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(54) **ELECTRICAL POWER CONNECTOR AND METHOD FOR ASSEMBLING SUCH A CONNECTOR**

(57) A connector and a method for assembling such a connector. At least one power terminal (8) is accommodated in a cavity (5) of a housing (4). The power terminal (8) has a groove (17). A rear grid (14) is attached to the to the housing (4) with a movement of the rear grid (14) toward the housing (4) in the longitudinal direction (L) of the cavity (5). When attached to the housing (4), the rear grid (14) is maintained in a delivery position on the housing with first locking means. The rear grid (14) is pushed between the delivery position and a closed position along a transversal direction essentially perpendicular to the longitudinal direction (L), thereby inserting in an adjusted manner a portion of the rear grid (14) in the groove (17).

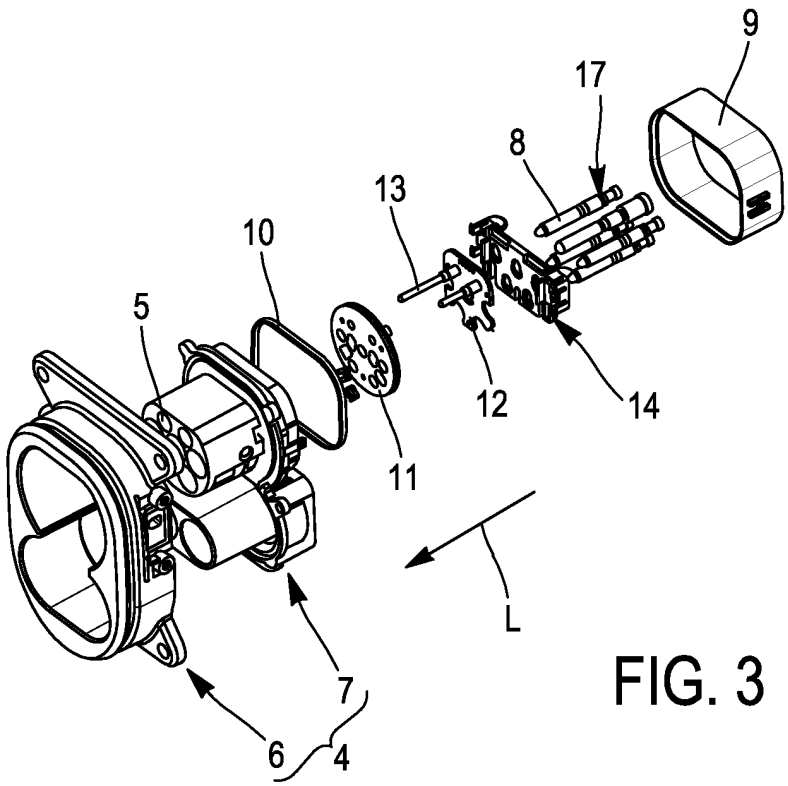

FIG. 3

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Description

Technical domain

[0001] The disclosure generally relates to the field of automotive connectors and more particularly to the field of power connectors for automotive vehicles. This disclosure also relates to a method for assembling such connectors. This disclosure relates for example to an inlet or socket connector such as those used for charging batteries of electric vehicles or plug-in hybrid vehicles.

State of the art

[0002] As shown schematically in FIG. 1, electric vehicles or plug-in hybrid vehicles 100 may comprise a connector base or inlet or socket 200 on which a charge plug 300 powered by an electric charging station 400 can be connected via a cable 500. This charge plug 300 then makes it possible to charge battery cells on board of the vehicle 100.

[0003] The connector 200 comprises a housing made of dielectric material and terminals each respectively accommodated in a cavity formed in the housing.

[0004] For this kind of connector tight tolerances are imposed by standards (e.g. IEC 62196-3 standard for DC power terminals or IEC 62196-2 standard for AC power terminals) for the distance between the outermost edge of the cavity and the outermost electrically conductive portion of the power terminal accommodated in this cavity.

[0005] In order to meet the requirements of the standards, the terminals of such connectors are mounted in a separate module which is tightly screwed on the housing of the connector 200. The screws allow for a precise positioning of the module relatively to the housing. The module and the connector housing are supplied separately and the vehicle manufacturers have to assemble them. However, the screwing operation is time consuming and may be difficult when there is not much room around the back side of the connector 200.

[0006] This disclosure aims at contributing to mitigate, at least partially, problems such as those mentioned above, encountered with connectors of the prior art.

Summary of the invention

[0007] The present disclosure provides an electrical connector according to claim 1.

[0008] The electrical connector of the present disclosure facilitates improved assembly. Indeed, the connector can be supplied with the rear grid already attached in the delivery position. The terminals (possibly previously electrically and mechanically connected to a respective cable) can be then inserted in a respective cavity, and the rear grid is pushed from the delivery position to a closed position where the terminals are locked into their respective cavity, so as to prevent each power terminal from being removed from its cavity.

