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(54) **Airbag connector**

(57) An airbag electrical connector assembly comprising a socket connector (1) and a plug connector (2) having an actuator (6) for breaking the shorting condition of the shorting element (13) in the socket connector, and a CPA member (7) for latching the plug connector in a pre-mounted position within the socket connector and for locking the plug connector when the connectors (1, 2) are fully mated. The CPA member (7) includes a pair of locking legs (70) and spring arms (73).

The locking legs are shifted through interspaces (24)

between the latch arms (22) and the plug projection (21) into the locking position. The free end of each spring arm (73) of CPA member (7) is formed as a single lug (74) having a supporting surface (74a) for being supported on stop wall means in the plug housing (3) in the pre-mounted position of the connectors (1, 2), and first and second slanting surfaces (74b, 74c) on the lug (74) for cooperating with an inner insert wall (17) of the socket connector for deflecting the spring arm (73) to come free from the stop wall means, and for being latched behind the stop wall means.

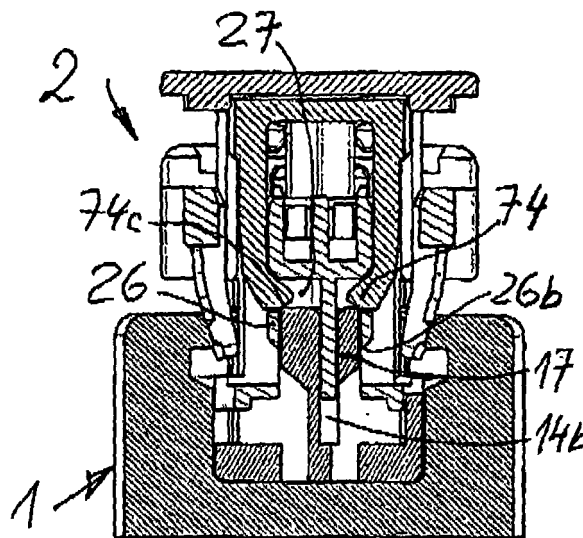


Fig. 8b

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Description

Field of Invention

[0001] The invention relates to an electrical connector and an electrical connector assembly for an automotive airbag restrained system.

[0002] Such vehicle airbag systems use an electrical connection system which comprises a receptacle or socket connector on the side of the airbag and a plug connector on the side of a control unit. These connectors have to be mated while fulfilling safety requirements relating to electrical safety (shorting electrical terminals on the side of the airbag) and mechanical safety (firm connection between the mated connectors).

Description of Prior Art

[0003] Electrical connectors for airbags are known for example from EP 0 591 948 B1 and include a socket connector having a shorting insert, and a plug connector having a safety latch element which is for moving the shorting element to a non-shorting position when the connectors are mated. The safety latch element is also provided for actuating lock means which prevent separation of the electrical connectors mated.

[0004] There are further developments in the electrical connection system with safety interlock. US 6,364,683 B1 discloses an electrical connector comprising a dielectric housing with a rib therein having tapered surfaces, a locking device having downwardly projecting beams and being movably mounted on the dielectric housing for engaging the rib for holding the locking device in a temporary position. In other documents, the locking device is also termed "secondary locking device" or "CPA member" (Connector Position Assurance). The socket connector has a projection which cooperates with tapered surfaces of the beams of the plug connector causing the beams to be released from the stop surface of the rib, thereby enabling the locking device to be moved to a fully-locked position. The locking device has latching arms for being latched on the plug connector housing at the fully-locked position, and locking arms which are deflected by a boss of the housing to enter into latching grooves of the socket connector housing. Thus, the locking arm is in a stressed condition when the connectors are mated which is a not allowed condition for certain applications.

[0005] A shorting electrical connector assembly with positive lock is known from EP 1 160 934 B1 and shows a plug connector comprising a locking device for locking the connectors in mated condition, and an actuating device separated from and independent of the locking device for opening the short circuit in the socket connector when the connectors are fully mated. The locking device includes locking arms having hook-shaped ends which, in a prelocked position, rest on supporting surfaces of latch arms of the plug connector, and when the connec-

tors are fully mated, the locking arms are deflected to get beyond the supporting surface and snap into recesses of the socket connector. The actuating device consists of a plate with an elongated finger and, parallel thereto, short latches, the plate being fixed to the plug connector housing and can be moved into a channel formed by the plug connector and the socket connector in a pre-locked position thereof. However, the holding force is not big enough for certain applications, particularly where a holding force > 50 N or even > 80 N is requested.

[0006] In a further known electrical connector assembly (US 6,402,540 B1) the socket connector includes a coupling piece which is an essentially cylindrical sleeve with a recess with at least one guide shoulder running parallel to the insertion direction of the plug connector and which props above the contact pins of the socket connector. The plug connector has L-shaped arms which define a T-shaped slot encompassing the arm having the guide shoulder. Two tongues extend parallel to the projection of the plug connector and have noses to be latched in appropriate recesses in the coupling piece. A secondary locking mechanism includes a pair of legs having end faces supported on a cross brace in a pre-mounted position of the connector assembly. During the mating process, the cross brace is pushed by the guide shoulder out of the path of the secondary locking device so that the same can be pressed downwardly. This electrical connector assembly needs a special socket connector having bevelled surfaces which push the cross brace away, even at the beginning of the mating process so that a reliable holding of the secondary locking device in a pre-mounted condition of the connector assembly is not possible.

[0007] A further plug connector having a secondary locking device is known from US 6,530,799 B2. The plug connector has a plug projection with locking arms fixed on the end of the plug projection and extending upwardly and forming a slot between locking arm and plug projection. The secondary locking device has several legs, among them the locking leg, a short circuit releasing leg and a spring arm with a step and a projection. In the pre-mounted position, the step of the spring arm rests on a wedge-shaped crest projecting from the locking arm and a locking projection formed on the plug connector housing. During the insertion of the plug connector into the socket, the spring arm is deflected by the locking projection acting against the step so that the spring arm bends, whereby the step is lifted from the locking projection. This allows a further depression of the secondary locking device where the projection of the spring arm slides in the socket connector, and the spring arm is bent and stays bended in the fully inserted position of the connectors. Such bend condition of the safety member is not desirable for certain applications.

