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(54) ELECTRICAL CONNECTOR WITH MATE-ASSIST LEVER AND INTEGRATED CPA

(57) The present invention relates to an electrical connector (100) comprising a connector housing (110), a mate assist lever (200) arranged movably on the connector housing (110) to facilitate the mating process with a corresponding counter connector and a locking device (300) mounted movably on said lever (200), wherein the locking device (300) can be arranged in two positions, a deactivated position wherein movement of said lever (200) is prevented and an activated position, which allows movement of said lever (200) characterized in that said lever (200) is arranged on the housing (110), such that in a first position the mating process of the connector (100) with the corresponding counter connector can be initiated and wherein in said first position movement of said lever (200) can be prevented by arranging the locking device (300) in its deactivated position.

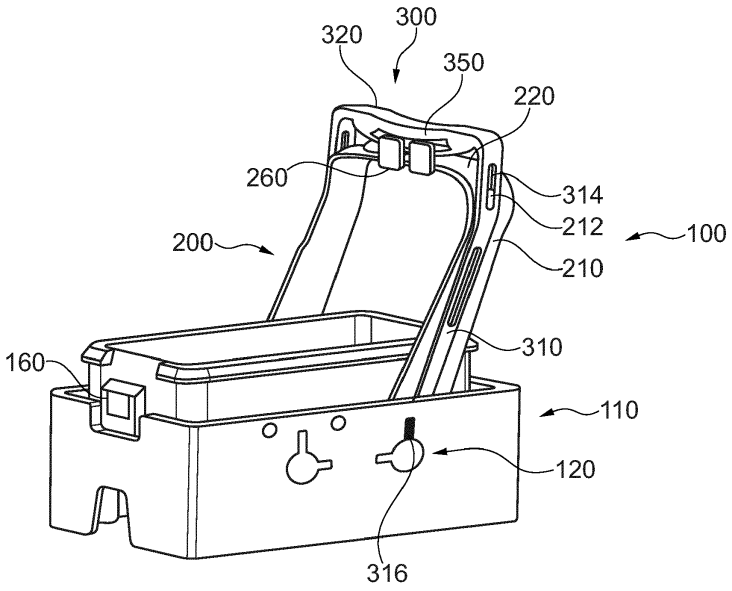

Fig. 1

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Description

1. Field of invention

[0001] The present application relates to an electrical connector and in particular to an electrical connector with a mate-assist lever comprising a locking device.

2. Technical background

[0002] Electrical connector systems are used for joining electrical circuits, wherein typically a male contact terminal is mated with a female contact terminal. Both terminals are arranged in respective connector housings that can be mated with each other to establish the electrical connection between the terminals. In some connector applications a large amount of terminals and/or space constraints make it difficult to apply sufficient force to the connector housings in order to mate with corresponding counter connector housings. In such cases the mating process can be facilitated by mate-assist devices, for example levers or sliders. Since a safe and particularly reliable coupling of contact terminals is of high importance, connector position assurance (CPA) systems can be used to safeguard a successful mating.

[0003] The patent application WO 2006/101816 A1 shows a typical connector assembly, comprising a mate-assist lever, wherein the rotational movement of the mate-assist lever leads to an engagement of the connector housing with a counter connector to establish an electrical connection. A first mechanical lock in form of a cantilever latch and a catch is provided, which prevents the lever from moving out of the mated position. Additional mating safety is provided by a CPA, which is slidably guided on the top surface of the connector housing. The CPA cannot be moved to the closed position until the lever has fully reached its final mating position. After bringing the CPA to the closed position it also functions as a second mechanical lock of the lever. Additional means are provided to inhibit a rearward movement of the CPA out of its locked position.

[0004] A further example of a lever based mating assistance is shown in the patent application WO 2007/098253 A2, wherein an electrical connector assembly is shown with a compact design. In this assembly the lever is movable between an unlocked and a locked position and can be arrested in the locked position by a catch at the lever, which engages a latch of a wire guide. This locking inhibits further movement of the lever out of the locked position. Additionally, the lever comprises an overstress mechanism to prevent overextension of the latch. Further, a longitudinal moveable CPA is located on the top side of the wire guide to lock the lever in its final position.

[0005] The patent application US 2006/0089031 A1 shows an electrical connector with a pivotably mounted mate-assist lever, comprising a CPA, mounted on the mate-assist lever such that the CPA can be slidably switched between an unlocked and a locked position. The connector includes complementary interengaging latching means between a cross portion of the mate-assist lever and a wire shroud to hold the mate-assist lever in its latched position. In addition, complementary interengaging locking means are provided between the CPA member and the wire shroud to lock the lever in its latched position, when the CPA member is moved to its locked position. The CPA is also held in place in an inoperative position by means that are only released when the lever reaches its latched position, subsequently allowing the CPA member to be locked.

[0006] Another connector using a mate-assist system but with a sliding design is shown in the patent application WO 2010/076592 A1. In here, the mate-assist device can be linearly pushed towards and into a corresponding connector housing. The mate-assist device comprises cam slots in its walls and in the corresponding counter connector housing complementary cam pegs are arranged such that a sliding movement of the mate-assist device leads to an interaction of the cam pegs with the cam slots. This leads in effect to a relative movement of the two connector housings towards each other. In other words: The actuating or working direction of the mate assist-device is a translatory movement perpendicular to the mating direction of the two connector housings. A flexible blocking wing acts as a stop member, and prevents actuation of the mate-assist device unless the second connector housing is at least partially mated with the first connector housing. To improve security of the mated connection, latching recesses are provided, which snap into corresponding protrusions when the insertion of the mate-assist device into the connector housing is finished.

[0007] According to the state-of-the-art, CPA systems are mostly used to ensure the correct mating of a connector with a corresponding counter connector. CPA systems in addition often safeguard the finalization of the mating process by additionally locking the connectors in the correct position and/or indicating that a mate-assist device is in a defined end position, where the mating process is finished.

[0008] However, a successful mating relies also on a correct initiation of the mating process, which is in particular for mate-assisted connectors dependent on the position of the mate-assisting device.

[0009] Thus, it is the objective of the present invention to provide an electrical connector with a facilitated mating process.

3. Summary of the invention

[0010] The present invention relates to an electrical connector comprising a connector housing, a mate assist lever arranged movably on the connector housing to facilitate the mating process with a corresponding counter connector and a locking device mounted movably on said lever, wherein the locking device can be arranged in two positions, a deactivated position wherein movement of

said lever is prevented and an activated position, which allows movement of said lever. The lever is arranged on the housing, such that in a first position the mating process of the connector with the corresponding counter connector can be initiated and wherein in said first position movement of said lever can be prevented by arranging the locking device in its deactivated position.

