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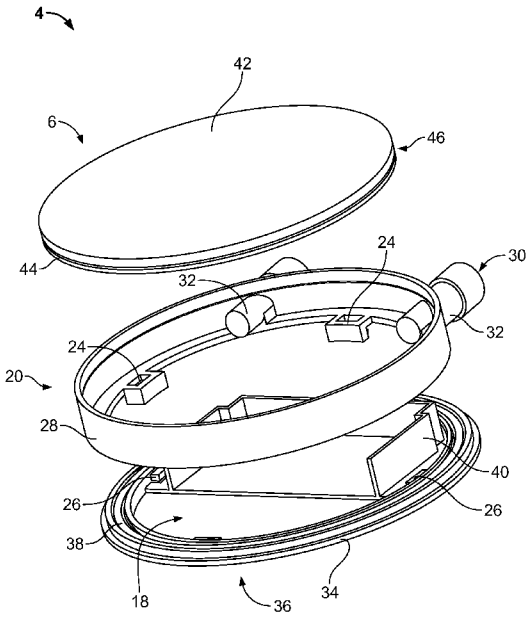

Fig. 4

(57) Abstract: A connection device (4) for connecting at least one electrical conductor to an electrical solar module assembly (2) is equipped with a housing (6) for attachment to an electrical solar module assembly (2) and for connection of at least one electrical conductor (8) to the solar module assembly (2), wherein the housing (6) is equipped with a lower housing region and a housing cover (42) and forms a housing internal space (18). The lower housing region is equipped with a base element (34) with a base surface (36) for fitting to a surface of the solar module assembly (2), and a central element (20) between the base element (34) and the housing cover (42), having at least one connection port (30) for the introduction of the electrical conductor (8) into the internal space (18) of the housing. The central element (20) herein encloses a portion of the internal space (18) of the housing. Further provided is a locking device (24, 26) to join the central element (20) to the base element (34).

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CONNECTION DEVICE FOR CONNECTING AN ELECTRICAL CONDUCTOR TO A SOLAR MODULE ASSEMBLY AND SOLAR MODULE ASSEMBLY WITH A CONNECTION DEVICE OF THIS KIND

The present invention relates to a connection device for connecting at least one electrical conductor to an electrical solar module assembly, having a housing for attachment to the solar module assembly and for connecting at least one electrical conductor to the solar module assembly. The invention further relates to a solar module assembly with a connection device of this kind.

A known connection device for connection of one or more electrical conductors, e.g. of a connecting cable, to an electrical solar module assembly is generally equipped with a housing for attachment to the solar module assembly. In its internal space, on the one hand, connection components such as contacts and diodes, especially bypass diodes, are attached, and, on the other, one or more electrical connecting leads, which are introduced into the housing, are connected to a proportion of the connection components. Using one or more connecting leads, the solar module assembly is electrically connected to e.g. a consuming device. It is, for instance, conventional here to attach those connecting devices also known as connection sockets or connection boxes to one of the main surfaces of a solar module, e.g. to the rear of a solar panel. Electrical conductors of an electrical connection system of the solar panel are routed out of the solar panel and connected to a proportion of the connection components in the interior of the connection device. The routed-out electrical conductors conventionally take the form of connection foils.

A well-known process for manufacturing a housing for a connection device of this kind uses a thermoplastic injection moulding procedure in which a melted compound is injected via injection nozzles into an injection mould under high pressure to produce the housing of the connection device. Formed in the housing are connection ports for the entry of the connecting leads, at which the electrical conductors of the connecting leads are introduced into the interior of the housing. Owing to these connection ports, the design of the housing is very complex from the injection moulding viewpoint, especially in the region of the connection ports, and requires, for instance at the wall portions at which the connection ports are disposed, a large amount of material. The reason for this is that the plastic material for producing the housing is injected unilaterally into an injection mould in order to create housing walling and the housing base in this injection mould. The connection ports in the housing wall are herein created adjacent to the housing base. Below the connection ports, which are generally tubular in shape for the purpose of cable entry, regions are thus created at which material accumulations occur, especially in difficult-to-access zones below the tubular regions in the vicinity of the housing base.

These material accumulations involve the disadvantage that, as it cools, the plastic material contracts more slowly, and frequently non-homogeneously, at this location, and air inclusions may occur in walls and base surfaces, leading to sink marks. This sometimes leads to an undefined injection process, and may require a post-injection of melted compound. Material accumulations of this kind occur, in particular, in cases where a relatively large-volume connecting cable will be introduced into the housing, so the connection ports have to be made accordingly larger. As a result of the partially undefined injection process and the necessary post-injection, extended time spans occur for a work cycle in the manufacturing process, and tool wear increases. In combination also with the additional quantity of material in the region of the material accumulations, this leads to a manufacturing process that is more complex overall, as a result of which the manufacture of the connection device becomes more costly.