[0008] A further electrical connector assembly is known from US 7,108,540 B2 = DE 10 2004 034321 B3. The plug connector includes a spring stop device for the secondary locking device which has a stop leg for that

purpose so that the secondary locking device is held in a pre-assembled position. For mating the connectors, the secondary locking device is pressed down so as to pivot the spring stop device into a release position from the blocking position through a sliding guiding action on a wall area of the socket against a spring resistance of the spring stop device. The secondary locking device integrally carries a guiding leg which is used for braking the shorting condition of the shorting element in the socket connector. It is not possible to move the secondary locking device independently from the actuator for braking the shorting condition.

Summary of the Invention

[0009] It is an object of the invention to design an electrical connector assembly for an automotive airbag restrained system which avoids the drawbacks discussed.

[0010] It is a further object to design an electrical plug connector having a CPA member and an actuator for braking a shorting condition in a socket connector where the CPA member and the actuator can be moved separately and independently from one another to the fully locked position of the mated socket and plug connectors.

[0011] Yet another object is to design an electrical plug connector wherein the CPA member and the actuator can be reliably held in a pre-mounted position of the connector assembly, such as with a holding force of more than 50 N or even 80 N in the case of an electrical connector assembly for an automotive airbag restrained system.

[0012] Still another object is to design an electrical plug connector where any of its latching or locking members is in an essentially relaxed condition when the plug and socket connectors are fully mated.

[0013] The invention is defined in claims 1 and 10.

[0014] The electrical connector assembly comprises a socket connector of a predetermined construction, and a plug connector designed to fulfill the objects noted. The socket connector comprises a socket housing having a receptacle cavity formed with a latching groove and with insert walls. Terminal means are accommodated in the socket housing, among them a shorting element. The plug connector comprises a plug housing which is formed with a body portion, with a cylindrical plug projection and with latch arms extending from the body portion parallel to the plug projection. The plug connector also includes an actuator for braking the shorting condition of the shorting element in the socket connector, and a CPA member for locking the plug connector in the socket connector when fully mated. The plug housing has compartments and passages partially with guiding surfaces for accommodating the plug terminals as well as the actuator and the CPA member. The plug housing and the CPA member are constructed to hold the CPA member in a pre-mounted position with a predetermined latching force (larger than 50 N or even 80 N for airbag systems). The CPA member has locking legs which, when the connec-

tors are fully mated, fill a respective gap between the latch arms of the plug housing and insert walls of the socket housing, so that the latch arms which are latched in grooves of the socket housing are locked. The CPA member also has spring arms which, starting from the pre-mounted position, are spread apart to snap in latching openings formed by the plug housing when the CPA member is fully inserted in the plug housing. In this condition of fully insertion, the spring arms are essentially or practically without stress.

[0015] A particular feature of the spring arms is the shape of its free end which is formed as a lug. The lug has a flat lowermost surface (seen in direction to the socket connector) and two slanting or sloping surfaces in an angle to the horizon plane and to one another. The lowermost surface of the lug props on a stop surface formed with the plug housing in the pre-mounted position of the CPA member, the lug being latched in a latching opening of the plug housing. When pressing on the CPA member, the lower slanting surface of the lug gets into engagement with an insert wall of the socket connector and is cammed out of the latching opening and snaps into the lower latching opening in the plug connector which corresponds to the fully mated position of the connectors. This lower latching opening is also formed with a sloping surface for cooperating with the upper slanting surface on the lug of the spring arm. Therefore, when pulling on the CPA member, the lug of the spring arm is driven out of the lower latch opening in the plug housing so that the CPA member can be moved upwardly (away from the socket connector) so as to remove the locking legs of the CPA member out of the gap between the latch arms of the plug housing and the insert wall in the socket connector. This allows unlatching the latch arms of the plug connector from grooves in the socket connector and removing the plug connector from the socket connector.

Brief Description of the Drawings

[0016] An embodiment of the present invention will be described by way of example with reference to the accompanying drawings, in which:

- Fig. 1 is a perspective view of the several components of a plug connector,
- Fig. 2 is a perspective view of the plug connector assembled,
- Fig. 3 is a perspective view of an actuator,
- Fig. 4 is a perspective view of the plug housing,
- Fig. 5 is a perspective view of a housing cover,
- Fig. 6 is a perspective view of the CPA member,
- Figs. 7a through 7c are sectional views corresponding to VII-VII in Fig. 2 of the plug and socket connectors during mating,
- Figs. 8a through 8e are similar sectional views according to VIII-VIII in Fig. 2, and
- Figs. 9a through 9c are sectional views according to IX-IX in Fig. 2.

Detailed Description

[0017] The connector assembly includes a socket connector 1 and a plug connector 2. Fig. 1 shows the main component parts of the plug connector 2 of invention, namely a housing 3, a cover 4, a terminal assembly 5, an actuator 6 and a connector position assurance element or CPA member 7. These components are tiny, that is, the housing 3 has a length dimension of about 20 mm and the latch features of about 1 mm.

[0018] The plug connector housing 3 has a body portion 20, a cylindrical plug projection 21 and latch arms 22 with lugs 29 formed thereon. The plug projection 21 includes a hollow 23 and each a recess 24 forming an interspace adjacent to each latch arm 22. Within the hollow 23, wall formations 25 (Fig. 2) are provided, also for fixing terminal contacts 51, 52. The wall formations 25 include a cross rib 26 (Figs. 8a, 9a) so as to define, together with the body portion 20, an upper latch opening 27 and, together with a wall of the plug projection 21, a lower latch opening 28 (the terms "upper" and "lower" relate to the normal position of the receptacle or socket connector 1 and are not at all restrictive). Furthermore, each cross rib 26 divides the space adjacent to it in an outer shaft 23a and in an inner shaft 23b (Fig. 8d).

