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(54) **ELECTRICAL CONNECTOR**

(57) Electrical connector 1 comprising a connector housing 10; a U-shaped lever 20, comprising a crossbar 22 and two sidebars 24, 25 extending from the ends of the crossbar 22; a pair of gear wheel elements 30 for meshing with a teethed rack 102 of a corresponding counter electrical connector 100, each gear wheel element 30 being integrally formed at a respective ends of the sidebars 24, 25 and being rotatable around a pair of rotation pins 14, 15 extending to the outside from opposing outer side walls 18 of the connector housing 10; at least one latch 40 for preventing rotation of the lever 20 from a lever initial position 47 to a lever final position 48, wherein the latch 40 is arranged at the inner side of one of the sidebars 24, 25 for engaging a latching protrusion 12 arranged at one of the side walls 18 of the connector housing 10; wherein the latch 40 is arranged to move out of engagement with the latching protrusion 12 when the electrically connector 1 is pushed onto the corresponding counter electrical connector 100.

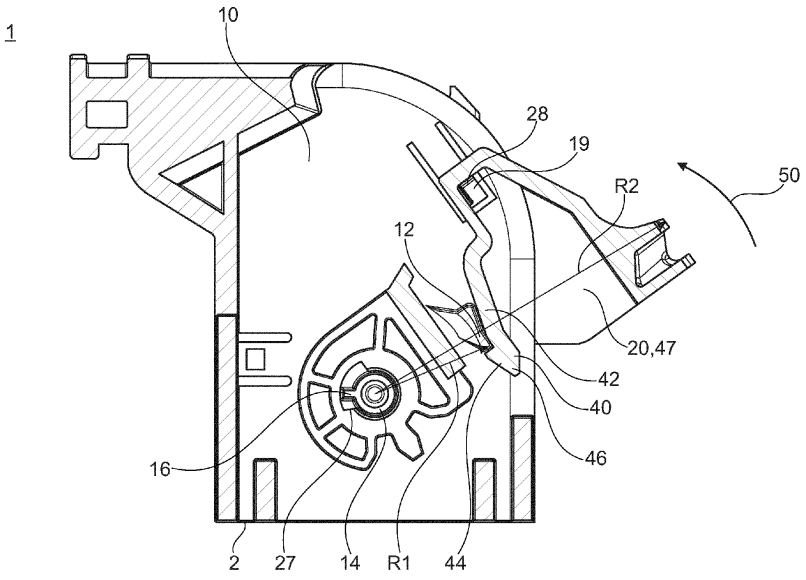

Fig. 2

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Description

1. Field of the invention

[0001] This invention generally relates to an electrical connector. Particularly it relates to an electrical connector that is connected and disconnected with a corresponding mating connector by operation of a lever of the electrical connector.

2. Prior art

[0002] A common "lever-type" electrical connector includes an assembly of a first connector or housing and a second counter connector or header or interface. To mate the connectors together, the assembly has an actuating or assist lever mounted for pivoting on the first connector with pivoting of the lever causing the first and second connectors to shift between unmated and fully mated configurations. Usually, the actuating lever and the second connector typically have a cam groove and a cam follower arrangement for drawing the second connector into mating condition with the first connector in response to pivoting of the lever. Such connectors are commonly used in the automotive industry but sometimes require a complex mechanics.

[0003] A typical example for such lever-type electrical connectors is to provide a generally U-shaped lever structure having a pair of relatively thin-walled lever arms that are disposed on opposite sides of the housing connector. The lever arms may have cam grooves for engaging cam follower projections or posts on opposite sides of the header assembly. These types of lever connectors are often used where relatively large forces are required to mate and un-mate a pair of connectors. For instance, frictional forces encountered during connecting and disconnecting the connectors may make the process difficult to perform by hand. In some cases, relatively large electrical connectors with high pin counts, such as connectors with 90 or more pin contacts, require at least about 300 N to mate or un-mate the connectors. Further, automotive industry standards specify a maximum of 75 N of user input force be required to perform this mating and un-mating of the connectors.

[0004] An example for such a lever-type connector with a U-shaped lever engaging cam-grooves is disclosed in the patent document US 10,374,356 B2.

[0005] Although such lever-type connectors provide significant advantages over connectors without mating aid, current lever-actuator configurations have problems during the mating operation. For a correct mating the lever has to be in an initial mating position that allows a correct engagement of the lever's connection features with features of the counter connector. If the lever is not in the correct initial mating position no engagement of the connection features may be possible or the lever cannot be actuated.

[0006] The object of the present invention is to overcome the disadvantages of the prior art connectors, particularly provide an electrical connector that easy in use, fail-safe and can be mated and un-mated with little effort.

3. Summary of the invention

[0007] The above-mentioned object is realized by an electrical connector according to claim 1 or by an electrical connector system according to claim 8 or by a method for the assembly of an electrical connector system according to claim 11.

[0008] Particularly, the above-mentioned object is realized by an electrical connector comprising a connector housing; a U-shaped lever, comprising a crossbar and two sidebars extending from the ends of the crossbar; a pair of gear wheel elements for meshing with a teethed rack of a corresponding counter electrical connector, each gear wheel element being integrally formed at a respective ends of the sidebars and being rotatable around a pair of rotation pins extending to the outside from opposing outer side walls of the connector housing; at least one latch for preventing rotation of the lever from a lever initial position to a lever final position; wherein the latch is arranged at the inner side of one of the sidebars for engaging a latching protrusion arranged at one of the side walls of the connector housing; wherein the latch is arranged to move out of engagement with the latching protrusion when the electrically connector is pushed onto the corresponding counter electrical connector.

[0009] The latch prevents unintended rotation of the lever prior to assembly and ensures that the lever is held in the perfect position for mating with a counter connector. Thus, the lever and the connector housing can be preassembled at the connector manufacturer prior to shipping to the harness maker. This saves time and assembly effort for the harness manufacturer. Further, due to the arrangement of the lever at the inner side of the sidebar it is protected from being unintentionally released in a non-mating position of the connector. Thus, for the final connection of the connector to a counter connector or counter terminal or counter interface the lever is in the optimal position for actuation. The latch further ensures that the connector has been pushed to the necessary amount onto the counter connector to assume a defined pre-mating position for the actuation of the lever. Thus, a hassle-free assembly of the connector is ensured.

[0010] Preferably, a latching position of the latch is arranged at a latch radius of 40% to 60% of a crossbar radius of the crossbar around one of the rotation pins. Thus, the latch has a large lever arm for applying a large retention force against unintentional rotation of the lever out of the lever initial position.

[0011] Preferably, the latch comprises an elastic latch arm and a latching hook at a free end of the latching arm. The elastic latching arm provides a good latching and an easy de-latching without significantly increasing the mating force of the connector.

[0012] Preferably the sidebars comprise pivot openings for rotation with the rotation pins; wherein the rotation pins comprise a rotation pin protrusion in radial direction and the pivot openings comprise a keyway entry for allowing rotation pin protrusions to pass during assembly of the lever. The keyway entry and the corresponding rotation pin protrusion ensure that the lever stays on the rotation pins after assembly.

