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(54) **Tubular lighting device and an end cap for such a lighting device**

(57) An end cap (14) for a tubular lighting device (10) comprises first (14a) and second parts (14b) which are rotatable relatively to each other. One part carries an external connector and the other part connects to the housing of a tubular lighting device. The two parts are electrically connected together via an internal rotatable plug and socket electrical connector (20, 22, 24), internal to the end cap.

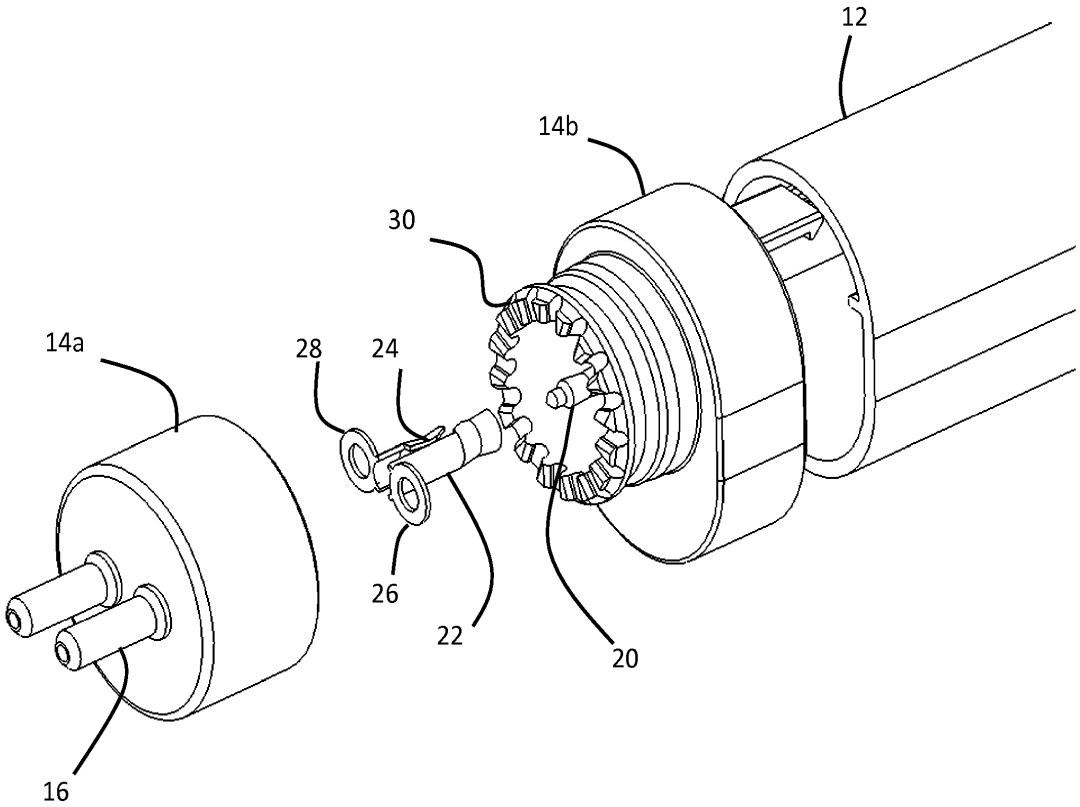


FIG. 6

EP 3 032 164 A1

Description

FIELD OF THE INVENTION

[0001] This invention relates to a tubular lighting device, and also to an end cap for such a lighting device.

BACKGROUND OF THE INVENTION

[0002] Solid state lighting (SSL) is rapidly becoming the norm in many lighting applications. This is because SSL elements such as light emitting diodes (LEDs) can exhibit superior lifetime and energy consumption.

[0003] Tubular lighting devices are widely used in office lighting applications. Traditionally, fluorescent tube lighting has been used. There are therefore many existing lighting fittings designed for receiving a fluorescent light tube.

[0004] A traditional fluorescent light tube has a pair of connector pins at each end. To fit the light tube into a light fitting, the two pins are aligned with a slot in the fitting, pushed into place, and then rotated by 90 degrees to complete the mechanical and electrical connection. The fluorescent light tubes are generally circular in cross section and they emit light substantially radially uniformly in all directions. The light fitting generally comprises a reflector arrangement to redirect the light to create a desired lighting profile.

[0005] There is increasing interest to replace fluorescent tube lighting with LED lighting, which can fit to the existing light fittings.

[0006] Typical tubular LED lamps comprise an end cap which carries the external pin connector, and the end cap connects to the internal driver board and LED board within the tubular housing of the lamp.

[0007] LED lighting offers many more design options, including more efficient directional lighting. A tubular LED lamp with a directional light output (i.e. one which is not uniform in all radial directions) requires fitting with a particular orientation. As a result, a particular orientation of the external connector pins with respect to the tubular housing of the lamp is required. However, as no such alignment was required with traditional fluorescent lighting, there are light fittings with different orientations of the slot and socket arrangement for receiving the external connector pins. This means that a single design of directional tubular lighting device may not be possible for all existing tubular lighting device fittings.

[0008] CN 103256569A discloses a rotary LED lamp holder having an internal wire connection between external connector pins and the LED lamp. The use of a twisting wire presents potential problems of wear and tear and therefore premature failure.

SUMMARY OF THE INVENTION

[0009] The invention is defined by the claims.

[0010] According to an aspect of the invention, there is provided an end cap for a tubular lighting device, comprising:

a first part having an external electrical connector for making mechanical and electrical connection to a light fitting; and

a second part for making mechanical connection to an end of a tubular housing of the tubular lighting device and electrical connection to a light source of the tubular lighting device,

wherein the first and second parts are rotatable relatively to each other, and electrically connected together via a rotatable plug and socket electrical connector internal to the end cap.

[0011] The relative rotation provided between the two parts of the end cap enables the rotational position of the external electrical connector to be adjusted, so that a tubular lighting device having the end caps can be mounted in a desired rotational position relative to the lighting fitting. This may be important for light sources which have a directional output, for example non-circular tubular lighting device. The plug and socket design enables simple assembly, and it enables rotation while maintaining good electrical contact and avoiding wear and tear.

[0012] The internal rotatable plug and socket electrical connector may comprise a pin with at least two electrical contact rings at different positions along the length of the pin and each surrounding the pin, and at least two corresponding spring contacts which are biased towards the electrical contact rings.

[0013] This pin can be in the form of a jack plug, for example similar to a headphone jack plug. This is rotatable while maintaining electrical contact. The spring contacts together define a socket arrangement. However, other rotatable connectors maybe used, such as a coaxial connector with a central pin and a surrounding concentric annular electrical contact.

[0014] The pin may be coupled to the second part of the end cap and project along the axis of relative rotation, and the spring contacts are then coupled to the first part of the end cap. Alternatively, the pin may be coupled to the first part of the end cap and project along the axis of relative rotation, and the spring contacts are then coupled to the second part of the end cap.

[0015] The external electrical connector may comprise a pin arrangement which is electrically connected to the rotatable electrical connector. The external connector pin arrangement is designed to mate with the light fitting. The external electrical connector for example comprises two pins projecting in parallel with the axis of relative rotation, spaced apart on each side of the rotation axis. This means the pin positions depend on the rotational orientation. This is the standard connector arrangement for a tubular light such as a T5 tubular light fitting.