It is an object of the present invention to specify a connection device for connecting at least one electrical conductor to an electrical solar module assembly, which connection device is comparatively cost-effective to produce.

The invention relates to a connection device according to the features of claim 1. In addition, the invention relates to a solar module assembly according to the features of claim 12. Extensions and developments of the invention are specified in the sub-claims.

A connection device according to the invention for connecting at least one electrical conductor to an electrical solar module assembly is equipped with a housing for attachment to the solar module assembly and for connection of at least one electrical conductor, e.g. of a connecting cable, to the solar module assembly, wherein the housing is equipped with a lower housing region and a housing cover, and forms a housing internal space. The lower housing region is equipped with a base element with a base surface for placing onto a surface of the solar module assembly, and a central element between the base element and the housing cover, in which central element is located at least one connection port for the introduction of the electrical conductor into the internal space of the housing. The central element encloses at least a portion of the internal space of the housing. Further provided is a locking device to join the central element to the base element.

The lower housing region of the connection device according to the invention thus consists of at least two housing components that can be separately manufactured, these being the base element and the central element, which, following their respective manufacture, are joined together by means of the locking device to form the lower housing region of the housing. The division of the lower housing region of the housing of the connection device into the two elements specified has the advantage that each of these elements is comparatively simple from a manufacturing viewpoint, and can be produced with a simple injection tool. The melted compound for production of the respective housing elements can be injected from two sides via injection nozzles, using a conventional

thermoplastic manufacturing process, to create the respective housing elements. With a design of this kind for the lower housing region, it is possible to create the connection ports located in the central element without the aforementioned material accumulations in the region between the connection port and the housing base, since better access from two sides is enabled for the creation of the connection ports in the central element. The formation of sink marks in this region can thus also be reduced or even prevented, with the result that any post-injection of melted compound is no longer necessary. The design according to the invention of a connection device thereby enables a shorter manufacturing process, which is less complex from the manufacturing viewpoint and is more cost-effective.

One further advantage of the invention consists in the fact that the connection device according to the invention, or specifically its housing, can be assembled in modular fashion. It is, in particular, possible to configure the housing variably in the region of the central element in order to take account of differing requirements relating to the application area of the connection device. It is, in particular, possible to match the housing of the connection device to different cable diameters of a connecting cable to be introduced. Thus, for example, different embodiments of central elements may be produced, differing only in respect of e.g. the type, quantity and/or size of the connection ports for the entries of the connecting cable(s). According to the principle of a modular kit, a housing of a connection device can thus be provided in which the base element is connected to a matching central element according to the area of application in order to form the housing of the connection device. This modular design further makes it possible to adapt an already installed connection device to any subsequent requirements. In this event, it is advantageous for the locking device used to join together the central element and the base element to take the form of a detachable locking device. The central element is thereby exchangeable, and can be replaced by a central element matched to the particular application without having to detach the entire housing unit from the solar module assembly. A connection device according to the invention can thereby be upgraded or modified subsequently.

According to one embodiment of the invention, the central element forms at least one portion of a peripheral housing wall between the housing cover and the base element. The housing wall of the central element running over at least one portion of the housing perimeter forms in its interior, or on its side facing the internal space of the housing, an open or closed internal space, which is part of the internal space of the housing. In particular, the central element assumes the shape of a frame, wherein the frame-shape may be open or closed, and may, as a matter of course, be configured as desired in terms of its geometry. In one embodiment, the central element, or its peripheral housing wall, assumes an essentially annular shape. A rectangular or some other geometric shape is, however, also possible. Furthermore, the central element may be connected at one of its end faces to

the base element by means of the locking device. If no further housing element of the connection device is present between the central element and the housing cover, then, for example, the other end face of the central element is connected to the cover of the housing.

To join the central element to the housing cover, the connection device may be equipped with another locking device, which may also be of detachable design.

In a development of the invention, a first sealing ring is provided between the central element and the base element in order to protect the internal space of the housing from environmental influences. In addition, a second sealing ring may be fitted between the central element and the housing cover to protect the internal space of the housing from environmental influences. One embodiment of the invention herein provides that the second sealing ring between the central element and the housing cover essentially corresponds in its geometric dimensions with the first sealing ring between the central element and the base element. One or both of these sealing rings may be attached by means of e.g. a dual-component injection moulding process. Owing to the essentially identical design of the first sealing ring between the central element and the base element, and the second sealing ring between the central element and the housing cover, the manufacture of the first and second sealing rings can take place in an identical manner, or the same type of sealing ring and embodiment may be selected for both housing regions, which has a positive effect on the manufacturing costs of the connection device.

