



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
24.05.2017 Bulletin 2017/21

(51) Int Cl.:
H01R 13/629 (2006.01)

(21) Application number: **16199361.3**

(22) Date of filing: **17.11.2016**

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

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(30) Priority: **23.11.2015 DE 102015223113**

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(54) **ELECTRIC CONNECTOR WITH SECONDARY LOCKING MEMBER AND ELECTRIC CONNECTOR ASSEMBLY**

(57) The invention relates to an electric connector (5) with a U-shaped locking lever (9), which is held rotatably around an axis of rotation (11) in the electric connector (5) for engagement to a complementary electric connector (7) and relates to an electric connector assembly (1) comprising an electric connector (5) with a U-shaped locking lever (9) held rotatably around an axis of rotation (11) in the electric connector (5) from an open position (13) to a locked position (89), a complementary electric connector (7) adapted to be connected to the electric connector (5), wherein, in the locked position (89) of the locking lever (9), the electric connector (5) and the complementary electric connector (7) are engaged in a primary lock (117). Electric connectors (5) and electric connector assemblies (1) of the prior art have the disadvantage that the primary lock (117) may be disengaged by chance or by misuse. The inventive electric connector (5) solves this problem by providing the locking lever (9) with a secondary locking member (37) for additional engagement to the complementary electric connector (7), wherein the secondary locking member (37) is fixed to the locking lever (9) slidably along an insertion direction (38), which is substantially perpendicular to the axis of rotation (11), into the locking lever (9) from a first (123) to a second position (125). The inventive electric connector assembly (1) solves this problem by providing the

locking lever (9) with a secondary locking member (37) which is adapted to be slid on the locking lever (9) perpendicular to the axis of rotation (11) into engagement with the complementary electric connector (7) to form a secondary lock (119).

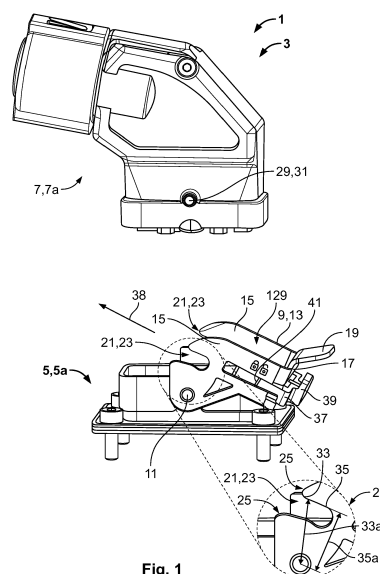


Fig. 1

Description

[0001] The invention relates to an electric connector with a U-shaped locking lever, the locking lever being held rotatably around an axis of rotation in the electric connector for engagement to a complementary electric connector. The invention further relates to an electric connector assembly comprising an electric connector with a U-shaped locking lever held rotatably around an axis of rotation in the electric connector from an open position to a locked position, a complementary electric connector adapted to be connected to the electric connector, wherein, in the locked position of the locking lever, the electric connector and the complementary electric connector are engaged in a primary lock.

[0002] Such electric connectors and electric connector assemblies are known in the art and for instance described in German patent publication DE 10 2010 002 176 B4. Solutions of the prior art have the disadvantage that the locking lever could be opened by chance or by misuse.

[0003] One objective of the present invention is therefore to provide an electric connector and an electric connector assembly which provides a secondary lock for securing the primary lock and for preventing the electric connector assembly from unlocking by chance or by misuse.

[0004] The electric connector of the aforementioned type solves this problem by providing the locking lever with a secondary locking member for additional engagement to the complementary electric connector, the secondary locking member being fixed to the locking lever slidably along an insertion direction, which is substantially perpendicular to the axis of rotation, into the locking lever from a first to a second position.

[0005] The electric connector assembly of the aforementioned type solves this problem by providing the locking lever with a secondary locking member, the secondary locking member being adapted to be slid on the locking lever perpendicular to the axis of rotation into engagement with the complementary electric connector to form a secondary lock.

[0006] Those solutions provide a secured primary lock, which may not be unlocked prior to disengaging the secondary lock, whereas the secondary lock may, in particular, not be disengaged by hand and may therefore prevent disengagement of the secondary lock by chance or by misuse.

[0007] Another objective of the inventive electric connector and the inventive electric connector assembly may be prevention of an incomplete engagement of the electric connector to the complementary electric connector, which may not be secured by the locking lever and which may be disengaged by chance or for instance vibrations of the electric connector assembly.

[0008] Engagement of the secondary lock between the electric connector and the complementary electric connector may only be possible after engagement of the pri-

mary lock.

[0009] In the following, further embodiments are given that are advantageous on their own. The solutions represented by these embodiments of the invention can be combined as desired.

[0010] In a first advantageous embodiment of the inventive electric connector the secondary locking member is U-shaped. A U-shaped secondary locking member has the advantage that the secondary locking member may be firmly fixed to the locking lever, not altering the general shape or the size of the electric connector.

[0011] The U-shaped secondary locking member may in particular comprise two opposing longitudinal structures connected to each other by a common base, wherein the longitudinal structures are oriented substantially perpendicular to the base. The secondary locking member may comprise connection portions connecting the longitudinal structures of the secondary locking member to the base, wherein said connection portions may be embodied with a substantially rectangular edge or may be embodied as a rounding with a rounding radius of up to half the distance between the longitudinal structures of the secondary locking member.

[0012] In a second advantageous embodiment of the inventive electric connector the secondary locking member has at least two legs which form a pocket in which at least a section of a leg of the locking lever is received. Receiving the locking lever in the pocket of the secondary locking member has the advantage that fixing the secondary locking member to the locking lever, as well as guiding the secondary locking member along the insertion direction into the locking lever, is facilitated.

[0013] The pocket of the secondary locking member may in particular receive a section of each of the two legs of the locking lever. Such an arrangement allows for a symmetrical mounting of the secondary locking member to the locking lever preventing blocking of the secondary locking member due to its rotation with respect to the locking lever when pushed on one side.

[0014] In another advantageous embodiment of the inventive electric connector, the at least two legs comprise an inner leg and an outer leg on the outside of the leg of the locking lever, the inner leg being shorter than the outer leg.

[0015] The inner leg may be located on the side of the locking lever which is closer to an opposite leg of the locking lever.

[0016] The inner leg may be located in a space between the legs of the locking lever and the outer leg on the outside of this space.

[0017] The inner leg and the outer leg of the secondary locking member may therefore form a sub-pocket for receiving at least a portion of the wall of the locking lever, therefore allowing an easy and secure fixation, and guidance of the secondary locking member to and within the locking lever.

[0018] In another embodiment of the inventive electric connector, it is advantageous if, in the first position, the

inner leg extends parallel to and is spaced apart from the leg of the locking lever received in the pocket adjacent to this inner leg.

[0019] The leg of the locking lever may preferentially be received in the sub-pocket adjacent to the inner leg, the sub-pocket may be formed between the inner and the outer leg.

[0020] Such a spacing may allow the inner leg to be deflected towards the leg of the locking lever, which may be advantageous to allow for an imperfect insertion of the secondary locking member into the locking lever that is not along the insertion direction, but with an angle to the insertion direction without blocking the insertion of the secondary locking member.

[0021] The spacing may be adapted to allow a deflection of the inner leg by up to one width of the inner leg, wherein the width is measured in the direction of deflection.

[0022] The deflection of the inner leg may be limited by a maximum deflection of the inner leg or by an abutment of the inner leg with the leg of the locking lever. The inner leg may be attached to the base of the secondary locking member by a reinforced pedestal which may be adapted to limit the deflection of the inner leg and/or may be adapted to transfer shear forces, which are due to deflection of the inner leg, to the base of the secondary locking member.

[0023] In another advantageous embodiment of the inventive electric connector, in the second position, the spacing between the inner leg and the leg of the locking lever is decreased with respect to the first position or the inner leg abuts the leg of the locking lever.

[0024] If engagement of the primary lock between the electric connector and the complementary electric connector requires the deflection of the inner arm of the secondary locking member, a reduced spacing in the second position may prevent engaging the primary lock by rotating the locking lever with the secondary locking member being in the second position.

[0025] The side of the leg of the locking lever facing towards the volume between the legs of the locking lever may comprise a chamfer, which substantially faces towards the inner leg, that is, the chamfer is tilted from the insertion direction towards the base of the secondary locking member.

[0026] Upon moving the secondary locking member from the first position to the second position, the inner leg may pass by this chamfer or may touch the chamfer resulting in a deflection of the inner leg away from the spacing leading to an abutment between the inner leg and the leg of the locking lever.

[0027] In another advantageous embodiment of the inventive electric connector, the inner leg protrudes into a volume between the legs of the locking lever.

[0028] The inner leg may protrude into the volume only in the second position, or in both the first and the second position of the secondary locking member. Similarly to the at least one protrusion extending into the volume be-

tween the legs of the locking lever, the inner leg may be part of or may support the secondary lock between the electric connector and the complementary electric connector.

[0029] In another embodiment of the inventive electric connector, it is advantageous if the outer leg is provided with a locking element that locks the secondary locking member in the first position. Such a locking element prevents an unwanted unmounting of the secondary locking member from the locking lever.

[0030] The locking element may be embodied as a detent hook with an inclined surface, substantially facing away from the base of the secondary locking member and a shoulder being substantially oriented parallel to and facing towards the base of the secondary locking member.

[0031] The locking lever may comprise hook receptacles adapted to slidably receive the detent hook of the secondary locking member, the hook receptacles may comprise a first receptacle wall facing substantially in the insertion direction, thus, facing opposite to the shoulder of the detent hook of the secondary locking member installed to the locking lever.

[0032] Abutment of the first receptacle wall of the locking lever and the shoulder of the detent hook may occur in the first position of the secondary locking member or when the secondary locking member is moved opposite to the insertion direction out of the locking lever.

[0033] In another advantageous embodiment of the inventive electric connector, the secondary locking member has a base section extending parallel to a lever base section connecting the legs of the locking lever, the base section being provided with at least one protrusion that, at least in the second position, protrudes through at least one opening of the locking lever into the volume between the legs of the locking lever. The at least one protrusion may be a part of, or may support the secondary lock between the electric connector and the complementary electric connector.

