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# (54) HV CONNECTOR HAVING A REAR GRID WITH STRAIN RELIEF MEANS AND METHOD FOR ASSEMBLING THEREOF

(57) Connector comprising a housing (2) for accommodating terminals (7) and a strain relief device (4). The strain relief device (4) comprises a rear grid (9) to be attached on a rear portion (15) of the housing (2). The terminals (7) are electrically connected to cables (14) that exit the housing (2) through the rear grid (9).

The strain relief device (4) comprises a slider (10) that can be moved, in a direction generally perpendicular to the cables (14) exiting from the housing (2), between a pre-locking position where it does not press the cables (14) and a locking position where it presses the cable (14) so as to tighten them and minimize their movements. The slider (10) can be moved from the pre-locking position to the locking position, only if the rear grid (9) is properly mounted on the housing (2). The rear grid (9) minimizes movements and/or vibrations of cables (14) and terminals (7) inside the housing (2), due to external forces such as vibrations on the cables (14) and/or cable bending.

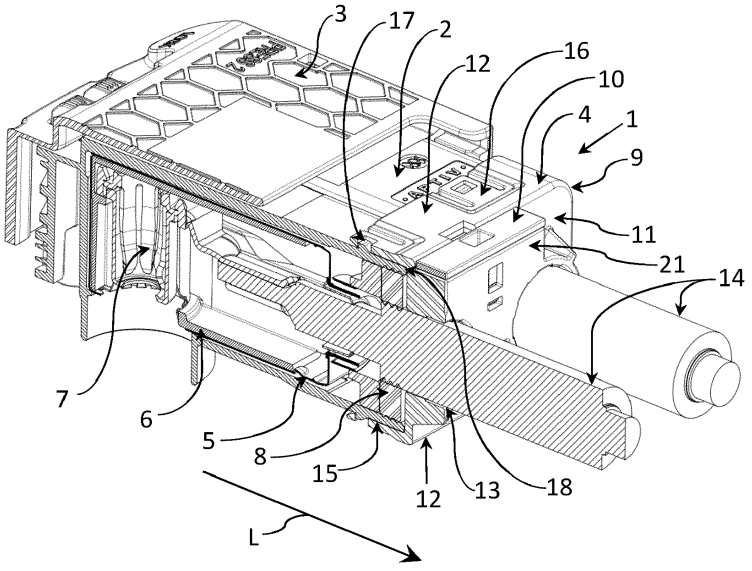


**Fig. 2**

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## Description

### TECHNICAL FIELD OF INVENTION

**[0001]** This disclosure generally relates to the field of automotive connections and more particularly to the field of power connectivity for motor vehicles. For example, this disclosure relates to a cable connector such as those implemented in power circuits interconnecting inverters, batteries or electrical motors of electric vehicles or a plug-in hybrid vehicles.

### BACKGROUND OF INVENTION

**[0002]** In power circuits, the cables electrically linked to cable connectors have a rather large cross section for passing high-intensity-current through. Consequently, such cables may have a relatively high stiffness. When there is not much room in the connector environment, the cables must be very curved or bent, which causes stress on the terminals accommodated in the connector and to which the cables are linked. Such stress may be detrimental to the electrical contact quality between the terminals and those of a counter-connector to which the connector is mated.

**[0003]** This disclosure aims at contributing to minimize the movements of the terminals inside such connectors due to external forces and vibrations, in providing a connector according to claim 1.

**[0004]** The use of the strain relief device comprising a slider that can be moved for pressing the cable(s) only if the rear grid is properly mounted on the housing, provides for means that ensure that, on the one hand, the grid is rigidly fixed to the housing to precisely guide the cable(s), and that, on the other hand, the slider finishes tightening firmly the cable(s).

**[0005]** Other features of this connector are mentioned in the dependent claims, considered separately from one another, or each one considered in combination to one or several other claims.

**[0006]** The disclosure below also relates to a method for assembling a connector, as defined by claims 8 and 9.

### BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

**[0007]** Connectors are disclosed below, by way of examples with reference to the accompanying drawings, in which:

FIG. 1 is a schematic perspective view of a connector in accordance with one embodiment;
FIG. 2 is a schematic longitudinal cross-section view of the connector of FIG. 1;
FIG. 3 is a schematic view from the back side of the connector of FIGS. 1 and 2;
FIG. 4 is a schematic perspective exploded view of the strain relief device of the connector of FIGS. 1 to 3;
FIG. 5 is a schematic cross-sectional view of the back-side portion of the connector of FIGS. 1 to 4;
FIG. 6 is a schematic cross-sectional view of the locking means of the slider of the connector of FIGS. 1 to 5, the slider being in its pre-locking position;
FIG. 7 is a schematic cross-sectional view of the locking means of the slider of the connector of FIGS. 1 to 5, the slider being in its locking position;
FIG. 8 is a schematic perspective view of the back-side portion of the connector of FIGS. 1 to 5, with a cross-section through the slider and its compartment;
FIG. 9 is a schematic view from the back side of a connector according to a second embodiment, the slider being in its pre-locking position;
FIG. 10 is a schematic cross-sectional view of the back-side portion of the connector of FIG. 9;
FIG. 11 is a schematic cross-sectional view of the locking means of the slider of the connector of FIGS. 9 and 10;
FIG. 12 is a view similar to the one of FIG. 9, the slider being in its locking position; and
FIG. 13 is a schematic view from the back side of a connector according to a third embodiment, the slider being in its pre-locking position.

### DETAILED DESCRIPTION

**[0008]** In the following description, the terms "upper", "lower", "lateral", "downward", "upward", etc. and derivatives thereof refer to arbitrary orientations as shown on the drawings. However, it is to be understood that various alternative orientations may be used for illustrating this disclosure.