[0009] With such a configuration it is quite easy to assemble the connector, the rear grid and terminals being already connected to cables, even when there is not much room around the back side of the connector. Screws are not necessary while tight tolerances can be achieved thanks to the positioning, which can be precisely defined, of the surface behind the stop provided on the corresponding terminal.

[0010] The disclosed connector may also optionally include one and / or the other of the features of any one of claims 2 to 10.

[0011] The disclosure also relates to a method for assembling a connector according to claim 11.

Brief description of the drawings

[0012] Other features, objects and advantages of the invention will become apparent from reading the detailed description that follows, and the attached drawings, given as non-limiting examples and in which:

FIG. 1 is an illustration of an electric vehicle or plug-in hybrid vehicle equipped with a power connector.
FIG. 2 is a schematic perspective view of a power connector in accordance with an example embodiment, seen from its front (or mating) side;
FIG. 3 is a schematic perspective exploded view of elements of the power connector of FIG. 2;
FIG. 4 is a schematic perspective view of the power connector of FIGs 2 and 3, seen from its back (or rear) side;
FIG. 5 is a schematic perspective view of a rear grid as the one mounted on the power connector of FIGs 2 and 3,
FIG. 6 is a schematic view of the power connector of FIGs 2 and 3, seen from its back side; with the rear grid in a delivery position;
FIG. 7 is a schematic lateral view of the power connector of FIG. 6;
FIG. 8 is a schematic cross section at B-B of the power connector of FIG. 6;
FIG. 9 is a schematic cross section at A-A of a portion of the power connector of FIG. 6;
FIG. 10 is a schematic view of the power connector of FIGs 2 and 3, seen from its back side; with the rear grid in a closed position;
FIG. 11 is a schematic lateral view of the power connector of FIG. 10;
FIG. 12 is a schematic cross section at B-B of the power connector of FIG. 10;
FIG. 13 is a detail taken from FIG. 11; and
FIG. 14 is a schematic cross section at A-A of a portion of the power connector of FIG. 10.

Detailed description

[0013] The power connector 200 shown on FIG. 2 is

designed to be mounted in a vehicle 100. The embodiment of the power connector 200 shown on FIG. 2 comprises a front face 201 from which two connecting interfaces 2, 3 are accessible. Such a connector is also known as a Combo socket. It allows AC charging through a first interface 2 and fast DC charging through a second interface 3. The power connector 200 shown on FIG. 2 is protected by a door which is not shown.

[0014] Only the part of the connector corresponding to the first (AC) interface 2 is described below, but the description of a part of the connector corresponding to the second (AC) interface 3 would be very similar.

[0015] The power connector 200 comprises a housing 4 which can be made of one or more components moulded from dielectric material. For example, the housing 4 comprises an outer housing 6 and an inner housing 7 (See FIG. 2). The inner housing 7 comprises cavities 5 for accommodating male power terminals 8, as well as signal terminals 13. The male power terminals 8 are connected to cables or wires arranged in a single charging cable 500.

[0016] Advantageously, the inner housing 7 forms a sealed box with a cover (only a cover interface 9 is shown on FIG. 3). In order to prevent humidity, dust, etc. to ingress in this box, a cover seal 10 is provided between the inner housing 7 and the cover interface 9 and a mat seal 11 is provided between the male power terminals 8 and the inner housing 7 (See FIG. 3).

[0017] The power connector 200 also comprises a printed circuit board 12 onto which the signal terminals 13 are mounted, as well as a rear grid 14.

[0018] The outer housing 6, the inner housing 7, the cover seal 10, the mat seal 11, the printed circuit board 12 with its signal terminals 13 and the rear grid 14 are delivered all together in the form of a sub-assembly.

[0019] The cavities 5 extend in a longitudinal direction L from a front opening 15 (see FIG. 2) to a rear opening 16 (see FIG. 4). The rear opening 16 of a cavity 5 has dimensions equal or greater than that of the largest cross-section of the portion of the power terminal 8 inserted, from the rear opening 16, into this cavity 5. In other words, these dimensions allow for the insertion of a portion of the power terminal 8 in the cavity 5. The portion of each power terminal 8 inserted in a respective cavity 5 includes a contact portion, i.e. the portion of a power terminal 8 designed to be mated with a female power terminal of a counter-connector (e.g. a plug connector).

[0020] Each power terminal 8 comprises an annular groove 17 in an intermediate portion located between the contact portion of the power terminal 8 inserted into a cavity 5 and a fixation portion of the terminal 8, the fixation portion being designed to be electrically and mechanically connected (for example by crimping) to a cable or wire. The groove 17 has a gutter shape with two lateral annular walls 18 facing each other (see FIG. 9). Each annular wall 18 extends in a plane perpendicular to the longitudinal direction L (i.e. the longitudinal direction of both the cavity 5 and the terminal 8). One of the annular walls 18 is located closer to the rear opening 16 of the cavity 5. This annular wall 18 forms a stop 21 against which the rear grid 14 abuts, when the rear grid 14 is in its closed position (see FIG. 14), so as to prevent the power terminal 8 from being pulled out from this cavity 5.

