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(72) Inventors:
• **URBANIAK, Andreas**
48153 Münster (DE)
• **GANESAN, Uvaraj**
600077 Poonamallee, Chennai, Tamilnadu (IN)

(71) Applicant: **Aptiv Technologies AG**
8200 Schaffhausen (CH)

(74) Representative: **Bardehle Pagenberg**
Partnerschaft mbB
Patentanwälte Rechtsanwälte
Prinzregentenplatz 7
81675 München (DE)

(54) **ELECTRICAL CONNECTOR ASSEMBLY WITH MATE ASSIST LEVER**

(57) The present invention relates to an electrical connector assembly comprising a connector comprising a connector housing (20), a corresponding counter-connector (30) comprising a counter-connector housing and a mate assist member comprising a rotatable lever (10) to facilitate the mating process of the connector with the corresponding counter connector. The lever further com-

prises a lever cam slot (11) and a lever cam peg (12) and the connector housing (20) comprises a connector cam peg (22) and a connector cam slot (24), wherein in mounted condition, the lever cam slot (11) interacts with the connector cam peg (22) and the lever cam peg (12) interacts with the connector cam slot (24).

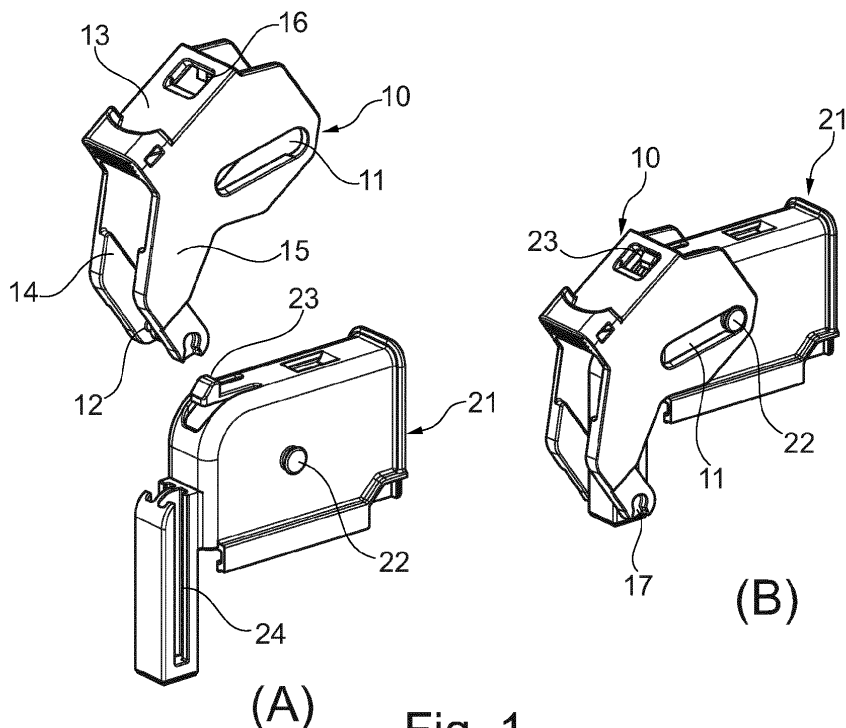


Fig. 1

Description

1. Field of the invention

[0001] This invention generally relates to an electrical connector arrangement. Particularly, it relates to an electrical connector arrangement comprising connector and counter connector and a mate assist device in the form of a rotary lever, to facilitate the mating of the connectors.

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. 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 counter connector typically have a cam slot (groove) and a cam peg (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 offer room for improvement.

[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 pegs 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] A typical example of a connector assembly with a mate assist mechanism in the form of a rotatable lever is described in WO 2013/ 011345 A1. The mate assist lever disclosed in this document is provided rotatable on a connector housing and has generally a U-shaped form with two lever arms connected by a common web. Each lever arm comprises a cam groove (cam slot) that is adapted to interact with a corresponding cam peg or cam follower provided on the counter connector housing. Upon mating, the cam follower is introduced in the cam groove of the lever and upon rotating of the lever from a preliminary mating position to a fully mated position, the cam groove acts on the cam follower, whereby the two connectors to be mated are pulled towards each other.

[0005] Although such lever-type connectors provide significant advantages over connectors without mating aid, current lever-actuator configurations have problems to mate or to un-mate large connectors such as described above while keeping user input force at or below the level specified by the industry standard, or the levers are relatively large to generate the required forces. With current lever connector configurations, the mechanical advantage provided by the lever actuators is often not sufficient to overcome the high frictional forces seen by large electrical connector assemblies between pins and sockets of the connectors as they are mated and un-mated. Generally speaking, the known solutions of the prior art with regard to rotary-lever-type mate assist devices function satisfactorily, but still offer room for improvement.

[0006] The object of the present invention is to overcome the disadvantages of the prior art connectors, and particularly to provide an electrical connector that can be mated and un-mated with little effort, provides a reliable design and has only a small space consumption.

3. Summary of the invention

[0007] The above-mentioned object is realized by an electrical connector assembly according to claim 1.

[0008] Particularly, the above-mentioned object is realized by an electrical connector assembly comprising a connector comprising a connector housing, a corresponding counter-connector comprising a counter-connector housing and a mate assist member comprising a rotatable lever to facilitate the mating process of the connector with the corresponding counter connector. By actuating the lever, e.g. manually, the two connectors are pulled together in mating direction to facilitate mating and un-mating of the two connectors depending on the direction of rotation of the lever. To this end, the lever comprises a lever cam slot (cam groove) and a lever cam peg (cam follower) and the connector housing comprises a connector cam peg and a connector cam slot, wherein in mounted condition, the lever cam slot interacts with the connector cam peg and the lever cam peg interacts with the connector cam slot. In other words, the rotatable lever and the connector housing interact by means of a double cam slot arrangement, wherein each of lever and housing comprises at least one cam slot and at least one cam peg. One advantage of this arrangement is a particularly robust construction and an improved mechanical guidance of the relative movements of lever and housing.

