



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
08.03.2023 Bulletin 2023/10

(51) International Patent Classification (IPC):
H01R 13/627 ^(2006.01) **H01R 13/641** ^(2006.01)
H01R 13/639 ^(2006.01)

(21) Application number: **21306196.3**

(52) Cooperative Patent Classification (CPC):
H01R 13/641; H01R 13/6273; H01R 13/639;
H01R 2201/26

(22) Date of filing: **01.09.2021**

(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:
KH MA MD TN

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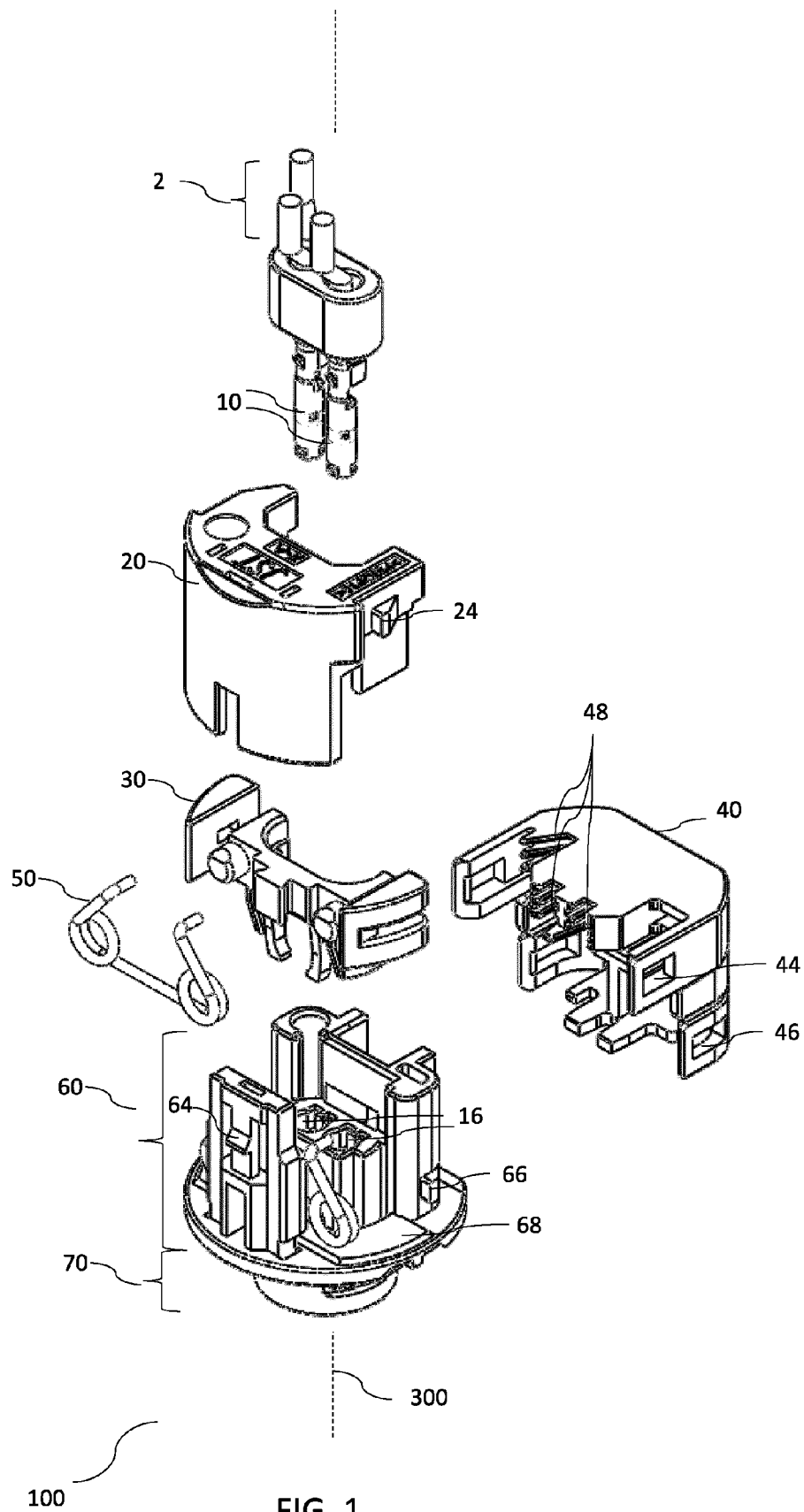
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(54) **ELECTRICAL CONNECTOR AND METHODS**

