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(54) **Modular emitter device and manufacturing method thereof**

(57) A modular emitter device that can be applied to lamps and similar products, comprising at least a source (2) emitting electromagnetic radiations provided with at least one LED and a lens associated to the same LED, support means (3) of the emitting source (2), an optical concentrator (8) for the emitting source (2), feeding means (7) of the emitting source (2) and is characterized in that the support means (3) comprise a covering element (6) making one piece with the optical concentrator (8). The emitting source (2) and the feeding means (7) are at least partially embedded inside the covering element (6) in order to make the device (1) substantially waterproof. The absence of electrical parts in direct contact with the outside makes the device substantially waterproof and allows using it in wet and humid environments or immersed into tanks of various kinds, such as swimming pools or aquaria.

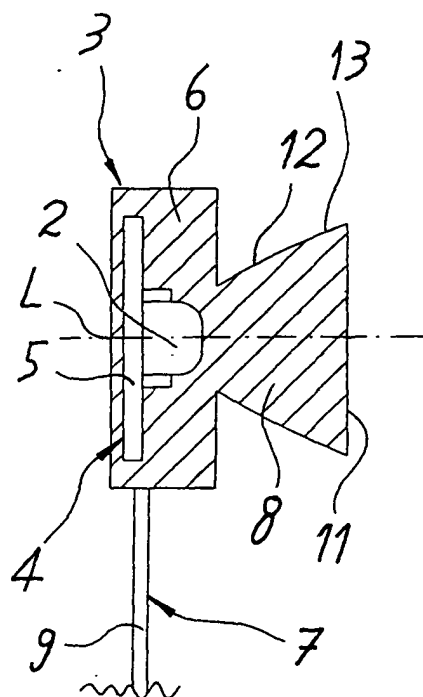


FIG. 2

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Description

[0001] The present invention can be applied in the field of the artificial lighting both for internal and external environments and, more generally, in the field of the electromagnetic radiation sources; its particular object is a modular emitter device and a manufacturing method thereof. More particularly, the modular emitter device is of the LED type.

[0002] Many embodiments of lighting devices whose lighting source is made of one or more light emitting diodes that are commonly designated with the name of Light Emitting Diodes or LEDs are known. A LED is generally an electronic device suitable to generate electromagnetic radiations with different wavelength, and in particular also in the band of visible light. A LED uses the radiative recombination transition of the charge carriers through the energy gap of a semiconductor.

[0003] The radiation generated by a LED is peculiar to the material used and cannot be in any way traced back to the thermal radiation the material could generate due to its temperature according to the Planck law. In particular, the emission efficiency of a LED is generally higher than the one of a device operating by thermal emission and the spectral distribution of the emitted radiation contains only one relatively narrow wavelength band. For this reason, the lighting devices of the LED type allow, for the same installed power, a considerable energy saving compared with the incandescent devices and the spectral content of the emitted light can be accurately selected.

[0004] Patents no. US-A-6274924, US-A-20020057057, US-A-415624, EP-A-0290697 disclose embodiments of photoemitter devices, each of them comprising a single LED mounted on a high thermal conductivity support element to dissipate the generated heat. The LED is protected by a box-shaped case or by means of a plastic material injected into a mould or into a containment seat. In some embodiments, a preformed lens whose sizes can be compared with the ones of the LEDs to concentrate the emitted electromagnetic radiations can be added.

[0005] A limit of these devices lies in their reduced power requiring the use of various single parallel devices or of additional elements such as reflecting surfaces or converging lenses that are properly sized in order to direct the emitted light energy to a spot beam.

[0006] When light sources with relatively high power are required, various photoemitter devices of the above-cited type are usually mounted on a common base and are controlled and fed by one control unit. In particular, patents no. US-A-6371636, US-A-20010037591, US-A-6283613 and WO-A-02065427 disclose signal devices to be used outdoors having a plurality of LEDs contained into one protective cover.