[0021] The rear grid 14 comprises a panel 19 extending essentially in a plane perpendicular to the longitudinal direction L. The panel 19 has five apertures 20 for the passage of a portion of a respective power terminal 8 inserted into a cavity 5. When the rear grid 14 is attached to the inner housing 7, in delivery position, each one of the apertures 20 is generally aligned, in the longitudinal direction L, with a rear opening 16. Each one of the apertures 20 has a closed edge 22. The closed edge 22 of each aperture 20 comprises two regions. A first region 23 of the closed edge 22 has an arc-of-circle shape with a first radius of curvature. A second region 23 of the closed edge 22 has an arc-of-circle shape with a second radius of curvature. The second radius of curvature is less than the first radius of curvature. More particularly, the first radius of curvature is such that it does not prevent the passage of the largest cross-section of the portion of the power terminal 8 inserted, from a rear opening 16, into a cavity 5. On the contrary, the second radius of curvature is such that it limits the movement of the portion of the power terminal 8 inserted into the corresponding cavity 5, so as to prevent the terminal 8 from being pulled out from this cavity 5.

[0022] The rear grid 14 has a front face 25 and a back face 26. On the front face 25 of the rear grid 14, around each one of the five apertures 20, the panel 19 has a first surface 27 and a second surface 28. Both the first 27 and second 28 surfaces are on the front face 25. The first surface 27 runs essentially along the first region 23. The second surface 28 runs essentially along the second region 24. The first surface 27 is disposed rearward relatively to the second surface 28. The second surface 28 partially faces and closes the rear opening 16 of the corresponding cavity 5. The rear grid 14 has an interlocking thickness between the second surface 28 and its back face 26. The width of the groove 17 between the two annular walls 18 corresponds essentially to the interlocking thickness so that the rear grid 14 is engaged in an adjusted manner in the groove 17, when the rear grid 14 is in the closed position. When the rear grid 14 is in the closed position, one of the annular walls 18 abuts the second surface 28 and the other annular wall abuts against the back face 26 of the rear grid 14 (See FIG. 14).

[0023] The rear grid 14 comprises first locking means 29. In the example illustrated in FIG. 5, the first locking means 29 comprises four flexible legs 30 extending essentially in the longitudinal direction L. The rear grid 14 comprises two flexible legs 30 on each one of its lateral sides. The stiffness of the rear grid 14 and the symmetrical distribution of the flexible legs 30 on each one of its lateral sides ensure a reliable and precise positioning of the rear grid 14 relative to the inner housing 7. Each flexible leg 30 extends from an end linked to the rear grid 14

to a free end provided with a hook 31. Each hook 31 has a locking surface perpendicular to the longitudinal direction L and directed rearward. When the rear grid 14 is in its delivery position, each hook 31 engages an edge 32 of an aperture 33 made in a peripheral flange 34 of the inner housing 7 (See FIG.s 7 and 13). The rear grid 14 is attached on the inner housing 7 in pushing the rear grid 14, along the longitudinal direction L, with the panel 19 essentially perpendicular to the longitudinal direction L, toward the back side 202 of the connector 200 until each hook 31 is clipped into a corresponding aperture 33. Each aperture 33 has a first edge 35, a second edge 36 and a ramp portion 37 in between (See FIG. 13). The first edge 35 is located further back than the second edge 36. When the rear grid 14 is attached on the inner housing 7 in its delivery position, each hook 31 engages the first edge 35 (See FIG. 8). When the rear grid 14 is moved from its delivery position to its closed position, each hook 35 slides on the ramp portion 37 and engages the second edge 36 (See FIGs. 11 and 12), so as to move the rear grid 14 closer to rear openings 16 of the cavities 5. The rear grid 14 is moved from its delivery position to its closed position in pushing on actuating surfaces 38, in a top-down sliding direction TD on the drawings. This movement of the rear grid 14 has both a component parallel to the longitudinal direction L and perpendicular to the longitudinal direction L.

[0024] The rear grid 14 comprises second locking means 39 for locking the rear grid 14 in its closed position (See FIG. 5). In the illustrated example, the second locking means 39 comprises one flexible leg 40 on each one of its lateral sides. Each flexible leg 40 extends from an end linked to the rear grid 14 to a free end provided with a hook 41. Each hook 41 has a locking surface parallel to the longitudinal direction L and perpendicular to the sliding direction (TD direction) of the rear grid 14 from its delivery position to its closed position. When the rear grid 14 is moved from its delivery position to its closed position, each hook 41 engages a corresponding shoulder 42 made on the inner housing 7, and locks behind this shoulder 42 (See Fig. 10).

[0025] While the rear grid 14 is pushed from its delivery position to its closed position, the apertures 20 are moved downwardly (See FIGs 6 and 10). In other words, the rear grid 14 is moved so that each second region 24 of the edges 22 inserts into a respective groove 17. Since the rear grid 14 is precisely secured on the inner housing 7 thanks to the first locking means 29, and since the power terminals 8 are precisely positioned thanks to the interaction between the rear grid 14 and the annular grooves 17, the power terminals 8 are precisely positioned with regard to the inner housing 7. For example, the gap measured parallel to the longitudinal direction L, between the outermost edge of a cavity 5 and the outermost electrically conductive portion of a power terminal 8 accommodated in this cavity 5 may be between 11.015 millimetres and 11.485 millimetres.