[0016] The first part may comprise a first tooth or slot arrangement and the second part may comprise a second tooth or arrangement, wherein the first and second

tooth or slot arrangements interlock to define a plurality of rotational orientations. These teeth and/or slots can be used to provide locking of the end cap with the chosen rotational position, instead of relying on friction alone. The number of teeth/slots will be selected to give a desired range and number of adjustments.

[0017] In one set of arrangements, one of the first and second tooth or slot arrangements comprises a single tooth or slot and the other of the first and second tooth arrangements comprises a plurality of slots or teeth. In this way, a slot on one part engages with one of a plurality of teeth on the other part, or else a tooth on one part engages with one of a plurality of slots on the other part. This provides a simple design with few components.

[0018] There may be a single tooth for engaging with one of five slots at relative angular orientations, with respect to a central slot, of $\pm 22.5°$ and $\pm 45°$. These five possible relative orientations may be sufficient to enable fitting to a range of standard light fittings. However, if desired a larger number of adjustments range can be provided, and over a larger angular range, up to a full 360 degree rotation.

[0019] The end cap may comprise a mechanically actuated button for decoupling the first and second tooth or slot arrangements to allow the relative rotation between the first and second parts. This provides a secure way of fixing the end cap in a chosen rotational position. The mechanically actuated button may be spring-loaded, wherein the button is adapted to be depressed to decouple the first tooth or slot arrangement from the second tooth arrangement, and is adapted to be released to recouple the first and second tooth or slot arrangements. This provides an easy to use adjustment mechanism for the user.

[0020] The first and second parts may instead be slidable relative to each other along a direction parallel to the axis of relative rotation between first and second configurations, wherein in the first configuration the first and second tooth or slot arrangements are decoupled to allow the relative rotation between the first and second parts, and in the second configuration the first and second tooth or slot arrangements are interlocked to prevent the relative rotation between the first and second parts.

[0021] The invention also provides a tubular lighting device, comprising:

a tubular housing;
a light source within the tubular housing; and
an end cap as defined above at each end of the tubular housing.

[0022] The light source for example comprises an LED arrangement, and the tubular housing may have a non-circular cross sectional shape, for example an oval shape, in cross section perpendicular to the tubular housing elongate axis.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023] Examples of the invention will now be described in detail with reference to the accompanying drawings, in which:

Figure 1 shows a basic known tubular LED lamp;
Figure 2 shows the lamp fitted to a light fitting which is suitable for the lamp design;
Figure 3 shows a light fitting with a slot at 45 degrees to the horizontal which is not suitable for the lamp design of Figure 1;
Figure 4 shows an end cap which allows rotation of the external connector;
Figure 5 shows an end cap applied to a tubular housing of a lighting device;
Figure 6 shows a first design for the internal parts of the design in Figure 5.
Figure 7 shows more clearly the spring contacts, each connected to a respective pin;
Figure 8 shows a second design in which a release button is pushed in a radial direction and shows the unlocked position during which adjustment can be made;
Figure 9 shows the second design in a locked position;
Figure 10 shows a third design in which a release button is pushed in an axial direction and shows the unlocked position;
Figure 11 shows the design of Figure 10 in the unlocked position in more detail;
Figure 12 shows the design of Figure 10 in the locked position;
Figure 13 shows the design of Figures 10 and 12 in the locked position in more detail;
Figure 14 shows a further design in the unlocked position;
Figure 15 shows the design of Figure 14 in the locked position; and
Figure 16 shows in more detail the internal connections made between the external pins and the spring contacts.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0024] The invention provides an end cap for a tubular lighting device which comprises first and second parts which are rotatable relatively to each other. One part carries an external connector and the other part connects to a tubular lighting device housing. The two parts are electrically connected together via an internal rotatable plug and socket electrical connector, internal to the end cap.

[0025] Figure 1 shows a basic known tubular LED lamp 10, comprising a tubular housing 12 having an end cap 14 at each end (only one is shown). The end cap carries external connectors 16 in the form of two pins offset to each side from a central axis of the end cap 14, parallel

to the elongate axis of the tubular housing 12. The end cap 14 connects electrically to the internal driver board and LED board inside the tubular housing 12.

[0026] The lamp has a directional output and in this example has a non-circular cross sectional shape. Note that even with a circular tubular shape, the light output may still be directional.

[0027] The directional output means there is a preferred angular orientation, which in the example shown is with the long axis of the elliptical cross section in a vertical direction.

[0028] A problem arises that existing fittings may not give rise to this desired orientation.

[0029] Figure 2 shows the lamp fitted to a fitting 20 which is suitable for the lamp design. The two pins 16 are aligned with a slot 22 of the fitting, and then the lamp is slid into place (left image). It is then rotated by 90 degrees to complete the electrical and mechanical connection (right image).

[0030] Some existing light fittings for tubular lamps do not have vertical slots. Figure 3 shows a light fitting with a slot at 45 degrees to the vertical. As shown, after inserting the lamp of Figure 1 (left image) and twisting it (right image), the light output beam 23 is not downwardly directed as desired.

[0031] Figure 4 shows how to address this problem, by providing an end cap which allows rotation of the external connector 16. Before or during fitting, the end cap is twisted so that after installation, the light output beam 23 faces downwardly as shown in the right image. The left image shows the twisting having taken place to the desired orientation, before insertion into the slot.

[0032] Figure 5 shows an end cap 14 applied to a tubular housing 12 of a lighting device. The end cap has a first part 14a having the external electrical connector 16 for making mechanical and electrical connection to the light fitting. A second part 14b is for making mechanical connection to the end of the tubular housing 12 and electrical connection to the light source (not shown) inside the tubular housing 12. The first and second parts are rotatable relatively to each other, and electrically connected together via an internal rotatable plug and socket electrical connector.

[0033] The relative rotation enables the rotational position of the external electrical connector to be adjusted.

[0034] Figure 6 shows a first example of the internal parts of the design in Figure 5.

[0035] The internal connector comprises a male pin part 20 and a female socket part. The male pin part 20 has two electrical contact rings at different positions along the pin length, in the form of a jack plug. The female socket comprises first and second corresponding spring contacts 22 and 24 which are biased towards the electrical contact rings. This is the form of a female jack socket. The first spring contact 22 is coupled to a ring 26 for fixing to one of the external connector pins 16 and the second spring contact 24 is coupled to a ring 28 for fixing to the other of the external connector pins 16.

[0036] Other rotatable connectors may be used, such as a coaxial connector with a central pin and one or more surrounding concentric annular electrical contacts. In all cases, there may be a first solid member functioning as a male plug part and a second solid member functioning as a female socket part, and the two parts can rotate relatively to each other. This provides an arrangement which is not prone to wearing, as the electrical contact is formed between two solid metal surfaces which can be biased against each other, or can be a tight fit with each other.

[0037] In the example of Figure 6, the pin 20 is coupled to the second part 14b of the end cap and projects along the axis of relative rotation, and the spring contacts 22, 24 are then coupled to the first part 14a of the end cap. Alternatively, the pin maybe coupled to the first part 14a of the end cap and project along the axis of relative rotation and the spring contacts 22, 24 are then coupled to the second part of the end cap.

[0038] In the example of Figure 6, the second part 14b has a toothed wheel 30. This can engage with a corresponding single tooth, or set of teeth, or another complete toothed wheel (not shown) in the first part 14a to define a set of possible relative rotational positions.