**[0009]** In the drawings and in the description, same reference numbers are used for the same or similar elements.

**[0010]** FIG. 1 to 8 illustrate a first connector embodiment. As shown on FIG. 1, the connector 1 comprises a housing 2, a mate-assist device 3, a strain relief device 4, all of them being made of plastics. The longitudinal cross-section of this connector shows on FIG. 2 that the housing 2 defines an internal volume in which several other components such as an electromagnetic shield 5, an internal housing 6, terminals 7 in cavities formed in the internal housing 6, and a sealing joint 8, etc. are accommodated. Each terminal 7 is electrically linked to an electrical cable. For instance, each terminal 7 has a portion crimped or welded onto the electrical core of a cable. Each cable has a shielding braid or sheath electrically linked to the electromagnetic shield. Each cable extends inside the housing 2 parallel to the longitudinal direction L of the housing 2.

**[0011]** The strain relief device 4 comprises a rear grid 9 and a slider 10. The rear grid 9 has a general parallelepipedal shape with a rear wall 11 and four lateral walls 12. The four lateral walls 12 extend from the rear wall 11

parallel to the longitudinal direction L of the housing 2. The rear wall 11 substantially closes the housing 2 except where two passages 13 are kept for cables 14 to pass through. The four lateral walls 12 surround the external surface of a rear portion of the housing 2. The upper and lower lateral walls 12 comprise each two tabs 16 with a notch locked on a protrusion 17 made on the external surface of the housing 2. The rear wall 11 is located against a rear edge 18 of the housing 2, when the strain relief device 4 is mounted on the housing 2. In other words, the rear grid 9 is completely outside the internal volume of the housing 2 and does not have any portion located inside the internal volume of the housing 2. Further, the rear grid 9 is attached to the housing 2 with fixing means (tabs 16, notches and protrusions 17) located outside the housing 2. Such a configuration has the advantage that the strain relief device 4 does not take any room inside the connector housing 2, leaving more room for the shielding 5 and sealing 8 means.

**[0012]** As shown on FIGS. 3 and 4, the rear wall 11 comprises a passage 13 for each cable 14. Each passage 13 has a straight tubular wall 19 extending longitudinally along a cable longitudinal direction (parallel to the housing longitudinal direction L as long as the cable 14 is inside the connector 1 and the tubular wall 19 more particularly). Each tubular wall 19 is strengthened by pillars 20 and a slider compartment 21. The internal diameter of each tubular wall 19 is slightly larger than the external diameter of a cable 14. In other words, each cable 14 can pass through a respective passage 13 with a small tolerance. Each tubular wall 19 has a flexible portion 22 extending over a portion of its circumference (for instance over about 90 degrees), for instance approximately between two pillars 20. The flexible portion 22 has a rib 23 extending longitudinally parallel to the longitudinal axis of the tubular wall 19. The rib 23 has a convex surface 52 directed inwardly of the tubular wall 19. Each tubular wall 19 also has a window 24 opening into the slider compartment 21.

**[0013]** The slider 10 has a general triangular or wedged shape, with a pushing portion 25 on one side of the triangle and two retaining surfaces 26 on the other sides of the triangle. These retaining surfaces 26 may be concave. The slider 10 also has two opposite parallel main faces 27, 28 parallel to the rear wall 11 of the strain relief device 4 (see FIG. 5). A flexible locking leg 29, 30 extends in a general direction parallel to, and from, each one of the main faces 27, 28 of the slider 10. Each flexible leg 29 or 30 extends from an end connected to a main face 27 or 28, toward a free end having a hook 31 or 32 projecting on this main face 27 or 28. The slider 10 and its flexible legs are enclosed in a compartment.

**[0014]** The slider compartment 21 has a back wall 33 parallel to the rear wall 11 of the strain relief device 4. The slider compartment 21 has an inlet 34 through which the slider 10 can be inserted. When inserted in the slider compartment 21, the slider 10 can move along a sliding direction which is parallel to the rear wall 11 and perpendicular to a line M joining the central axis of each passage 13 (see FIG. 3). In particular, the slider 10 can be operated in the sliding direction between a pre-locking or upward position and a locking or downward position. In the pre-locking position, the pushing portion 25 of the slider 10 projects over the upper lateral face 12 of the rear grid 9. The slider 10 comprises locking means for locking the slider 10 in the pre-locking position. In the pre-locking position, the slider 10 is downwardly stopped by the hook 32 of the locking leg 30 which is on the side of the rear wall 11 of the strain relief device 4. In the pre-locking position, the slider 10 is upwardly retained by the hook 31 of the locking leg 29 which is on the side of the back wall 33 of the slider compartment 21. The slider 10 is then locked in its pre-locking position. In this pre-locking position, the retaining surfaces 26 cannot interact with the outer surface of cables 14 passing through the passages 13. When a cable 14 is inserted in a passage 13, it is not blocked. The flexible portions 22 cooperate with the outer surface of cables 14, without blocking these cables 14. Such a configuration assists the mounting of the strain relief device 4 on the cables 14 and/or on the connector housing 2 but does not prevent the strain relief device 4 to be moved along the cables 14.

**[0015]** When the rear grid 9 is mounted on the housing 2, the locking means of the slider 10 cooperates with the housing 2 for releasing the slider 10 from the pre-locking position (see FIG. 5). Indeed, when the rear grid 9 is pushed against the rear edge 18 of the housing 2, the hook 32 of the locking leg 30 which is close to the rear wall 11 of the strain relief device 4 is pushed back by the rear edge 18 of the housing 2 and the corresponding locking leg 30 is deflected to release the hook 32 from a notch 35 in the rear wall 11 of the strain relief device 4. The rear wall 11 may have a slanted surface 38 adjacent the notch 35 which helps the hook 32 to move back when the slider 10 is pushed downwardly (See FIG. 6). The slider 10 is no longer blocked in the downward direction. An operator can press the pushing portion 25 for moving the slider 10 from its pre-locking position to its locking position. Such a movement in this direction is particularly ergonomic.

**[0016]** While the slider 10 is pushed downwardly, the hook 31 of the locking leg 29 which is on the side of the back wall 33 of the slider compartment 21 is moved from a first notch in which it was blocked upwardly but not blocked downwardly to a second notch similar to the first notch, but at a lower location relative to the translation of the slider 10 from its pre-locking position to its locking position. The hook 31 of this locking leg 29 is blocked upwardly in the second notch to lock the slider 10 in its locking position (See FIG. 7).

