

(51) International Patent Classification:

F21V 15/015 (2006.01) *F21W 131/40* (2006.01)
F21V 17/10 (2006.01) *F21Y 115/10* (2016.01)
F21V 31/00 (2006.01) *F21Y 103/10* (2016.01)

(21) International Application Number:

PCT/EP2020/052413

(22) International Filing Date:

31 January 2020 (31.01.2020)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

19155433.6 05 February 2019 (05.02.2019) EP

(71) Applicant: **SIGNIFY HOLDING B.V.** [NL/NL]; High Tech Campus 48, 5656 AE Eindhoven (NL).

(72) Inventors: **DE KONING, Niels**; c/o High Tech Campus 7, 5656 AE Eindhoven (NL). **VAN DE LEUR, Juul, Hans**; c/o High Tech Campus 7, 5656 AE Eindhoven (NL).

(74) Agent: **STIL, Lambert, Johannes et al.**; Signify Netherlands B.V., High Tech Campus 7, 5656 AE Eindhoven (NL).

(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, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, 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, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, 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, ST, 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, KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))

(54) Title: A TUBULAR LIGHTING DEVICE AND AN END CAP OF SUCH A LIGHTING DEVICE

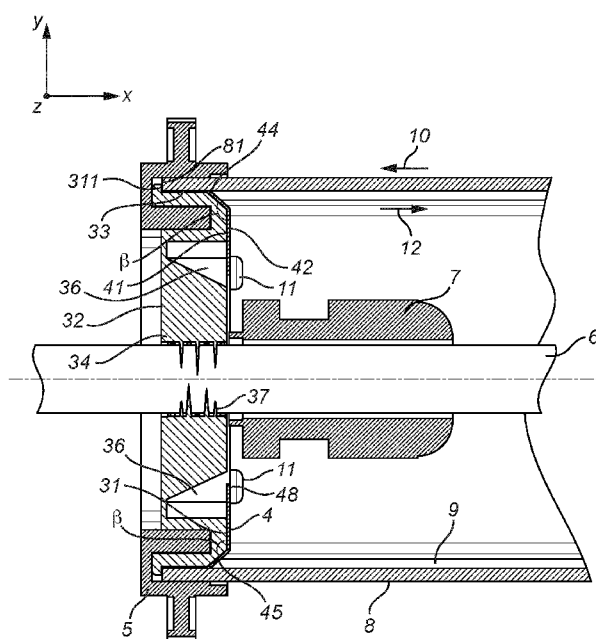


Fig. 4

(57) Abstract: An end cap (2) of a tubular lighting device comprising a first part (3) comprising a first surface (31) and a second surface (32), the first surface and the second surface being parallel and mutually opposite surfaces, and an at least partially circumferential wall (33) connecting the first surface and the second surface, and a second part (4) comprising a central body (411) with a third surface (41) and a fourth surface (42), the third surface and the fourth surface being parallel and mutually opposite surfaces, where the third surface (41) of the second part is adapted for, in an assembled state of the end cap, abutting the first surface (31) of the first part, an insertion direction (12) is defined as extending from the third surface (41) towards the fourth surface (42) and perpendicular to both the third surface and the fourth surface, and where the second part (4) further comprises at least one plurality of rigid protrusions (44, 45) extending from the central body (411) in an angle (α) with the insertion direction (12) being more than 90 degrees and less than 180 degrees..

Published:

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

A TUBULAR LIGHTING DEVICE AND AN END CAP OF SUCH A LIGHTING DEVICE

FIELD OF THE INVENTION

The invention concerns an end cap of a tubular lighting device comprising a first part comprising a first surface and a second surface, the first surface and the second surface being parallel and mutually opposite surfaces, and an at least partially circumferential wall connecting the first surface and the second surface, and a second part comprising a central body with a third surface and a fourth surface, the third surface and the fourth surface being parallel and mutually opposite surfaces, where the third surface of the second part is adapted for, in an assembled state of the end cap, abutting the first surface of the first part.

The invention further concerns a tubular lighting device comprising at least one such end cap.

BACKGROUND OF THE INVENTION

One application of such tubular lighting devices is as horticulture LED lighting devices. For this application a very high water proof performance is required as the lighting devices are subjected to high humidity, water and high temperatures.

To achieve this, prior art solutions employ a typically coextruded tube as enclosure of the LEDs and electronics, closed with end caps at the ends and then sealed by means of glue. A cable (8-12mm in diameter) is fed through the endcap, which will subject the end cap connection to forces. The weight and length of the cable are significant, and the cable will therefore easily force the end cap into an undesired position compromising the water tightness of the lighting device. This gives rise to problems when handling this product in the factory.

In one prior art LED fixture it is also known to fix the endcap temporarily to the tube by means of over-dimensioned ribs provided in the end cap. However, the adhesion force provided with this method is not sufficient to hold the end cap in place, especially when mechanical tolerances are taken into account.

In some prior art solutions, the end cap is screwed directly onto the tube. This solution will inflict high mechanical stresses on the tube. Moreover, with this solution it is very difficult to create a good sealing as the screws act as a leak path to the outside. Thus, in

such solutions the use of an end cap with a rubber seal has also been attempted. This provides for an overly complex structure, and further the rubber seal is prone to wear over time thus posing a risk for the end cap not remaining watertight.

Another prior art tubular lighting source is known from US 2016/0123543 A1, in which the end cap and the tubular housing are provided with a mutually complementary set of resilient rigid protrusions extending in a radial direction of the tubular lighting device such as to ensure that the end cap is rotatable with respect to the tubular housing. However, the engagement force provided with this construction is not sufficient to hold the end cap in place, especially when mechanical tolerances are taken into account.

There is thus a need and desire to provide a solution in which it is possible to fix the endcap to the tube with an easy to mount and robust solution, while providing an engagement force being sufficient to hold the end cap in place, especially when mechanical tolerances are taken into account, such as to ensure that the lighting device is watertight and durable.

SUMMARY OF THE INVENTION

It is an object of the present invention to overcome this problem, and to provide an end cap for a tubular lighting device which is possible to fix to the tube with an easy to mount and robust solution, while providing an engagement force being sufficient to hold the end cap in place, especially when mechanical tolerances are taken into account, such as to ensure that the lighting device is watertight and durable.

According to a first aspect of the invention, this and other objects are achieved by means of an end cap of a tubular lighting device comprising a first part comprising a first surface and a second surface, the first surface and the second surface being parallel and mutually opposite surfaces, and an at least partially circumferential wall connecting the first surface and the second surface, and a second part comprising a central body with a third surface and a fourth surface, the third surface and the fourth surface being parallel and mutually opposite surfaces, where the third surface of the second part is adapted for, in an assembled state of the end cap, abutting the first surface of the first part, where an insertion direction is defined as extending from the third surface towards the fourth surface and perpendicular to both the third surface and the fourth surface, and where the second part further comprises at least one plurality of rigid protrusions extending from the central body in an angle, α , with the insertion direction, the angle, α , being more than 90 degrees and less than 180 degrees.