[0011] The electrical connector presented herein fulfil the requirement of an unambiguous defined position of the mate-assist lever at the start of the mating process. This clearly defined starting position of the mate-assist lever can facilitate the mating process as it prevents initiation of the mating process as long as the mate-assist lever is in an unfavorable position. As the connector can comprise a multitude of electrically conductive terminals, it can be understood that, with an increasing terminal number, an increased force must be applied to mate said connector with its counterpart. Also it is obvious that a correct alignment of said connector can be difficult, in particular, when the corresponding parts have small dimensions due to a compact design of the connector. Hence, the mate-assist lever can be used to guide and facilitate the movement of said connector. The mate-assist lever can be for example rotationally hinged with the connector housing. Thus, the rotational movement of the mate-assist lever can be translated to a translational movement of one connector towards its counterpart. The locking device can, as long as it is in a deactivated position, arrest the lever in the starting position. Safeguarding this particular position of the lever allows a secure initialization of the mating process of the two connectors. For the initiation of the mating process, the locking device can be switched to its activated position, thus unlocking the lever. Thereafter it is possible to move the lever towards a second position at which the mating process is finished. The movement of the lever leads to a guided movement of the connector towards a counter connector, hence facilitating the mating process. Arranging the locking device directly movable on the mate-assist lever offers the advantage that unlocking of the lever and subsequent mating of the connector can be performed one-handed and in one go. The locking device prevents that the lever is unintentionally moved out of its first position, for example during shipment of the connector to a customer or during handling of the connector during installation of the same.

[0012] In a preferred embodiment, the locking device mounted on said lever comprises at least one blocking element adapted to interact with a corresponding blocking element provided on said connector housing to prevent movement of said lever, wherein the blocking elements are preferably blocking protrusion and blocking recess respectively. Hence, any undesired movement of the mate-assist lever is blocked while the blocking recess is engaged with the corresponding blocking protrusion. The blocking elements can be produced as integral parts of the locking device and the connector housing, respectively. This simplifies the production of said parts since no additional components must be produced or assembled and both parts can be manufactured as molded parts in a one-piece design, which also increases mechanical stability.

[0013] In another preferred embodiment, the mate-assist lever comprises at least one actuating lever arm and the locking device comprises a locking device leg arranged parallel to the actuating lever arm, preferably along the outer surface of the actuating lever arm. The actuating lever arm is coupled at its distal end to the connector such that any rotational movement of the actuating lever arm is translated to a corresponding connector recipient, for example a connector axle. Each arm/leg preferably comprises a handle bar, located at the proximal end. The arm/leg can be of the same material as the corresponding handle bar and preferably each arm/leg is produced together with each corresponding handle bar in a one-piece design, preferably as a single molded parts. This simplifies the production and the assembly process of the mate-assist lever and locking device, reducing costs and also improving mechanical stability of the components. The preferable close arrangement of the parallel arms allows a compact design, since any movement of the locking device only marginally increases the volume envelope of the connector during operation.

[0014] In another preferred embodiment, the locking device comprises a spring mechanism which is adapted to force the locking device into its deactivated position. Applying a spring mechanism has the advantage that the locking device is automatically put into deactivated position, securely arresting the mate-assist lever in the predefined first position before initiation of the mating process. The spring has the advantageous effect of preventing the locking device from being mistakenly put into its activated position, thus releasing the arrest of the mate-assist lever unintentionally. Even further, due to the constantly applied spring force, the locking device can easily be designed to have exactly two predetermined positions: (1) the deactivated position into which the spring force automatically drives the locking device, when the mate-assist lever is in the first position, and (2) the activated position into which the locking device can be actively brought by applying a force opposite to the direction of the spring force, for example by manually pushing the locking device handle bar. Only in said activated position a movement of the mate-assist lever is possible.

[0015] In a further preferred embodiment, the spring mechanism is integrally formed with the locking device, in particularly in form of a molded plastic part. This preferred one-piece design simplifies manufacturing of the whole locking device, comprising the spring mechanism, the handle bar and the leg to one single unit and improving the stability of said device.

[0016] In another preferred embodiment, said lever is further arranged on the housing, such that in a second position the mating process of the connector with the corresponding counter connector is completed and

wherein in said second position movement of said lever can be prevented by arranging the locking device (again) in its deactivated position. Similar to the requirements before initiation of the mating process, a successful completion of the mating process needs to be safeguarded for a proper connector functionality. Using the same locking device for securing both, mated and unmated state, is of advantage, since no additional parts need to be manufactured or assembled. The second lever position corresponds to a successful mating of the connector with the counter connector. Corresponding to the first position of the mate-assist lever, also in said second position, unintentional movement of the locking device out of its deactivated position can be prevented. Once the lever has reached its second position, e.g. the spring of the locking device will force the locking device into its deactivated position, thereby blocking any unintended movement of the lever, hence safeguarding the connector in the mated state. If a spring is provided, the locking device is forced automatically by the spring, thus no additional interaction of an operator is necessary to securely arrest the lever in the second position and accordingly safeguarding the coupling between the connector and the counter connector. Another benefit is that the procedure for activating the locking device is the same for both lever positions. Thus, switching the mate-assist lever between the first and second position is relatively straightforward for an operator, thus facilitating the mating process.

[0017] In another preferred embodiment, the locking device is adapted such that it cannot be moved in its deactivated position when the lever is between the first and second position. Once the lever has moved out of the first position, the locking device is arrested by means, avoiding a back snapping of the locking device into its deactivated position. Accordingly, the locking device stays in its activated position, even when no further force is applied. In other words: An operator only has to actuate the locking device once in the beginning of the mating process. As soon as the lever has been moved out of its first position, a continuous actuation of the locking device is not necessary. The same applies for the reverse action, when the lever is moved from its second position back to the first position, resulting in an unmating of the connector. The state of the locking device can be visualized by suitable means, indicating if the locking device is currently activated or deactivated, which helps an operator in determining the current status of the locking device.

[0018] In another preferred embodiment, the lever comprises primary locking means to lock the lever onto the housing in the second position of the lever. The additional primary locking means ensure an additional protection of the electrical coupling between the connectors, when the connector is in a fully mated state. Said primary locking means comprise for example latches at the connector housing, protruding from the outer surface of the housing and corresponding catches or recesses provided at the respective surface of the mate-assist lever. When the mate-assist lever arrives in the second position, both components engage each other, forming a retaining mechanical connection that prevents the lever from moving out of the second position. Additional (e.g. manual) force must be applied to disconnect said mechanical connection, when the lever for example shall be returned to its first position. Since any unwanted interruption of an electrical connection can cause severe consequences during operation, additional safeguarding of the mated state of the connector is desirable and of high importance.

[0019] In another preferred embodiment, the at least one actuating lever arm of the lever comprises a length of at least 1 to 20 cm, preferably 3 to 15 cm and most preferred 5 to 10 cm, which corresponds to the desired range of dimensions in which the herein described connector and corresponding mate-assist lever is supposed to be used. These dimensions offer for most applications sufficient length of the lever arms to provide a significant mate assist functionality.