[0034] In the first position of the secondary locking member, the at least one protrusion may not extend into the volume between the legs of the locking lever. This embodiment has the advantage that the locking lever may be rotated around the axis of rotation without the at least one protrusion blocking this rotational movement by touching any structure located in the volume between the legs of the locking lever.

[0035] The at least one protrusion may be embodied as a locking tooth, wherein several locking teeth may be provided symmetrically or asymmetrically along the base section of the secondary locking member.

[0036] The at least one protrusion may be embodied as one single protrusion extending along the whole base section of the secondary locking member.

[0037] In another embodiment of the inventive electric connector, it is advantageous if a catch is provided which locks the secondary locking member both in the first and in the second position.

[0038] Such a catch has the advantage that the first and the second position may be clearly distinct from any intermediate position of the secondary locking member between the first and the second position.

[0039] This catch may further comprise indication means providing a feedback to the end-user, and allowing for an indication in which position the secondary locking member is located.

[0040] The catch may be embodied as a catch member comprising inclined surfaces, wherein the surface being located closer to the base of the secondary locking member is inclined towards this base and wherein the surface being located further from the base of the secondary locking member is inclined away from this base.

[0041] Such a catch member may be adapted to be received in a catch receptacle which may be embodied as a hole in the leg of the locking lever. Two of such catch receptacles may be provided in the leg of the locking lever according to the first and the second position of the secondary locking member.

[0042] In another advantageous embodiment of the inventive electric connector the secondary locking member is provided with a plate-like handling member, which protrudes from the locking lever in a direction facing away from the volume between the legs of the locking lever and in that, in the second position, the handling member comprises a section which is spaced apart from the locking lever and thus defines a tool insertion space.

[0043] The plate-like handling member may be adapted to transfer a handling force exerted on the handling member to the secondary locking member. The handling member may preferentially be located in a central portion of the base of the secondary locking member in order to allow for a symmetric exertion of the handling force to the secondary locking member.

[0044] The locking lever may comprise a lever handle also extending substantially away from the volume between the legs of the locking lever, whereas this lever handle may at least partially prevent accessing the handling member.

[0045] The tool insertion space may be adapted to receive a release tool such as a screw driver in order to move the secondary locking member from the second position to the first position. The lock of the catch member with the catch receptacle may therefore be sufficiently strong to prevent a movement of the secondary locking member from the second position to the first position by hand.

[0046] The inventive electric connector assembly of the aforementioned type may be adapted to allow a movement of the secondary locking member from the first and second position only in the locked position of the locking lever that is after engagement of the electric connector and the complementary electric connector in the primary lock.

[0047] In a first embodiment of the electric connector assembly, the secondary locking member engages with a complementary locking member of the complementary

electric connector, the complementary locking member being one of a stepped surface, a protrusion or a recess of the complementary electric connector located in the volume between the legs of the locking lever.

[0048] The complementary locking member may be embodied as an at least partially circumferential edge which may be present per se at the complementary electric connector.

[0049] The complementary locking member may be located in the volume between the legs of the locking lever in both, the open and the locked position of the locking lever, but may as well be only located in said volume when the locking lever is moved to the locked position.

[0050] The overlap between the complementary locking member, which may be embodied as a stepped surface, may be quite small, in the order of 1 mm, in order to achieve a reliable locking effect. Therefore a compact design may be combined with an efficient locking effect.

[0051] It is conceivable that the locking lever may only be moved from the open to the locked position with the secondary locking member in the first position, whereas when the secondary locking member is in the second position, movement of the locking lever from the open to the closed position may be prevented.

[0052] When the electric connector and the complementary electric connector are plugged together and the locking lever is in the open position, a translation of the secondary locking member from the first position to the second position may be prevented by the complementary electric connector.

[0053] A procedure for engaging the primary and the secondary lock between the electric connector and the complementary electric connector may comprise the following steps:

(a) if not already in the open position, the locking lever is moved to the open position, the secondary locking member is installed to the locking lever and is in the first position;

(b) the electric connector and the complementary electric connector are plugged together and subsequent to completion of plugging them together, the locking lever is moved from the open position to the locked position, whereas the secondary locking member remains in the first position and is moved along with the locking lever;

(c) When the locking lever has reached the locked position, that is upon completion of engagement between the electric connector and the complementary electric connector in the primary lock, the secondary locking member may be translated from the first position to the second position, wherein when reaching the second position, the electric connector assembly engages the additional secondary lock between the electrical connector and the complementary electrical connector.

[0054] When moving the locking lever from the open position to the locked position, the inner legs and the at least one protrusion extending from the base of the secondary locking member may already extend into the volume between the legs of the locking lever, whereas a spacing between the complementary electric connector and the locking lever may allow the inner legs and/or the at least one protrusion to extend into the volume between the legs of the locking lever without touching the complementary electric connector when the locking lever is moved from the open position to the locked position.

[0055] After completion of the primary lock, pushing the handling member may insert the inner legs and/or the at least one protrusion into the volume or further into the volume between the legs of the locking lever.

[0056] During this insertion the inner legs and/or the at least one protrusion may be moved or slid along the complementary locking member of the complementary electric connector in an overlapping manner, thus engaging a positive lock between the complementary locking member and the secondary locking member. The complementary locking member abuts the inner legs and/or the at least one protrusion such that a movement of the locking lever from the locked position to the open position is blocked.

[0057] Several abutment regions between the complementary locking member and the secondary locking member are advantageous as they may allow distribution of a force exerted on the locking lever in the direction of the open position into the complementary electric connector, into the locking lever and into the secondary locking member.

[0058] In a second advantageous embodiment of the inventive electrical connector assembly the at least one inner leg of the secondary locking member is adapted to be deflected by the complementary electric connector towards the locking lever in the first position of the secondary locking member and in that the locking lever is adapted to be moved into engagement with the complementary electric connector with the secondary locking member fixed to the locking lever in the first position.

[0059] Such a spacing may be advantageous if the secondary locking member is mounted to the locking lever in a direction with an angle to the insertion direction. In such a case, insertion of the secondary locking member is not blocked by abutment of the legs of the secondary locking member with the locking lever.

[0060] In a third advantageous embodiment of the inventive electrical connector assembly, the secondary locking member is snapped over the complementary locking member of the complementary electric connector when the electric connector is engaged in the primary lock with the complementary electric connector.

[0061] In particular the at least one inner leg of the secondary locking member may be snapped over the complementary locking member. When the electric connector is being engaged in the primary lock with the complementary electric connector, in particular the at least

one inner leg of the secondary locking member may be slid along a housing of the complementary electric connector, wherein prior to completion of the primary lock between the electric connector and the complementary electric connector the at least one inner leg of the secondary locking member may snap over the complementary locking member.

[0062] As a deflection of the inner leg towards the locking lever is possible in the first position of the secondary locking member, rotation of the locking lever from the open to the locked position may be possible even if the inner leg touches the complementary electric connector in the first position of the secondary locking member.

[0063] This abutment may cause a deflection of the inner leg towards the leg of the locking lever, whereas the deflected inner leg may be slidably moved together with the locking lever rotated from the open position to the locked position.

[0064] During this movement, the inner leg remains deflected and slides above the complementary electric connector until reaching the complementary locking member of the complementary electric connector.

[0065] When reaching the complementary locking member, the inner leg may return to its relaxed state, that is the non-deflected state by a snapping movement over said complementary locking member. Thus, the state reached after this snapping movement may be understood as an intermediate lock occurring between the primary lock and the secondary lock.

[0066] The snapping movement furthermore yields the advantage that an acoustic and/or haptic feedback may be provided to the end-user, indicating completion of engagement in the primary lock.

[0067] For sliding the secondary locking member from the first position to the second position, an insertion distance has to be overcome. This insertion distance determines the overlap of the inner leg and/or the at least one protrusion with the complementary locking member of the complementary electric connector.

[0068] On the one hand, a larger overlap will result in a higher strength of the secondary lock. On the other hand, a larger overlap requires a larger insertion distance. This compromise may be overcome at least partially by providing a deflectable inner leg canceling the direct proportionality between the overlap and the insertion distance.

[0069] After reaching the locked position of the locking lever, the secondary locking member may, as described above, be moved from the first position to the second position with the inner leg remaining in the relaxed state.

[0070] In the second position of the secondary locking member, the spacing between the inner leg and the leg of the locking lever may be decreased or the inner leg may even abut the leg of the locking lever, thus preventing a deflection of the inner leg towards the leg of the locking lever.

[0071] This may ensure that once the secondary locking member has reached the second position, the deflec-

tion of the inner arm is blocked and the primary and secondary lock may not be disengaged prior to moving the secondary locking member from the second position to the first position.

[0072] The movement of the secondary locking member from the second position to the first position may be performed by the end-user by means of a release tool, for instance a screw driver, inserted into the tool insertion space defined by a section of the handling member which is spaced apart from the locking lever.

[0073] Subsequent to moving the second locking member from the second position to the first position, rotation of the locking lever from the locked position to the open position is possible, wherein prior to this movement the inner leg is deflected towards the leg of the locking lever and wherein during this movement the inner leg slides at least partially along the complementary electric connector.

[0074] In the following, the invention will be described in more detail by way of example hereinafter using advantageous embodiments and with reference to the accompanying drawings. The individual features of the described embodiments may be implemented independently of each other or may be omitted if the technical effect of the omitted feature is not relevant. Equal technical features and technical features with similar functions or technical effects illustrated in the drawings are provided with equal reference signs. Redundant parts of the description related to equal elements illustrated in different drawings are omitted.

[0075] The figures show:

- Fig. 1 a perspective view of the electric connector assembly;
- Fig. 2 a perspective view of a first embodiment of the secondary locking member;
- Fig. 3 a perspective view of a second embodiment of the secondary locking member;
- Fig. 4 a perspective detailed view of the electric connector assembly with an engaged primary lock and unmounted secondary locking member;
- Fig. 5a a perspective view of the electric connector assembly with the locking lever in the open position;
- Fig. 5b a perspective view of the electric connector assembly with the locking lever in the locked position;
- Fig. 5c a perspective view of the electric connector assembly with engaged primary and secondary lock;

Fig. 6 a partially cut perspective view of the electric connector assembly of Figure 5c;

Fig. 7a/7b sectional views of the electric connector assembly with the secondary locking member of Figure 2; and

Fig 8a/8b sectional views of the electric connector assembly with the secondary locking member of Figure 3.

