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(54) **Radome and antenna system housing**

Radom und Antennensystemgehäuse

Boîtier de système d'antenne et de radôme

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(56) References cited:
JP-A- 2006 096 079
JP-A- 2012 080 511
US-A- 5 606 732
US-A1- 2005 030 250
US-A1- 2005 168 385
US-A1- 2006 227 051
US-A1- 2008 169 996
US-A1- 2011 234 473
US-B1- 6 348 894

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Description

FIELD OF THE INVENTION

[0001] The present invention relates to the technical field of radomes and antenna systems housing.

BACKGROUND OF THE INVENTION

[0002] As used herein, by "radome" is meant the box-like structure transparent to radio-frequency radiation, used to house/enclose an antenna.

[0003] A radome may be further configured to enclose an antenna system including more than one antenna element (such as, multi-band antenna systems). For instance, a same radome may be intended to enclose a plurality of ground-based antenna elements of a communication base station.

[0004] In this respect, various radome structures and antenna housing methods are known in the prior art, but they have not been entirely satisfactory and alternative solutions are required.

[0005] Such radomes are for example disclosed by documents US2008/169996 A1; US2005/030250 A1, US2005/168385 A1 and JP2012 080511 A.

SUMMARY OF THE INVENTION

[0006] This summary is not an exhaustive overview of the disclosed embodiments. It is not intended to identify critical elements or to delineate the scope of these various embodiments. Its sole purpose is to present some concepts in a simplified form as a prelude to the more detailed description that is discussed later.

[0007] Various embodiments relate to an apparatus comprising and antenna and a radome enclosing the antenna, as set out in independent claim 1. The antenna is provided with a connector, the radome comprises a side opening provided in a side wall of the radome, this side opening giving access to the connector, this connector being located inside the radome. In accordance with a broad aspect, the connector is located in front of the side opening.

[0008] In accordance with another broad aspect, the side opening is provided in the form of pre-cut shape formed in the side wall of the radome.

[0009] In accordance with another broad aspect, the above radome further comprises a cover for covering the side opening.

[0010] In accordance with another broad aspect, the electrical property of the cover is sensibly the same as that of the radome.

[0011] In accordance with another broad aspect, the cover includes a pre-cut hole intended for leading a cable to be connected to the connector.

[0012] While the various embodiments are susceptible to various modification and alternative forms, specific embodiments thereof have been shown by way of example in the drawings. It should be understood, however, that the description herein of specific embodiments is not intended to limit the various embodiments to the particular forms disclosed.

[0013] It may of course be appreciated that in the development of any such actual embodiments, implementation-specific decisions should be made to achieve the developer's specific goal, such as compliance with system-related and business-related constraints. It will be appreciated that such a development effort might be time consuming but may nevertheless be a routine understanding for those or ordinary skill in the art having the benefit of this disclosure.

DESCRIPTION OF THE DRAWING

[0014] The objects, advantages and other features of various embodiments will become more apparent from the following disclosure and claims. The following non-restrictive description of preferred embodiments is given for the purpose of exemplification only with reference to the accompanying drawing in which

- FiG.1 and FiG.2 are two schematic diagrams illustrating two side view of a radome according to one embodiment;
- FiG.3 is a schematic diagram illustrating an installed radome according to one embodiment;
- FiG.4 is schematic diagram illustrating the packaging of a radome according to one embodiment.

DETAILED DESCRIPTION OF ILLUSTRATIVE EMBODIMENTS

[0015] With reference to figure 1 and 2, there is shown a radome **1** including a side opening **2** located in the side wall of the radome **1** (i.e. in a lateral wall of the radome **1**).

[0016] The radome **1** may be of any structure suitable for housing/enclosing an antenna system. For instance, the radome **1** may have a rounded rectangular cross section, a circular/semicircular cross section, an ovoid/semi-avoid cross section, or any combination of them.

[0017] The side opening **2** serves as an aperture to permit a cable to be connected to an antenna connector **3** located inside the radome **1.** Thus, the side opening **2** may be of any suitable shape (for instance, rectangular, circular, elliptical) and size suitable for passing at least a cable (e.g. a coaxial cable) therethrough.

