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(54) LED-TECHNOLOGY LIGHTING SYSTEM WITH EXPLOSION-PROOF CHARACTERISTICS, FOR USE IN EXPLOSION-RISK AREAS

LED-TECHNOLOGIE-BELEUCHTUNGSSYSTEM MIT EXPLOSIONSSICHEREN EIGENSCHAFTEN ZUR VERWENDUNG IN EXPLOSIONSGEFÄHRDETEN BEREICHEN

SYSTÈME D'ÉCLAIRAGE À TECHNOLOGIE DEL AVEC CARACTÉRISTIQUES ANTIDÉFLAGRANTES, DESTINÉ À ÊTRE UTILISÉ DANS DES ZONES À RISQUE D'EXPLOSION

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(73) Proprietor: **Saras Ricerche e Tecnologie S.p.A.**
09032 Assemini (CA) (IT)

(72) Inventor: **Marongiu, Pier Luigi**
I-09134 CAGLIARI (IT)

(74) Representative: **Baroni, Matteo et al**
Metroconsult S.r.l.
Foro Buonaparte, 51
20121 Milano (IT)

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Description

Field of the invention

[0001] The present invention relates to a LED-technology lighting system with explosion-proof characteristics, for use in explosion-risk areas.

Background art

[0002] Electric appliances are commonly used in potentially explosive environments. An explosion may occur in the presence of a potentially explosive atmosphere, i.e. an atmosphere composed of a mixture of air and inflammable substances in the form of gas, vapor, mist or dust, in which, after ignition, combustion propagates rapidly (by explosion) at atmospheric pressure.

[0003] Electric appliances must therefore be so designed as to prevent the risk of an explosion that might be generated by sparks or electric discharges caused, for example, by the switching of electric switches.

[0004] In particular, European Directives exist which concern the risk of explosion in the presence of a potentially explosive atmosphere, which are known as ATEX (ATmospheres EXplosibles). The ATEX directive (94/9/EC) (ATEX 95) deals with the requirements for appliances intended for use in explosion-risk areas, and identifies different risk Groups and Zones by defining the technical/construction characteristics of appliances to be used in such groups/zones.

[0005] Several types of lighting appliances for explosion-risk areas are known and are commercially available. The main components of such systems are the light source, the explosion-proof casing and the power supply unit (if present).

[0006] Casings are classified according to the areas of possible installation (appliances suitable for zone 1, zone 2, etc.) or the type of light source contained therein. As far as the latter is concerned, the most widespread one in ATEX environments is the linear fluorescent tube.

[0007] One example of a known lamp for ATEX environments consists of a linear fluorescent tube with a casing made up of the following main components (see Figure 1): body 1 of polymeric or metallic material, equipped with hooks; diffuser 2 of transparent material (polycarbonate or glass); reflector of metallic material (within the body); lamp (within the body); electronic reactor; cable gland and cable for the internal wiring.

[0008] The LED technology is not much used in the field of lighting systems for ATEX areas, and anyway it is always employed as a "retrofit" technology, i.e. lamps with shapes and dimensions corresponding to those of traditional ones, which incorporate LED elements and which are intended to replace the light source only, leaving the lighting appliance unchanged or only requiring it to undergo small modifications. The "retrofit" technology, however, poses safety problems as well as problems of compatibility among different technologies, which are not easily solved and which, in most cases, imply losing the product's certifications. Every modification made may cause variations in one or more characteristics of the original product, thus invalidating the analyses made by the manufacturer of the original appliance for obtaining the necessary certifications of compliance with the ATEX standard. Also, every appliance is especially designed for the specific light source it is intended to contain, since every light source has different light emission properties. As a consequence, when the type of light source is changed it is not possible to guarantee that the initial lighting characteristics will be maintained. Moreover, due to the importance of these problems and to the recent tendency towards the use of the LED technology, reference standards are still under development in an effort to keep pace with the ongoing technological innovation. This is also a consequence of the fast diffusion of LED systems on the market, which is a direct result of achieved technologic maturity, price reduction and undoubted advantages in terms of energy consumption.

[0009] Therefore, if one wants to use LED-technology lamps in such environments, important problems need to be solved, which are essentially related to the lighting appliance, i.e. the enclosure that contains the light source. In particular, in lighting systems for hazardous areas a need is felt for appliance that can be assembled, installed and maintained easily, with improved heat sinking capacity, and requiring lower installation and maintenance costs, which would otherwise be high especially in such environments, due to more difficult installation and maintenance.

[0010] US2011242828 shows a LED lighting system with sections having substantially different diameters, which comprises an upper body containing the power supply system and the electric and electronic circuitry, a central body only performing the thermal dissipation function, a lower body containing the lighting system. The arrangement of the bodies of the system of US2011242828 is not optimized for proper heat dissipation.

[0011] US2013/0286675-A1 shows a LED lighting system wherein the power supply section is arranged on top of the LED lighting section and has a rectangular shape. The lighting section comprises a variable number of side-by-side elements separated from the power supply section. In order to increase the lighting power and hence the heat sinking capacity of the system, it is necessary to increase the number of side-by-side elements, thus considerably increasing the overall dimensions of the system.

[0012] LED-technology lighting systems are also known, such as, for example, those described in US2013/0141890, which have been developed for applications not suited to the above-described ATEX environments.

Summary of the invention

[0013] It is therefore the object of the present invention to provide a LED-technology lighting system having explosion-proof characteristics for use in explosion-risk areas, which can solve the above-mentioned problems.

[0014] The present invention relates to an explosion-proof lighting system adapted for use in explosion-risk areas, which comprises:

- a power supply body equipped with a heat sink having a substantially cylindrical shape;
- a lamp body, in which a lighting system based on LED technology is inserted, the lighting system being housed on a support plate adapted to act as a heat sink;
- a power mains connection body;

said power supply body, lamp body and power mains connection body having an essentially cylindrical shape and each being distinct, aligned and joined axially through mechanic and electric interconnections, said power mains connection body being located on the power supply body side.

[0015] In the lamp body, the LED-technology lighting system is housed on a support plate adapted to act also as a heat sink.

[0016] All bodies have a cylindrical shape, are distinct from one another, and are joined axially by means of mechanic and electric connections. All the metallic parts are interconnected in such a way that the heat generated by the power supply unit and by the LED strips can be dissipated also because of the wholly metallic surface of the lighting system.

[0017] It is a particular object of the present invention to provide a LED-technology lighting system having explosion-proof characteristics for use in explosion-risk areas as set out in the claims, which are an integral part of the present description.

Brief description of the drawings

[0018] Further objects and advantages of the present invention will become apparent from the following detailed description of a preferred embodiment (and variants) thereof referring to the annexed drawings, which are only supplied by way of non-limiting example, wherein:

Figure 1 shows some examples of prior-art LED lamps;
Figure 2 shows an example of embodiment of a LED-technology lighting system according to the invention;
Figures 3.1, 3.2 are two exploded axonometric views of some components of the system of Fig. 2;
Figure 4 is an exploded axonometric view of some components of the power mains connection body of the system of Fig. 2;
Figure 5 is an exploded axonometric view of some components of the power supply body of the system of Fig. 2;
Figure 6 is an exploded axonometric view of some components of the lamp body of the system of Fig. 2;
Figures 7.1, 7.2, 7.3 show three possible configurations of the LED carrier system of the system of Fig. 2;
Figure 8.1 shows a cross-section of the transparent tube of the lamp body, in which a first variant of the support of the LED carrier system is implemented;
Figure 8.2 shows a second variant of the support of the LED carrier system;
Figure 9 shows a ring nut for light beam orientation;
Figure 10 shows an example of a LED strip suitable for insertion into the LED carrier system;
Figure 11 shows an example of installation of the lighting system of the invention.
Figure 12.1 shows a second example of embodiment of a LED-technology lighting system according to the invention;
Figures 12.2, 12.3 are two exploded axonometric views of some components of the system of Fig. 12.1;
Figures 13.1, 13.2 are two exploded axonometric views of some components of the lamp body of the system of Fig. 12.1;
Figures 14.1, 14.2, 14.3 are exploded axonometric views of some components of the power supply body of the system of Fig. 12.1;
Figures 15.1, 15.2, 15.3, 15.4 show some examples of embodiment of the components of the LED carrier system of Fig. 12.1;
Figure 16 is an exploded axonometric view of some components of the power mains connection body of the system of Fig. 12.1;
Figure 17 shows a third example of embodiment of a LED-technology lighting system according to the invention.

[0019] In the drawings, the same reference numerals and letters identify the same items or components.

Detailed description of some embodiments of the invention

[0020] A first variant of the lighting system of the invention, represented in Figures 2, 3.1 and 3.2, has a substantially cylindrical shape and is made up of two distinct main elements aligned and joined axially by means of suitable mechanic and electric interconnections:

- power supply body 4;
- lamp body, in which a lighting system based on LED technology is inserted;
- power mains connection body 3, connected to the power supply body 4, which in turn is connected to the lamp body 5.

[0021] These three elements are completely independent and are connected together by means of mechanical interconnections, e.g. through suitable connectors and a sealing system including a ring nut, NPT threads and gaskets. These elements are also electrically connected to one another by means of electric interconnections.

[0022] The separation of the power supply body from the lamp body allows physical separation of the power supply unit/transformer from the LED sources, and this allows replacing the single elements easily, quickly and economically. The physical separation of the power supply system from the LED sources ensures, at the same time, less overheating of the power supply unit/transformer and junction temperatures (i.e. the temperature of the point where each LED diode is connected to its base) that will not cause a fast decay of the LED lamp that would otherwise shorten the service life thereof.

[0023] The power mains connection body 3 (Figure 4) comprises the following main elements to be connected: cable gland 41; terminal with internal thread 42, having a hollow and substantially cylindrical shape; VAC connector (female) 43; gasket (O-ring) 44.

[0024] The power cable, which is present in the environment where installation is taking place, is inserted into the cable gland 41 integral with the terminal 42, and is connected to the terminals of the VAC connector 43. The gasket 44 is needed to seal the connection between the terminal 42 and the power supply body 4, when these are connected, by means of the ring nut and the NPT thread.

[0025] The power supply body 4 (Figure 5) comprises the following main elements: power supply unit/transformer 53, adapted to transform the VAC input voltage into a VDC voltage; cap for the power supply body on the VAC side 51; threaded ring nut 52 on the VAC side; gasket (O-ring) 54; heat sinking cylinder 55 made of light alloy, with a support for the power supply unit; gasket (O-ring) 56; threaded ring nut 57 on the VDC side; cap for the power supply body on the VDC side 58; VAC connector (male) 59; VDC connector (female) 50.

[0026] Of course, electric connection cables are also present.

[0027] The power supply unit/transformer 53 is secured by means of screws into a suitable flat support (not shown in the drawing) provided inside the hollow heat sinking cylinder 55; it is an electronic unit performing functions as a transformer/converter, receiving a VAC voltage (through the connector 59 in Fig. 5) and supplying the LED strips, through the VDC connector (connector 50 in Fig. 5), with a levelled and stabilized VDC voltage. The power supply unit can be equipped with suitable power selectors (not shown in the drawing) for varying the power as a function of the voltage required by the lamp body.