[0007] A clear limit of these solutions lies in the fact that in the manufacturing of the whole device, for each single LED, a reflecting element and a lens to increase

its efficiency need to be additionally mounted. Moreover the LEDs and their feeding and control circuits must be protected from water and humidity by means of gaskets or other seals making the manufacturing difficult and increasing its cost. Water or humidity leakages inside the protective case could cause dangerous short circuits and undesirable power losses due to the forming of condensed steam among the components, for example between the LED emitting surface and their lenses.

[0008] Many embodiments of signal devices or modular lighting designed to be used in various applications are also known. These kinds of embodiments are disclosed in patents no. WO-A-02052656, WO-A-0024062, EP-A-0979969, EP-A-0523927, US-A-6250774. Each modular device is made of one or more LEDs installed on a high thermal conductivity support element and protected by a case having at least one transparent portion to the emitted light and from which only the electric contacts come out, in order to make a compact light source with relatively small sizes. The light source thus obtained is fixed on a base being able to disperse heat and coupled with a concentrator element with optical refraction and/or reflectance features of the light emitted by the LED.

[0009] This solution allows using manufactured modular devices whose concentrator element is already coupled; they are very useful and versatile in the manufacturing of lamps, signal lights and the like with very different shapes and sizes. Moreover, the modularity of the devices makes the maintenance and repair easy in case of failures.

[0010] A drawback of this solution lies in that the concentrator element is coupled with the modular device by joints, mechanical constraints or bonding agents. Therefore, even in this case the use of additional seals to avoid water or humidity leakages inside the single modular device causing the above-said drawbacks is required. Moreover, possible shocks of the modular devices during the various steps leading to the final products could damage the alignment of the concentrator element or causing its removal.

Presentation of the invention

[0011] A primary object of the present invention is to remove the above-mentioned drawbacks, manufacturing a simple, solid, shock-resistant LED modular emitter device without losing the optical alignment among its components.

[0012] A particular object is the manufacturing of a device assuring a high resistance in wet and humid environments with waterproof features allowing its use also when immersed into tanks or aquaria.

[0013] A further object of the present invention is to carry out a versatile device to be used to assemble lighting and signal lamps of different kind for their type, sizes and complexity.

[0014] Another general object is the manufacturing of

a cost-effective device that keeps its features unchanged in time.

[0015] Another particular object is the manufacturing of a device assuring high security levels without requiring special and additional arrangements such as expressly designed gaskets.

[0016] These and other objects that will result clearer from the following description are reached according to claim 1 by a modular emitter device that can be applied to lamps and the like, comprising at least a source emitting electromagnetic radiations provided with at least one LED and a lens associated to a LED, support and feeding means of the emitting source and an optical concentrator for the same source. The device is characterized in that the support means comprise a covering element making one piece with the optical concentrator. Moreover, the emitting source and the feeding means are at least partially embedded inside the covering element in order to make the device substantially waterproof.

[0017] Thanks to this particular configuration a solid, reliable device assuring a high resistance in wet and humid environments with waterproof features allowing its use when immersed into tanks or aquaria can be obtained.

[0018] The feeding means are preferably electrically connected to the emitting source by an electric circuit that is entirely embedded into the covering element and comprise at least a couple of electric cables, each of them is provided with an insulating sheath extending at least partially inside the covering element.

[0019] Thanks to this particular configuration a high security level can be obtained without using special and expensive additional arrangements such as expressly designed gaskets or seals.

[0020] The support means properly comprise a dispersion element of the heat entirely embedded into the covering element and comprising a thermal conductivity plate upon which the emitting source is placed.

[0021] Thanks to this particular configuration, during operation, the temperature of the emitting source can be kept within a range of pre-set values and allows the same emitting source keeping its features substantially unchanged in time.