[0018] The side opening **2** may be formed in the radome **1** afterwards by appropriate and well-known machining methods. Alternatively, the side opening **2** may be planned during the radome production.

[0019] In one embodiment, the side openings **2** are provided in the form of pre-cut shape (i.e. a perforate outline of the side opening **2**) formed in the side wall of the radome **1.**

[0020] The side opening **2** gives access to antenna connectors **3** located inside the radome **1.** In other words,

this side opening **2** is intended for passing therethrough a cable to be connected to at least an antenna connector **3** located inside the radome.

[0021] It results in that the antenna connectors **3** are placed/located in counter-relief and not in projection (overhanging) with respect to the side wall of the radome. In other words, the antennas connectors **3** are inside the global shape of the radome **1** and neither the side opening **2** nor the antenna connectors **3** does extend beyond the outer surface of the radome **1** (i.e. nothing does exceed the global dimensions of the radome **1**).

[0022] The side opening **2** may be at different high of the lateral wall of the radome **1.** Preferably, this side opening **2** is located in the side wall of the radome **1** so that it is close to at least an enclosed antenna element in order to give access to the connector **3** of this enclosed antenna element.

[0023] In one embodiment, a subset of connectors **3** of enclosed antenna elements is mounted on a connector support **4.** The connector support **4** is set facing to (i.e. in front of) the side opening **2** so that this side opening gives access to connectors mounted on this connector support **4.** In combination, another subset of connectors is placed at the bottom of the radome.

[0024] Accordingly, at least a subset of connectors **3** of the enclosed antenna system are placed inside the structure of the radome **1,** offsetted from the radome bottom (i.e. shifted by an offset from the bottom of the radome), and accessible through a side opening **2** formed in the side wall of the radome **1.**

[0025] In order to not alter the electrical property of the radome, the side opening **2** is formed in the side wall opposite to the enclosed antennas orientation (namely, behind the antenna system).

[0026] In one embodiment shown in figure 1, the connector support **4** is fixed to the antenna system **5.** At least a connector (such as, type "N" connectors, "7/16" connectors) is mounted on the connector support **4.**

[0027] The connector support **4** is a plate arranged so that facilitating the accessibility and connectivity of connectors **3** mounted thereon from the side opening **2.** In other words, the connector support **4** is configured so that when the connectors **3** are mounted thereon, the side opening **2** gives directly onto these connectors. It results in that the mounted connectors **3** are easily reachable from the side opening **2.**

[0028] In one embodiment, the connector support **4** comprises a part arranged in a sensibly stair-step shape. Each step in this stair-step shape may receive at least a connector. For instance, the connector support **4** comprises a folded aluminum plate, or any other soldered/folded metal plate in a sensibly stair-step shape. The connector support **4** is fixed inside the radome so that the stair-step shape is oblique (i.e. slantwise) with respect to the plane of the side opening **2** (see figure 2).

[0029] In an alternative embodiment, the connector support **4** is fixed to the inner surface of the radome **1.**

[0030] With reference now to figure 3, a cover **32** for the side opening with convenient mounting means (for instance, with a sealing assembly) is provided so as to protect the connectors.

[0031] A cover **32** (i.e. a protection, a covering shell) is placed on top for covering the side opening. This cover hides connectors from potential damage.

[0032] Preferably, the cover **32** is of the same material as that of the radome **31** (i.e. having the same or similar electrical property). More generally, the electrical property of the cover **32** is sensibly the same as that of the radome **31.**

[0033] Further, pre-cut holes **33** are provided in the cover **32.** These pre-cut holes **33** are intended to be, if needed, removed and leading cables **34** to the connectors located in front of the side opening. In one embodiment, the pre-cut holes **33** are of O-shaped. Alternatively, these pre-cut holes **33** are U-shaped, or semi-circular shaped and performed on the outline of the cover **32.**

[0034] In one embodiment, more than one dedicated side opening are formed in the side wall of the radome (for instance, side openings **2** and **11** in figure 1).