By providing the second part with at least one plurality of rigid protrusions extending from the central body in an angle with the insertion direction being more than 90 degrees and less than 180 degrees, the rigid protrusions are adapted to function as barbs. The end cap is thus in effect provided with barbs. Thus, when the end cap and tubular housing of a lighting device are assembled, the rigid protrusions are brought into engagement with the tubular housing acting as barbs. Thereby an end cap for a tubular lighting device is provided which end cap may be fixed to the tubular element in such a way as to provide an engagement force being sufficient to hold the end cap in place, especially when mechanical tolerances are taken into account, such as to ensure that the lighting device is watertight and durable.

Such a construction eliminates the need for attaching the end cap directly to the inner tubular element. Thereby, inflicting high mechanical stresses on the tube, and in particular on the inner tubular element, is avoided. Furthermore, a good sealing is created as the need for screws and tuber sealing elements is eliminated.

In an embodiment, the second part comprises at least two pluralities of rigid protrusions, each extending from the central body in an angle, α , with the insertion direction, the angle, α , being more than 90 degrees and less than 180 degrees.

Thereby, when the end cap and tubular housing of a lighting device are assembled, the thus provided rigid protrusions are brought into engagement with the tubular housing acting as barbs with an improved barb effect thus providing an improved engagement force.

In a particular embodiment, the at least one plurality of rigid protrusions or the at least two pluralities of rigid protrusions extend in an angle, α , with the insertion direction being more than 100 degrees and less than 170 degrees. Under two pluralities is in the context of the present application understood at least a first plurality of protrusions and a second plurality of protrusions.

Thereby, when the end cap and tubular housing of a lighting device are assembled, the thus provided rigid protrusions are brought into engagement with the tubular housing acting as barbs with a particularly good barb effect thus providing a particularly efficient engagement force.

In an embodiment, the at least one plurality of rigid protrusions or the at least two pluralities of rigid protrusions extend in an angle, β , with the third surface being more than 90 degrees and less than 180 degrees.

Thereby an end cap for a tubular lighting device is provided which end cap may be fixed to the tubular element in such a way as to provide an engagement force being sufficient to hold the end cap in place, especially when mechanical tolerances are taken into account, such as to ensure that the lighting device is watertight and durable.

5 In a particular embodiment, the at least one plurality of rigid protrusions or the at least two pluralities of rigid protrusions extend in an angle, β , with the third surface being more than 100 degrees and less than 170 degrees.

Thereby, when the end cap and tubular housing of a lighting device are assembled, the thus provided rigid protrusions are brought into engagement with the tubular housing acting as barbs with a particularly good barb effect thus providing a particularly efficient engagement force.

10 In an embodiment a first direction is defined as extending from the fourth surface towards the third surface and perpendicular to both the third surface and the fourth surface, and the at least one plurality of rigid protrusions or the at least two pluralities of rigid protrusions extend in an angle, γ , with the first direction being more than 0 degrees and less than 90 degrees or being more than 10 degrees and less than 80 degrees.

Thereby an end cap for a tubular lighting device is provided which end cap may be fixed to the tubular element in such a way as to provide an engagement force being sufficient to hold the end cap in place, especially when mechanical tolerances are taken into account, such as to ensure that the lighting device is watertight and durable.

20 In an embodiment, the at least one plurality of rigid protrusions extends from an edge of the central body of the second part.

In another embodiment, the at least two pluralities of rigid protrusions extend from opposite parts of an edge of the central body of the second part.

25 By any of these two embodiments, when the end cap and tubular housing of a lighting device are assembled, the thus provided rigid protrusions are brought into engagement with the tubular housing acting as barbs with a further improved barb effect thus providing a further improved engagement force.

30 In an embodiment, the at least one plurality of rigid protrusions or the at least two pluralities of rigid protrusions comprise a rigid protrusion pitch of between 1 and 5 mm.

Thereby an end cap with an optimized barb effect and thus an optimized engagement force is provided for.

In an embodiment, the at least one plurality of rigid protrusions or the at least two pluralities of rigid protrusions comprise a rigid protrusion height h of between 1 and 2 mm.

5 Thereby an end cap with an optimized barb effect and thus an optimized engagement force is provided for, while also ensuring that the rigid protrusions are not penetrating through the wall of the tubular housing.

In an embodiment, at least the central body of the second part is a plate shaped element.

10 Thereby an end cap having a particularly simple structure and which is particularly simple and cheap to produce is provided for.

In an embodiment, the central body of the second part comprises at least one opening adapted for receiving a resilient protrusion provided on the first surface of the first part such as to form a snap-locking connection between the first part and the second part.

15 In an embodiment, the central body of the second part comprises at least one opening adapted for receiving a fastening element for fastening the second part to the first part.

By each of these two embodiments a structurally simple connection between the first and second parts of the end cap may be formed, thus ensuring a simple construction of the end cap as a whole as well as a simple and efficient assembly of the end cap.

20 In an embodiment, the second part further comprises at least one connection portion connecting the central body and the at least one plurality of rigid protrusions or the at least two pluralities of rigid protrusions.

Thereby an end cap with a reinforced second part thus being particularly robust is provided for.

25 In an embodiment, at least the at least one plurality of rigid protrusions or the at least two pluralities of rigid protrusions of the second part is made of a metal, or wherein the second part is made of a metal.

30 Thereby it is ensured that the pluralities of rigid protrusions are made of a material being rigid and in particular being harder than that of the tubular housing, which in turn ensures that an enhanced barb function of the rigid protrusions is provided for. By also providing the remaining part(s) of the second part of a metal, a particularly durable and robust second part and thus end cap is provided for.

The invention also concerns a tubular lighting device comprising a tubular housing, a light source within the tubular housing, and an end cap at each end of the tubular

housing, wherein each of the end caps are an end cap according to any one of the above embodiments.

In an embodiment, the tubular element is made of a first material, where at least the at least one plurality of rigid protrusions or the at least two pluralities of rigid protrusions of the second part of each of the end caps is made of a second material, and where the second material comprises a larger hardness than the first material.

In an embodiment, the tubular element is made of a plastic material, and at least the at least one plurality of rigid protrusions or the at least two pluralities of rigid protrusions of the second part is made of a metal.

In an embodiment, the tubular element is made of a first material, the second part is made of a second material, and the second material comprises a larger hardness than the first material.

In an embodiment, the tubular element is made of a plastic material, and the second part is made of a metal.

