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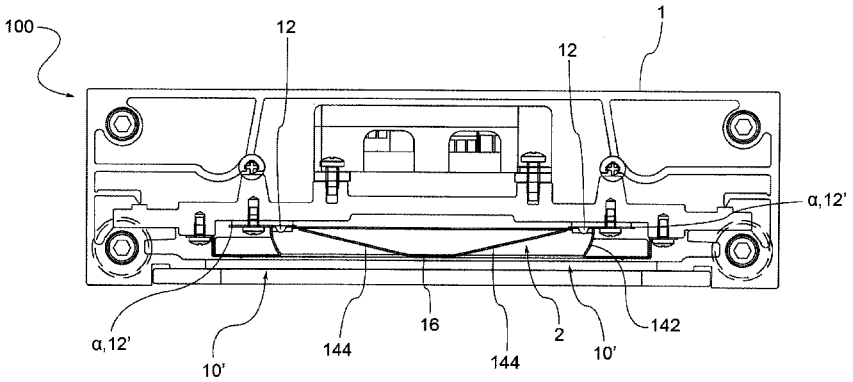

FIG.2

(57) Abstract: A lighting module, in particular for a street lighting apparatus, comprises two module portions suitable to illuminate respective portions of an object, said module portions being equal to each other and symmetrical with respect to a longitudinal module axis. Each module portion comprises a lighting source and a respective reflector. The lighting sources lie on a same source plane and are placed at the ends of the lighting module. Each reflector comprises a side wall that extends parallel to the longitudinal module axis and that extends from the source plane forming a parabolic surface with a parabola axis inclined with respect to the source plane, a first inclined plane that extends with increasing width ' from the lighting source until in proximity of the longitudinal module axis, and a second inclined plane that extends with increasing width from the light source toward a front edge of the lighting module substantially orthogonal to the longitudinal module axis.

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DESCRIPTION

"LIGHTING MODULE"

[0001] This invention relates to a lighting module, in particular for realising a street lighting apparatus, and a lighting apparatus comprising a plurality of such lighting modules.

[0002] The lighting groups for street applications that belong to the state of the art and are commonly available on the market generally comprise: a main body suitable to provide mechanical support to the entire structure and provided with suitable means of coupling and fixing on poles, cables, heads, catenaries and walls; a lighting source (generally of the filament or discharge type) provided with the related mechanical fixing means and power supply connection; a possible reflector suitable to convey the light output of said lighting source in a portion of space and optics generally comprising a diffuser constituted by a transparent or semi-transparent screen, suitable to close the main body and, if necessary, to filter the light emitted in the desired ways.

[0003] Street lighting has specific peculiarities related to the reflection characteristics of the street surface, which is, in general, not isotropic. The light is reflected as a function of the angles of incidence and of

reflection of the light on the street surface and thus, to optimise the street lighting and avoid dangerous shadow areas, the light output must be directed where it is most effective, i.e., in the direction in which the luminance is greater and more uniform.

[0004] In essence, the light output must be directed to the areas of the street surface in which the ration between the resulting luminance and the illumination is greater in order to achieve better lighting results with less light output, and in the areas in which the resulting luminance is more uniform, so as to respect the parameters of uniformity of illumination prescribed by current regulations.

[0005] In the case of LED lighting groups, there is the possibility of directing the total flow of light output in a more precise manner by being able to intervene on each LED to suitably direct the emitted light beam.

[0006] In state of the art apparatuses, the individual LEDs are generally arranged on the same plane and the light must be deflected in the desired directions in order to achieve the overall band of illumination desired.

[0007] To achieve this purpose, TIR (Total Internal Reflection) type lenses are used, which are associated to each individual LED.

[0008] If, on the one hand, the use of single TIR-type

lenses provides a high degree of flexibility, it involves a series of technical problems, on the other. In the first place, since these TIR lenses are normally made of plastic, there can be problems related to the natural deterioration of the characteristics of the material. In fact, yellowing and opacification of the plastics used can occur in relatively short times and heavily impact the performance of the apparatus.

[0009] Furthermore, the use of the TIR lenses in street lighting groups makes it very difficult to direct the light output with a precision such as to avoid dispersing the light in areas adjacent to the area to be illuminated and, consequently, penalising the energy savings of the system. In fact, it is particularly important to assess and control the useful portion of the flow, which is the fraction of the flow of the apparatus actually falling on the area to be illuminated and provides direct information about the amount of light that the lighting apparatus in question casts on the area of interest and outside of it. The percentage of light flow directed to unintended areas lowers the energy yield of the lighting device and thus, in the final analysis, is a waste of energy to be avoided or at least limited.

[0010] Finally, due to the optical laws regarding the phenomenon of refraction, each time that a light

radiation passes from one material to another (such as passages between air and plastic and then between plastic and air) there is a loss of the intensity and quality of the emitted light beam. In the case of the output of white light, refraction can cause phenomena of the decomposition of light into coloured components.

[0011] There is a clear need for lighting apparatuses suitable to optimise their emission profile without compromising an efficient management of the power dissipated from the lighting sources used, so as to eliminate the technical problems described above.

[0012] WO 2012/011136 describes a lighting module comprising a reflector and at least two lighting sources or groups of lighting sources. The reflector comprises a central part and two wings inclined with respect to the central part. The lighting sources are arranged at the ends of the central part and are oriented, with respect to a system of reference coordinates C/γ, according to an angle C respectively comprised between 0° and 30° and between 150° and 180°, and according to an angle γ, with respect to the vertical, comprised between 50° and 90°.