**[0017]** In the locking position, the retaining surfaces 26 pass through the tubular wall windows 24 and pinch the outer surface of each cable 14. The retaining surfaces 26 penetrate an area 36 located between the two cables 14. Due to the wedged shape of the slider 10, the retention forces resulting from pressing the retaining surfaces

26 on the outer surface of each cable 14 are particularly effective. The forces applied on the cables 14 may push the cables 14 against the flexible portions 22. Advantageously, spikes 37 are provided on the inner surface of the tubular walls 19, so as strengthen the cable retention.

**[0018]** As shown on FIG. 2, when the strain relief device 4 is fixed to the housing 2 and that the slider 10 is in its locking position, the cables 14 are forced to remain straight inside the connector housing 2, in particular due to the guidance provided by the tubular walls 19 and the retaining surfaces 26 of the slider 10.

**[0019]** Thanks to such a strain relief device 4, even if the cables 14 must be curved or bent, and even if the cables 14 are quite rigid due to a large conductive cross-section (for instance in a range of 16 to 70mm$^2$), inside the housing 2, the cables 14, the terminals 7, the sealing joints 8, the shielding elements 5, etc. are protected and do not move from their respective original positions.

**[0020]** If there is a need for removing the strain relief device 4 from the connector housing 2, a tool can be inserted in the second notch in order to push the hook 31 back. Then, the slider 10 can be pulled upwardly from its locking position to its pre-locking position. The tabs 16 on the upper and lower lateral walls 12 of the rear grid 11 are lifted and the strain relief device 4 can be moved back along the cables 14.

**[0021]** A second embodiment of connector 1 is shown on FIGS. 9 to 12. The only difference between the connectors 1 of the first and second embodiments lies in the strain relief device 4. Consequently, only the strain relief device 4 will be described again.

**[0022]** Referring to FIGS. 9 to 12, the strain relief device 4 according to the second embodiment comprises a rear grid 9 and a slider 10. The rear grid 9 has a general parallelepipedal shape with a rear wall 11 and four lateral walls 12. The four lateral walls 12 extend from the rear wall 11 parallel to the longitudinal direction L of the housing 2. The rear wall 11 substantially closes the housing 2 except where two passages 13 are kept for cables 14 to pass through. The four lateral walls 12 surround the external surface of a rear portion 15 of the housing 2. The upper and lower lateral walls 12 comprise each two tabs with a notch locked on a protrusion 17 made on the external surface of the housing 2. Consequently, the rear grid 9 is attached to the housing 2 with fixing means located outside the housing 2. The rear wall 11 is located against the rear edge of the housing 2, when the strain relief device 4 is mounted on the housing 2.

**[0023]** The rear wall 11 comprises a passage 13 for each cable 14. Each passage 13 is bordered by a semi-cylindrical wall 39 extending, from the rear wall 11 surface, outwardly relatively to the housing 2. The semi-cylindrical wall 39 is strengthened by outward pillars 20. Advantageously, spikes 37 are formed on the inner surface of the semi-cylindrical wall 39.

**[0024]** A slider 10 is slidably mounted on the rear grid 9. The slider 10 has a panel 40 having a general rectangular shape, with a pushing portion 25 on an upper edge or side. The panel 40 also has two lateral sides 41 and a lower side 42 having two generally semi-circular recesses 43. Spikes 37 are also formed on the edge of the semi-circular recesses 43. Each semi-circular recess 43 is opposite a respective semi-cylindrical wall 39. When the slider 10 is in its locking position, each semi-circular recess 43 and its corresponding semi-cylindrical wall 39 form a round retention means around a cable 14. The slider 10 has two lateral flexible locking legs 29 and one central flexible locking leg 30. Each one of the two lateral flexible locking legs 29 extends from an upper corner (a corner between the upper side and a lateral side 41), and runs alongside a lateral side 41. A lateral hook 44 is located at the free end of each lateral flexible locking leg 29. This lateral hook 44 extends inwardly, toward a lateral side 41. In the pre-locking and locking positions of the slider 10, each lateral hook 44 engages respectively in a first notch and a second notch formed in the rear grid 9 of the strain relief device 4.

**[0025]** The central flexible locking leg 30 extends in a general direction parallel to, and from, the main face 28 of the slider panel 40 which faces the rear wall 11 of the rear grid 9. A hook 32 projects from an end of the central flexible locking leg 30. In the pre-locking position, the slider 10 is downwardly stopped by this hook 32 and upwardly retained by the lateral hooks 44. In this pre-locking position, the edges of the semi-circular recesses 43 cannot interact with the outer surfaces of cables 14 passing through the passages 13. When a cable 14 is inserted in a passage 13, it is not blocked. In the pre-locking position, the pushing portion 25 of the slider 10 projects over the upper lateral face of the rear grid 9.

**[0026]** When the strain relief device 4 is mounted on the housing 2, the housing 2 pushes a tooth 45 located in the vicinity of the free end of the central flexible locking leg 30. This tooth 45 is pushed back and the hook 32 is released from the notch in which it is located in the pre-locking position. Then, the slider 10 can be pushed down by an operator toward its locking position. In the locking position, the tooth 45 is accommodated in a free space 46 so as to keep the central flexible locking leg 30 unconstrained. In the locking position, the lateral hooks 44 block the slider 10 so as to prevent an upward translation, while the edges of the semi-circular recesses 43 pinch the cables 14 in the passages 13 (See FIG.12).

**[0027]** If there is a need for removing the strain relief device 4 from the connector housing 2, the lateral flexible locking legs 29 are laterally spaced apart from the rear grid 9. Then, the slider 10 can be pulled upwardly from its locking position to its pre-locking position. The tabs on the upper and lower lateral walls 12 of the rear grid 9 are lifted and the strain relief device 4 can be moved back along the cables 14.

