(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 4 387 002 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
19.06.2024 Bulletin 2024/25

(21) Application number: **22214025.3**

(22) Date of filing: **15.12.2022**

(51) International Patent Classification (IPC):
H01R 13/52 *(2006.01)* ***H01R 13/6599*** *(2011.01)*
H01R 9/05 *(2006.01)* *H01R 13/6582* *(2011.01)*

(52) Cooperative Patent Classification (CPC):
H01R 13/6599; H01R 9/0527; H01R 13/5208; H01R 13/5216; H01R 13/5205; H01R 13/6582; H01R 2201/26

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA
Designated Validation States:
KH MA MD TN

(71) Applicant: **Aptiv Technologies Limited**
St. Michael (BB)

(72) Inventors:
- **FABRE, Jean**
  28000 CHARTRES (FR)
- **LEVEQUE, Jérémy**
  28000 Chartres (FR)

(74) Representative: **INNOV-GROUP**
310, avenue Berthelot
69372 Lyon Cedex 08 (FR)

(54) POWER CONNECTOR WITH A CONDUCTIVE SEAL

(57) An electrical power connector (1), comprising
- a housing (2) having cavities (12) in which are accommodated power terminals (6) electrically connected to respective shielded cables (13), each having an individual shielding layer (15),
- an shielding element (4) being mounted outside said cavities (12).

The power connector (1) further comprises an elastomeric conductive seal (11) mounted on an outer surface of the housing (2), inserted between the housing (2) and the outer shielding element (4), this elastomeric conductive seal (11) having connection means (23) passing through passages (17) made in the housing (2) so as to electrically connect the shielding layers (15) to the outer shielding element (4).

Method for assembling such a power connector;

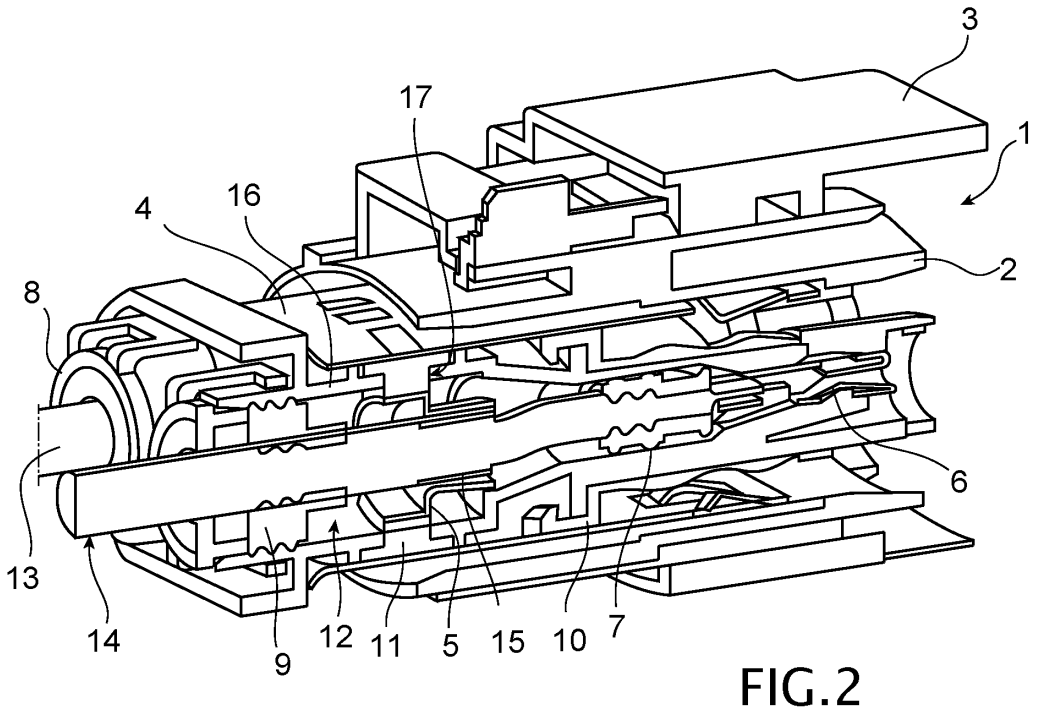

FIG.2

EP 4 387 002 A1

Description

Technical Field

[0001] The disclosure below relates to the field of power connectors. More particularly, this disclosure relates to power connectors equipped with electromagnetic shielding. Such power connectors can be used in motor vehicles.