[0028] The heat sinking cylinder 55 has suitable radial heat sinking fins so designed as to promote the dissipation of the heat produced by the electronic element, thereby preventing the latter from overheating, which is the main cause of the rapid decay of its service life.

[0029] At its two opposite ends, the heat sinking cylinder 55 features the caps 51 and 58 of the power supply body. Such caps are tightened by means of screws evenly arranged around the cap circumference, and are sealed by gaskets 54, 56.

[0030] On the cap 51 of the power supply body on the VAC side there is a connector 59, which is connected to the power supply unit/transformer 53 through electric cables. The electric connection is established by joining together the two VAC connectors (connector 43 in Fig. 4 and connector 59 in Fig. 5). The mechanical connection is provided by screwing the ring nut into the terminal. The sealing of the connection is ensured by the presence of the gasket. On the cap 58 of the power supply body on the VDC side there is the VDC connector 50 (Fig. 5). The electric connection is established by joining together said connector to the matching VDC connector 67 (Fig. 6) integral with the lamp body 5. The mechanical connection is ensured by screwing the ring nut into the connection cylinder of the lamp body.

[0031] The lamp body 5 shown in Figure 6 essentially comprises:

connection cylinder with internal thread 61; gasket (O-ring) 62; transparent cylindrical tube 63 with internal guides; LED carrier system 64 made of light alloy with LED strips; gasket (O-ring) 65; sealing head 66 with internal thread; VDC connector (male) 67; electric connector 68 for the light source (female); electric connector 69 for the light source (male); threaded sealing cylinder 60 with orientation system (enlarged detail in Fig. 9).

[0032] Of course, electric connection cables are also present.

[0033] The transparent cylindrical tube 63, which contains the lighting part, may be made of self-extinguishing polycarbonate or tempered glass, or borosilicate glass, and is integrally secured (e.g. by gluing or welding) to one end of the connection cylinder 61, while the other end is integrally secured to the threaded sealing cylinder 60 for the engagement of the sealing head 66. Both connections are sealed by the gaskets 62, 65.

[0034] On the two faces of the connection cylinder 61 there are the following connectors: on the face adjacent to the power supply body there is the VDC connector 67 of Fig. 6, which is connected to the matching VDC connector 50 (Fig. 5) integral with the power supply body when the connection is established between the lamp body 5 and the power supply body 4. On the inner face of the tube there is the light source connector 68 (Fig. 6), which must be connected to the connector 69 integral with the LED carrier system.

[0035] The electric connection of the LED sources is established in a simple and direct manner by means of the light source connectors 68, 69 (Fig. 6). The lighting part is connected when the LED carrier system is fully

inserted in the tube. This connection is ensured by tightening the threaded sealing head 66 with its gasket.

[0036] The lighting part consists of a LED carrier system having an elongated profile with a constant cross-section, which will be described in detail below, the side surface of which accommodates LED strips 10 (shown in Figure 10) in suitable tracks. The lighting part can be easily replaced by dismounting the sealing head 66 and extracting the LED carrier system 64.

[0037] In a first variant (Figure 8.1), the LED carrier system 64 is supported within the transparent tube 63 in such a way that it can slide on guides 81, 82 formed in the inner part of the transparent tube 63, in opposite positions on the inner surface.

[0038] The LED carrier system 64 is locked into the guides within the transparent tube when the terminal head 66 is fastened to the transparent tube.

[0039] In a second variant (Figure 8.2), the LED carrier system 64 is supported within the transparent tube 63 by means of a metallic guide 85 internal to the transparent tube 63 and adapted to allow the LED carrier system to slide. The metallic guide 85 is arranged longitudinally and is integral, at one end, with the face (on the lamp body side) of the connection cylinder 61, is locked and at the other end by the sealing head 66. The metallic guide 85 provides the necessary support for the insertion and extraction of the LED carrier system 64, and may have a circular or rectangular cross-section, with different proportions between its sides.

[0040] Different configurations of the LED carrier system 64 have been developed (some examples of which are shown in Figures 7.1, 7.2, 7.3) in order to fulfill various needs in terms of illumination and installed power. Depending on the profile adopted for the cross-section of the LED carrier system, different irradiation diagrams can be obtained with variable angular sectors, even with the same number of LED carrier strips. For example, the system of Fig. 7.1 has a straight profile cross-section, with an in-line arrangement of the strips towards the same lighting direction. The system of Fig. 7.2 has a cross-section with a convex profile, with a divergent strip arrangement, thus providing an irradiation diagram with a larger angular sector towards the same lighting direction. The system of Fig. 7.3 has a profile cross-section with double convexity, with the strips arranged on opposite sides, thus providing an omnidirectional irradiation diagram.

[0041] Installed power and/or illumination can be varied by simply changing the number of LED strips or the LED carrier system; this gives the system great flexibility.

[0042] The dimensions of the lamp body and of the power supply body may vary according to the dimensional and illumination parameters that must be guaranteed in each specific installation.

[0043] The lighting system can be equipped with a luminous flux orientation system obtained on a mechanical interconnection of the lamp body, in particular in the threaded cylinder 60 (Figure 9), in the form of a ring nut, the outer edge of which shows indications about the orientation angle of the light beam (-45° ..... +45°). When the threaded cylinder is turned, the entire lighting system will turn as well, thereby allowing the luminous flux to be oriented in the desired direction.

[0044] In one embodiment the following performance characteristics can be obtained from the system.

Ambient temperature: -40/-20 ÷ 40/60°C
Type of protection: II 2 G Ex d IIC T6/ II 2 D Ex tD IIC T6
Degree of protection: IP 66/67
Voltage: 230 V.

[0045] An example of installation of the LED-technology lighting system is shown in Fig. 11, which comprises a support pole 111, suspensions 112, 113.

[0046] With reference to Figures 12.1 to 16, the following will describe a further example of an implementation variant of the invention.

[0047] The lighting system of said variant has a substantially cylindrical structure and essentially comprises, just like the previously described variant:

- a power supply body 4.1, which contains the power supply unit;
- a lamp body 5.1, in which a system is housed for supporting LED strips.
- a power mains connection body 3.1, connected to the power supply body 4.1, which in turn is connected to the lamp body 5.1.

[0048] As in the first variant, also in this version the three elements are aligned and joined axially, are completely independent, and are connected together by means of mechanical interconnections, e.g. through suitable connectors and a sealing system including a ring nut, NPT threads and gaskets. These elements are also electrically connected to one another by means of electric interconnections.

[0049] There is a LED strip kit (Figures 15.1, 15.2, 15.3), which comprises strips equipped with SMD (Surface Mounting Device) LEDs. The strips can be installed within the lighting system, and their number may vary, for example, from one to six. The strips can be easily separated and may also be bent, such that the two lateral strips will form angles of, for example, ± 15° with the central strip.

[0050] A non-limiting example of the characteristics of the LED strip kit is as follows:

rated voltage: 24 V;
rated power of one strip: 19 ±0.5 W;
luminous efficiency of one strip: 110 lm/W;
color temperature: ≤ 6000 K;
color yield: ≥ 70;
dimensions of one strip (LxW): 900x18 mm.

[0051] The electric connections between the various parts of the system are preferably established by means of pairs of connectors having the following characteristics:

"quick release" type;
rated voltage: 230VAC/24VDC;

[0052] The materials used for manufacturing the main parts of the lighting system are, for example:

- Metallic body: 44XXX and 60XX series aluminum alloy (AlSi12 aluminum-silicon and C40 steel;
- Transparent cylindrical tube 13.5: borosilicate glass (De= 70 mm).

[0053] The lamp body 5.1 may be enclosed in and protected by a removable external protection grid (not shown).

[0054] The power mains connection body 3.1 preferably comprises (Fig. 16):

terminal 16.1;
O-ring 16.2;
grounding system 16.3.

[0055] The power mains connection body 16.1 is also fitted with an NPT threaded housing 16.5 for an Exd cable gland (½", ¾", 1") to provide the interface for the external mains cable.

[0056] In order to prevent accidental rotation and undesired torsion of the mains cable, a hole is provided for housing a cylindrical pin between the terminal 16.1 and the power supply body 4.1.

[0057] On the outer face of the terminal 16.1 there is a hole 16.4 for connection to a grounding system. A suitable screw 16.3 is inserted into this hole to fasten a grounding cable.

[0058] The power supply body 4.1 comprises the following elements (Figures 14.1, 14.2, 14.3): ring nuts 14.1;

heat sink 14.2, having a hollow and substantially cylindrical shape, with a substantially smooth external side surface;
heat sink terminal 14.3;
power supply unit plate 14.4 (Fig. 14.1);
O-ring 14.5;
power supply unit 14.6;
connector on the power mains connection body side 14.7;
connector on the lamp body side 14.8;
systems for supporting/fastening the power supply unit plate 14.9;
grounding system 14.10;
screws for fastening the power supply unit 14.11;
electric cables.

[0059] On the outer part of the heat sink 14.2 the ring nuts 14.1 can slide, ensuring the coupling of the heat sink to the terminal 16.1 belonging to the power mains connection body 3.1, on one side, and to the connection cylinder 13.1 (Figures 13.1 and 13.2) belonging to the lamp body 5.1, on the other side. These couplings are preferably implemented by means of M90 cylindrical threads having a 2mm pitch and being 20mm long.

[0060] The stroke of the ring nuts 14.1 on the heat sink 14.2 is limited by the circular crown 14.12 formed on the heat sink itself or provided on the heat sink terminal. The heat sink terminal 14.3 is connected to the heat sink 14.2 through a suitable M58 cylindrical thread 14.13.

[0061] The power supply unit plate 14.4 (Fig. 14.1) is provided with holes, two of which are used for fastening the power supply unit 14.6 by means of suitable screws 14.11. Other holes are used for fastening the plate 14.4 within the heat sink 14.2, through a connection implemented by means of the systems for supporting/fastening the power supply unit plate 14.9. Finally, there is a hole for the grounding system 14.10: a suitable grounding screw is inserted into this hole to clamp the grounding cable.

[0062] Dust proofing is ensured by the presence of the O-rings 14.5 housed in suitable grooves between the respective elements, which are thus sealed.

[0063] The lamp body 5.1 comprises the following elements (Figures 12.3, 13.1, 13.2):

connection cylinders 13.1;
tie rod terminals 13.2;
metallic guide tie rod 13.3;
LED board support 13.4;
transparent cylindrical tube 13.5;
LED strips 13.8;
O-ring 13.6;
nuts 13.10 for fastening the tie rod 13.3 to the tie rod terminal 13.2;
pins 13.11 for locking the tie rod terminal 13.2 to the connection cylinders 13.1;
collars 13.7 for mounting the lighting system on a support, e.g. the pole 111 (Fig. 11).

[0064] The coupling between the glass part and the metal part is made by connecting the ends of the transparent cylindrical tube 13.5 to the connection cylinders 13.1, e.g. by elastic gluing through a suitable adhesive having a minimum sealing length of 10 mm.