[0026] The mat seal 11 is mounted, inside the peripheral flange 34 of the inner housing 7, between the back side of the inner housing 7 and the printed circuit board 12. The rear grid 14 has two posts 43, each one of which is located on a lateral side of the rear grid 14 and extending from its front face 25 in planes parallel to both the longitudinal direction L and the sliding direction TD (See FIG. 5). When the rear grid 14 is pushed from its delivery position to its closed position, the rear grid is moved downwardly and forwardly so that the posts 43 press the mat seal against the rear side of the inner housing 7.

[0027] The printed circuit board 12 is mounted, inside the peripheral flange 34 of the inner housing 7, between the mat seal 11 and the rear grid 14.

[0028] According to an example of a method for assembling the connector 200, the outer housing 6, the inner housing 7, the mat seal 11, the cover seal 10 and the printed circuit board 12 are fitted one inside the other. The rear grid 14 is attached to the inner housing 7 with the first locking means 29. The rear grid 14 maintains in particular the inner housing 7, the mat seal 11 and the printed circuit board 12 all together. This assembly can be supplied to a vehicle manufacturer. Then, power terminals 8 are inserted into their respective cavities 5 and an operator presses downwardly on the actuating surfaces 38 and pushes the rear grid 14 from the delivery position to the closed position. If one or several power terminals 8 are not properly inserted into a cavity 5, the sliding movement of the rear grid 14 is blocked by this or these terminals and the rear grid 14 cannot be placed in the closed position. The rear grid 14 acts as a terminal position assurance device (TPA). When every power terminal 8 is properly and fully inserted, the rear grid 14 can be pressed down and inserted in the annular grooves 17, the interlocking thickness being adjusted to the groove width.

Claims

1. Electrical connector comprising a housing (4) and a rear grid (14)
the housing (4) having at least one cavity (5) for accommodating at least one portion of at least one a power terminal (8), the cavity (5) extending in a longitudinal direction (L) from a front opening (15) to a rear opening (16), the rear opening (16) having dimensions equal to or greater than that of the largest cross-section of said at least one portion of said at least one power terminal (8) to be inserted into the cavity (5) from the rear opening (16),
the rear grid (14) having a front face (25) and a back face (26), the rear grid (14) being attached with first locking means (29) to the housing (4), behind said at least one cavity (5), the first locking means (29) being operated with a movement of the rear grid (14) toward the housing (4) in the longitudinal direction (L); the rear grid (14) being attached by the first locking means (29) in a delivery position,

the rear grid (14) being slidably movable between the delivery position and a closed position along a transversal direction (TD) essentially perpendicular to the longitudinal direction (L);
the rear grid (14) having a surface (28) partially closing said at least one cavity (5) so as to abut against a stop (21) of said at least one terminal (8) accommodated in said cavity (5), when the rear grid (14) is in its closed position, in order to prevent said at least one power terminal (8) from being removed from said cavity (5).

2. A connector according to claim 1, comprising second locking means (39) for locking the rear grid (14) in its closed position.

3. A connector according to claim 1 or 2, wherein the first locking means (29) comprises flexible legs (30) extending in the longitudinal direction (L) and along which, or at the end of which, is positioned a hook (31) engaged with an edge (35) located on the housing (4), when the rear grid (14) is in its delivery position.

4. A connector according to any one of the preceding claims, wherein the rear grid (14) has at least one aperture (20) for the passage of a portion of said at least one power terminal (8), said at least one aperture (20) having a closed edge (22), a first region (23) of said edge (22) having an arc-of-circle shape with a first radius of curvature and a second region (24) of said edge (22) having an arc-of-circle shape with a second radius of curvature, the second radius of curvature being less than the first radius of curvature so as to limit the movement of at least one portion of said at least one power terminal (8) in said at least one cavity (5).

5. A connector according to any one of the preceding claims, comprising a printed circuit board (12) inserted between the housing (4) and the rear grid (14).

6. A connector according to the preceding claim, comprising signal terminals (13) mounted onto the printed circuit board (4).

7. A connector according to any one of the preceding claims, comprising a mat seal (11) inserted between the housing (4) and the rear grid (14).

8. A connector according to the preceding claim, wherein the rear grid (14) comprises at least one post (43) for maintaining the mat seal (11) against the housing (4).

9. A connector according to any one of the preceding claims, comprising at least one power terminal (8) accommodated in said at least one cavity (5), wherein the rear grid (14) has an interlocking thickness between said surface (28) partially closing said at least one cavity (5) and the back face (26), and wherein said at least one power terminal (8) has a groove (17) the width of which corresponds essentially to the interlocking thickness so that the rear grid (14) is engaged in an adjusted manner in the groove (17), when the rear grid (14) is in the closed position.

