantageously usable for obtaining assembled asymmetric reflectors starting from geometrical curves of different equations.

By way of example, hereinafter is the implementation process related to the combination of a greater ellipsoid and a smaller ellipsoid, jointed along tangent planes suitable deprived of the symmetrical half parts with respect to the symmetry plane of the smaller ellipsoid.

With reference to figure 13, a second embodiment of the circular asymmetric projector according to the present invention derives from a geometrical figure in plane X, Y composed of an ellipse E1, symmetrical with respect to the Cartesian axes, and of an ellipse E2, tangent to ellipse E1 in points E1E2', E1E2".

A closed curvature 7 is formed by stretches of ellipse E1 and by stretches of ellipse E2, jointed at points E1E2', E1E2".

Let's call the outer profile of the flat figure thus generated "Bi-ellipse", highlighted in bold.

The figures composed of an open curvature 8, a sectional areas 9, a rotationally or revolution symmetrical solid 10 and a rotationally symmetrical solid 11 allow an assembled rotational asymmetric bi-ellipsoidal (with dual ellipse) reflector 12 (which hereinafter will be referred to simply as biellipsoid for simplicity) to be obtained in the same way as for constructing the assembled rotational asymmetric para-ellipsoidal reflector 6.

Note that axis Y (figures 14-21) does not correspond to axis Y' of figure, but to the smaller axis of ellipse E2.

It is noted that said open curvature 8 (figure 14) consists of a first ellipse E1 with a focus suitable for the type of light source tangent in points E1E2' and E1E2'' to a second ellipse E1. Mathematically, such ellipse E2 is the only one to be tangent in those points once a focus F1E2 thereof has been fixed. The determination of points E1E2' and E1E2'' and of a focus F1E2 of the ellipse is dictated by the value of the maximum intensity to be obtained and by allowing the whole light reflected by the first ellipse E1 to directly exit from the final reflector with a single reflection.

In particular, biellipsoid 12 is formed of parts 111 and 112 first separated by 3D laser cutting with cutting angle α corresponding to the asymmetry axis of maximum light intensity of the reflector, and then assembled by means of connecting inserts 121, 122 after rotating part 112 by about 180°.

The connecting inserts 121, 122, such as rivets or screws, are inserted around the center of the three Cartesian axes, also allowing the inclination of part 112 to be varied with respect to part 111 approximately within a range of +/-20° with respect to the theoretical angle α, an overlapping of few millimeters occurring between the two parts as in the above-described case of the para-ellipsoid 6. In the same way as already seen for the connecting inserts 61, inserts 121, 122 constitute a hold for the reflector housing to the bearing support structure of the reflector (not depicted).

The biellipsoid reflector 12 has the same advantages as the para-ellipsoid reflector 6, with an increase in efficiency due to the fact that the light rays converge towards the focus of the first ellipse E1 with limited multiple reflection phenomena on the second ellipse E2.

Biellipsoid 12 may also be seen as a solid obtained from: the combination of two ellipsoids 125, 126 jointed along a line 127 formed by points 128 on which common tangent planes 129 pass (figure 16), suitable deprived of the symmetrical half parts; the division into two parts, 111 and 112, of the remaining solid by a cutting plane inclined by an angle α equal to the asymmetry angle of maximum light intensity (figures 18, 19); the reciprocal rotation of the two parts 111 and 112 (figure 20); the assembly by means of union means 121, 122 applied along the overlapping zone of the respective edge of the two parts 111 and 112 (figures 21 and 22).

Once the geometrical parameters that allow the maximum light intensity and energy efficiency value to be obtained have been defined, an assembled asymmetric reflector according to the present invention is preferably industrially made by means of: forming machines of three-dimensional solids capable of reproducing the outline of the spatial figures; three-dimensional welding and cutting means; processes for finishing and coating the reflecting surfaces.

The forming of the rotationally or revolution symmetrical solid 5, 10 is preferably carried out by sheet turning. The sheet turning implies the deformation of a metal disc (steel, iron, brass, copper, aluminum, etc.) rotating on a pin having the axial-symmetrical shape of the concave reflecting surface of the rotationally symmetrical solid 5, 10. The machinery that allows this type of modeling is a lathe that rotates the metal disc on which a tool acts, which deforms the initial disc up to making it take the desired shape relative to the rotationally symmetrical solid 5, 10.

The rotationally symmetrical solid 5, 10 is cut by three-dimensional laser cutting technology.

The increase in the lighting efficiency is obtained by resorting to techniques of metallization, anodizing and buffing of the reflecting metal surfaces constituting parts 51, 52 and 111, 112.

An assembled rotational asymmetric reflector of lighting installations implemented according to the present invention relates to any type of lamp and appliance, in particular having a power from 20 to 2000W, with long arch and short arch.

Para-ellipsoid 6 and the variants such as that relating to biellipsoid 12, allow high illuminance intensities and high efficiencies to be obtained resorting to asymmetry angles preferably close to 60° with respect to the vertical.

An identical conceptual analysis was conceived for implementing the flat figure "Bi-ellipse" and thereafter of the final three-dimensional reflector "Biellipsoid".

CLAIMS

1. Procedure for construction of a rotational asymmetric assembled reflector (6, 12) for projectors for lighting installations, with an angle of asymmetry, α, between an axis corresponding to a light beam of maximum light intensity and an axis orthogonal to a light output plane, characterized in that it comprises the following steps:

- construction of a rotationally symmetrical solid (5, 10) symmetrical with respect to an axis of rotation (X), formed by two rotationally symmetrical solids (65, 66, 125, 126) having a same tangent plane (69, 129) at common points (68, 128) along a conjunction line (67, 127) of said rotationally symmetrical solids (65, 66, 125, 126);

- cutting of said rotationally symmetrical solid (5, 10) according to a cutting plane (60) inclined to an axis (Y) orthogonal to said axis of rotation (X), by an angle corresponding to the said angle of asymmetry, α, aimed at obtaining two parts (51, 52, 111, 112);

- rotation of about 180 ° of one (52, 112) of the two parts obtained by means of said cutting around an axis orthogonal to a plane (X, Y) containing said axis of rotation (X) and its orthogonal axis (Y);

- assembling of the parts (51, 52, 111, 112) thanks to connecting means (61, 121);

- overlapping of a quantity (OL) of one part (52, 112) with respect to the other part (51, 111);

- adjustment of the inclination of the parts (51, 52, 111, 112) according to a optimum light performance;

- assembling (62, 122) of the parts (51, 52, 111, 112).

2. Procedure according to claim 1, characterized in that said rotationally symmetrical solid (5) is formed by a paraboloid (65) and by an ellipsoid (66).

3. Procedure according to claim 1 or 2, characterized in that said rotationally symmetrical solid (10) is formed by two ellipsoids (125, 126).