[0076] Figure 1 shows an electric connector assembly 1 in an unassembled state 3. The electric connector assembly 1 comprises an electric connector 5 and a complementary electric connector 7.

[0077] In the electric connector assembly 1 shown in Figure 1, the electric connector 5 is embodied as a socket 5a and the complementary electric connector 7 as a plug 7a.

[0078] The electric connector 5 comprises a locking lever 9, which is held rotatably around an axis of rotation 11 in the electric connector 5. Figure 1 shows the locking lever 9 in an open position 13, whereas in the unassembled state 3 the locking lever 9 may be freely rotated around the axis of rotation 11 from the shown open position 13 to the locked position (not shown in Figure 1).

[0079] The locking lever 9 comprises two lever legs 15 which are connected to each other by a lever base 17. The lever legs 15 are oriented substantially perpendicular to the axis of rotation 11, whereas the lever base 17 is substantially parallel to the axis of rotation 11.

[0080] The lever 9 further comprises a lever handle 19 extending away from the axis of rotation 11 and two primary lock elements 21 which are embodied as pin receptacles 23 and located in the lever legs 15 distal to the lever handle 19.

[0081] The pin receptacles 23 comprise rounded entrance edges 25 which are shown in more detail in the zoom 27. The rounded entrance edges 25 allow for a correct positioning of the complementary electric connector 7 with respect to the electric connector 5 by means of complementary primary lock elements 29 which are embodied as pins 31 in the embodiment of the electric connector assembly 1 shown in Figure 1.

[0082] The pin receptacle 23 has a convex region 33 and a concave region 35, wherein the point of the convex region 33, which is the nearest to the axis of rotation 11, is located in the distance 33a from the axis of rotation 11 and the point of the concave region 35, which is furthest away from the axis of rotation 11, is located in the distance 35a from the axis of rotation 11. The distance 33a is smaller than the distance 35a.

[0083] Figure 1 furthermore shows a secondary locking member 37 with a handling member 39 and an indication member 41. The secondary locking member 37 is fixed to and received by the locking lever 9 along an insertion direction 38, respectively. Further details of the locking lever 9 and the secondary locking member 37

are described with reference to the following figures.

[0084] Figures 2 and 3 show a first and a second embodiment of the inventive secondary locking member 37 prior to mounting on the electrical connector 5 (not shown).

[0085] The secondary locking member 37 extends substantially into an x-direction and a y-direction as well as in a z-direction.

[0086] The secondary locking member 37 is substantially U-shaped and comprises two opposing legs embodied as two outer legs 43 which are connected to a base 45 at a first end 47. The two outer legs 43 are substantially parallel to each other and substantially perpendicular to the base 45.

[0087] A second end 49 of the outer legs 43 comprises a locking element 51, which is embodied as a hook 53 extending into a pocket 55 enclosed by the outer legs 43 and the base 45.

[0088] Approximately in the center of both outer legs 43, a catch 56 is embodied as a catch member 57 extending into the pocket 55. In a direction perpendicular to the base 45, the catch members 57 comprise inclined surfaces 59, whereas the hooks 53 comprise an inclined surface 59 facing away from the base 45 and a shoulder 61 facing towards the base 45.

[0089] Parallel to the outer legs 43, two inner legs 63 extend from the base 45 into the pocket 55 of the secondary locking member 37. The connection of the inner legs 63 to the base 45 is reinforced by a broadening of the inner legs 63 in a pedestal region 65. A sub-pocket 55a is formed between the outer leg 43 and the inner leg 63.

[0090] The secondary locking member 37 furthermore comprises six protrusions 66 embodied as locking teeth 67, each of them extending from the base 45 into the pocket 55 of the secondary locking member 37.

[0091] The handling member 39 is located outside the secondary locking member 37 and also extends into a direction substantially perpendicular to the base 45 and substantially perpendicular to the outer legs 43. The secondary locking member 37 comprises a stop edge 69, which is clearly visible in Figure 4.

[0092] The outer legs 43 have a leg length 71, the inner legs 63 have an inner leg length 73 and the secondary locking member 37 has a width 75. An insertion length 77 is measured between the stop edge 69 and the shoulder 61 of the hook 53, and a gap width 78 between the stop edge 69 and the handling member 39. The first catch distance 83 is measured from the stop edge 69 to the catch member 57, the second catch distance 85 is measured from the shoulder 61 of the outer legs 43 to the catch member 57. The base 45, the locking teeth 67 and the inner legs 63 have a height 79, whereas the outer legs 43 have, from the stop edge 69 in y-direction onwards, a leg height 81, which is smaller than the height 79. For reasons of visibility the lengths 71, 73, 77, the widths 75, 78, the heights 79, 81 and the distances 83, 85 are drawn in Figure 3.

[0093] The difference between the two embodiments of the secondary locking member 37 of Figure 2 and Figure 3 is the inner leg length 73, which is larger than the first catch distance 83 in the second embodiment (Figure 3) of the secondary locking member 37, whereas in the first embodiment of the secondary locking member 37 (Figure 2), the inner legs 63 do not extend in y-direction from the base 45 beyond the catch members 57.

[0094] Figure 4 shows a detailed perspective view of the electric connector assembly 1 with the electric connector 5 and the complementary electric connector 7 in the assembled state 87.

[0095] The locking lever 9 is in a locked position 89, that is the pins 31 of the complementary electric connector 7 are received in the pin receptacles 23 of the locking lever 9 and abut the concave region 35 of the pin receptacles 23. The electric connector 5 and the complementary electric connector 7 are engaged in a primary lock 117.

[0096] In Figure 4, the secondary locking member 37 is not mounted to the locking lever 9, therefore showing technical features of the locking lever 9 which were hidden in the previous figures.

[0097] The locking lever 9 comprises several openings 93 located in the lever legs 15 and the lever base 17. The openings 93 in the lever base 17 extend partially into the lever legs 15 and are embodied as locking member receptacles 95, adapted to receive the secondary locking elements 97. The secondary locking elements 97 comprise the inner legs 63 and the front locking teeth 67. A bridge member 149 is located between the locking member receptacles 95 to increase stability of the locking lever 9.

[0098] The openings 93 located in the lever legs 15 are embodied as a hook receptacle 99 or catch receptacles 101, wherein the locking member receptacles 95 have a first receptacle height 103, which is larger than a second receptacle height 105 of the hook receptacles and catch receptacles 99, 101.

[0099] The first receptacle height 103 is on the same order of magnitude as the height 79 of the base 45 and the inner legs 65, that is the inner legs 65 as well as the locking teeth 67 may be inserted into the locking member receptacles 95 without abutting the outside of the locking lever 9.

[0100] Furthermore, it is advantageous if the play between the locking member receptacles 95 and the base 45, respectively between the locking member receptacles 95 and the inner legs 63, is as small as possible to prevent unwanted relative movements between the locking lever 9 and the secondary locking member 37 and as large as necessary to prevent degradation of the guidance of the secondary locking member 37 in the locking lever 9.

[0101] The secondary locking member 37 comprises an indication member 107 located on the side of the outer leg 43 facing away from the pocket 55. The locking lever 9 comprises a first indicator mark 109 and a second in-

indicator mark 111.

[0102] The distance between the first indicator mark 109 and a first receptacle wall 113 equals approximately the distance between the second indicator mark 111 and a second receptacle wall 115, whereas both distances equal approximately the second catch distance 85 (see Figure 3).

[0103] Figures 5a-5c illustrate a sequence of plugging the electric connector 5 to the complementary electric connector 7 and engagement of the primary 117 and the secondary lock 119. The electric connector assembly 1 (shown in Figures 5a-5c) is in the assembled state 87.

[0104] In Figure 5a the electric connector assembly 1 is in the assembled state 87, but as no lock is engaged yet, it is also in the unlocked state 121. The locking lever 9 is in the open position 13 and the secondary locking member 37 is in a first position 123 which is indicated by the indication member 107 located next to the first indicator mark 109.

[0105] The pin 31 is located in the entrance of the pin receptacle 23 and upon exertion of a force F on the lever handle 19. The locking lever 9 rotates around the axis of rotation 11 counter-clockwise until the locked position 89 of the locking lever 9 is reached.

[0106] This is shown in Figure 5b, illustrating the electric connector assembly 1 in the assembled state 87 and with the primary lock 117 engaged. The pin receptacle 23 was rotated together with the locking lever 9 and received the pin 31 in a pin receptacle region distal to the entrance of the pin receptacle 23. The secondary locking member 37 remained in the first position 123 and simply moved along with the locking lever 9.

[0107] Without the further step explained in the following with reference to Figure 5c, the situation shown in Figure 5b corresponds to an electric connector assembly 1 of the state of the art. Although being engaged in a primary lock 117, certain circumstances (accidentally touching the locking lever 9, dropping of a tool) may result in a movement of the locking lever 9 from the locked position 89 to the open position 13 by chance. This movement is initiated by a possible force F_p, indicated by a dashed arrow.

[0108] In order to avoid that the exertion of the possible force F_p on the lever handle 19 of the locking lever 9 results in moving the locking lever 9 from the locked position 89 to the open position 13, the secondary locking member 37 is moved from the first position 123 (Figure 5b) to the second position 125, which is shown in Figure 5c.

[0109] By moving the secondary locking member 37 from the first position 123 to the second position 125, the secondary lock 119 of the electric connector assembly 1 is engaged.

[0110] In the second position 125, the indication member 107 is located next to the second indicator mark 111.

[0111] In the second position, the handling member 39 is located closer to the locking lever 9 and defines a tool insertion space 127 located between the handling mem-

ber 39 and the locking lever 9. The tool insertion space 127 is just large enough to allow insertion of the blade of a screw driver, to pry apart the secondary locking member 37 from the locking lever 9

[0112] The secondary lock 119 secures the primary lock 117 by preventing a movement of the locking lever 9 from the locked position 89 to the open position 13 and furthermore locks the electric connector 5 to the complementary electric connector 7.

[0113] The embodiment of the lever handle 19 shown in Figures 5a-5c extends away from a volume 129 between the legs of the lever 15 (see Figure 1). The lever handle 19 therefore partially shields the access to the handling member 39 of the secondary locking member 39 in both the first position 123 and the second position 125.