[0013] Preferably, the keyway entry and the rotation pin protrusion are arranged to be not aligned in the lever initial position and not in any position from the lever initial position to the lever final position. Thus, the assembly position of the lever, where the keyway entries allow the rotation pin protrusions to pass through, is different from the lever initial position and different from any position from the lever initial position to the lever final position. Thus, the lever in use by the harness maker or by the final user is always rotatably fixed to the connector housing and cannot be lost.

[0014] Preferably, at least one of outer side walls further comprise a back-rotation prevention feature that in the pre-mating position prevents the lever from being rotated against the actuating rotation direction. Thus, the lever is also prevented from a rotation against the lever actuating rotation direction.

[0015] Preferably, the lever in the non-mating position is blocked from a rotation by the latch and the back-rotation prevention feature.

[0016] The above mentioned objectives are also be solved by an electrical connector system comprising an electrical connector as described before and a corresponding counter electrical connector; wherein the counter electrical connector 100 comprises a counter connector housing for receiving a connecting end of the connector housing; at least one de-latching protrusion that extends to the inside of the counter connector housing; wherein the latch is pushed out of engagement with the latching protrusion when the electrically connector is pushed onto the counter electrical connector to a assume the pre-mating position. By such an electrical connector system it is assured that the connectors can be connected easily.

[0017] Preferably, the de-latching protrusion comprises a slanted end opposite to a connection direction of the electrical connector system. Thus, the de-latching protrusion can push the latch generally perpendicular to the rotation direction for de-latching.

[0018] Preferably, the electrical connector comprises two latches and the counter electrical connector comprises two de-latching protrusions. Thus, the lever comprises one latch at each sidebar. This doubles the latching force and improves holding the lever in the lever initial position.

[0019] The above mentioned objectives are also be solved by a method for the assembly of an electrical connector system as described above; comprising the following steps:

a. pushing a connecting end of the electrical connector into a receiving end of the counter electrical connector until a pre-mating position is achieved;

b. by the pushing step, moving by means of the de-latching protrusion the latch out of engagement with the latching protrusion for allowing rotation of the lever in a lever actuation direction from a lever initial position to a lever final position; and

c. rotating the lever in actuation direction from the lever initial position to the lever final position for drawing the electrical connector completely into the counter electrical connector to assume a fully mated position.

4. Short description of the drawings

[0020] In the following, preferred embodiments of the invention are disclosed by reference to the accompanying figures, in which shows:

Fig. 1	a three-dimensional view of a preferred embodiment of an electrical connector;
Fig. 2	a sectional side view of the connector of Fig. 1;
Figs. 3A-D	a sequence of sectional side views of the connector of Fig. 1 and a counter connector during a mating procedure;
Fig. 4	a three-dimensional partial view of a counter connector;
Fig. 5	a top view of the counter connector of Fig. 4;
Figs. 6A-B	a top view and a side view of the connector of Fig. 1 during assembly of a lever to the connector housing;
Figs. 6B-C	a top view and a side view of the connector of Fig. 1 during assembly of a lever to the connector housing, wherein the lever is in a lever mounting position;
Fig. 7A	a sectional side view of the connector of Fig. 6B-C;
Fig. 7B	a side view of the connector of Fig. 1 during assembly of a lever to the connector housing, wherein the lever is in a lever initial position;
Figs. 8A-B	three-dimensional views of the connector of Fig. 1 during assembly of a terminal insert into the connector housing; and

Figs. 9A-D a sequence of side views of the connector of Fig. 1 and a counter connector during a mating procedure, corresponding to Figs. 3A-D.

5. Detailed description of preferred embodiments

[0021] In the following, preferred embodiments of the invention are described in detail with respect to the figures.

[0022] Fig. 1 shows an electrical connector 1 according to an embodiment of the invention. The electrical connector 1 comprises a connector housing 10, a U-shaped lever 20, a pair of first gear wheel elements 30 at the lower end of the lever and a latch 40 that protects the lever 20 from unintentionally movement in lever actuation direction 50.

[0023] The electrical connector 1 preferably comprises a terminal insert 60 that holds one or more electrical contacts (not shown) that are connected to corresponding electrical wires 62. It should be understood, that the electrical connector 1 according to the invention does not require the terminal insert 60, electrical contacts and wires 62, because such components may be added at a later point in time by a harness maker.

[0024] The housing 10 comprises an insert cavity 17 for holding one or more terminal inserts 60. The terminal inserts 60 are inserted from the side into the cavity 17 of the connector housing 10 and preferably latch therein by means of elastic latches 11 (see Fig. 8A-B) within corresponding snap hooks 64 at the terminal insert 60. The housing further has a connecting 2 by which the connector 1 can be inserted into a connecting cavity 150 of a counter connector 100 (see Figs. 4 and 5).

[0025] The lever 20 is generally U-shaped and comprises a generally horizontal crossbar 22 and two sidebars 24, 25 that extend along the side walls 18 of the connector housing 10. The sidebars 24, 25 extend generally perpendicular from the ends of the crossbar 22.

[0026] The lever 20 further comprises the pair of gear wheel elements 30 which are integrally formed with the lower end of the respective sidebars 24, 25. The gear wheel elements 30 and thus the overall lever 20, are rotatably mounted to the lateral side walls 18 see Fig. 2A and 2B of the connector housing around rotation pins 14, 15. The rotation pins 14, 15 extend from the opposing side walls 18 vertically to the outside.

[0027] The teeth of the gear wheel elements 30 mesh with teethed racks 102 of a counter electrical connector 100 (see Fig. 3C-D). By rotating the lever 20 in lever actuation direction 50 the gear wheel elements 30 draw the connector 1 into the counter connector 100 until a fully mated position 54 of connector 1 and counter connector 100 is achieved. In this fully mated position 54 (see Fig. 3D) the crossbar 22 has slipped over a lever lock hook 13 that holds the lever (releasably) in this position.

[0028] Figs. 2 and 3A-D show details of the functioning of the latch 40. The latch 40 is preferably an integral part of the lever 20 and integrally connected to one of the sidebars 24, 25 via an elastic latch arm 42. A lever 20 can preferably have one or two latches 40. As mentioned, the latch 40 prevents rotation of the lever 20 from a lever initial position 47 (Fig. 2, 3A-B) to a lever final position 48 (Fig. 3D). To do so the latch 40 is preferably arranged at the inner side of one of the sidebars 24, 25 for engaging a latching protrusion 12 arranged at one of the side walls 18 of the connector housing 10. The latch 40 engages the latching protrusion 12 by means of a latching hook 44 at the free end 46 of the latch arm 42. The latch 40 engages the latching protrusion 12 when the connector 1 is in a non-mating position 51 in which the connector is not at all or not sufficiently deep inserted into a counter connector 100 as shown in Figs. 3A-B.

[0029] As shown in Fig. 2 the latching position of the latch 40 is arranged at a latch radius R1 of 40% to 60% of a crossbar radius R2 of the crossbar around 50 one of the rotation pins 14, 15. Thus, the latch 40 has a large lever arm for applying a large retention force against unintentional rotation of the lever 20 out of the lever initial position 47.