According to a further embodiment of the invention, the connection port may be equipped with an apparatus for fastening the electrical conductor to the housing. For example, the connection port exhibits a cable union or a screw thread for a cable union, with which a connecting cable is mechanically connected to the housing.

The invention is explained in greater detail below with reference to the drawings, by way of examples of different embodiments.

Fig. 1 shows a schematic cross-sectional view of one embodiment of an electrical solar module assembly, which is provided with a connection device according to the invention,

Fig. 2 shows a perspective view of a central element of the housing of the connection device according to one embodiment example of the invention,

Fig. 3 shows a perspective view of a base element of the housing of the connection device according to one embodiment example of the invention,

Fig. 4 shows an exploded view of one embodiment of a connection device according to the invention, with a central element and a base element as shown in Figs. 2 and 3.

Fig. 1 shows a schematic cross-sectional view of a photovoltaic solar module, which is equipped with a connection device in the form of a connection socket or connection box. The solar module assembly 2 consists of a layer assembly with a planar-type, irradiation-side first layer 12,

which may take the form of a glass panel or a foil-type layer. The solar module assembly 2 further consists of a planar second layer 10, which is remote from the irradiation side and may likewise take the form of a glass panel or a foil-type layer. In the embodiment shown, the layers 10 and 12 each take the form of glass panels. Located between the two layers 10 and 12 is at least one solar cell 14 or an assembly comprising a plurality of solar cells 14, which produce electrical energy when irradiated with light owing to a photovoltaic effect. The solar cell(s) 14 is/are connected to an electrical connection system 15. In Fig. 1, this is only indicated schematically and serves, in particular, to electrically link the solar cell(s) and connect it/them with the outside world. The electrical connection system 15 comprises e.g. a copper foil, which, on one side, is electrically contacted to the rear of the solar cell(s) 14 and, on the other, graduates into an electrical conductor 13 of the solar module or is connected to an electrical conductor 13 of the solar module, which takes the form of e.g. one or more connection foils or connection strips. The electrical connection system 15 may be connected via the connection foils 13 to an external electrical connecting lead 8, e.g. in the form of a connecting cable.

As also shown in Fig. 1, on the rear of the layer 10, which forms an external surface of the solar module assembly, a connection device 4 with a housing 6, is fastened, e.g. by bonding with adhesive 16. The layer 10 further exhibits a through-hole, through which the connection foils 13 can be routed to the connection device 4. Electrical connection components such as contacts in the form of busbars or similar that are provided in the housing 6 serve in particular to link the connecting cable(s) 8 to one or more connection foils 13.

A connection device 4 according to the invention will be explained below in greater detail with reference to an embodiment example as shown in Figs. 2 to 4.

The connection device 4 is equipped with a housing 6, which on the one hand serves for attachment of the connection device 4 to the solar module assembly 2 and, on the other, defines a housing internal space 18 in which electrical connection components such as contacts and bypass diodes are disposed. For reasons of clarity, these connection components are not shown in Figs. 2 to 4. Introduced into the internal space 18 of the housing 6 are, on the one hand, electrical conductors for the solar module, which take the form of e.g. connection foils. These connection foils are introduced e.g. through a housing port in the housing base, and contacted with corresponding connection elements. Introduced on the other hand into the internal space 18 of the housing are electrical conductors for one or more connecting cables, such as connecting cable 8 shown in Fig. 1, which are connected to these and/or to further connection components in the internal space 18 of the housing.

The housing 6 is divided into a plurality of housing elements. Thus, the housing 6 is equipped with a lower housing region, which, in the embodiment shown, is comprised of a base element 34

and a central element 20. The base element 34 includes a base surface 36, at which the housing can be attached to a surface of a solar module assembly. For instance, the underside of the base surface 36 is permanently attached with adhesive to a rear of a solar module, as described with reference to Fig. 1. The housing base, which defines the base surface 36, serves on the side facing the internal space 18 of the housing for attachment of the connection components, which are connected to the housing base by e.g. latching or by some other mechanical means. Further provided on the housing base is a housing internal profile 40, which serves e.g. for adherence to insulating clearances from components carrying electrical current. According to a different embodiment, the internal profile 40 of the housing may, however, also assume a different form or may even be omitted. As indicated in Fig. 3, the internal profile 40 of the housing is equipped with conductor entries 41, which are indicated in Fig. 3 by way of example as V-shaped grooves or slots, and which correspond with the connection ports 30. They are not shown further in Fig. 4. The conductor entries may vary in dimensions as required.