[0009] Generally preferred, the rotary lever has a substantially U-shaped configuration as it is known from the art, wherein the connector housing is arranged between the legs of the lever, and lever and connector housing have a symmetrical configuration, where for example each leg of the U-shaped lever has a corresponding cam slot and cam peg and likewise the connector housing comprises on two opposite sides corresponding connector cam pegs and connector cam slots.

[0010] Preferably, the lever is pivotably hinged onto

the counter connector. Thus, the pivot point around which the lever is rotated is arranged on the counter connector and the lever accordingly can rotate relative to said counter connector. Upon rotation of the lever, the respective cam slots and cam pegs arranged on the lever and the connector housing interact to move the connector and the counter connector in mating direction for mating and un-mating depending on the direction of rotation of the lever.

[0011] Preferably, the lever comprises a pivot member, such as a pivot pin or pivot pin recess, and the counter connector comprises a corresponding pivot member, such as a corresponding pivot recess or pivot pin. For example, the lever may comprise two pivot pins or pivot recesses that are engaged into corresponding pivot recesses or pivot pins on the counter connector, such that the pins and recesses define a rotating axis for the lever with respect to the counter connector.

[0012] Preferably the pivot members are fixed, such that upon rotating of the lever, no linear displacement between the pivot members of lever and counter connector occurs. In other words, the pivot members allow a relative rotational movement of the lever with respect to the counter connector, but the pivot axis itself remains stationary with respect to counter connector and lever.

[0013] Preferably, the cam slot of the connector housing extends linearly in mating direction. As described above, the connector housing comprises a cam slot as well as a cam peg (cam follower). In this preferred arrangement, the cam slot extends in the mating direction of connector and counter connector. As the cam slot of the connector interacts with the lever cam peg, this means that the lever upon actuating can move relative to the connector housing essentially linearly in mating direction. It should be noted that the term mating direction as used herein indicates the direction of movement upon mating and un-mating of connector and counter connector. Thus, depending on the direction of rotation of the lever, the same can move in two linear opposite directions with respect to the connector housing guided by the connector cam slot.

[0014] Preferably, the lever cam slot and/or the connector cam slot are straight. Typically, in the prior art, cam slots provided with rotary levers have a curved arrangement. With the present preferred arrangement, the cam slots do not have active curved cam surfaces but are preferably both straight. This allows for an improved force transmission between the different parts of the connector assembly.

[0015] Preferably, the cam slots of lever and connector are arranged in parallel planes and extend at transvers angles relative to each other. That is, if for example as described above, the cam slot of the connector housing extends generally in mating direction, the lever cam slot when mounted, extends generally transverse to said mating direction. For example, in an unmated or pre-mated position of the mate assist lever, the cam slots of lever and connector housing may be arranged at an angle of

approximately 90° to each other.

[0016] Preferably, upon actuating of the lever, the angle between the cam slots varies. Typically, the connector cam slot has a certain orientation, like for example extending generally in mating direction and the lever cam slot extends in a different direction, as for example essentially perpendicular when the lever is in the unmated or pre-mated position. Upon rotation of the lever, the lever cam slot follows the rotational movement of the lever, so that the relative angle between the lever cam slot and the connector cam slot changes.

[0017] Preferably, upon actuating the lever, the lever cam peg is guided by the connector cam slot and the connector cam peg is guided by the lever cam slot. Thereby, the movement of the lever relative to the connector housing is guided double, once by the interaction of the lever cam peg with the connector cam slot and at the same time by the interaction of the lever cam slot with the connector cam peg. The skilled person will understand, that in all the embodiments described herein, the lever preferably may have a U-shaped configuration with two lever legs or arms, whereby each leg is e.g. provided with one cam slot and one cam peg and the connector housing will likewise have e.g. one cam slot and one cam peg on opposite faces of the housing.

[0018] Preferably, upon actuating of the lever, the lever cam slot and the connector cam peg interact such that a force is exerted onto the connector housing in mating direction. As already mentioned above, the term mating direction is used to indicate the general direction of movement of connector and counter connector relative to each other upon mating and un-mating. Thus, due to the arrangement of the respective cam slots and cam pegs, the lever will transfer a force onto the connector housing upon rotation to facilitate mating and un-mating.

[0019] Preferably, the lever has U-shaped configuration and is essentially symmetrical. As it is common in the art, the lever typically has two parallel lever legs that are interconnected by a common web, giving the whole lever a so-called U-shaped configuration. Typically, the connector housing is arranged between the two legs and each leg of the lever comprises for example a corresponding configuration of cam slot and cam peg, so that the lever is essentially symmetrical at least with regard to its functional features. Accordingly, also the connector housing preferably has a symmetrical configuration with a cam slot and a cam peg on both opposing housing sides.

[0020] Preferably, upon actuating of the lever, the lever is adapted to rotate relative to the connector housing. Thereby, the lever path is increased, without necessarily increasing the structural size of the lever itself. This allows a very compact construction.

[0021] Preferably, the lever has a symmetrical U-shape and two opposing side faces and two lever arms extending from the side faces, wherein a respective pivot member is arranged at the distal ends of the lever arms, and the counter connector comprises two corresponding

pivot members adapted to engage with the pivot members of the lever arms, such that upon actuating of the lever, the lever pivots relative to the counter connector around said pivot members. Thereby, the lever is hinged to the counter connector and rotates around a rotation axis defined by the pivot members. Preferably, the pivot axis remains stationary with respect to counter connector and lever, so that the lever only comprises a rotational movement with respect to the counter connector. Even more preferred, due to the arrangement of a cam slot in the connector housing, which for example extends in mating direction as described above, the lever may realize also a linear movement essentially in mating direction with regard to the connector (but not with regard to the counter connector).