[0019] Fig. 4 is a look on the upper side of the plug housing 3 and shows a left-hand compartment 30a and a right-hand compartment 30b. The terminal assembly 5 includes the terminals 51, 52 and respective conductors 50 surrounded by each a ferrite element 53, and is mounted into the compartments 30a, 30b. The terminals 51, 52 extend through openings 31 in the housing wall 25. The conductors 50 extend through strain relief recesses 33. Stitching openings 34 are provided to receive fixing ends 54 of the terminals 52. The cover 4 is latched on noses 32 of the housing 3 to clamp the conductors 50 and to bear onto the ferrite 53 by means of a leave spring 41 fixed on the upper wall 40 of the cover 4.

[0020] The compartment 30b is constructed to accommodate the upper portions of the actuator 6 and of the CPA member 7. For the lower ends of the actuator 6 and the CPA member 7, several passages are provided, namely a slot-like passage 36, a pair of arcuate passages 37, a pair of narrow passages 38 and, besides the compartment 30b, a further slot-like passage 39, which is narrowed by a pair of noses 39a at the upper end and a nose (not shown) near the lower end of the passage 39. Each passage 37 opens into a respective recess 24 (Fig. 7b) to form a straight guiding channel for a respective locking leg 70 of the CPA member 7.

[0021] The actuator 6 (Fig. 3) has an upper base plate 60 and an opening 61 to get access to the CPA member 7. Depending from the base plate 60, there are a guiding wall 62, a pair of latch arms 64 and a guiding leg 65. The guiding wall 62 has a recess to form an inclined shoulder 62a (Fig. 1) for latching corporation with a nose (not shown) extending in the passage 39 of the plug housing. Alternatively, or additionally, latches 62b (Fig. 3) are pro-

vided for releasably holding the guiding wall 62 within passage 39. The latch arms 64 are provided with hooks at their ends. The leg 65 is provided with a latch nose 65a. The actuator 6 is mounted within the plug housing 3 to cover the compartment 30b and the passage 39. In doing so, wall 62 is guided in passage 39 and guiding leg 65 passes through passage 36.

[0022] The CPA member 7 (Fig. 6) has a pair of locking legs 70 connected by a plate 71 which has openings 72 in it for accommodating the latch arms 64 of the actuator 6. The hooks of the arms 64 carry the plate 71 and thus catch the CPA member 7 overlying the opening 61 of the actuator 6. Furthermore, the CPA member 7 has at least one spring arm 73 and preferably a pair of spring arms 73 which are fixed to, and integrally formed with the plate 71. Each spring arm 73 has a lower end with a lug 74 formed thereon. The lugs 74 each have a lowermost surface 74a as well as an upper slanting surface 74b and a lower slanting surface 74c. The slanting surfaces 74b, 74c are sloping to the horizon plane and take an acute angle in a range between 60 and 90 degrees to one another. The cross rib 26 (Fig. 8a) in the hollow 23 of the plug projection 21 has a rhomboid outline with an upper surface 26a (Fig. 8e) which is essentially horizontal and a lower sloping surface 26b (Fig. 8b) which extends essentially parallel to the slanting surface 74b of the spring arms 73. The cross rib 26 forms a stop wall, that is, the upper surface 26a of the cross rib 26 is arranged for supporting the lowermost surface 74a of the spring arm 73.

[0023] The receptacle connector 1 represented diametrically in Figs. 7, 8 and 9 has an outer housing 10 and an inner insert 11 with pin terminals 12 arranged in the insert. A shorting clip 13 normally bridges the pins 12 (Fig. 9a) to create a short circuit therebetween, and by the action of the leg 65 of actuator 6 can be lifted to brake the short circuit (Fig. 9c). The housing 10 forms a circular cavity 14 with lead-ins 14a for the plug connector, particularly for the latch arm lugs 29 thereof. The cavity 14 also has a radial groove 15 for latchingly receiving the lugs 29 of the latch arms 22. The insert 11 has outer walls 16, the outer surface thereof forming guiding surfaces for the inner surface of the outer walls of the plug extension 21 (Fig. 7b). The insert 11 also has inner walls 17 (Fig. 8a - 8e) with a slot 14b for guiding a web 25a of the plug connector housing 3 and also for cooperation with the lug 74 of the CPA member 7.

[0024] Mating the plug connector 2 in the socket connector 1 is as follows:

[0025] The plug connector 2 is assembled with the actuator 6 and the CPA member 7 which are inserted in the appropriate passages 36, 39 and 37, 38, respectively, of the plug connector housing 3 as shown in Figs. 7a, 8a and 9a. The lower rim portion of the plug projection 21 is inserted in the circular cavity 14 of the socket connector 1 such that the lugs 29 of the latch arms 22 reach the lead-ins 14a of the socket connector 1, and the terminals 51, 52 reach the pin terminals 12 (Fig. 7b and Fig. 8a). Further depressing the plug connector leads to flexing

the latch arms 22 so that the lugs 29 are clamped between the walls 16 and the lead-ins 14a of the socket connector housing (Fig. 7c and Fig. 8b). In this situation, the locking legs 70 of the CPA member 7 are blocked from further entering into the plug connector 2, and the lugs 74 of the CPA member 7 reach the cross rib 26 so that the lowermost surface 74a rests on the upper surface 26a of the cross rib 26, and the lower slanting surface 74c touches the wall 17 of the socket connector 1 (Fig. 8b). Furthermore, the lugs 74 of the CPA member 7 are latched in the respective openings 27. This is the pre-mounted position of the plug connector 2 in the socket connector 1 (Fig. 7c, Fig. 8b and Fig. 9a). There is reliable fixing of the CPA member 7 and the actuator 6 in such pre-mounted position.