10. A connector according to the preceding claim, wherein the rear grid (14) has at least one aperture (20) for the passage of a portion of said at least one power terminal (8), said at least one aperture (20) having a closed edge (22), a first region (23) of said edge (22) having an arc-of-circle shape with a first radius of curvature and a second region (24) of said edge (22) having an arc-of-circle shape with a second radius of curvature, the second radius of curvature being less than the first radius of curvature so as to limit the movement of at least one portion of said at least one power terminal (8) in said at least one cavity (5) and wherein the groove (17) is annular, extends in a plane perpendicular to the longitudinal direction (L), and has an internal circumference adjusted inside the second region (24) of said edge (22).

11. A method for assembling a connector, comprising:

- providing a housing (4), at least one power terminal (8), and a rear grid (14); the housing (4) having at least one cavity (5) extending in a longitudinal direction (L) from a front opening (15) to a rear opening (16); said at least one power terminal (8) having a groove (17);
- attaching the rear grid (14) to the housing (4) with a movement of the rear grid (14) toward the housing (4) in the longitudinal direction (L); the rear grid (14) being attached to the housing (4) by a first locking means (29) in a delivery position;
- inserting at least one portion of said at least one power terminal (8) in said at least one cavity (5);
- pushing the rear grid (14) between the delivery position and a closed position along a transversal direction (TD) essentially perpendicular to the longitudinal direction (L), and thereby inserting in an adjusted manner a portion of the rear grid (14) into the groove (17).