4. Assembled rotational asymmetric reflector (6, 12) for projector for lighting installations with an angle of asymmetry, α, between an axis corresponding to a light beam of maximum light intensity and an axis orthogonal to a light output plane, comprising reflective parts of different shapes, including a first reflecting part (51, 111) to which the lamp it is set and a second reflecting part (52, 112) assembling to said first reflecting part (51, 111) such as to define a horizontal plane (70) apt to contain the glass of the projector, a vertical straight line (71) orthogonal to said horizontal plane (70) being inclined at said angle α with respect to the ray of light of a maximum intensity (72) emitted by the reflector, characterized in that said first (51, 111) and second reflecting parts (52, 112) being formed together from a rotationally symmetrical solids (5, 10), having a same tangent plane (69, 129) at common points (68, 128) along a conjunction line (67, 127) of said rotationally symmetrical solids (5, 10), the second reflecting part (52, 112) being obtained by cutting the said rotationally symmetrical solid (5, 10) along a cutting plane (60) inclined to an axis (Y) orthogonal to the axis of rotation (X) of said rotationally symmetrical solid (5, 10) by the angle of asymmetry α, the first reflecting part(51, 111) formed by the remaining portion of said rotationally symmetrical solid (5, 10), the assembly of said first (51, 111) and second reflecting parts (52 , 112) occurring as a result of said cut and prior rotation of said second reflecting part (52, 112) of approximately 180° with respect to said first reflecting part (51, 111).

5. Reflector according to claim 4, characterized in that said second reflecting part (52, 112) surmounts said first reflecting part (51, 111).

6. Reflector according to claim 4 or 5, characterized in that said rotationally symmetrical solid (5) is formed by a paraboloid (65) and by an ellipsoid (66).

7. Reflector according to claim 6, characterized in that the paraboloid (65) provides a plurality of facets (81).

8. Reflector according to claim 4 or 5, characterized in that said rotationally symmetrical solid (10) is formed by two ellipsoids (125, 126).