Prior Art

[0002] Indeed, for example, in the field of motor vehicles and in particular electric, hybrid or plug-in hybrid vehicles, high currents can be transmitted in wiring networks and/or electrical power circuits, such as those interconnecting elements such as a battery, a motor, a voltage converter, etc. Due to the electrical power involved in these applications, the shielding of cables and connectors is of paramount importance. It is therefore important to ensure the continuity of the shielding in the cable harnesses involved in these applications and in particular at the level of the connectors included in these harnesses.

[0003] Typically, there are two types of shielded connectors for power applications: the connectors comprising a global shielding and the connectors in which the shielding is provided by a shielding continuity through individual shielded wires.

[0004] Further, these types of connectors are usually sealed against ingress of water. Then, depending on the shielding technology (global or through individual shielded wires), the shielding elements are placed inside or outside the sealed area.

[0005] For example, the patent document EP3155692A1 discloses a connector with shielding elements inside the sealed area and the patent document FR3032835A1 discloses a connector with shielding elements outside the sealed area.

[0006] The respective architectures of these two types of connectors are very different from each other. As a consequence, the counter-connectors designed to connect respectively each one of these types of connectors are also different. This multiplies the number of parts to be manufactured, stored, supply, etc., which has disadvantages in terms of economics, logistics, etc.

[0007] The present disclosure is intended to provide a solution that at least partially reduces these drawbacks.

Summary of the invention

[0008] For this purpose, it is proposed a power connector according to claim 1. Thanks to this power connector, the shielding layer of individual shielded wires are connected, via the elastomeric conductive seal to the outer shielding elements. Thus, this connector can be used for both shielding technologies: global or through individual shielded wires. The connector interface remains compatible with a single reference of counter-connector. It is not necessary to manufacture two counter-connectors for use in each of these two shielding technologies.

[0009] Advantageously, this electrical connector possibly comprises one or more of the features mentioned in claims 2 to 6, each one of these features being considered independently of each other or in combination of one or several others.

[0010] It is also disclosed below a method for assembling an electrical power connector. Advantageously, this method possibly comprises one or more of the features mentioned in claims 8 to 10, each one of these features being considered independently of each other or in combination of one or several others.

Brief description of the drawings

[0011] Other features, purposes and advantages of the disclosure will become apparent on reading the following detailed description given with reference to the appended drawings and by way of non-limiting examples and in which:

Figure 1 is a schematic representation in perspective of an example embodiment of power connector (from which the seal retainers have been removed);
Figure 2 is a schematic perspective cross-section of the power connector shown in Figure 1;
Figure 3 is a schematic perspective cross-section of a portion of the power connector shown in Figure 2;
Figure 4 is a schematic representation in perspective of a first embodiment example of elastomeric conductive seal;
Figure 5 is a schematic elevation front view of a second embodiment example of elastomeric conductive seal;
Figure 6 is a schematic representation in perspective of the second embodiment example of elastomeric conductive seal mounted in an outer shielding element.

Detailed description

[0012] An example of an embodiment of a power connector 1 is shown in Figures 1 to 3. In this example, the power connector 1 is a 2-way female connector, but this disclosure can be transposed to other types of connectors.

[0013] In this description, adjectives such as "rear", "front", etc. refer to the mating direction of the connector 1, the front side corresponding to the mating interface of the connector 1 with a counter-connector.

[0014] The connector 1 is a cable connector. It comprises in particular a housing 2, a mate assist system 3, an outer shielding element 4 (which can be formed by one or several parts), two ferules 5, two female terminals 6, two front single-wire seals 7, two seal retainers 8, two rear single-wire seals 9, a global seal 10 and an elasto-

meric conductive seal 11.

[0015] The housing 2, the mate assist system 3 and the seal retainers 9 are made of a dielectric material (for example they are made by molding). The outer shielding element 4 and the ferules 5 are made of a conductive material (for example the ferules 5 are made by deep-drawing of a sheet metal). The female terminals 6 are made for example of copper or a copper alloy (although, other conductive metals can be used, such as aluminum for example). The front single-wire seals 7, the rear single-wire seals 9 and the global seal 10 are made of elastomeric material. The elastomeric conductive seal 11 is made of elastomeric material with conductive fillers (For example, the elastomeric material is a silicone or fluorosilicone, and the fillers may comprise carbon, graphite, silver and/or copper particles). For example, the elastomeric conductive seal 11 is made of a graphite mixed dry silicone. Such an elastomeric conductive seal 11 has properties which are suitable for sealing the connector 1, as well as a suitable electrical conductivity. For example, the elastomeric material with conductive fillers is chosen to achieve a resistance of less than 100mOhms, and more advantageously less than 50mOhms (for example, about 30mOhms). It has been confirmed that such a material does not reduce the performances of the shielding properties (attenuation) of the overall connector 1.