Disposed between the base element 34 and a housing cover 42 in the embodiment shown is a central element 20, which forms a peripheral housing wall 28 between the housing cover 42 and the base element 34. The central element 20 thus forms part of the lateral peripheral external housing profile between the housing cover 42 and the base element 34, which borders or encloses the internal space 18 of the housing in its interior. In the case shown, the central element 20 forms essentially the entire lateral peripheral external profile of the housing. The frame-type central element 20 encloses on the internal side of the housing wall 28 an internal space 22, which forms part of the internal space 18 of the housing 6. In other words, the central element 20 borders at least part of the internal space 18 of the housing, or forms at least part of the boundary of the internal space 18 of the housing on its side facing the internal space 18 of the housing. In the embodiment shown, the internal space 18 of the housing 6 is formed essentially by the internal space 22 of the central element 20. Other embodiments are conceivable however, in which a further housing component, e.g. in the form of a further central element, is provided between the housing cover 42 and the central element 20 and/or between the central element 20 and the base element 34, e.g. in the event that the internal space 18 of the housing 6 is to be enlarged. In this case, the internal space 22, which is defined by the central element 20, forms only part of the internal space 18 of the housing.

It is also perfectly possible for the central element 20 to be designed in such a manner that it only partially covers the perimeter of the housing 6 and thus only partially encloses the internal space 18 of the housing. In this case, the central element 20 forms only part of the peripheral housing wall 28 between the housing cover 42 and the base element 34 with an open internal space 22. Other components of the lateral peripheral housing wall 28 may in this case be provided on the base element 34, on the housing cover 42 and/or on any other additional housing components.

Provided in the housing wall 28 of the central element 20 in the embodiment shown are two connection ports 30, which serve for the introduction of the respective electrical conductors of e.g. one or more connecting cables into the internal space 18 of the housing. The connection ports 30 are here each formed by a respective cable entry 32, which is essentially tubular in shape in this example. The cable entries 32 penetrate the housing wall 28 and are each equipped in the region of a larger diameter with a thread connection 33 for a cable union. A connecting cable may be fastened by means of a cable union to the central element 20 of the housing at each thread connection 33. In its vertical dimension, the central element 20 may exhibit a height that is slightly greater than the diameter of the cable entries 32.

The housing 6 is further equipped with a locking device, which serves to join the central element 20 to the base element 34. In the case shown, this locking device takes the form of a detachable locking device, and may, in principle, provide any type of unlockable connection. For instance, the locking device takes the form of a bayonet lock, screw-thread connection or a snap lock, latch-type lock or similar. In the embodiment shown in Figs. 2 to 4, the locking device takes the form of a bayonet lock, which comprises the locking elements 24 on the part of the central element 20, and the locking elements 26 on the part of the base element 34. The joining of the central element 20 and the base element 34 takes place in that the locking elements 24 are moved in a rotational motion over the locking elements 26 of the base element 34 so that the locking elements 24, 26 engage in one another and thereby mechanically join the central element 20 to the base element 34.

The detachable design of the locking device, e.g. in the form of the bayonet lock shown, has the advantage that the central element 20 may, at a later date, be again detached from the base element 34. The central element 20 may thus be replaced by, for instance, a different embodiment of a central element, which exhibits e.g. larger or smaller connection ports with cable entries 32. Correspondingly, the central element 20, designed with an annular housing wall 28, which central element 20 is connected at its lower end face to the base element 34 via the bayonet lock, is exchanged for a different central element. In this manner, a kit of modular structure with differently designed central elements can be provided, wherein, depending on the requirement, an appropriate central element 20 is selected in order to provide a housing 6 of a connection device that matches the particular area of application. In addition to the size of the connection ports 30, the quantity and/or positioning of the connection ports may be varied in this manner. It is therefore made possible, according to the present invention, to exchange the central element 20 for a different central element even if the base element 34 is already permanently attached with adhesive to the solar module 2 at its base surface 36. Thus, for example, further modules may be retrofitted to the solar module assembly 2 and, if required, the connection device 4 subsequently matched to these modified conditions by exchanging the central element.

On the end face remote from the base element 34, the central element 20 is connected to the housing cover 42 via a further locking device 46. In the case shown, the further locking device 46 is also designed as a detachable locking device and may comprise the aforementioned embodiments of a detachable locking device.