[0039] Figure 7 shows more clearly the spring contacts 22,24 each connected to a respective pin 16, and it shows the contact rings of the pin 20 as cross hatched areas.

[0040] The adjustment of the relative rotational position of the two parts 14a, 14b is carried out manually. There are various possible ways to implement the manual adjustment.

[0041] Figures 8 and 9 show a second design with a push button which is pushed radially in. Figure 8 shows the second design in an unlocked position during which adjustment can be made and Figure 9 shows the design in a locked position. Each of Figures 8 and 9 shows a plan view, an end view in cross section and a side view in cross section.

[0042] The first part 14a has a first tooth or slot arrangement, which in this example comprises an array of slots 40. The slots do not cover a full 360 degree angle, and in this example there are five slots which cover only 90 degrees. The second part 14b has a second tooth or slot arrangement which in this example comprises a single tooth 42. The tooth 42 can move be moved radially in and out by means of a button 44. The tooth 42 engages radially outwardly with an aligned slot 40, and is biased radially outwardly by a spring 46. The button 44 can be pushed in against the spring bias to release the tooth 42 from the slot 40 and thereby enable the relative rotation between the two parts 14a, 14b.

[0043] Figure 8 shows the tooth 42 in the depressed position so that the two parts 14a, 14b are unlocked and Figure 9 shows the tooth in the spring biased engaged position so that the two parts are locked.

[0044] Figure 10 shows a third design in which a release button 50 is pushed in an axial direction to release the two parts 14a, 14b to allow relative rotation. Figure

10 shows the push button 50 depressed so that the two parts 14a, 14b are unlocked.

[0045] Figure 11 shows the design of Figure 10 in the same depressed position and shows a plan view, an end view in cross section and a side view in cross section.

[0046] The end of the push button 50 carries a tab which functions as a single tooth 42, which again engages with one of the slots 40 in the first part 14a to prevent relative rotation.

[0047] The button is biased to the engaged position by the elasticity of the material from which the end cap is made, such as a plastics material.

[0048] Figure 12 shows the same design with the push button 50 sprung back to its locked position. Figure 13 shows the design of Figures 10 and 12 in the same locked position and again shows a plan view, an end view in cross section and a side view in cross section. The tooth 42 projects axially into one of the slots 40 to prevent relative rotation.

[0049] The examples of Figures 8 to 13 make use of a push button.

[0050] In a further design shown in Figures 14 and 15, the first and second parts 14a, 14b are slidable relative to each other along a direction parallel to the axis of relative rotation. Figure 14 shows a first configuration in which the first and second tooth or slot arrangements are decoupled to allow the relative rotation between the first and second parts 14a, 14b. Figure 15 shows a second configuration in which the first and second tooth or slot arrangements are interlocked to prevent the relative rotation between the first and second parts 14a, 14b.

[0051] In these examples, the first part 14a has an outer sleeve 60 which overlaps a collar of the second part 14b.

[0052] The first part 14a in this example has a single tooth 42 for engaging with one slot of a slot ring 40 which forms part of the second part 14b. The sleeve 60 of the first part 14a has a ribbed inner surface which engages with a ribbed outer surface of the collar. In this way, the sleeve 60 is a snap fit into the two different positions as shown in Figures 14 and 15. In each of these positions, a projection engages with a recess where the sleeve and collar are coupled. The engagement is enough that a force is needed to slide the sleeve between the two positions which is greater that will be experienced in normal use. The sleeve resists complete removal as a result of a one-way step part 62. This step part allows the first part 14a to be a push fit over the second part 14b during assembly (and the toothed ring 40 will deform radially inwardly during this assembly), but it then resists removal of the first part 14a. In the locked configuration of Figure 15, the first part 14a reaches a stop 64 defined by the interaction between the ribbed inner and outer surfaces.

[0053] In the decoupled state of Figure 14, the electrical connection between the pin 20 and the socket connections is broken as a result of the relative axial position, so that the adjustment is made with a non-contact safe configuration of the internal plug and socket connector.

[0054] Figure 16 shows the internal connections made by the first part 14a between the pins 16 and the first and second spring contacts 22, 24.

[0055] As shown in some of the examples above (for example Figure 6), there maybe full 360 degree rotation allowed between the two parts 14a, 14b. However, this is not essential. For example the double external pin is 180 degree symmetric in any case, so that all possible relative orientations can be achieved with 180 degree relative rotation and by selecting which way around to insert the pins 16 into the slot. Furthermore, the twisting movement to lock the lamp into the fitting (i.e. the twisting that takes place between the left and right parts of Figure 2) may be allowed in both rotational directions. In this case, all possible relative orientations can be achieved with only a 90 degree range of relative rotation between the first and second parts 14a, 14b, by choosing the orientation to insert into the slots and the direction to rotate the fitting. For example, as shown in some example above, there may be five slots at relative angular orientations, with respect to a central slot, of $\pm 22.5°$ and $\pm 45°$. These five possible relative orientations cover a 90 degree range. These discrete values enable fitting to a range of standard light fittings.

[0056] Although engaging teeth are used in the examples above, a frictional engagement may instead be used, or a ratchet mechanism which allows clicked rotation in one angular direction. Instead of teeth and slots, a polygonal male part may engage with a polygonal female part. For example a hexagon feature on one part may engage with a hexagon feature on the other part to define six possible angular orientations.

[0057] The internal plug and socket is generally a concentric arrangement which allows full 360 degree relative rotation between the plug and socket parts.

[0058] A tubular lighting device using the end cap has a tubular housing, a light source within the tubular housing and an end cap at each end of the tubular housing.

[0059] The light source for example comprises an LED arrangement, and the tubular housing may have a non-circular cross sectional shape, for example an oval shape, in cross section perpendicular to the tubular housing elongate axis. However, it may have a circular cross section but a light output which is not rotationally symmetric.

[0060] Other variations to the disclosed embodiments can be understood and effected by those skilled in the art 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 measured cannot be used to advantage. Any reference signs in the claims should not be construed as limiting the scope.

Claims

1. An end cap (14) for a tubular lighting device (10), comprising:

   a first part (14a) having an external electrical connector for making mechanical and electrical connection to a light fitting (20); and
   a second part (14b) for making mechanical connection to an end of a tubular housing of the tubular lighting device and electrical connection to a light source of the tubular lighting device,
   wherein the first and second parts (14a, 14b) are rotatable relatively to each other, and electrically connected together via a rotatable plug and socket electrical connector (20, 22, 24) internal to the end cap.

2. An end cap as claimed in claim 1, wherein the internal rotatable plug and socket electrical connector comprises a pin (20) with at least two electrical contact rings at different positions along the pin and each surrounding the pin, and at least two corresponding spring contacts (22, 24) which are biased towards the electrical contact rings.

3. An end cap as claimed in claim 2, wherein:

   the pin (20) is coupled to the second part (14b) of the end cap and projects along the axis of relative rotation and the spring contacts (22, 24) are coupled to the first part (14a) of the end cap; or
   the pin (20) is coupled to the first part (14a) of the end cap and projects along the axis of relative rotation and the spring contacts (22, 24) are coupled to the second part (14b) of the end cap.

4. An end cap as claimed in any one of claim 1 to 3, wherein the external electrical connector comprises a pin arrangement (16) which is electrically connected to the rotatable electrical connector (20, 22, 24).