[0065] Inside the transparent cylindrical tube 13.5 the tie rod 13.3 is housed, which slides within the holes 15.1 formed in the LED board support 13.4. The tie rod is fastened by means of the tie rod terminals 13.2, which are housed on the connection cylinders 3.1, and the rotation of which is prevented by the above-mentioned pins. The tie rod terminals have suitable protrusions 13.8 that engage with the terminal parts 15.2 of the LED board support, so as to prevent the support from translating and rotating. Apertures 13.9 are formed on the tie rod termi-

nals to allow easy extraction and reinsertion, e.g. for maintenance.

[0066] The LED board support 13.4 (Figures 15.1, 15.2, 15.3) is advantageously adapted to facilitate the thermal dispersion of the heat produced by the LED strips 13.8, and is characterized by two LED strip support planes 15.3 having a trapezoidal cross-section, with side wings protruding relative to the central part, and preferably having a certain inclination, e.g. 15° relative to the central part, a central hole 15.1 for inserting the tie rod 13.3; the structure comprising the side wings promotes dissipation of the produced heat.

[0067] The connection cylinders 13.1 are provided with external cylindrical gas threads for connecting to the lamp body terminal 5.11 provided with a similar internal thread, on one side, and to the power supply body 4.1 by means of the ring nut 14.1 provided with a similar internal cylindrical thread, on the other side.

[0068] The O-rings employed in the system are preferably gaskets with a continuous operating temperature > 150°C.

[0069] In the external part of the metallic elements, except for the threads and the elements that require some surface roughness (e.g. 6,3 μm), there is preferably a powder paint for outdoor environments, resistant to corrosion and saline mist.

[0070] The peculiar technical features of the above-described lighting system are as follows.

[0071] In the lamp body, the LED-technology lighting system is housed on a support plate adapted to act also as a heat sink.

[0072] All bodies of the system have a cylindrical shape, are distinct from one another, and are joined axially by means of mechanic and electric connections.

[0073] The lighting system is structured in a manner such that it ensures metallic continuity throughout its length.

[0074] All the metallic parts are interconnected in such a way that the heat generated by the power supply unit and by the LED strips can be dissipated also because of the wholly metallic surface of the lighting system. It is understood that the non-metallic parts of the system are the transparent cylindrical tube, the single LEDs, the O-rings, the gluing material, some elements of the power supply unit, the container thereof; all the other parts are metallic.

[0075] With reference to Figure 17, the following will describe a further example of an implementation variant of the invention.

[0076] The lighting system of said variant essentially comprises:

- a power mains connection body 3.2;
- a lamp body 5.2 comprising LED strips.

[0077] De facto, this further variant is created by using components which are wholly equivalent to those described with reference to the preceding variant, wherein all the components of the power supply body are absent (Figures 14.1 - 14.3), while the components of the power mains connection body (e.g. designed as described with reference to Figures 16, 12.1, 12.2, 12.3) provide a direct connection to the components of the lamp body (e.g. designed as described with reference to Figures 12.1 to 15.4).

[0078] The above-described example of embodiment may be subject to variations without departing from the protection scope of the present invention, including all equivalent designs known to a man skilled in the art.

[0079] The elements and features shown in the various preferred embodiments may be combined together without however departing from the protection scope of the present invention.

[0080] The advantages deriving from the application of the present invention are apparent.

[0081] The invented lighting system solves the most important problems suffered by prior-art LED lighting appliances. In fact, the system of the invention:

- is suitable for use in a potentially explosive atmosphere, in the presence of inflammable substances in the form of gas, vapor, mist or dust. Appliances certified for use in hazardous areas can also be used in "safe" areas, thus being suitable for any application;
- is robust, and its weight and dimensions are reduced compared to the lighting systems currently available on the market, resulting in easier installation. The lighting part and the power supply system can be individually replaced easily and quickly, resulting in shorter maintenance times and lower maintenance costs; furthermore, the lighting power can be increased by simply increasing the number of LED strips installed on the same support structure without requiring a bigger lamp body, while still ensuring sufficient heat sinking capacity;
- is equipped with a suitable heat sinking system, made of a material that promotes heat dissipation and prevents the lamp from decaying rapidly, which is the main cause of the short life of LED lamps;
- is suitable, based on the known ATEX zone classification, for use in zones at risk of explosion for the presence of gas (zone 1) and dust (zone 21); zone 0 evaluation is excluded, both because of the great difficulty in obtaining the ATEX certification and because zone 0 always refers to small areas, for which special lighting systems are employed;
- is also suitable for use in zones 2 and 22, so that it can be used in most sites with potentially explosive atmospheres.

[0082] From the above description, those skilled in the art will be able to produce the object of the invention without introducing any further construction details.

Claims

1. Explosion-proof lighting system adapted for use in explosion-risk areas, comprising:

   - a power supply body (4, 4.1) equipped with a heat sink having a substantially cylindrical shape;
   - a lamp body (5, 5.1), in which a lighting system (64, 10, 13.4, 13.8) based on LED technology is inserted, the lighting system being housed on a support plate adapted to act as a heat sink;
   - a power mains connection body (3, 3.1);

   said power supply body, lamp body (5, 5.1) and power mains connection body (3, 3.1) having an essentially cylindrical shape and each being distinct, aligned, and joined axially through mechanic and electric interconnections, said power mains connection body being located on the power supply body side.

2. Explosion-proof lighting system as claimed in claim 1, wherein said power supply body (4, 4.1) comprises:

   - a power supply unit/transformer (53, 14.6), adapted to transform the input voltage into a voltage to be supplied to said lighting system (10, 13.8);
   - said heat sink is a hollow heat sinking cylinder (55, 14.2), adapted to internally and fully contain said power supply unit/transformer (53, 14.6);
   - side caps (51, 52, 57, 58, 14.1, 14.13) for said heat sinking cylinder (55, 14.2), sealed by means of gaskets (54, 56, 14.5).

3. Explosion-proof lighting system as claimed in claim 2, wherein said hollow heat sinking cylinder (55, 14.2) is provided with radial heat sinking fins, or with a substantially smooth outer side surface.

4. Explosion-proof lighting system as claimed in claim 1, wherein said lamp body (5, 5.1) comprises:

   - said lighting system (64, 10, 13.4, 13.8), comprising a LED carrier system (64, 13.4) and one or more LED strips (10, 13.8) applied onto one or more side surfaces of said LED carrier system (64, 13.4);
   - a transparent cylindrical tube (63, 13.5) adapted to fully contain said lighting system (64, 10, 13.4, 13.8);
   - side caps (60, 61, 66, 13.1, 13.2, 5.11) for said transparent cylindrical tube (63, 13.5), sealed by means of gaskets (62, 65, 13.6), one of said side caps comprising electric connectors (67, 68) towards said power supply body (4, 4.1) and towards said lighting system (10, 13.8).

5. Explosion-proof lighting system as claimed in claim 4, wherein said LED carrier system (64) is adapted to be contained in said transparent cylindrical tube (63), so that it can slide along guides (81, 82) formed on the inner surface of said transparent cylindrical tube (63).

6. Explosion-proof lighting system as claimed in claim 4, wherein said LED carrier system (64, 13.4) is adapted to be contained in said transparent cylindrical tube (63, 13.5), so that it is removably supported by a metallic guide or tie rod (85, 13.3) arranged longitudinally within the transparent cylindrical tube (63, 13.5).

7. Explosion-proof lighting system as claimed in claim 4, wherein said LED carrier system (64, 13.4) has an elongated shape with a constant cross-section, one or more of said side surfaces having a straight profile.

8. Explosion-proof lighting system as claimed in claim 7, wherein said LED carrier system (13.4) comprises two support planes (15.3) for said one or more LED strips (13.8) with side wings protruding relative to the central part, a central hole (15.1) for the insertion of a tie rod (13.3), said side wings being preferably inclined relative to the central part.

9. Explosion-proof lighting system as claimed in claim 6, wherein said metallic guide or tie rod (13.3) is secured at both ends by means of tie rod terminals (13.2) comprising protrusions (13.8) that fit into the terminal parts (15.2) of said LED carrier system (13.4).

10. Explosion-proof lighting system as claimed in claim 1, wherein said power mains connection body (3.1) comprises a grounding system (16.3), and a threaded hole (16.5) for the insertion of a cable gland with an electric cable.

11. Explosion-proof lighting system as claimed in claim 4, wherein said transparent cylindrical tube (63, 13.5) is made of self-extinguishing polycarbonate or tempered glass, or borosilicate glass.

12. Explosion-proof lighting system according to any one of the preceding claims, wherein said power supply body (4, 4.1), said lamp body (5, 5.1) and said power mains connection body (3, 3.1) comprise metallic elements interconnected with each other so as to ensure metal continuity throughout the length of the explosion-proof lighting system for heat sinking purposes.

13. Explosion-proof lighting system according to any one of the preceding claims, comprising a luminous-flux orientation system adapted to rotate said lighting system in order to orient said luminous flux in one or more desired directions.

14. Explosion-proof lighting system as claimed in claim 13, wherein said luminous-flux orientation system comprises a ring nut (60) or the like, the outer edge of which shows indications about the orientation angle of the luminous flux.

Patentansprüche

1. Explosionsgeschütztes Beleuchtungssystem für den Einsatz in explosionsgefährdeten Bereichen, umfassend:

    - einen Stromversorgungskörper (4, 4.1), der mit einem Kühlkörper mit im Wesentlichen zylindrischer Form ausgestattet ist;
    - einen Lampenkörper (5, 5.1), in den ein Beleuchtungssystem (64, 10, 13.4, 13.8) auf der Basis von LED-Technologie eingesetzt ist, wobei das Beleuchtungssystem auf einer Trägerplatte angeordnet ist, die als Kühlkörper ausgebildet ist;
    - einen Netzanschlusskörper (3, 3.1);

    wobei der Stromversorgungskörper, der Lampenkörper (5, 5.1) und der Netzanschlusskörper (3, 3.1) eine im Wesentlichen zylindrische Form aufweisen und jeweils verschieden, ausgerichtet und axial verbunden durch mechanische und elektrische Verbindungen sind, wobei sich der Netzanschlusskörper auf der Seite des Stromversorgungskörpers befindet.

2. Explosionsgeschütztes Beleuchtungssystem nach Anspruch 1, wobei der Stromversorgungskörper (4, 4.1) umfasst:

    - eine Stromversorgungseinheit/Transformator (53, 14.6), die eingerichtet ist, die Eingangsspannung in eine Spannung umzuwandeln, die dem Beleuchtungssystem (10, 13.8) zugeführt werden soll;
    - dass der Kühlkörper ein hohler Kühlzylinder (55, 14.2) ist, der eingerichtet ist, die Stromversorgungseinheit/Transformator (53, 14.6) im Inneren aufzunehmen und vollständig zu enthalten;
    - Seitenkappen (51, 52, 57, 58, 14.1, 14.13) für den Kühlzylinder (55, 14.2), der durch Abdichtmittel (54, 56, 14.5) abgedichtet ist.