[0026] For fully mating the connectors, the plug connector 2 is further depressed as shown in Fig. 7d, and the lugs 29 of the latch arms 22 snap into the groove 15 of the socket connector housing 10. In doing so, the guiding channels for the locking legs 70 between passages 37 and recesses 24 get unimpeded. Simultaneously, the spring arms 73 of the CPA member 7 are spread apart by the camming action of the walls 17 in the socket connector housing 10 onto the slanting surface 74c, compare Fig. 8b and Fig. 8c. The lugs 74 are leaving their upper rest positions in the openings 27, as also shown in Fig. 9b. Further pressing onto the plug connector 2 leads to a relative shift between actuator 6/CPA member 7 and the plug connector housing 3 as shown in Fig. 8d. Spreading apart of the spring arms 73 is continued by the camming action of the cross rib 26 onto the slanting surface 74c of the spring arm 73 as can be seen when comparing Figs. 8c and 8d. Finally, the lugs 74 reach the lower rest positions 28 as shown in Figs. 8e and 9c. In this position, the lugs 65a of the actuator 6 latch behind appropriate recesses (not shown) of the plug housing 3, and the actuator leg 65 moves the shorting clip 13 out of bridging contact with the terminal pins 12 of the socket connector. Simultaneously, each leg 70 of the CPA member 7 slides along the outer surface of wall 16 in the passage 37 and the recess 24 forming an interspace in the socket housing 10 and gets in the gap behind its respective lug 29 so as to lock the respective latch arm 22 in its latched position, as shown in Figs. 7d, 7e. In this condition, the plug connector cannot be removed without lifting the CPA member.

[0027] Unmating the plug connector 2 from the socket connector 1 is brought about by pulling the actuator 6 and the CPA member 7 to the position shown in Fig. 7d, so as to unlock the latch arms 22 of the plug connector housing. This allows removing the plug connector from the socket connector housing as shown with Figs. 7c, 7b and 7a.

[0028] The design of the plug connector 2 allows to lock and unlock the CPA member 7 and the actuator 6 more than one time. Furthermore, by inserting the plug connector housing 3 and depressing the CPA member 7 while remaining the actuator 6 in an upper position, the

pins 12 stay still short-circuited (as shown in Fig. 9b), while the connectors 1, 2 are mated and locked. Thus, the design of the plug connector 2 allows to brake the short circuit in a later step of installation.

Claims

1. An electrical connector assembly comprising
 - a socket connector (1) having
 - a socket housing (10) which includes a receptacle cavity (14) having outer and inner insert walls (16, 17) and a latching groove (15) and terminals (12) bridged by a shorting element (13);
 - a plug connector (2) having
 - a plug housing (3) comprising
 - a body portion (20) forming compartments (30a, 30b) and passages (36, 37, 38, 39),
 - a cylindrical plug projection (21) with a hollow (23) and stop wall means in it, and
 - latch arms (22) with lugs (29) for cooperation with the latching groove (15) of the socket connector (1),
 - an actuator (6) for breaking the shorting condition of the shorting element (13) in the socket connector, and
 - a CPA member (7) for latching the plug connector in a pre-mounted position within the socket connector and for locking the plug connector when the connectors (1, 2) are fully mated;
 - wherein the CPA member (7) includes
 - a pair of locking legs (70) and at least one spring arm (73) with a lug (74) on end of it, for latching the plug connector in the pre-mounted position,
 - wherein the latch arms (22) of the plug connector (2), remote from the socket connector (1), extend from the body portion (20) parallel to the plug projection (21) so as to form each an interspace (24) between the latch arms (22) and the plug projection (21) which is open from the side of the socket connector (1), and by virtue of body portion passages (37) is also open from the side of the compartment (30b) of the plug housing;
 - wherein the interspaces (24) are provided for accommodating the outer insert walls (16) of the socket connector (1) and allow deflection of the latch arms (22) when mating the connectors (1, 2), and after mating, together with body portion passages (37), offer a straight channel for inserting the locking legs (70) of the CPA member (7) which, when inserted, are supported on the outer insert walls (16) of the socket housing (10) and on the latch arms (22) to lock the latch arms (22) of the plug housing (3) within the socket housing (10), and
 - wherein the free end of the spring arm (73) of the CPA member (7) is formed as a single lug (74) having a supporting surface (74a) for being supported on the stop wall means in the plug housing (3) in the pre-mounted position of the connectors (1, 2), and