By any of the above-mentioned four embodiments, it is ensured that the pluralities of rigid protrusions are made of a material being rigid and in particular being harder than that of the tubular housing, which in turn ensures that an enhanced barb function of the rigid protrusions and thus a particularly well-functioning and robust connection between end cap and tubular housing is provided for. By also providing the remaining part(s) of the second part of a metal, a particularly durable and robust second part and thus end cap is provided for.

In such a tubular lighting device the light source may be an LED light source. Also, such a tubular lighting device may be used in horticultural applications, or in connection with swimming facilities, bathing facilities, car washes or other high humidity environments.

It is noted that the invention relates to all possible combinations of features recited in the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

This and other aspects of the present invention will now be described in more detail, with reference to the appended drawings showing embodiment(s) of the invention.

Fig. 1 shows an exploded and perspective view of a tubular lighting device comprising an end cap according to the invention, the end cap comprising a first part and a second part.

Fig. 2 shows a partially exploded and perspective view of the tubular lighting device according to Fig. 1 seen from a different angle of view.

Fig. 3 shows another partially exploded perspective view of the tubular lighting device according to Fig. 1 seen from the same angle of view as that of Fig. 1.

5 Fig. 4 shows a cross-sectional view of an assembled tubular lighting device according to the invention.

Fig. 5 shows a top view of a second part of an end cap according to the invention.

10 Fig. 6 shows a perspective view of the second part according to Fig. 5.

DETAILED DESCRIPTION

The present invention will now be described more fully hereinafter with reference to the accompanying drawings, in which currently preferred embodiments of the invention are shown. This invention may, however, be embodied in many different forms and
15 should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided for thoroughness and completeness, and fully convey the scope of the invention to the skilled person.

Fig. 1 to 4 show different views of an exemplary embodiment of a tubular lighting device 1 according to the invention. Generally, such a tubular lighting device 1
20 comprises a tubular housing 8, a light source arranged within the tubular housing 8, and two end caps 2, one arranged at each end of the tubular housing 8. Typically, but not limiting, the light source is an LED light source and the tubular lighting device is used in horticultural applications. Other applications may for instance include lighting in swimming facilities, bathing facilities, car washes and other places with a high humidity environment.

25 The tubular lighting device 1 further comprises an inner tubular element 9 (Fig. 4) arranged within the tubular housing 8. Typically, the inner tubular element 9 is made of a metal, such as aluminum, and the tubular housing 8 is made of a suitable plastic material.

The end caps 2 acts as a mechanical base to hold the cable gland and cable 6 and create the fixation with the Tube. The end caps 2 are sealed to the tubular housing 8 by
30 applying an adhesive, such as glue, on the circumferential element 51 of the third part 5. In this way the adhesive is transferred, and by pushing part 5 onto the tubular housing 8 and end cap 2 assembly a robust sealing is created such as to avoid intrusion of moisture, which could otherwise deteriorate the lighting device 1, into the interior of the lighting device 1. Each end cap 2 generally and irrespective of the embodiment comprises a first part 3 and a second part

4 (Figs. 1-4). Each end cap 2 may furthermore optionally comprise a third part 5 (Figs. 1 and 3) forming an outer covering part of the end cap 2.

Referring now particularly to Fig. 4, the first part 3 generally and irrespective of the embodiment comprises a first surface 31 and a second surface 32 as well as an at least partially circumferential wall 33 connecting the first surface 31 and the second surface 32. The first surface 31 and the second surface 32 are parallel and mutually opposite surfaces. The first part 3 may be made of a suitable plastic material.

The first part 3 may further optionally comprise a bushing 34 (Figs. 2 and 4) for introducing an electrical connection element, such as an electrical cable 6, connecting the light source of the tubular lighting device 1 to an external power source. The bushing 34 may further be adapted for receiving an element, such as a cable feed through 7, adapted for receiving the electrical connection element 6. The bushing 34 may further comprise sealing elements 37 (Fig. 4), a membrane or the like which serves to seal the transition between the bushing 34 and the electrical connection element 6, and which may further serve to fix the electrical connection element 6 in place in the bushing 34. Typically, a tubular lighting device 1 according to the invention comprises one end cap 2 with such a bushing 34, and one end cap 2 without such a bushing 34. Alternatively, the lighting device 1 is provided with a cable 6 at both ends. Thereby the main cable may be fed cable trough the tubular housing 8. In such an embodiment a tubular lighting device 1 according to the invention comprises two end caps 2 with a bushing 34 as described above.

The first part 3 may further optionally comprise at least one resilient protrusion 35 (Fig. 1), the function of which will be described further below. Fig. 1 shows two such resilient protrusions 35. In other embodiments one resilient protrusion 35 or more than two resilient protrusions 35 may be provided.

The first part 3 may further optionally comprise at least one bushing 36 (Fig. 4) for receiving fastening elements 11, such as screws or bolts, serving to attach the first part 3 and the second part 4 of the end cap 2 to one another. Fig. 4 shows two such bushings 36. In other embodiments one bushing 36 or more than two bushings 36 may be provided. In yet another embodiment the first part 3 and the second part 4 of the end cap 2 may be attached to one another using a suitable adhesive, and the bushings 36 may be omitted.

Referring now also to Figs. 5 and 6, the second part 4 generally and irrespective of the embodiment comprises a central body 411 with a third surface 41 and a fourth surface 42. The third surface 41 and the fourth surface 42 are parallel and mutually opposite surfaces. The second part further comprises an at least partially circumferential edge

43 connecting the third surface 41 and the fourth surface 42. The third surface 41 of the second part 4 is adapted for, in an assembled state of the end cap 2, abutting the first surface 31 of the first part 3 – cf. Fig. 4.

Generally, and irrespective of the embodiment, the second part 4 further
5 comprises at least one plurality of rigid protrusions 44, 45. Each such rigid protrusion comprises a pointed end 441, 451 (Fig. 5). In the figures, two pluralities of rigid protrusions 44 and 45 are shown. In alternative embodiments one, three or four pluralities of rigid protrusions may be provided. The one, two, three or four, as the case may be, pluralities of rigid protrusions 44, 45 extend from the central body 411 in a direction outward from the
10 central body 411. In the figures, the pluralities of rigid protrusions 44, 45 are shown as rigid teeth 44, 45. However, other configurations such as tips, points, spikes or the like are also feasible.

It is noted that as used herein, the term “rigid” is used generally as an opposite to the term “flexible”. More particularly, the term “rigid” is intended used in the sense that
15 the at least the one, three or four pluralities of rigid protrusions 44, 45, or indeed the whole second part 4, is made of a material having a hardness or rigidity being larger than the hardness or rigidity of the material of the tubular housing 8. Thus, and as the tubular housing 8 is typically made of a plastic material, the second part 4 or at least the one, three or four pluralities of rigid protrusions 44, 45, may be made of a suitable metal, such as aluminum or
20 steel.