[0020] In another preferred embodiment, the mate assist lever has a U-shape with two lever arms and a handle bar and the locking device has a corresponding U-shape with two legs and a handle bar, and wherein the locking device is arranged on said lever such that the respective handle bars are arranged adjacent to each other and such that the respective legs and arms are arranged adjacent to each other. The U-shape provides an increased mechanical stability of the mate-assist lever and the locking device, respectively. Said increased mechanical stability also allows choosing materials with reduced rigidity for the lever and the locking device, hence leading to additional freedom in the selection of appropriate materials for manufacturing said lever and locking device. It is further preferred, that both, the U-shaped locking device and the U-shaped mate-assist lever are produced each in a one-piece design, for example as molded plastic parts. Preferably, the handle bars are arranged directly adjacent to each other to ensure that the mating process can be performed one handed.

[0021] In another preferred embodiment, the U-shaped locking device is arranged outside of the lever such that the legs extend alongside the outer faces of the respective lever arms. Arrangement of the locking device legs in said manner and the combination with the before mentioned close arrangement of the handle bars result in a compact design of the mate-assist lever with locking device mounted thereupon. Activation and deactivation of the locking device only marginally increases the volume envelope of the connector during the mating process.

[0022] In another preferred embodiment, the outer surfaces of the lever arms comprise guiding means, preferably guiding recesses, which extend along the outer surface of the lever arms to guide the up- and down-movement of the legs. The guiding recesses are preferably grooves in which the legs of the locking device are at least partially embedded and said grooves guide the legs along the outer surfaces of the arms. This reduces any

undesired movements of the arms, besides said up- and down-movement during the activation and deactivation of the locking device, thus ensuring an optimal force and movement translation along the whole locking device. Further, this additional stabilization of the arms allows selecting also more flexible materials for the locking device. The at least partial embedding also results in a more compact design of the assembly of the actuating lever arms with the locking device legs mounted thereupon.

[0023] In another preferred embodiment, guiding slots are provided at the lever arms, which extend along the lever arms and wherein the slots are located opposite to the handle bar and wherein guiding protrusions are provided at the surfaces of the locking device legs to engage with said guiding slots to guide the up- and down-movement of the locking device. In a further preferred embodiment, guiding slots are provided at the locking device legs, which extend along the locking device legs; and wherein the slots are located adjacent to the handle bar and wherein guiding protrusions are provided at the surfaces of the lever arms to engage with said guiding slots to guide the up- and down-movement of the locking device. Said slots and respective protrusions, provided at the actuating lever arms and locking device legs engage each other, providing additional movement guidance of the locking device legs along the actuating lever arms. Dependent on the dimensioning of said slots and protrusions, the permissible movement of the protrusions within the slots define the range of up- and down-movement of the locking device.

[0024] In another preferred embodiment, the locking device mounted on said lever comprises at least one blocking element in form of a protrusion adapted to interact with a corresponding blocking element in form of a rounded, preferably circular, recess provided on said connector housing, which rounded recess comprises two slots extending in the same plane and perpendicular from the circumference of said rounded recess, wherein the two slots are formed to receive said protrusion. Said blocking protrusion of the locking device can engage said rounded blocking recess, located on the connector housing, hence establishing a mechanical connection between the lever and the connector housing. Accordingly, the movement of the lever can be locked when the protrusion is located in one of the blocking recess slots. The blocking protrusion is dimensioned so that it tightly fits in the blocking recess slot.

[0025] In a preferred embodiment, the longitudinal axes of the two slots define an angle between 30 and 120°, preferably between 60 and 100° and most preferably between 80 and 90°. Since the movement of the lever can correlate with the movement of the protrusion within the rounded blocking recess, said angle between the slots can be similar to the angle that a rotationally hinged mate-assist lever performs during the mating process. For example, if the angle between first and second position of a mate-assist lever defines 90°, said blocking recess slots can also define an angle of 90°.

[0026] In a further preferred embodiment, in the deactivated position of the locking device, said protrusion is located inside one of the slots and in the activated position said protrusion is located outside of the slots and inside the rounded recess. Said blocking protrusion can be guided coaxially to the extending direction of the slot, hence confining the movement to the up- and down-movement during the activation and deactivation of the locking device. Once the protrusion is located outside the slots and inside the rounded blocking recess also other degrees of movement are allowed, for example rotational movement and hence the mate-assist lever can be turned. The rounded, preferably circular shape of the inner walls of the blocking recess facilitate the movement of the blocking protrusion within the blocking recess, since said spring mechanism forces the protrusion towards the inner wall of the rounded blocking recess. Preferably, the rounded blocking recess can be provided in the outer wall of the connector housing, and the position of the blocking protrusion within the rounded blocking recess can be visually recognized by an operator from the outside. Since the two slots can correspond to the first and second lever position said described visualization of the protrusion position can function as an additional CPA, indicating the current state of the mate-assist lever, for example if the lever is arrested or unarrested and if the locking device is completely arranged in the first or second position.

4. Description of the drawings

[0027] For a better understanding of the present invention and to appreciate its practical applications, the following figures are provided and referenced hereafter. It should be noted that the figures are given as examples only and in no way limit the scope of the invention.

Fig. 1 shows a connector with a mounted mate-assist lever and a locking device.

Figs. 2a-b show the mate-assist lever and the locking device in a disassembled (a) and in an assembled state (b).

Figs. 3a-c show a close up view of the blocking recess of the housing for first (a), intermediate (b) and second lever positions (c).

Figs. 4a-d show the connector with the mounted mate-assist lever and locking device in different states during mating operation.

Figs. 5a-b show a close up view of the mate-assist lever with mounted locking device thereupon after the end of the mating process in a top view (a) and a sectional view (b).

5. Description of preferred embodiments

[0028] In the following the present invention will now be described in more detail hereinafter with reference to the accompanying figures, in which exemplary embodiments of the invention are illustrated. However, the present invention may be embodied in different forms and should not be construed as limited to the embodiments set forth herein. Rather, these examples are provided so that this disclosure will be thorough and will convey the scope of the invention to persons skilled in the art.

[0029] **Fig. 1** shows as a preferred embodiment of the invention, a connector 100 with a mounted mate-assist lever 200 and a locking device 300 mounted on said mate-assist lever 200. The connector 100 can be mated with a corresponding counter connector to establish a mechanical or electrical connection. To protect the housed electrically conducting parts from physical damages or ingressing moisture the connector 100 comprises a connector housing 110, which is usually made of an insulative material, such as plastic.