- first (74c) and second (74b) slanting surfaces (74b, 74c) on the lug (74) being arranged in an angle to one another, the first slanting surface (74c) cooperating with the inner insert wall (17) of the socket connector (1) for deflecting the spring arm (73) to come free from the stop wall means, and the second slanting surface (74b) being for latching behind the stop wall means.
2. The electrical connector of claim 1, wherein the stop wall means comprises a cross rib (26) arranged in the hollow (23) of the cylindrical plug projection (21) so as to form a first latch opening (27) adjacent to the housing body portion (20) and a second latch opening (28) remote from the housing body portion (20).
 3. The electrical connector of claim 2, wherein the cross rib (26) has a rhomboid cross-section with a top surface (26a) cooperating with the supporting surface (74a) of the spring arm (73), and a sloping surface (26b) cooperating with the second slating surface (74b) of the spring arm lug (74).
 4. The electrical connector of claim 2 or 3, wherein the cross rib (26) of the stop wall means separates the hollow (23) of the cylindrical plug projection (21) into a first shaft (23a) for guiding a respective spring arm (73), and a second shaft (23b) for guidingly receiving the inner insert wall (17) of the socket connector (1) when the connectors (1, 2) are mated.
 5. The electrical connector according to one of the claims 2 to 4, wherein the CPA member (7) has a pair of spring arms (73), each with a single lug (74) on its lower end which face to one another, wherein the plug connector (2) includes a pair of the cross ribs (26), each lug (74) cooperating with a respective one of the cross ribs (26), and wherein a pair of inner insert walls (17) of the socket connector (1) is provided for cooperation with a respective one of the spring arms (73) when the connectors (1, 2) are mated.
 6. The electrical connector according to one of the claims 1 to 5, wherein the socket housing (10) has a guiding slot (14b), and the plug housing (3) has a guiding rib (25a), the slot (14b) and the rib (25a) cooperating with one another when the connectors (1, 2) are mated.
 7. The electrical connector according to one of the claims 1 to 6, wherein the CPA member (7) has a horizontal plate (71) with at least one opening (72) in it, and wherein the actuator (6) has latch arm means (64) for cooperating with the CPA member opening (72) so as to catch the CPA member (7) on the actuator.
 8. The electrical connector according to claim 7, wherein the actuator (6) has a horizontal plate (60) with an opening (61) in it to get access to the CPA member (7) caught on the underside of the horizontal plate (60).
 9. The electrical connector according to one of the claims 1 to 6, wherein the actuator (6) and the CPA member (7) are integrally formed as one part.
 10. A plug connector comprising a plug housing (3) including compartments (30a, 30b) for taking up terminal means (5), a cover (4) for closing the compartments, an actuator (6) for cooperation with a shorting element (13) in a socket connector (1), and a CPA member (7) for latching the plug connector (2) in a pre-mounted position relative to the socket connector (1) and for locking the connectors (1, 2) together, when the same are mated, the plug housing (3) being formed with a body portion (20), a cylindrical plug projection (21) which has a hollow (23) for accommodating portions of the actuator (6) and of the CPA member (7), and wherein at least one cross rib (26) extends to form stop wall means, and with latch arms (22), each having a lug (29) at its end for cooperation with the socket connector (1), the latch arms (22) extending from the body portion (20) essentially parallel to the plug projection (21) facing a recess (24) in the plug projection (21), a passage (37) being left between each latch arm (22) and body portion (20), the CPA member (7) comprising a pair of locking legs (70) and at least one spring arm (73), wherein the locking legs (70) are adapted to pass through the respective passages (37) between each latch arm (22) and body portion (20) so as to support and lock the respective lugs (29) of the latch arms (22) when the same are latched within the socket connector (1), and wherein the spring arm (73) has a free end which is formed as a single lug (74) having an end surface (74a) and a first (74c) and a second (74b) slanting surfaces (74c, 74b) arranged in an angle to one another and to the mating direction, the end surface (74a) of the lug (74) resting on the cross rib (26) in the pre-mounted position of the CPA member (7), the first slanting surface (74c) being arranged for cooperation with wall surfaces (17) of the socket connector (1) during mating, and

the second slanting surface (74b) being adapted to rest behind the cross rib (26) in a relaxed condition of the spring arm (73).

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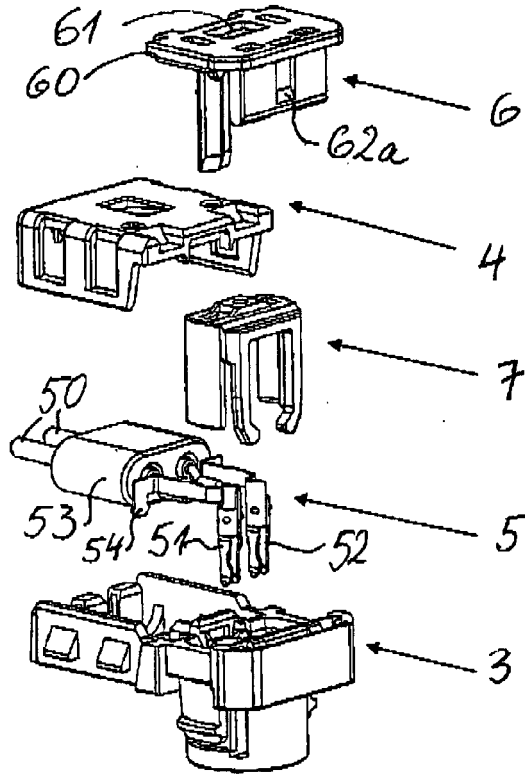