[0022] Further features and advantages of the invention will be clearer with reference to the detailed description of some preferred non-exclusive embodiments of a modular emitter device according to the invention, disclosed by way of non-limitative example with the help of the attached tables of drawings wherein:

Fig. 1 represents a front view of a first embodiment of an emitter device according to the invention;

Fig. 2 represents a side sectioned and enlarged view of a particular of the device of Fig. 1;

Fig. 3 represents a further side sectioned and en-

larged view of a particular of the device of Fig. 1;

Fig. 4 represents a partial perspective view of the device of Fig. 1;

Fig. 5 represents an enlarged perspective view of a particular of the device of Fig. 1;

Fig. 6 represents a partially sectioned perspective view of a second embodiment of an emitter device according to the invention;

Fig. 7 represents a front view of the emitting device of Fig. 6;

Fig. 8 represents a partially sectioned perspective view of a third embodiment of an emitter device according to the invention;

Fig. 9 represents a sectioned side view of the emitter device of Fig. 8.

[0023] With particular reference to the cited Figures, a modular emitter device according to the invention marked in its whole with reference number 1 that can be applied to lamps and similar products is disclosed.

[0024] The device 1 comprises at least an emitting source of electromagnetic radiations provided with at least one LED. The emitting source 2 can be properly formed by at least one partially hollow case wherein one or more LEDs are positioned. The case can comprise a protection lens being transparent to the electromagnetic radiations emitted by the LEDs.

[0025] The emitting source 2 is mounted on suitable support means 3, comprising a dispersion element 4 of the heat generated by the emitting source 2. The dispersion element 4 can be made of a thermal conductivity plate 5 with a suitable shape. Moreover, the support means 3 comprise a covering element 6.

[0026] A peculiar feature of the invention lies in that the covering element 6 is shaped and sized in such a way that the emitting source 2 is at least partially embedded into the same element. Advantageously, the covering element 6 can contain a plurality of emitting sources 2.

[0027] The electric power allowing the operation of the emitting source 2 is supplied by proper feeding means 7 being also partially embedded into the covering element 6. This particular configuration substantially makes the device 1 waterproof.

[0028] In order to direct the electromagnetic radiations emitted by the emitting source 2, the device 1 comprises also an optical concentrator 8 obtained in such a way to make one piece with the covering element 6.

[0029] The feeding means 7 are electrically connected to the emitting source 2 by an electric circuit (not shown in drawings) entirely embedded into the covering element 6. The feeding means 7 can be of different kind

and shape and can be made of stiff and/or flexible conductors. In particular, in the preferred embodiments shown in the attached tables of drawings, the feeding means 7 are formed by at least a couple of electric cables 9. Each electric cable 9 is provided with an insulating sheath 10 to insulate the relevant electric cable 9 and protect it from humidity, liquids and other potentially dangerous agents.

[0030] In order to use the device 1 also in humid or wet environments, the insulating sheath 10 of each electrical cable 9 at least partially extends inside the covering element 6. This arrangement protects the feeding means 7 from water and other liquids, and in particular the electric cables 9 also in correspondence with their ends.

[0031] The electric circuit can comprise at least a couple of beam leads (not shown in the drawings) obtained on the plate 5. The beam leads electrically connect the feeding means 7 to at least a couple of projections (not shown in the drawings) coming out of the emitting source 2.

[0032] In a first embodiment shown in the attached Fig. 1-4, the plate 5 is entirely embedded into the covering element 6. In this way, the plate 5, the emitting source 2, the couple of beam leads, the electric connections between the emitting source 2 and the couple of beam leads and between the latter and the electric cables 9 are entirely embedded into the covering element 6. Moreover, there are not electric parts being directly in contact with the air or being accidentally reached by water or other liquids.

[0033] The optical concentrator 8 and the covering element 6 are formed with the same material of the polymeric type. Advantageously, in the embodiment shown in Fig. 1-4, the optical concentrator 8 has a substantially flat end surface 11 and a sidewall 12 tapered towards the emitting source 2. The sidewall 12 at least partially reflects the electromagnetic radiations emitted by the emitting source 2 towards the end surface 11.