[0030] In the embodiment the mating process of the connector 100 with a counter connector is facilitated by a U-shaped mate-assist lever 200 comprising a lever handle bar 220 and two actuating lever arms 210 mounted on the connector 100. Said mate-assist lever 200 is arranged in a first position at which the mating process between the connector 100 and the counter connector can be initiated. To ensure that the mate-assist lever 200 is in the correct position, a locking device 300 is mounted thereupon. The locking device 300 also comprises a U-shaped form with a locking device handle bar 320 and two locking device legs 310. The locking device 300 is mounted in a way that the locking device handle bar 320 is adjacent and on top of the lever handle bar 220. Also the locking device legs 310 are adjacent and extend along the actuating lever arms 210. The locking device 300 comprises a spring mechanism 350, which can be biased/activated by pushing the locking device handle bar 320 downwards (in the orientation shown in Fig. 1; in practice the connector can be arranged in any spatial orientation). Pushing of the locking device handle bar 320 leads to a movement of the whole locking device 300 in pushing direction. To guide the movement of the locking device 300 during activation of the locking device 300, and a corresponding upwards movement during deactivation of the locking device 300, locking device leg guiding slots 314 are provided at the locking device legs 310. Said locking device leg guiding slots 314 are located adjacent to the locking device handle bar 320 and extend along the locking device legs 310. Corresponding lever arm guiding protrusions 212 are located at the outer surface of the actuating lever arms 210 to engage with the locking device leg guiding slots 314 to guide the movement of the locking device legs 310 during activation/deactivation of the locking device 300. The locking device 300 is connected to the connector housing 110 via a blocking recess 120, wherein the locking device leg blocking protrusion 316 of said locking device leg 310 can engage. The blocking recess 120 can also function as a CPA, wherein the position of the mate-assist lever 200 can be visually indicated by the position of the locking device leg blocking protrusion 316 within the blocking recess 120. This supports an operator in determining if the mate-assist lever 200 is in the desired first or second position.

[0031] The mate-assist lever 200 also comprises primary locking means 260 located at the inner surface of the lever handle bar 220. Said primary locking means of the lever 260 can engage corresponding primary locking means of the housing 160, located at the outer surface of the connector housing 110, when the mate-assist lever 200 is put into second position. This provides an additional safeguarding of the end position of the mate-assist lever 200.

[0032] **Fig. 2a** shows a detailed view of the locking device 300 and the mate-assist lever 200. Both components comprise a U-shaped design, each with handle bars 220; 320 and corresponding arms/legs 210; 310 extending from said handle bars 220; 320, respectively. The locking device 300 and the mate-assist lever 200 are each produced in a one-piece design, for example as molded plastic parts. This facilitates their manufacturing process, since each component can be produced in one go. The one-piece design also includes the depicted spring mechanism 350 of the locking device 300, which is integrally formed with the locking device handle bar 320. Multiple supportive means are provided to ensure a proper guidance of the movement of the locking device 300 during activation/deactivation. The lever arm guiding protrusions 212 extend from the outer surface of the actuating lever arm 210 and engage with said locking device leg guiding slots 314. Said guiding means 212; 314 are provided adjacent to the lever handle bar 220. Similar guiding means 214; 312 are also provided at the opposite end of the actuating lever arms 210, adjacent to the distal end of the actuating lever arms 210. At this location lever arm guiding slots 214 are provided on the actuating lever arm 210 and locking device leg guiding protrusions 312 are provided on the corresponding locking device leg 310, which engage said lever arm guiding slots 214. The guiding protrusions 212; 312 fit into the corresponding guiding slots 214; 314, constricting the movement of the locking device 300 to an up- and down-movement during activation/deactivation. These guiding means can define the length of the movement of the locking device 300, depending on the dimensions of the slots 214; 314 and the dimensions of the protrusions 212; 312. Additional guidance of the locking device 300 is provided by lever arm guiding recesses 216, located at the outer surface of the actuating lever arms 210. The locking device legs 310 are at least partially embedded in said recesses 216, stabilizing said locking device legs 310 during said up- and down-movement. Further, locking device leg blocking protrusions 316 are provided at the distal ends of the locking device legs 310. Said protrusions 316 can en-

gage with said blocking recess 120 of the connector housing 110, establishing a mutual mechanical connection between the connector housing 110 , the mate-assist lever 200 and in particular the locking device 300.

[0033] **Fig. 2b** shows the mate-assist lever 200 and the locking device 300 in mounted state. As depicted, the guiding slots 214; 314 and protrusions 212; 312 of the actuating lever arms 210 and locking device legs 310 engage each other. The locking device handle bar 320 is located right upon the lever handle bar 220 such that the locking device handle bar 320 and lever handle bar 220 can be used one-handed by an operator. The close assembly of the two components provides a compact and space saving design, since the volume envelope of the mate-assist lever 200 only marginally increases with the assembly of the locking device 300.

[0034] **Fig. 3a** shows a close up view of the blocking recess 120 as shown in Fig. 1, wherein said blocking recess 120 is located in the outer walls of the connector housing 110. The blocking recess 120 preferably has a rounded shape, even more preferably a circular shape. Two blocking recess slots 124, 124' are provided at the blocking recess 120, which fit to and retain the locking device leg blocking protrusion 316. The blocking recess slots 124; 124' define an angle in between, preferably corresponding to the angle by which the mate-assist lever 200 can be turned during the mating process. The locking device leg blocking protrusion 316 is depicted in a state, when the locking device 300 is in a deactivated position and the mate-assist lever 200 is in a first position. In this position mating of the connector with the counter connector can be initiated. The spring mechanism 350 forces the locking device 300 away from handle bar 220 (upwards in the orientation of Fig. 1) and accordingly forces the locking device leg blocking protrusion 316 into the upright blocking recess slot 124' in Fig. 3a. In the shown state, movement of the locking device leg blocking protrusion 316 is restricted to one direction, in this particular example of Fig. 3a downwards. Thus the interaction of the locking device 300 with the connector housing 110 blocks any movement of the mate-assist lever 200 and arrests the mate-assist lever 200 in the first position. Preferably, the position of the locking device leg blocking protrusion 316 inside the blocking recess 120 can be visually recognized from an operator, such that the correct positions of the mate-assist lever 200 and the locking device 300 can be estimated. This provides a visual assistance for guaranteeing that the electrical connector 100 is in a ready-to-mate state.

[0035] **Fig. 3b** depicts the blocking protrusion 316 in an intermediate position, which corresponds to a mate-assist lever 200 between the first and second position, for example during the mating process. The locking device leg blocking protrusion 316 is located inside the blocking recess 120, allowing a rotational movement of the mate-assist lever 200. The blocking protrusion 316 contacts the inner walls of the blocking recess 120 because of the biased spring mechanism 350 that forces the locking device leg blocking protrusion 316 outwards the blocking recess 120. Thereby, the inner walls of the blocking recess 120 maintain the locking device 300 in its activated position.

[0036] **Fig. 3c** shows the blocking protrusion 316 with the mate-assist lever 200 in the second position after the mating process is completed. Similar to the state of the connector 100 in Fig. 3a, the locking device leg blocking protrusion 316 is automatically forced by the spring 350 into the horizontal blocking recess slot 124, preventing any further movement of the mate-assist lever 200. Again, the position of the locking device leg blocking protrusion 316 inside the blocking recess slot 124 can be visually recognized from an operator providing a visual assistance for ensuring that the electrical connector 100 is fully mated.