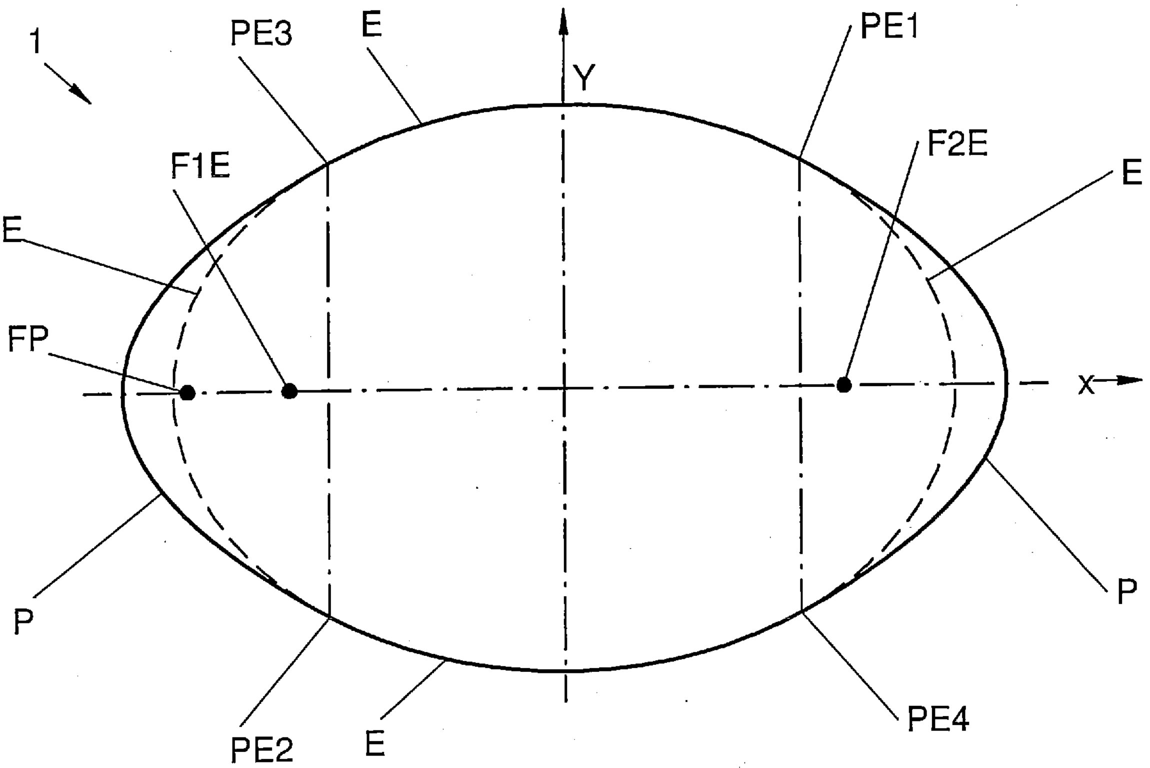


Fig. 1

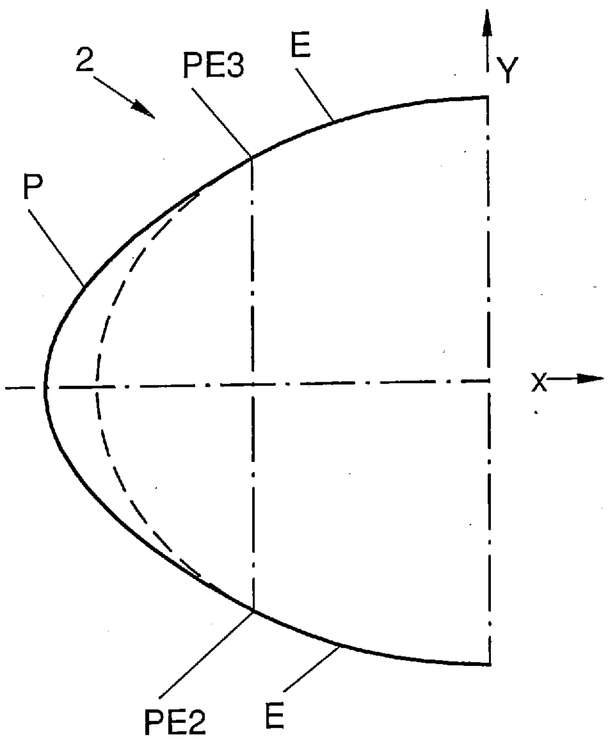


Fig. 2

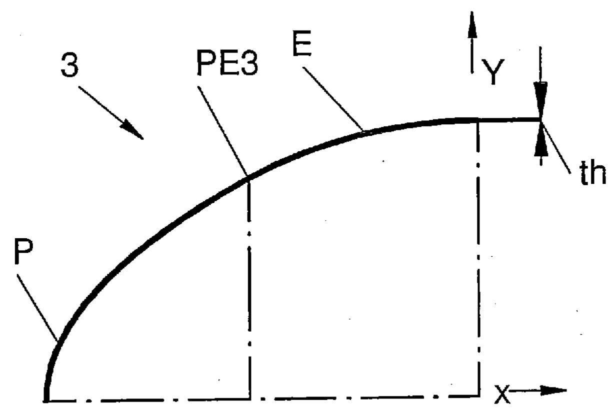


Fig. 3

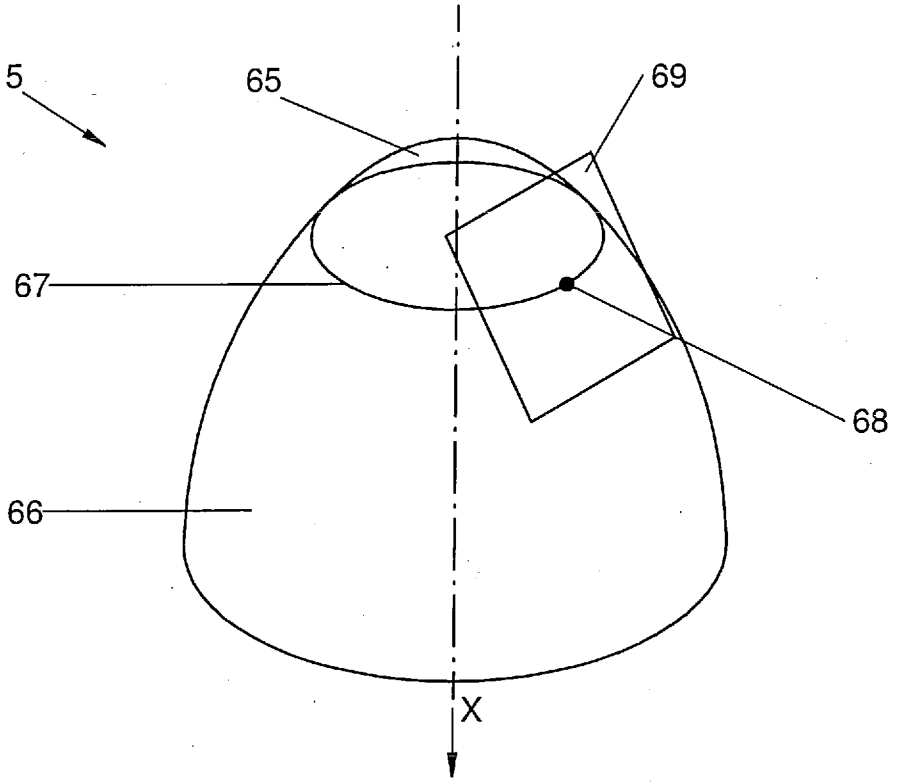