Fig. 1

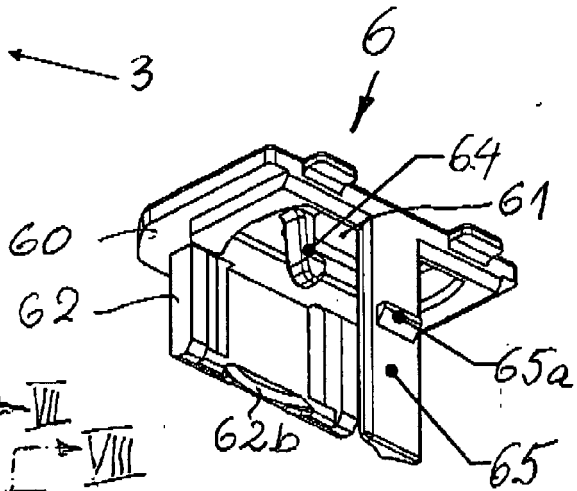


Fig. 3

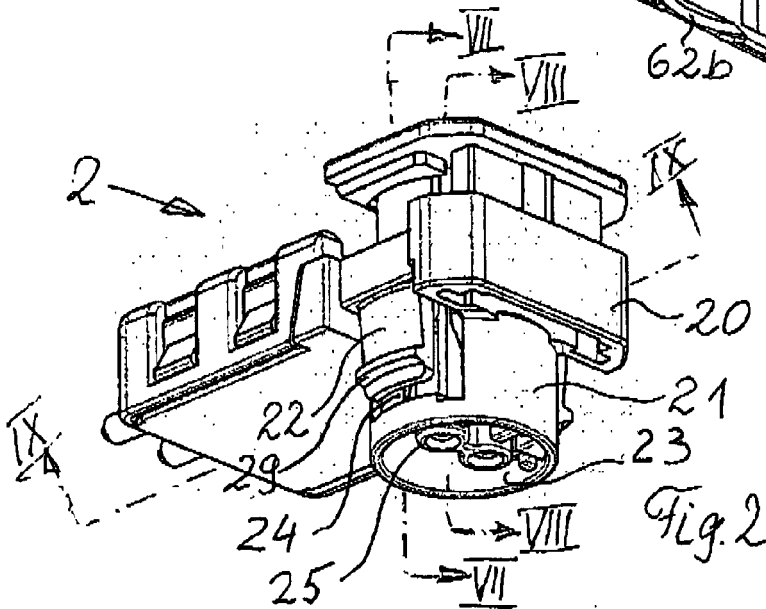
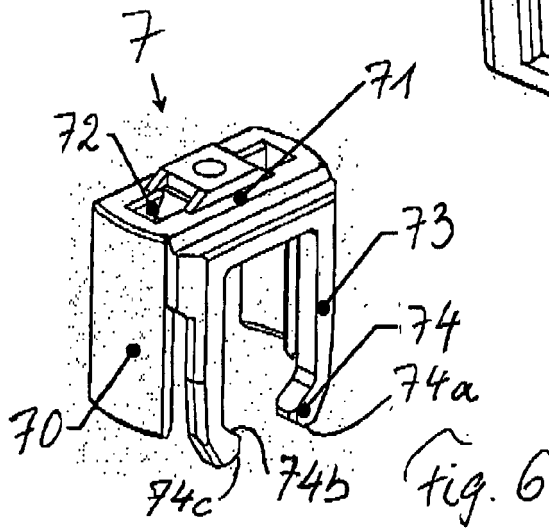
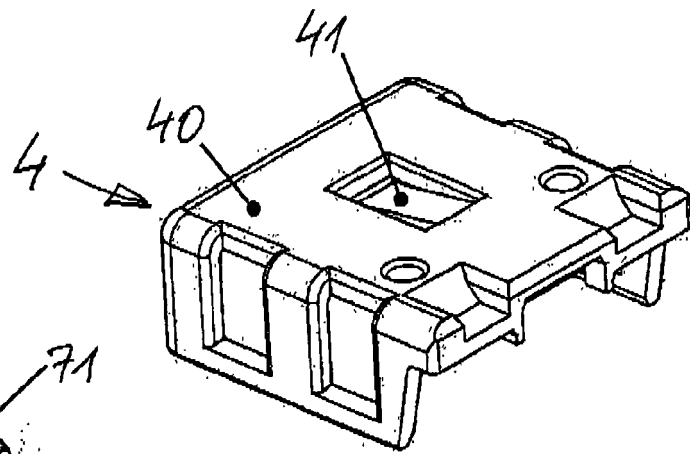
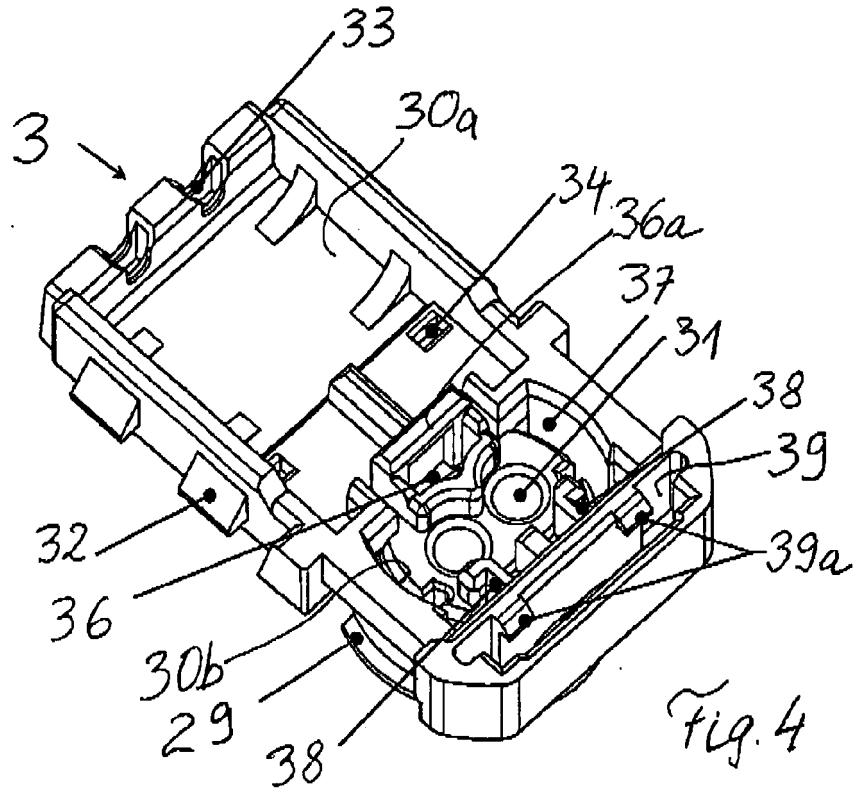