[0030] When the connector 1 is further pushed from the non-mating position 51 of Fig. 3B into a pre-mating position of Fig. 3C the latch 40 is pushed out of engagement with the latching protrusion 12 by a de-latching protrusion 120 of the counter connector. As shown in Fig. 3C the de-latching protrusion 120 preferably pushes the hook-shaped latch 40 sideways such that its elastic latch arm 42 bends and the latch 40 comes out of engagement with the latching protrusion 12. By de-latching the latch 40 the lever 20 is free to move in lever actuation direction 50. Thus, an assembly person can move the lever 20 in actuation direction 50 such that the teeth of the gear wheel elements 30 engage the teethed racks 102 and draw the connector 1 into fully mated position 54 (see Fig. 3D).

[0031] Figs. 4 and 5 shows further details of the preferred embodiment of the counter connector 100. The de-latching protrusion 120 preferably comprises a slanted end 122 that facilitates bending the latch 40 sideways. Further, the counter connector 100 comprises a plurality of male electrical terminals 130 of different sizes and shapes. To ensure that only the correct connector 1 mates with counter connector 100 it further comprises coding ridges 140 that correspond to coding slots 32 of the connector 1.

[0032] The housing 10 further comprises at the outer side walls 18 a back-rotation prevention feature 19, preferably in form of a snap hook, that prevents the lever 10) from being rotated against the lever actuating direction 50. As shown in Fig. 2 the back-rotation prevention feature 19 engages a ridge 28 of the lever 20, when the lever is in the lever initial position 47.

[0033] Figs. 6A-6D show the assembly of the lever 20 to the connector housing 10. In a first step as shown in Figs. 6A-B the sidebars 24, 25 of the lever 20 are bent outwards and the lever 20 is pushed onto the connector

housing 10 wherein the sidebars 24, 25 are aligned with the sidewalls 18 of the connector housing 10. Then pivot openings 26 of the sidebars 24, 25 are slipped onto the rotation pins 14, 15. The pivot openings 26 comprise a keyway entries 27 at the outer perimeter of the pivot openings 26 and the pivot pins 14, 15 comprise corresponding rotation pin protrusions 16 at the outer perimeter of the pivot pins 14, 15. Thus, lever 20 can only be mounted to rotation pins 14, 15 when the rotation pin protrusions 16 are aligned with the keyway entries 27. This is the case, when the lever 20 is in its lever mounting position 49 as shown in Fig. 6D.

[0034] When the lever 20 is moved out of this lever mounting position 49 the rotation pin protrusions 16 engage an outer side wall of the sidebars 24, 25 and securely hold the pivot openings 26 onto the corresponding rotation pins 14, 15.

[0035] Figs. 7A-B show the further assembly of the lever 20 to the connector housing 10. From the lever mounting position 49 of Fig. 7A the lever 20 is rotated in lever actuation direction 50 as shown be the arrow. Thereby the latch 40 catches the latching protrusion 12 and the back-rotation prevention feature 19 catches the ridge 28. This provides a bi-directional locking of the lever 20. Further, the rotation pin protrusions 16 engage an outer side wall of the sidebars 24, 25 to securely fix the lever 20 to the connector housing 10. Thus, the lever 20 reaches the lever initial position 47 of Fig. 7B.

[0036] In this lever initial position 47 the lever 20 is securely mounted to the connector housing 10 and cannot rotate. By preventing rotation it is on the one hand ensured that the lever 20 does not separate from the connector housing 10 and that the lever 20 is in the optimal position for the mating of the electrical connector 1 with the counter electrical connector 100. In this lever initial position 47 the connector 1 is ready to be shipped to a harness manufacturer.

[0037] Figs. 8A-B show the further assembly step of inserting a terminal insert 60 with the electrical terminals inside (not shown) and the electrical or optical wires 62 attached. The terminals (not shown) are secured within the terminal insert 60 by a terminal position assurance element (TPA) 66. As shown the terminal insert 60 is inserted into an insert cavity 17 from the side of the connector housing 1. By the insertion the terminal insert 60 latches by the snap hooks 64 at both sides of the terminal insert 60 by means of elastic latches 11 with the connector housing 10. Instead of only one large terminal insert 60 it is also possible to use more than one smaller terminal inserts 60, for example for different electrical or optical terminal types.

[0038] Figs. 9A-D in combination with Figs. 3A-D show an electrical connector system 200 comprising of a connector 1 and a corresponding counter connector 100. Particularly, these figures show a method for the assembly of the electrical connector system 200. The method comprising the following steps:

a. pushing (Figs. 9A to 9C) a connecting end 2 of the electrical connector 1 into a connecting cavity 150 of the counter electrical connector 100 until a pre-mating position 52 is achieved;

b. by the pushing step, moving by means of the de-latching protrusion 120 the latch 40 out of engagement with the latching protrusion 12 for allowing rotation of the lever 40 in a lever actuation direction 50 from a lever initial position 47 to a lever final position 48; and

c. rotating the lever 40 in actuation direction 50 from the lever initial position 47 (Fig. 9C) to the lever final position 48 (Fig. 9D) for drawing the electrical connector 1 completely into the counter electrical connector 100 to assume a fully mated position 54.

[0039] The latch 40 prevents unintended rotation of the lever 20 prior to final assembly and ensures that the lever 20 is held in the perfect position for mating with the counter connector 100. The latch 40 also ensures that the electrical connector 1 has been pushed to the necessary amount onto the counter connector 100 as shown by the movement between the non-mating position 51 of Fig. 9B to the pre-mating position 52 of Fig. 9C in which the latch 40 is released by the de-latching protrusion 120 and the electrical connector 1 assumes a perfect position for the actuation of the lever 20. Thus, a hassle-free assembly of the electrical connector system 200 is ensured.

List of reference signs:

[0040]

1	electrical connector
2	connecting end
10	connector housing
11.	insert latches
12	latching protrusion
13	lever lock hook
14,15	rotation pins
16	rotation pin protrusions
17	insert cavity
18	side walls
19	back-rotation prevention feature
20	lever
21	protrusions
22	crossbar
24, 25	sidebars
26	pivot openings
27	keyway entries
28	ridge
30	gear wheel elements
40	latch
42	latch arm
44	latching hook

46	free end
47	lever initial position
48	lever final position
49	lever mounting position
50	lever actuation direction
51	non-mating position (nicht aufgesteckt)
52	pre-mating position (korrekt aufgesteckt, latch entriegelt)
54	fully mated position (vollstandig kontaktiert)
60	terminal insert
62	wires
64	snap hooks
66	terminal position assurance element (TPA)
100	counter electrical connector
102	teethed rack
110	counter connector housing
120	de-latching protrusion
122	slanted end
130	electrical terminals
140	coding ridges
150	connecting cavity
200	electrical connector system
R1	latch radius
R2	crossbar radius
CD	connection direction

Claims

1. Electrical connector (1) comprising:

a. a connector housing (10);
b. a U-shaped lever (20), comprising a crossbar (22) and two sidebars (24, 25) extending from the ends of the crossbar (22);
c. a pair of gear wheel elements (30) for meshing with a teethed rack (102) of a corresponding counter electrical connector (100), each gear wheel element (30) being integrally formed at a respective ends of the sidebars (24, 25) and being rotatable around a pair of rotation pins (14, 15) extending to the outside from opposing outer side walls (18) of the connector housing (10);
d. at least one latch (40) for preventing rotation of the lever (20) from a lever initial position (47) to a lever final position (48), wherein the latch (40) is arranged at the inner side of one of the sidebars (24, 25) for engaging a latching protrusion (12) arranged at one of the side walls (18) of the connector housing (10); wherein
e. the latch (40) is arranged to move out of engagement with the latching protrusion (12) when the electrically connector (1) is pushed onto the corresponding counter electrical connector (100).