Fig. 4

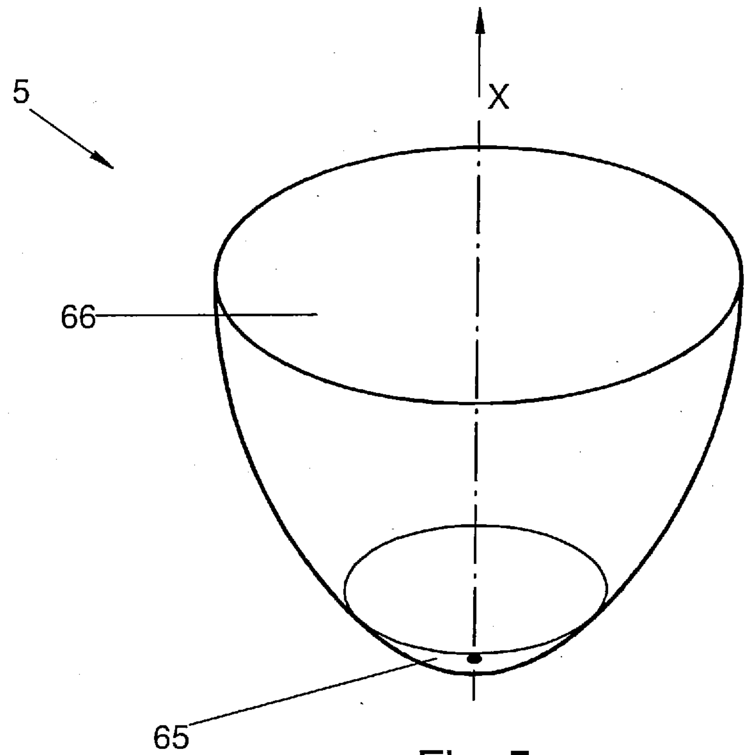


Fig. 5

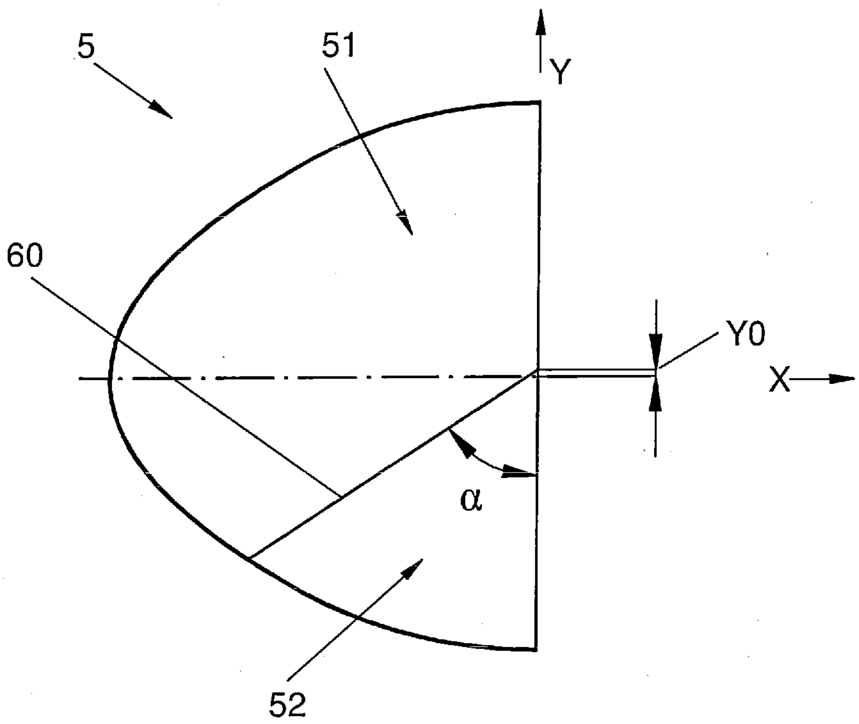


Fig. 6

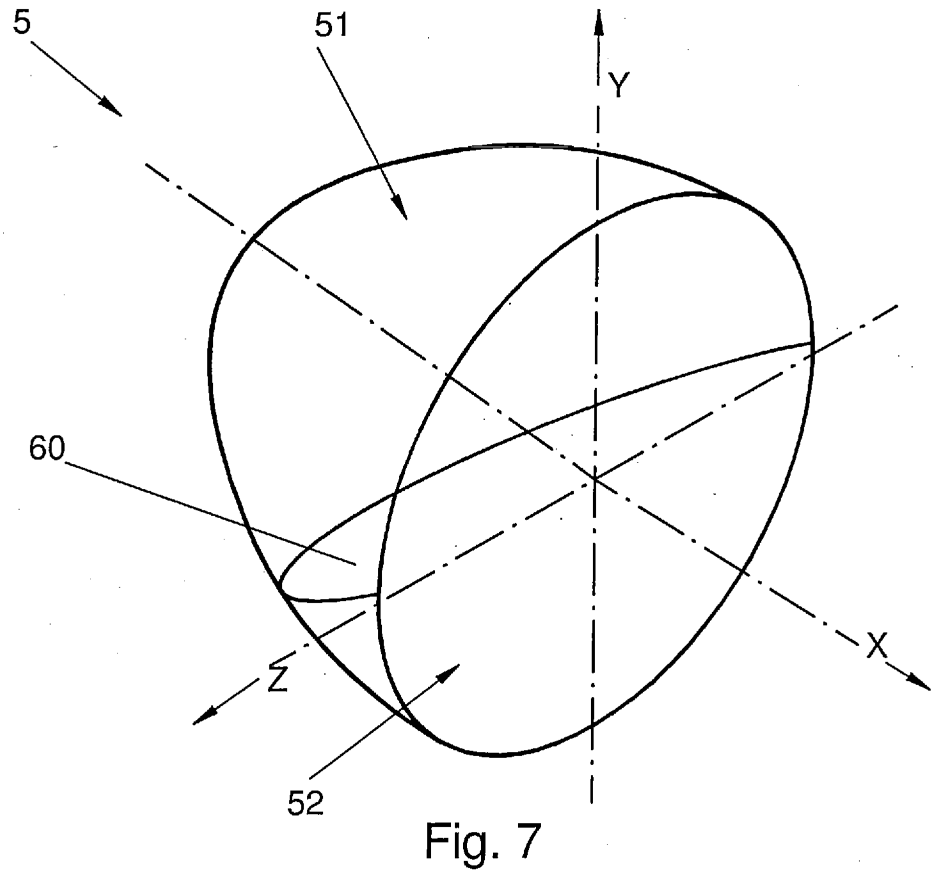