[0013] If, on the one hand, such a lighting module allows avoiding the use of TIR lenses, on the other hand, it requires the assembly of the sources on respective inclined planes, which obviously makes the structure of

the lighting apparatus and its assembly more complex with respect to a configuration with the lighting sources mounted on a same plane.

[0014] The purpose of this invention is to provide a lighting module and a lighting apparatus able to eliminate the drawbacks mentioned above with reference to known art and, in particular, able to combine an optimal light output profile, efficient management of the power dissipated by the lighting sources used, and real simplicity of construction.

[0015] Said purpose is achieved with a lighting module according to claim 1 and a lighting apparatus according to claim 12. The dependent claims describe particularly advantageous preferred embodiments.

[0016] Further details and advantages of the lighting apparatus according to this invention will, in any case, be evident from the following description of a preferred embodiment, provided by way of non-limiting example, with reference to the accompanying drawings, in which:

[0017] Figure 1 is a plan view from below of a lighting apparatus, comprising a plurality of lighting modules according to the invention;

[0018] Figure 2 is a transverse section of the lighting apparatus along the line A-A in Figure 1;

[0019] Figure 3 is a longitudinal section of a portion of

the lighting apparatus along the line B-B in Figure 1;

[0020] Figure 4 is an optical diagram of a reflector of the lighting module according to the invention, in the plane A-A in Figure 1, corresponding to the plane C0-C180 in the coordinate system C/γ;

[0021] Figure 5 is an optical diagram of a reflector of the lighting module according to the invention, in the plane B-B in Figure 1, corresponding to the plane C90-C270 in the coordinate system C/γ;

[0022] Figures 6, 7 and 8 are perspective views of as many elements that, in an embodiment, contribute to forming an array of reflectors for the apparatus of Figure 1;

[0023] Figure 9 shows, in perspective view, the assembled array of reflectors;

[0024] Figures 10 and 11 are two perspective views, from below and above, of the end of a street lighting apparatus according to the invention; and

[0025] Figures 12 and 13 are two sectional views of a street lighting apparatus according to the invention in correspondence of a connection joint to a support pole, in two different configurations of use.

[0026] In said drawings, 100 indicates, in its entirety, the body of a lighting apparatus according to the invention, in particular for street lighting.

[0027] The apparatus body 100 comprises a support structure

1 and a lighting body 2 supported by such support structure 1. The lighting body 2 comprises a plurality of lighting modules 10 placed one next to the other so as to form a row, or array, of lighting modules 10. The lighting body 2 can also comprise several adjacent rows of modules, so as to form a matrix.

[0028] Each row of lighting modules 10 extends along a longitudinal axis X (hereinafter called the longitudinal module axis) that, in the case of an apparatus for street lighting, is the axis that identifies the direction that goes from the street edge towards the centre of the street.

[0029] Each individual lighting module 10 comprises two module portions 10' suitable to illuminate respective portions of an object, for example portions of a street surface.

[0030] The module portions 10' are equal to each other and symmetrical with respect to the longitudinal module axis X. Each module portion 10' comprises a lighting source 12 and a respective reflector 14.

[0031] Advantageously, the lighting sources 12 of each lighting module 10 lie on a same source plane α, for example substantially parallel to the object to be illuminated, and are placed at the ends of the lighting module 10.

[0032] In a preferred embodiment, the lighting sources 12 are LED lighting sources, and can be constituted each by a single LED or by a group of LEDs. The lighting sources are mounted on one or on respective electronic cards 12' that define the source plane α.

[0033] Each reflector 14 comprises a side wall 142, a first inclined plane 144 and a second inclined plane 146. The side wall 142 extends parallel to the longitudinal module axis X and extends from the source plane α forming a parabolic surface (i.e., the profile of which corresponds to portion of a parabola) with parabola axis Y inclined with respect to the source plane α.

[0034] The first inclined plane 144 extends with increasing width from the lighting source 12 to near the longitudinal module axis X.

[0035] The second inclined plane 146 extends with increasing width from the lighting source 12 towards a front edge 102 of the light output opening of the lighting module 10. This front edge 102 is preferably substantially orthogonal to the longitudinal module axis X.

[0036] The reflector 14 is also delimited, on the opposite side and preferably parallel to the front edge 102, by a rear wall 148 that extends from the source plane α. In a preferred embodiment, also this rear wall 148 form a

parabolic surface, i.e., has a profile corresponding to a portion of a parabola, with parabola axis Z preferably inclined with respect to the source plane α.

[0037] In other words, the side wall 142 and the first inclined plane 144 determine the light distribution of the lighting source 12 in the plane C0-C180 of the coordinate system C/γ (Figure 4); the real wall 148 and the second inclined plane 146 determine the light distribution of the lighting source 12 in the plane C90-C270 of the coordinate system C/γ (Figure 5).

[0038] In a preferred embodiment, the reflectors 14 of each lighting module form a light emission window of substantially rectangular shape. In this case, the lighting sources 12 are placed in correspondence of the two corners between the side walls 142 and the rear wall 148.

[0039] In a preferred embodiment, the projection of the side wall 142 on the source plane seen in plan view partially covers the lighting source 12. More precisely, the projection of the side wall 142 covers exactly half the lighting source 12, as shown in Figure 4. This constructive choice allows obtaining the best uniformity of the light beam generated by the lighting source 12.

[0040] Defining with W the axis of the lighting source 12 perpendicular to the source plane α, in a preferred

embodiment, the axis Y of the parabola of the side wall 142 is inclined with respect the source axis W by an angle β comprised between 60° and 80°, preferably 70°.

[0041] In a preferred embodiment, each lighting source 12 is placed in the focus of the parabola defining the side wall 142.