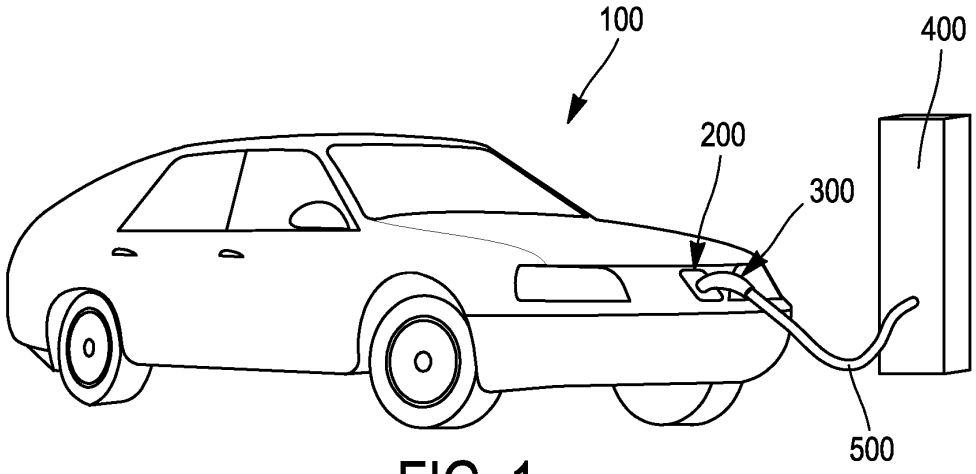

FIG. 1

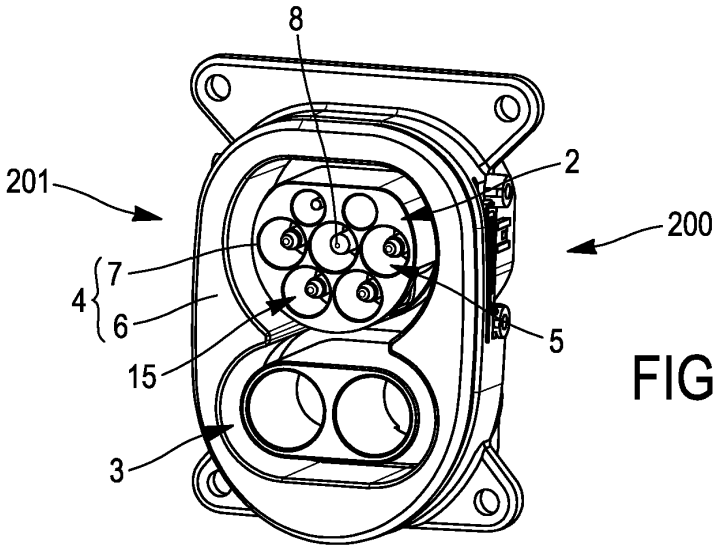

FIG. 2

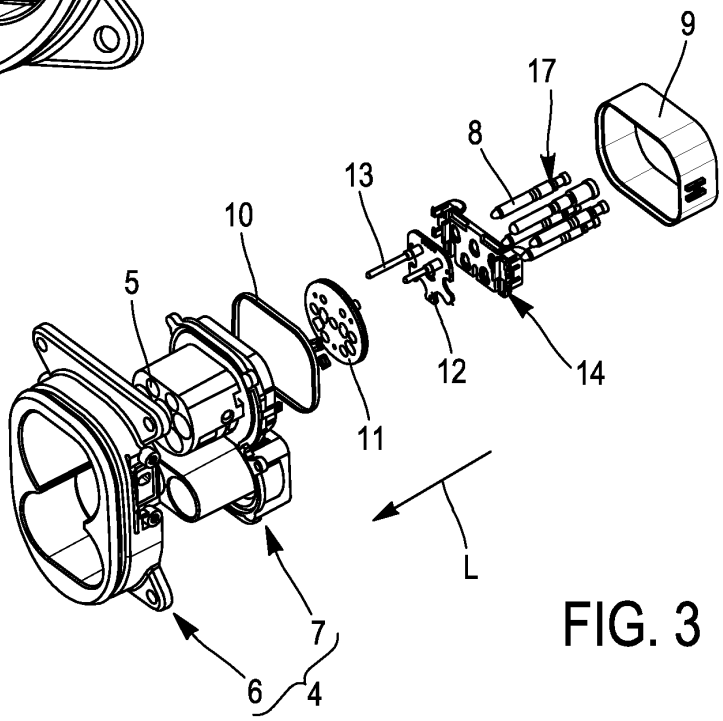

FIG. 3

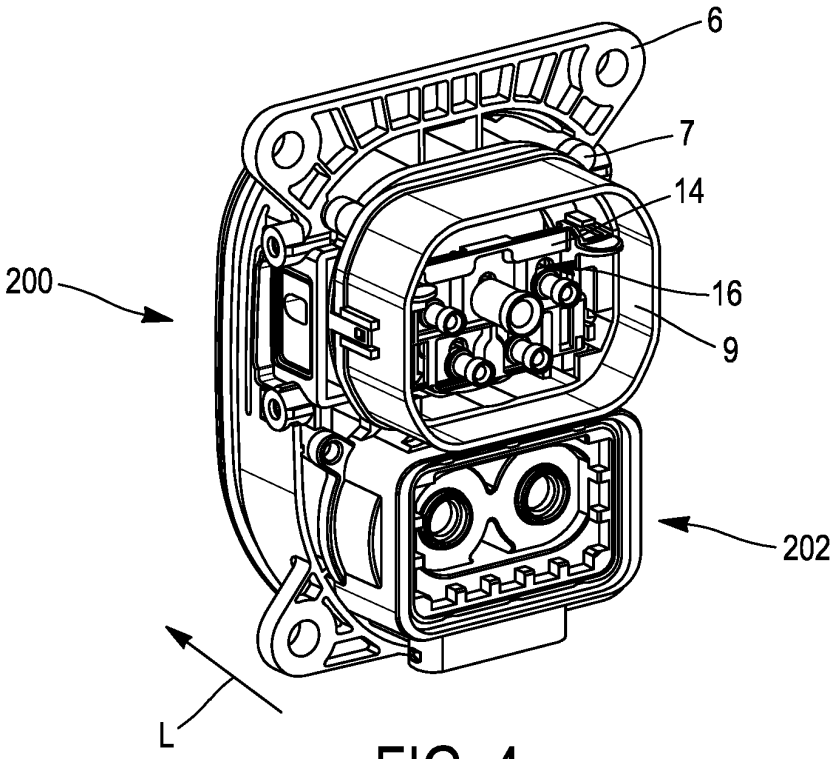
6
7
14
200
16
9
202
L

FIG. 4

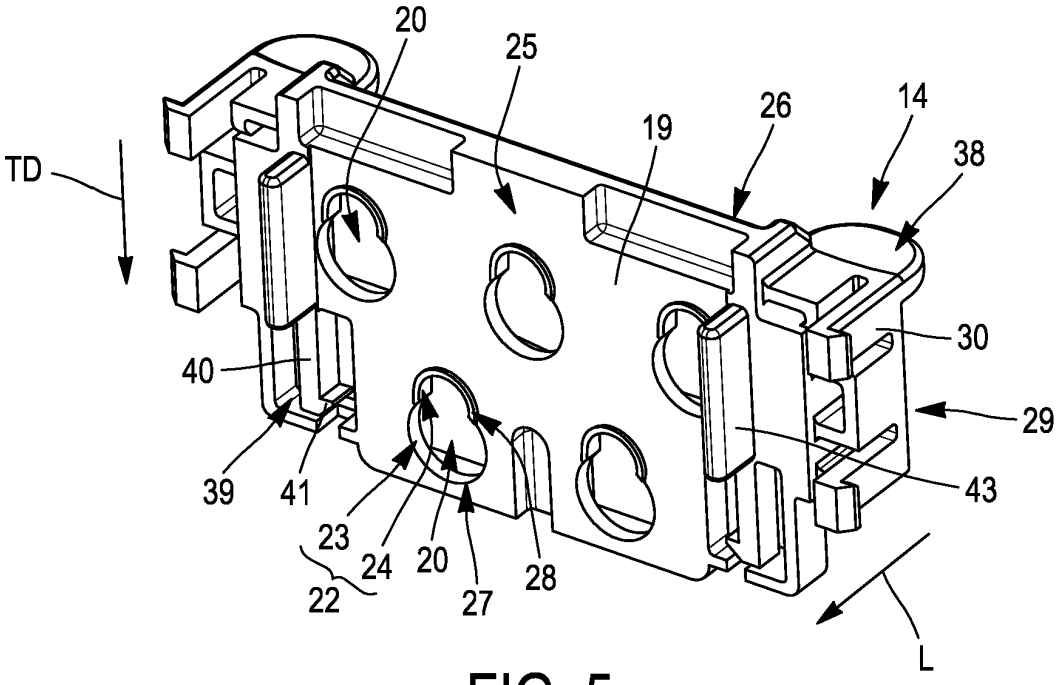
20
25
19
26
14
38
TD
30
40
29
39
41
43
23
24
20
28
22
27
L