Fig. 7

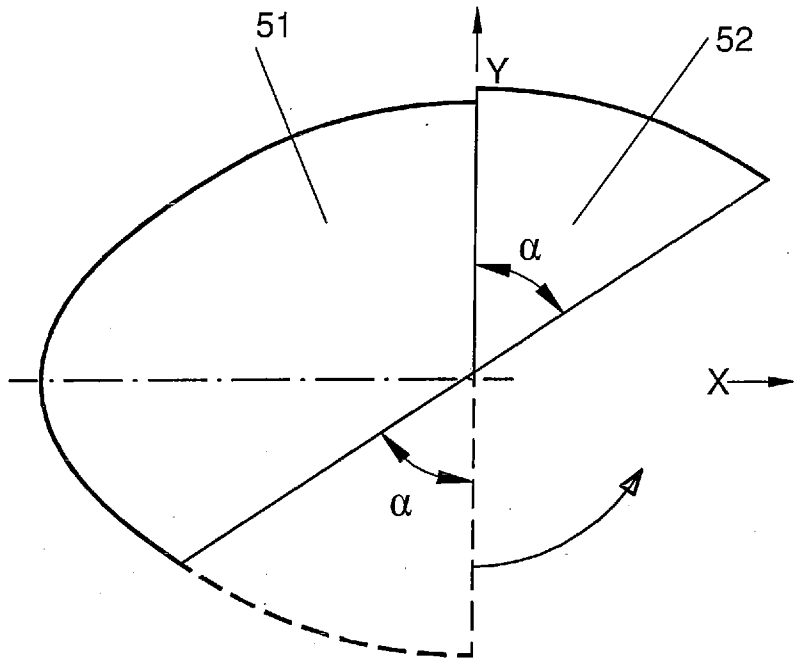


Fig. 8

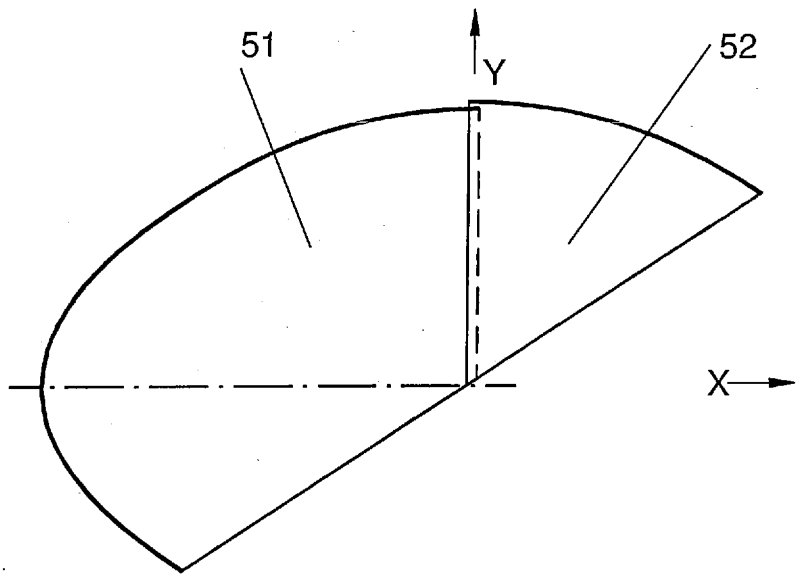


Fig. 9

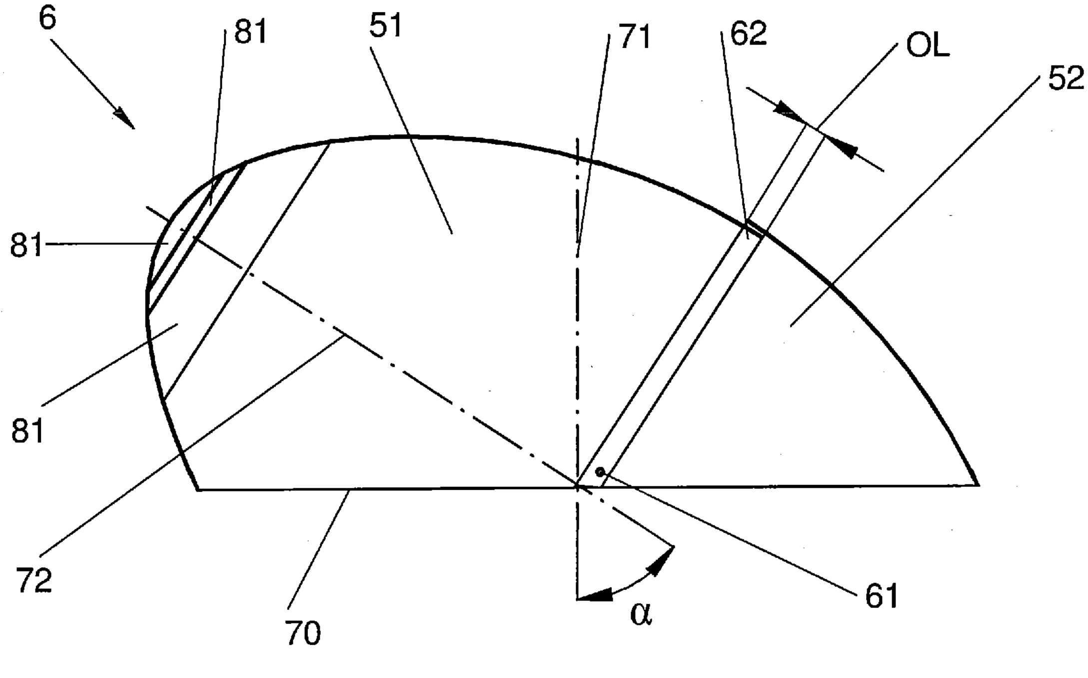


Fig. 10