[0042] Preferably, the first inclined plane 144 is inclined with respect to the source axis W by an angle comprised between 65° and 85°, more preferably 77°.

[0043] Preferably, the second inclined plane 146 is inclined with respect to the source axis W by an angle comprised between 60° and 80°, more preferably 67°.

[0044] Preferably, the parabola axis Z of the rear wall 148 is inclined with respect to the source axis by an angle ρ comprised between 25° and 35°, more preferably 31°.

[0045] In a preferred embodiment, the first inclined planes 144 of the reflectors 14 of a same lighting module 10 are connected to each other by a central plane 16 parallel to the source plane α.

[0046] Returning now to the lighting apparatus 100, as said the lighting body 2 is formed by an array or by a matrix of lighting modules 10. In an embodiment illustrated in Figures 2 and 6 to 9, the side walls 142 of the reflectors 14 of all the lighting modules 10 are integrally formed in a single first frame element 20 that

is fixed to the support body 1 and which bears the other elements of the reflectors 14, as described below.

[0047] To the frame element 20 is fixed, for example interlocking, a single second sawtooth element 22 which integrally forms all the second inclined planes 146 and rear walls 148 of the reflectors 14.

[0048] Finally, on each portion of the sawtooth element 22 is fixed, for example interlocking, a third reflective element 25 which integrally forms the first inclined planes 144 and the central connecting plane 16.

[0049] Therefore, with a reduced number of components it is possible to realise the entire lighting body 2.

[0050] In an embodiment, the apparatus body 100 is fixed near the upper end of a pole 3.

[0051] The apparatus body 100 is connected to the pole 3 by means of a hollow ball joint 30 that slips over the end of pole 3 and which is fixed to this at a predetermined height, for example by means of one or more joint fixing screws 32.

[0052] In an embodiment, the hollow ball joint 30 is formed by two halves that are juxtaposed and fixed together to embrace the pole 3.

[0053] The support body 1 is formed by two body parts, front 1', which supports the lighting body 2, and rear 1", which embrace the hollow ball joint 30 and which are

fixed together, for example by means of body fixing screws.

[0054] The hollow ball joint 30 is provided with a front tooth 36 and a rear tooth 38 facing respectively towards the front body part 1′ and towards the rear body part 1″. Correspondingly, in the front body part 1′ and in the rear body part 1″ are formed respective front 37 and rear 39 tooth seats, suitable to be engaged by the front 36 and rear 38 teeth. The front body part 1′ being more extensive and therefore heavier than the rear body part 1″, the front tooth seat 37 is engaged by the upper side of the front tooth 36, while the rear tooth seat 39 is engaged from the lower side of the rear tooth 38.

[0055] Advantageously, the apparatus body 100 is then secured to the pole 3 only thanks to the interaction due to the weight force of the apparatus body 100 between the teeth of the hollow ball joint 30 and the respective tooth seats.

[0056] According to a further aspect of the invention, and independently of the optical configuration of the lighting body 2, the same apparatus body 100 can be fixed to the pole 3 in a first configuration of use, wherein the apparatus body 100 is substantially orthogonal to the pole 3 (Figure 12), or in a second configuration of use, inclined, for example by an angle of 10°, with respect to

the first configuration of use (Figure 13).

[0057] For this purpose, the front 36 and rear 38 teeth of the hollow ball joint 30 are formed in diametrically opposite positions with respect to the centre of the hollow ball joint 30 and rotated with respect to the horizontal diametral plane of the joint 30, for example by about 10°. Therefore, in a first installation configuration, the teeth 36, 38 are formed in such a way that the apparatus body 100 extends in a substantially horizontal position (Figure 12). By mounting the hollow ball joint 30 on the pole 3 rotated 180° with respect to a horizontal axis of rotation, a second installation configuration is obtained wherein the apparatus body 100 is inclined by about 10° with respect to a horizontal plane.

[0058] To the embodiments of the lighting module and apparatus according to the invention, a technician in the field, to satisfy contingent requirements, may make modifications, adaptations and replacements of features with others functionally equivalent, without departing from the scope of the following claims. Each of the characteristics described as belonging to a possible embodiment can be achieved independently from the other embodiments described.

Claims

1. Lighting module, in particular for a street lighting apparatus, comprising two module portions suitable to illuminate respective portions of an object, said module portions being equal to each other and symmetrical with respect to a longitudinal module axis, each module portion comprising a lighting source and a corresponding reflector, where said lighting sources lie on a same source plane and are placed at the ends of the lighting module, each reflector comprising a side wall that extends parallel to the longitudinal module axis and that extends from the source plane forming a parabolic surface with a parabola axis inclined with respect to the source plane, a first inclined plane that extends with increasing width from the lighting source until in proximity of the longitudinal module axis, and a second inclined plane that extends with increasing width from the light source toward a front edge of the lighting module substantially orthogonal to the longitudinal module axis.

2.Lighting module according to claim 1, wherein the plan projection of the side wall on the source plane partially covers the lighting source.

3.Lighting module according to claim 1 or 2, wherein, the source axis being an axis orthogonal to the source plane,

the parabola axis of the side wall is inclined with respect to said source axis at an angle between 60° and 80°.

4.Lighting module according to any of the preceding claims, wherein each lighting source is placed in the focus of the parabola defining the side wall.

5. Lighting module according to any of the preceding claims, wherein, the source axis being an axis orthogonal to the source plane, the first inclined plane is inclined with respect to said source axis at an angle between 65° and 85°.

6.Lighting module according to any of the preceding claims, wherein, the source axis being an axis orthogonal to the source plane, the second inclined plane is inclined with respect to said source axis at an angle between 60° and 80°.