[0022] Preferably, the connector housing comprises an electrical contact module and a cover member mountable to the module, and wherein the connector cam slot and the connector cam pin are arranged on the cover member. Such a model or arrangement allows the use of different contact modules, having for example different numbers of electrical terminal slots, without the necessity for a redesign of the components related to the mate assist functionality. For example, the cover member and the lever and corresponding structural features relating to the mate assist functionality can remain the same, while using different contact modules according to need.

[0023] Preferably, the lever is provided with a latching means adapted to automatically latch the lever onto the connector housing in fully mated condition of connector and counter connector. The latching means may serve as an additional safety measure to prevent an accidental release of the lever, which might lead to an undesired un-mating of connector and counter connector. The latching means may comprise for example an elastic latching tongue provided on the lever and a corresponding latching aperture provided on the connector housing or vice versa. Upon actuating of the lever and rotating it into the mating position, i.e. a position in which connector and counter connector are fully mated with each other, the latching tongue and aperture will automatically engage, thereby providing a releasable locking of the lever onto the connector housing.

4. Short description of the drawings

[0024] In the following, preferred embodiments of the invention are disclosed by reference to the accompanying figures, in which:

Fig. 1A and 1B show schematic illustrations of a lever and a part of the connector housing;

Fig. 2A and 2B illustrate the assembly of the connector housing;

Fig. 3A and 3B show schematic illustrations of the lever from two different perspectives;

Fig. 4A and 4B show schematic illustrations of a part of the connector housing from two different perspectives;

Fig. 5 shows the counter connector;

Fig. 6A and 6B illustrate details of the counter connector and the arrangement of the lever;

Fig. 7 shows the mating process of the connector assembly in accordance with the invention; and

Fig. 8 shows the mating process of Fig. 7 in a partly cut side view.

[0025] Figure 1A shows a rotary mate assist lever 10 and a connector cover 21 of a connector housing in accordance with the invention in a 3-dimensional exploded view. The lever 10 has essentially a U-shaped configuration with two parallel legs 14, 15 that extend from parallel faces that are interconnected by a common web 13. The common web 13 is provided with a latching means 16 that allows for locking of the lever 10 onto the connector cover 21 in the finally mated position. The lever 10 comprises cam slots 11 and cam pegs 12. As the skilled person will recognize, and as it is shown in figure 3, the lever 10 is symmetrical and comprises corresponding cam slots 11 as well as corresponding cam pegs 12 on both sides. The connector cover 21 is likewise structured symmetrically, as it is for example shown in figure 4, having cam pegs 22 arranged on both opposite faces of the connector cover 21 and connector cam slots 24, again on both opposite faces. The connector cover 21 further comprises a latching hook 23, that serves to hold the lever 10 in the pre-mating position, as shown in figure 1B.

[0026] Figure 1B shows the assembly of lever 10 with the connector cover 21. One can see, how the connector cam peg 22 is arranged in the lever cam slot 11 and the skilled person will recognize, that accordingly the lever cam peg 12 is arranged in the respective connector cam slot 24. Although figure 1B only shows the assembly of connector cover and lever from one perspective, the skilled person will understand, that the opposite, in the perspective not visible side, comprises the same arrangement, as lever and connector cover are symmetrical.

[0027] Figures 2A and 2B show the assembly of connector housing 20, which comprises the above-described connector cover 21 as well as a connector module 25. The module 25 comprises 12 contact terminal apertures but it is also possible to use modules with more or less terminal apertures. Thereby it is possible to easily adapt the connector housing 20 for different applications, as different modules 25 may be used with the same cover 21.

[0028] Figures 3A and 3B show the lever 10 in a 3-dimensional schematic illustration from two different per-

spectives. One can readily recognize that the lever is symmetric and comprises the same functional components on both legs 14 and 15. One can see two cam pegs 12, that are adapted to interact with the corresponding cam slots 24 of connector cover 21. The lever further comprises two pivot recesses 17, that are adapted to interact with corresponding pivot pins 31 or spigots provided on the counter connector, as will be described in more detail in connection with figures 5 and 6.

[0029] Figures 4A and 4B show the respective connector cover 21 in a 3-dimensional schematic view from two different perspectives. One can see, that also the cover 21 is structurally symmetrical comprising two opposing connector cam slots 24 as well as two cam pegs 22 on opposite sides of the cover 21.

[0030] Figure 5 shows the counter connector 30, that is in the shown embodiment a header. The counter connector 30 comprises two pivot pins 31. The counter connector 30 is designed to receive the connector at least partially, in particular the module 25 of the connector housing 20.

[0031] Figures 6A and 6B show further details of the counter connector 30. In figure 6A one can see contact terminals 32, that are adapted to interact with the connector module 25 to establish an electrical connection between the connector and the counter connector. The pivot pins 31 are adapted to be received in the respective pivot recesses 17 of lever 10 as one can see from the cut side view in figure 6B. When the lever 10 is rotated the pivot pins 31 and pivot recesses 17 define a rotation axis that is fixed with respect to the counter connector 30. In other words, the lever 20 can rotate with respect to counter connector 30, but it does not move linearly with respect to the counter connector 30.

[0032] Figure 7 shows the mating process of connector housing 20 and counter connector 30. In the left figure 7A, the lever 10 is arranged on cover 21 and positioned in a pre-mating arrangement. The module 25 is mounted onto cover 21. In figure 7B, the connector housing 20 is plugged partially into the counter connector 30, and the pivot recesses 17 of lever 10 are engaged with the pivot pins 31. Upon rotation of the lever 10 to the left in figure 7, the lever cam slot 11 interacts with the connector cam peg 22, thereby pushing the connector 20 further down towards the mating direction with the counter connector 30. At the same time, the lever cam peg 12 moves inside the connector cam slot 24, so that the lever 10 is moved linearly relative to connector housing 20. In figure 7D, connector and counter connector are fully mated. The connector cam peg 22 has reached the end of lever cam slot 11 and the lever cam peg 12 has reached its end position in connector cam slot 24. The latching means 16 latch onto a corresponding latching apertures 26 of connector housing 20.