Fig. 2



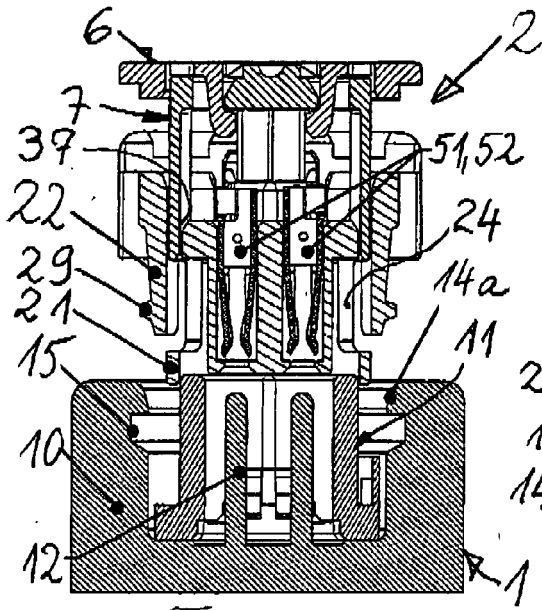


Fig. 7a

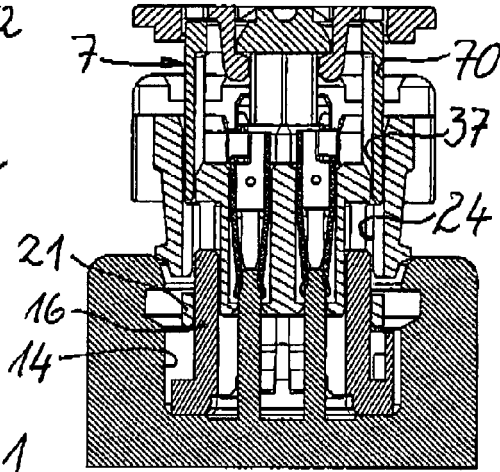


Fig. 7b

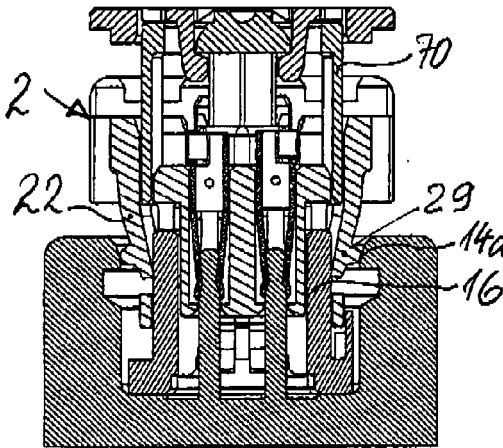


Fig. 7c

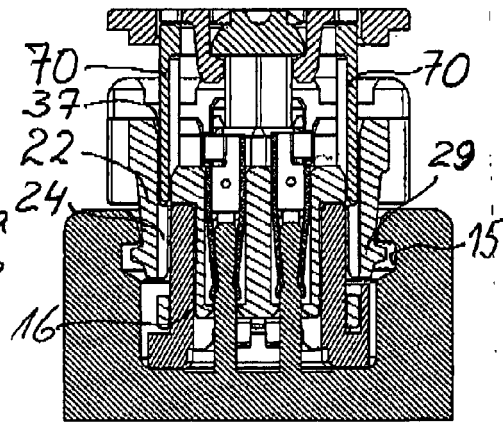


Fig. 7d

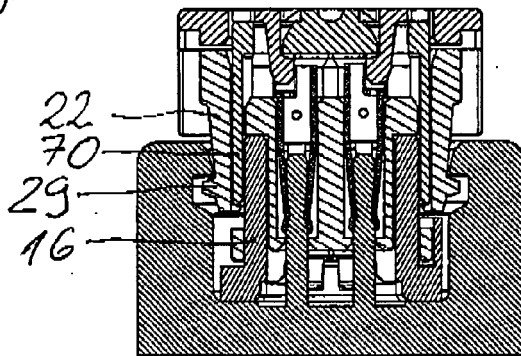


Fig. 7e

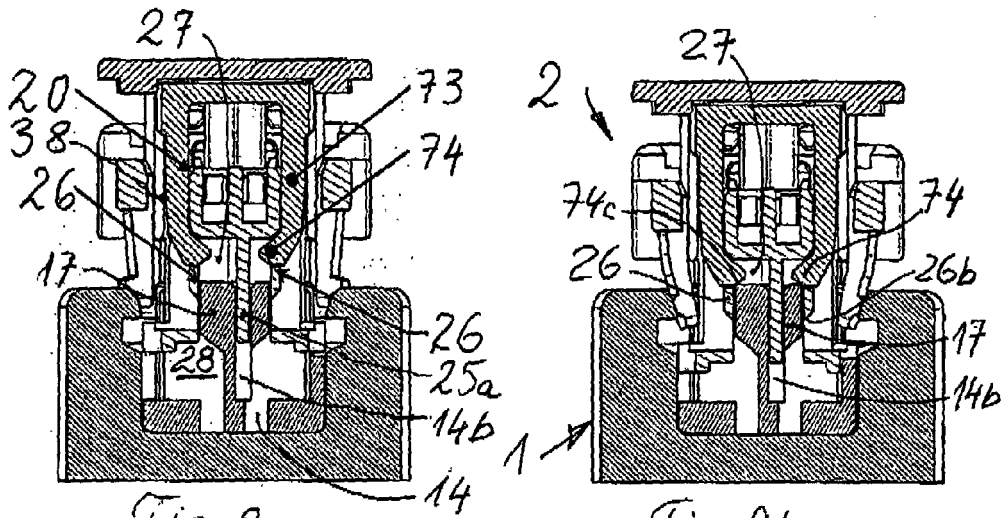


Fig. 8a

Fig. 8b