[0114] Figure 6 shows the electric connector assembly 1 in the assembled state 87 and with the primary and secondary lock 117, 119 engaged. The detailed view is partially cut to illustrate the abutment of the secondary locking members 97 embodied as locking teeth 67 with a complementary locking member 131 of the complementary electric connector 7, whereas the complementary locking member 131 is embodied as a stepped surface 133 in the housing 135 of the complementary electric connector 7. The overlap between the complementary locking member 131, embodied as stepped surface 133, with the secondary locking member 37 may be quite small, in the order of 1 mm, in order to achieve a reliable locking effect.

[0115] Figure 6 shows that the stepped surface 133 is embodied circumferentially around the housing 135.

[0116] As the secondary locking member 37 is in the second position 125, the locking teeth 67 are extending through the locking member receptacles 95 into the volume 129 between the lever legs 15. The locking teeth 67 therefore abut the stepped surface 133 and block a movement of the complementary electric connector 7 away from the electric connector 5.

[0117] Figures 7a, 7b, 8a, 8b show the electric connector assembly 1 in the assembled state 87 with engaged primary lock 117 in a cut along a line A-A, which is shown in Figure 5c. Figures 7a, 7b show the secondary locking member 37 and the locking lever 9 in a first embodiment and Figures 8a, 8b show the secondary locking member 37 and the locking lever 9 in a second embodiment.

[0118] In the first embodiment of the secondary locking member 37 and the locking lever 9 it is preferred if the locking lever 9 is made of a stiff material as for instance a metal, which does not allow a deflection. the secondary locking member 37 is preferably made of a resin material.

[0119] The second embodiment of the secondary locking member 37 and the locking lever 9 is preferred if those elements 7, 37 are made of a deflectable material as for instance a polymer, which allows a deflection of parts of both elements.

[0120] The secondary locking member 37 further com-

prises a bridge member 149 which increases the stability of the locking lever 9 in the regions of the locking member receptacles 95 (see Figure 4).

[0121] In Figure 7a, the secondary locking member 37 is in the first position 123, in which the catch member 57 is engaged in a positive lock with the catch receptacle 101 which is located farther away from the axis of rotation 11.

[0122] The hook 53 is engaged in the hook receptacle 99, wherein the shoulder 61 is located close to the first receptacle wall 113, the pins 31 are monolithically connected to the housing 135 of the complementary electric connector 7, and the volume 129 between the lever legs 15 is indicated by a dashed line.

[0123] In the first position 123 of the secondary locking member 37, the inner legs 63 extend through the locking member receptacles 95 into the volume 129 between the lever legs 15, whereas the locking teeth 67 (only two of them are indicated by reference signs for the sake of visibility) do not extend into the volume 129.

[0124] Figure 7a and 7b also show the stepped surface 133 which is located circumferentially around the housing 135 of the complementary electric connector 7. The inner legs 63 do not overlap or abut the stepped surface 133 in the first position 123 of the secondary locking member 37.

[0125] Therefore, movement of the locking lever 9 from the open 13 to the locked position 89 (not shown) is possible without the secondary locking member 37 touching the complementary electric connector 7.

[0126] Figure 7b shows the electric connector assembly 1 of Figure 7a wherein, additionally to the primary lock 117, the secondary lock 119 is engaged. The secondary lock 119 is engaged by moving the secondary locking member 37 into the second position 125, the second position 125 is characterized in that the inner legs 63 and the locking teeth 67 extend into the volume 129 between the lever legs 15 (indicated by the dashed line).

[0127] Furthermore, in the second position 125 of the secondary locking member 37, the inner legs 63 as well as the locking teeth 67 overlap the stepped surface 133 of the housing 135. Also, the pedestal regions 65 of the secondary locking member 37 overlap with the stepped surface 133 and thus contribute to the secondary lock 119. A movement of the inner legs 63 and/or the locking teeth 67 in a direction into the drawing plane, respectively a movement of the housing 135 in a direction out of the drawing plane, is blocked by the abutment of the inner legs 63 and the locking teeth 67 with the stepped surface 133.

[0128] In the second position 125 of the secondary locking member 37, the catch member 57 is located in the catch receptacle 101 located closer to the axis of rotation 11 and the hook 53 is shifted inside the hook receptacle 99, wherein, in the second position 125 of the secondary locking member 37, the hook 53 is closer to the second receptacle wall 115.

[0129] The second embodiment of the locking lever 9

and the second embodiment of the secondary locking member 37, as shown in Figures 8a and 8b, are preferentially made of a flexible material as, for instance, a polymer.

[0130] In comparison to Figures 7a and 7b, the lever thickness 137 of the second embodiment of the locking lever 9 is larger than the lever thickness 137 of the second embodiment of Figure 7a because the preferentially used material for this second embodiment is less rigid than the material used in the first embodiment (Figures 7a and 7b) and therefore the locking lever 9 and the secondary locking member 37 require a larger lever thickness 137 in order to maintain mechanical properties of the locking lever 9 and the secondary locking member 37.

[0131] The inner legs 63 extend from the base 45 of the secondary locking member into the volume 129 between the lever legs 15, wherein the inner leg length 73 is larger than the first catch distance 83 (see Figure 3), the inner legs 63 therefore extend further towards the axis of rotation 11 than the catch members 57.

[0132] In the first position 123 of the secondary locking member 37 shown in Figure 8a, the inner legs 63 overlap the stepped surface 133 of the housing 135 of the complementary electric connector 7, whereas the locking teeth 67 do not extend into the volume 129 between the lever legs 15.

[0133] The locking lever 9 comprises an inclined surface 59 partially facing towards the base 45 of the secondary locking member 37, the inclined surface 59 are located in transition regions 139, which are located between an abutment region 141 and a deflection region 143.

[0134] In Figure 8a, the inner legs 63 are located in the deflection regions 143 in which the inner legs 63 are deflectable towards the lever legs 15 because of a spacing 145.

[0135] The overlap of the inner legs 63 with the stepped surfaces 133 in an overlap region 147 may be considered as an intermediate lock 118, wherein this intermediate lock 118 may be easily disengaged by deflecting the inner legs 63 towards the lever legs 15.

[0136] In Figure 8b, the secondary locking member 37 is shown in the second position 125, in which the locking teeth 67, the pedestal regions 65 and the inner legs 63 overlap the stepped surface 133 of the housing 135, engaging the electric connector 5 and the complementary electric connector 7 in the secondary lock 119.

[0137] By insertion of the secondary locking member 37 further into the volume 129 between the legs 15 of the locking lever 9, each inner leg 63 extends through the deflection region 143 and through the transition region 139 into the abutment region 141.

[0138] As the inner legs 63 are located in the abutment regions 141, the spacing 145 between the inner legs 63 and the lever legs 15 is decreased which is shown in the zoom 27. In different embodiments of the locking lever 9 and the secondary locking member 37, the inner legs 63 may even abut the lever legs 15.

[0139] The decreased spacing 145a prevents a deflection of the inner legs 63 towards the lever legs 15 as well as a disengagement of the secondary lock 119 prior to moving the secondary locking member 37 from the second position 125 to the first position 123.

[0140] Further features and/or technical effects of or between the housing 135, the locking lever 9, and the secondary locking member 37 related to the catch members 57 or the hooks 53 are similar to those features and/or technical effect described in Figures 7a and 7b.

REFERENCE NUMERALS

[0141]

1 electric connector assembly
 3 unassembled state
 5 electric connector
 5a socket
 7 complementary electric connector
 7a plug
 9 locking lever
 11 axis of rotation
 13 open position
 15 lever leg
 17 lever base
 19 lever handle
 21 primary lock elements
 23 pin receptacle
 25 entrance edge
 27 zoom
 29 complementary primary lock element
 31 pin
 33 convex region
 35 concave region
 37 secondary locking member
 38 insertion direction
 39 handling member
 41 indication member
 43 outer leg
 45 base
 47 first end
 49 second end
 51 locking element
 53 hook
 55 pocket
 55a sub-pocket
 56 catch
 57 catch member
 59 inclined surface
 61 shoulder
 63 inner leg
 65 pedestal region
 66 protrusion
 67 locking tooth
 69 stop edge
 71 leg length
 73 inner leg length

75 width
 77 insertion length
 78 gap width
 79 height
 5 81 leg height
 83 first catch distance
 85 second catch distance
 87 assembled state
 89 locked position
 10 93 opening
 95 locking member receptacle
 97 secondary locking members
 99 hook receptacle
 101 catch receptacle
 15 103 first receptacle height
 105 second receptacle height
 107 indication member
 109 first indicator mark
 111 second indicator mark
 20 113 first receptacle wall
 115 second receptacle wall
 117 primary lock
 118 intermediate lock
 119 secondary lock
 25 121 unlocked state
 123 first position
 125 second position
 127 tool insertion space
 129 volume between the lever legs
 30 131 complementary locking member
 133 stepped surface
 135 housing
 137 lever thickness
 139 transition region
 35 141 abutment region
 143 deflection region
 145 spacing
 145a decreased spacing
 147 overlap region
 40 149 bridge member
 F force
 F_p possible force
 45 x x-direction
 y y-direction
 z z-direction

50 Claims

1. Electric connector (5) with a U-shaped locking lever (9), the locking lever (9) being held rotatably around an axis of rotation (11) in the electric connector (5) for engagement to a complementary electric connector (7), **characterized in that** the locking lever (9) is provided with a secondary locking member (37) for additional engagement to the complementary elec-