[0037] **Figs. 4a-d** show the mating process of the connector 100 of Fig. 1. The mate-assist lever 200 is in the first position, wherein the mating process with a corresponding counter connector (not shown) can be initiated. The locking device 300 arrests the mate-assist lever 200 in the first position, which can be visually recognized at the blocking recess 120 located at the outer walls of the connector housing 110. As depicted, the locking device 300 can be activated by pushing the locking device handle bar 320 downwards, thus releasing the movement arrest of the mate-assist lever 200.

[0038] **Fig. 4b** shows the mate-assist lever 200 during the mating process, i.e. between first and second position. The locking device 300 stays activated during the movement of the mate-assist lever 200. A close up view of the blocking recess 120 in the shown state is depicted in Fig. 3b.

[0039] **Fig. 4c** shows the connector 100 in a state, where the mating process is completed. This is indicated by the mate-assist lever 200, which is arranged in the second position. The spring mechanism 350 of the locking device 300 forces the locking device 300 back into its deactivated form, hence pushing the blocking protrusion 316 out of the blocking recess 120.

[0040] **Fig. 4d** shows the connector 100 in a state, where mating process is completed and where the spring mechanism 350 has forced the locking device 300 into its deactivated position. Accordingly, the blocking protrusion 316 of the locking device 300 has been forced into the corresponding horizontal blocking recess slot 124, blocking any further movement of the mate-assist lever 200. A close up view of the blocking recess 120 in the shown state is depicted in Fig. 3c.

[0041] In addition, primary locking means of the lever 260, provided at the inner surface of the lever handle bar 220 engage with corresponding primary locking means of the housing 160, provided at the outer surface of the connector housing 110. Engaging of these primary locking means 160; 260 additionally ensures safeguarding the mated state of the connector 100.

[0042] **Fig. 5a** shows a top view of the connector 100 in a fully mated state, similar to Fig. 4d. The primary lock-

ing means of the housing 160 are fully engaged with the corresponding primary locking means of the lever 260, ensuring that the mate-assist lever 200 is in the second position and thus ensuring that the connector 100 is fully mated.

[0043] **Fig. 5b** shows a sectional view of the connector 100 in a fully mated state. The engagement of the protruding primary locking means of the housing 160 and the protruding primary locking means of the lever 260 are depicted. The primary locking means 160; 260 prevent the lever from moving out of the second position. Thus, additional force is needed to release said engagement and the mate-assist lever 200 is safeguarded in said second position.

Reference signs

Figure 1: Overview connector

[0044]

100 Connector
110 connecor housing
120 blocking recess
160 primary locking means of the housing
200 mate-assist lever
210 actuating lever arm
212 lever arm guiding protrusion
220 lever handle bar
260 primary locking means of the lever
300 locking device
310 locking device leg
314 locking device leg guiding slots
316 locking device leg blocking protrusion
320 locking device handle bar
350 spring mechanism

Figure 2: Lever arm and locking device

[0045]

200 mate-assist lever
210 actuating lever arm
212 lever arm guiding protrusion
214 lever arm guiding slots
216 lever arm guiding recess
220 lever handle bar
300 locking device
310 locking device leg
312 locking device leg guiding protrusion
314 locking device leg guiding slots
316 locking device leg blocking protrusion
320 locking device handle bar
350 spring mechanism

Figure 3: Blocking recess

[0046]

110 connecor housing
120 blocking recess
124 blocking recess slots
316 locking device leg blocking protrusion

Figure 4 a-d: Mating process

[0047]

100 Connector
110 connecor housing
120 blocking recess
200 mate-assist lever
300 locking device

Figure 5: Primary locking means

[0048]

110 connecor housing
160 primary locking means of the housing
200 mate assist lever
260 primary locking means of the lever
300 locking device

Claims

1. An electrical connector (100) comprising
a connector housing (110),
a mate assist lever (200) arranged movably on the connector housing (110) to facilitate the mating process with a corresponding counter connector; and
a locking device (300) mounted movably on said lever (200), wherein
the locking device (300) can be arranged in two positions, a deactivated position wherein movement of said lever (200) is prevented and an activated position, which allows movement of said lever (200);
characterized in that
said lever (200) is arranged on the housing (110), such that in a first position the mating process of the connector (100) with the corresponding counter connector can be initiated and wherein in said first position movement of said lever (200) can be prevented by arranging the locking device (300) in its deactivated position.

2. The connector according to claim 1, wherein the locking device (300) mounted on said lever (200) comprises at least one blocking element adapted to interact with a corresponding blocking element provided on said connector housing (110) to prevent movement of said lever (200), wherein the blocking elements are preferably blocking protrusion (316) and blocking recess (120) respectively.

3. The connector according to one of the preceding

claims, wherein the mate-assist lever (200) comprises at least one actuating lever arm (210) and the locking device (300) comprises a locking device leg (310) arranged parallel to the actuating lever arm (210), preferably along the outer surface of the actuating lever arm (210).

4. The connector according to one of the preceding claims, wherein the locking device (300) comprises a spring mechanism (350) which is adapted to force the locking device (300) into its deactivated position.

5. The connector according to the preceding claim, wherein the spring mechanism (350) is integrally formed with the locking device (300), in particularly in form of a molded plastic part.

6. The connector according to one of the preceding claims, wherein said lever (200) is further arranged on the housing (110), such that in a second position the mating process of the connector (100) with the corresponding counter connector is completed and wherein in said second position movement of said lever (200) can be prevented by arranging the locking device (300) in its deactivated position.

7. The connector according to the preceding claim, wherein the locking device (300) is adapted such that it cannot be moved in its deactivated position when the lever (200) is between the first and second position.

8. The connector according to any one of the preceding claims, wherein the lever (200) comprises primary locking means (160; 260) to lock the lever onto the housing (110) in the second position of the lever (200).

9. The connector according to one of the preceding claims, wherein
the at least one actuating lever arm (210) of the lever (200) comprises a length of at least 1 to 20 cm, preferably 3 to 15 cm and most preferred 5 to 10 cm.

10. The connector according to one of the preceding claims, wherein
the mate assist lever (200) has a U-shape with two lever arms (210) and a handle bar (220); and
the locking device (300) has a corresponding U-shape with two legs (310) and a handle bar (320), and wherein the locking device (300) is arranged on said lever (200) such that the respective handle bars (220; 320) are arranged adjacent to each other and such that the respective legs (310) and arms (210) are arranged adjacent to each other.

11. The connector according to the preceding claim, wherein
the U-shaped locking device (300) is arranged outside of the lever (200) such that the legs (310) extend alongside the outer faces of the respective lever arms (210).

12. The connector according to the preceding claim, wherein
the outer surfaces of the lever arms (210) comprise guiding means, preferably guiding recesses (216), which extend along the outer surface of the lever arms (210) to guide the up- and down-movement of the legs (310).