[0016] The housing 2 comprises two cavities 12, each one accommodating one female terminal 6. Each female terminal 6 is mechanically attached and electrically linked to a shielded cable 13. Each shielded cable 13 comprises, from the outside in, an outer insulating sheath 14, a shielding layer 15 (for example a shielding braid), an inner insulating sheath and a core wire (not shown). A ferule 5 is mounted on a stripped area of each shielded cable 13, on which a portion of the outer insulating sheath 14 is removed to expose the shielding layer 15. A rear single wire seal 9 is mounted on each shielded cable 13, on a rear portion of this stripped area. Each rear single-wire seal 9 seals a cavity 12 between an inner surface of the housing 2 and the outer insulating sheath 14 of a shielded cable 13. A front single wire seal 7 is mounted on each shielded cable 13, between the stripped area and a female terminal 6. For example, each front single wire seal 7 is maintained on a shielded cable by a crimping portion of a female terminal 6. Each front single-wire seal 7 seals a cavity 12 between an inner surface of the housing 2 and the inner insulating sheath of a shielded cable 13. Accordingly, each cavity 12, as in prior art configurations, is sealed at the front and at the rear, respectively by a front single-wire seal 7 and a rear single-wire seal 9. Indeed, in prior configurations, each cavity 12 is only open at its rear and front ends. But, further in this embodiment example, each cavity 12 has a peripheral wall 16 comprising passages 17. In other words, passages 17 are made in the housing 2, between the outer surface and the inner surface of the peripheral wall 16 of each cavity 12. Then, an elastomeric conductive seal 11 is required to complete the sealing of the cavity 12 at the passages 17. Further, the elastomeric conductive seal 11 provides an electrical continuity between the outer shielding element 4 and the ferules 5.

[0017] Indeed, the outer shielding element 4 is placed outside each cavity 12, on an outer surface of the housing 2 and each ferule 5 is placed inside each cavity 12. More precisely, each ferule 5 has a fixation portion 18 and funnel portion 19 (see Figure 3). The funnel portion 19 serves to guide a free end of the shielded cable 13 towards and in the fixation portion 18. The funnel portion 19 also provides a smoother and larger electrical contact area that the fixation portion 18. This improves the electrical contact between the elastomeric conductive seal 11 and the ferule 5. The fixation portion 18 is tightly held on the stripped portion of the shielded cable 13 so as to establish an electrical contact and connection between the shielding layer 15 of the shielded cable 13. The elastomeric conductive seal 11 is in electrical contact both with the with outer shielding element 4 and the funnel portion 19, which is itself electrically connected to the fixation portion 18. Therefore, an electrical continuity is established between the outer shielding element 4 and the shielding layer 15 of the shielded cable 13 through the passages 17 via the elastomeric conductive seal 11.

[0018] According to the embodiment example shown in Figure 4, the elastomeric conductive seal 11 has an essentially oval shape. This essentially oval shape forms a closed loop or ring. This ring has an outer circumferential surface 20 and an inner surface 21. The outer circumferential surface 20 faces radially outward (of the ring shape) and is smooth. The inner surface 21 is essentially opposite the outer circumferential surface 20, faces radially inward and includes two crenelated sections 22 on which contacting projections 23 extend radially inward from the inner surface 21. For example, the contacting projections 23 form a single piece with the ring. For example, each crenelated section 22 comprises five contacting projections 23. The elastomeric conductive seal 11 is placed on the outer surface of the housing 2, with one contacting projection 23 in each passage 17. The elastomeric conductive seal 11 is shared by the two cavities 12 of the connector 1, but the elastomeric conductive seal 11 comprises one crenelated section 22 for each cavity 12. The elastomeric conductive seal 11 is essentially inserted between the outer surface of the housing 2 and the outer shielding element 4, even though each contacting projection 23 penetrates, through a passage 17, in a cavity 12 to make an electrical contact with the corresponding ferule 5. In other words, the elastomeric conductive seal 11 has connection means (i. e. contacting projection 23) passing through at least one passage 17, and such connection means electrically connects the shielding layer 15 to at least one outer shielding element 4.

[0019] According to another embodiment example shown in Figure 5, the elastomeric conductive seal 11 is manufactured as an open strip. This open strip can be bent so as to form a ring (see Figure 6). Then, the elas-

tomeric conductive seal 11 has four contacting projections 23, as well as fixation projections 26, 27. The fixation projections 26, 27 are intended to be inserted in opposite openings or notches made in the housing 2. More particularly, the elastomeric conductive seal 11 has two end fixation projections 26 each respectively located at a free end of the open strip and one central fixation projection 27 located essentially in the middle of the open strip. When inserted in an opening or a notch, the two end fixation projections 26 (which are each respectively equivalent to half of the central fixation projection 27) maintain the strip as a ring.