Disposed between the central element 20 and the base element 34 for protection against environmental influences such as water, dust or dirt is a first sealing ring 38, which may take the form of e.g. an O-ring seal. A second sealing ring, essentially of identical design and also in the form of an O-ring seal 44, is provided between the housing cover 42 and the central element 20. Also conceivable at this location are dual-component seals, which are produced in a dual-component injection moulding process. In a dual-component injection moulding process of this kind, two materials, specifically the plastic material for creation of the relevant housing portion and the sealing material for creation of the seal in question are injected in succession during the manufacturing process. The two materials, e.g. plastic for creating the housing element in question and silicone for creating the seal, form a permanent connection on cooling. Seals of this kind may be disposed, for example, on both opposing end faces of the central element 20, on the side facing the housing cover 42 and the side facing the base element 34 respectively. It is, however, possible and just as effective to provide the seal on the housing cover 42 or on the base element 34.

Owing to the design of the housing 6 with a base element 34 and a central element 20 that can be manufactured separately therefrom, it is possible to avoid the aforementioned problems in the manufacturing process when creating the plastic housing. This is enabled, in particular, by the fact that both housing components can be manufactured by dual-sided injection of plastic material into an appropriate injection mould, in particular using the simplest “open/shut” tools. The avoidance of material accumulations in the region of the cable entries 32 in the vicinity of the housing base is, in particular, enabled, since, owing to dual-sided injection, the cable entries 32 and the housing wall 28 connected thereto can be created with precision and in a material-saving manner from a plurality of opposing directions. This two-part splitting of the lower housing region renders the housing design simpler to produce, so the connection device is overall more cost-effective to manufacture.

LIST OF REFERENCE NUMERALS:

2 Solar module assembly
4 Connection device
6 Housing
8 Electrical conductor (connecting cable)
10 Second layer
12 First layer
13 Connection foil
14 Solar cell(s)
15 Electrical connection system
16 Adhesive layer
18 Housing internal space
20 Central element
22 Internal space
24, 26 Locking element
28 Housing wall
30 Connection port
32 Cable entry
33 Screw thread for cable union
34 Base element
36 Base surface
38 First sealing ring
40 Housing internal profile
41 Conductor entry
42 Housing cover
44 Second sealing ring
46 Locking device

CLAIMS

1. Connection device (4) for connecting at least one electrical conductor to an electrical solar module assembly (2), equipped with

a housing (6) for attachment to an electrical solar module assembly (2) and for connection of at least one electrical conductor (8) to the solar module assembly (2);

wherein the housing (6) is equipped with a lower housing region and a housing cover (42) and forms a housing internal space (18);

wherein the lower housing region is equipped with a base element (34) with a base surface (36) for placing onto a surface of the solar module assembly (2), and a central element (20) between the base element (34) and the housing cover (42), having at least one connection port (30) for the introduction of the electrical conductor (8) into the internal space (18) of the housing;

wherein the central element (20) encloses at least a portion of the internal space (18) of the housing;

and equipped with a locking device (24, 26) to join the central element (20) to the base element (34).

2. Connection device (4) according to claim 1, wherein the central element (20) forms at least one portion of a peripheral housing wall (28) between the housing cover (42) and the base element (34).

3. Connection device (4) according to claim 1 or 2, wherein the central element (20) assumes the shape of a frame.

4. Connection device (4) according to claim 3, wherein the central element (20) is connected at one of its end faces to the base element (34) by means of the locking device (24, 26).

5. Connection device (4) according to any of claims 1 to 4, wherein the central element (20) assumes an essentially annular shape.

6. Connection device (4) according to any of claims 1 to 5, wherein the connection port (30) is equipped with an apparatus for fastening the electrical conductor (8) to the housing (6).

7. Connection device (4) according to any of claims 1 to 6, wherein a first sealing ring (38) is disposed between the central element (20) and the base element (34) to protect the internal space (18) of the housing from environmental influences.

8. Connection device (4) according to claim 7, wherein a second sealing ring (44) is fitted between the central element (20) and the housing cover (42) to protect the internal space (18) of the housing from environmental influences, said second sealing ring (44) essentially corresponding in its geometric dimensions with the first sealing ring (38) between the central element (20) and the base element (34).

9. Connection device (4) according to claim 7 or 8, wherein the first sealing ring (38) is fitted between the central element (20) and the base element (34) and/or the second sealing ring (44) is fitted between the central element (20) and the housing cover (42) by means of a dual-component injection moulding process.

10. Connection device (4) according to any of claims 1 to 9, equipped with a further locking device (46) to join the central element (20) to the housing cover (42).