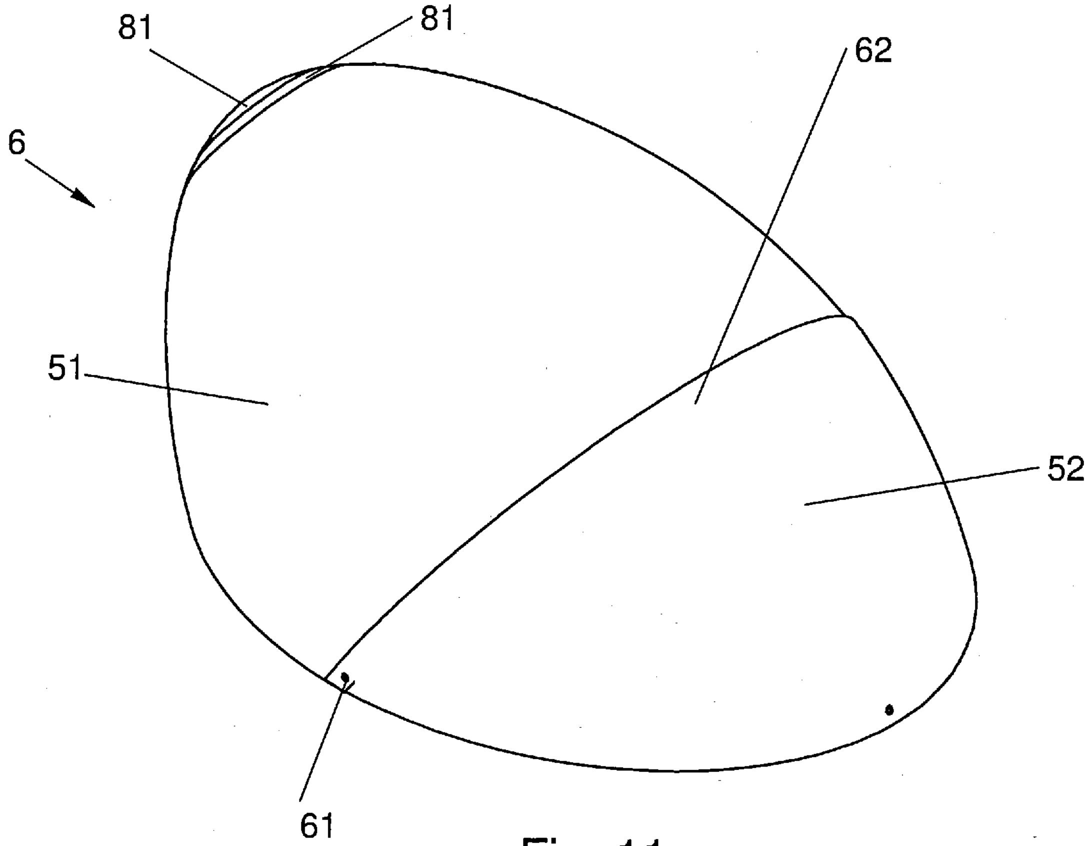


Fig. 11

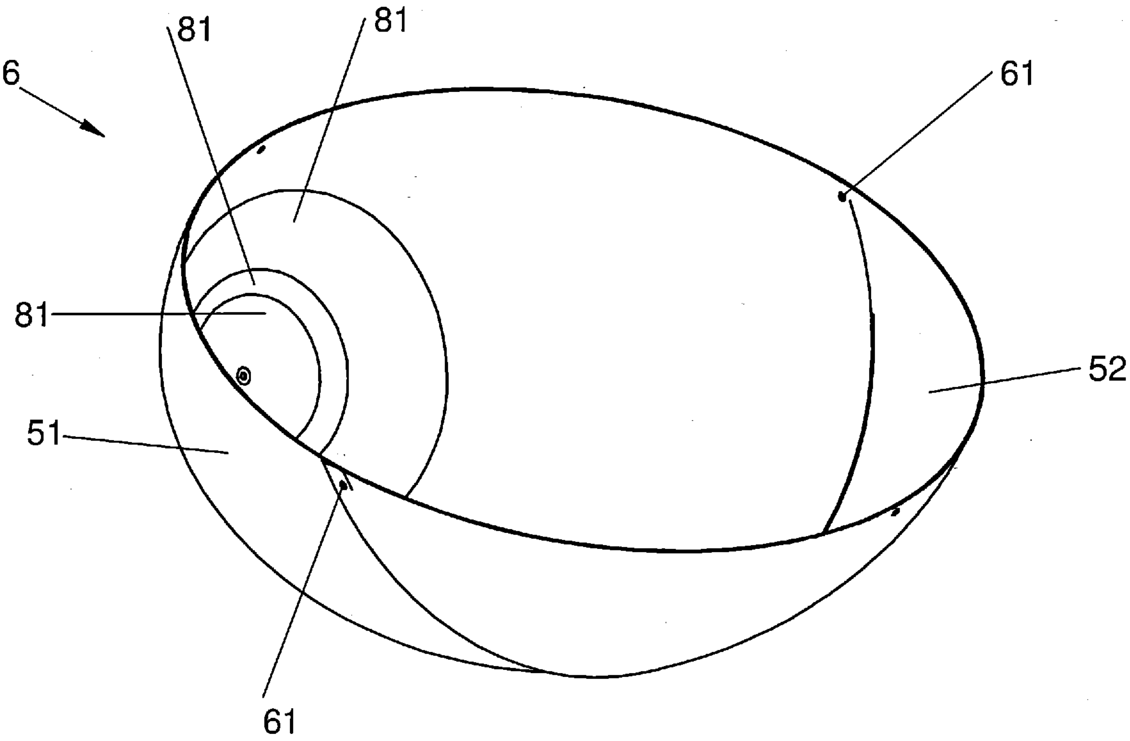


Fig. 12

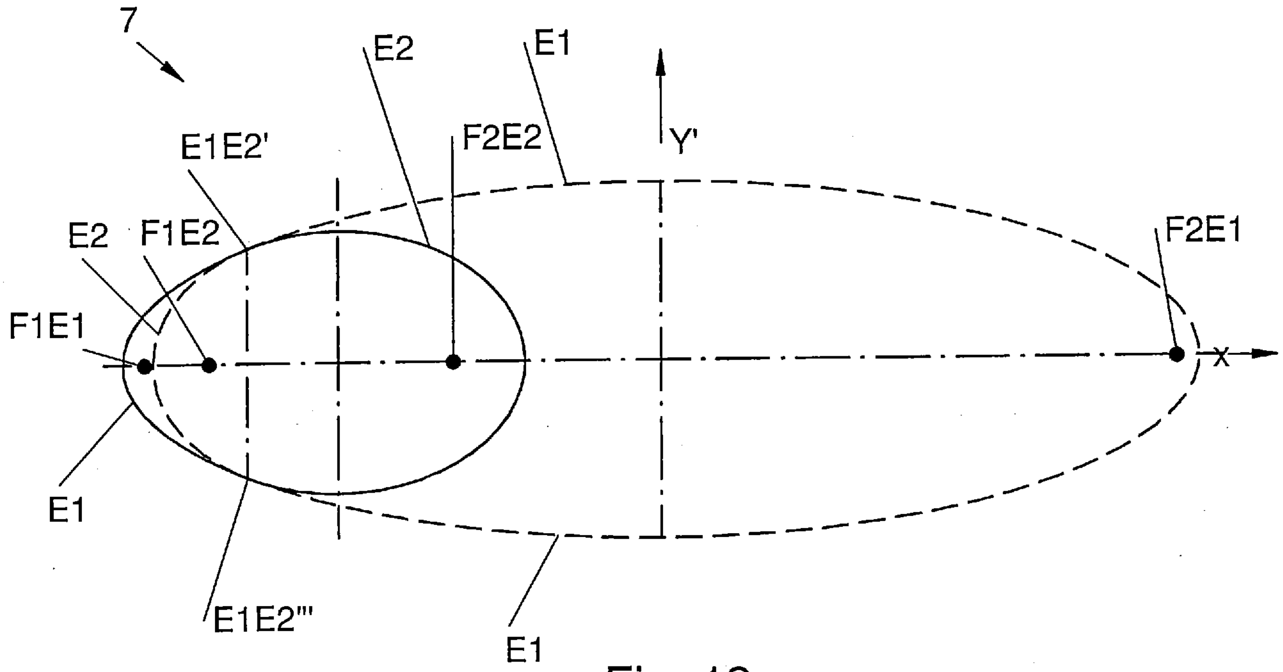
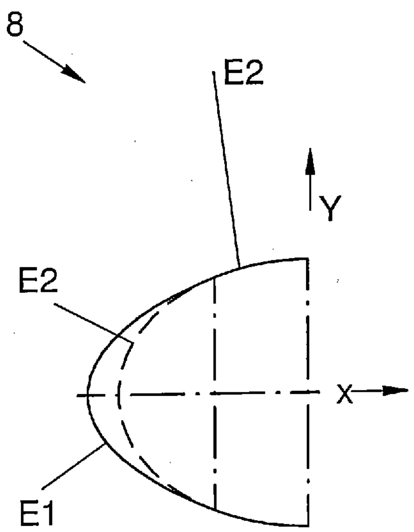