As shown in the figures, an insertion direction 12 (arrow in Fig. 2) is defined as extending from the third surface 41 towards the fourth surface 42 and perpendicular to both the third surface 41 and the fourth surface 42, a first direction X (cf. also the arrow 10 shown in Fig. 4) is defined as extending from the fourth surface 42 towards the third surface
25 41 (i.e. oppositely to the insertion direction 12) and perpendicular to both the third surface 41 and the fourth surface 42, and a second direction Y and a third direction Z, respectively, are defined as extending in parallel with the third surface 41 and the fourth surface 42, perpendicular to one another and perpendicular to the first direction X and to the insertion direction 12.

30 Thus, and in general terms the one, two, three or four, as the case may be, pluralities of rigid protrusions 44, 45 may be said to extend from the central body 411 in a backwards direction with respect to the insertion direction 12. Thereby, the pluralities of rigid protrusions 44, 45 may, in an assembled condition of the lighting device 1, work as barbs

thus keeping the end cap 2 secured firmly and in a watertight manner to the tubular housing 8.

More particularly, the one, two, three or four, as the case may be, pluralities of rigid protrusions 44, 45 may also be said to extend in an angle α of more than 90 degrees and less than 180 degrees, more than 100 degrees and less than 170 degrees or more than 110 degrees and less than 160 degrees with the insertion direction 12 – cf. particularly Fig. 4 and 6.

Put in other words, the one, two, three or four, as the case may be, pluralities of rigid protrusions 44, 45 may be said to extend from the central body 411 in the first direction X. More particularly, and still using the first direction X, the one, two, three or four, as the case may be, pluralities of rigid protrusions 44, 45 extend in an angle γ of more than 0 degrees and less than 90 degrees, more than 10 degrees and less than 80 degrees or more than 20 degrees and less than 70 degrees with the direction X – cf. likewise Figs. 4 and 6.

Furthermore, the one, two, three or four, as the case may be, pluralities of rigid protrusions 44, 45 extend in an angle β (Fig. 4 and 6) with the third surface 41, where the angle α is more than 90 degrees and less than 180 degrees, more than 100 degrees and less than 170 degrees or more than 110 degrees and less than 160 degrees.

The rigid protrusions of the or each plurality of rigid protrusions 44, 45 comprise a height h and a pitch p – cf. Fig. 5. The height h is measured as the distance from a tip or pointed end 441, 451 to a bottom of any given rigid protrusion. The pitch p is measured as the distance between the tips of two adjacent rigid protrusions. The height h of the rigid protrusions is less than 2 mm, or even less than 1 mm. The pitch p of the rigid protrusions is less than 5 mm, less than 3 mm or even less than 2 mm. The pitch p may be equal to or different from the height h .

Generally, the one, two or more pluralities of rigid protrusions 44, 45 extend from the edge 43 of the central body 411 of the second part 4. In case of at least two pluralities of rigid protrusions 44, 45 are provided, the pluralities of rigid protrusions 44, 45 extend from opposite parts of the edge 43 of the central body 411 of the second part 4 as shown on Figs. 5 and 6. The second part 4 may further optionally comprise a connecting element 46, 47 connecting the plurality of rigid protrusions 45, 46 with the central body 411. As shown in Fig. 5, each of the two pluralities of rigid protrusions 45 and 46 are connected to the central body 411 by means of a connecting element 46 and 47, respectively. In an alternative only one or some of the pluralities of rigid protrusions may be connected to the central body 411 by means of a connecting element. In yet other embodiments the pluralities

of rigid protrusions may be connected directly to the central body 411, and the connecting element(s) may thus be omitted.

The second part 4 may further optionally comprise a central opening 48 (Fig. 5 and 6) adapted for leading through an electrical connection element, such as an electrical cable 6, connecting the light source of the tubular lighting device 1 to an external power source. Thus the opening 48 of the second part 4 and the bushing 34 of the first part 3 are, in the assembled state of the end cap 2, arranged coaxially.

The second part 4 may further optionally comprise at least one opening 491 (Fig. 5 and 6) adapted for receiving a resilient protrusion 35 (Fig. 1) of the first part 3. Thereby the second part 4 may be attached to the first part 3 by means of a snap locking connection as shown in Fig. 1 in that the resilient protrusion 35 is adapted and configured to abut an edge of the at least one opening 491 in a snap locking manner. The at least one opening may have a rectangular cross section as shown on Fig. 5 and 6, but may just as well have another cross sectional shape, such as round, square, oblong or even triangular. As shown on Fig. 1, 5 and 6 there are provided two openings 491. In other embodiments there may be provided one or more than two openings 491. In yet other embodiments the opening(s) 491 may be omitted.

The second part 4 may further optionally comprise at least one opening 492 (Fig. 5 and 6) adapted for receiving a fastening element 11, such as a screw or a bolt, serving to attach the first part 3 and the second part 4 of the end cap 2 to one another. Figs. 5 and 6 shows two such openings 492. In other embodiments one opening 492 or more than two openings 492 may be provided. Thus the openings 492 of the second part 4 and the bushing 36 of the first part 3 are, in the assembled state of the end cap 2, arranged coaxially. In yet other embodiments the opening(s) 492 may be omitted.

The above-mentioned optional third part 5 is best shown in Fig. 1. The third part 5 comprises a central opening 52 and a circumferential element 51. The circumferential element 51 is configured and constructed in such a way as to allow the third part 5 to be attached to the first part 3, and more particularly to a structure 38 (Fig. 2) corresponding to the circumferential element 51 provided in the second surface 32, by means of a snap or friction locking connection.

Referring again to Figs. 1 to 4, the tubular housing 8 and the end caps 2 of the tubular lighting device 1 are assembled as follows.

In a first step, cf. Fig. 1, the electrical connection element 6 is led through the central opening or bushing 34 of the first part 3, the central opening 48 of the second part 4

and the central opening 52 of the third part 5, and the electrical connection element 6 is connected to the light source arranged within the tubular housing 8.

In a second step, cf. Fig. 1, the first part 3 and the second part 4 are attached to one another. This may also be done before the first step. This is, depending of the embodiment of the first and second parts 3 and 4, achieved by one or more of bringing the resilient protrusions 35 into snap locking engagement with the openings 491, inserting fastening elements 11 through the openings 492 and into engagement with the bushings 36 and applying an adhesive to either of the first surface 31 and the fourth surface 42 and bringing the first surface 31 and the fourth surface 42 into abutment with one another.

In an optional third step, cf. Fig. 1, the first part 3 and the second part 4 are attached to the electrical connection element 6 in a suitable position by means of the cable feed through 7.