5. An end cap as claimed in claim 4, wherein the external electrical connector comprises two pins (16) projecting parallel with the axis of relative rotation, spaced apart on each side of the rotation axis.

6. An end cap as claimed in any one of claims 1 to 5, wherein the first part (14a) comprises a first tooth or slot arrangement (40) and the second part (14b) comprises a second tooth or arrangement (42), wherein the first and second tooth or slot arrangements interlock to define a plurality of rotational orientations.

7. An end cap as claimed in claim 6, wherein one of the first and second tooth or slot arrangements comprises a single tooth or slot (42) and the other of the first and second tooth arrangements comprises a plurality of slots or teeth (40).

8. An end cap as claimed in claim 7, wherein the one of the first and second tooth or slot arrangements comprises a single tooth (42) and other of the first and second tooth arrangements comprises five slots (40) at relative angular orientations, with respect to a central slot, of $\pm 22.5°$ and $\pm 45°$.

9. An end cap as claimed in any one of claims 6 to 8, further comprising a mechanically actuated button (44; 50) for decoupling the first and second tooth or slot arrangements to allow the relative rotation between the first and second parts (14a, 14b).

10. An end cap as claimed in claim 9, wherein the mechanically actuated button (44) is spring-loaded, wherein the button (44) is adapted to be depressed to decouple the first tooth or slot arrangement from the second tooth arrangement, and is adapted to be released to recouple the first and second tooth or slot arrangements.

11. An end cap as claimed in claim 6, wherein the first and second parts (14a, 14b) are slidable relative to each other along a direction parallel to the axis of relative rotation between first and second configurations, wherein in the first configuration the first and second tooth or slot arrangements (40, 42) are decoupled to allow the relative rotation between the first and second parts (14a, 14b) and in the second configuration the first and second tooth or slot arrangements (40, 42) are interlocked to prevent the relative rotation between the first and second parts (14a, 14b).

12. A tubular lighting device (10), comprising:

    a tubular housing (12);
    a light source within the tubular housing; and
    an end cap (14) at each end of the tubular housing (12), each end cap as claimed in any preceding claim.

13. A tubular lighting device as claimed in claim 12, wherein the light source comprises an LED arrangement.

14. A tubular lighting device as claimed in claim 12 or 13, wherein the tubular housing (12) has a non-circular cross sectional shape, for example an oval shape, in cross section perpendicular to the tubular housing elongate axis.