2. Electrical connector according to claim 1, wherein a latching position of the latch (40) is arranged at a latch radius (R1) of 40% to 60% of a crossbar radius (R2) of the crossbar (22) around one of the rotation pins (14, 15).

3. Electrical connector according to one of the claims 1 or 2, wherein the latch (40) comprises an elastic latch arm (42) and a latching hook (44) at a free end (46) of the latching arm (42).

4. Electrical connector according to one of the claims 1 to 3, wherein the sidebars (24, 25) comprise pivot openings (26) for rotation with the rotation pins (14, 15); wherein the rotation pins (14, 15) comprise a rotation pin protrusion (16) in radial direction and the pivot openings (26) comprise a keyway entry (27) for allowing rotation pin protrusions (16) to pass during assembly of the lever (20).

5. Electrical connector according to claim 4, wherein the keyway entry (27) and the rotation pin protrusion (16) are arranged to be not aligned in the lever initial position (47) and not in any position from the lever initial position (47) to the lever final position (48).

6. Electrical connector according to one of the claims 1 to 5, wherein at least one of outer side walls (18) further comprise a back-rotation prevention feature (19) that prevents the lever (20) from being rotated against the lever actuating direction (50).

7. Electrical connector according to claim 6, wherein the lever (10) in the pre-mating position (52) is blocked from a rotation by the latch (40) and the back-rotation prevention feature (19).

8. Electrical connector system (200) comprising an electrical connector (1) according to one of the previous claims and a corresponding counter electrical connector (100); wherein the counter electrical connector (100) comprises:

a. a counter connector housing (110) for receiving a connecting end (2) of the connector housing (10);
b. at least one de-latching protrusion (120) that extends to the inside of the counter connector housing (110);
c. wherein the latch (40) is pushed out of engagement with the latching protrusion (12) when the electrically connector (1) is pushed onto the counter electrical connector (100) to a assume the pre-mating position (52).

9. Electrical connector system (200) according to claim 8, wherein the de-latching protrusion (120) comprises a slanted end (122) opposite to a connection direction (CD) of the electrical connector system (200).

10. Electrical connector system (200) according to one of the claims 8 or 9, wherein the electrical connector (1) comprises two latches (40) and the counter electrical connector (100) comprises two de-latching protrusions (120).

11. Method for the assembly of an electrical connector system (200) according to one of the claims 8 to 10; comprising the following steps:

a. pushing a connecting end (2) of the electrical connector (1) into a connecting cavity (150) of the counter electrical connector (100) until a pre-mating position (52) is achieved;
b. by the pushing step, moving by means of the de-latching protrusion (120) the latch (40) out of engagement with the latching protrusion (12) for allowing rotation of the lever (40) in a lever actuation direction (50) from a lever initial position (47) to a lever final position (48); and
c. rotating the lever (40) in actuation direction (50) from the lever initial position (47) to the lever final position (48) for drawing the electrical connector (1) completely into the counter electrical connector (100) to assume a fully mated position (54).