- tric connector (7), the secondary locking member (37) being fixed to the locking lever (9) slidably along an insertion direction (38), which is substantially perpendicular to the axis of rotation (11), into the locking lever (9) from a first (123) to a second position (125).
2. Electric connector (5) according to claim 1, **characterized in that** the secondary locking member (37) is U-shaped.
 3. Electric connector (5) according to claim 1 or 2, **characterized in that** the secondary locking member (37) has at least two legs (43, 63) which form a pocket (55, 55a) in which at least a section of a leg (15) of the locking lever (9) is received.
 4. Electric connector (5) according to claim 3, **characterized in that** the at least two legs (43, 63) comprise an inner leg (63) and an outer leg (43) on the outside of the leg (15) of the locking lever (9), the inner leg (63) being shorter than the outer leg (43).
 5. Electric connector (5) according to claim 4, **characterized in that**, in the first position (123), the inner leg (63) extends parallel to and is spaced apart from the leg (15) of the locking lever (9) received in the pocket (55, 55a) adjacent to this inner leg (63).
 6. Electric connector (5) according to claim 5, **characterized in that** in the second position (125) the spacing (145) between the inner leg (63) and the leg (15) of the locking lever (9) is decreased with respect to the first position (123) or the inner leg (63) abuts the leg (15) of the locking lever (9).
 7. Electric connector (5) according to any one of claims 4 to 6, **characterized in that** the inner leg (63) protrudes into a volume (129) between the legs (15) of the locking lever (9).
 8. Electric connector (5) according to any one of claims 4 to 7, **characterized in that** the outer leg (43) is provided with a locking element (51) that locks the secondary locking member (37) in the first position (123).
 9. Electric connector (5) according to any one of claims 1 to 8, **characterized in that** the secondary locking member (37) has a base section (45) extending parallel to a lever base section (17) connecting the legs (15) of the locking lever (9), the base section (45) being provided with at least one protrusion (66) that, at least in the second position (125), protrudes through at least one opening (93) of the locking lever (9) into the volume (129) between the legs (15) of the locking lever (9).
 10. Electric connector (5) according to any one of claims 1 to 9, **characterized in that** a catch (56) is provided which locks the secondary locking member (37) both in the first (123) and in the second position (125).
 11. Electric connector (5) according to any one of claims 1 to 10, **characterized in that** the secondary locking member (37) is provided with a plate-like handling member (39), which protrudes from the locking lever (9) in a direction facing away from the volume (129) between the legs (15) of the locking lever (9) and **in that**, in the second position (125), the handling member (39) comprises a section which is spaced apart from the locking lever (9) and thus defines a tool insertion space (127).
 12. Electric connector assembly (1) comprising an electric connector (5) with a U-shaped locking lever (9) held rotatably around an axis of rotation (11) in the electric connector (5) from an open position (13) to a locked position (89), a complementary electric connector (7), adapted to be connected to the electric connector (5), wherein, in the locked position (89) of the locking lever (9), the electric connector (5) and the complementary electric connector (7) are engaged in a primary lock (117), **characterized in that** the locking lever (9) is provided with a secondary locking member (37), the secondary locking member (37) being adapted to be slid on the locking lever (9) perpendicular to the axis of rotation (11) into engagement with the complementary electric connector (7) to form a secondary lock (119).
 13. Electric connector assembly (1) according to claim 12, **characterized in that** the secondary locking member (37) is adapted to engage a complementary locking member (131) of the complementary electric connector (7), the complementary locking member (131) being one of a stepped surface (133), a protrusion (64) or a recess of the complementary electric connector (7) located in a volume (129) between legs (15) of the locking lever (9).
 14. Electric connector assembly (1) according to claim 12 or 13, **characterized in that** the at least one inner leg (63) of the secondary locking member (37) is adapted to be deflected by the complementary electric connector (7) towards the locking lever (9) in the first position (123) of the secondary locking member (37) and **in that** the locking lever (9) is adapted to be moved into engagement with the complementary electric connector (7) with the secondary locking member (37) fixed to the locking lever (9) in the first position (123).
 15. Electric connector assembly (1) according to claim 13 or 14, **characterized in that** the secondary locking member (37) is snapped over the complementary locking member (131) of the complementary electric

connector (7) when the electric connector (5) is being engaged in the primary lock (117) with the complementary electric connector (7).

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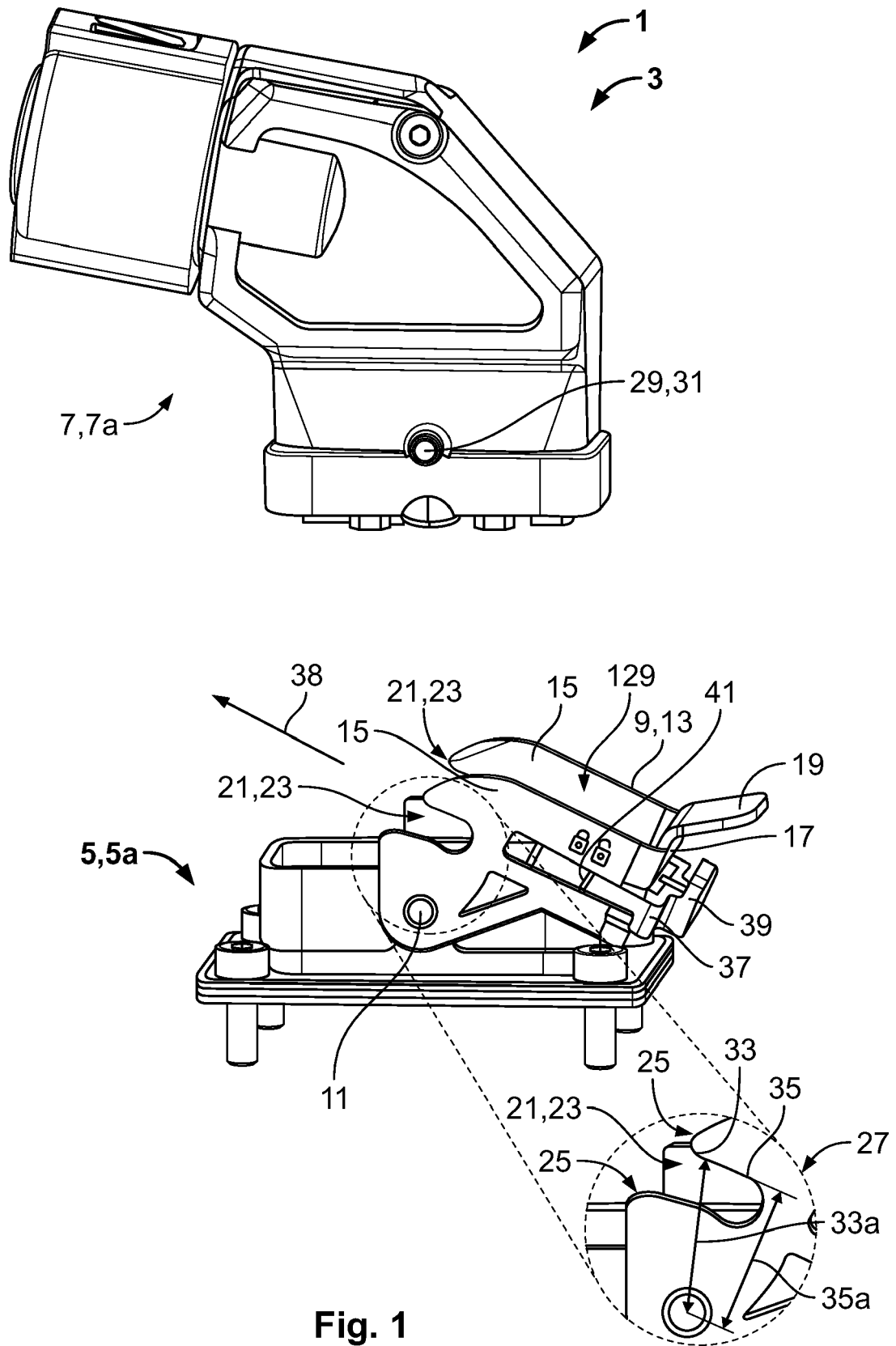
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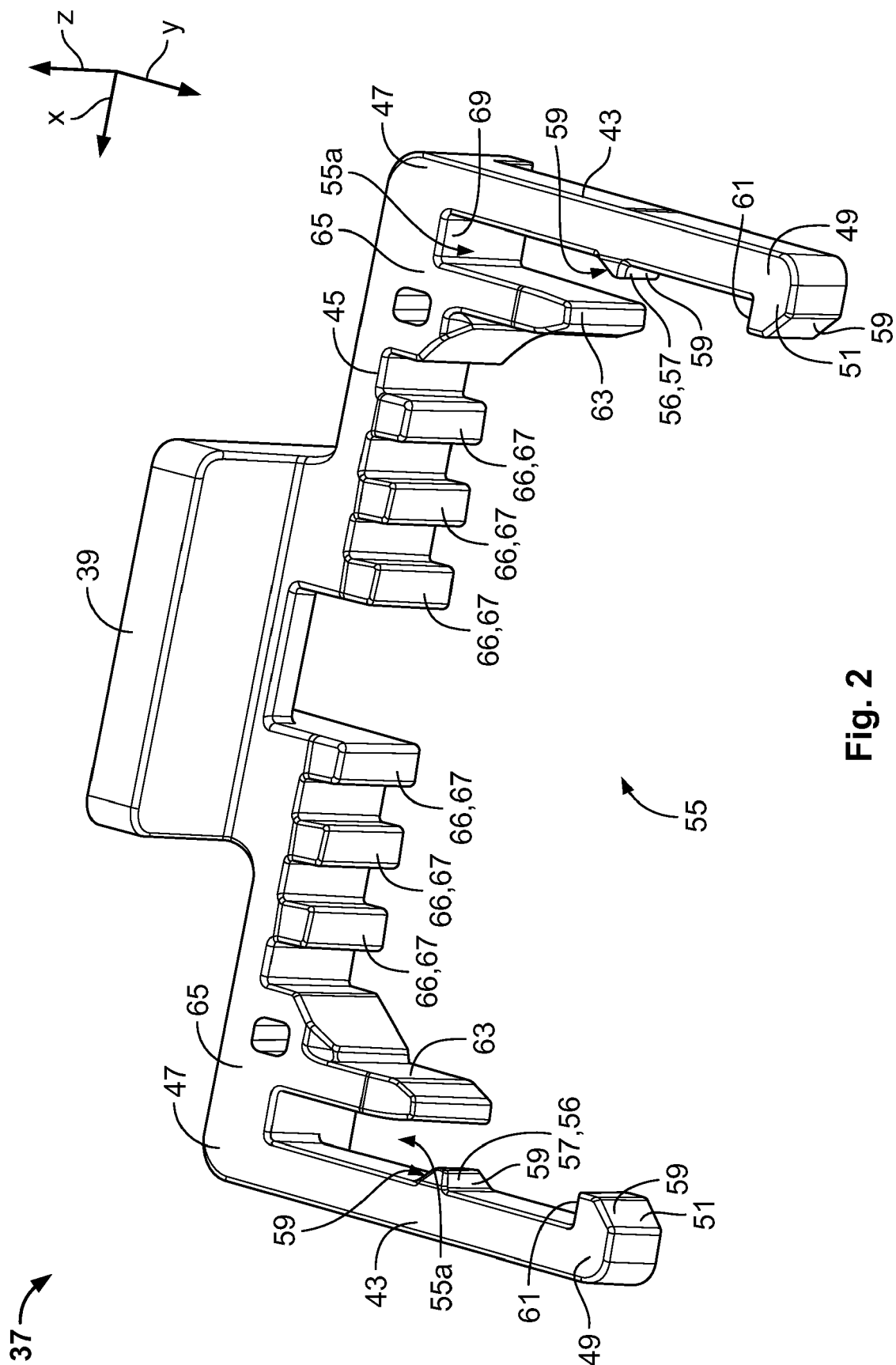