[0035] According to one advantage of the above-described embodiments, the radome reduces input cable **6** lengths of the antenna system **5** (see figure 1). In fact, the side opening and the antenna element(s) that its/their connector(s) is/are to be received in the side opening may be located close to each other. It results in that the length of the attachment means **6** of the connector to the antenna element is reduced. Advantageously, no bending and/or extra length of the attachment means imply

- less loss for the antenna element, and consequently better gain and higher performance for the antenna system; and
- a cost reduction of the attachment means (i.e. shorter internal input cables).

[0036] According to another advantage of the above-described embodiments, the housing/enclosing operation (also said, radoming operation) is no more complicated than housing a standard antenna. In fact, both the assembling process and the obtained assembly (i.e. radome plus antenna systems) providing a plurality of connectors are simplified.

[0037] According to another advantage of the above-described embodiments, the side opening does not substantially change the electrical property of the radome as it is located behind the antennas (i.e. outside radiation directions of the antenna).

[0038] According to another advantage of the above-described embodiments, the radome allows an easy management and implementation of a plurality of connectors.

[0039] According to another advantage of the above-described embodiments, the arrangement of the connector support (stair-step shape fixed obliquely with respect to the side opening plane) inside the radome provides enough clearance allowing easy cable installation,

easy/accessible connectivity, and easy sealing (see figures 1 and 2).

[0040] According to another advantage of the above-described embodiments, the radome including a plurality of side openings in pre-cut shape (perforated lines defining the side openings) permits to purchase an antenna system with more connectors than required at the beginning, and then remove the pre-cut shape/profile of a side opening so as to upgrade the antenna system. For instance, one can first use an antenna as a triple band, and then be able to upgrade this antenna to a hexa-band antenna by just removing the pre-cut side opening and connect the additional connectors located in front of this side opening. Advantageously, this allows anticipating the evolution of the network coverage easily and with few financial impacts.

[0041] According to another advantage of the above-described embodiments, provided pre-cut holes in the cover permit to easily add and lead cables intended to be connected to connectors mounted in front of the side opening (see figure 3).

[0042] According to another advantage of the above-described embodiments, the radome may be used for enclosing different antenna systems (i.e. such as "tri-band", "quad-band", "penta-band" or "hexa-band" antennas), regardless of the number of connectors. Advantageously, this represents a very important cost and development time reduction.

[0043] According to another advantage of the above-described embodiments, there is no connector or covering blister which extend beyond the outer shape of the radome. It results in that, advantageously, the protection of connectors during assembly, transportation, installation and antenna lifetime is increased. Therefore, there is no need for extra protection for added connectors.

[0044] According to another advantage of the above-described embodiments, the packaging of the radome is simplified (see figure 4) as there is no connector or covering blister which extend beyond the outer shape of the radome.

[0045] According to another advantage of the above-described embodiments, the external shape of the radome is unchanged, while supporting a plurality of antenna connectors. It results in that, advantageously, no wind loading is induced.

[0046] According to another advantage of the above-described embodiments, the number of the enclosed antenna may be increased without increasing the wind loading of the radome. Therefore, no additional stiffening of the masts to prevent differential movement of the antenna is needed.

[0047] According to another advantage of the above-described embodiments, the arrangement of connectors inside the radome allows the radome to support the environment wind loads.

[0048] According to another advantage of the above-described embodiments, there are no external parts as blister in the radome. The described solution has less impact on wind loads. Simple simulations of wind loading shows that an extra blister adds about 10% more wind loading for side wind orientation compared to an antenna with no added feature (i.e. when no need for extra connectors).

[0049] According to another advantage of the above-described embodiments, the covering shell placed at the end of the installation (after cable to connecter attachment and sealing) has insignificant impact on wind load.

[0050] According to another advantage of the above-described embodiments, the radome withstands wind pressures, rain, snow and ice, as there is no overhanging part in the radome (the connectors being inside the radome). It results in that advantageously, the radome supports a plurality of antennas while best satisfying environmental requirements.