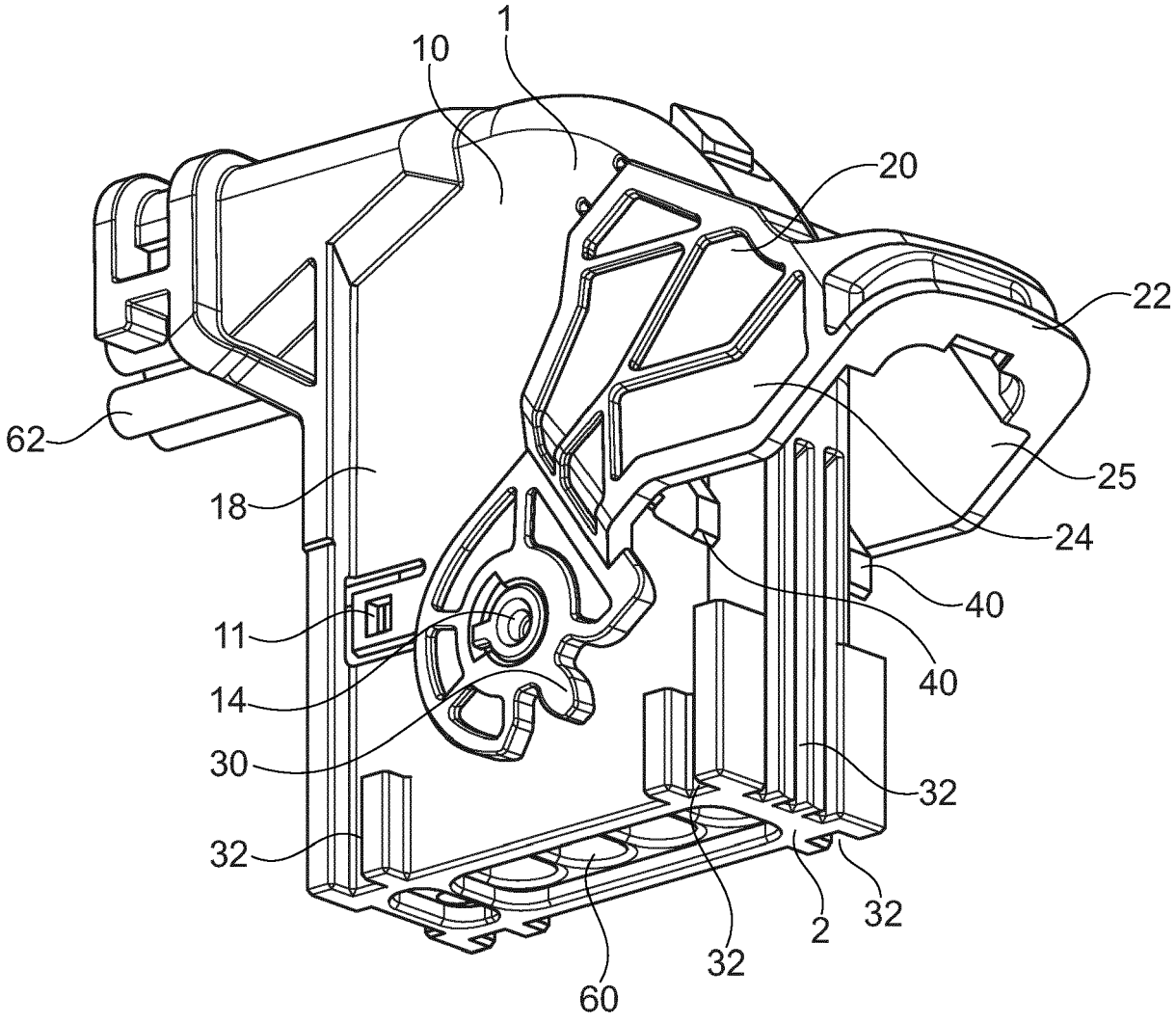

Fig. 1

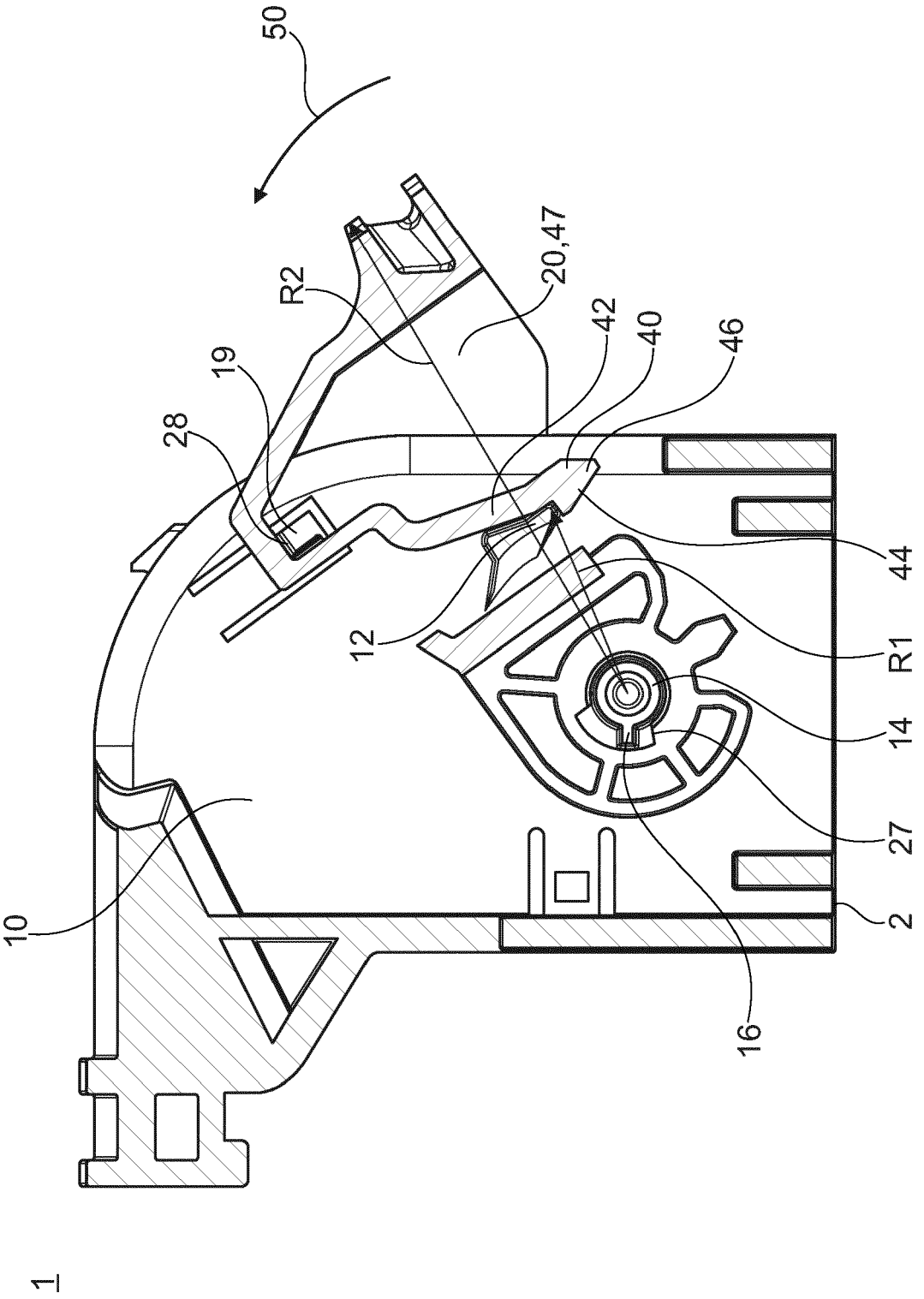

Fig. 2

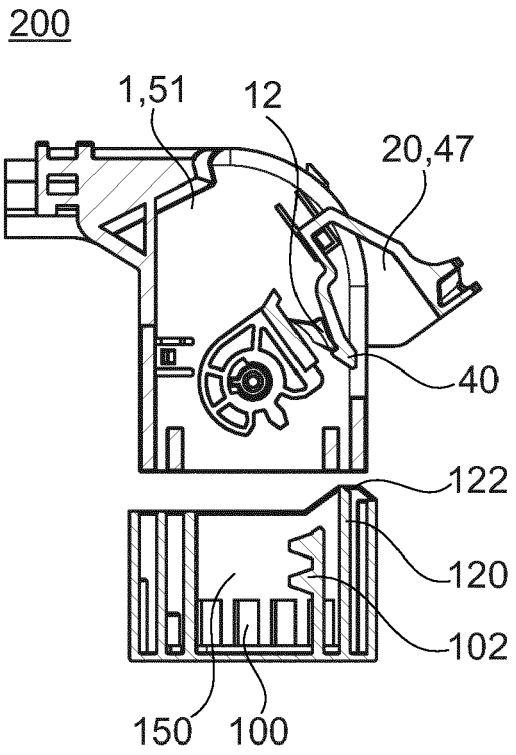

Fig. 3A

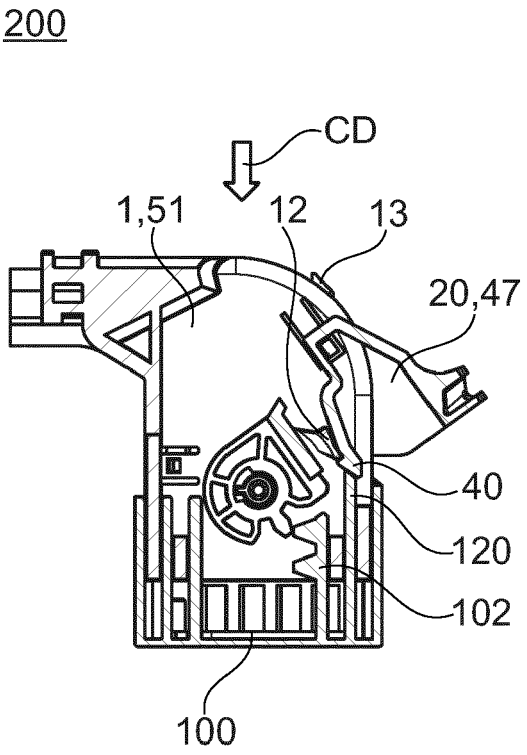

Fig. 3B

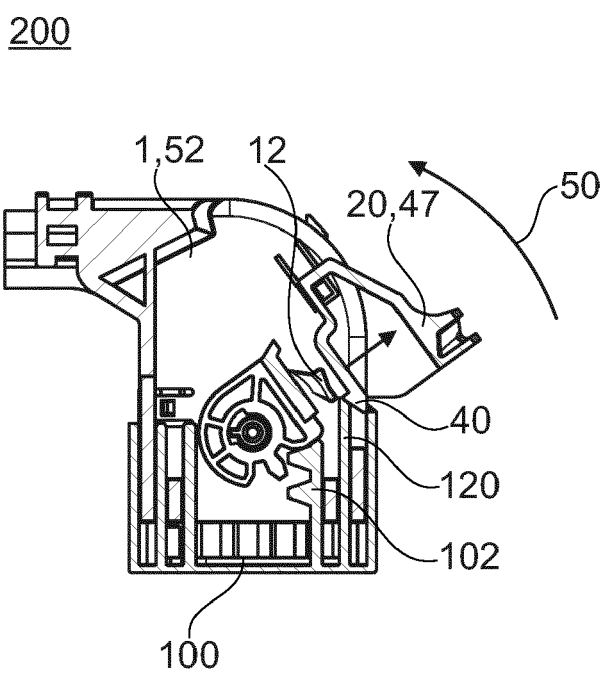

Fig. 3C