Fig. 2

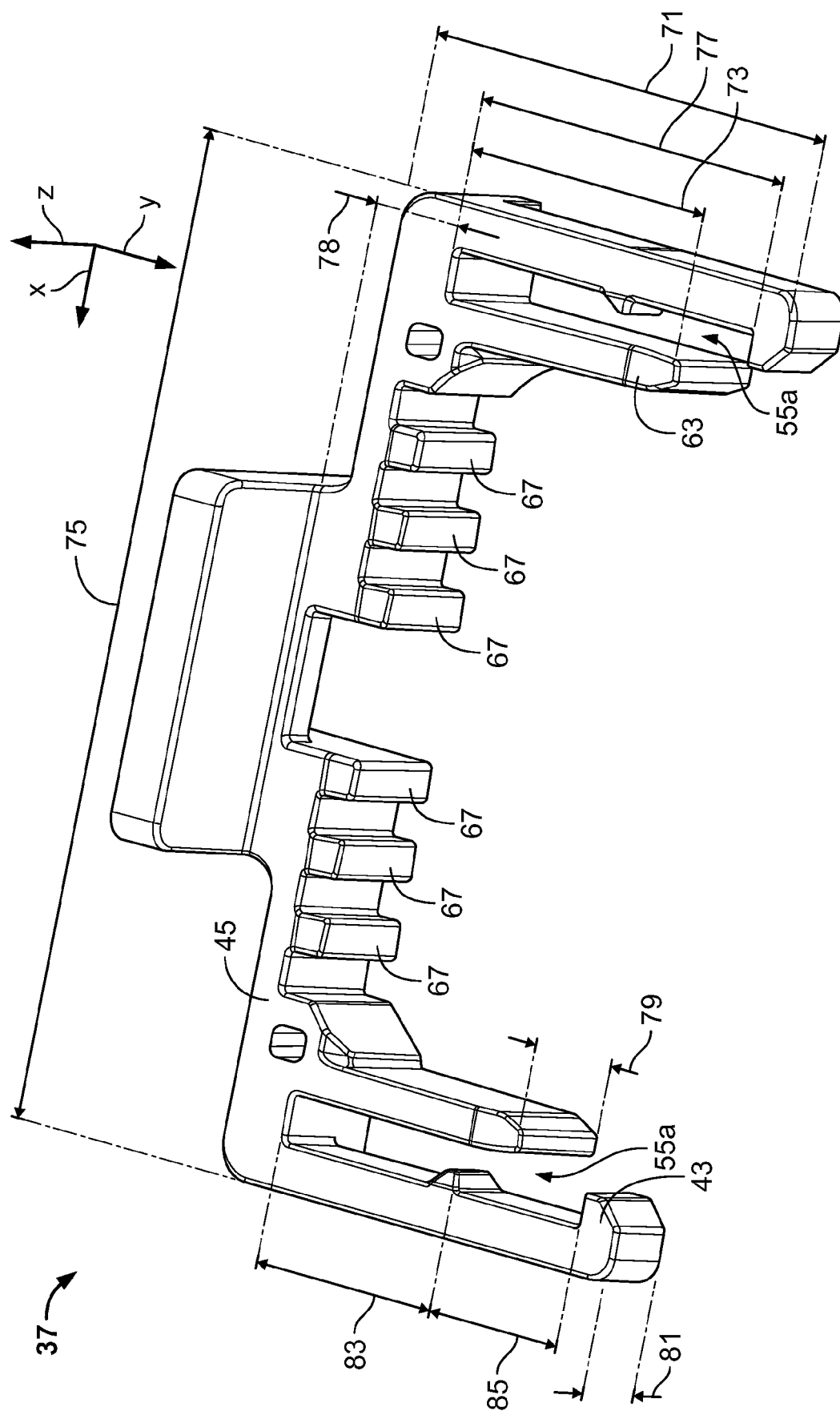


Fig. 3

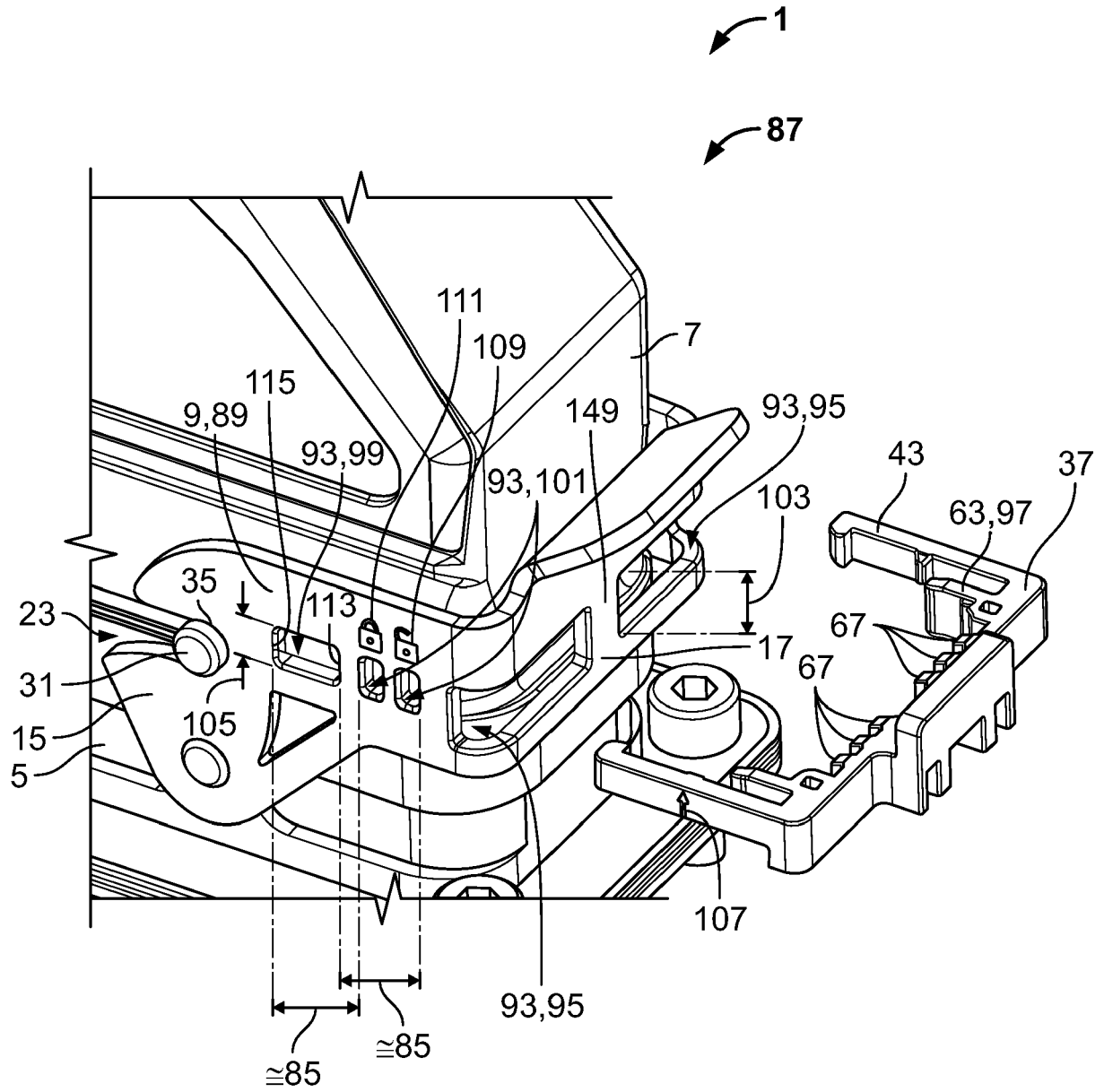


Fig. 4

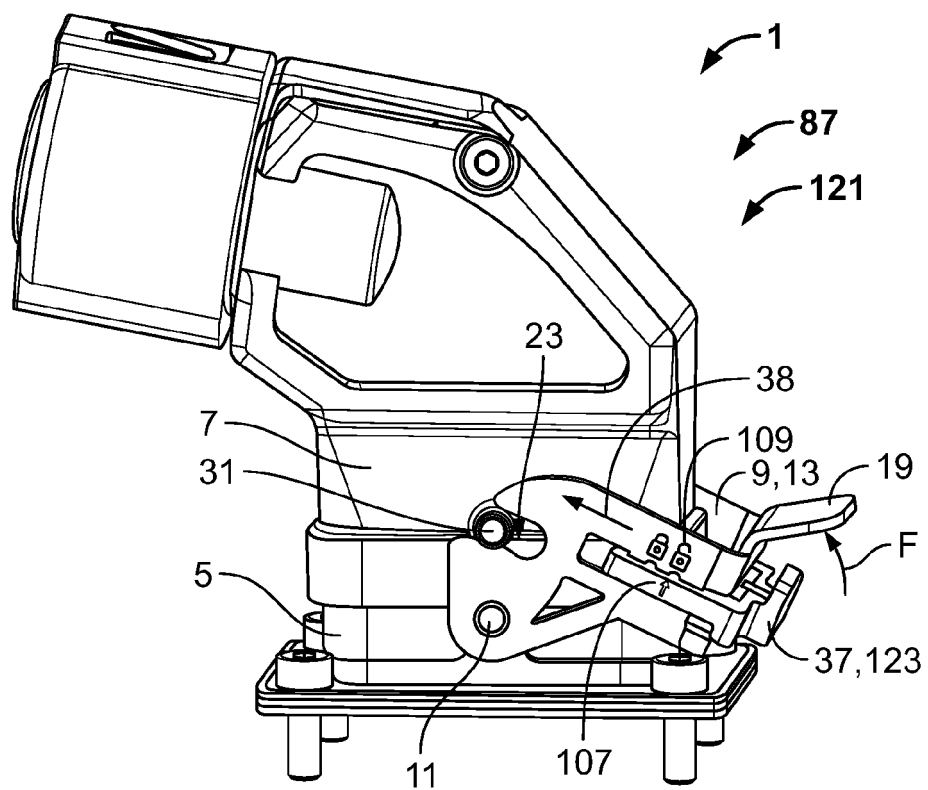


Fig. 5a

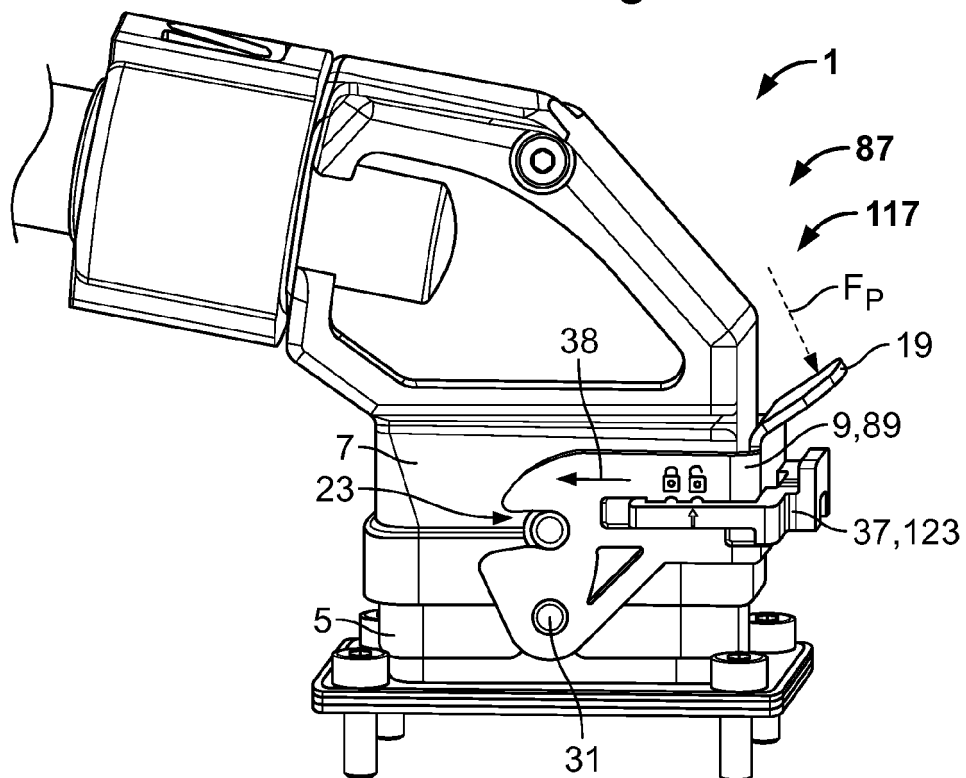