7.Lighting module according to any of the preceding claims, wherein each reflector is delimited, on the part opposite and parallel with respect to said front edge, by a rear wall that extends from the source plane forming a parabolic surface.

8. Lighting module according to the preceding claim, wherein, the source axis being an axis orthogonal to the source plane, the parabola axis of the rear wall is inclined with respect to said source axis at an angle

between 25° and 35°.

9.Lighting module according to any one of the preceding claims, wherein the first inclined planes of the reflectors are connected together by a central plane parallel to the source plane.

10. Lighting module according to any of the preceding claims, wherein the reflectors form a light emission window of substantially rectangular shape, the light sources being placed at two adjacent corners of said window.

11. Lighting module according to any of the preceding claims, wherein the lighting sources are LED sources, and wherein said source plane is formed by one or by respective electronic boards.

12. Lighting apparatus, in particular for street lighting, comprising at least one row of lighting modules according to any of the preceding claims, aligned with each other along the longitudinal module axis.

13.Apparatus according to the preceding claim, wherein a first frame element integrally forms the side walls of the reflectors of the lighting modules, a second sawtooth element integrally forms the second inclined planes and the rear walls, and of the row of lighting modules and the first inclined planes of the row of lighting modules, and wherein on each portion of the sawtooth element is

fixed a third reflecting element that integrally forms the first inclined planes and the central connecting plane.

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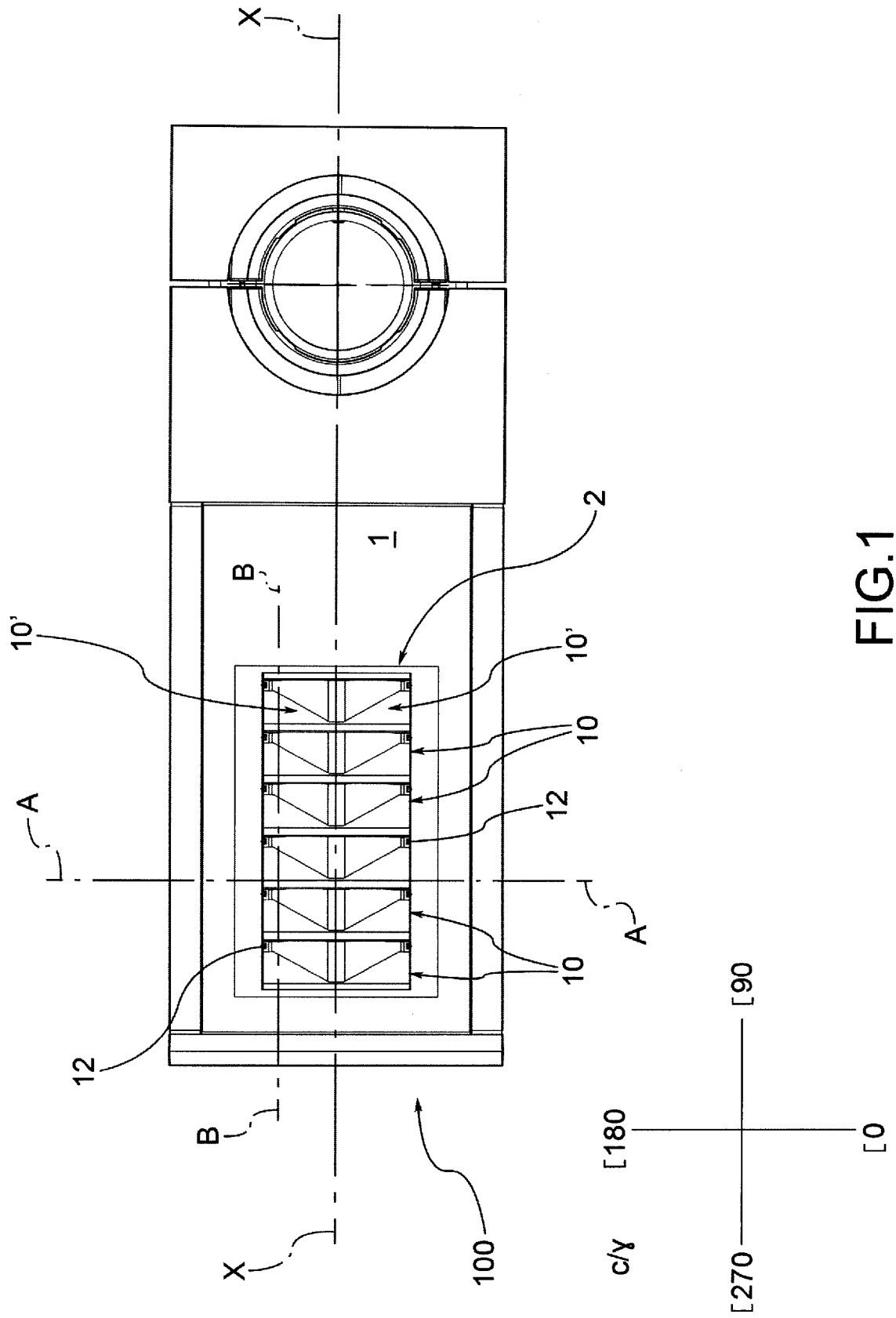