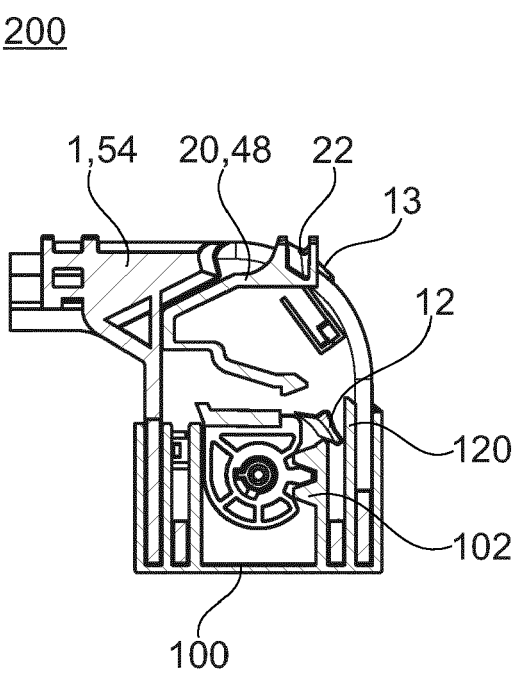

Fig. 3D

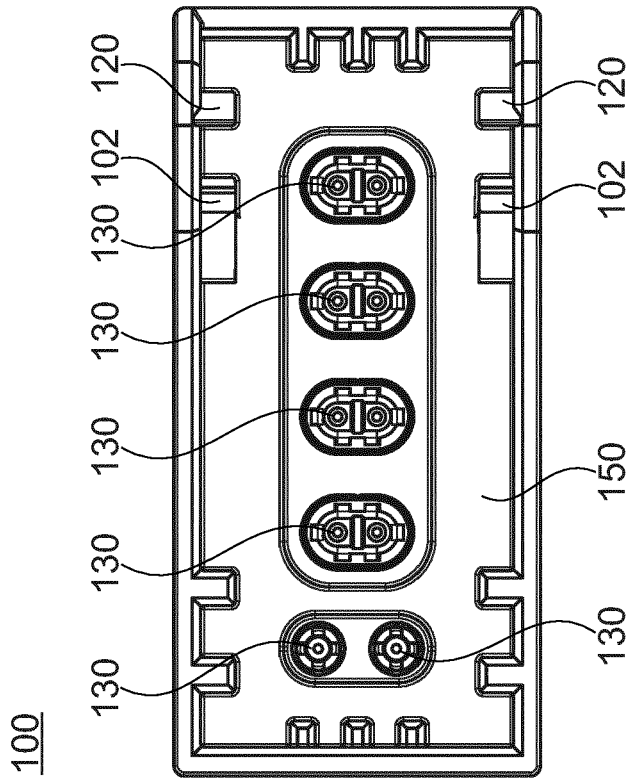
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Fig. 5

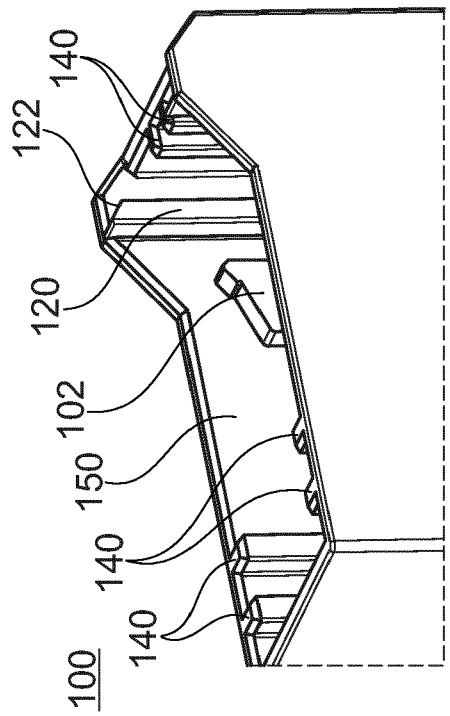
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Fig. 4