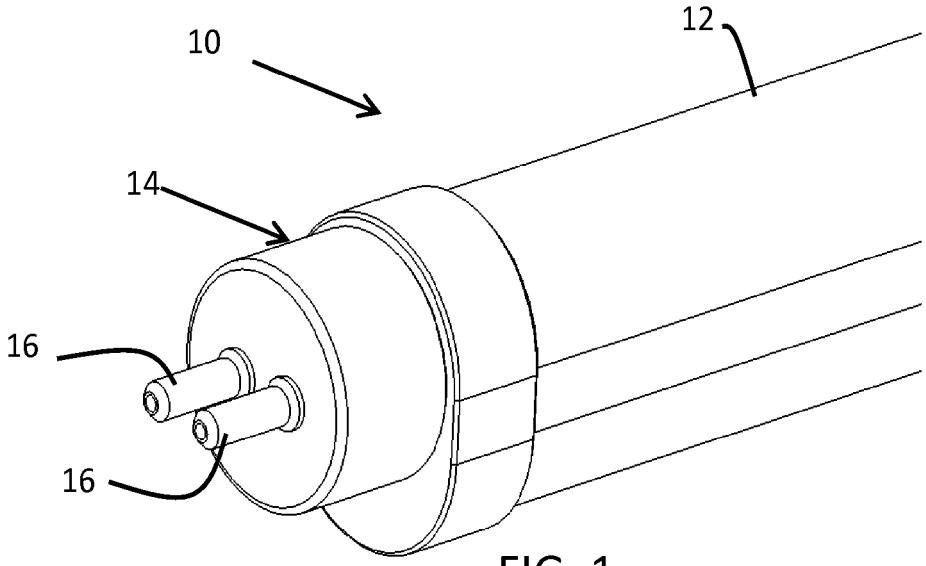


FIG. 1

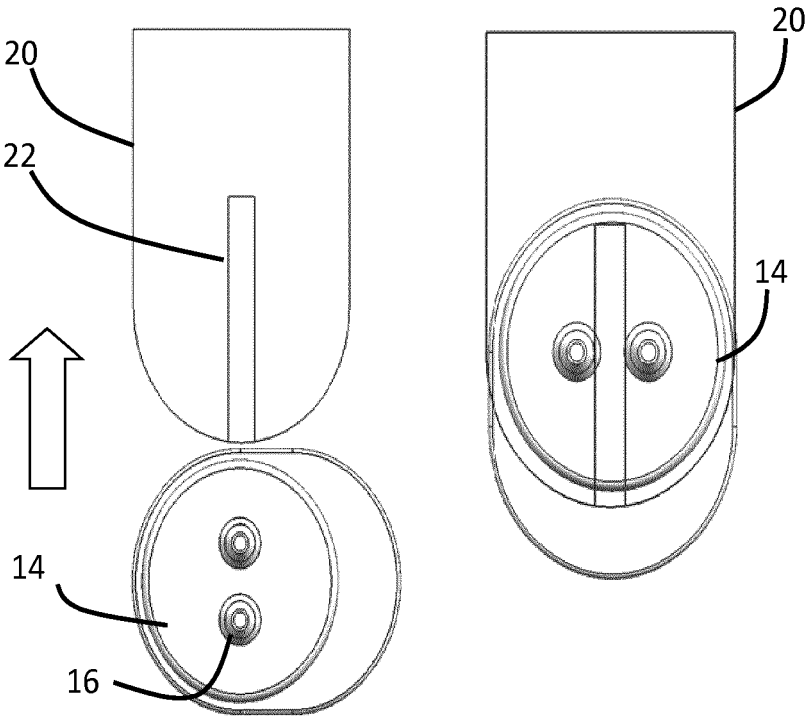


FIG. 2

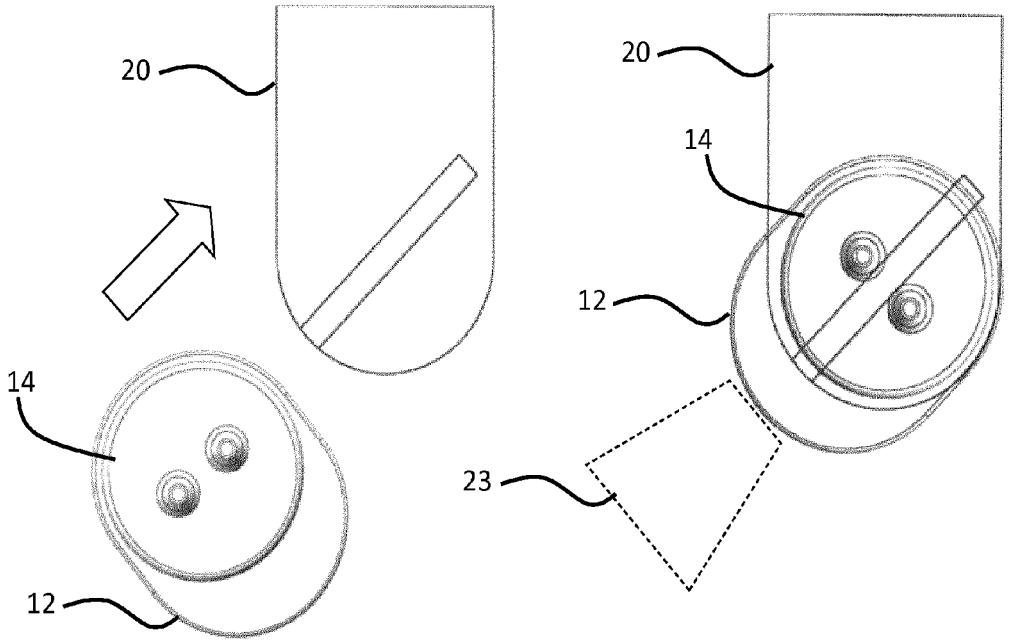


FIG. 3

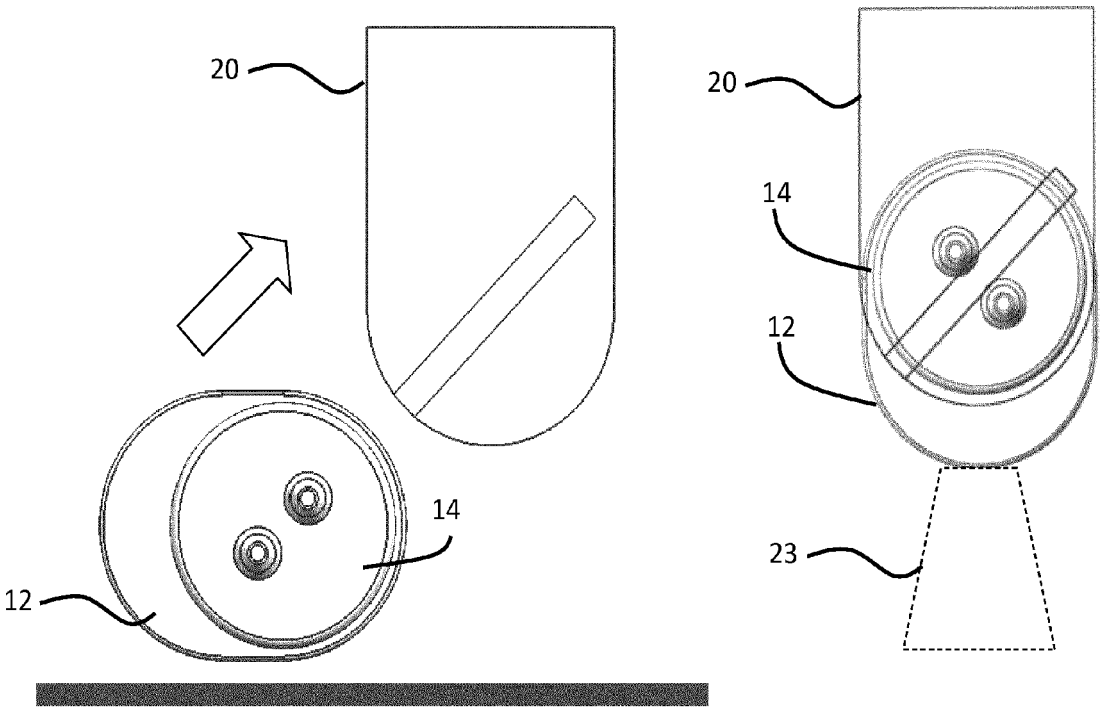


FIG. 4