[0033] Figure 8 shows the same mating process of figure 7 but in a cut side view. Figure 8A corresponds to figure 7B and shows the connector housing 20 being partially arranged inside of the counter connector 30. The

pivot pins 31 of the counter connector 30 interact with the corresponding pivot recesses 17 of lever 10. Figure 8B shows the configuration according to figure 7C in the middle of the mating process. As one can see them from the view of figure 8B, the lever 10 has moved linearly upwards relative to connector housing 20. Thereby, the lever cam pegs 12 move up relative to the connector cam slots 24. The skilled person will recognize, that in the shown configuration, it is actually the connector housing 20 that is moved downwards relative to the counter connector 30, while the lever 10 remains linearly stationary with respect to the counter connector 30. In other words, the rotation axis defined by pivot pins 31 and pivot recesses 17 is fixed relative to counter connector 30 but not with respect to connector housing 20. Figure 8C corresponds to the view of figure 7D and shows the finally mated condition of connector and counter connector. The skilled person will understand, that it is possible to unmate the connectors by means of actuating the lever 10, such that it rotates clockwise in the orientation shown in figure 8.

List of reference signs

[0034]

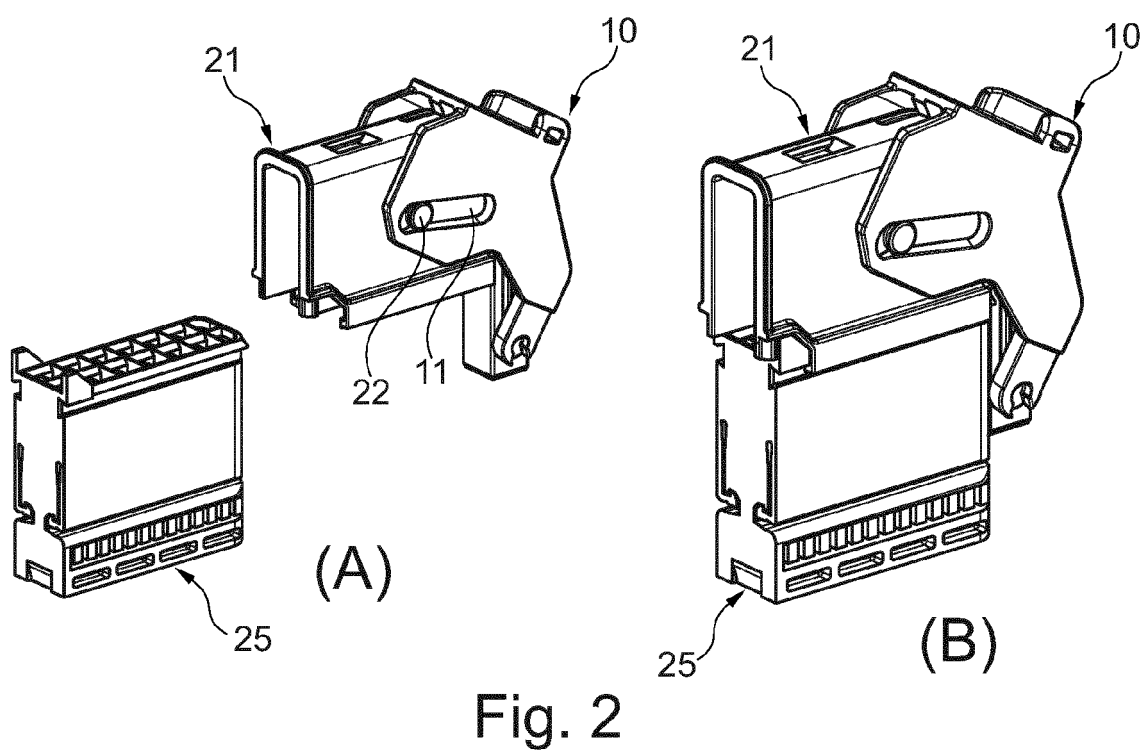
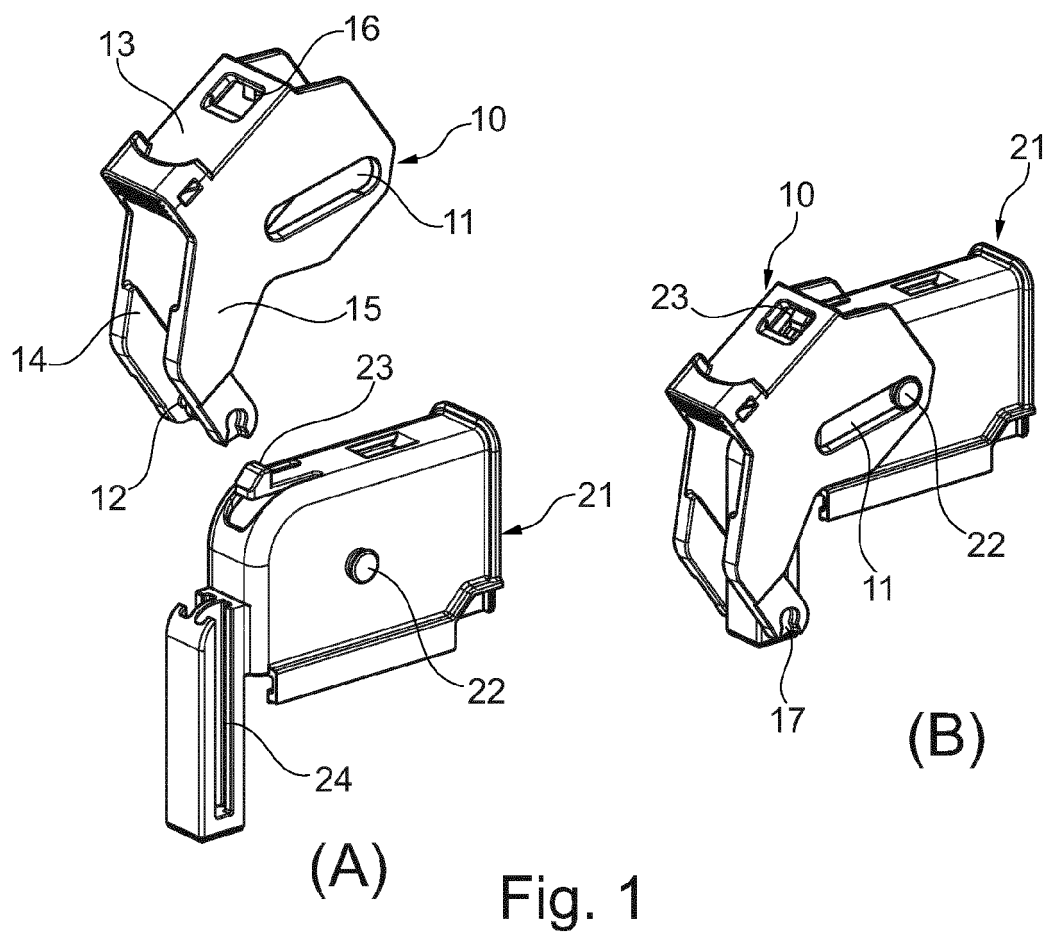
10	lever
11	lever cam slot
12	lever cam peg
13	web
14, 15	lever leg
16	latching means
17	pivot recess
20	connector housing
21	connector cover
22	connector cam peg
23	latching hook
24	connector cam slot
25	connector module
26	latching apertures
30	counter connector
31	pivot pin
32	contact terminals