In a fourth step, cf. Figs. 2 and 3, the first part 3 and the second part 4 are attached to the tubular housing 8. As may be seen also from Fig. 4 this is in practice achieved by pushing the first part 3 and the second part 4 in an insertion direction (arrow 12 in Figs. 2 and 4) opposite to the first direction X (arrow 10 in Figs. 2 and 4) into the tubular housing until the fourth surface 42 of the second part 4 comes into abutment with an edge 91 (Fig. 4) of the inner tubular element 9 and/or an outer circumferential part 311 of the first part 3 comes into abutment with an edge 81 of the tubular housing 8. Thereby, the two pluralities of rigid protrusions 44, 45 are brought into engagement with the tubular housing 8 in such a way that the two pluralities of rigid protrusions 44, 45 work as barbs thus keeping the end cap 2 secured firmly in place.

In a fifth step, cf. Fig. 4, the third part 5 is brought into engagement with the first part 3. This is in practice achieved by first applying an adhesive, such as glue, on the circumferential element 51 of the third part 5 and then bringing the third part 5 and the first part 3 into engagement with one another. Thereby, the adhesive ensures that the engagement is stable, and a robust sealing is created. Alternatively, the engagement between the third part 5 and the first part 3 may be achieved by bringing the complementary structures 51 and 38 into engagement with one another to achieve a snap locking or friction locking connection between the third part 5 and the first part 3. It is noted that as the mechanical forces of the cable(s) 6 will be transferred to the first part 3 which is mechanically well fixed to the tube, the third part 5 needs only be mounted by means of a minor friction force. Therefore an adhesive is sufficient.

The person skilled in the art realizes that the present invention by no means is limited to the preferred embodiments described above. On the contrary, many modifications and variations are possible within the scope of the appended claims.

5 Additionally, variations to the disclosed embodiments can be understood and effected by the skilled person in practicing the claimed invention, from a study of the drawings, the disclosure, and the appended claims. In the claims, the word "comprising" does not exclude other elements or steps, and the indefinite article "a" or "an" does not exclude a plurality. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage.

CLAIMS:

1. An end cap (2) of a tubular lighting device comprising:
a first part (3) comprising a first surface (31) and a second surface (32), the first surface and the second surface being parallel and mutually opposite surfaces, and an at least partially circumferential wall (33) connecting the first surface and the second surface,
5 and
a second part (4) comprising a central body (411) with a third surface (41) and a fourth surface (42), the third surface and the fourth surface being parallel and mutually opposite surfaces, where the third surface (41) of the second part is adapted for, in an assembled state of the end cap, abutting the first surface (31) of the first part, wherein
10 an insertion direction (12) is defined as extending from the third surface (41) towards the fourth surface (42) and perpendicular to both the third surface and the fourth surface, and wherein
the second part (4) further comprises at least one plurality of rigid protrusions (44, 45) extending from the central body (411) in an angle (α) with the insertion direction
15 (12) being more than 90 degrees and less than 180 degrees, and
wherein the at least one plurality of rigid protrusions (44, 45) comprise a protrusion pitch (p) of between 1 and 5 mm.
2. An end cap according to claim 1, wherein the second part (4) comprises at
20 least a first plurality of rigid protrusions (44) and a second plurality of rigid protrusions (45), each extending in an angle (α) with the insertion direction (12) being more than 90 degrees and less than 180 degrees.
3. An end cap according to any one of the above claims, wherein the at least one
25 plurality of rigid protrusions or the at least two pluralities of rigid protrusions (44, 45) extend in an angle (α) with the insertion direction (12) being more than 100 degrees and less than 170 degrees

4. An end cap according to any one of the above claims, wherein the at least one plurality of rigid protrusions or the at least two pluralities of rigid protrusions (44, 45) extend in an angle (β) with the third surface (41) being more than 90 degrees and less than 180 degrees or being more than 100 degrees and less than 170 degrees.
5. An end cap according to any one of the above claims, wherein the at least one plurality of rigid protrusions (44, 45) extends from an edge (43) of the central body of the second part, and/or wherein the at least two pluralities of rigid protrusions (44, 45) extend from opposite parts of an edge (43) of the central body of the second part.
6. An end cap according to any one of the above claims, wherein the at least one plurality of rigid protrusions or the at least two pluralities of rigid protrusions (44, 45) comprise a protrusion height (h) of between 1 and 2 mm.
7. An end cap according to any one of the above claims, wherein at least the central body (411) of the second part (4) is a plate shaped element.
8. An end cap according to any one of the above claims, wherein the central body (411) of the second part (4) comprises any one or more of:
- at least one opening (491) adapted for receiving a resilient protrusion (35) provided on the first surface (31) of the first part (3) such as to form a snap-locking connection between the first part and the second part, and
- at least one opening (492) adapted for receiving a fastening element (11) for fastening the second part to the first part.
9. An end cap according to any one of the above claims, wherein the second part (4) further comprises at least one connection portion (47) connecting the central body (411) and the at least one plurality of rigid protrusions or the at least two pluralities of rigid protrusions (44, 45).
10. An end cap according to any one of the above claims, wherein at least the at least one plurality of rigid protrusions or the at least two pluralities of rigid protrusions (44, 45) of the second part is made of a metal, or wherein the second part (4) is made of a metal.