**[0028]** A third embodiment of connector 1 is shown on FIG. 13. The only difference between the connectors 1 of the first and second embodiments and the connector 1 of the third embodiment lies in the strain relief device 4. Consequently, only the strain relief device 4 will be

described again.

**[0029]** Referring to FIG. 13, the strain relief device 4 according to the third embodiment comprises a rear grid 9 and a slider 10. The rear grid 9 has a general parallelepipedal shape with a rear wall 11 and four lateral walls 12. The four lateral walls 12 extend from the rear wall 11 parallel to the longitudinal direction L of the housing 2. The rear wall 11 substantially closes the connector housing except where two passages 13 are kept for cables 14 to pass through. The four lateral walls 12 surround the external surface of a rear portion of the housing 2. The upper and lower lateral walls 12 comprise each two tabs with a notch locked on a protrusion made on the external surface of the housing. The rear wall 11 is located against the rear edge of the housing 2, when the strain relief device 4 is mounted on the housing.

**[0030]** The rear wall 11 comprises a passage 13 for each cable 14. Each passage 13 is bordered by a partial tubular wall 47. For example, each partial tubular wall 47 extends, from a lower end 48 to an upper end 49, over about 200 to 270 degree around a cable 14. Each partial tubular wall 47 extends outwardly from the rear wall 11 and is strengthened by pillars 20. A flexible portion 50 extends in a curved shape from the lower end 48, to which it is flexibly hinged, towards a free end 51 close to the upper end 49 of the partial tubular wall 47. The flexible portion 50 can be moved to or away from the cable 14. Advantageously, spikes 37 are provided on the inner surface of the partial tubular wall 47 and the flexible portion 50.

**[0031]** The slider 10 is slidably mounted on the rear grid 9. The slider 10 has a wedged shape and is slidably mounted in a slider compartment 21. The slider compartment 21 has an opening 52 so that the lower portion of the slider 10 can come into contact with the flexible portions 50. The slider 10 has central and lateral flexible locking legs which are very similar to the central 30 and lateral 29 flexible locking legs of the slider 10 according to the second embodiment. The lateral locking legs 29 cooperate with lateral surfaces and notches of the slider compartment 21.

**[0032]** When the strain relief device 4 is mounted on the housing, the housing pushes a tooth located in the vicinity of the free end of the central flexible locking leg. This free end is pushed back and the hook is released from the notch in which it is located in the pre-locking position. Then, the slider 10 can be pushed down by an operator toward its locking position. In the locking position, the tooth is accommodated in a free space so as to keep the central flexible locking leg unconstrained. In the locking position, the lateral hooks 44 on the lateral flexible locking legs 29 cooperate with the lateral notches of the slider compartment 21 and block the slider 10 so as to prevent an upward translation. In the locking position, the lower portion of the slider 10 penetrates further an area located between the two cables 14 and pushes the flexible portions 50 against the outer surface of the cables 14 so as to pinch the cables 14 in the passages 13.

**[0033]** If there is a need for removing the strain relief device 4 from the connector housing 2, the lateral flexible locking legs 29 are laterally spaced apart from the slider compartment 21. Then, the slider 10 can be pulled upwardly from its locking position to its pre-locking position. The tabs on the upper and lower lateral walls 12 of the rear grid 9 are lifted and the strain relief device 4 can be moved back along the cables 14.

**[0034]** In the three connector embodiments described above the strain relief device 4 is designed to cooperate with two cables 14. However, it can be easily derived from the above description, connector embodiments with a strain relief device 4 designed to engage either only one cable 14 or more than two cables. In particular, the three above embodiments having a symmetry plane between the two cables 14, designing a connector for connecting only one cable 14 and corresponding for example to only one side of this symmetry plane is rather straightforward.

## Claims

1. Connector comprising a housing (2) for accommodating at least one terminal (7) and a rear grid (9) mounted on a rear portion (15) of the housing (2), wherein

   - said at least one terminal (7) is electrically linked to at least one cable (14) that exits the housing (2) through the rear grid (9),
   - the rear grid (9) comprises a strain relief device (4),

   **characterized in that** the strain relief device (4) comprises a slider (10) that can be moved, in a translation direction generally perpendicular to the cable (14) exiting from the housing (2), between a pre-locking position where it does not press the cable (14) and a locking position where it presses the cable (14), and **in that** the movement of the slider (10) from the pre-locking position to the locking position is determined by the mounting of the rear grid (9) on the housing (2).

2. Connector according to claim 1, wherein the slider (10) comprises locking means (30) for locking the slider (10) in the pre-locking position, the locking means (30) cooperating with the housing (2) for releasing the slider (10) from the pre-locking position, when the rear grid (9) is mounted on the housing (2).

3. Connector according to claim 1 or 2, wherein the slider (10) comprises a surface for pressing an outer surface of the cable (14) when the slider (10) is in its locking position.

4. Connector according to claim 3, comprising at least

two cables (14) and wherein the slider (10) has a wedged shape with a portion which penetrates an area (36) located between the two cables (14), when the slider (10) is in its locking position.

**5.** Connector according to claim 3, comprising at least two cables (14) and wherein the slider (10) has generally semi-circular recesses (43) for pinching the cables (14), against opposite respective semi-cylindrical walls (39), over corresponding semi-circular portions of the cables (14), in the passages (13), when the slider (10) is in its locking position.

**6.** Connector according to claim 3, comprising flexible portions (50) having a curved shape and flexibly hinged so as to be moved to or away from a respective corresponding cable (14), and wherein, in its locking position the slider (10), pushes the flexible portions (50) against the outer surface of the corresponding cable (14).

**7.** Connector according to any preceding claim, wherein the slider (10) has flexible locking legs (30) enclosed in a compartment.

**8.** Connector according to any preceding claim, wherein the cable (14) has a conductive cross-section in a range of 16 to 70$mm^2$.