3. Explosionsgeschütztes Beleuchtungssystem nach Anspruch 2, wobei der hohle Kühlzylinder (55, 14.2) mit radialen Kühlrippen oder mit einer im Wesentlichen glatten Außenseitenfläche versehen ist.

4. Explosionsgeschütztes Beleuchtungssystem nach Anspruch 1, wobei der Lampenkörper (5, 5.1) umfasst:

    - das Beleuchtungssystem (64, 10, 13.4, 13.8), das ein LED-Trägersystem (64, 13.4) und ein oder mehrere LED-Streifen (10, 13.8) umfasst, die auf einer oder mehreren Seitenflächen des LED-Trägersystems (64, 13.4) aufgebracht sind;
    - eine transparente zylindrische Röhre (63, 13.5), die eingerichtet ist, das Beleuchtungssystem (64, 10, 13.4, 13.8) vollständig aufzunehmen;
    - Seitenkappen (16, 61, 66, 13.1, 13.2, 5.11) für die transparente zylindrische Röhre (63, 13.5), die durch Abdichtmitteln (62, 65, 13.6) abgedichtet ist, wobei eine der Seitenkappen elektrische Anschlüsse (67, 68) zum Stromversorgungskörper (4, 4.1) und zum Beleuchtungssystem (10, 13.8) hin aufweist.

5. Explosionsgeschütztes Beleuchtungssystem nach Anspruch 4, wobei das LED-Trägersystem (64) derart eingerichtet ist, dass es in der transparenten zylindrischen Röhre (63) enthalten ist, sodass es entlang von Führungen (81, 82) gleiten kann, die an der Innenfläche der transparenten zylindrischen Röhre (63) befestigt sind.

6. Explosionsgeschütztes Beleuchtungssystem nach Anspruch 4, wobei das LED-Trägersystem (64, 13.4) derart eingerichtet ist, dass es in der transparenten zylindrischen Röhre (63, 13.5) enthalten ist, sodass es lösbar von einer metallischen Führung oder Spurstange (85, 13.3) getragen wird, die in Längsrichtung innerhalb der transparenten zylindrischen Röhre (63, 13.5) angeordnet ist.

7. Explosionsgeschütztes Beleuchtungssystem nach Anspruch 4, wobei das LED-Trägersystem (64, 13.4) eine längliche Form mit konstantem Querschnitt aufweist, wobei eine oder mehrere der Seitenflächen ein gerades Profil aufweisen.

8. Explosionsgeschütztes Beleuchtungssystem nach Anspruch 7, wobei das LED-Trägersystem (13.4) zwei Auflageebenen (15.3) für den einen oder die mehreren LED-Streifen (13.8) mit relativ zum mittleren Teil vorstehenden Seitenflügeln und eine zentrale Öffnung (15.1) zum Einbringen einer Spurstange (13.3) aufweist, wobei die Seitenflügel vorzugsweise relativ zum Mittelteil geneigt sind.

9. Explosionsgeschütztes Beleuchtungssystem nach Anspruch 6, wobei die metallische Führung oder Spurstange (13.3) an beiden Enden mittels Spurstangenanschlüssen (13.2) gesichert ist, die Vorsprünge (13.8) aufweisen, die in die Anschlussteile (15.2) des LED-Trägersystems (13.4) passen.

10. Explosionsgeschütztes Beleuchtungssystem nach Anspruch 1, wobei der Netzanschlusskörper (3.1) ein Erdungssystem (16.3) und eine Gewindebohrung (16.5) zum Einführen einer Kabelverschraubung mit einem elektrischen Kabel aufweist.

11. Explosionsgeschütztes Beleuchtungssystem nach Anspruch 4, wobei die transparente zylindrische Röhre (63, 13.5) aus selbstlöschendem Polykarbonat oder gehärtetem Glas oder Borosilikatglas hergestellt ist.

12. Explosionsgeschütztes Beleuchtungssystem nach einem der vorhergehenden Ansprüche, wobei der Stromversorgungskörper (4, 4.1), der Lampenkörper (5, 5.1) und der Netzanschlusskörper (3, 3.1) metallische Elemente umfassen, die miteinander verbunden sind, um eine Metallkontinuität über die gesamte Länge des explosionsgeschützten Beleuchtungssystems für Kühlungszwecke zu gewährleisten.

13. Explosionsgeschütztes Beleuchtungssystem nach einem der vorhergehenden Ansprüche, umfassend ein Lichtstromorientierungssystem, das eingerichtet ist, das Beleuchtungssystem zu drehen, um den Lichtstrom in eine oder mehrere gewünschte Richtungen auszurichten.

14. Explosionsgeschütztes Beleuchtungssystem nach Anspruch 13, wobei das Lichtstromorientierungssystem eine Ringmutter (60) oder dergleichen aufweist, deren Außenrand Hinweise auf den Orientierungswinkel des Lichtstroms gibt.

Revendications

1. Système d'éclairage antidéflagrant destiné à être utilisé dans des zones à risque de déflagration, comprenant :

- un corps d'alimentation électrique (4, 4.1) équipé d'un dissipateur thermique ayant une forme sensiblement cylindrique ;
- un corps de lampe (5, 5.1), dans lequel un système d'éclairage (64, 10, 13.4, 13.8) basé sur la technologie des DEL est inséré, le système d'éclairage étant logé sur une plaque de support adaptée pour servir de dissipateur thermique ;
- un corps de connexion au secteur électrique (3, 3.1) ;

ledit corps d'alimentation électrique, ledit corps de lampe (5, 5.1) et ledit corps de connexion au secteur électrique (3, 3.1) ayant une forme essentiellement cylindrique et étant chacun distincts, alignés, et assemblés axialement par des interconnexions mécaniques et électriques, ledit corps de connexion au secteur électrique étant situé sur le côté du corps d'alimentation électrique.

2. Système d'éclairage antidéflagrant selon la revendication 1, dans lequel ledit corps d'alimentation électrique (4, 4.1) comprend :

- une unité/un transformateur d'alimentation électrique (53, 14.6), adapté pour transformer la tension d'entrée en une tension à fournir audit système d'éclairage (10, 13.8) ;
- ledit dissipateur thermique est un cylindre de dissipation thermique creux (55, 14.2), adapté pour contenir à l'intérieur et totalement ladite unité/ledit transformateur d'alimentation électrique (53, 14.6) ;
- des bouchons latéraux (51, 52, 57, 58, 14.1, 14.13) pour ledit cylindre de dissipation thermique (55, 14.2), étanchéifiés au moyen de joints d'étanchéité (54, 56, 14.5).

3. Système d'éclairage antidéflagrant selon la revendication 2, dans lequel ledit cylindre de dissipation thermique creux (55, 14.2) est pourvu d'ailettes de dissipation thermique radiales, ou d'une surface latérale externe sensiblement lisse.

4. Système d'éclairage antidéflagrant selon la revendication 1, dans lequel ledit corps de lampe (5, 5.1) comprend :

- ledit système d'éclairage (64, 10, 13.4, 13.8), comprenant un système porteur de DEL (64, 13.4) et une ou plusieurs bandes de DEL (10, 13.8) appliquées sur une ou plusieurs surfaces latérales dudit système porteur de DEL (64, 13.4) ;
- un tube cylindrique transparent (63, 13.5) adapté pour contenir totalement ledit système d'éclairage (64, 10, 13.4, 13.8) ;
- des bouchons latéraux (60, 61, 66, 13.1, 13.2, 5.11) pour ledit tube cylindrique transparent (63, 13.5), étanchéifiés au moyen de joints d'étanchéité (62, 65, 13.6), l'un desdits bouchons latéraux comprenant des raccords électriques (67, 68) vers ledit corps d'alimentation électrique (4, 4.1) et vers ledit système d'éclairage (10, 13.8).

5. Système d'éclairage antidéflagrant selon la reven-

dication 4, dans lequel ledit système porteur de DEL (64) est adapté pour être contenu dans ledit tube cylindrique transparent (63), de façon à pouvoir coulisser le long de guides (81, 82) formés sur la surface interne dudit tube cylindrique transparent (63).

6. Système d'éclairage antidéflagrant selon la revendication 4, dans lequel ledit système porteur de DEL (64, 13.4) est adapté pour être contenu dans ledit tube cylindrique transparent (63, 13.5), de façon à être supporté de façon amovible par un guide ou tirant métallique (85, 13.3) agencé longitudinalement au sein du tube cylindrique transparent (63, 13.5).

7. Système d'éclairage antidéflagrant selon la revendication 4, dans lequel ledit système porteur de DEL (64, 13.4) a une forme allongée avec une section transversale constante, une ou plusieurs desdites surfaces latérales ayant un profil droit.

8. Système d'éclairage antidéflagrant selon la revendication 7, dans lequel ledit système porteur de DEL (13.4) comprend deux plans de support (15.3) pour lesdites une ou plusieurs bandes de DEL (13.8) avec des oreilles latérales faisant saillie par rapport à la partie centrale, un trou central (15.1) pour l'insertion d'un tirant (13.3), lesdites oreilles latérales étant de préférence inclinées par rapport à la partie centrale.

9. Système d'éclairage antidéflagrant selon la revendication 6, dans lequel ledit guide ou tirant métallique (13.3) est arrimé au niveau des deux extrémités au moyen de bornes de tirant (13.2) comprenant des saillies (13.8) qui s'ajustent dans les parties de borne (15.2) dudit système porteur de DEL (13.4).

10. Système d'éclairage antidéflagrant selon la revendication 1, dans lequel ledit corps de connexion au secteur électrique (3.1) comprend un système de mise à la terre (16.3), et un trou fileté (16.5) pour l'insertion d'un presse-étoupe avec un câble électrique.

11. Système d'éclairage antidéflagrant selon la revendication 4, dans lequel ledit tube cylindrique transparent (63, 13.5) est réalisé en polycarbonate autoextinguible ou en verre trempé, ou en verre borosilicaté.

12. Système d'éclairage antidéflagrant selon l'une quelconque des revendications précédentes, dans lequel ledit corps d'alimentation électrique (4, 4.1), ledit corps de lampe (5, 5.1) et ledit corps de connexion au secteur électrique (3, 3.1) comprennent des éléments métalliques interconnectés les uns aux autres de façon à assurer une continuité de métal sur toute la longueur du système d'éclairage antidéflagrant à des fins de dissipation thermique.

13. Système d'éclairage antidéflagrant selon l'une quelconque des revendications précédentes, comprenant un système d'orientation de flux lumineux adapté pour mettre en rotation ledit système d'éclairage afin d'orienter ledit flux lumineux dans une ou plusieurs directions souhaitées.

14. Système d'éclairage antidéflagrant selon la revendication 13, dans lequel ledit système d'orientation de flux lumineux comprend un écrou à oeil (60) ou similaire, dont le bord externe montre des indications concernant l'angle d'orientation du flux lumineux.