FIG.1

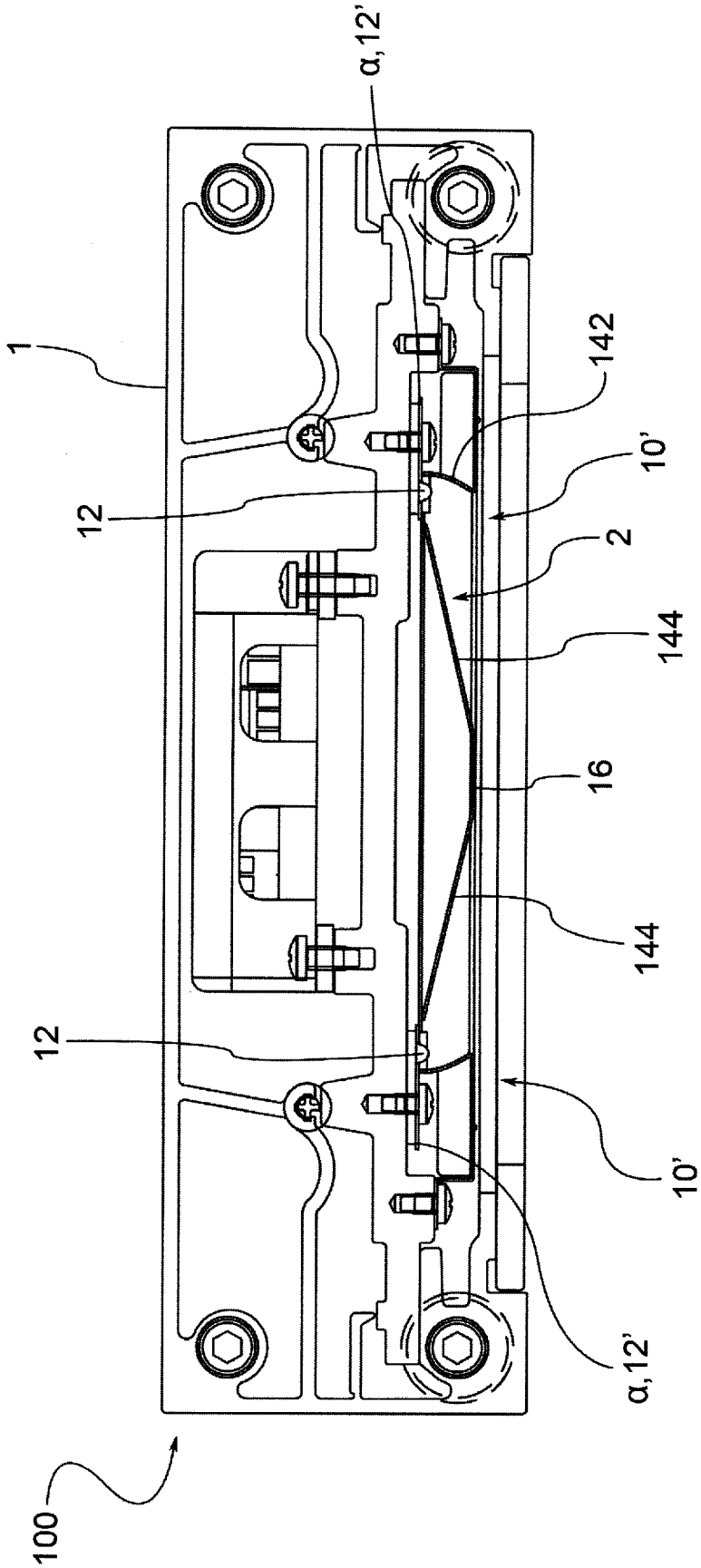

FIG.2

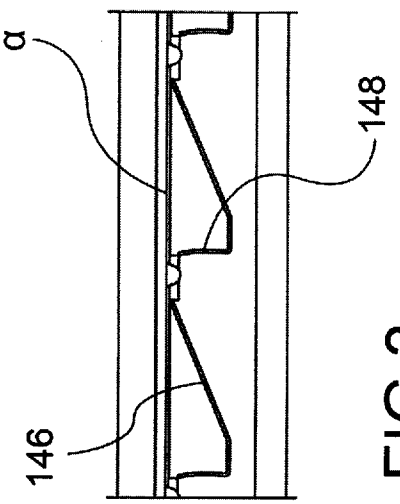

FIG.3

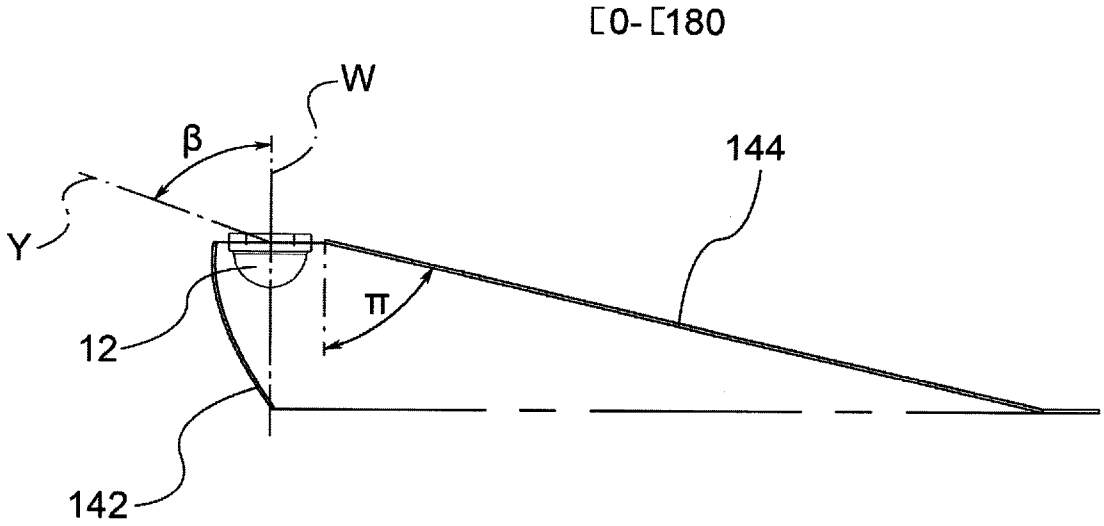