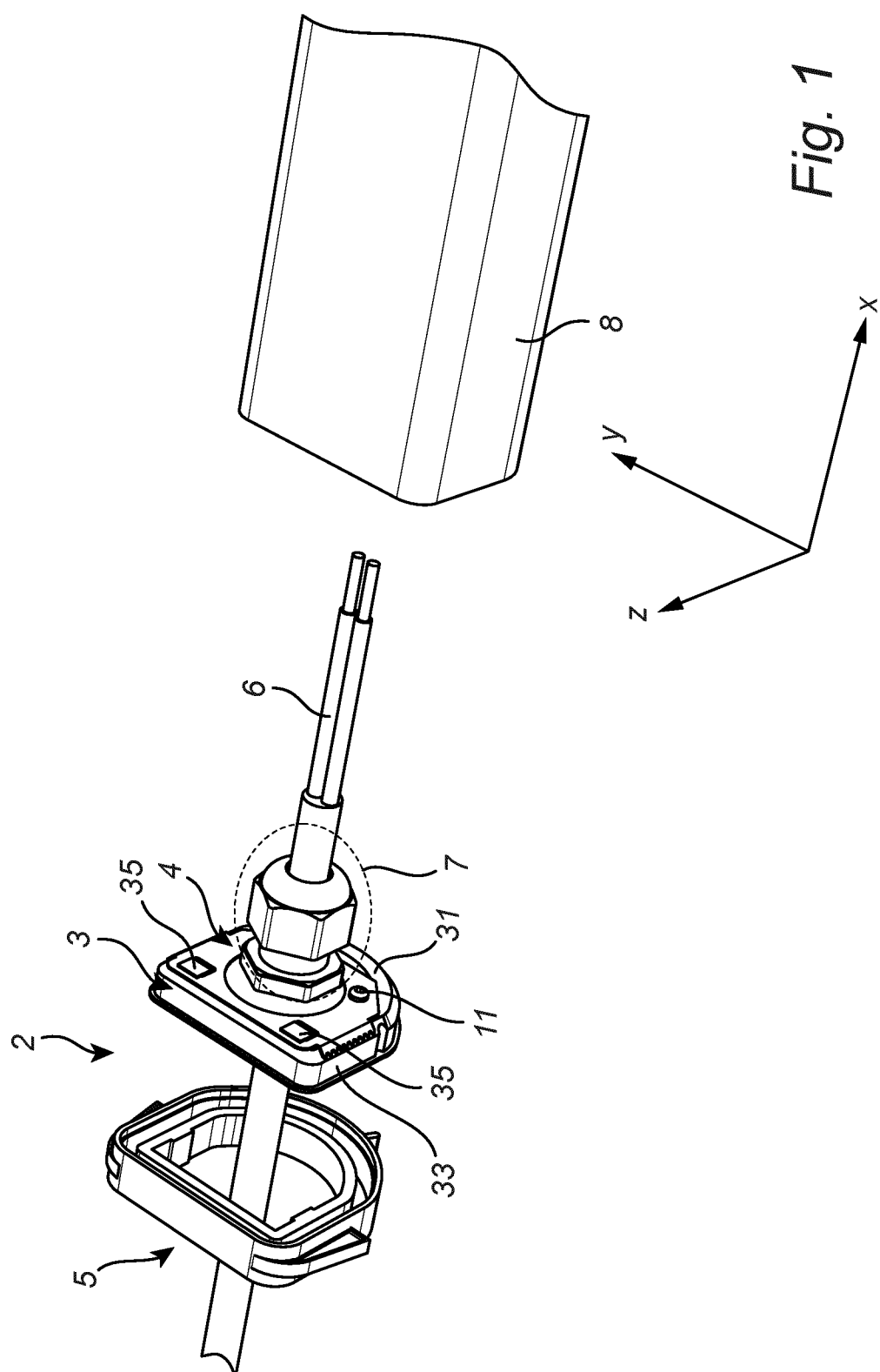
11. A tubular lighting device (1) comprising a tubular housing (8), a light source within the tubular housing, and an end cap (2) at each end of the tubular housing, wherein each of the end caps are an end cap (2) according to any one of the above claims.

5 12. A tubular lighting device according claim 11, wherein the tubular housing (8) is made of a first material, wherein at least the at least one plurality of rigid protrusions or the at least two pluralities of rigid protrusions (44, 45) of the second part (4) of each of the end caps (2) is made of a second material, and wherein the second material comprises a larger hardness than the first material and/or wherein
10 the tubular housing (8) is made of a plastic material, and at least the at least one plurality of rigid protrusions or the at least two pluralities of rigid protrusions (44, 45) of the second part (4) is made of a metal.

13. A tubular lighting device according to any one of claims 11 and 12, wherein
15 the tubular housing (8) is made of a first material, wherein the second part (4) is made of a second material, and wherein the second material comprises a larger hardness than the first material, and/or wherein
the tubular housing (8) is made of a plastic material, and the second part (4) is made of a metal.

20 14. A tubular lighting device according to any one of claims 11 to 13, wherein the light source is an LED light source and wherein the tubular lighting device (1) is used in horticultural applications, or in connection with swimming facilities, bathing facilities, car washes or other high humidity environments.