[0020] Each contacting projection 23 penetrates through a passage 17 to establish an electrical contact with a ferule 5. In the ring formed by the elastomeric conductive seal 11, the contacting projections 23 are symmetrically arranged with regard to a plane P (horizontal in Figure 6) passing through the longitudinal axis of the two ferules 5. They are also symmetrically arranged with regard to a plane P' (vertical in Figure 6) passing through the end fixation projections 26, 27.

[0021] The elastomeric conductive seal 11 shown in Figure 5 and 6 is easier to manufacture and to assemble on the housing 2, than the one shown in figure 4. The elastomeric conductive seal 11 shown in Figure 5 and 6 is essentially inserted between the outer surface of the housing 2 and the outer shielding element 4 as described for the previous embodiment (the one shown in Figure 4).

[0022] For assembling the electrical power connector 1, the following steps, for example, are implemented.

- preparing the shielded cables 13 : removing the outer insulating sheath 14 over a portion of the free end of the shielded cables 13 (and shielding layer 15 and the inner insulating sheath over other portions of the free end of the shielded cables 13, threading the seal retainers 10, the rear single-wire seals 9, the ferules 5 (the ferules 5 being positioned in electrical contact with the shielding layer 15) and the front single-wire seals 7 on the free end of the shielded cables 13, crimping the female terminals 6 on the free end of the shielded cables 13 (with a crimping portion crimped over a portion of the respective front single-wire seals 7 and another crimping portion over a portion of the core wire),
- mounting the elastomeric conductive seal 11 on the outer surface of the housing 2,
- mounting the outer shielding element 4 on the housing 2,
- inserting each free ends of the shielded cables 13 previously prepared in its respective cavity 12,
- attaching the seal retainers to the housing 2.

[0023] The order of these steps can be possibly changed by the skilled person.

Claims

1. An electrical power connector (1), comprising

   - a housing (2) made of a dielectric material, the housing (2) having at least one cavity (12), said at least one cavity (12) being configured for accommodating a power terminal (6), said power terminal (6) being electrically connected to a respective shielded cable (13) having an individual shielding layer (15),
   - at least one outer shielding element (4) being mounted outside said at least one cavity (12) and configured to be electrically connected to a respective shield of a counterpart connector when said power connector (1) is mated to said counterpart connector, **characterized in that** it comprises at least one elastomeric conductive seal (11) mounted on an outer surface of the housing (2), this outer surface being opposite to an inner surface of said at least one cavity (12), at least one passage (17) made in the housing (2), between said outer surface and said inner surface, said at least one elastomeric conductive seal (11) being inserted between the housing (2) and said at least one outer shielding element (4), said at least one elastomeric conductive seal (11) having connection means (23) passing through at least one passage (17), and said connection means (23) electrically connecting the shielding layer (15) to said at least one outer shielding element (4).

2. The electrical power connector (1) according to claim 1, comprising at least one ferrule (5) in electrical contact with the shielding layer (15) of a respective shielded cable (13), said at least one elastomeric conductive seal (11) being electrically connected to the shielding layer (15) via said ferrule (5).

3. The electrical power connector (1) according to claim 1 or 2, wherein said at least one elastomeric conductive seal (11) has a shape forming a closed ring, said at least one elastomeric conductive seal (11) having an outer circumferential surface (20) providing a sealing barrier to said at least one outer shielding element (4), and said connection means (23) of the conductive seal being formed as contacting projections extending radially from an inner surface (21) of said at least one elastomeric conductive seal (11) into said at least one cavity (12).

4. The electrical power connector (1) according to claim 1 or 2, wherein said at least one elastomeric conductive seal (11) is manufactured as an open strip configured to be bent to have an outer circumferential surface (20) providing a sealing barrier to said at least one outer shielding element (4), and said con-

nection means (23) of the conductive seal being formed as contacting projections extending radially from an inner surface (21) of said at least one elastomeric conductive seal (11) into said at least one cavity (12).

5. The electrical power connector (1) according to claim 4, wherein said at least one elastomeric conductive seal (11) comprises fixation projections (26, 27) extending radially from the inner surface (21) of said at least one elastomeric conductive seal (11) and inserted in notches made in the housing (2).

6. The electrical power connector (1) according to any preceding claim, wherein said at least one elastomeric conductive seal (11) is made of a graphite mixed dry silicone.