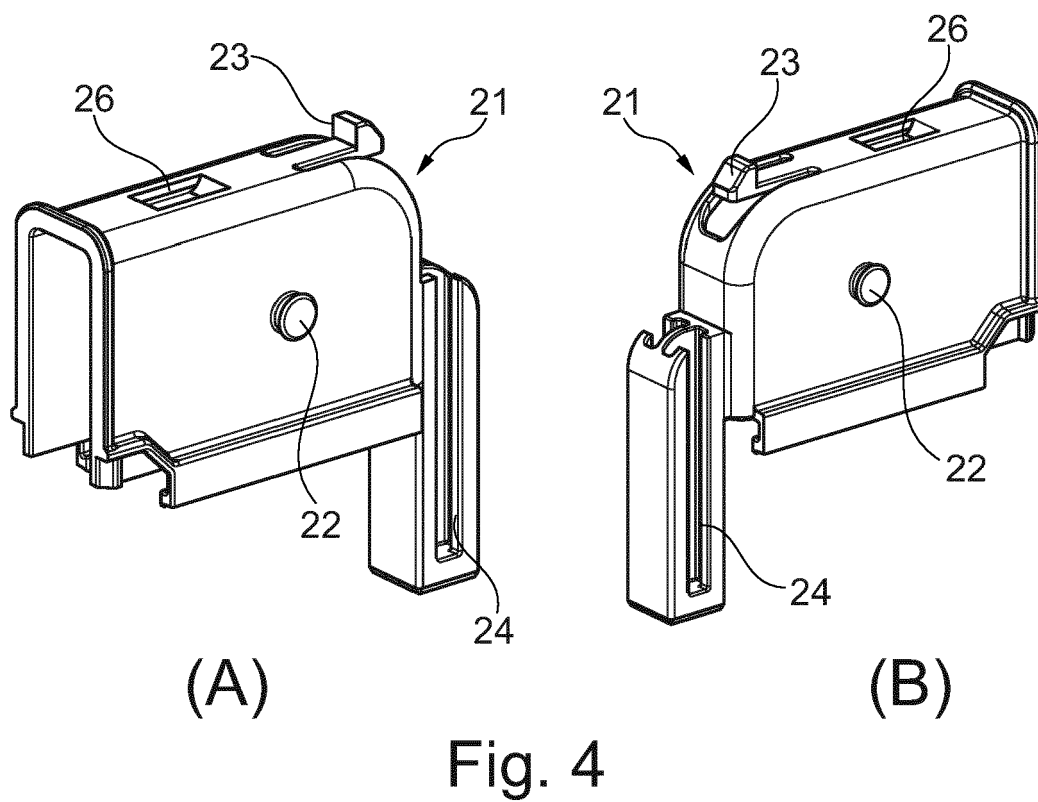
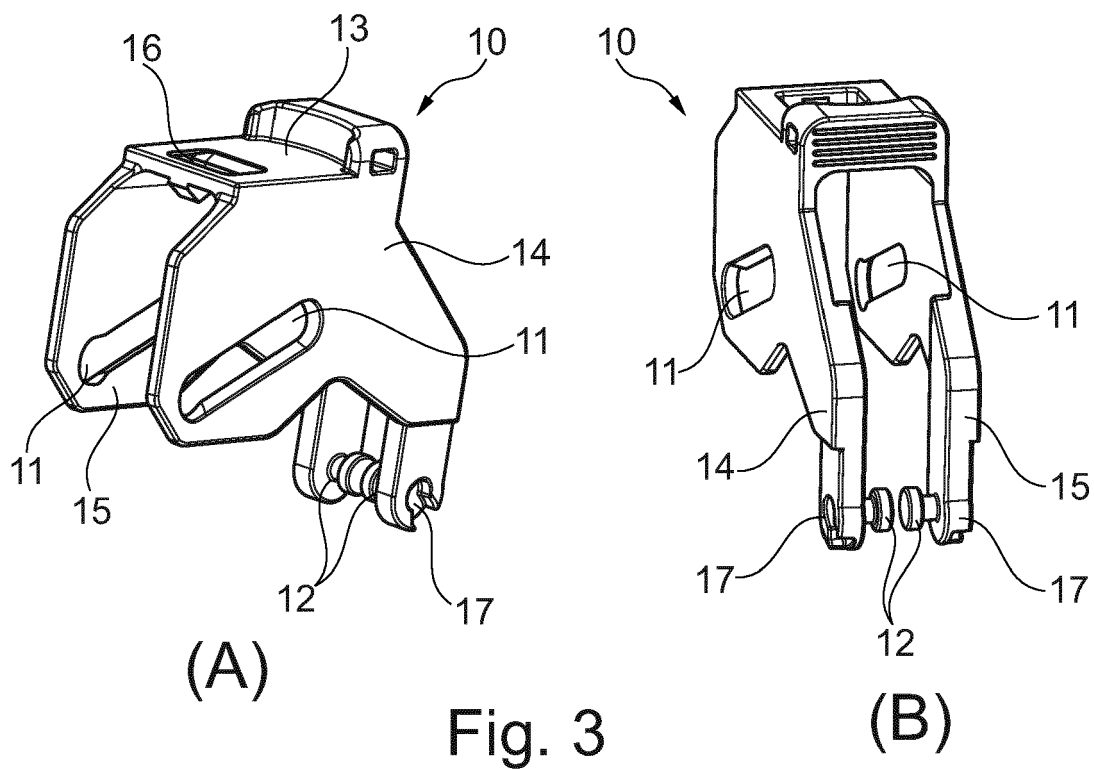
Claims