1/4



2/4

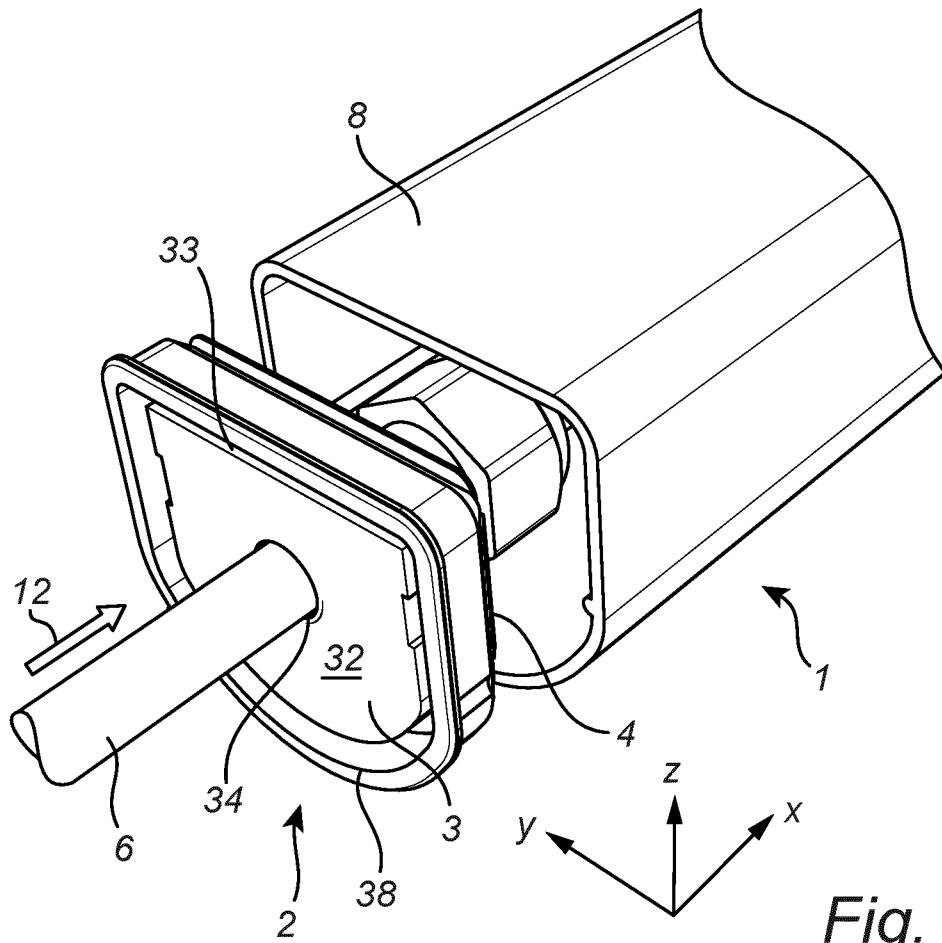


Fig. 2

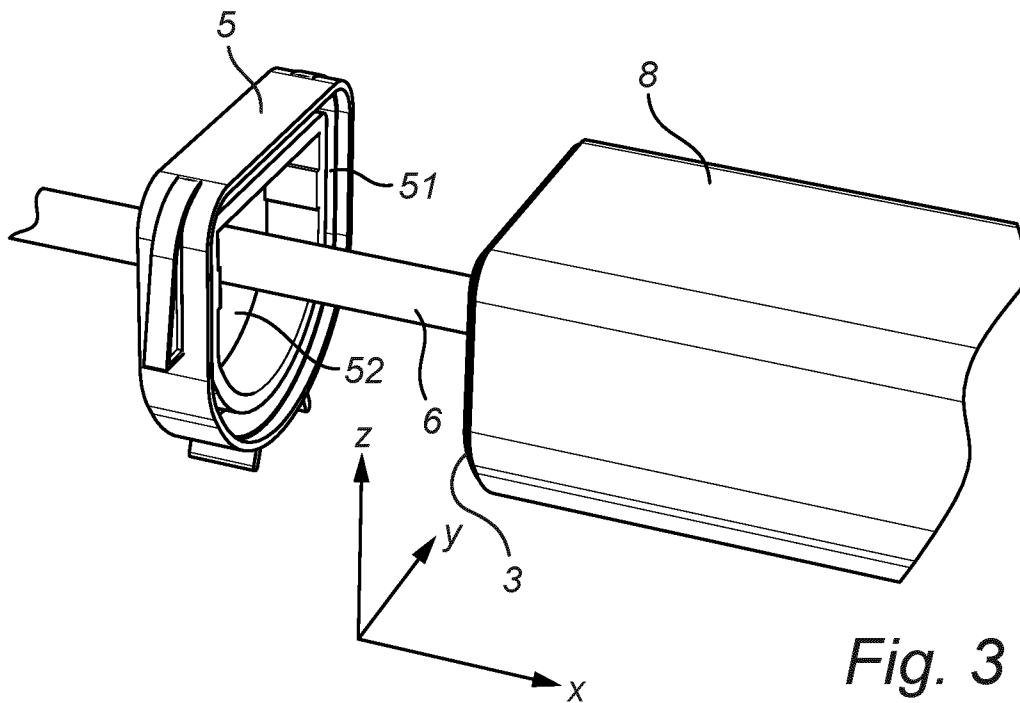


Fig. 3

3/4

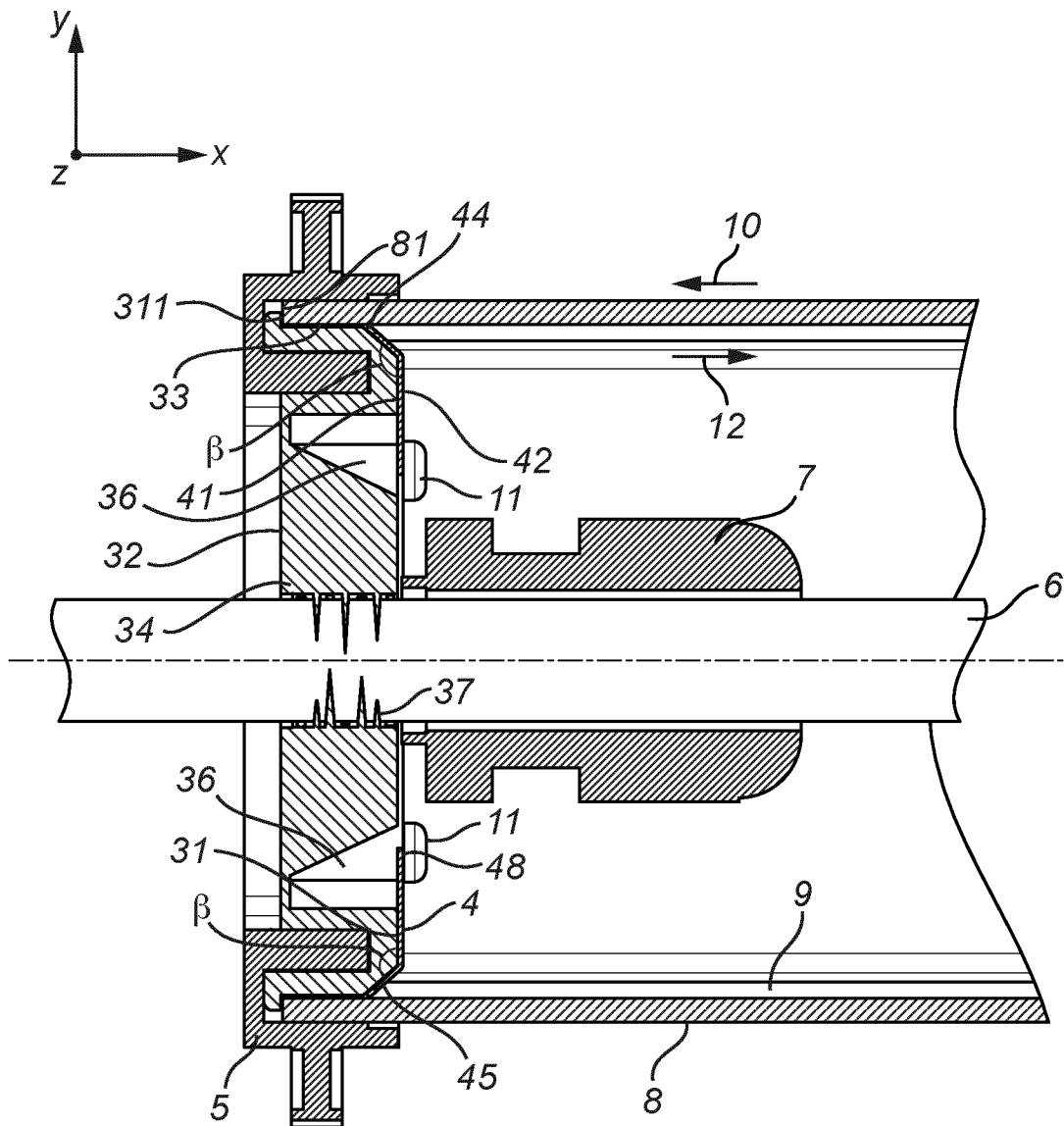


Fig. 4

4/4

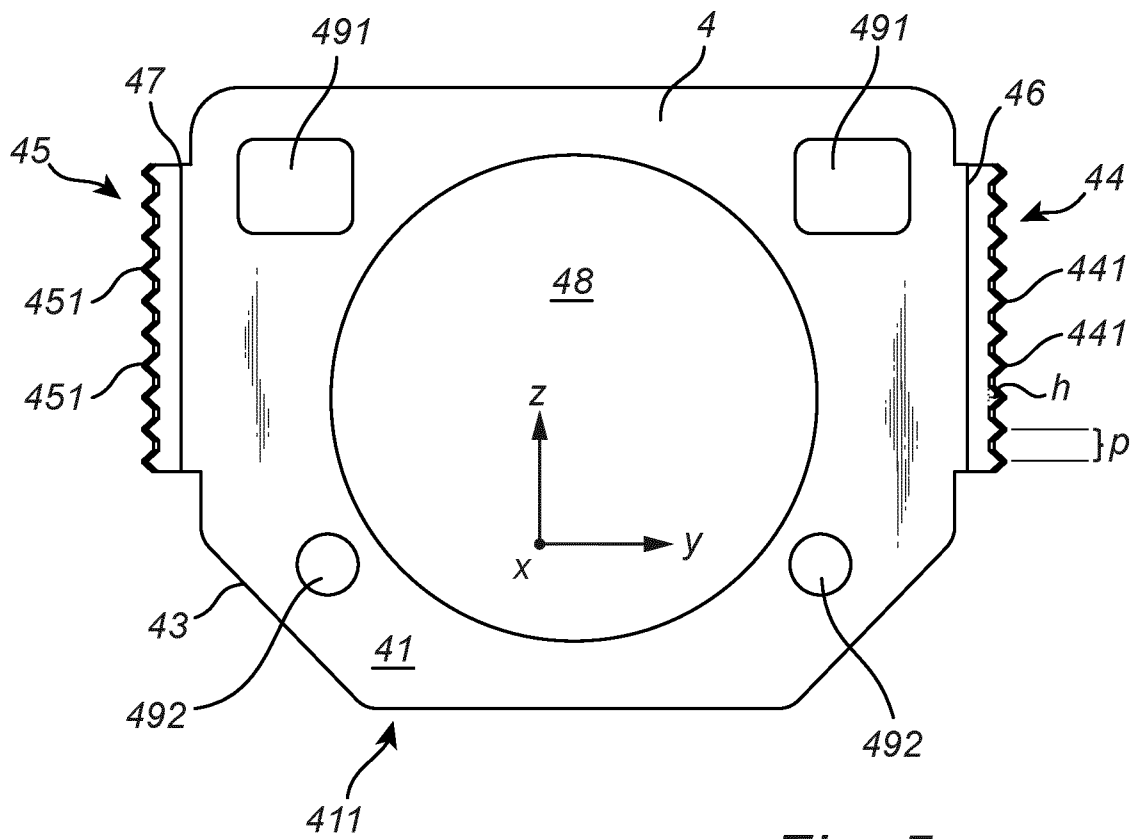


Fig. 5

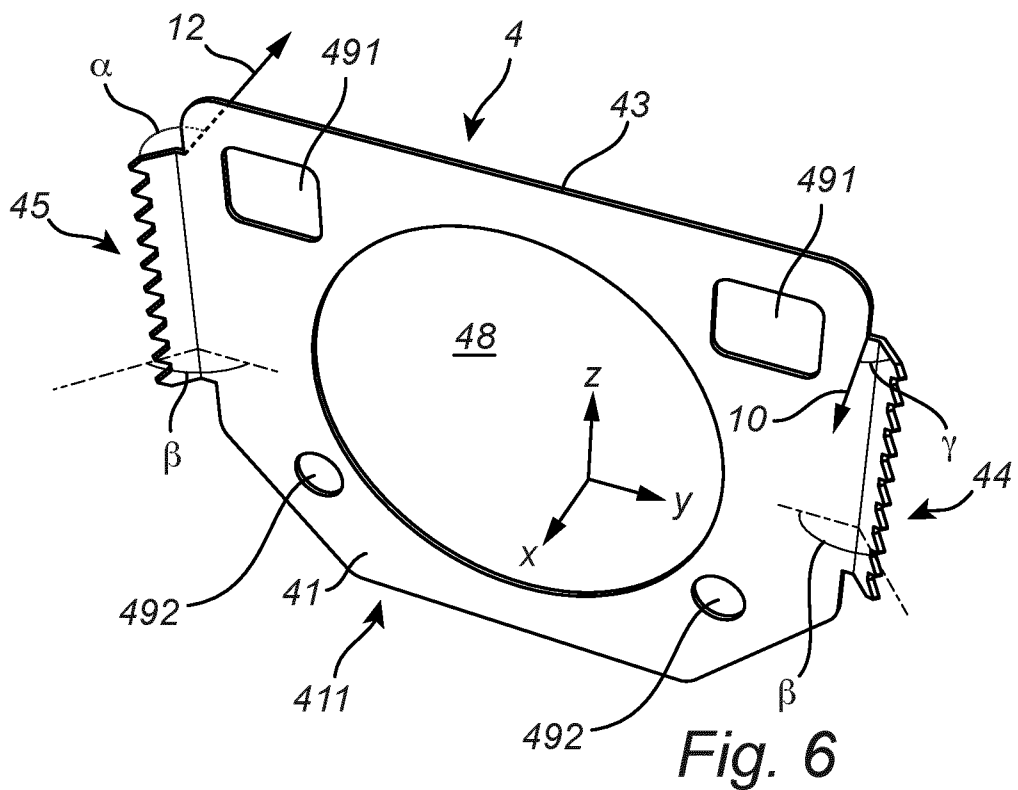


Fig. 6

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2020/052413

A. CLASSIFICATION OF SUBJECT MATTER

INV. F21V15/015 F21V17/10 F21V31/00
ADD. F21W131/40 F21Y115/10 F21Y103/10

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 F21S F21W F21Y F21K

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, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 2 194 315 A1 (VELDBOER NICOLAAS [NL]) 9 June 2010 (2010-06-09) paragraph [0016] - paragraph [0020] figures 1,4	1-14
A	----- US 2016/123543 A1 (HE JUNNAN [CN] ET AL) 5 May 2016 (2016-05-05) cited in the application the whole document	1-14
A	----- DE 20 2016 102334 U1 (ZUMTOBEL LIGHTING GMBH [AT]) 4 August 2017 (2017-08-04) paragraph [0052] - paragraph [0055] figures 8-10	1-14
A	----- EP 2 166 281 A2 (ZUMTOBEL LIGHTING GMBH [AT]) 24 March 2010 (2010-03-24) the whole document ----- -/-	1-14



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

30 March 2020

Date of mailing of the international search report

20/04/2020

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016

Authorized officer

Soto Salvador, Jesús

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2020/052413

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN 208 107 699 U (HAO ZHILONG) 16 November 2018 (2018-11-16) the whole document -----	1-14

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2020/052413

Patent document cited in search report		Publication date		Patent family member(s)		Publication date
EP 2194315	A1	09-06-2010	EP	2194315 A1		09-06-2010
			NL	1036293 C2		14-06-2011

US 2016123543	A1	05-05-2016	CN	104235768 A		24-12-2014
			EP	2986889 A1		24-02-2016
			US	2016123543 A1		05-05-2016
			WO	2014202361 A1		24-12-2014

DE 202016102334	U1	04-08-2017	AT	15658 U1		15-04-2018
			DE 202016102334	U1		04-08-2017
			EP	3242078 A1		08-11-2017

EP 2166281	A2	24-03-2010	DE 102008047928	A1		25-03-2010
			EP	2166281 A2		24-03-2010

CN 208107699	U	16-11-2018	NONE			