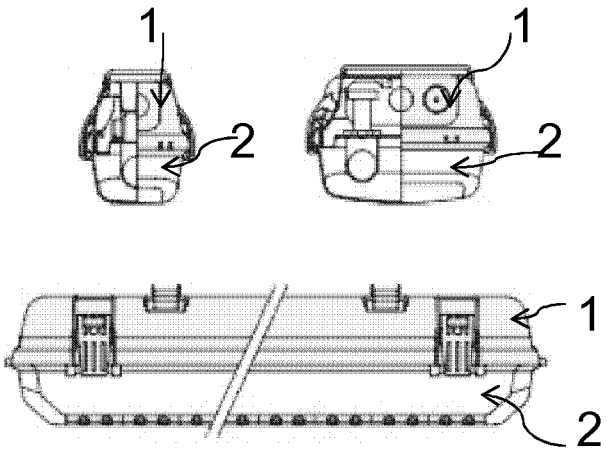


FIG. 1

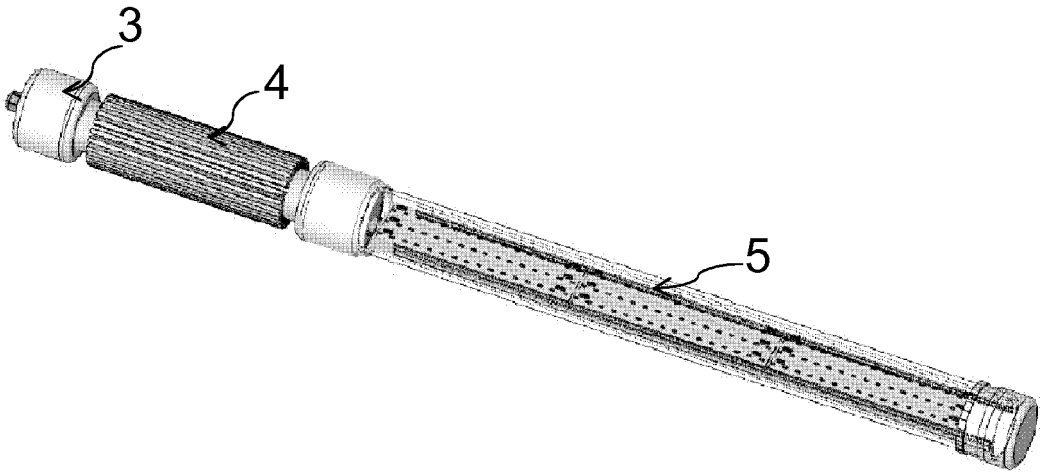


FIG. 2

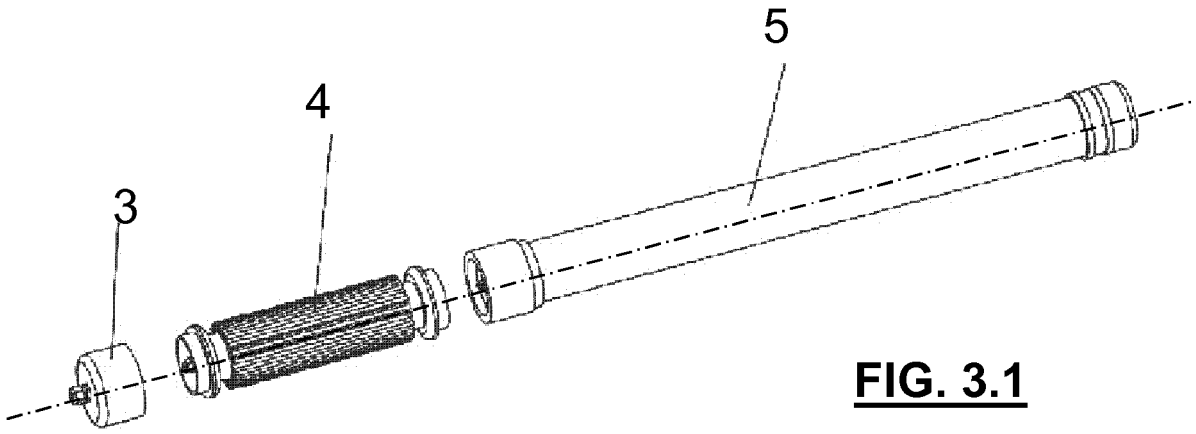


FIG. 3.1

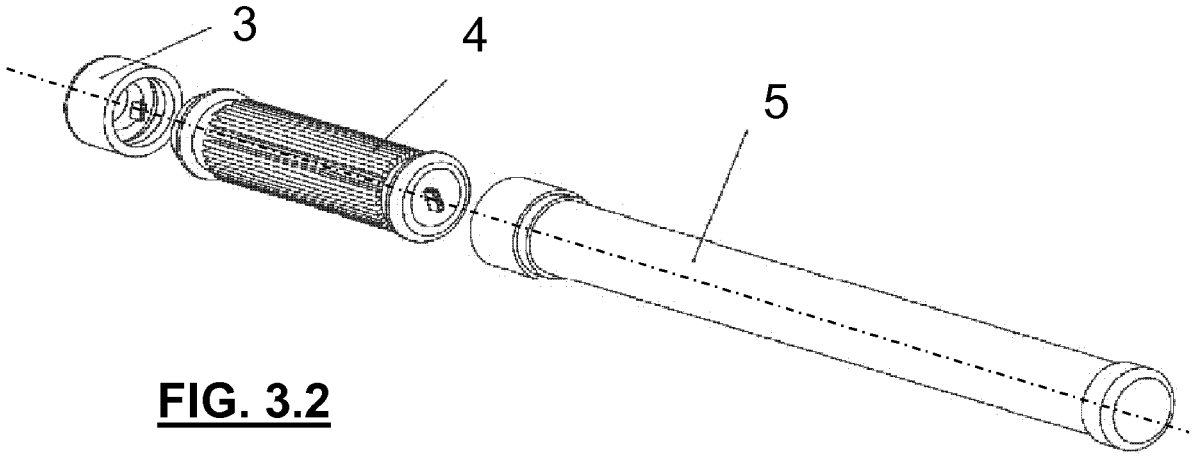


FIG. 3.2

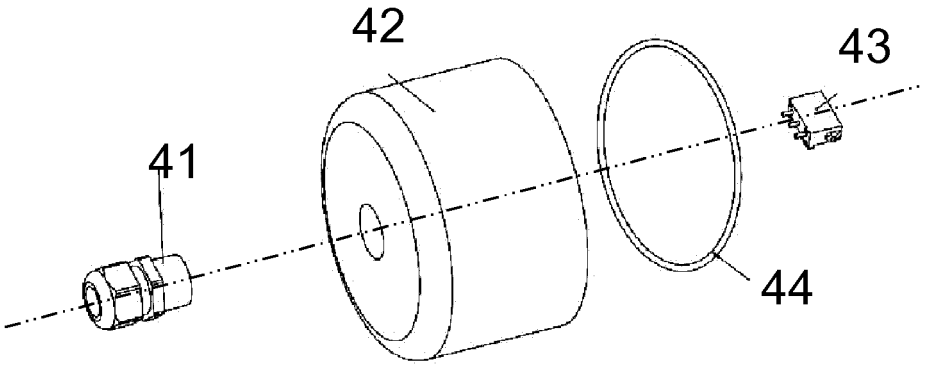


FIG. 4

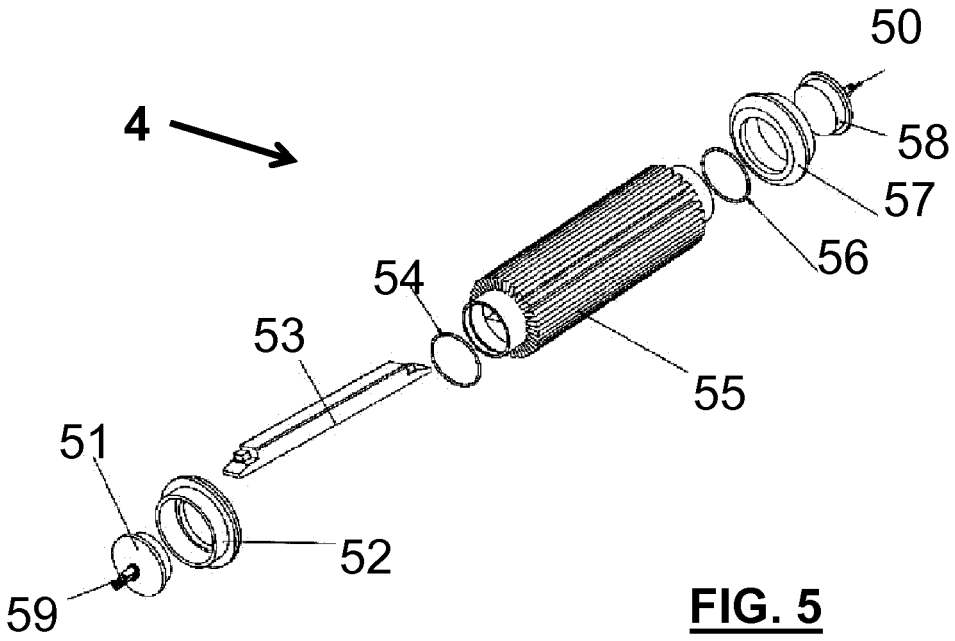


FIG. 5

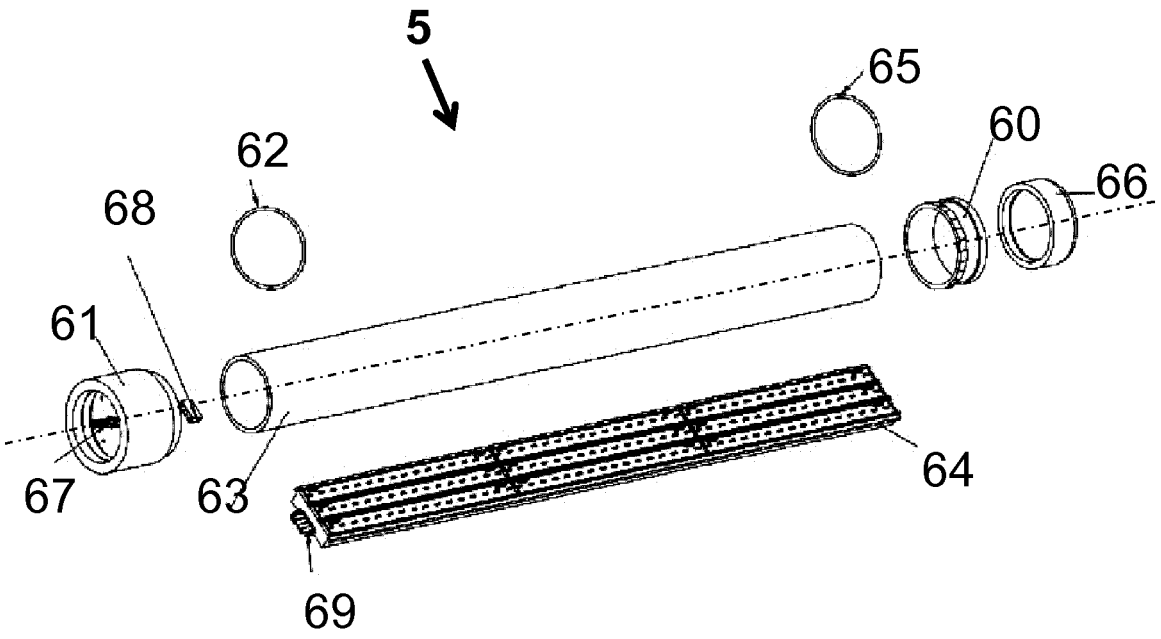


FIG. 6

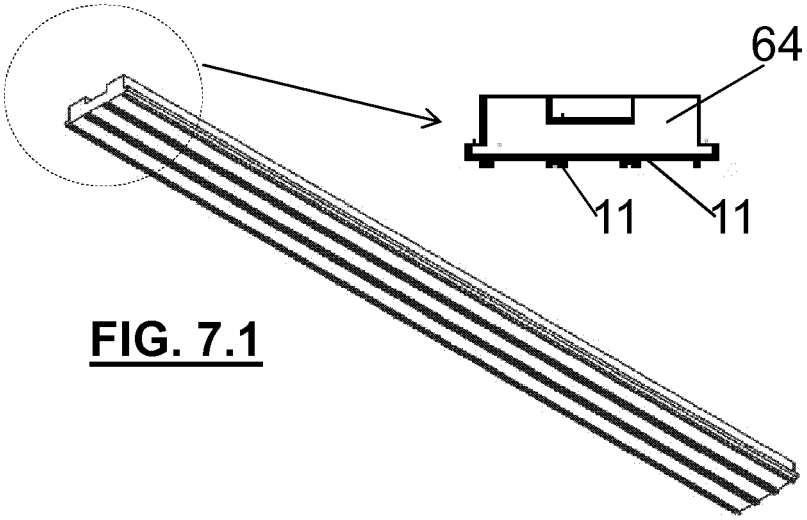