**9.** Method for assembling a connector comprising:

- providing at least one cable (14), one terminal (7), a connector housing (2), and a strain relief device (4) having a rear grid (9) with a passage (13) for the cable (14), and a slider (10) locked in a pre-locking position where the slider (10) leaves the passage (13) sufficiently clear for the cable (14) to pass through,
- passing the cable (14) through a passage (13) made in the rear grid (9),
- attaching the cable (14) to the terminal (7),
- mounting the rear grid (9) on a rear portion of the housing (2), thereby unlocking the slider (10),
- pressing the slider 10 in a locking position where it interacts with the cable (14).

**10.** Method according to claim 9, wherein the slider (10) is moved, between the pre-locking position and the locking position in a translation direction generally perpendicular to the cable (14) exiting from the housing (2).

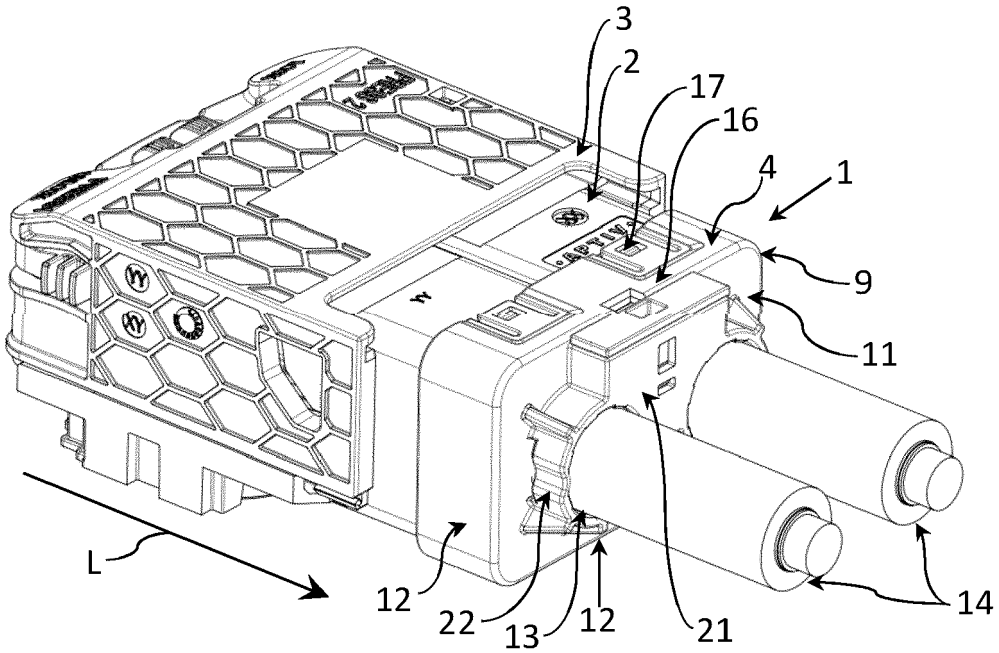
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Fig. 1

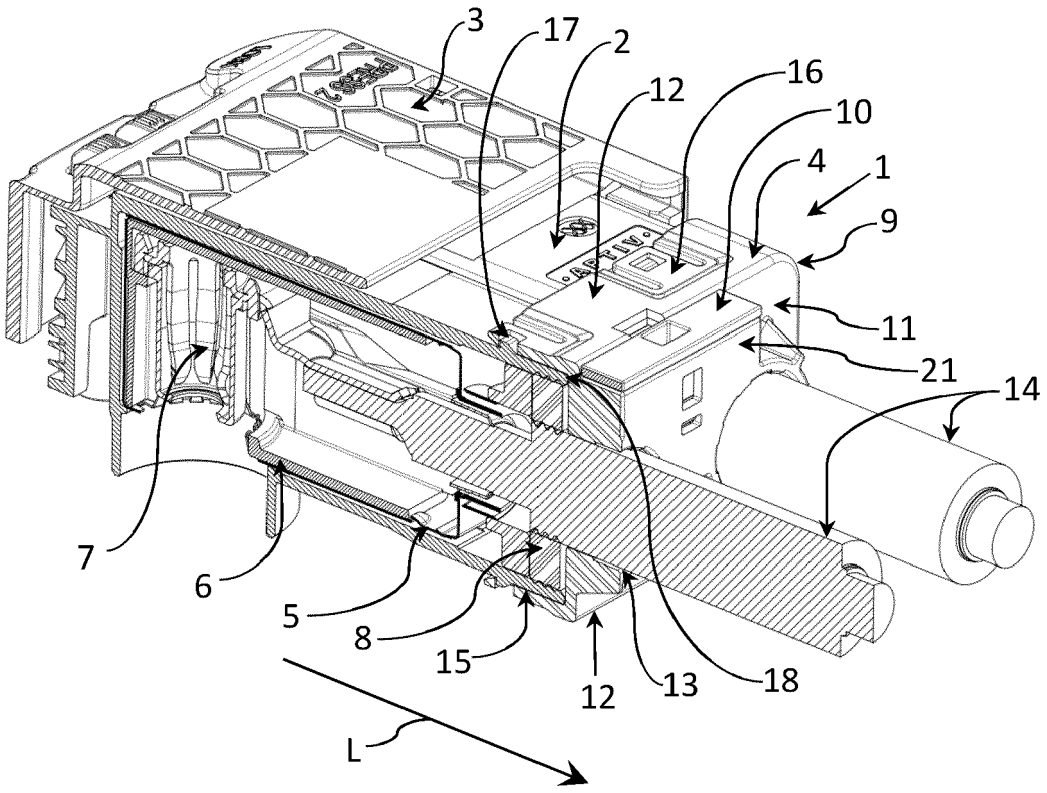
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Fig. 2