FIG.4

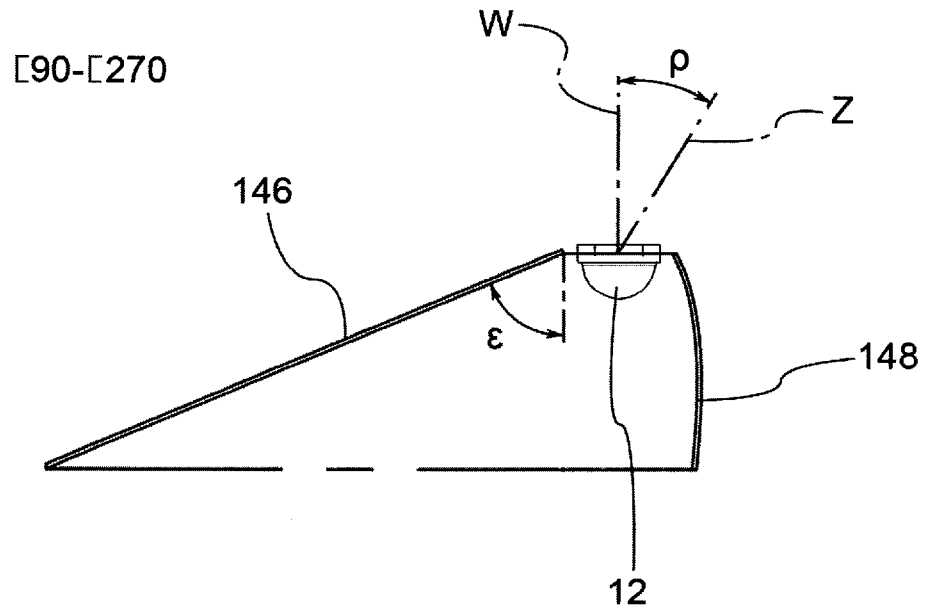

FIG.5

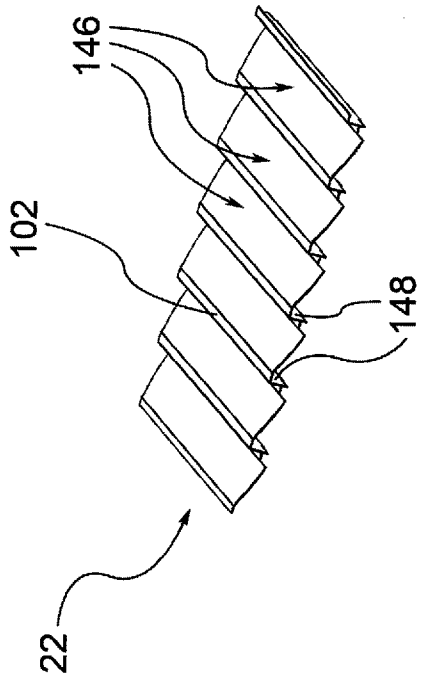

FIG.7

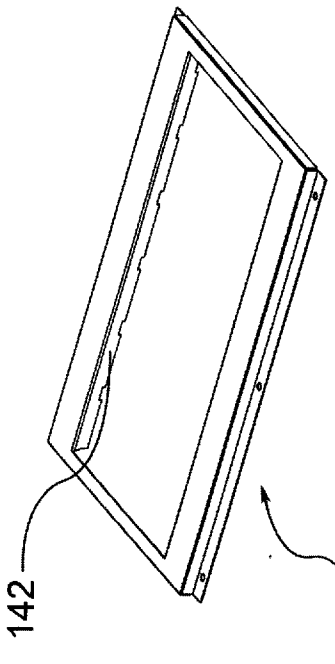

FIG.6