FIG. 7.1

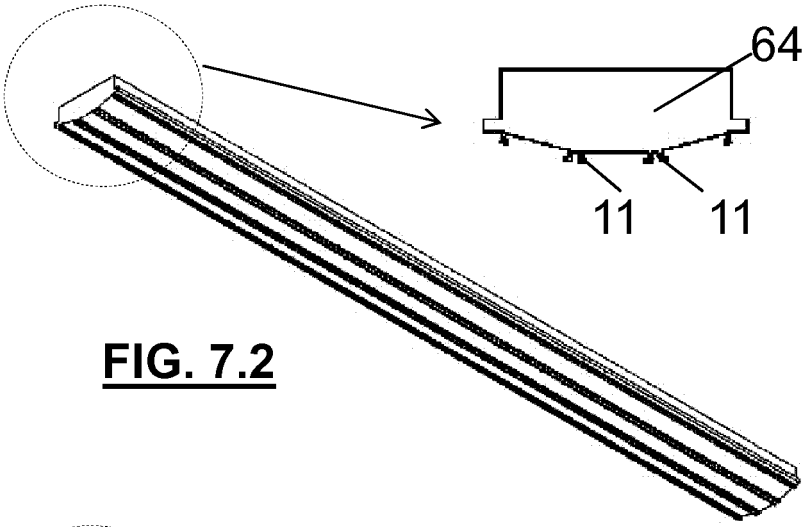


FIG. 7.2

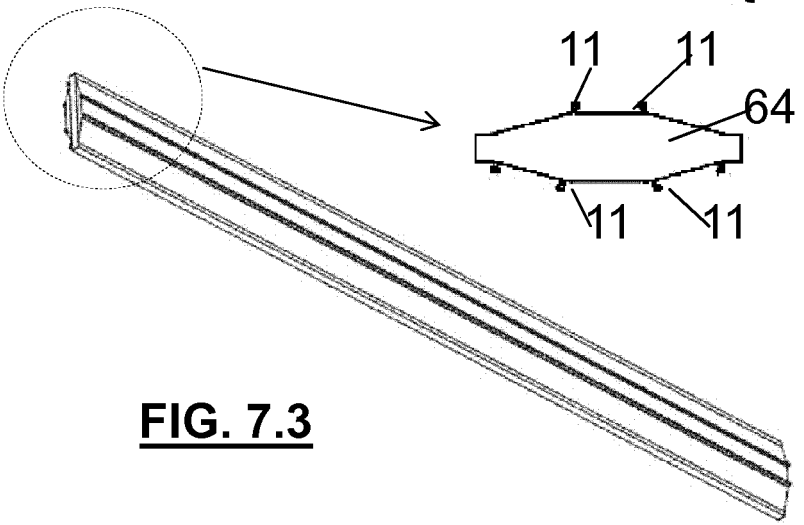


FIG. 7.3

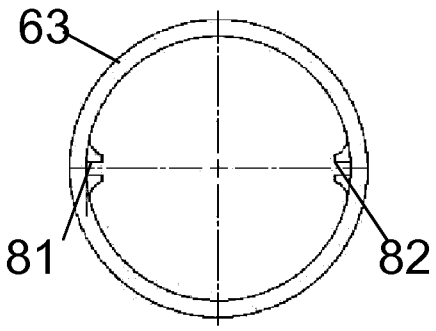


FIG. 8.1

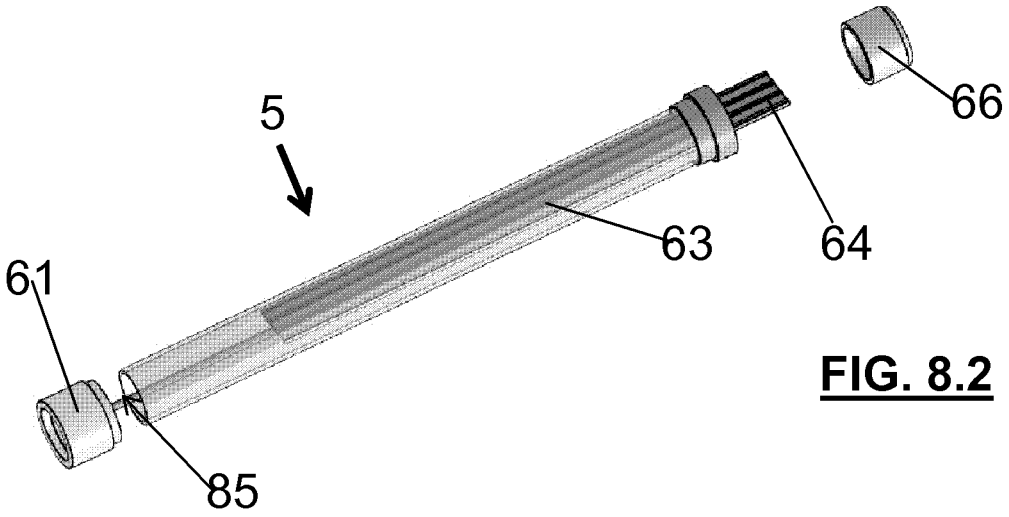


FIG. 8.2

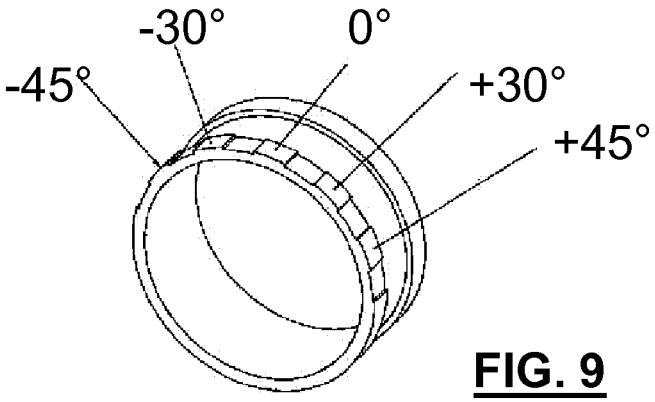


FIG. 9

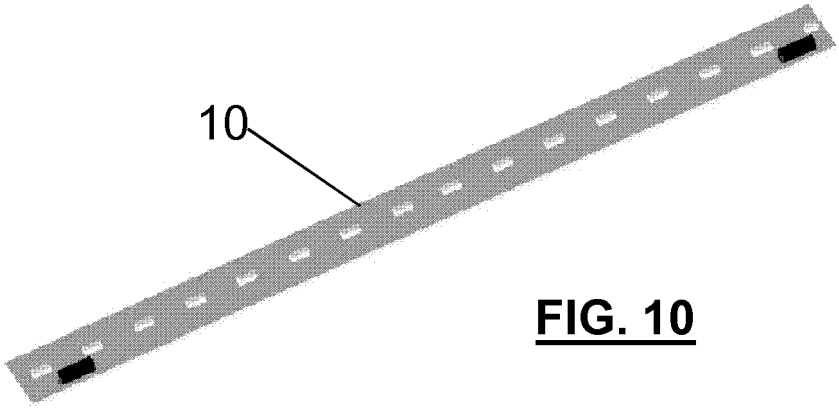


FIG. 10

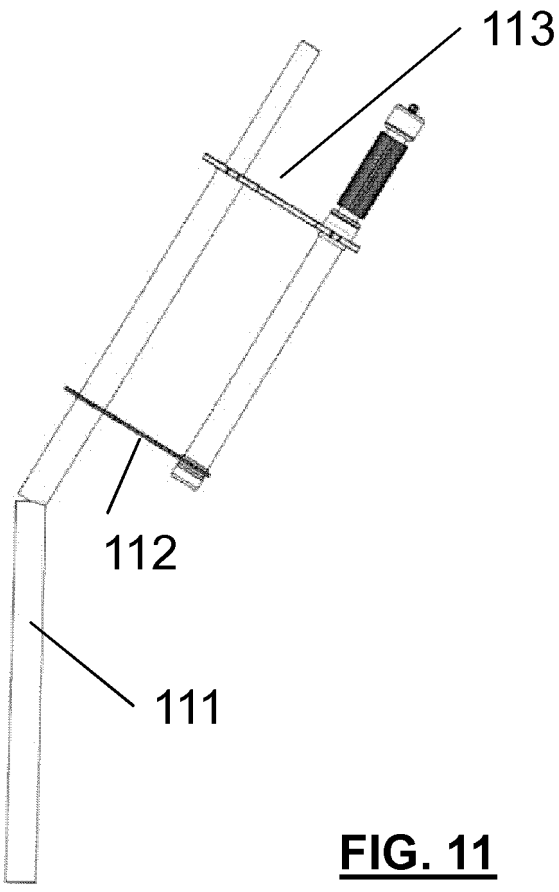


FIG. 11