7. A method for assembling an electrical power connector (1), this method comprising the steps of

- mounting at least one outer shielding element (4) on a dielectric housing (2), the housing (2) having at least one cavity (12), said at least one cavity (12) being configured for accommodating a power terminal (6), the outer shielding element (4) being outside said at least one cavity (12) and configured to be electrically connected to a respective shield of a counterpart connector when said power connector (1) is mated to said counterpart connector,
- inserting an electrical power terminal (6) in said at least one cavity (12), said power terminal (6) being electrically connected to a respective shielded cable (13) having an individual shielding layer (15),

characterized in that this method further comprises, prior to the step of mounting said at least one outer shielding element (4), a step of mounting an elastomeric conductive seal (11) on an outer surface of the housing (2), this outer surface being opposite to an inner surface of said at least two cavities (12), the elastomeric conductive seal (11) being inserted, once said at least one outer shielding element (4) mounted on the housing (2), between the housing (2) and said at least one outer shielding element (4), the elastomeric conductive seal having connection means (23) passing through at least one passage made in the housing (2), between said outer surface and said inner surface, for electrically connecting the shielding layer (15) to said at least one outer shielding element (4).

8. The method of claim 7, comprising a step of mounting at least one ferrule (5) in electrical contact with the shielding layer (15) of a respective shielded cable (13) and comprising a step of inserting, in said at least one cavity (12), the corresponding power terminal (6), a portion of the shielded cable (13) connected to this power terminal (6) and said at least one ferrule (5), so that the elastomeric conductive seal be electrically connected to the shielding layer (15) via said at least one ferrule (5).

9. The method of claim 7 or 8, wherein the step of mounting said at least one elastomeric conductive seal (11) on the housing (2), comprises providing the elastomeric conductive seal (11) as a strip extending between two free ends, and bending it on the housing (2) so as to form a ring shape.

10. The method of any of claims 7 to 9, wherein the step of mounting said at least one elastomeric conductive seal (11) on the housing (2), comprises inserting fixation projections (26, 27) in notches formed in the housing (2).