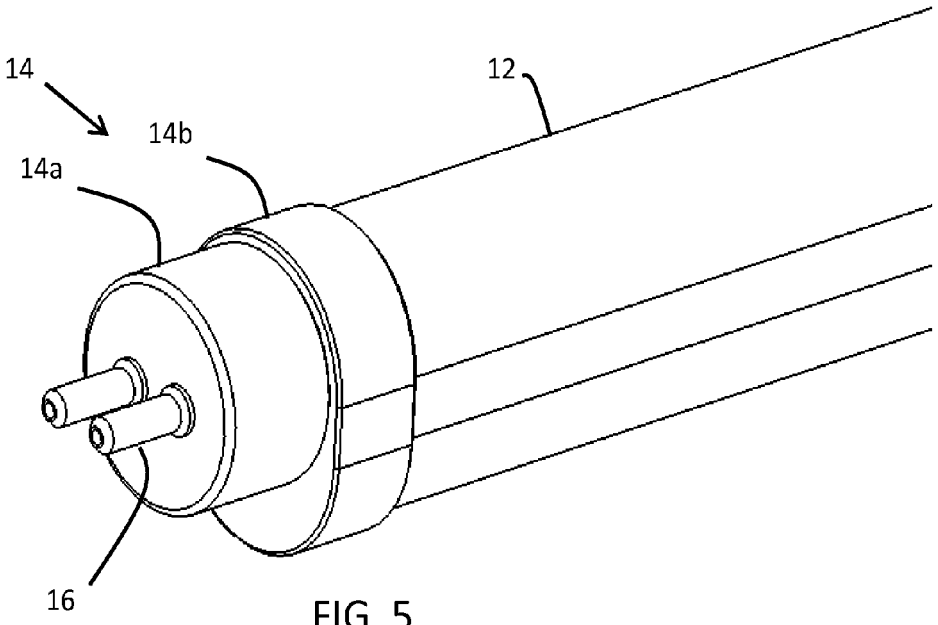


FIG. 5

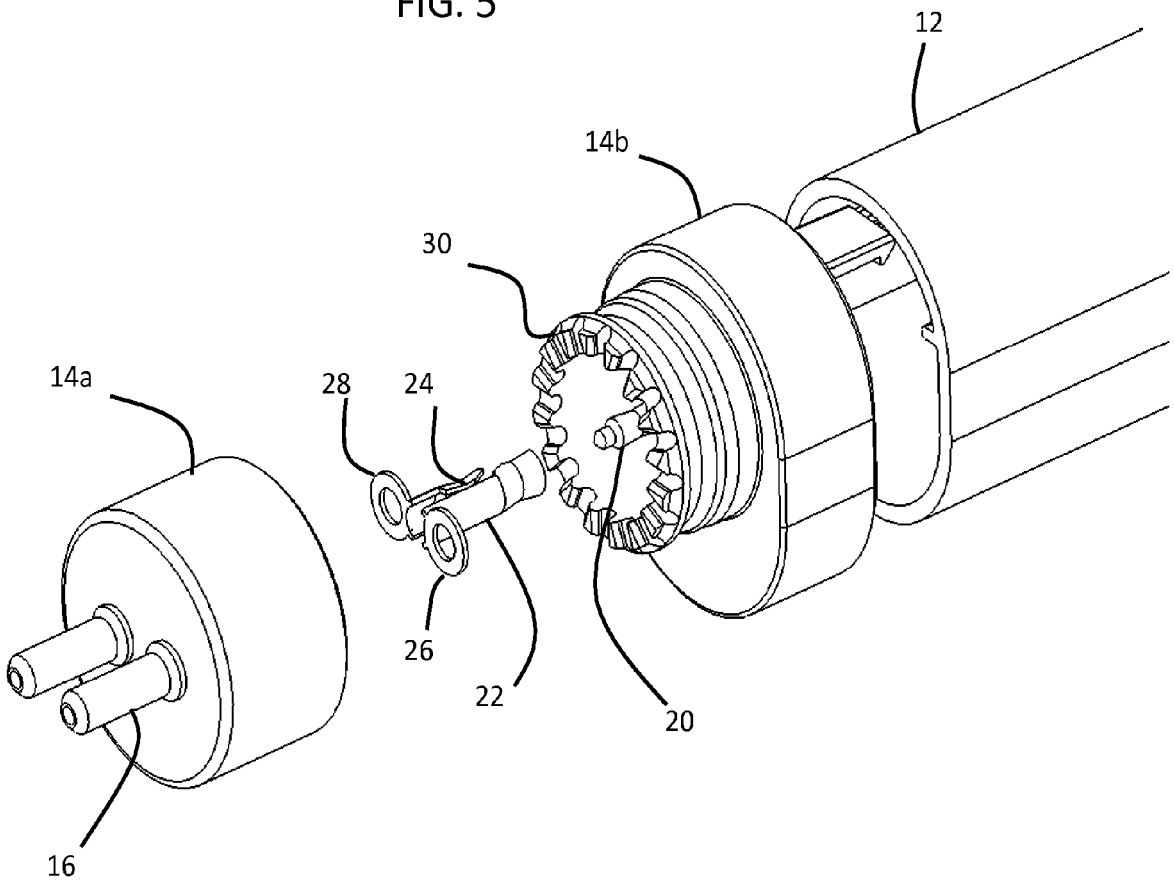


FIG. 6

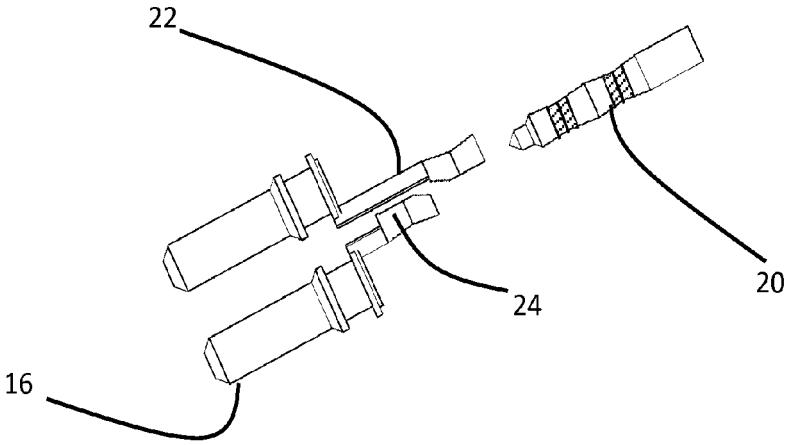


FIG. 7

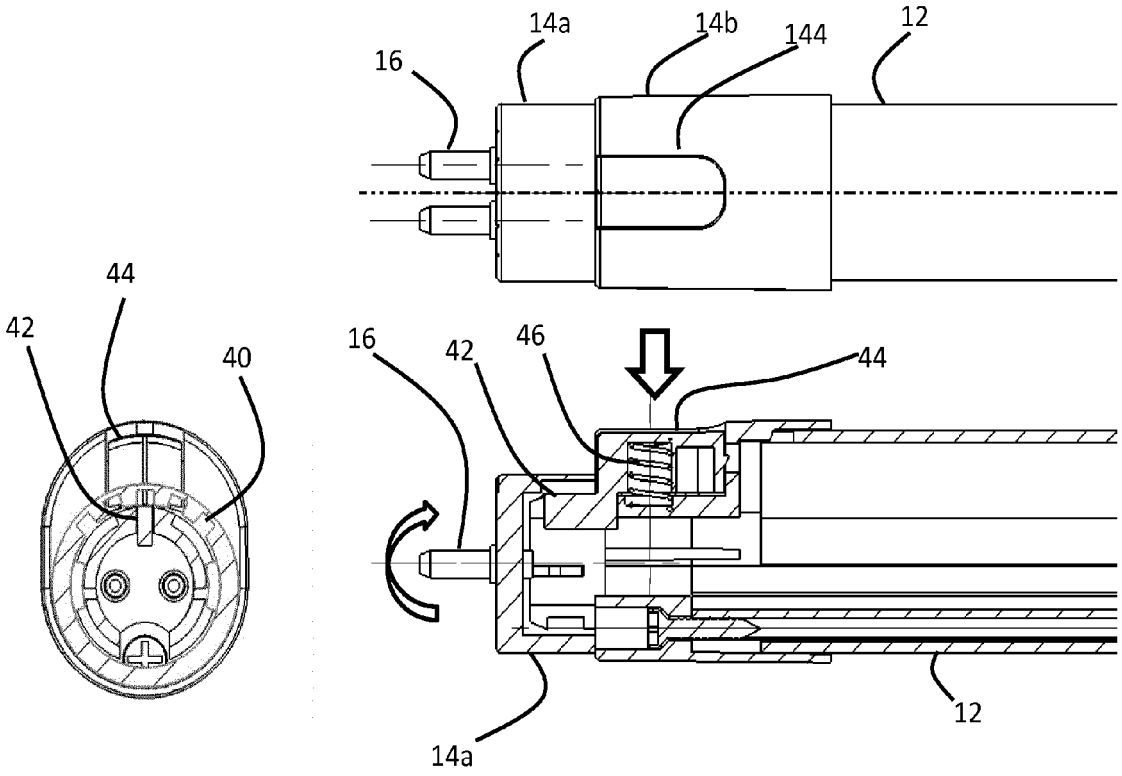
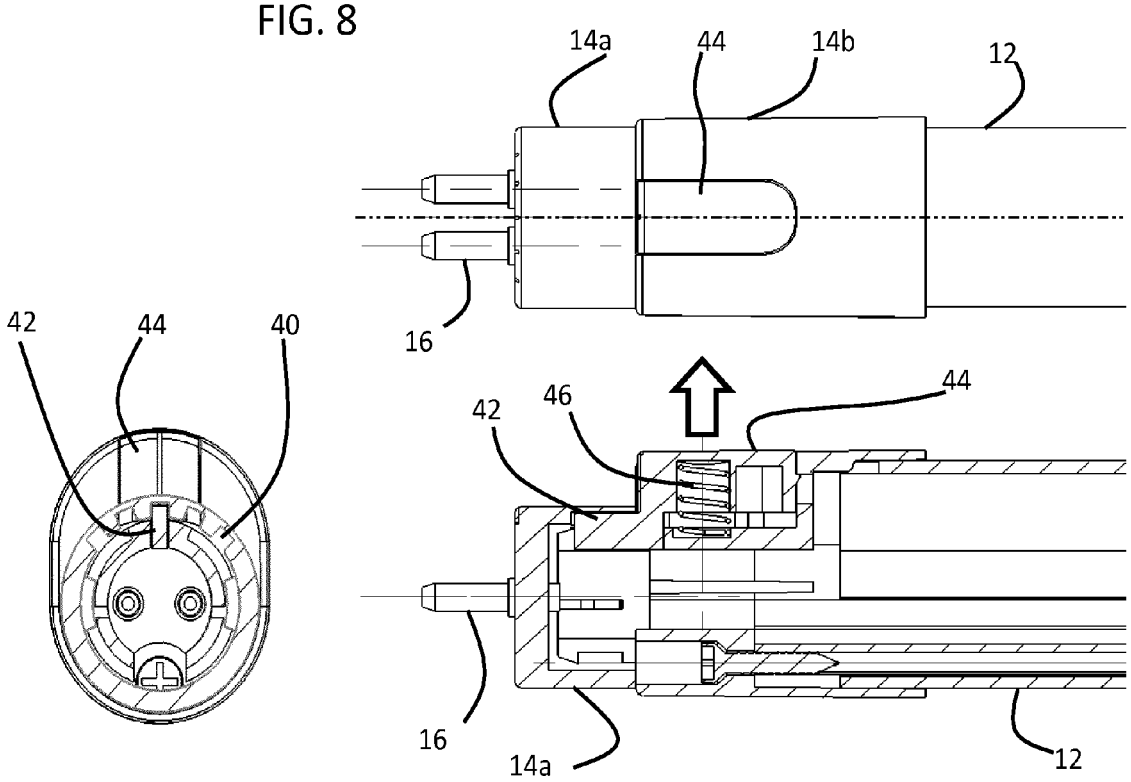