13. The connector according to one of the preceding claims, wherein
guiding slots (214) are provided at the lever arms (210), which extend along the lever arms (210); and wherein
the slots (214) are located opposite to the handle bar (220); and wherein
guiding protrusions (312) are provided at the surfaces of the locking device legs (310) to engage with said guiding slots (214) to guide the up- and down-movement of the locking device (300).

14. The connector according to one of the preceding claims, wherein
guiding slots (314) are provided at the locking device legs (310), which extend along the locking device legs (310); and wherein
the slots (314) are located adjacent to the handle bar (220); and wherein
guiding protrusions (212) are provided at the surfaces of the lever arms (210) to engage with said guiding slots (314) to guide the up- and down-movement of the locking device (300).

15. The connector according to one of the preceding claims, wherein the locking device (300) mounted on said lever (200) comprises at least one blocking element in form of a protrusion (316) adapted to interact with a corresponding blocking element in form of a rounded, preferably circular, recess (120) provided on said connector housing (110), which rounded recess (120) comprises two slots (124, 124') extending in the same plane and perpendicular from the circumference of said rounded recess (120); wherein the two slots (124) are formed to receive said protrusion (316).

16. The connector according the preceding claim, wherein the longitudinal axes of the two slots (124, 124') define an angle between 30 and 120°, preferably between 60 and 100° and most preferably between 80 and 90°.

17. The connector according to one of the preceding claims 15 to 16, wherein in the deactivated position

of the locking device (300), said protrusion (316) is located inside one of the slots (124, 124') and in the activated position said protrusion (316) is located outside of the slots (124, 124') and inside the rounded recess (120).