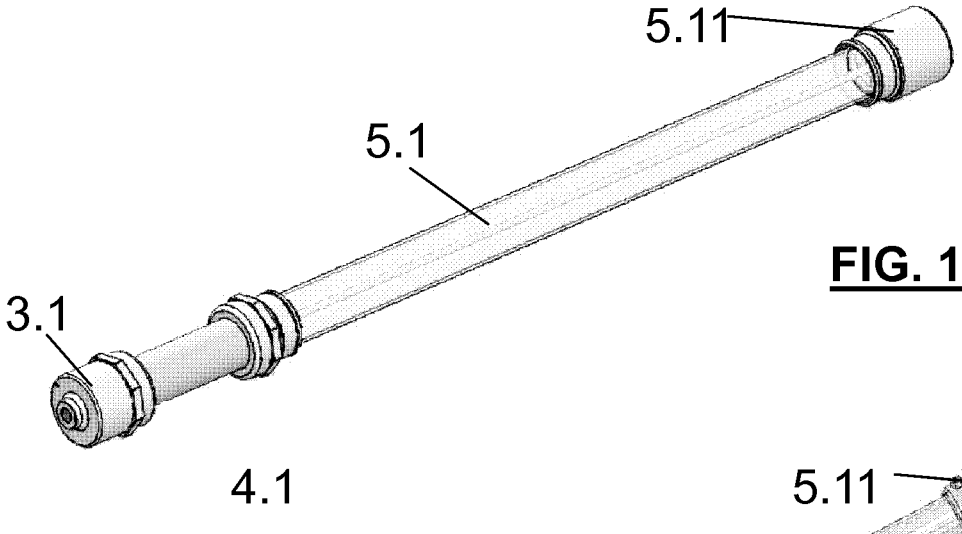


FIG. 12.1

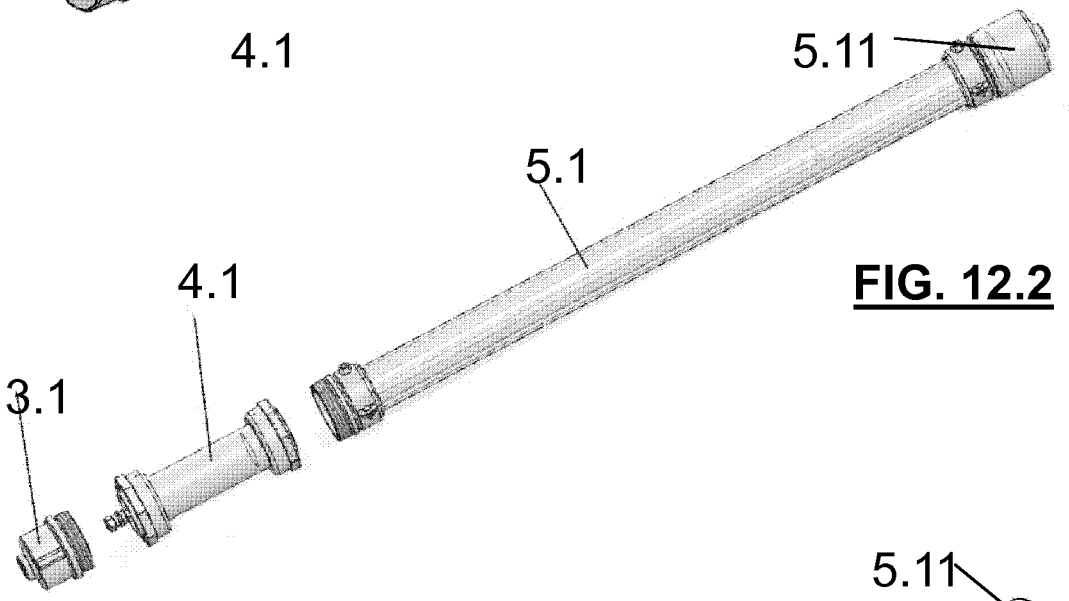


FIG. 12.2

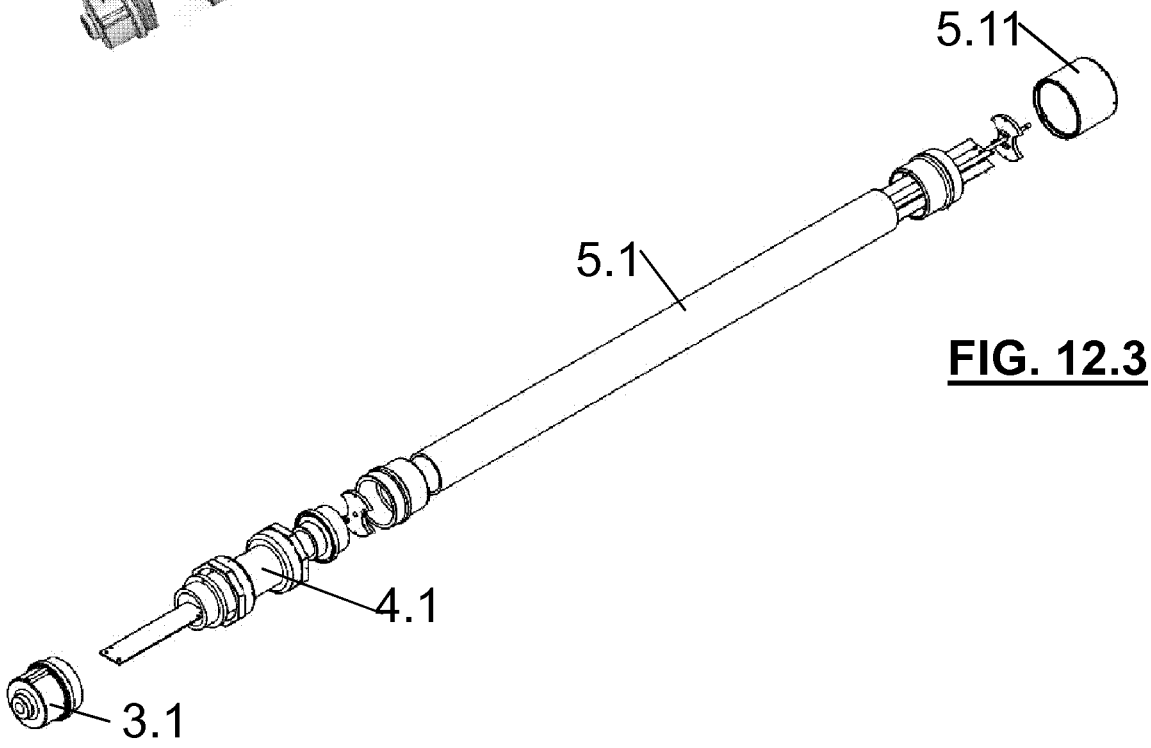


FIG. 12.3

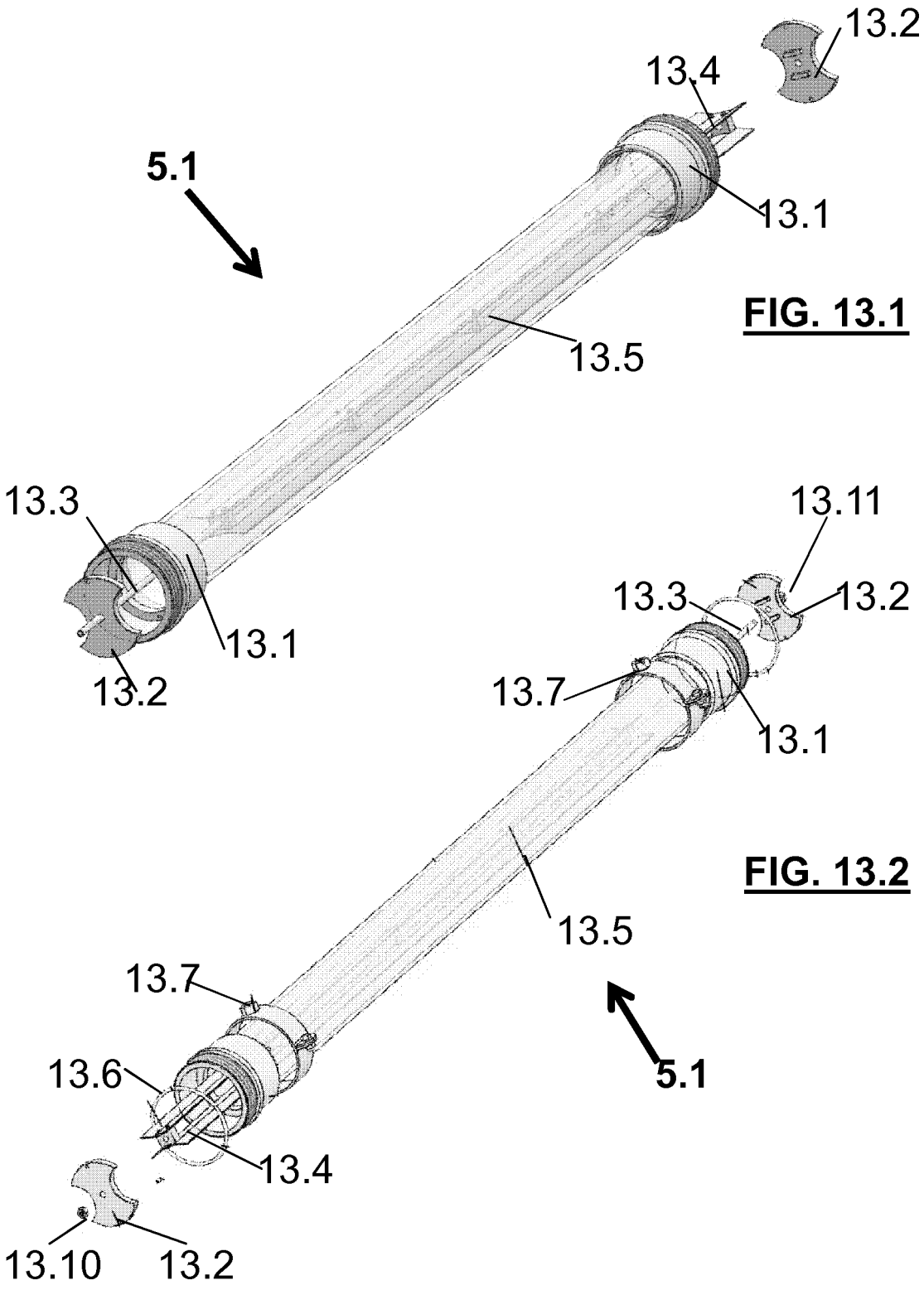


FIG. 13.1

FIG. 13.2

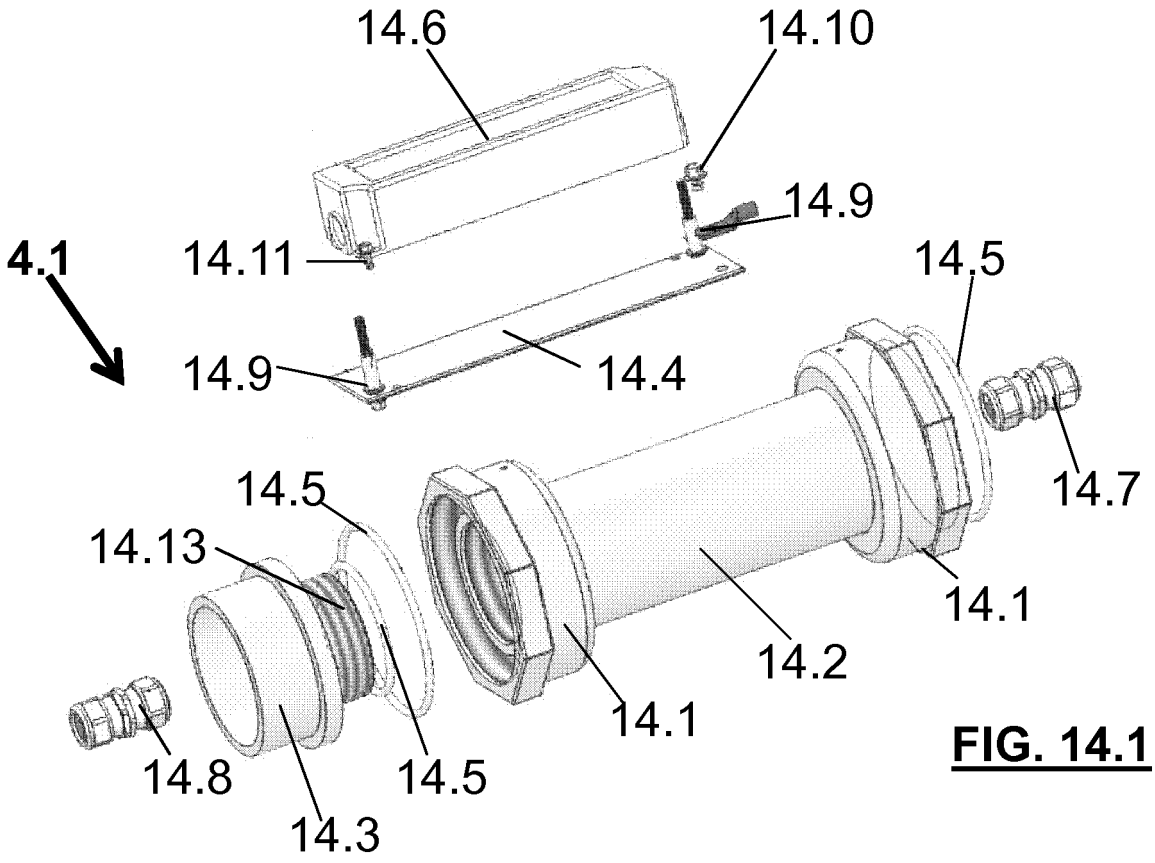


FIG. 14.1

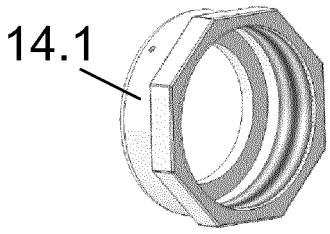


FIG. 14.2

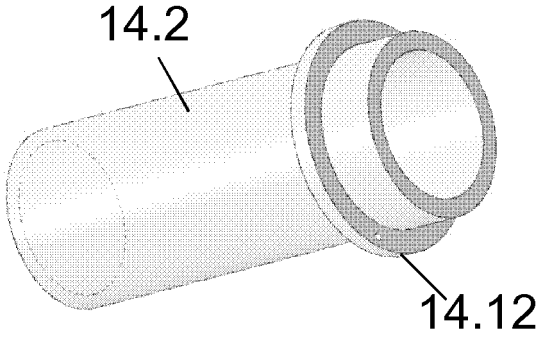


FIG. 14.3

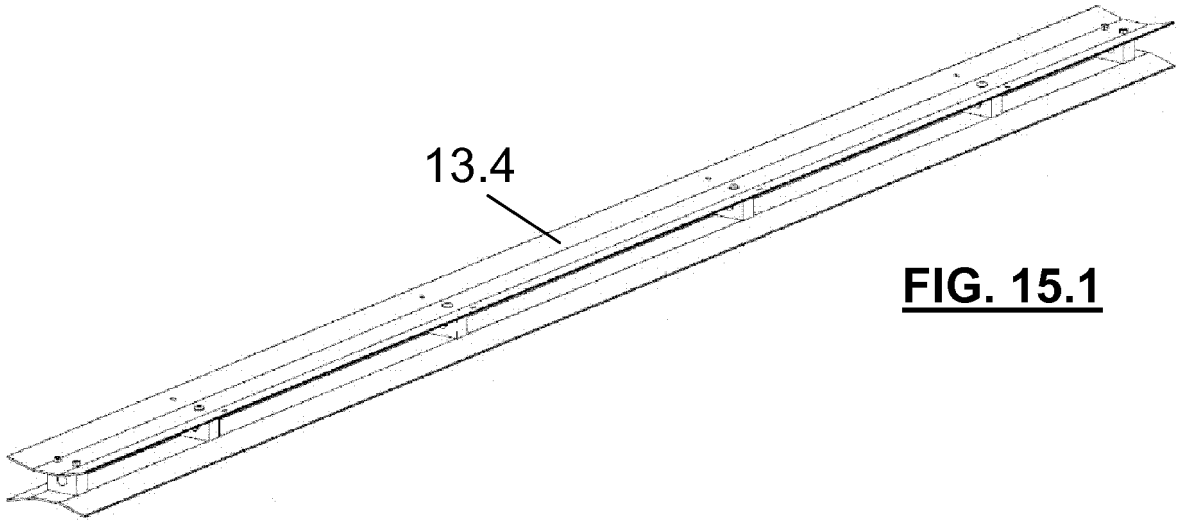