[0034] Advantageously, the optical concentrator 8 is a body of revolution whose axis of symmetry L is substantially orthogonal to the end surface 11. The generating line of the body of revolution has a bending apt to concentrate the electromagnetic radiations emitted by the emitting source 2 and direct them in order to form a radiation beam being substantially parallel to the axis of symmetry L.

[0035] In a second embodiment shown in Fig. 6, 7, the support means 3 comprise a thermal conductor base 4' upon which at least one dispersion element 4 and the relevant emitting source 2 are placed. The latter and partially also the thermal conductor base 4' are embedded into the covering element 6.

[0036] In a third embodiment shown in Fig. 8, 9, the support means 3 can comprise three dispersion elements 4, an emitting source 2 being mounted on each of them. The three dispersion elements 4 can be placed on the thermal conductor base 4' with a triangular setup.

In these two final embodiments, the covering element 6 protects from the contact with air, water or other liquids that could damage the correct operation of the device 1 if they are wet or in humid environments. On the contrary, the thermal conductor base 4' is not affected by the presence of liquids therefore it can remain uncovered from the covering element 6. Moreover, this feature allows the efficient transmission of the heat generated by the one or more emitting sources to the surrounding environments through the thermal conductor base 4'.

[0037] The device 1 is manufactured according to a method comprising a plurality of subsequent steps. In the first step a) the emitting source 1 is fastened to the support means 3. More particularly, the projections coming out of the emitting source 2 are connected to proper terminals of the beam leads obtained on the plate 5 for instance by soldering points.

[0038] A second step b) contemplates the connection of the feeding means 7 to the support means 3 in order to obtain an intermediate assembly 14. With reference to the attached tables of drawings, each electric cable 9 is electrically connected to one of its ends with the beam leads of the plate 5. The intermediate assembly 14 is therefore made of the emitting source 2 mounted on the plate 5 and of an end portion of the cables 9 in the first embodiment shown in Fig. 1-5.

[0039] In the second embodiment shown in Fig. 6, 7, the intermediate assembly 14 comprises the emitting source 2 mounted on the plate 5, the end portions of the cables 9 and the thermal conductor base 4' on which the plate 5 is positioned.

[0040] In the third embodiment shown in Fig. 8, 9, the intermediate assembly 14 comprises three emitting sources 2 with the relevant plates 5 positioned on the thermal conductor base 4'.

[0041] During this manufacturing step of the intermediate assembly 14, all the electric connections allowing the proper operation of each emitting source 2 are carried out. In the subsequent steps special arrangements are implemented in order to protect the intermediate assembly 14 and increase its efficiency.

[0042] A third step c) comprises the arrangement of a mould (not shown in the drawings) whose shape is complementary to the optical concentrator and to the covering element 6 to be obtained. The mould comprises a hollow whose sizes are suitable to allow the insertion of the intermediate assembly 14 and a shaped portion whose shape is complementary to the one of the optical concentrator to be obtained.

[0043] During the fourth step d), the intermediate assembly 14 is at least partially positioned inside the mould. In particular, in order to obtain the first embodiment of Fig. 1-4, the intermediate assembly is completely inserted into the mould in order to be completely wrapped by the moulding material during the following step.

[0044] On the contrary, to obtain the embodiments of Fig. 6-9, the intermediate assembly 14 is positioned with

a front portion 15 inside the mould and the thermal conductor base 4' partially outside the mould. Thanks to this positioning, the front portion 15 will be entirely embedded into the covering element 6, while the thermal conductor base 4' will be at least partially uncovered.

[0045] During the final step e) the moulded polymeric material is injected into the mould, in order to fill the hollow and at least partially embed the intermediate assembly 14. Advantageously, the polymeric material can be of the thermoplastic type.