[0051] According to another advantage of the above-described embodiments, there is available place remaining at the back of the antenna system to install peripheral devices as Remote Radio Head (RRH). The integration of RRH on the back of the antenna system is then facilitated. Advantageously, there are no bending radius constraints or extra blister so that it is possible to directly connect cables to the RRH. Further, cables can easily goes along the radome and be plug to the RRH.

[0052] According to another advantage of the above-described embodiments, the structural design of the radome satisfy load requirements, and avoid differential movements of the antenna due to the wind which may cause significant shift of equi-signal paths, or even worse the collapse of the radome itself.

[0053] According to another advantage of the above-described embodiments, the radome is a low wind-loading radome while being able to enclose a plurality of antennas. Accordingly, the radome may be used in areas where wind with high velocities is likely to be encountered.

[0054] According to another advantage of the above-described embodiments, the radome meets the development of multiband antennas where a plurality of sub-antennas operating in different frequency bands has to cohabit together in a common box kit. In fact, the radome provides enough space, in addition to the available space at the bottom of the radome, for placing a plurality of connectors with the required clearance around the connectors. Advantageously, this allows quick cable to connector attachment and detachment, properly tightening of cables to connects, and easy physical access to connectors.

[0055] According to another advantage of the above-described embodiments, the radome may enclose an antennas structure involving a plurality of connectors. For instance, an "antenna" structure may include 12 antenna arrays (6 ports +45° and 6 ports -45°) within different frequency bands. All these arrays require at least dedicated connector (some arrays are even eventually connected to duplexers or triplexers which can multiply again the number of connections).

Claims

1. Apparatus comprising:

   an antenna comprising a connector (3),
   a radome (1) enclosing the antenna, and comprising a side opening (2) provided in a side wall of the radome (1), said side opening (2) serving as an aperture to permit a cable to be connected to said connector (3),
   said connector (3) being located inside the radome (1),
   characterized in that the antenna further comprises a connector support (4) on which said connector (3) is mounted, said connector support (4) comprising a part arranged in a substantially stair-step shape, a step of this stair-step shape being configured to receive at least said connector (3), wherein said part arranged in a substantially stair-step shape is fixed inside the radome obliquely with respect to the plane of the side opening (2).

2. Apparatus according to claim 1, wherein the connector is located in front of the side opening (2).

3. Apparatus according to anyone of claims 1 or 2, wherein the side opening (2) is provided in the form of pre-cut shape formed in the side wall of the radome (1).

4. Apparatus according to anyone of the preceding claims, further comprising a cover (32) for covering the side opening.

5. Apparatus according to claim 4, wherein the electrical property of the cover (32) is sensibly the same as that of the radome (31).

6. Apparatus according to claims 4 or 5, wherein the cover (32) includes a pre-cut hole (33) intended for leading a cable (34) to be connected to the connector.

7. The rapparatus of any of claims 1 t0 6, further comprising a remote radio head.

Patentansprüche

1. Vorrichtung, Folgendes umfassend:

   eine Antenne, die einen Steckverbinder (3) umfasst,
   ein Radom (1), das die Antenne umschließt und eine Seitenöffnung (2) umfasst, die in einer Seitenwand des Radoms (1) vorgesehen ist, wobei die Öffnung (2) als Durchlass dient, um ein mit dem Steckverbinder (3) zu verbindendes Kabel hindurchzuführen, wobei sich der Steckverbinder (3) innerhalb des Radoms (1) befindet,
   dadurch gekennzeichnet, dass die Antenne ferner eine Steckverbinderhalterung (4) umfasst, auf der der Steckverbinder (3) montiert ist, wobei die Steckverbinderhalterung (4) ein Teil umfasst, das im Wesentlichen treppenstufenförmig angeordnet ist, wobei eine Stufe dieser Treppenstufenform dazu ausgelegt ist, zumindest den Steckverbinder (3) aufzunehmen, wobei das im Wesentlichen treppenstufenförmige Teil in Bezug zur Ebene der Seitenöffnung (2) innerhalb des Radoms schräg angeordnet ist.