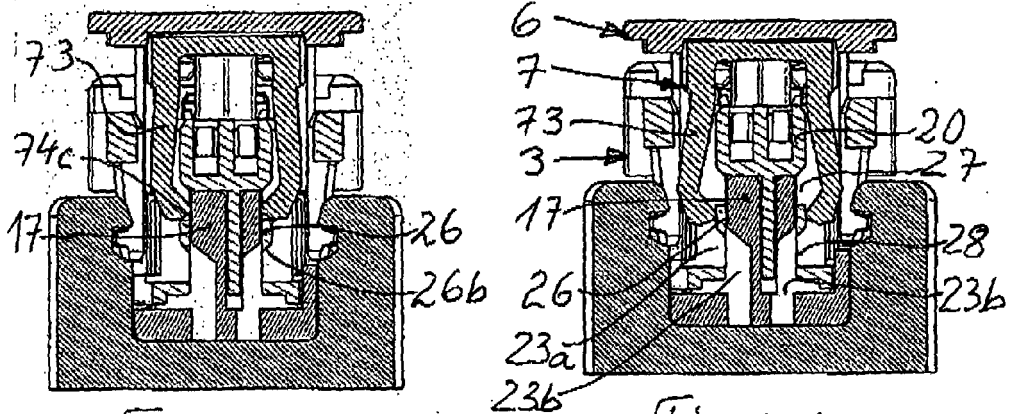


Fig. 8c

Fig. 8d

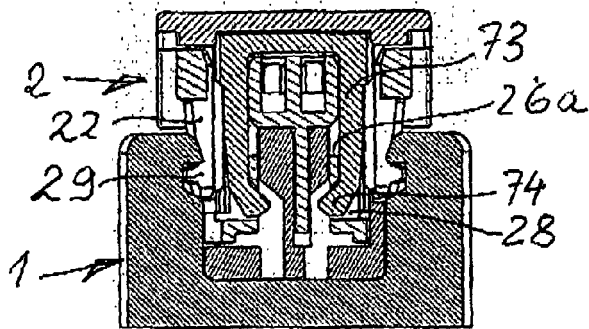


Fig. 8e

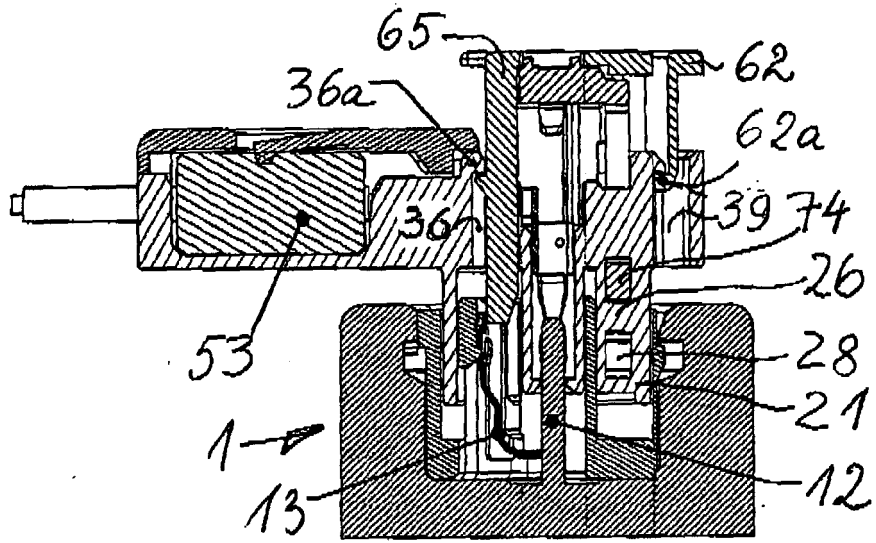


Fig. 9a

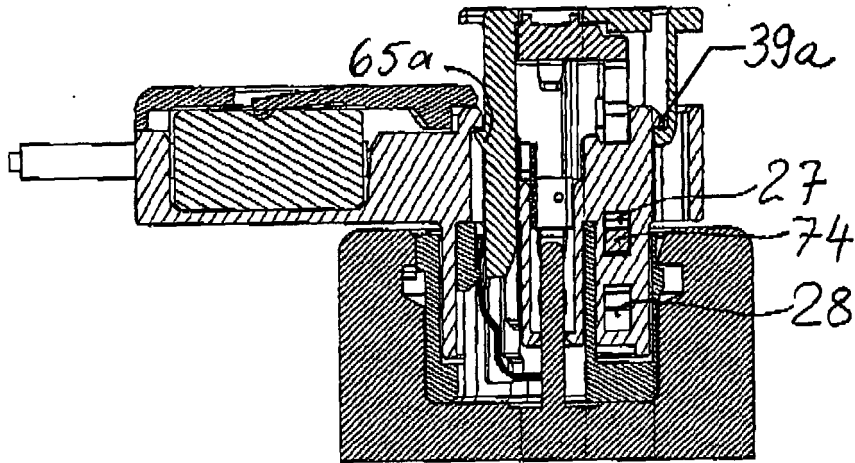


Fig. 9b

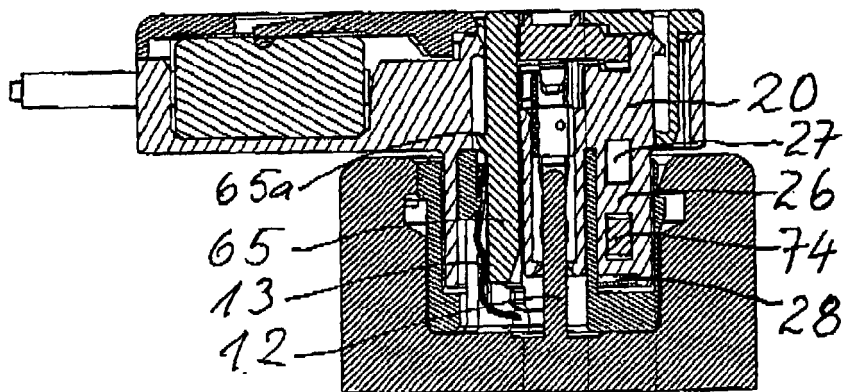


Fig. 9c



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