[0046] A body made in one piece with the covering element 6 and the optical concentrator 8 is thus obtained with one moulding.

[0047] From the above-mentioned description it is clear that the device according to the invention reaches the fixed objects and in particular the absence of electric parts in direct contact with the outside makes the device substantially waterproof so that it can be used in humid and wet environments or immersed into tanks of various kinds such as swimming pools and aquaria.

[0048] Many changes can be made to the device according to the invention falling within the purpose of the appended claims. All the particulars can be replaced by other technically equivalent elements and different materials can be used according to the needs without leaving the purpose of the following claims.

[0049] Even though the device has been described with particular reference to the attached Figures, the reference numbers used in the claims are meant to increase the comprehension of the invention and therefore do not constitute limits to the protective scope claimed.

Claims

1. A modular emitter device that can be applied to lamps and the like, comprising at least a source (2) emitting electromagnetic radiations provided with at least one LED protected by a case, support means (3) of said emitting source (2), an optical concentrator (8) for that emitting source (2), feeding means (7) of the emitting source (2), **characterized in that** said support means (3) comprise a covering element (6) making one piece with said optical concentrator (8), said emitting source (2) and said feeding means (7) being at least partially embedded inside said covering element (6) in order to make the device (1) substantially waterproof.
2. The device according to claim 1, **characterized in that** said feeding means (7) are electrically connected to said emitting source (2) by an electric circuit that is entirely embedded into said covering element (6).
3. The device according to claim 2, **characterized in that** said feeding means (7) comprise at least a couple

of electric cables (9), each of them being provided with an insulating sheath (10).

4. The device according to claim 3, **characterized in that** said insulating sheath (10) at least partially extends inside said covering element (6).
5. The device according to claim 1, **characterized in that** said support means (3) comprise a dispersion element (4) of the heat generated by said emitting source (2).
6. The device according to claim 5, **characterized in that** said dispersion element (4) comprises a thermal conducting plate (5) on which said emitting source (2) is placed.
7. The device according to claim 6, **characterized in that** said electric circuit comprises at least a couple of beam leads obtained on said plate (5).
8. The device according to claim 7, **characterized in that** said emitting source (2) comprises at least a couple of projections coming outwards and electrically connected to said beam leads to feed said LED.
9. The device according to claim 8, **characterized in that** said dispersion element (4) is entirely embedded into said covering element (6).
10. The device according to claim 1, **characterized in that** said optical concentrator (8) and said covering element (6) are made of the same material.
11. The device according to claim 10, **characterized in that** the material of said optical concentrator (8) and of said covering element (6) is of the polymeric type.
12. The device according to claim 1, **characterized in that** said optical concentrator (8) has a substantially flat end surface (11) and a side wall (12) tapered towards said emitting source (2), suited to at least partially reflect the electromagnetic radiations emitted by said emitting source (2) towards said end surface (11).
13. The device according to claim 12, **characterized in that** said optical concentrator (8) is a body of revolution whose axis of symmetry (L) is substantially orthogonal to said end surface (11).
14. The device according to claim 14, **characterized in that** the generating line (13) of said body of revolution has a bending apt to concentrate the electromagnetic radiations emitted by said emitting source (2) in order to form a beam of radiations that are substantially parallel to said symmetry axis (L).