11. Connection device (4) according to any of claims 1 to 10, wherein the locking device (24, 26) between the central element (20) and the base element (34) and/or the further locking device (46) between the central element (20) and the housing cover (42) takes the form of a detachable locking device (24, 26, 46), which is detachable again following assembly of the housing elements in question.

12. Solar module assembly (2) for the photovoltaic generation of electrical energy, equipped with

a layer assembly with a planar-type first layer (12) and a planar-type second layer (10), which are disposed with a clearance between them, and with at least one solar cell (14) between the first and second layers (10, 12);

with a connection device (4) according to any of the preceding claims, wherein the base element (34) is fitted to a surface of the first or second layer (10, 12) and at least one electrical conductor (8) is introduced into the internal space (18) of the housing at the central element (20).

13. Solar module assembly (2) according to claim 12, wherein the base element (34) is permanently attached, in particular bonded, to the surface of the first or second layer (10, 12).

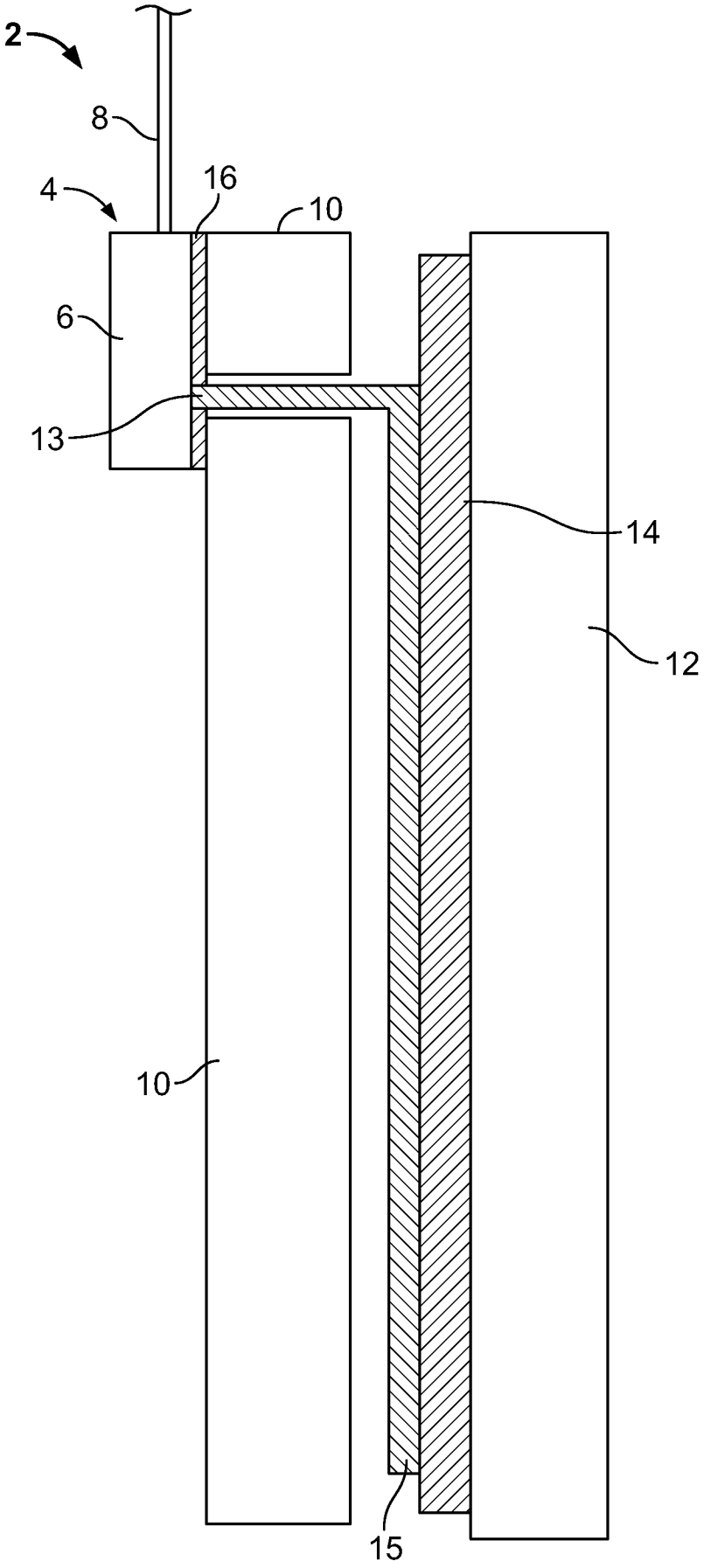

Fig. 1

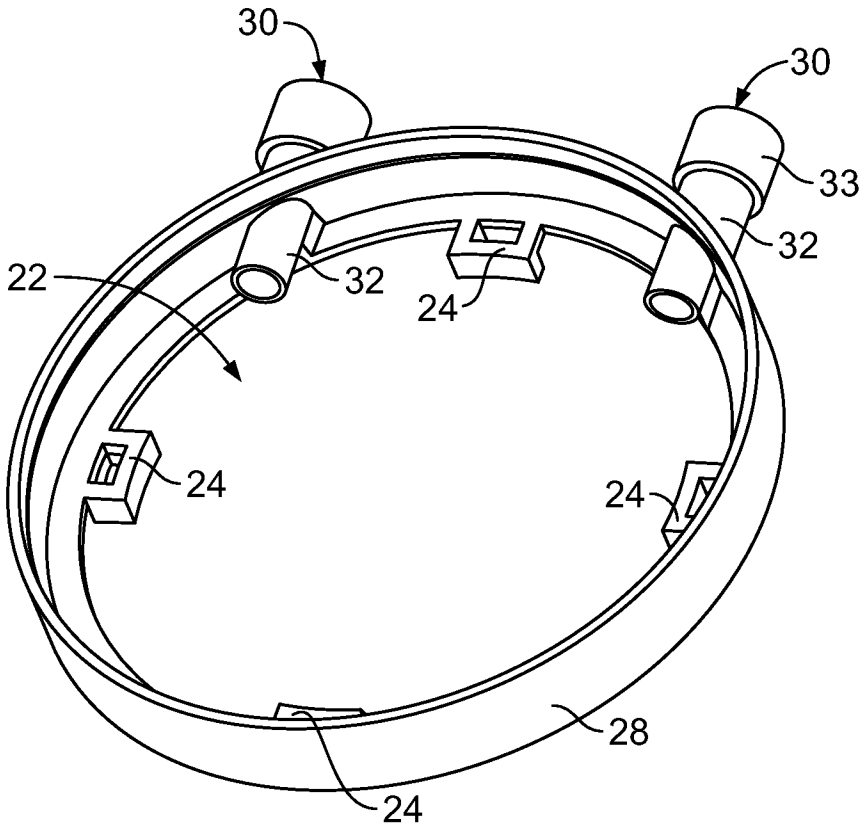

Fig. 2

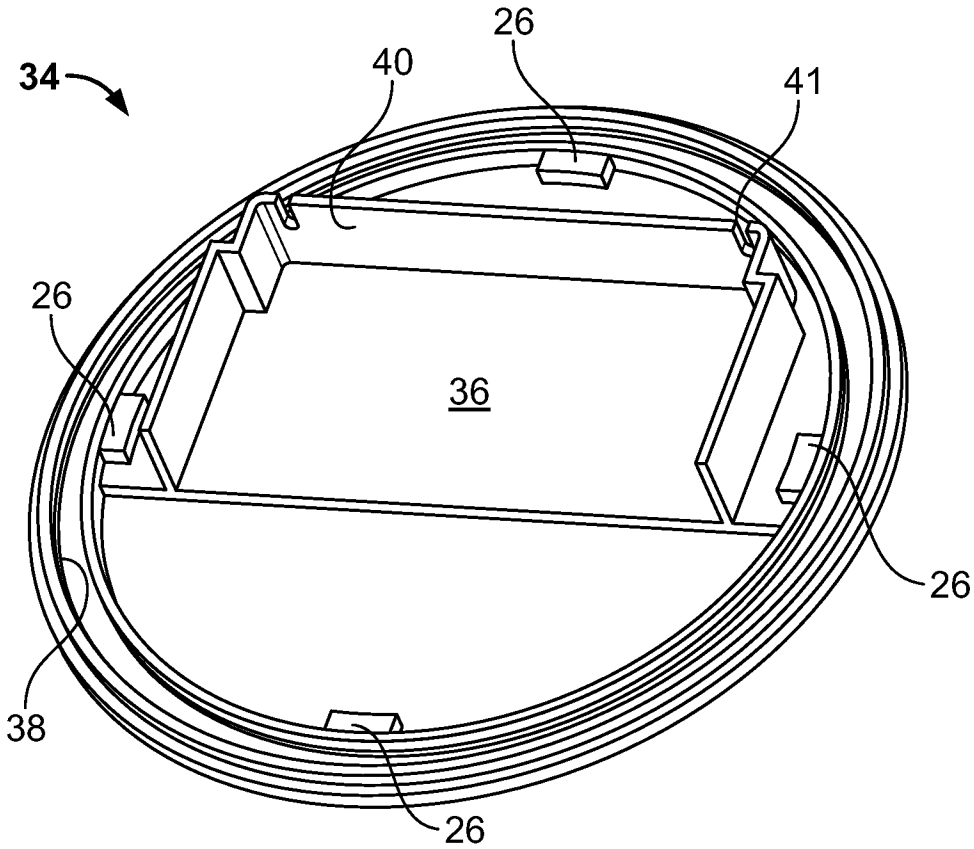

Fig. 3

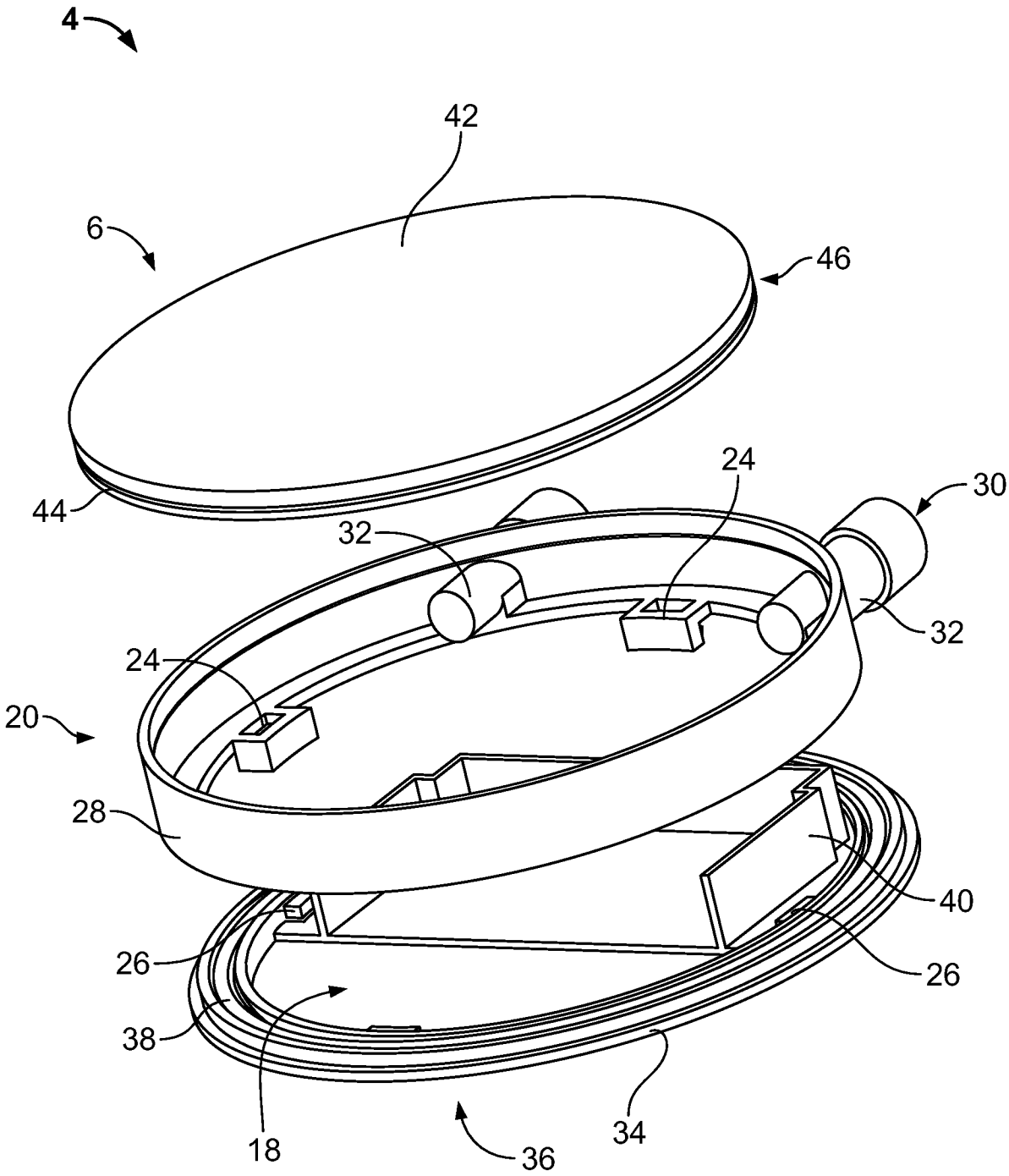

Fig. 4