2. Vorrichtung nach Anspruch 1, wobei sich der Steckverbinder vor der Seitenöffnung (2) befindet.

3. Vorrichtung nach einem der Ansprüche 1 oder 2, wobei die Seitenöffnung (2) in Form einer in der Seitenwand des Radoms (1) vorgestanzten Form vorgesehen ist.

4. Vorrichtung nach einem der vorstehenden Ansprüche, ferner eine Abdeckung (32) umfassend, um die Seitenöffnung abzudecken.

5. Vorrichtung nach Anspruch 4, wobei die elektrischen Eigenschaften der Abdeckung (32) sinnvollerweise die gleichen sind wie die des Radoms (31).

6. Vorrichtung nach Anspruch 4 oder 5, wobei die Abdeckung (32) ein vorausgestanztes Loch (33) enthält, das dazu bestimmt ist, ein mit dem Steckverbinder zu verbindendes Kabel (34) dort hindurchzuführen.

7. Vorrichtung nach einem der Ansprüche 1 bis 6, ferner einen entfernten Funkkopf umfassend.

Revendications

1. Appareil comprenant :

   une antenne comprenant un connecteur (3),
   un radôme (1) entourant l'antenne, et comprenant une ouverture latérale (2) prévue dans une paroi latérale du radôme (1), ladite ouverture latérale (2) servant d'ouverture pour permettre la connexion d'un câble audit connecteur (3), ledit connecteur (3) étant situé dans le radôme (1),
   caractérisé en ce que l'antenne comprend en outre un support de connecteur (4) sur lequel ledit connecteur (3) est monté, ledit support de connecteur (4) comprenant une partie agencée dans une forme sensiblement en escalier, une marche de cette forme en escalier étant confi-

gurée pour recevoir au moins ledit connecteur (3), ladite partie agencée dans une forme sensiblement en escalier étant fixée dans le radôme en biais par rapport au plan de l'ouverture latérale (2).

2. Appareil selon la revendication 1, dans lequel le connecteur est situé devant l'ouverture latérale (2).

3. Appareil selon l'une quelconque des revendications 1 et 2, dans lequel l'ouverture latérale (2) est prévue sous la forme d'une forme prédécoupée formée dans la paroi latérale du radôme (1).

4. Appareil selon l'une quelconque des revendications précédentes, comprenant en outre un couvercle (32) pour couvrir l'ouverture latérale.

5. Appareil selon la revendication 4, dans lequel la propriété électrique du couvercle (32) est sensiblement la même que celle du radôme (31).

6. Appareil selon la revendication 4 ou 5, dans lequel le couvercle (32) comporte un trou prédécoupé (33) destiné à guider un câble (34) à connecter au connecteur.