Fig. 13



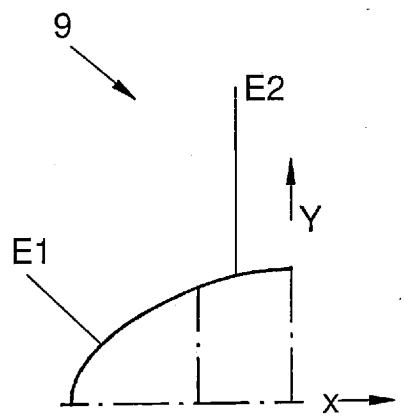


Fig. 14

Fig. 15

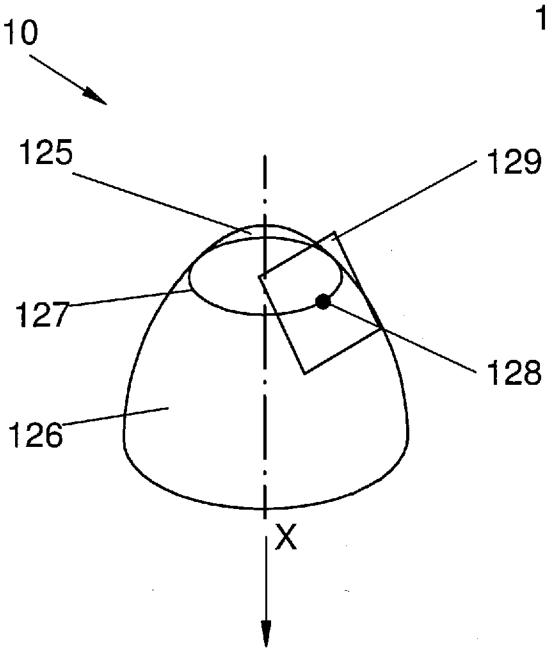


Fig. 16

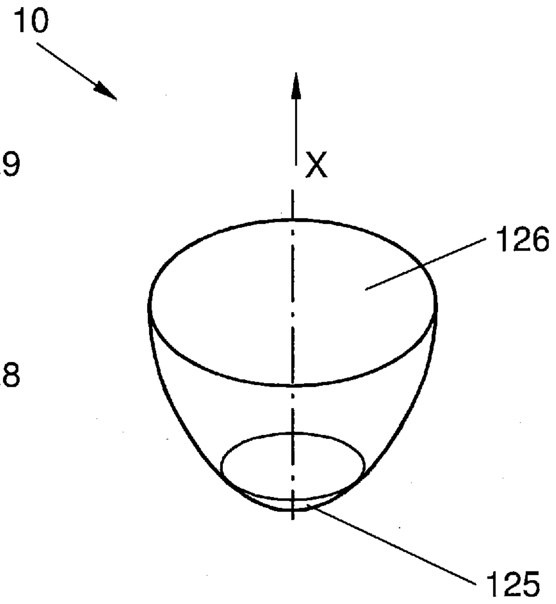


Fig. 17

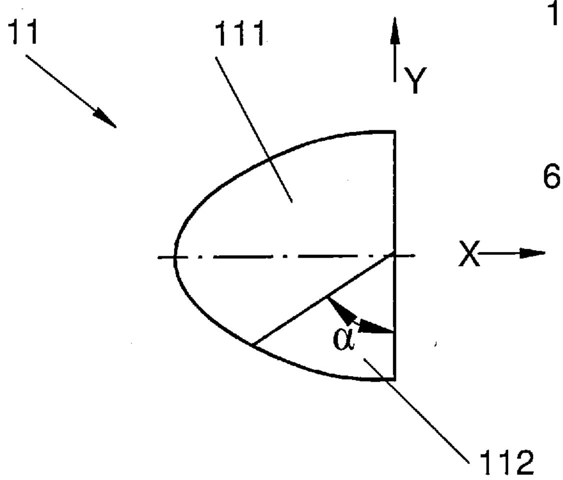


Fig. 18

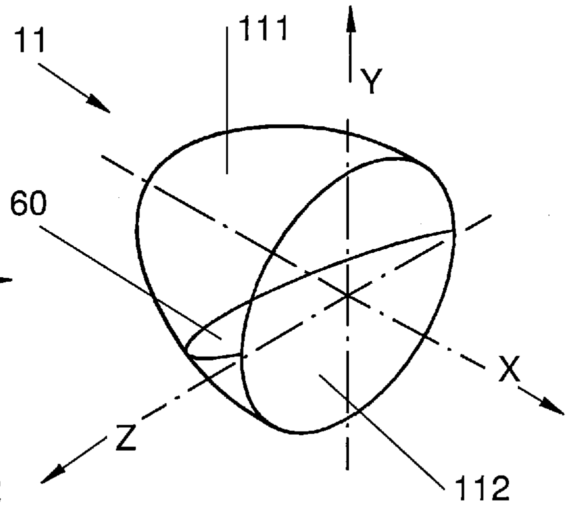


Fig. 19

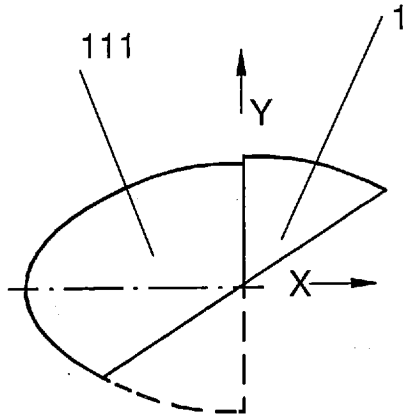


Fig. 20

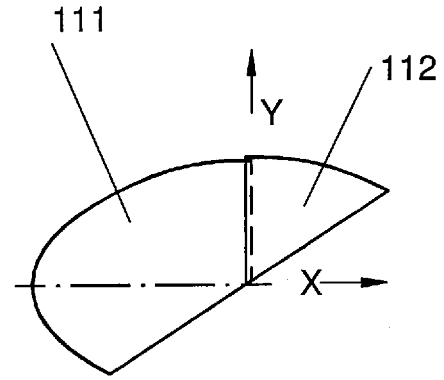


Fig. 21

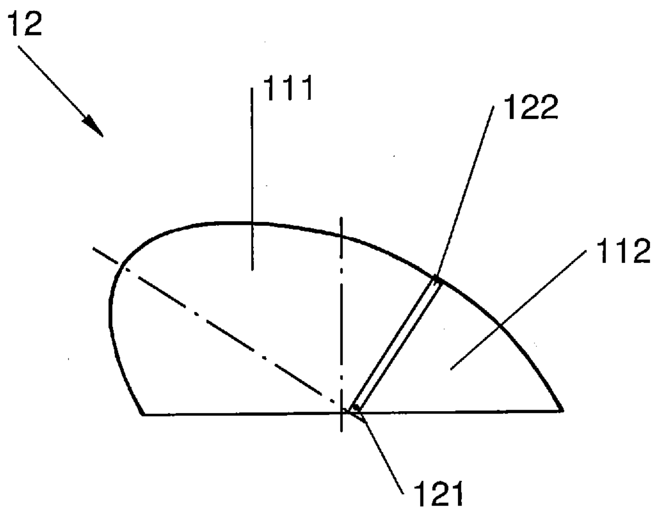


Fig. 22

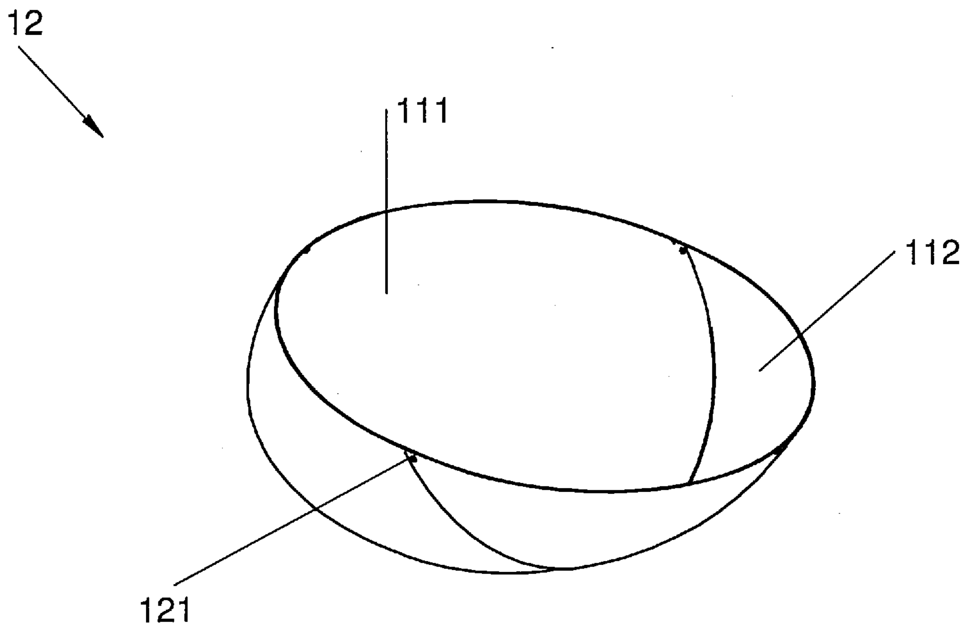


Fig. 23

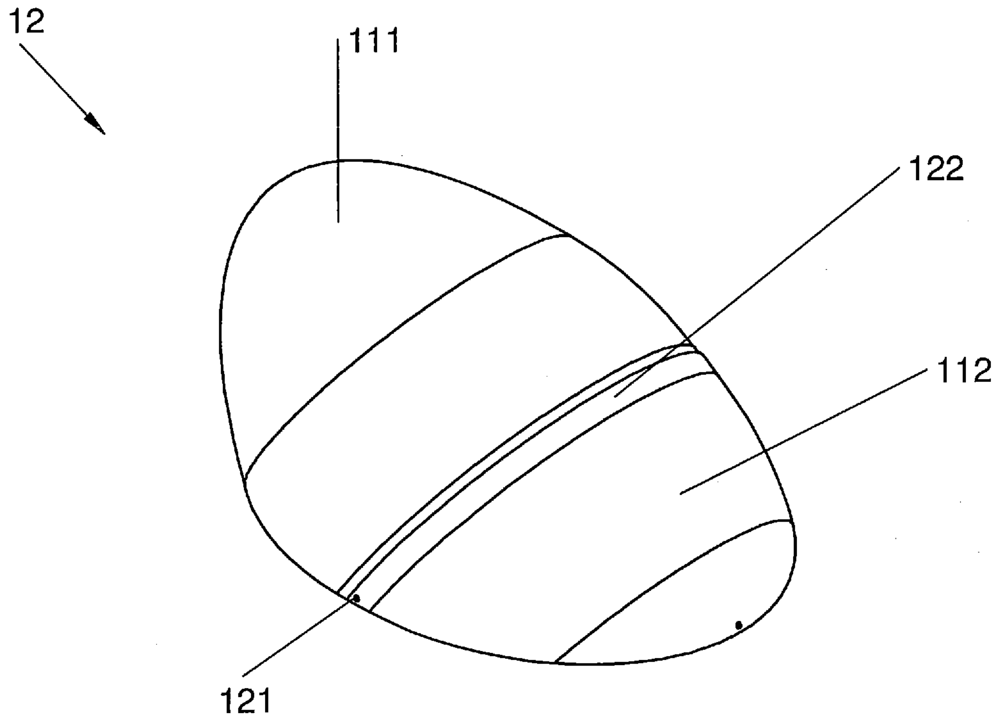


Fig. 24

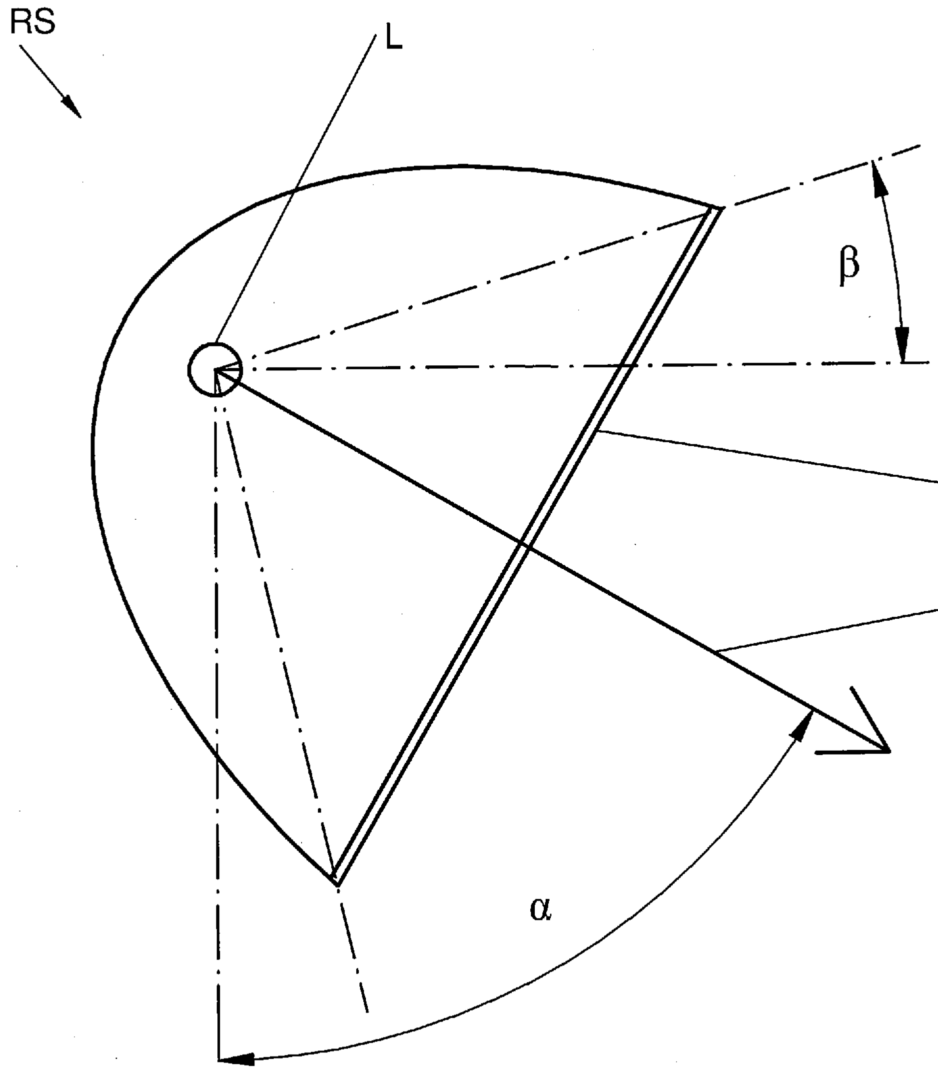


Fig. 25

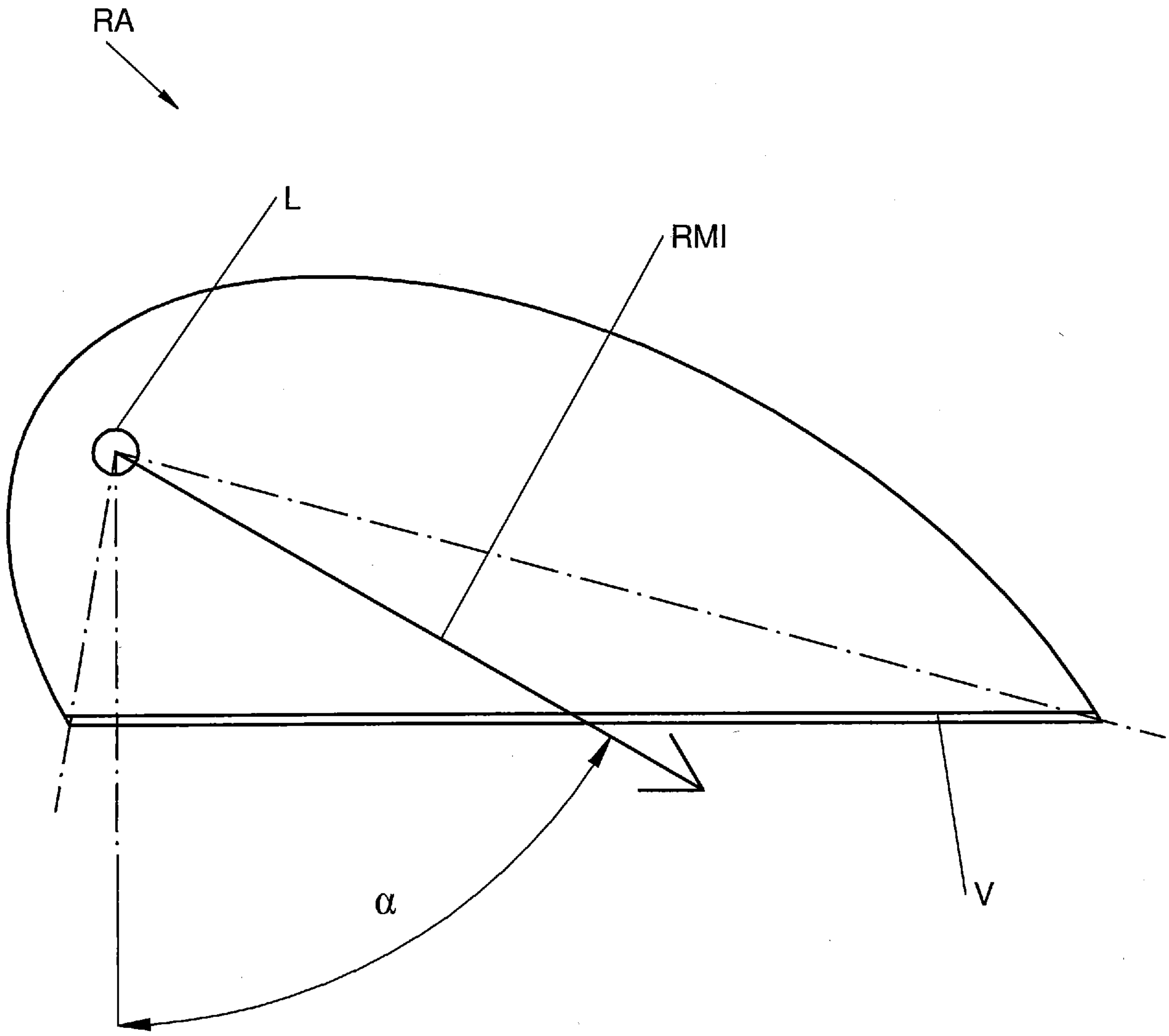


Fig. 26

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2013/056051

A. CLASSIFICATION OF SUBJECT MATTER
INV. F21V7/00 F21V7/09
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F21V

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2008/129511 A1 (KONINKL PHILIPS ELECTRONICS NV [NL]; MONTAGNE LOUIS [FR]) 30 October 2008 (2008-10-30) abstract; figures 2A, 2B, 4A, 4B -----	1,4,5,8
A	EP 2 019 255 A2 (ERCO GMBH [DE]) 28 January 2009 (2009-01-28) cited in the application paragraph [0136] - paragraph [0142] figures 6, 7, 13 -----	1,4

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
10 June 2013	18/06/2013

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Allen, Katie

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2013/056051

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2008129511 A1	30-10-2008	CN 101668986 A	10-03-2010
		EP 2153118 A1	17-02-2010
		JP 2010525408 A	22-07-2010
		RU 2009143328 A	27-05-2011
		US 2010182790 A1	22-07-2010
		WO 2008129511 A1	30-10-2008
EP 2019255 A2	28-01-2009	NONE	