14a
14b
144
12
16
44
42
40
16
42
46
44
12
14a

FIG. 8


14a
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14b
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14a
12

FIG. 9

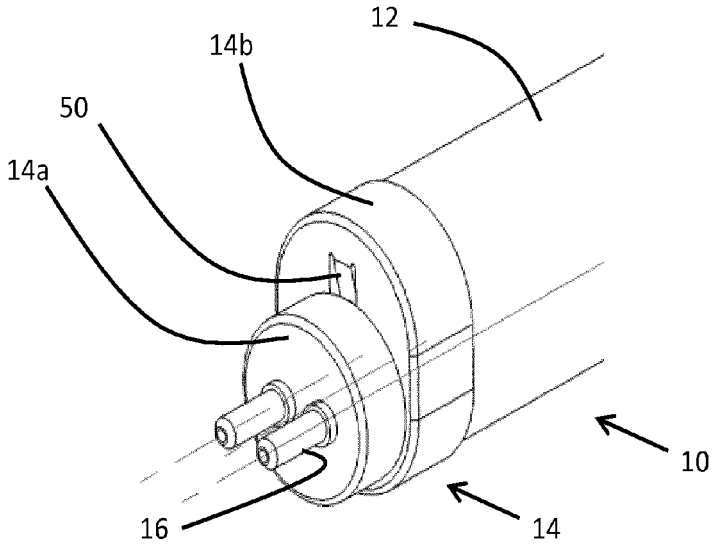
12
14b
50
14a
10
16
14

FIG. 10

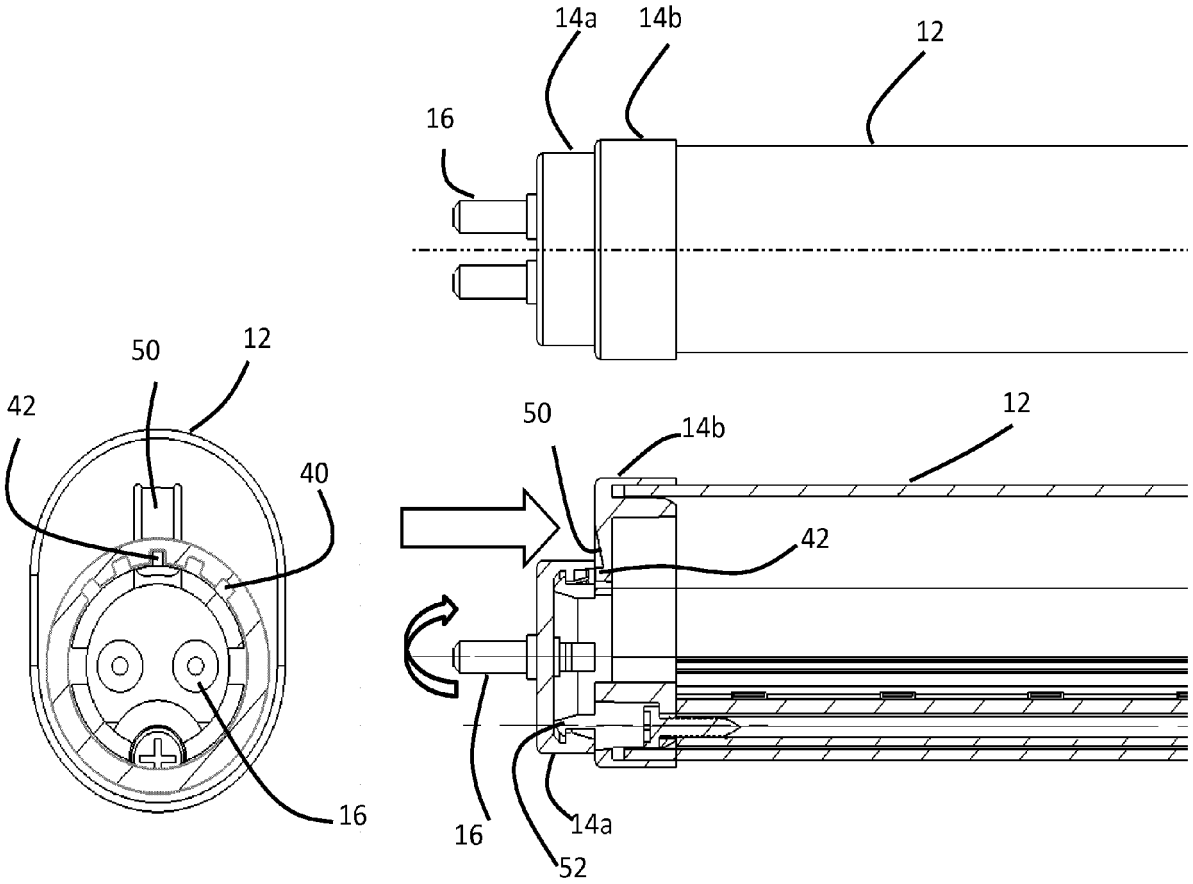
14a
14b
12
16
50
12
42
40
16
50
14b
12
42
16
14a
52