FIG. 5

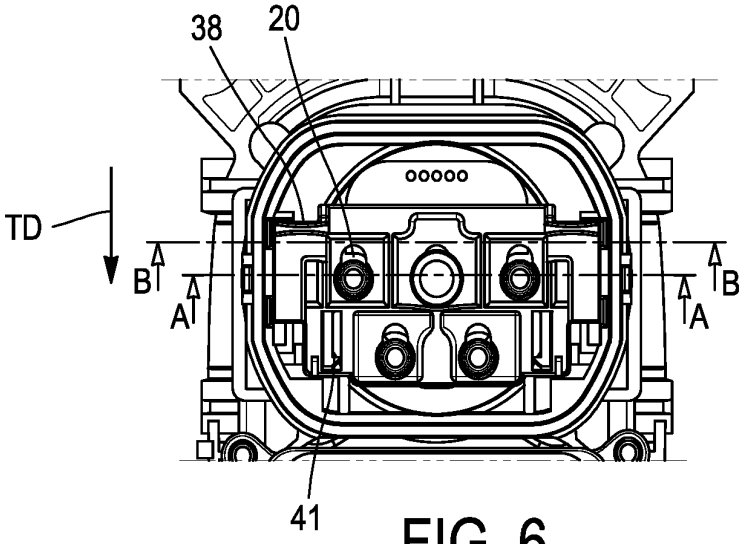

FIG. 6

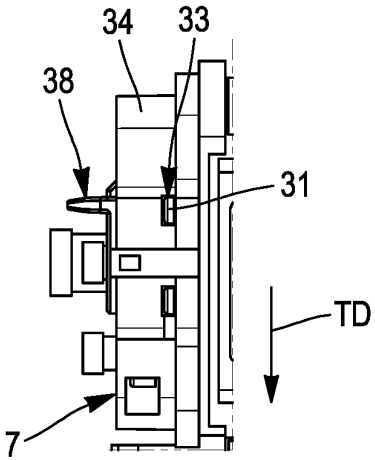

FIG. 7

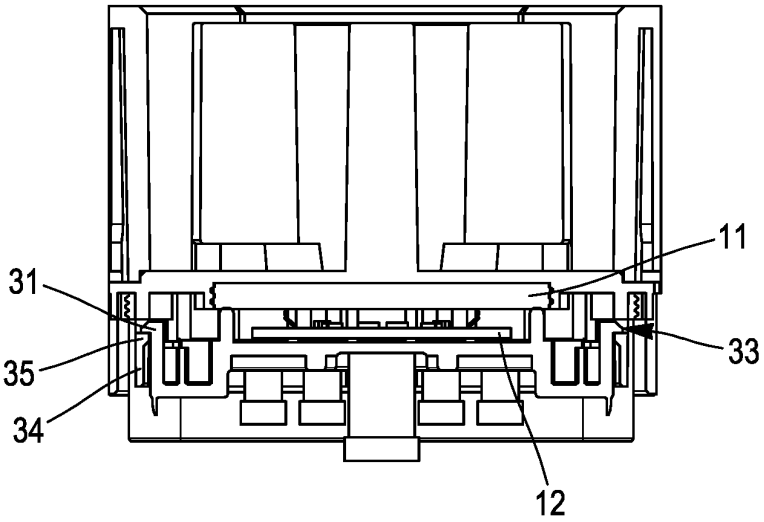

FIG. 8

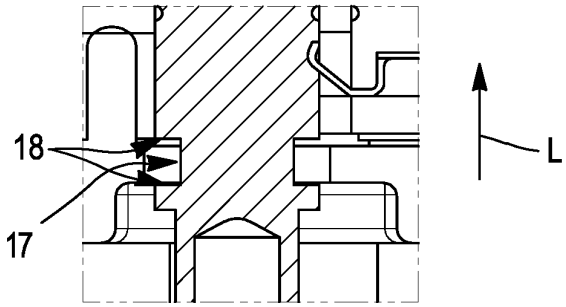

FIG. 9

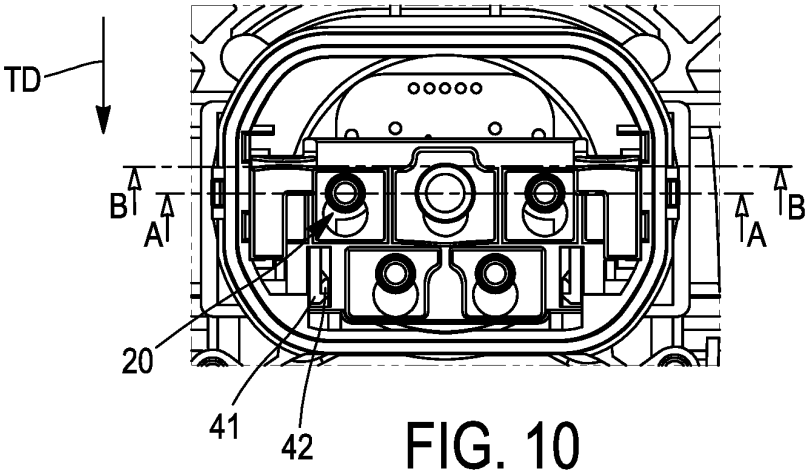

FIG. 10

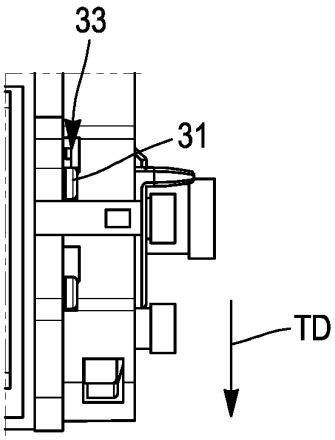

FIG. 11

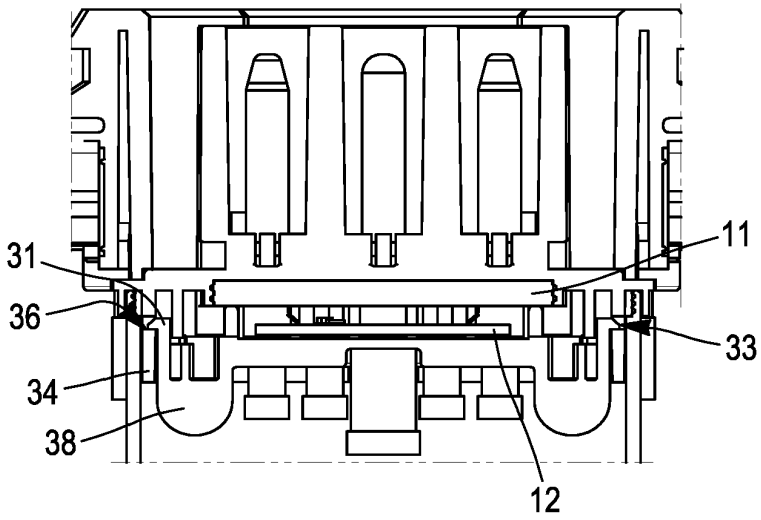

FIG. 12

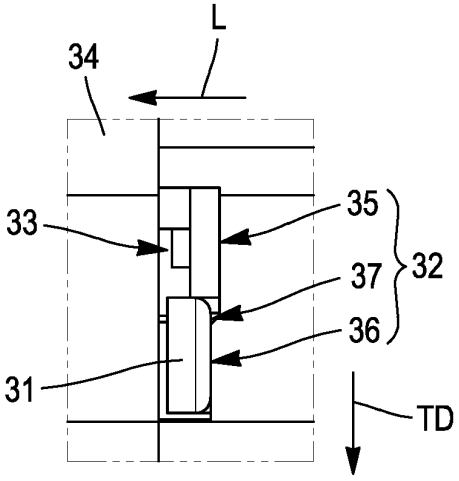

FIG. 13

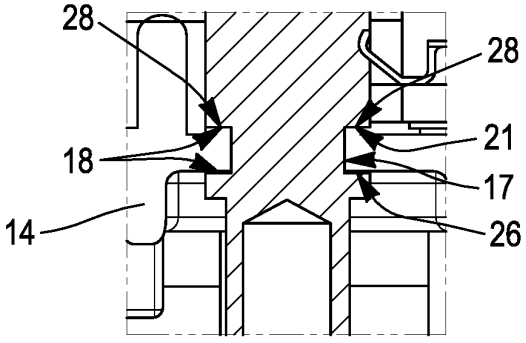

FIG. 14

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 20 16 6086

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X Y	US 2019/173221 A1 (DE CHAZAL AARON JAMES [US] ET AL) 6 June 2019 (2019-06-06) * figures 1-8 * -----	1-3,9,11 4,10	INV. H01R13/436 H01R43/20
X	US 10 263 356 B2 (TYCO ELECTRONICS SHANGHAI CO [CN]) 16 April 2019 (2019-04-16) * figures 1, 14-25 * -----	1-3,5-8, 11	
Y	US 5 941 737 A (SAKAI HITOSHI [JP] ET AL) 24 August 1999 (1999-08-24) * figure 7 * -----	4,10	
A	US 2015/087190 A1 (SCHWAN RALF [DE]) 26 March 2015 (2015-03-26) * figure 2 * -----	1-11	

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	24 September 2020	Philippot, Bertrand

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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L : document cited for other reasons

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EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 20 16 6086

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
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24-09-2020

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