Fig. 5b

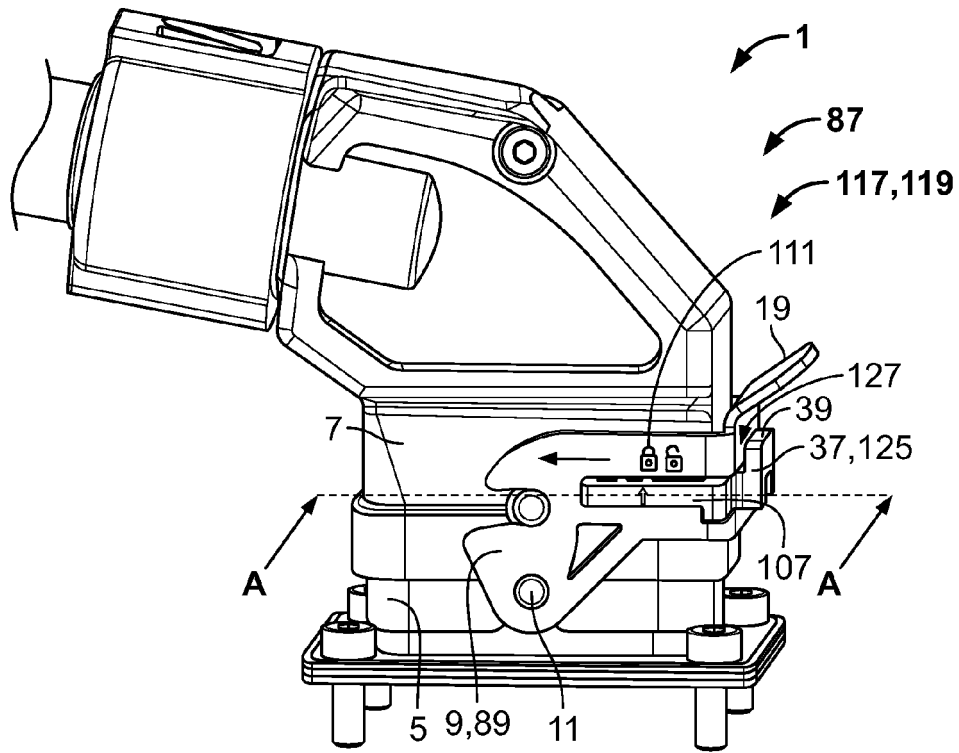


Fig. 5c

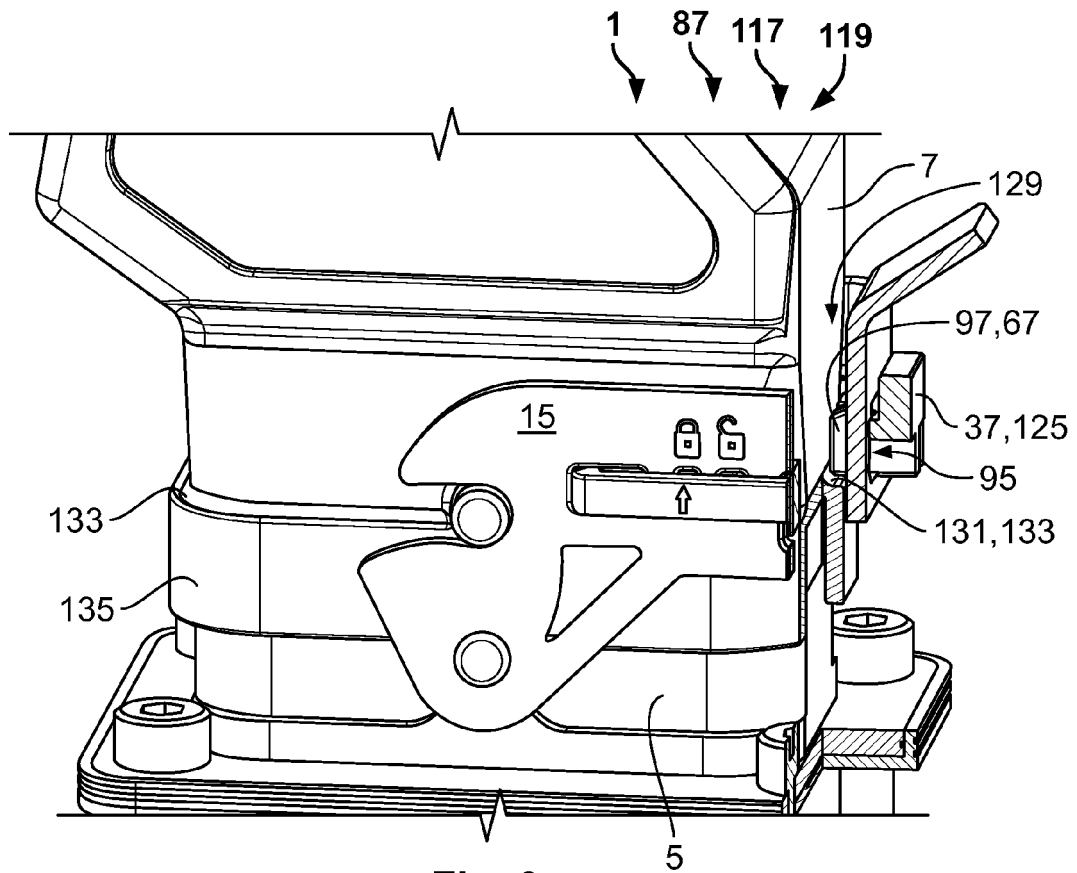
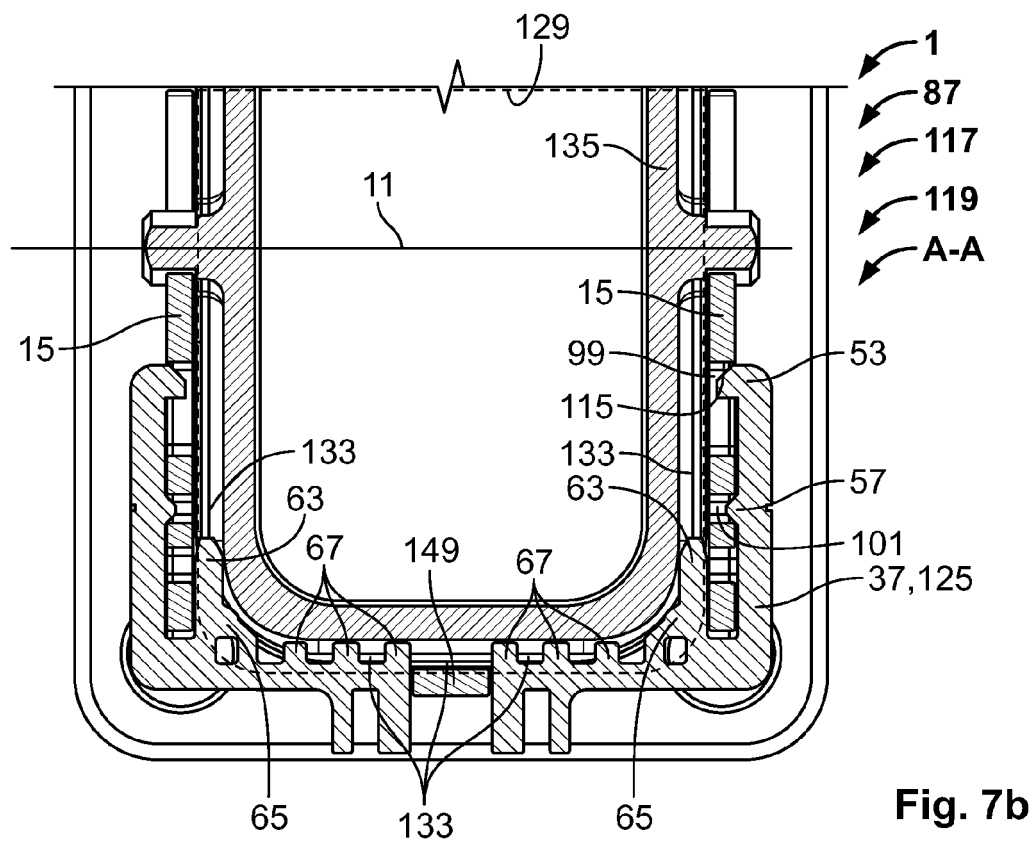
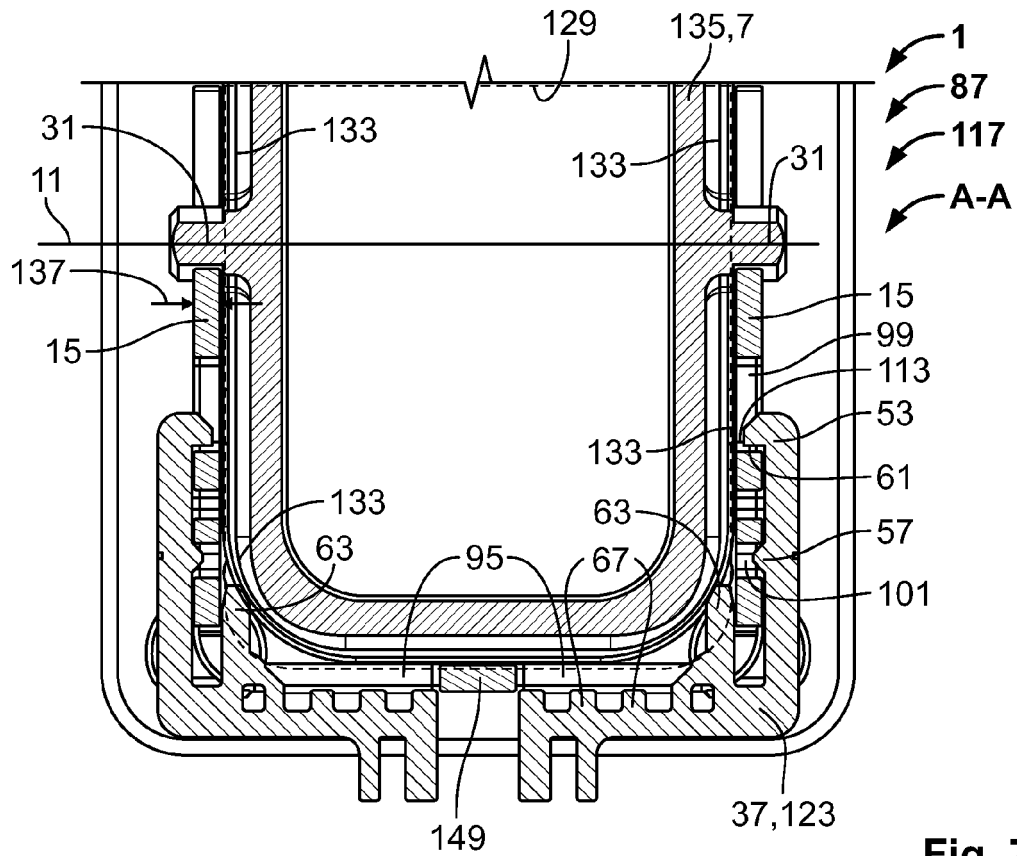