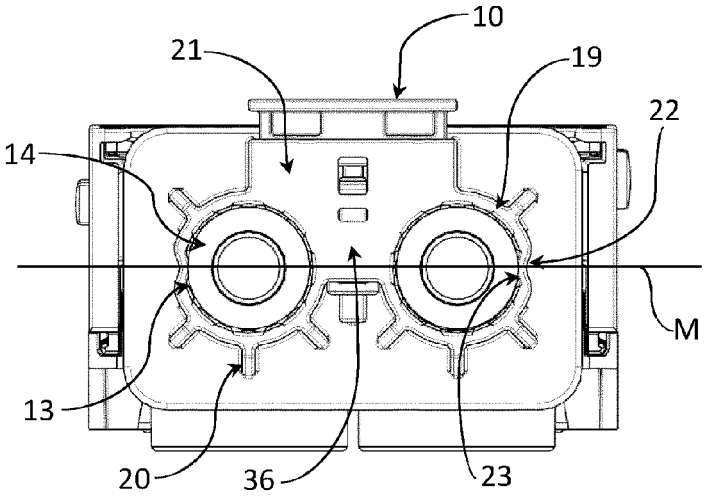


Fig. 3

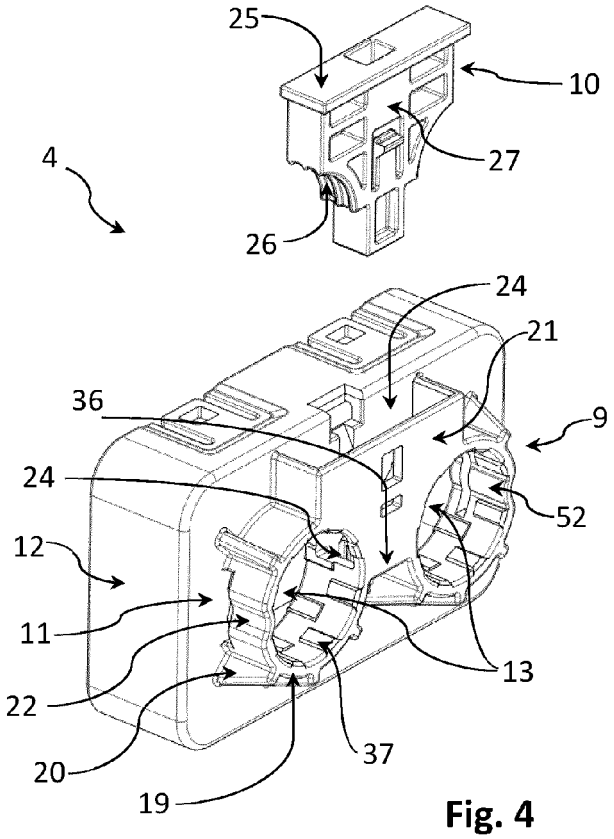


Fig. 4

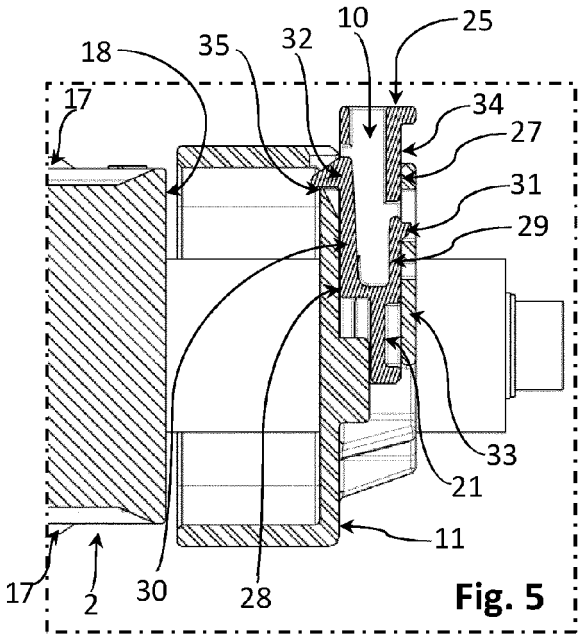


Fig. 5

Fig. 6

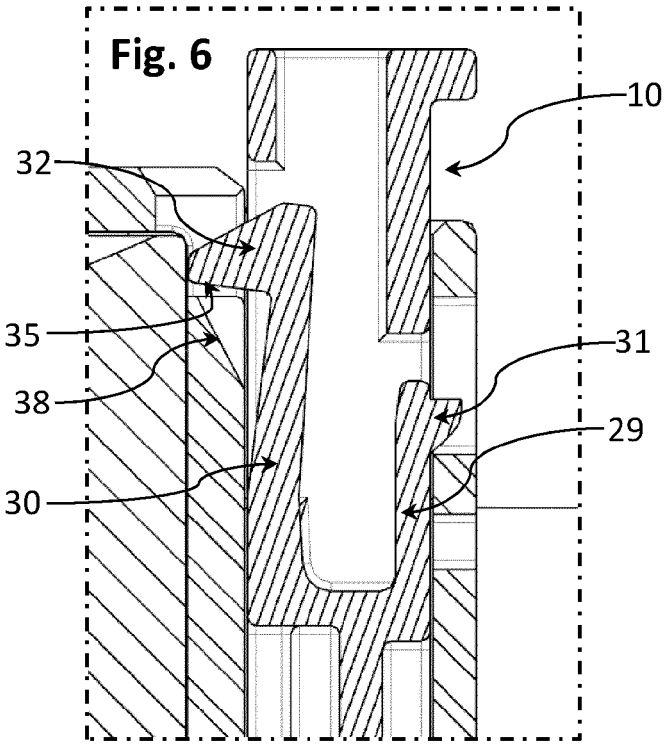


Fig. 7

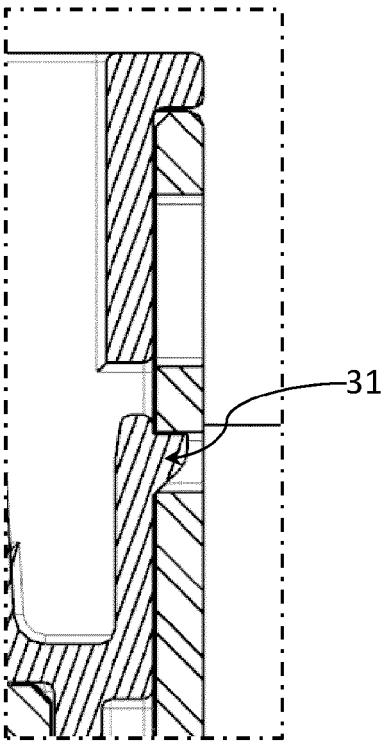