1. An electrical connector assembly comprising:

- a connector comprising a connector housing (20);
- a corresponding counter-connector (30) comprising a counter-connector housing;
- a mate assist member comprising a rotatable lever (10) to facilitate the mating process of the connector with the corresponding counter connector;
- the lever comprising a lever cam slot (11) and a

- lever cam peg (12) and the connector housing (20) comprises a connector cam peg (22) and a connector cam slot (24), wherein in mounted condition, the lever cam slot (11) interacts with the connector cam peg (22) and the lever cam peg (12) interacts with the connector cam slot (24).
2. The electrical connector assembly according to claim 1, wherein the lever (10) is pivotably hinged onto the counter connector (30).
 3. The electrical connector assembly according to claim 2, wherein the lever (10) comprises a pivot member (17), such as a pivot pin or pivot pin recess, and the counter connector (30) comprises a corresponding pivot member (31), such as a corresponding pivot recess or pivot pin.
 4. The electrical connector assembly according to claim 3, wherein the pivot members (17; 31) are fixed, such that upon rotating of the lever (10), no linear displacement between the pivot members (17; 31) of lever (10) and counter connector (30) occurs.
 5. The electrical connector assembly according to any one of the preceding claims, wherein the cam slot (24) of the connector housing (20) extends linearly in mating direction.
 6. The electrical connector assembly according to any one of the preceding claims, wherein the lever cam slot (11) and/or the connector cam slot (24) are straight.
 7. The electrical connector assembly according to any one of the preceding claims, wherein the cam slots (11; 24) of lever (10) and connector (20) are arranged in parallel planes and extend at transvers angles relative to each other.
 8. The electrical connector assembly according to the preceding claim, wherein upon actuating of the lever (10), the angle between the cam slots (11; 24) varies.
 9. The electrical connector assembly according to any one of the preceding claims, wherein upon actuating of the lever (10), the lever cam peg (12) is guided by the connector cam slot (24) and the connector cam peg (22) is guided by the lever cam slot (11).
 10. The electrical connector assembly according to any one of the preceding claims, wherein upon actuating of the lever (10), the lever cam slot (11) and the connector cam peg (22) interact such that a force is exerted onto the connector housing (20) in mating direction.
 11. The electrical connector assembly according to any one of the preceding claims, wherein the lever (10) has a U-shaped configuration and is symmetrical.
 12. The electrical connector assembly according to any one of the preceding claims, wherein upon actuating of the lever (10), the lever is adapted to rotate relative to the connector housing (20).
 13. The electrical connector assembly according to any one of the preceding claims, wherein the lever (10) has a symmetrical U-shape and two opposing side faces and two lever legs (14, 15) extending from the side faces, wherein a respective pivot member (17) is arranged at the distal ends of the lever legs, and the counter connector (30) comprises two corresponding pivot members (31) adapted to engage with the pivot members of the lever arms, such that upon actuating of the lever, the lever pivots relative to the counter connector around said pivot members.
 14. The electrical connector assembly according to any one of the preceding claims, wherein the connector housing (20) comprises an electrical contact module (25) and a cover member (21) mountable to the module, and wherein the connector cam slot (24) and the connector cam peg (22) are arranged on the cover member (21).
 15. The electrical connector assembly according to any one of the preceding claims, wherein the lever (10) is provided with a latching means (16) adapted to automatically latch the lever onto the connector housing in fully mated condition of connector and counter connector.