FIG. 11

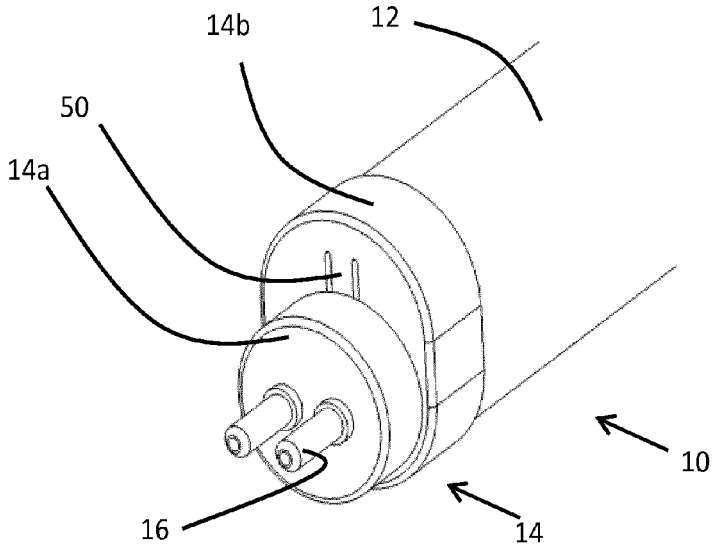
14b
12
50
14a
10
16
14

FIG. 12

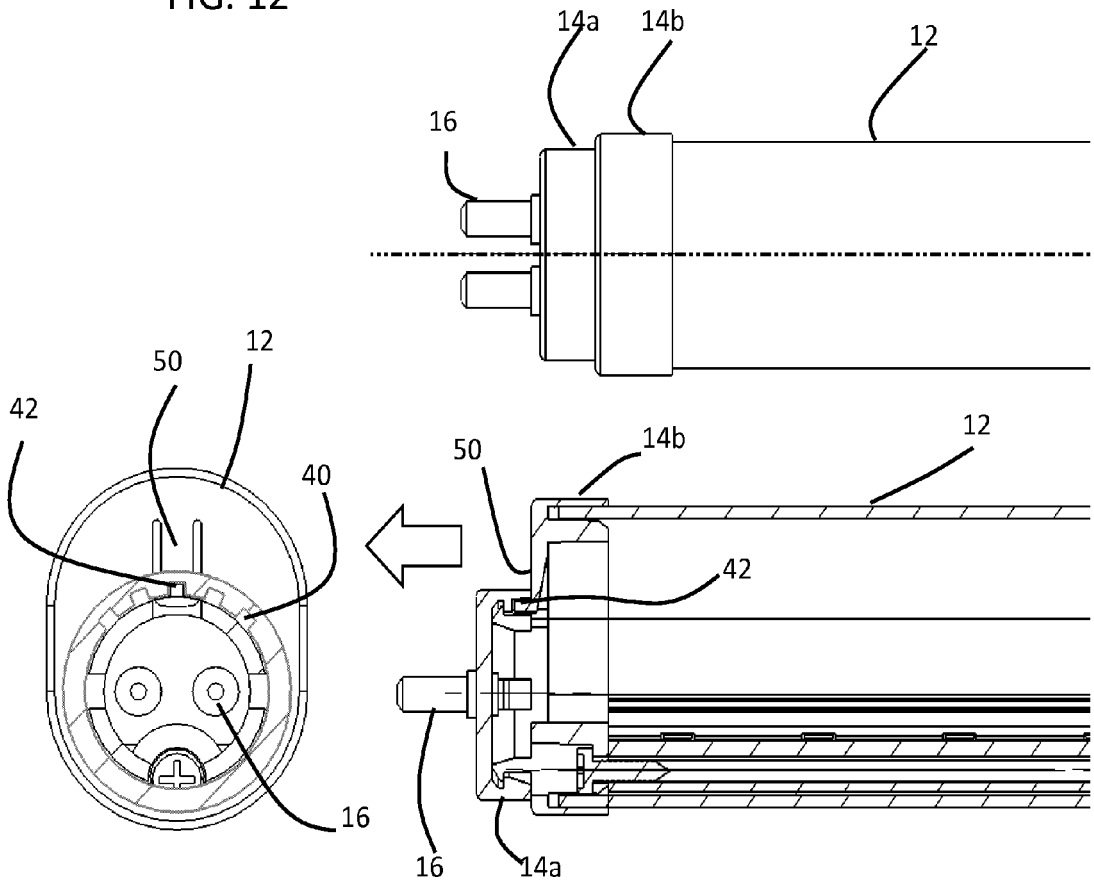
14a
14b
12
16
50
12
42
40
50
14b
12
42
16
16
14a

FIG. 13

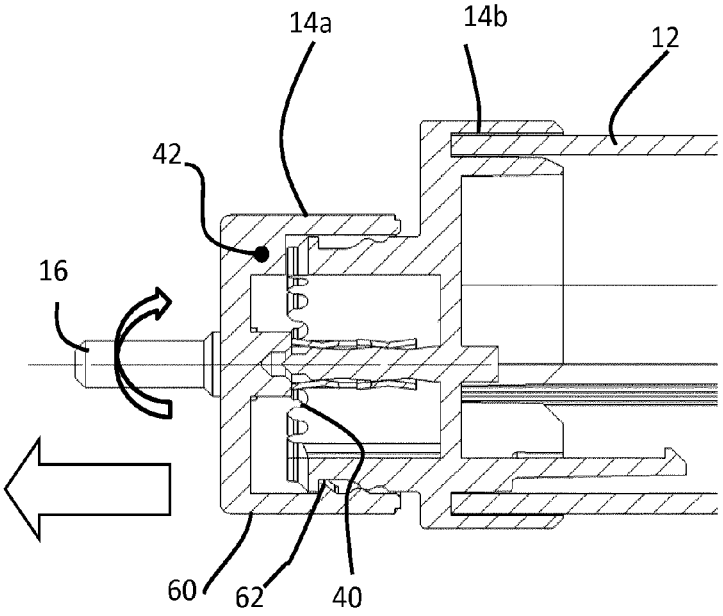

FIG. 14

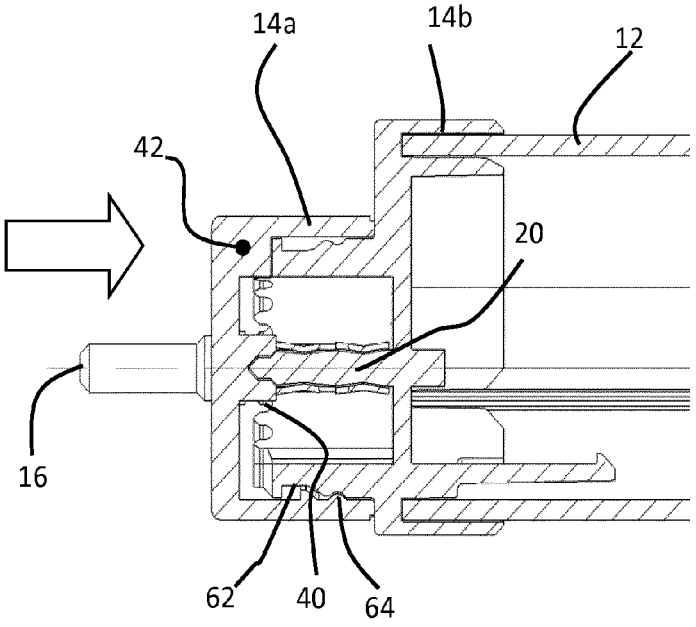

FIG. 15

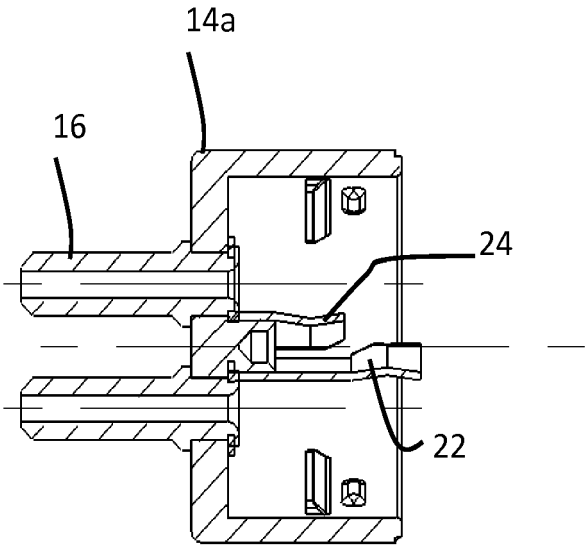

FIG. 16

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Place of search	Date of completion of the search	Examiner
The Hague	18 February 2015	Thibaut, Arthur

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