7. Appareil selon l'une quelconque des revendications 1 à 6, comprenant en outre une tête radio distante.

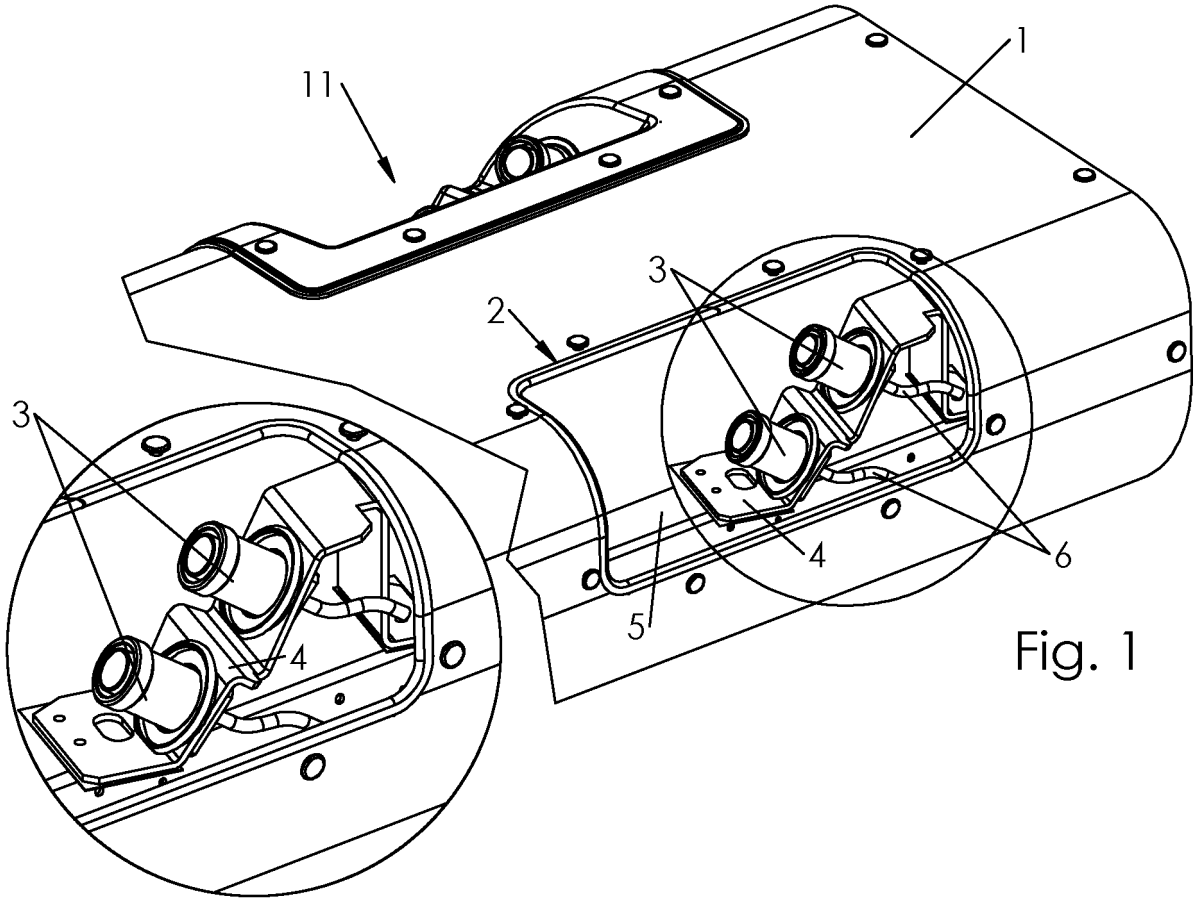


Fig. 1

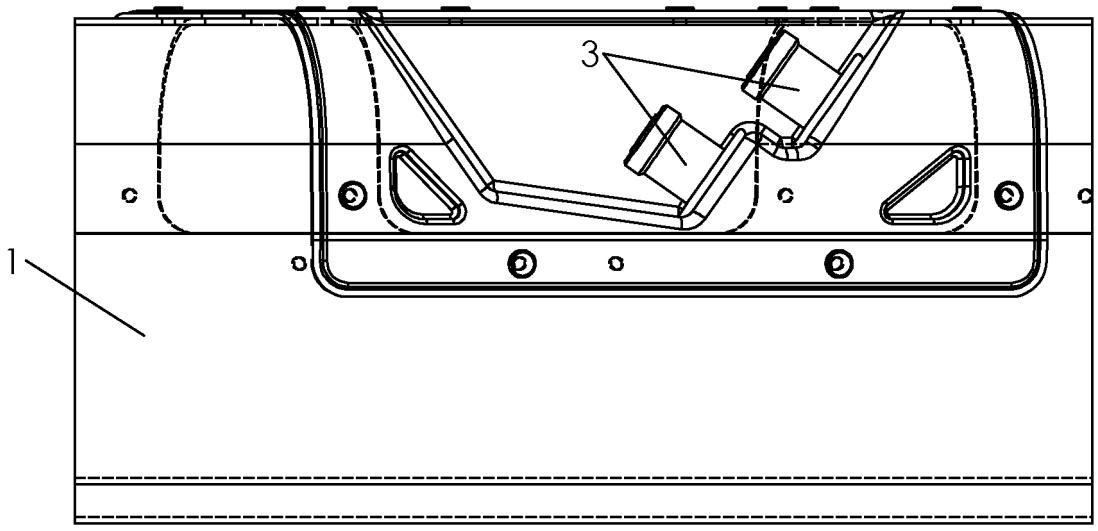


Fig. 2

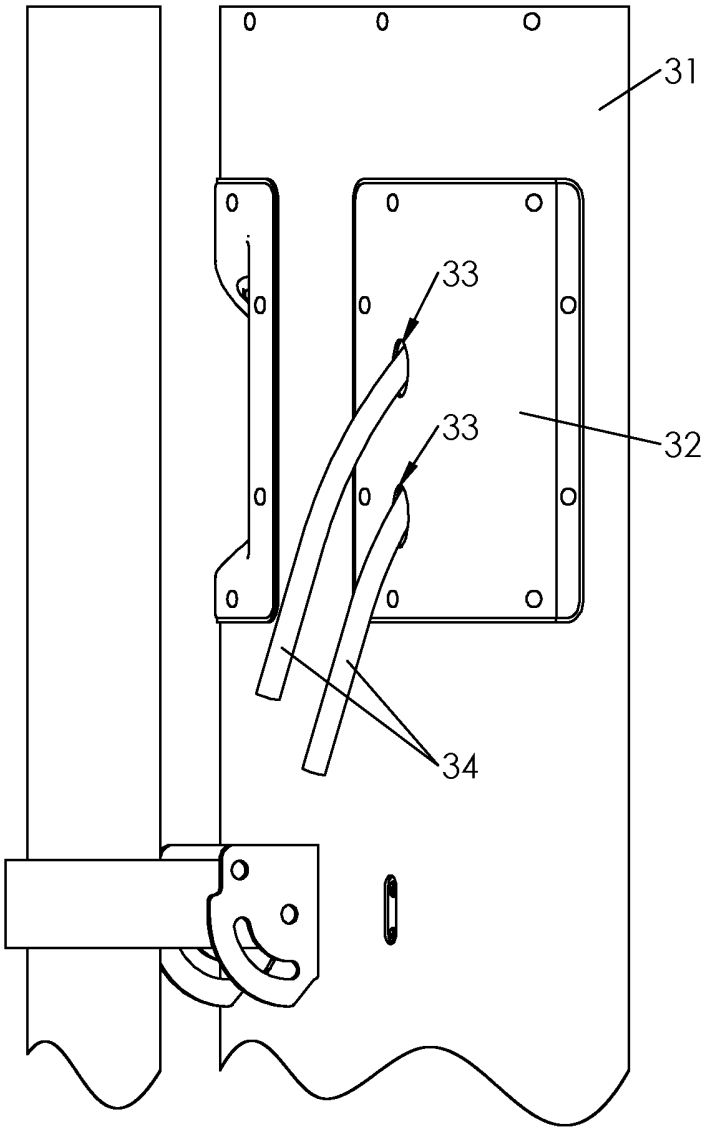