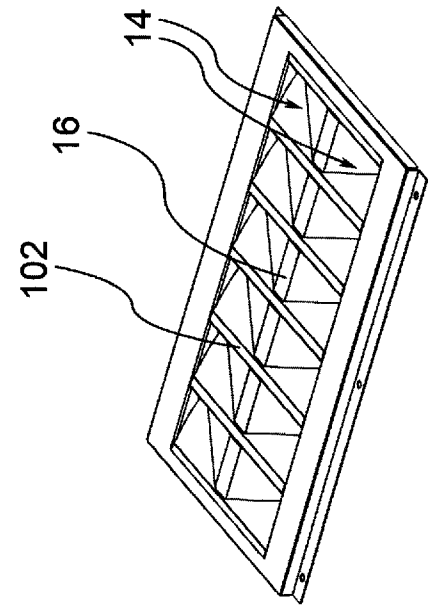

FIG.9

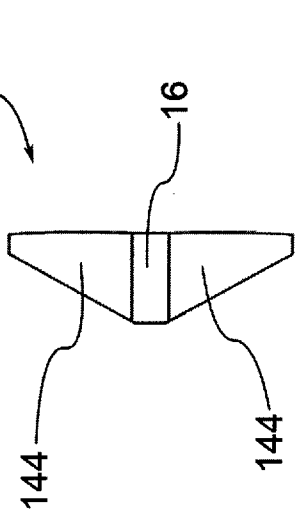

FIG.8

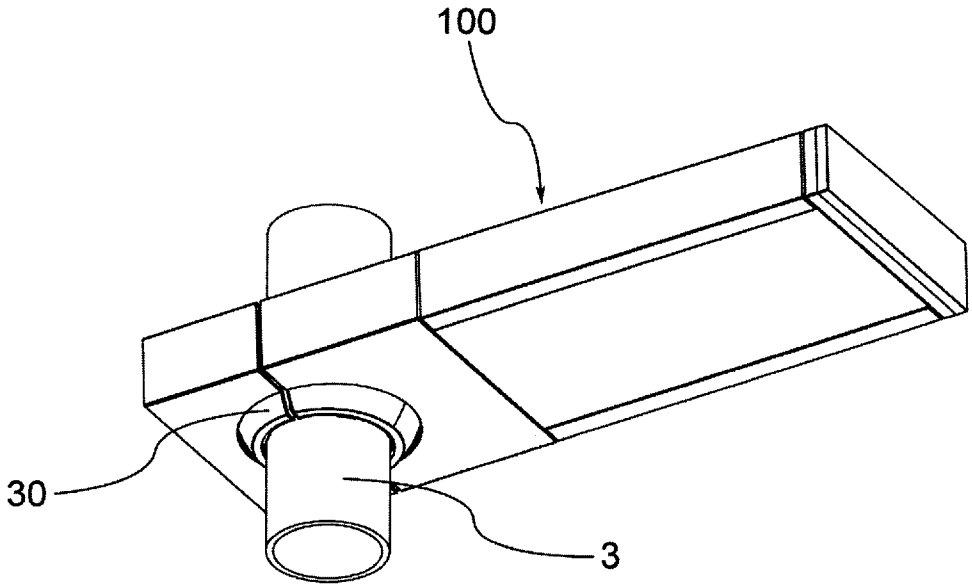

FIG.10