Fig. 8

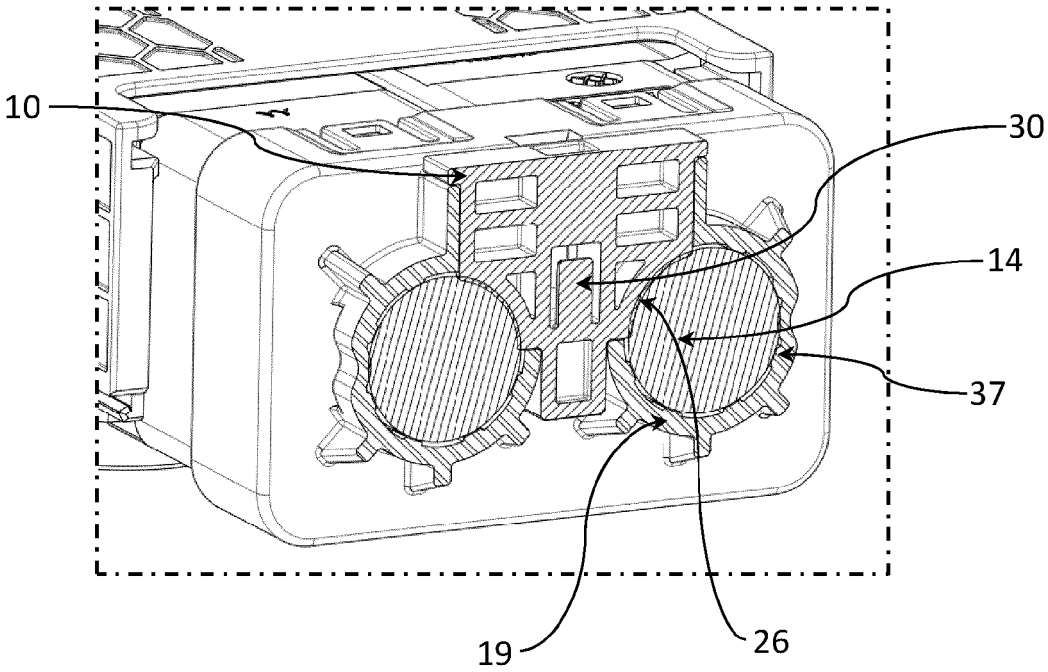

Fig. 9

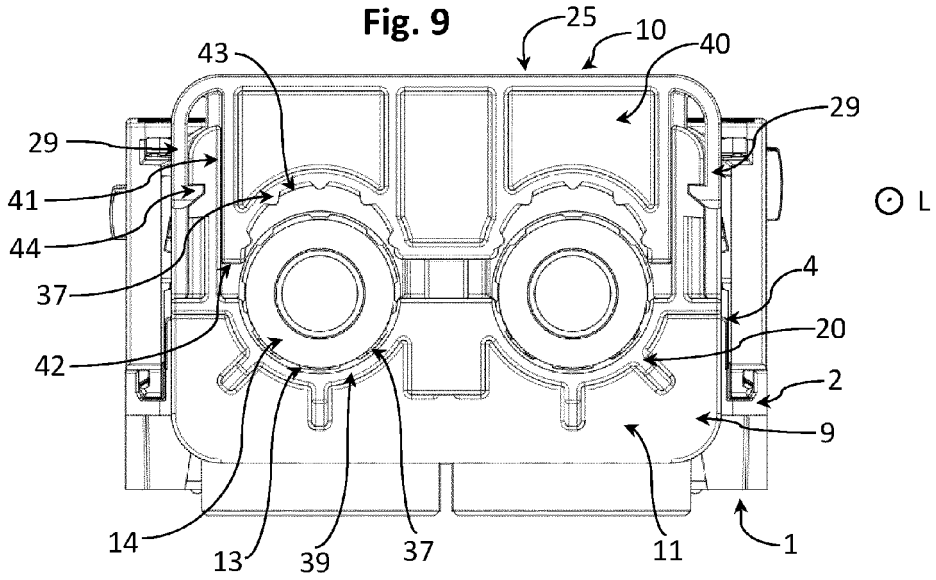


Fig. 10

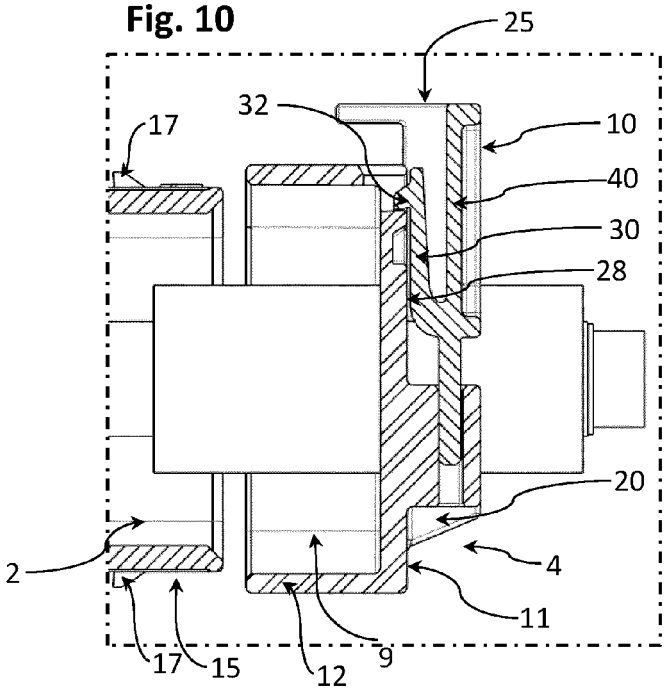


Fig. 11

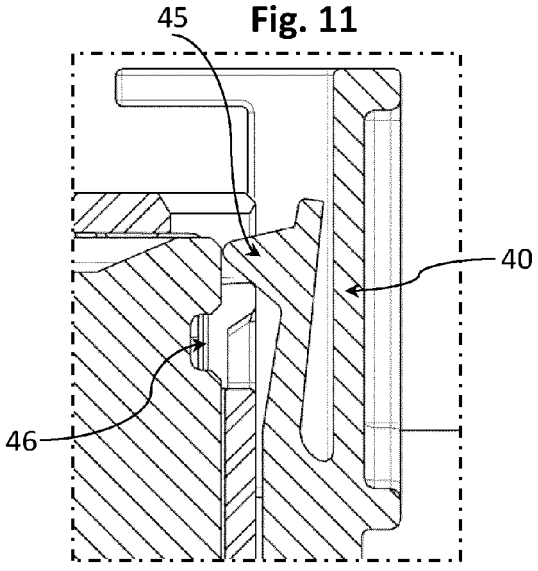

Fig. 12

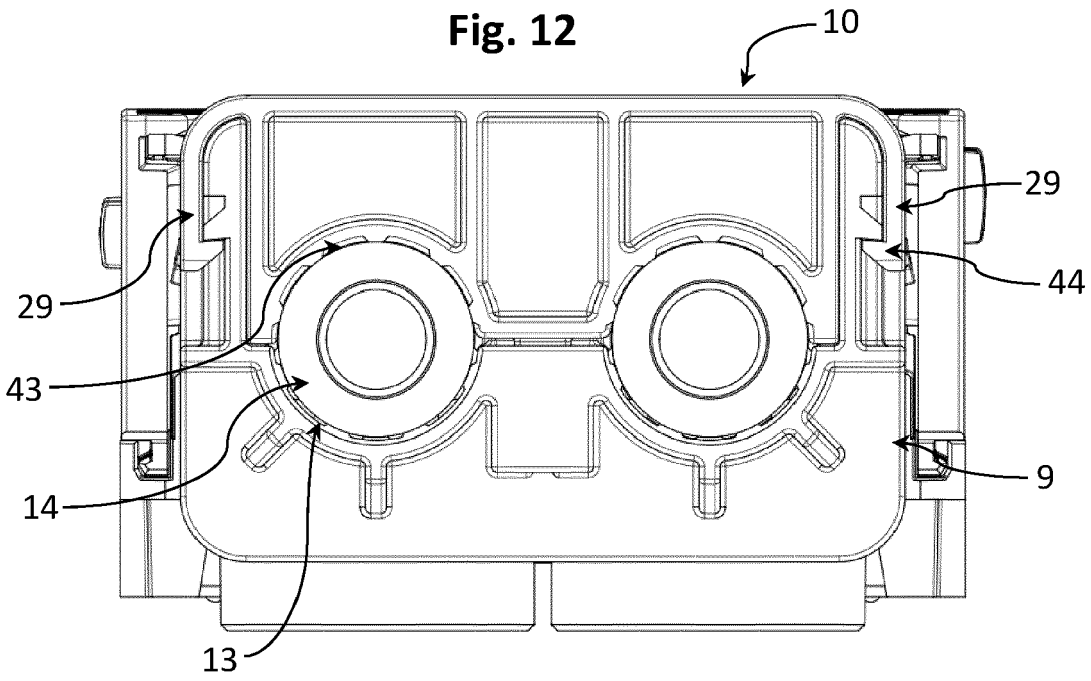