Fig. 6



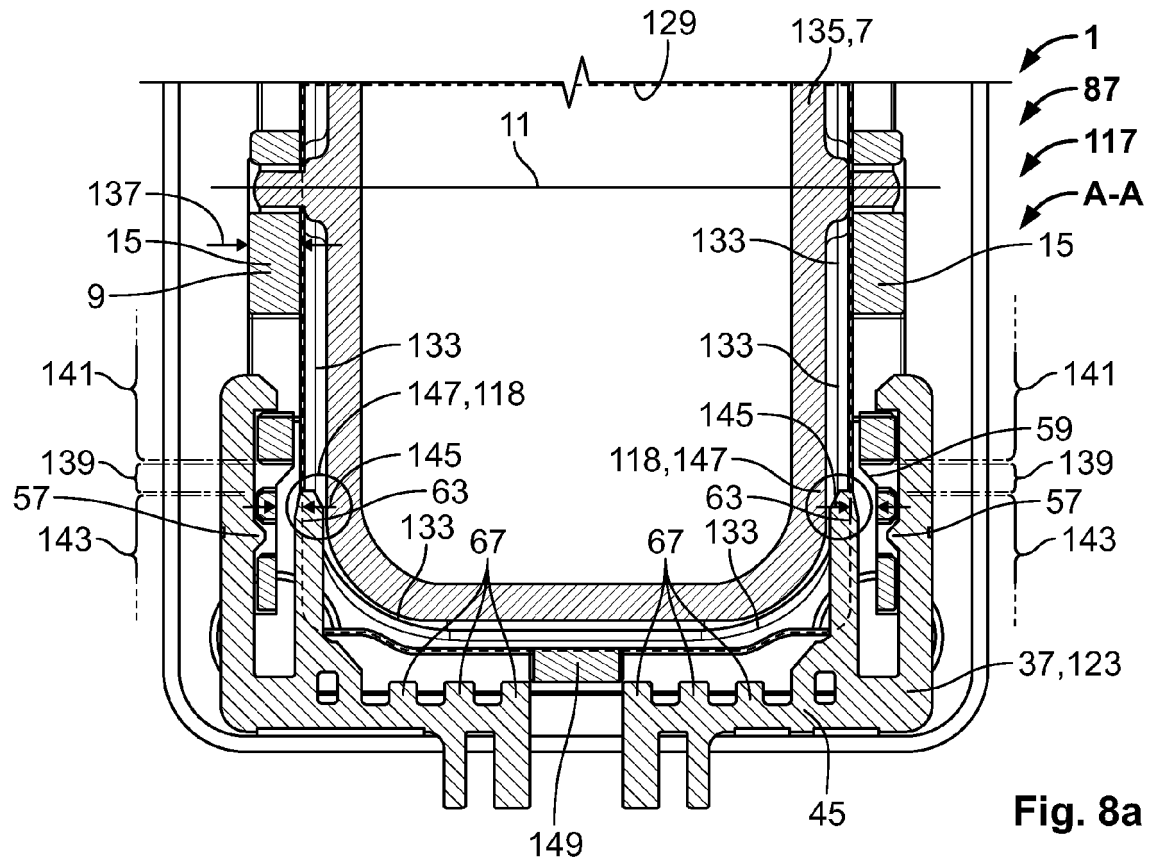


Fig. 8a

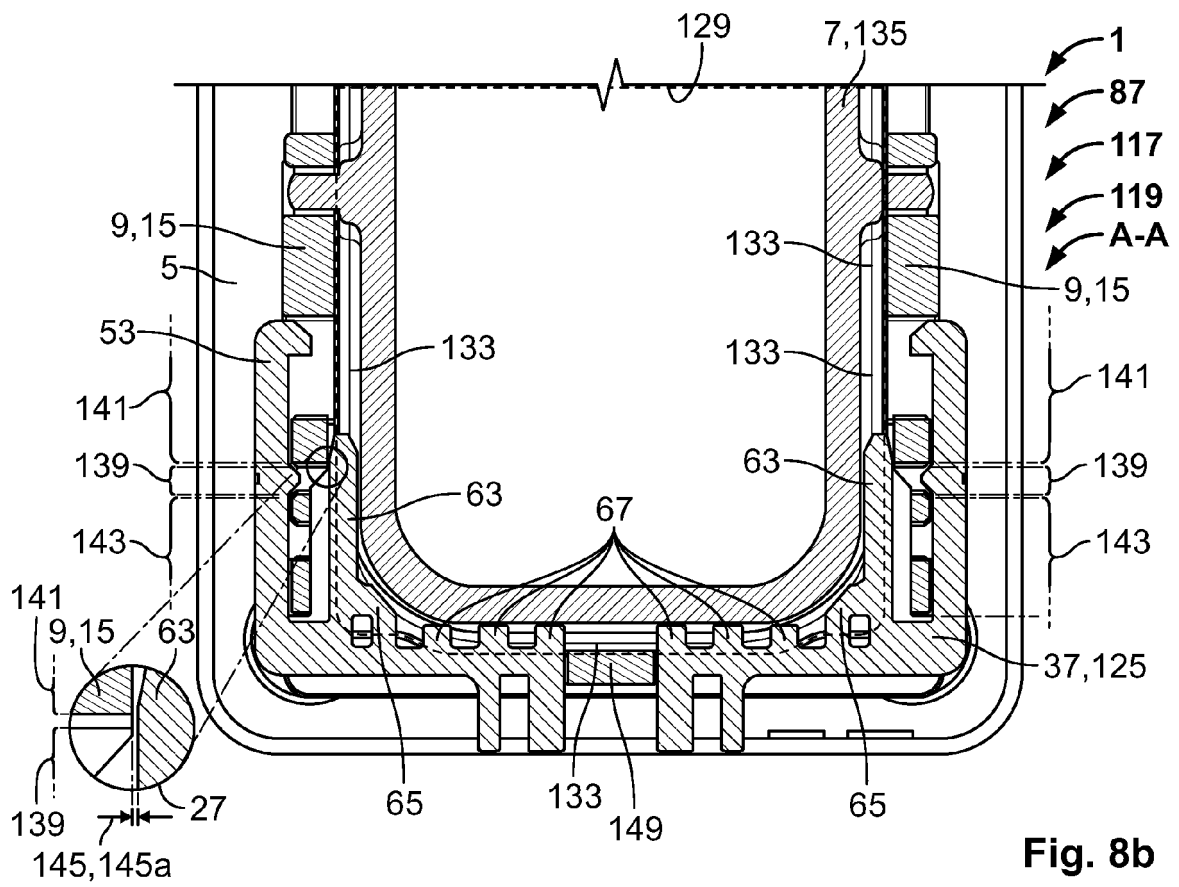


Fig. 8b



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 Application Number
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The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 16 March 2017	Examiner Philippot, Bertrand
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