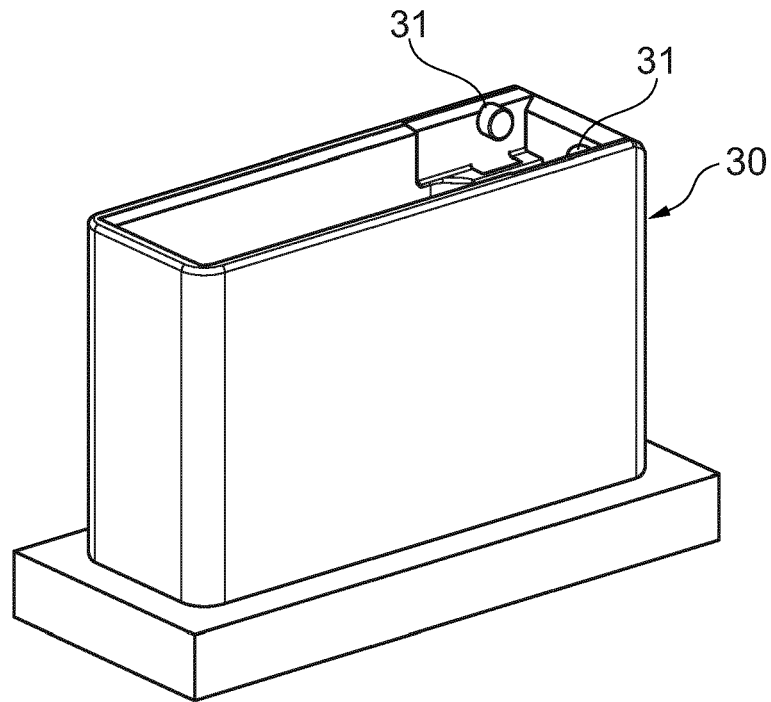


Fig. 5

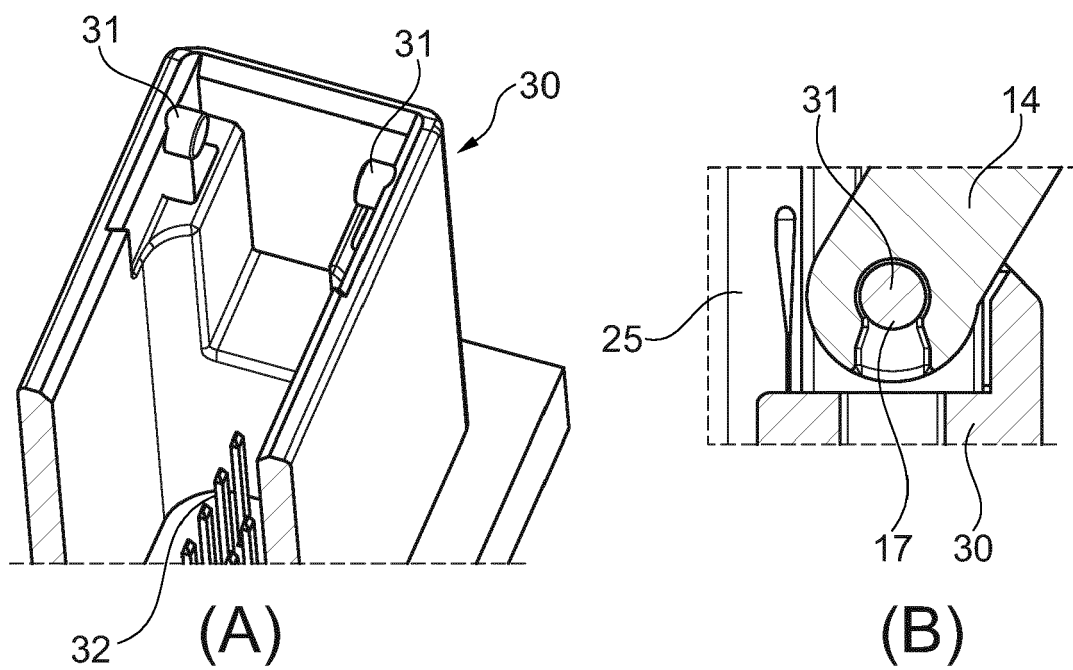


Fig. 6

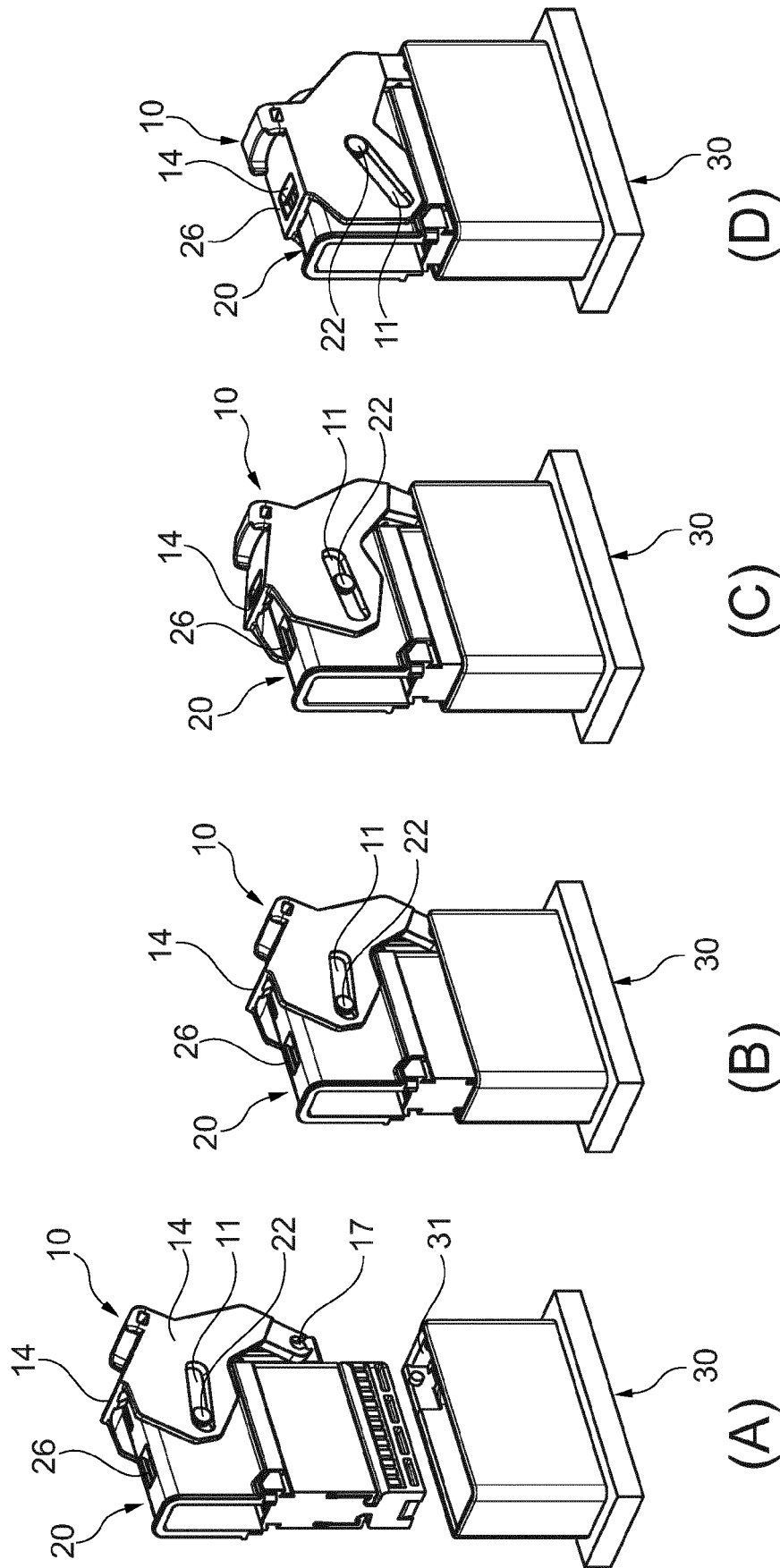


Fig. 7

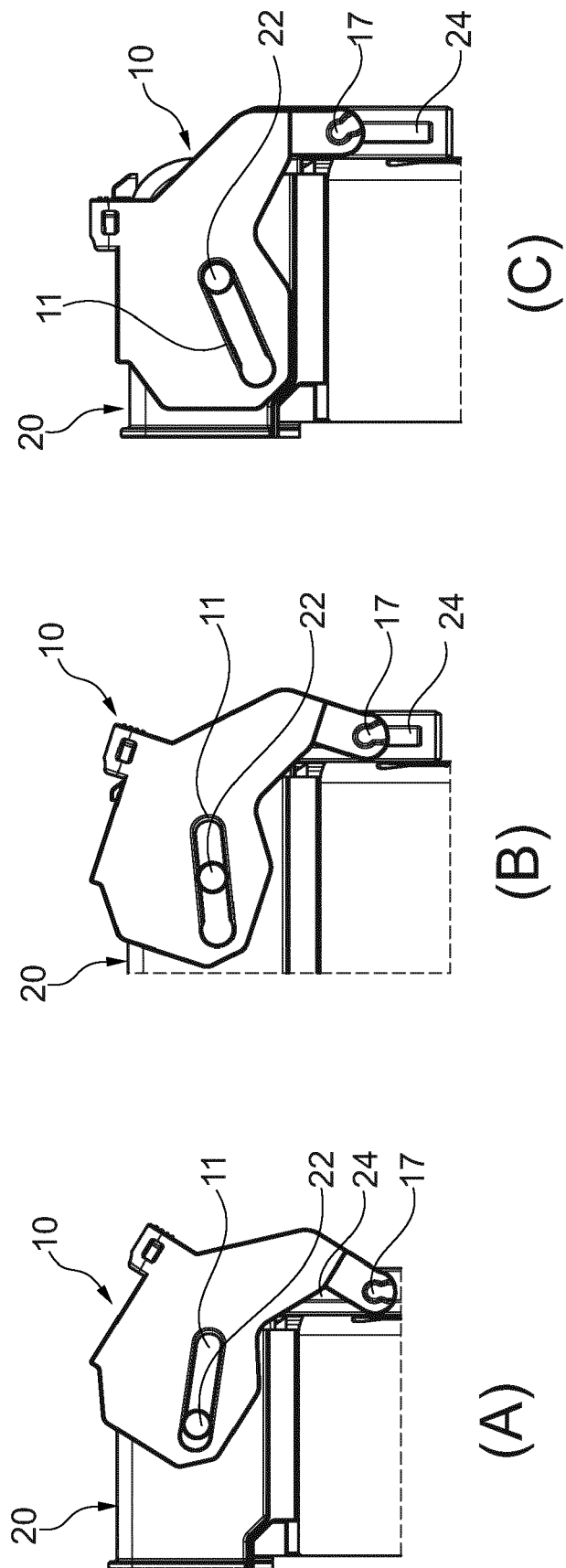
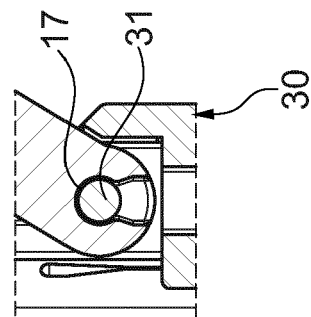


Fig. 8





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Application Number

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DOCUMENTS CONSIDERED TO BE RELEVANT			
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X	US 6 217 354 B1 (FENCL DUANE M [US] ET AL) 17 April 2001 (2001-04-17)	1, 5-7, 11, 14, 15	INV. H01R13/629
Y	* column 2, line 45 - column 4, line 64; figures 1-7 *	2-4, 8-10, 12, 13	
X	EP 1 875 558 B1 (JST CORP [US]) 27 February 2013 (2013-02-27)	1, 5-7, 11, 14, 15	
Y	* paragraph [0031] - paragraph [0050]; figures 1A-4C *	2-4, 8-10, 12, 13	
			TECHNICAL FIELDS SEARCHED (IPC)
			H01R
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 19 September 2023	Examiner Gomes Sirenkov E M.
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 23 16 7504

5 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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