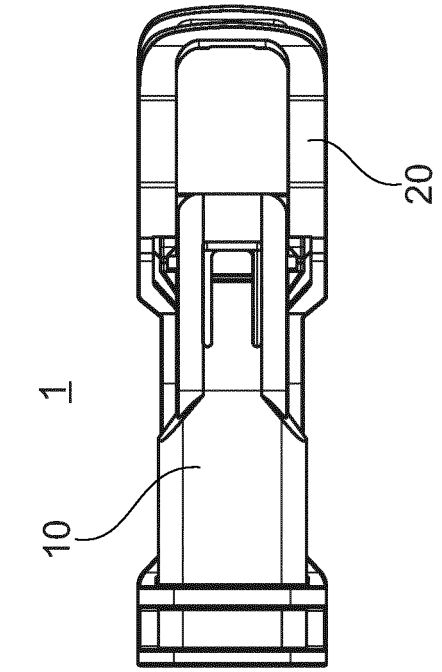

Fig. 6C

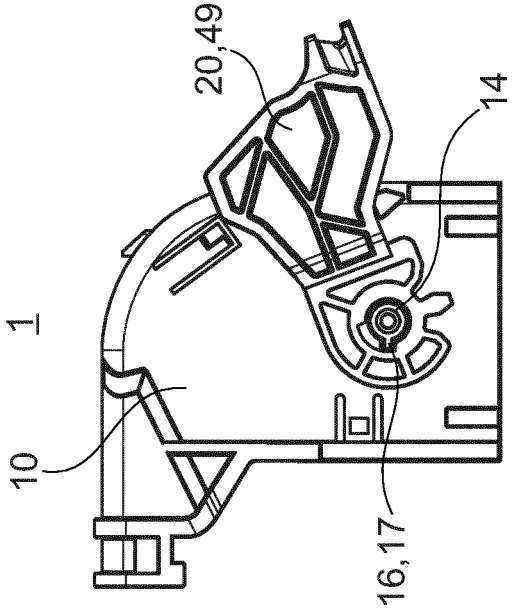

Fig. 6D

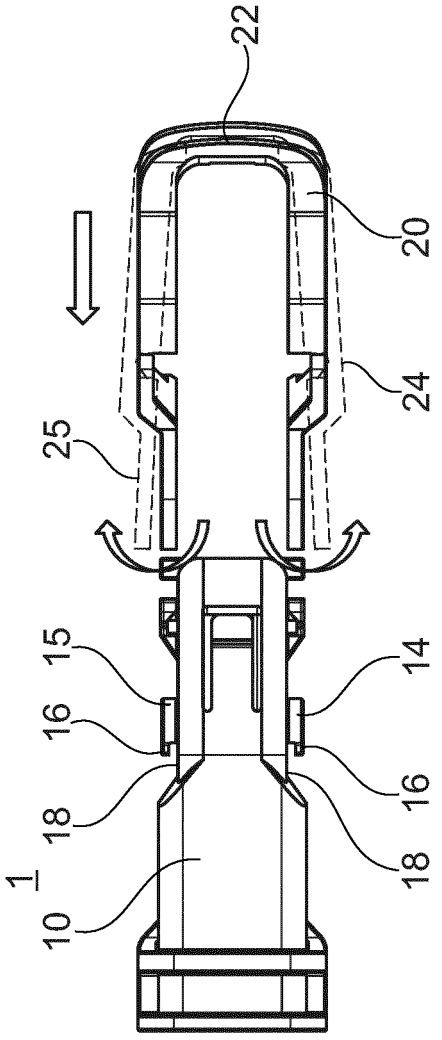

Fig. 6A

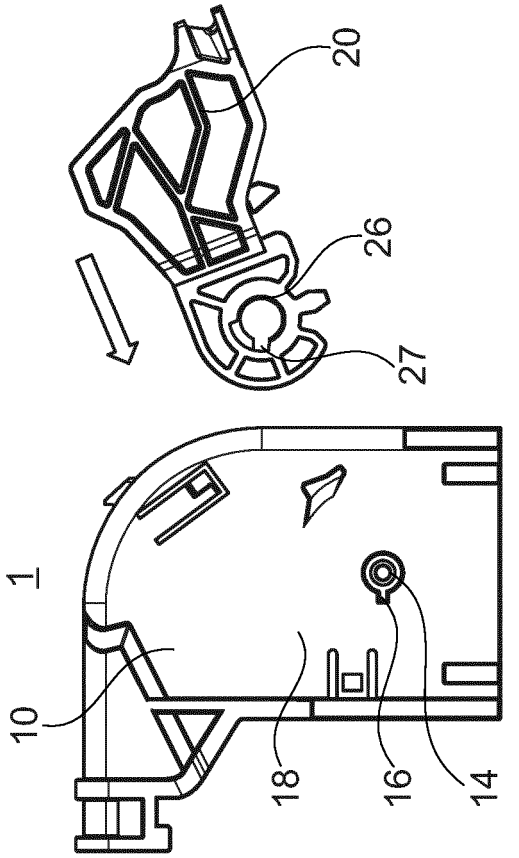

Fig. 6B

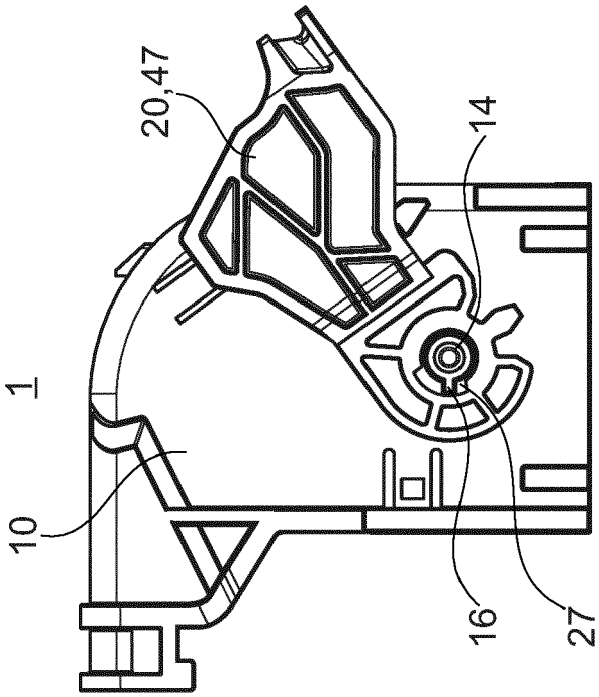

Fig. 7B

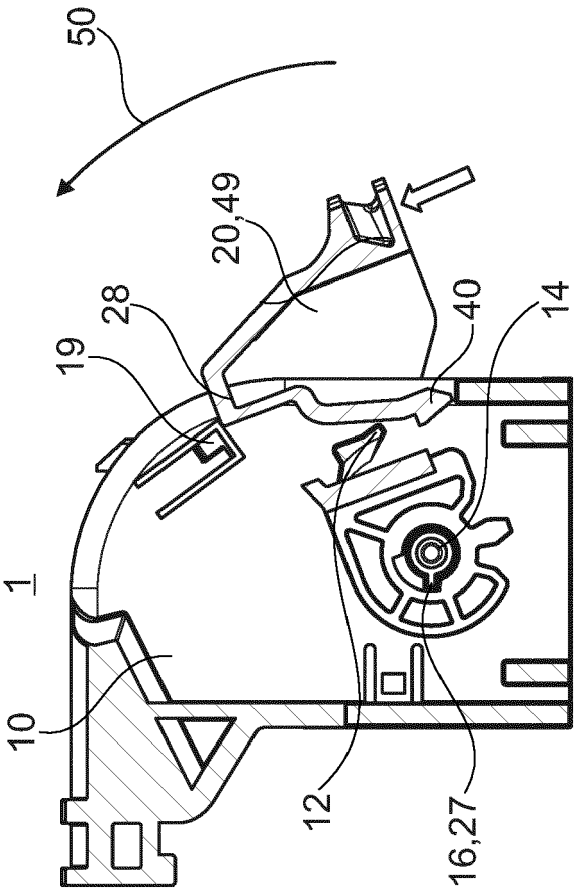

Fig. 7A

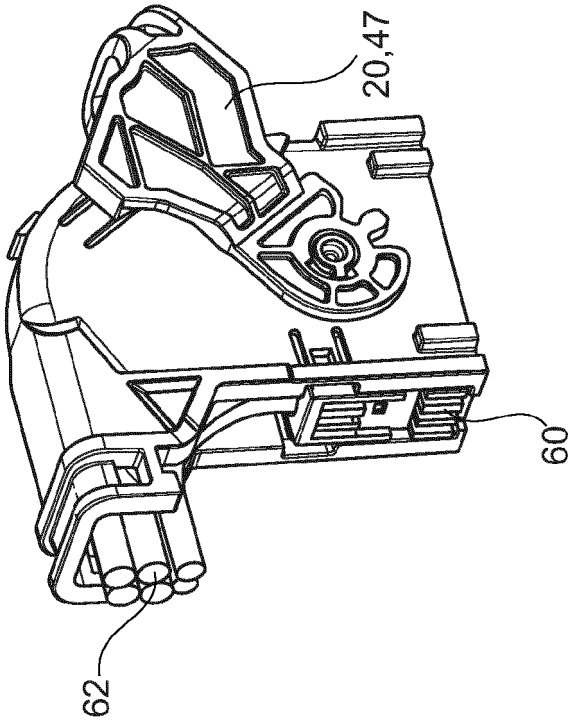

Fig. 8B

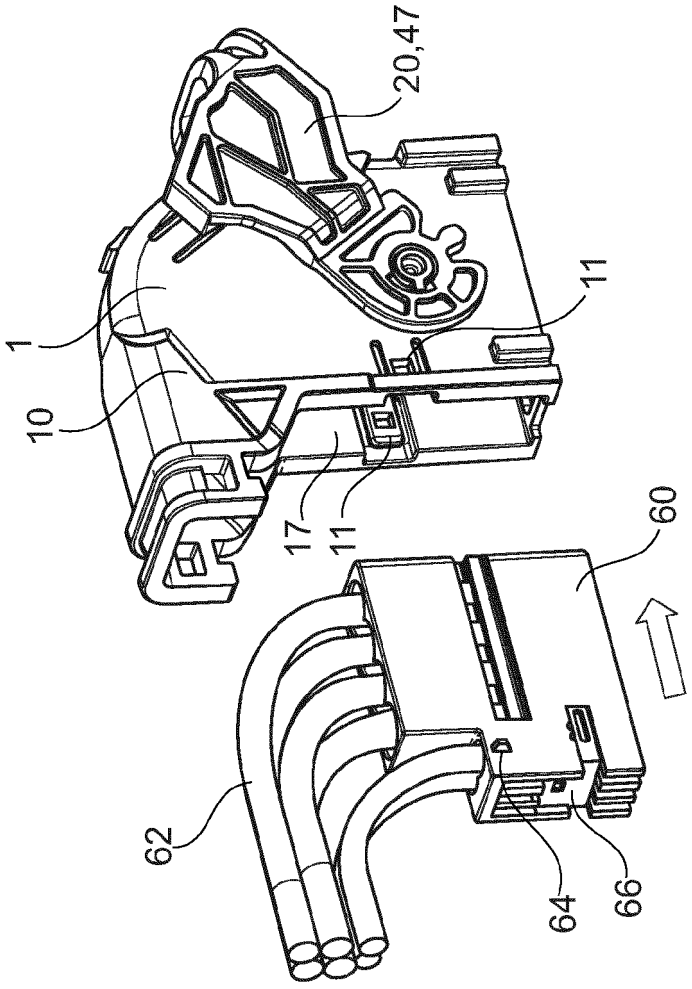

Fig. 8A

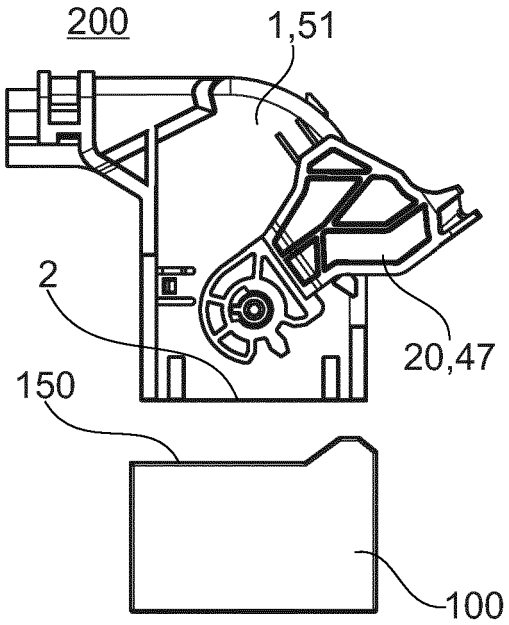

Fig. 9A

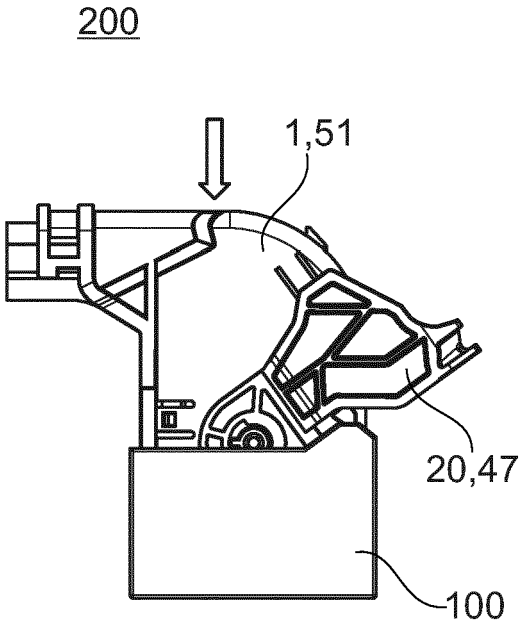

Fig. 9B

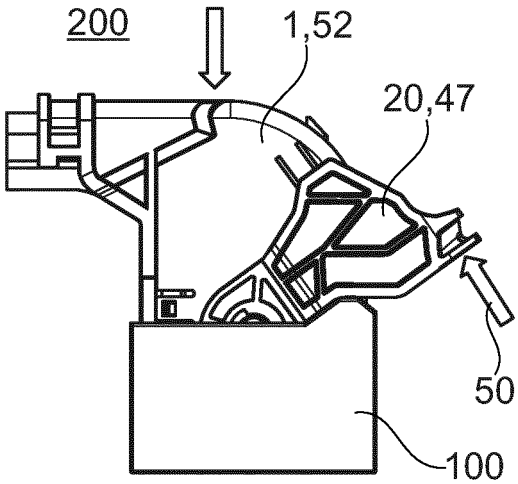

Fig. 9C

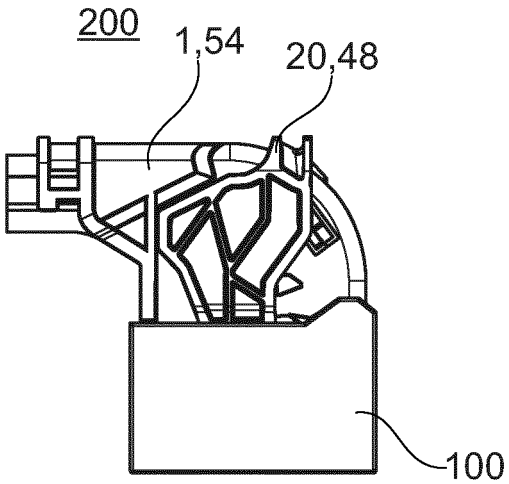

Fig. 9D

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EUROPEAN SEARCH REPORT

Application Number
EP 23 21 0356

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	US 6 325 647 B1 (MAY GUNTRAM [DE] ET AL) 4 December 2001 (2001-12-04) * column 2, line 30 - column 4, line 55; figures 1-4 *	1-11	INV. H01R13/629
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H01R

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	16 April 2024	Gomes Sirenkov E M.

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