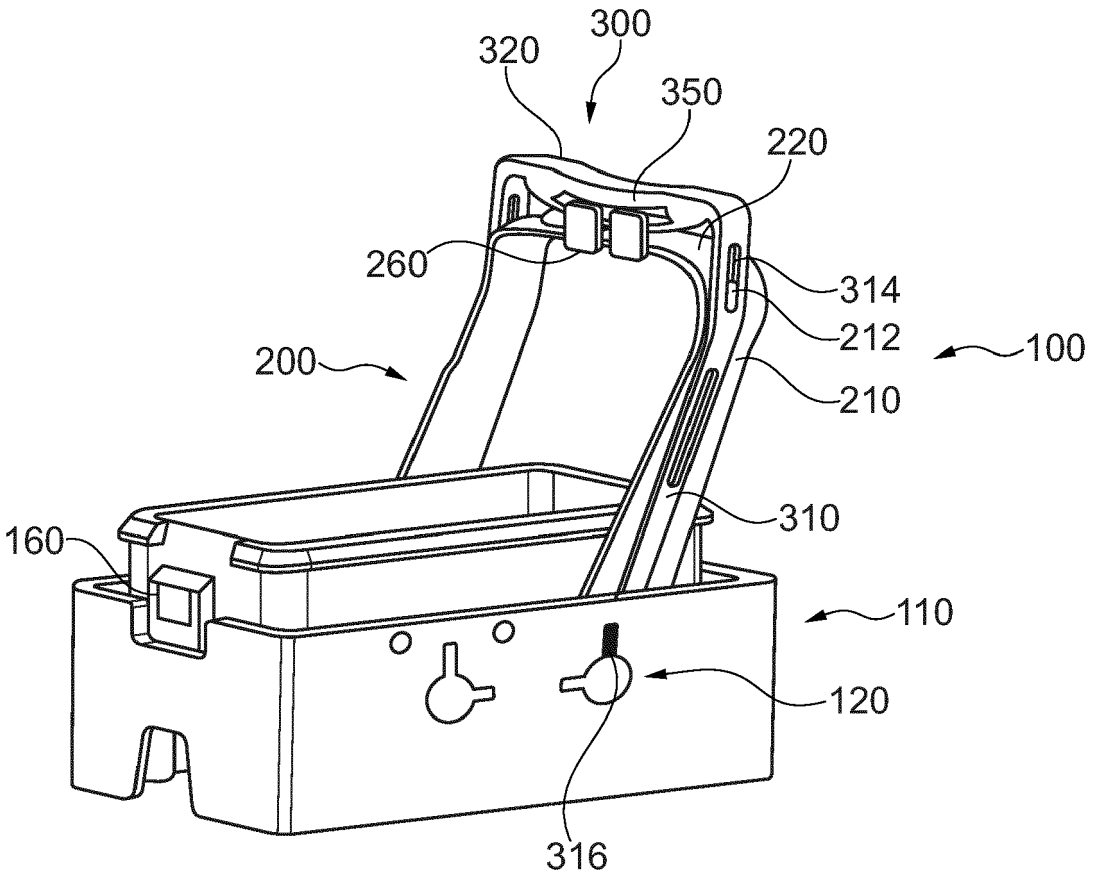

Fig. 1

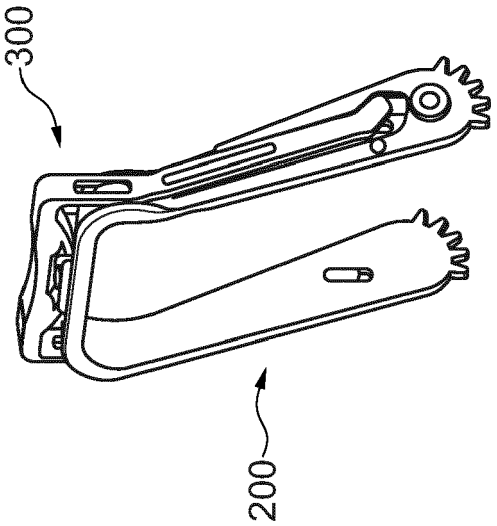

Fig. 2b

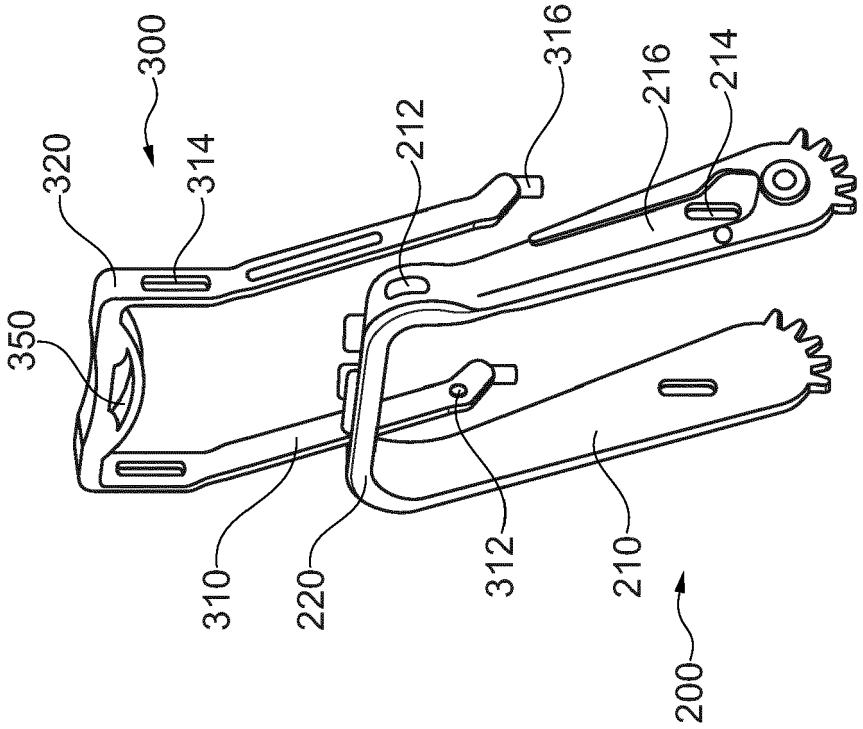

Fig. 2a

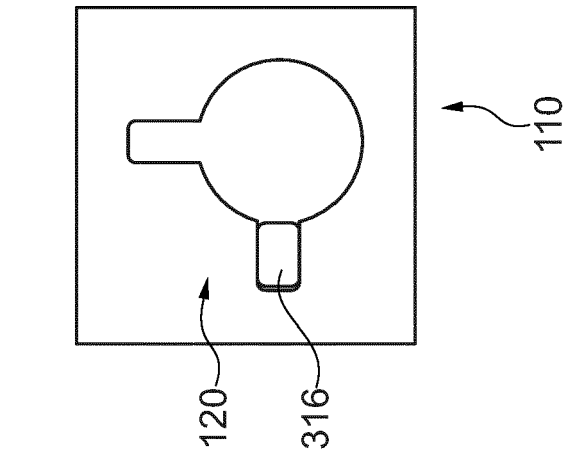

Fig. 3c

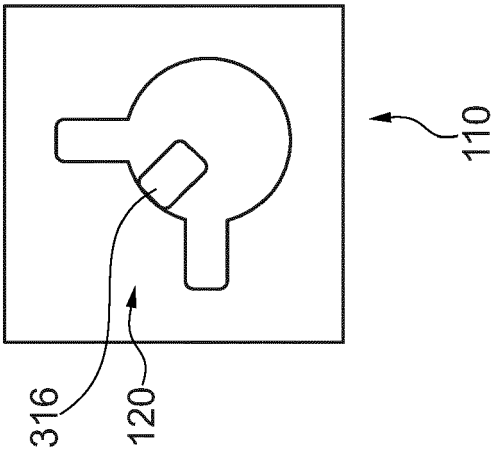

Fig. 3b

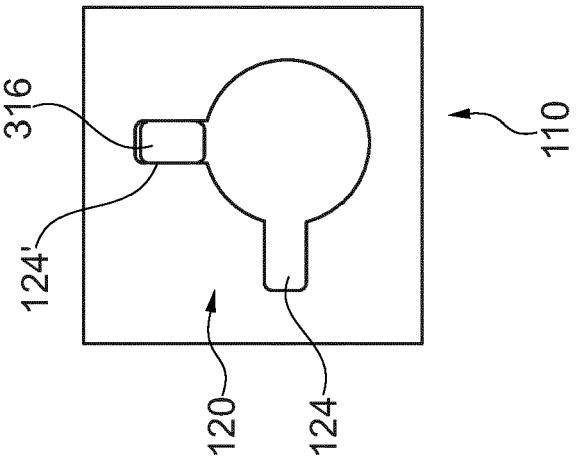

Fig. 3a

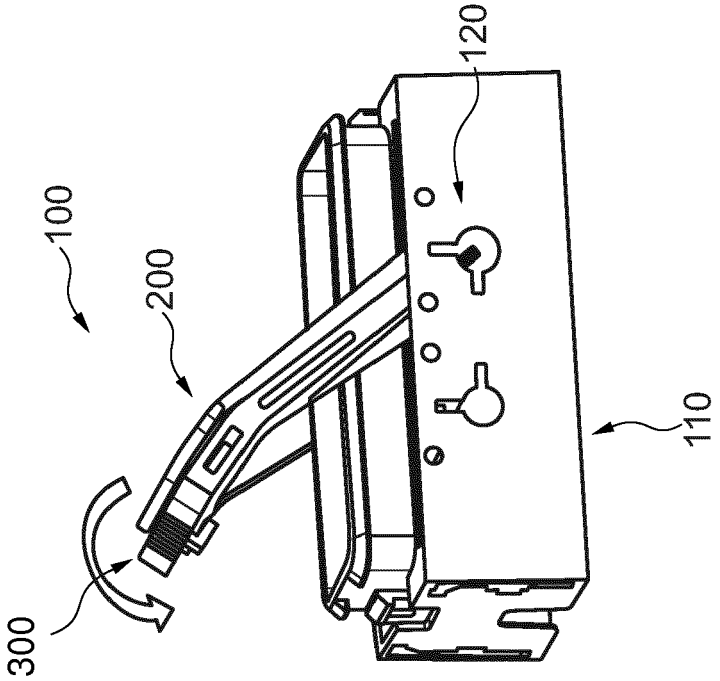

Fig. 4b

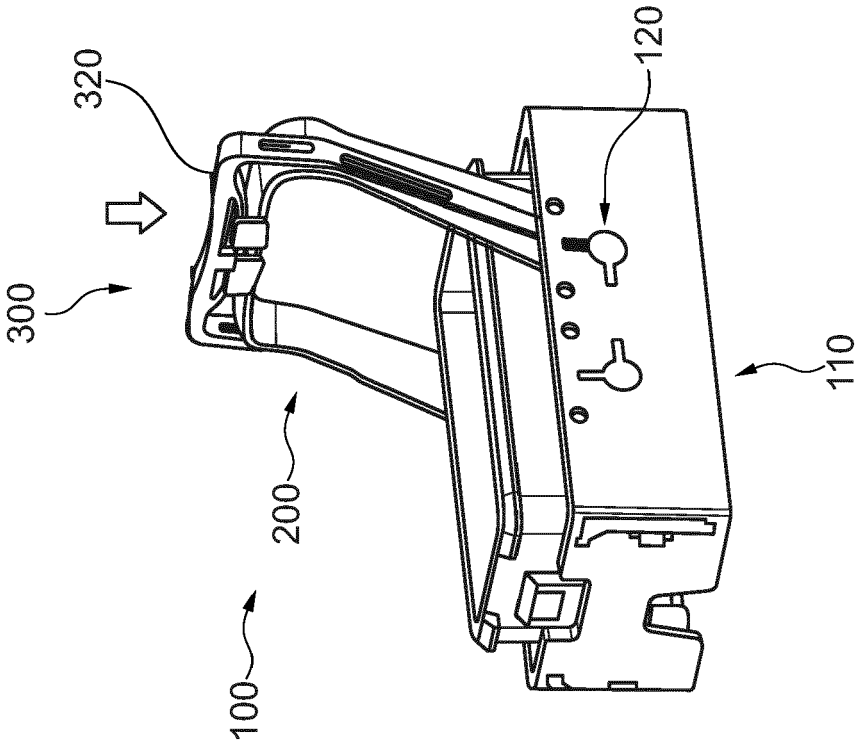

Fig. 4a

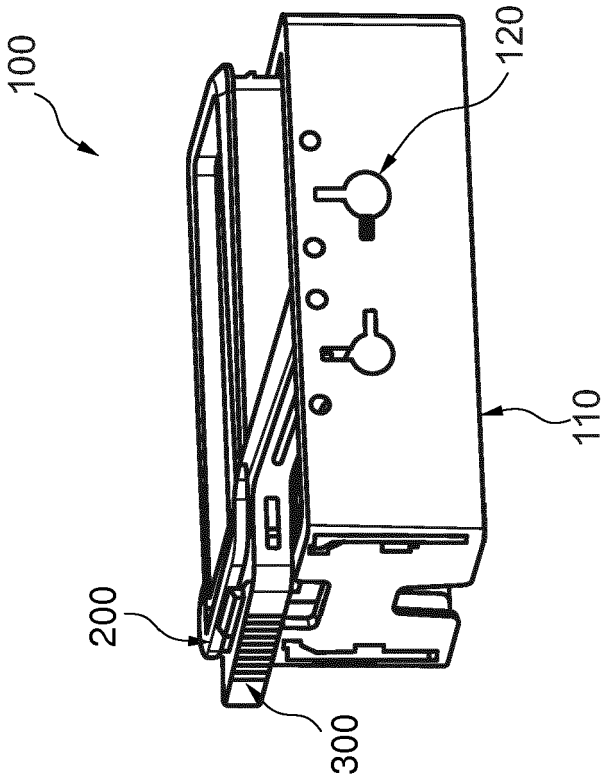