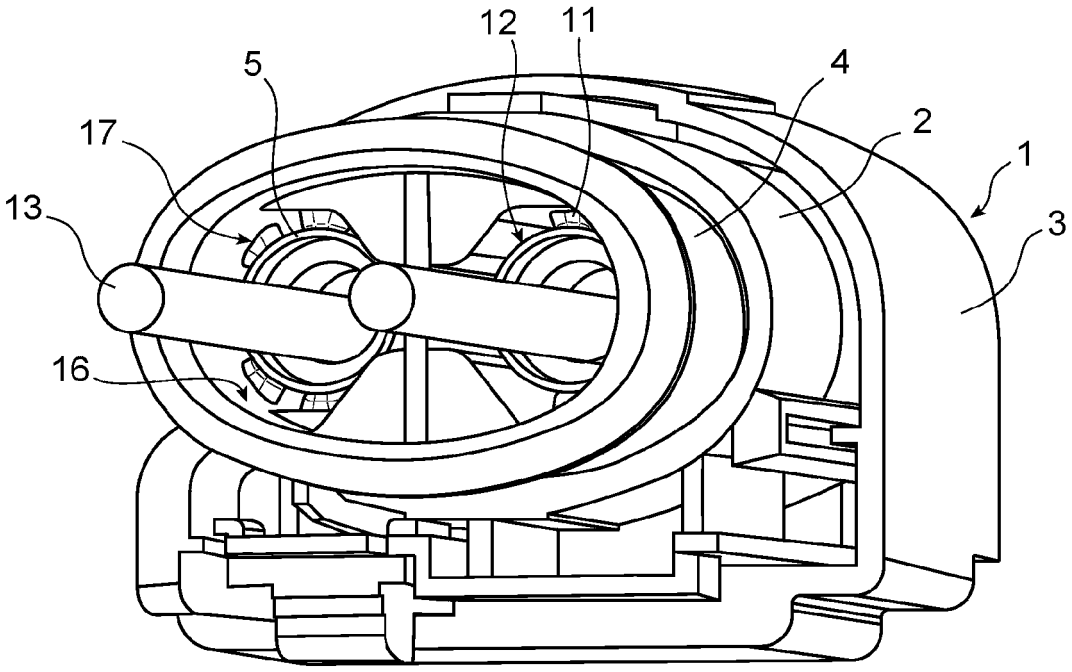

FIG. 1

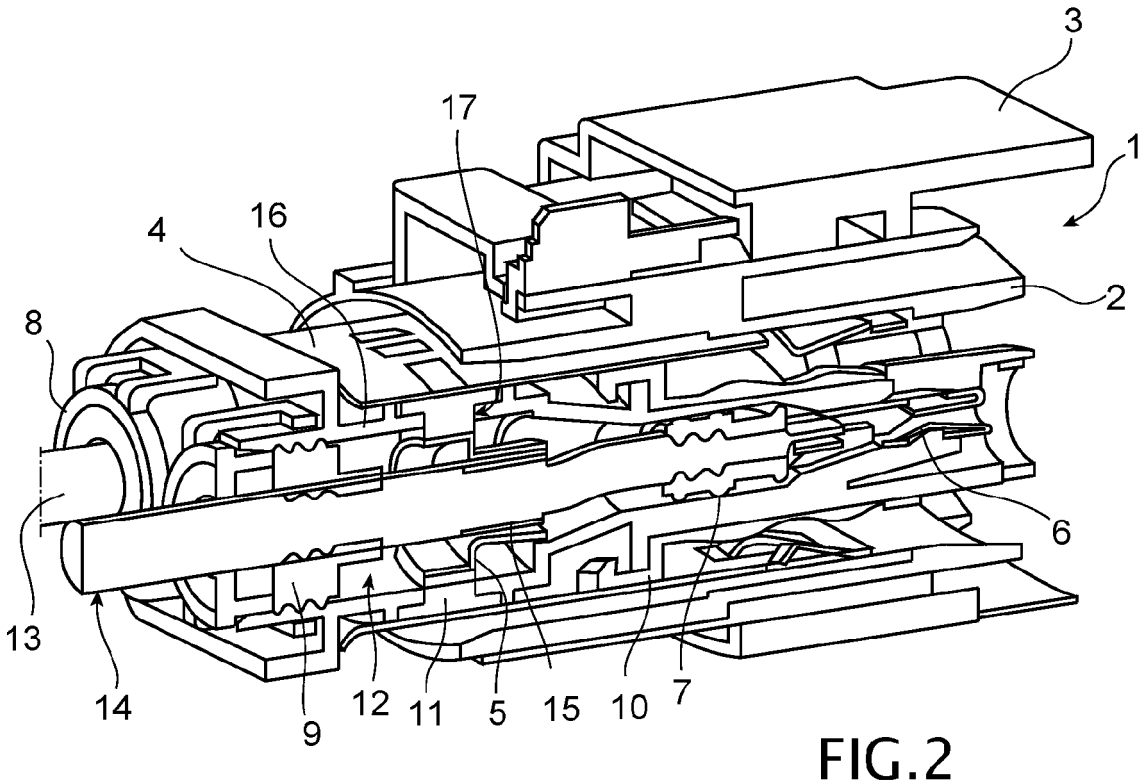

FIG.2

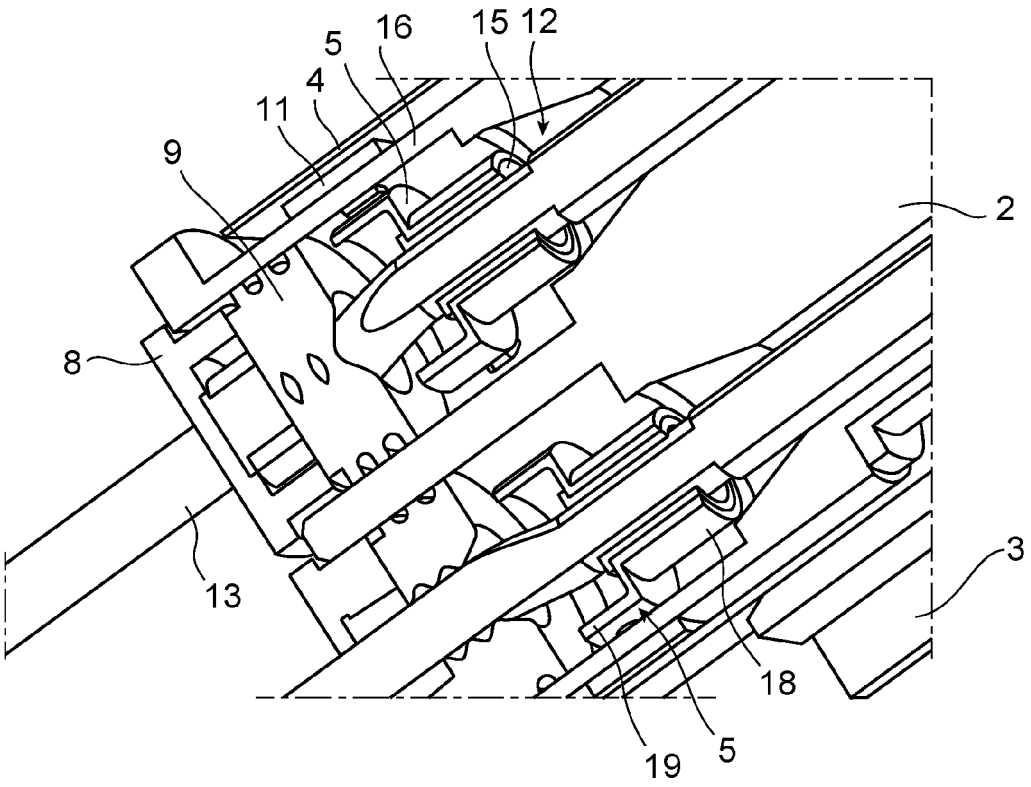

FIG. 3

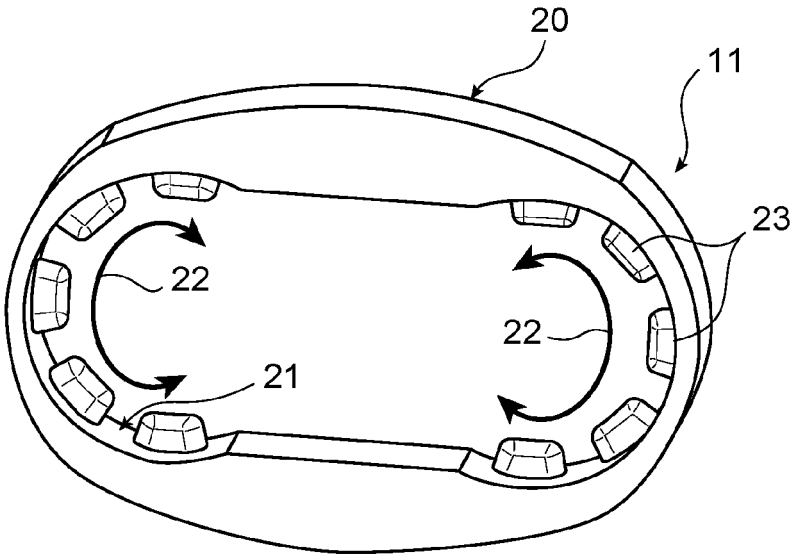

FIG. 4

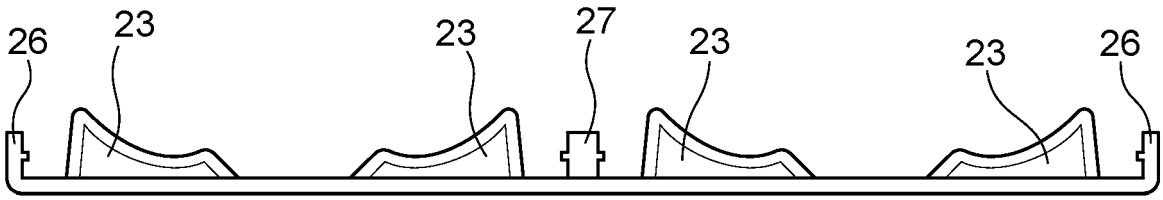

FIG. 5

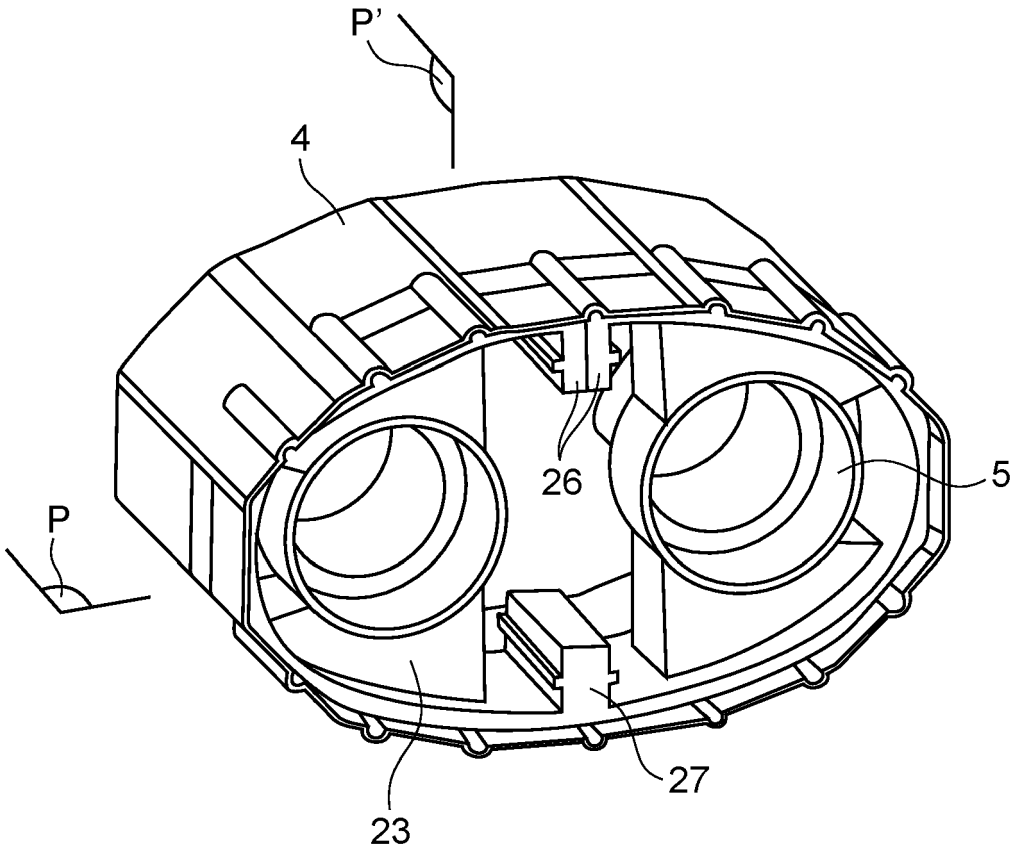

FIG. 6

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 22 21 4025

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	US 2015/288108 A1 (FISCHER CHARLES PITMAN [US]) 8 October 2015 (2015-10-08) * paragraphs [0085] - [0087]; figures 1A, 3A, 8-10B *	1-10	INV. H01R13/52 H01R13/6599 H01R9/05
A	US 11 450 990 B2 (J S T CORP [US]) 20 September 2022 (2022-09-20) * claim 1; figure 5 *	1,7	ADD. H01R13/6582
A	US 2020/280150 A1 (DEMARATOS DAVID [US]) 3 September 2020 (2020-09-03) * paragraph [0019]; figure 2A *	1,7	
A	US 2006/110977 A1 (MATTHEWS ROGER [US]) 25 May 2006 (2006-05-25) * paragraphs [0040] - [0042]; figure 1 *	1,7	