15. The device according to claim 8, **characterized in that** said support means (3) comprise a thermal conductor base (4') upon which at least one dispersion means (4) and the relevant emitting source (2) are supported, the latter and part of said thermal conductor base (4') being embedded into said covering element (6). 5
16. The device according to claim 15, **characterized in that** said support means (3) comprise three triangular setup dispersion elements (4), on said thermal conductor base (4'), on each of said dispersion elements (4) a relevant emitting source (2) is mounted. 10
17. A method for the manufacturing of a modular emitter device according to one or more of the previous claims, wherein the device (1) comprises at least one emitting source (2) of electromagnetic radiations, support means (3) provided with a covering element (6) to support and cover said emitting source (2), an optical concentrator (8) and feeding means (7) for said emitting source (2), wherein the method comprises the following steps: 15
- a) the fastening of said emitting source (2) to said support means (3); 20
 - b) the connection of said feeding means (7) to said support means (3) in order to obtain an intermediate assembly (14); 25
 - c) the arrangement of a mould whose shape is complementary to said optical concentrator (8) and to said covering element (6); 30
 - d) the positioning of said intermediate assembly (14) at least partially inside the mould; 35
 - e) the injection of a polymeric material in molten state into the mould, in order to partially embed said intermediate assembly (14) and obtain by one moulding a body made of one piece comprising said covering element (6) and said optical concentrator (8). 40
18. The method according to claim 17, **characterized in that** during said injection step e) of polymeric material the intermediate assembly (14) is entirely embedded. 45
19. The method according to claim 17, **characterized in that** said intermediate assembly (14) is positioned with a front end (15) internal to said mould and with a thermal conductor base (4') being partially external to the mould, so that the front portion (15) is entirely embedded into said covering element (6) and said thermal conductor base (4') is at least partially uncovered. 50
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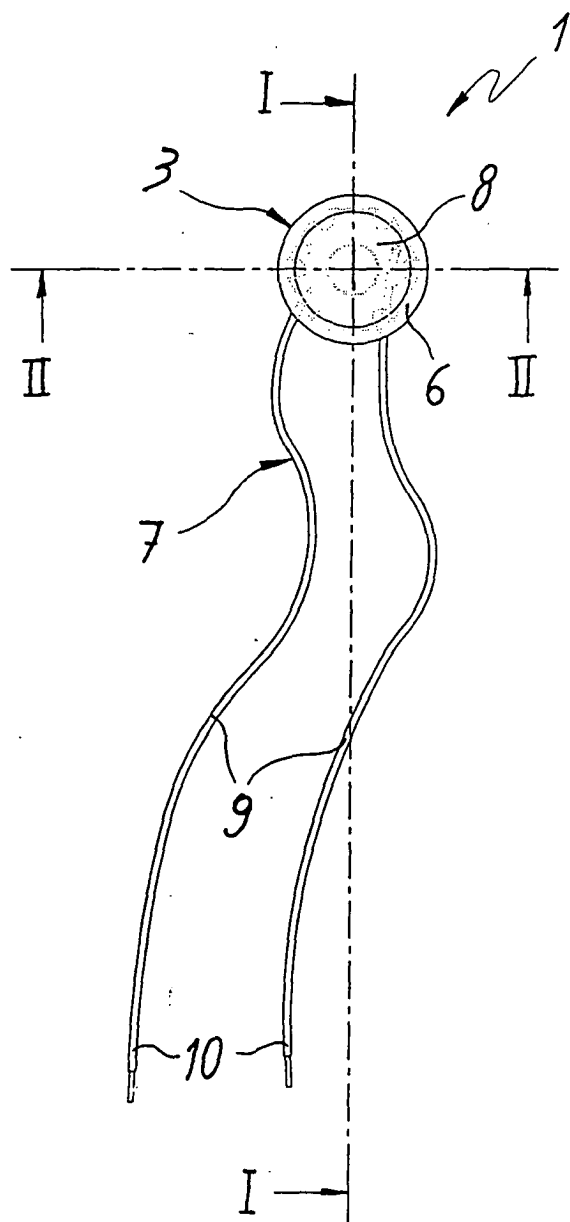