Fig. 4d

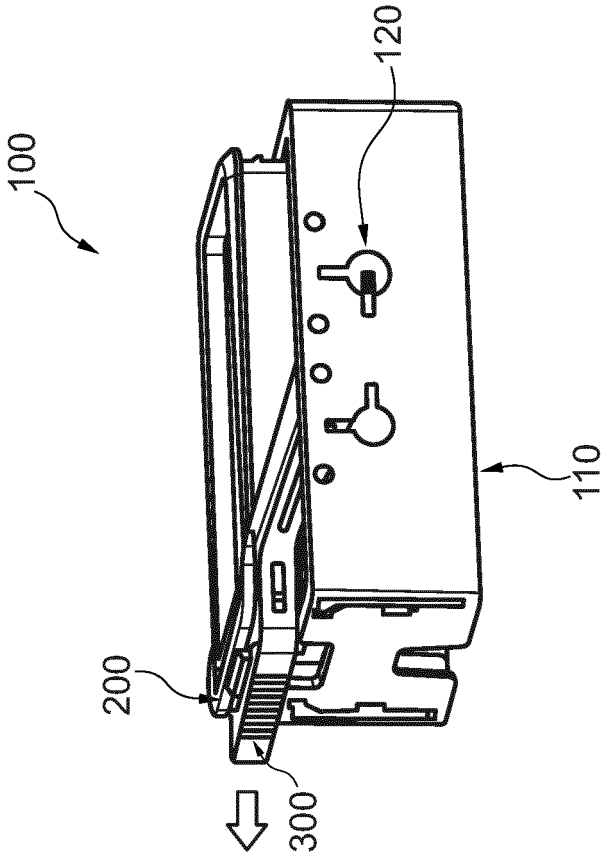

Fig. 4c

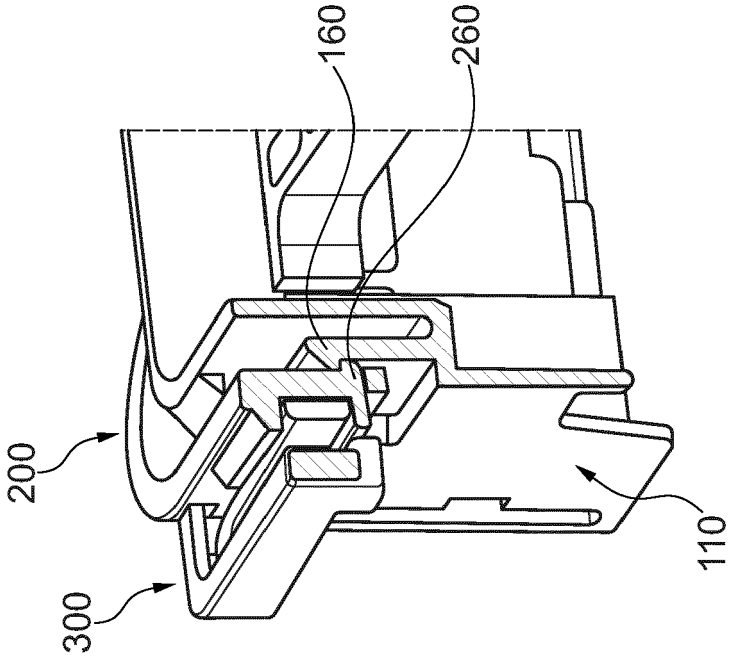

Fig. 5b

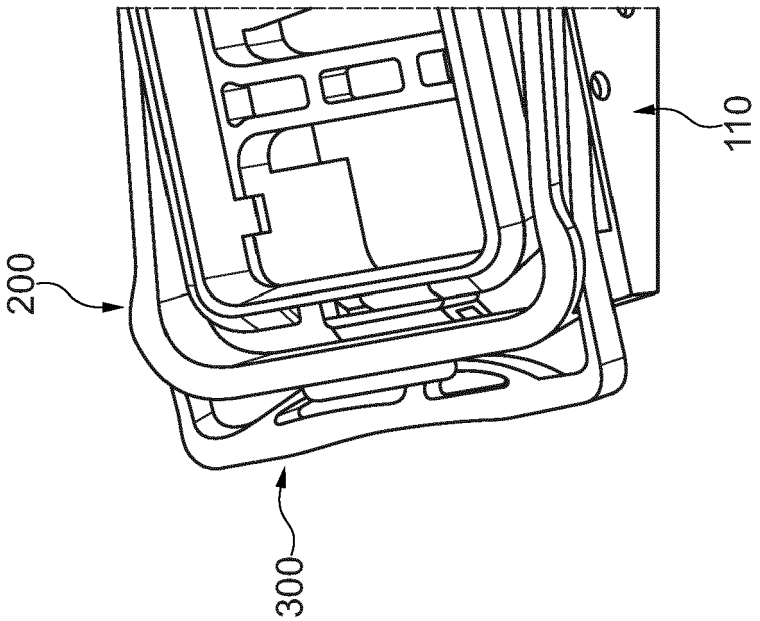

Fig. 5a

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EUROPEAN SEARCH REPORT

Application Number
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The Hague	26 October 2016	López García, Raquel

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