FIG. 15.1

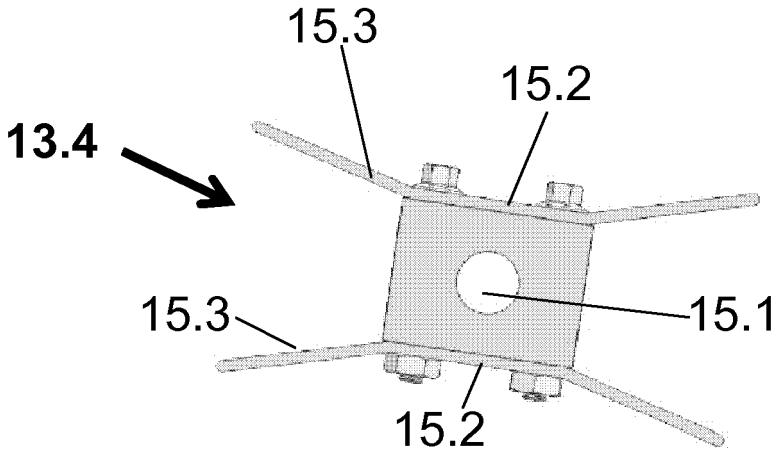


FIG. 15.3

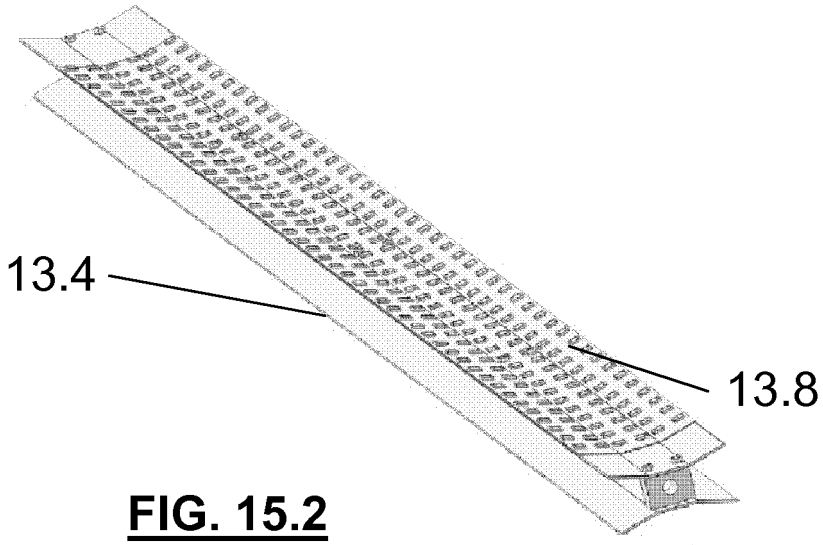


FIG. 15.2

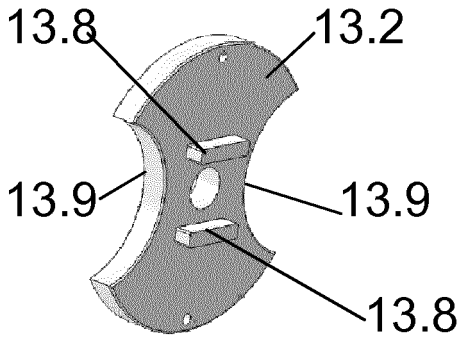


FIG. 15.4

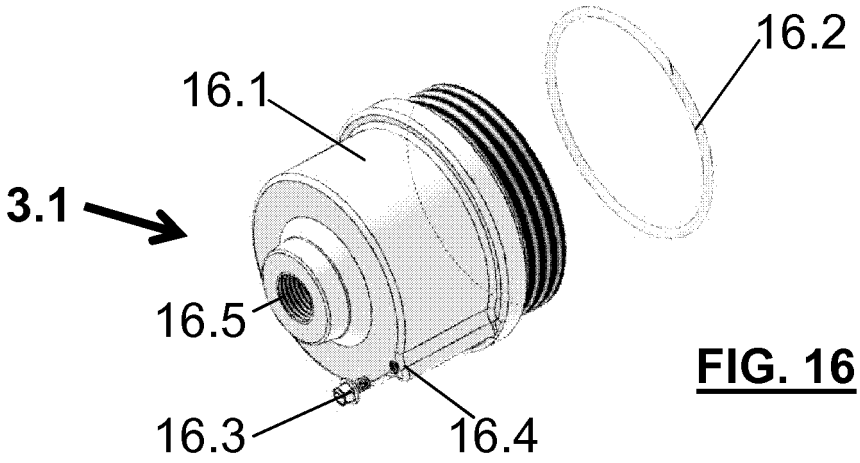


FIG. 16

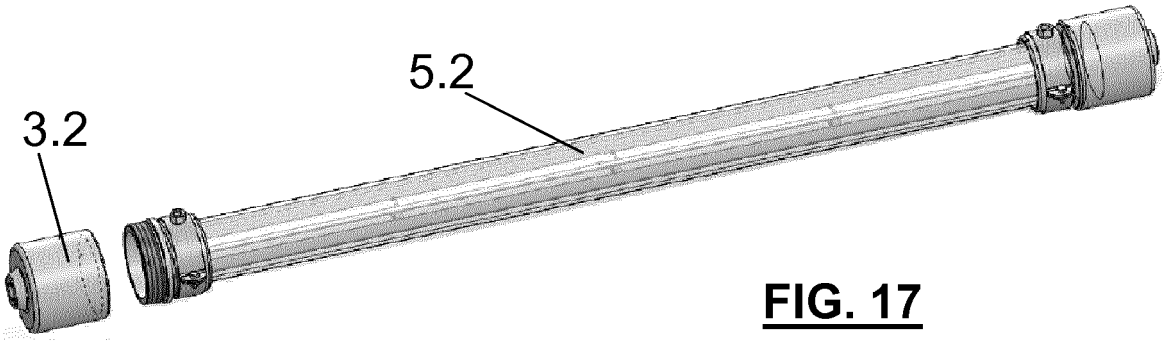


FIG. 17

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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