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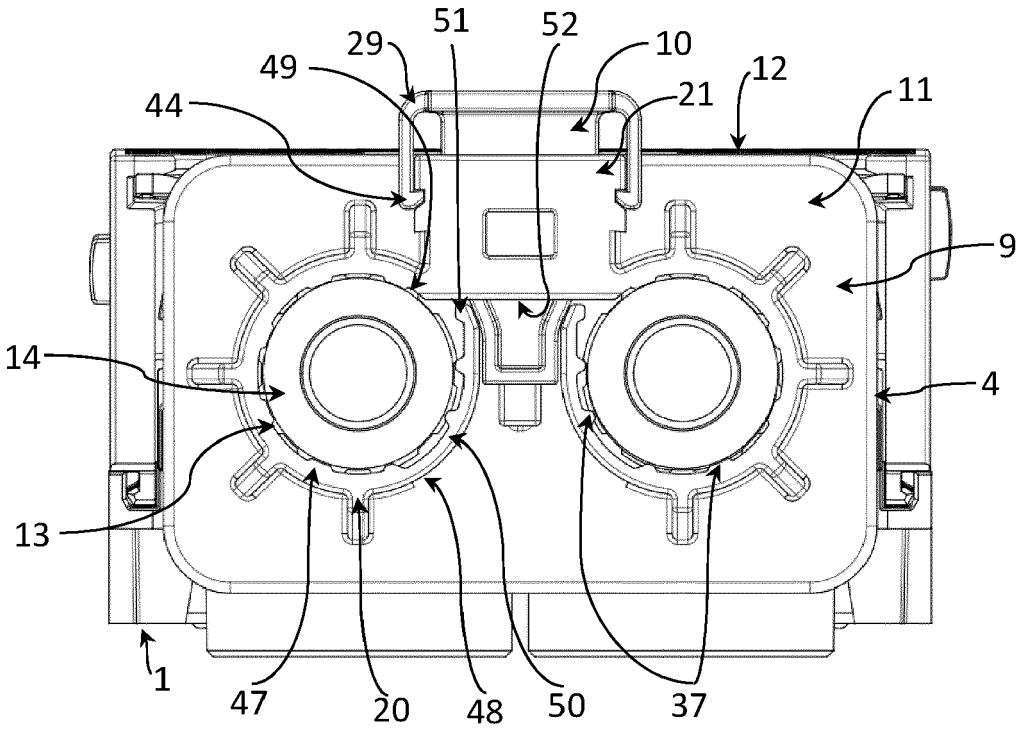
Fig. 13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Application Number
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