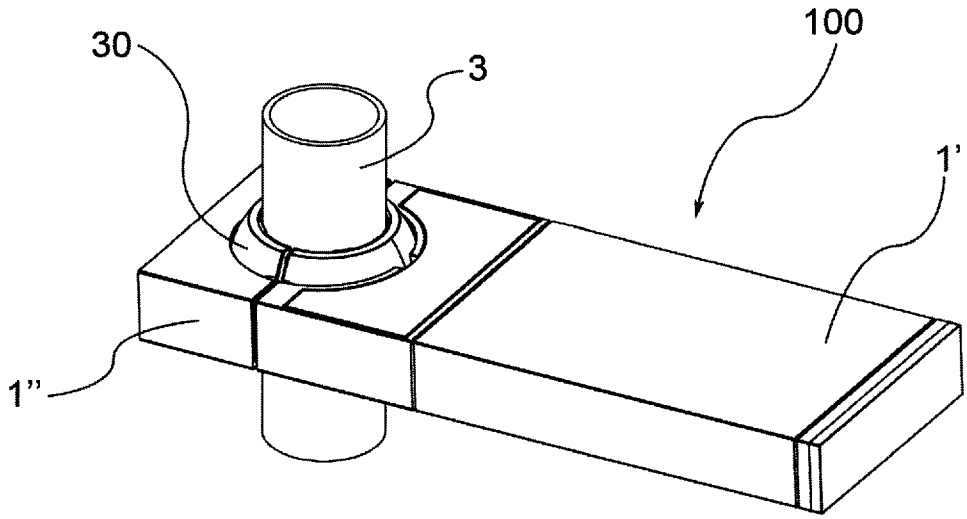

FIG.11

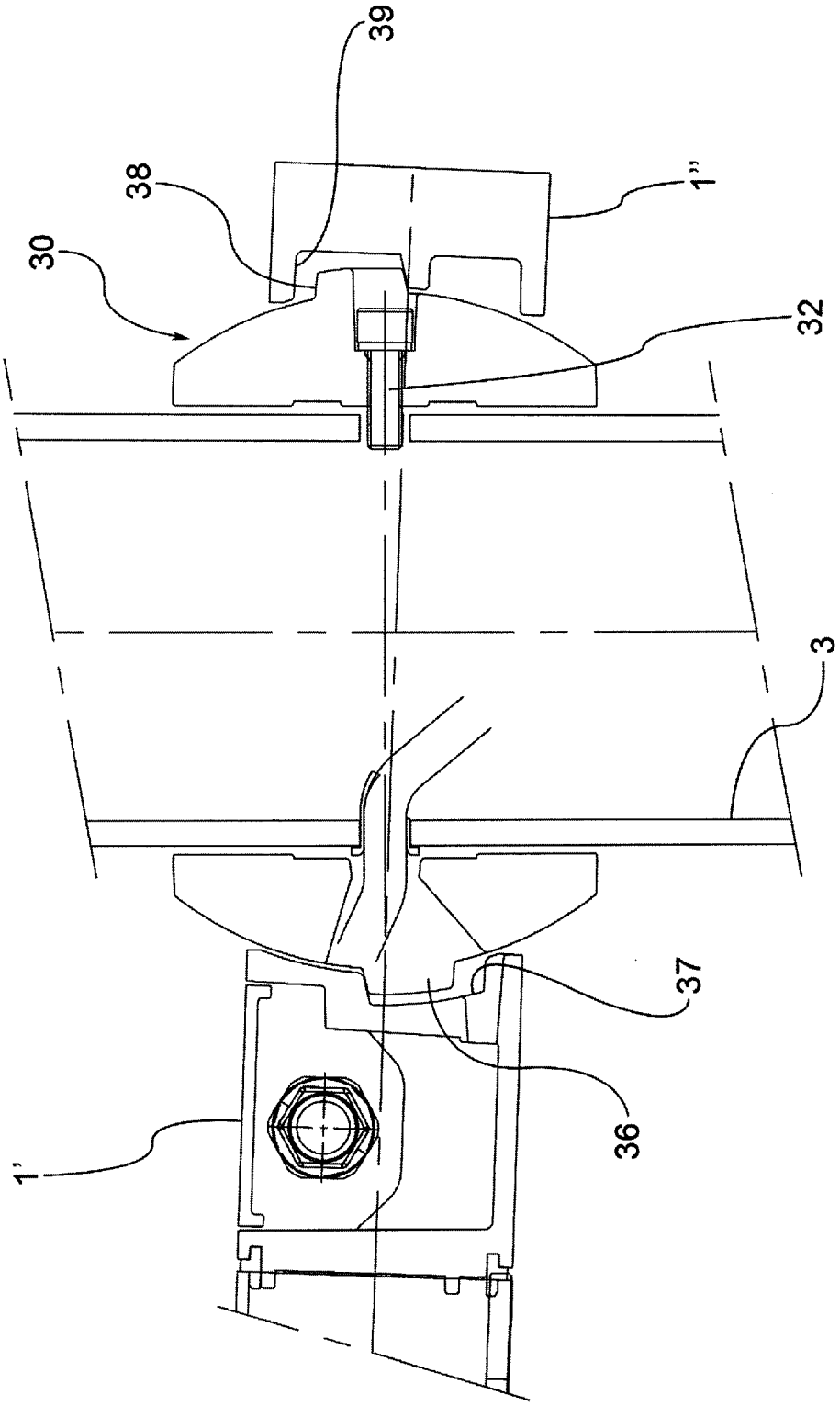

FIG.12

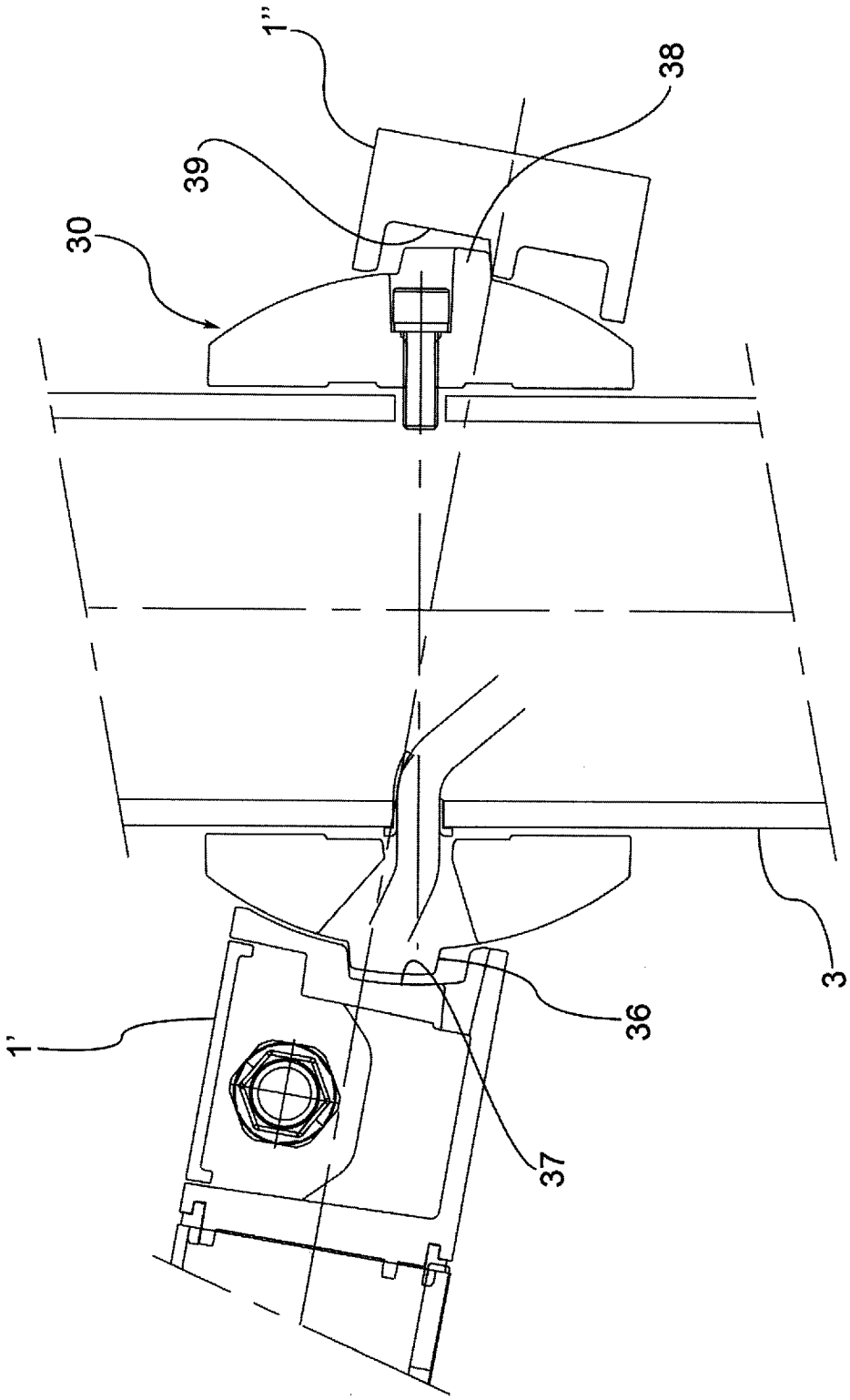

FIG.13