A	US 7 393 218 B1 (PAVLOVIC SIOBADAN [US] ET AL) 1 July 2008 (2008-07-01) * claim 1; figure 2 *	1,7	
A	FR 2 981 210 A1 (LEONI WIRING SYSTEMS FRANCE [FR]) 12 April 2013 (2013-04-12) * abstract; figures 1-7 *	1,7	TECHNICAL FIELDS SEARCHED (IPC) H01R

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	19 May 2023	Jiménez, Jesús

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 22 21 4025

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

19-05-2023

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2015288108 A1	08-10-2015	GB 2539154 A	07-12-2016
		US 2015288108 A1	08-10-2015
		US 2016329661 A1	10-11-2016
		WO 2015153826 A1	08-10-2015
US 11450990 B2	20-09-2022	CN 112956088 A	11-06-2021
		CN 113424374 A	21-09-2021
		EP 3931916 A1	05-01-2022
		EP 3931918 A1	05-01-2022
		JP 2022520686 A	01-04-2022
		JP 2022521362 A	07-04-2022
		US 2020274297 A1	27-08-2020
		US 2020274303 A1	27-08-2020
		WO 2020176129 A1	03-09-2020
		WO 2020176427 A1	03-09-2020
US 2020280150 A1	03-09-2020	CN 113169486 A	23-07-2021
		EP 3931917 A1	05-01-2022
		JP 2022523891 A	27-04-2022
		US 2020280150 A1	03-09-2020
		WO 2020176126 A1	03-09-2020
US 2006110977 A1	25-05-2006	BR PI0518268 A2	11-11-2008
		CN 101095264 A	26-12-2007
		DK 1815559 T3	16-01-2012
		EP 1815559 A1	08-08-2007
		ES 2371431 T3	02-01-2012
		KR 20070073831 A	10-07-2007
		US 2006110977 A1	25-05-2006
		US 2009176396 A1	09-07-2009
		US 2009186505 A1	23-07-2009
		US 2009203256 A1	13-08-2009
		US 2011053413 A1	03-03-2011
		WO 2006057737 A1	01-06-2006
US 7393218 B1	01-07-2008	CN 101272009 A	24-09-2008
		DE 102008006340 A1	25-09-2008
		US 7393218 B1	01-07-2008
FR 2981210 A1	12-04-2013	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- EP 3155692 A1 **[0005]**
- FR 3032835 A1 **[0005]**