Fig. 3

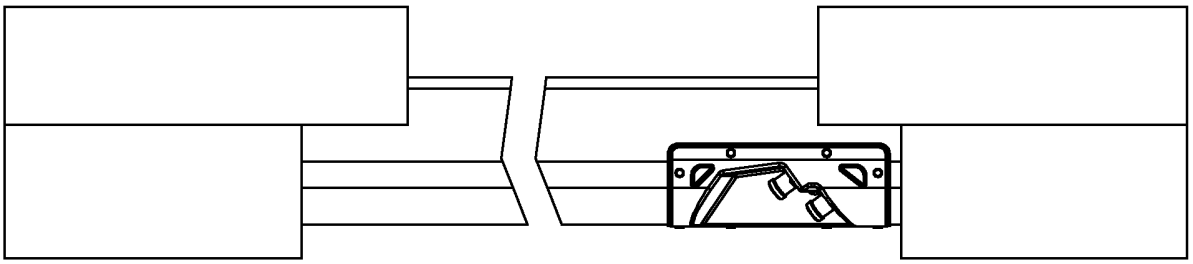


Fig. 4

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 2008169996 A1 **[0005]**
- US 2005030250 A1 **[0005]**
- US 2005168385 A1 **[0005]**
- JP 2012080511 A **[0005]**