FIG. 1

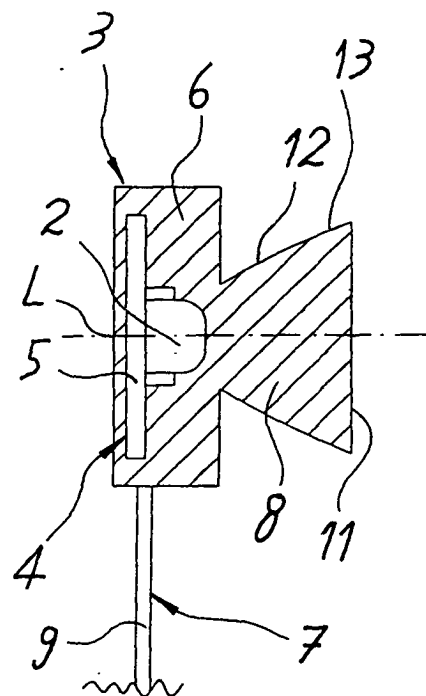


FIG. 2

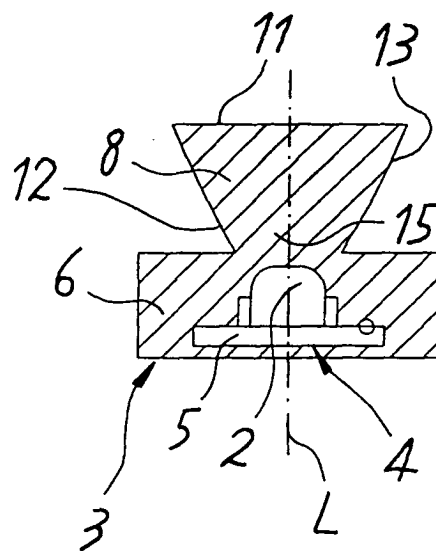


FIG. 3

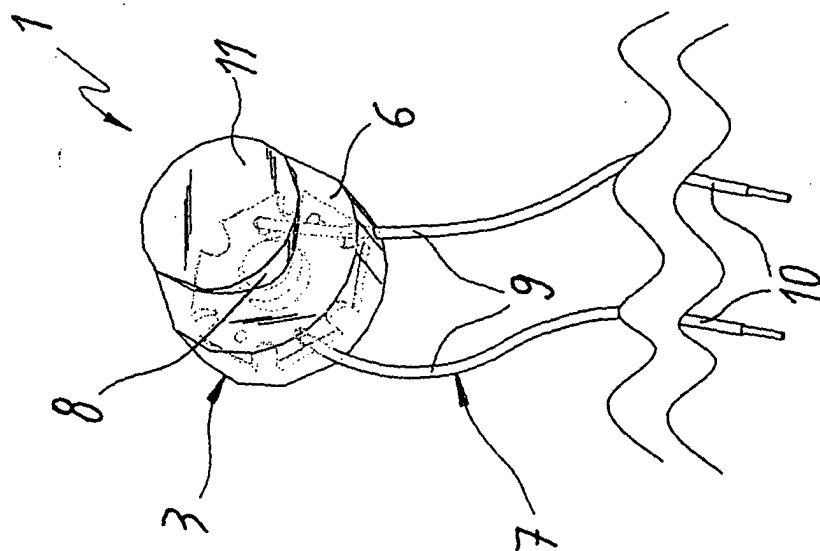


FIG. 4

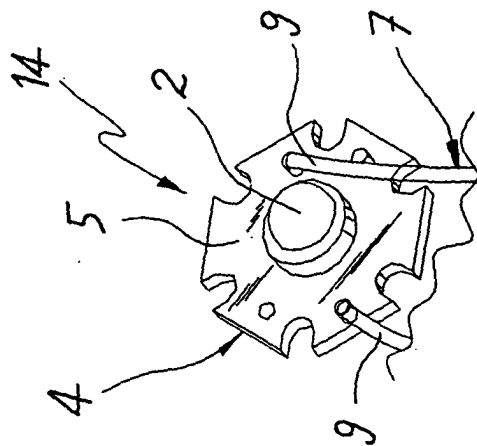


FIG. 5