(57) An electrical connector for coupling to a squib holder along a mating axis to provide an electrical connection in a motorised vehicle is provided. The electrical connector comprises a connector position assurance, CPA, part configured to provide a locking position assurance. The electrical connector comprises a spring formed by a wire with one or more ends of the wire extending to form a respective one or more engagement rods. The electrical connector comprises a body of the electrical connector. The body of the electrical connector comprises a cover part, a connecting part, and a locking part configured to lock with the squib holder. The locking part is connected to the cover part by the connecting part and the CPA part is configured with the body to move along the mating axis along the connecting part between a position proximate the locking part and a position distal the locking part. The spring is mounted on the CPA part or the cover part such that the engagement rods are configured in a plane defined by the mating axis to engage with an engagement surface of the other of the CPA part or the cover part, and the spring is configured to exert a

biasing force on the CPA part to retain the CPA part in the proximate position. The electrical connector is configured in a first coupling stage, in which the CPA part is retained in the proximate position by the biasing force of the spring to prevent the locking part from engaging with the squib holder. The electrical connector is configured in a second coupling stage, in which the CPA part is moved along the mating axis along the connecting part against the biasing force of the spring between the proximate position and the distal position allowing the locking part to engage with the squib holder. The electrical connector is configured in a third coupling stage, in which the CPA part is held in the distal position against the biasing force of the spring which allows the locking part to lock with the squib holder. The electrical connector is configured in a fourth coupling stage, in which the CPA part returns to the proximate position by the biasing force of the spring, which allows the CPA part to provide the locking position assurance of the locking part and the squib holder.



Description**BACKGROUND****Field**

[0001] The present disclosure relates to an electrical connector for coupling with a squib holder to provide an electrical connection in a motorised vehicle.

Description of Related Art

[0002] The "background" description provided herein is for the purpose of generally presenting the context of the disclosure. Work of the presently named inventors, to the extent it is described in this background section, as well as aspects of the description which may not otherwise qualify as prior art at the time of filing, are neither expressly or impliedly admitted as prior art against the present invention.

[0003] Modern motorised vehicles such as automobiles may include an array of electrical systems. Such electrical systems are used not only for conventional lighting, instrumentation, and for engine management but are also used in a variety of safety applications. For example, the electrical systems of a vehicle may include a controller for deploying an airbag inflation in response to a detected sudden reduction in speed of the vehicle, which is consistent with a collision of the vehicle, based on feedback from sensors. Control signals for deploying the airbag may be communicated from the controller to the airbag via electrical cables, the controller and the airbag being connected to each other via the electrical cables by an electrical connector which connects the cables. Typically, an electrical connector on one cable may be connected to a squib holder on another cable. For the example of airbags, electrical connectors are typically referred to as "squib connectors", and the squib holders typically include an "initiator" and a "retainer" to facilitate the connection with the squib connector.

[0004] A technical problem associated with electrical connectors in the automobile industry is ensuring reliable connections between electrical connectors and squib holders. This is particularly relevant for safety devices such as airbags. Modern motor vehicles are typically assembled on a production line from a combination of separate parts, which may themselves have been preassembled. Part of the assembly process may require electrical components to be connected together by electrical connectors being mated with corresponding squib holders. When in the electrically connected state, the electrical connector and the squib holder are typically locked together to ensure a reliable connection. However, on some occasions, such as during assembly of the vehicle on a production line, it is possible that an electrical connector and a squib holder may not be fully or correctly locked together. Despite this incomplete locking, the electrical systems may provide a reading indicating that a successful electrical connection between the electrical connector and the squib holder has been achieved. In other words, the electrical connector and the squib holder may be electrically connected but not correctly locked together. As such, the electrical connection may fail later in the life of the vehicle as a result of being susceptible to accidental disconnection by vibration during vehicular motion. Such a reading is known as a "false positive" reading and is highly undesirable, particularly for safety applications, such as airbag connection in which the reliability of electrical connections is paramount. In order address this problem of electrical connectors not being fully or correctly locked together when they may appear to be, it is known that electrical connectors can be configured with what is known as a "Connector Position Assurance" (CPA) device. Such CPA devices can provide for example some positive feedback when both connectors are correctly mated or some mechanism for positively rejecting a connection between both connectors if they are not correctly mated.

[0005] Some existing electrical connectors in the automobile industry for use with airbag connectors use spring-lock systems configured to prevent incorrect locking between electrical connectors and a corresponding squib holders. Some examples such as that disclose in US 7,238,039 use helical springs, which are configured to push the electrical connector and the squib holder apart if the force applied to mate them is insufficient to ensure correct locking. In other words, if an electrical connector and a squib holder are incorrectly locked, they will be forced apart by the spring to ensure that they are also electrically disconnected, thereby removing the possibility of a "false-positive" reading. Other example connectors, such as that disclosed in EP 3047545 use a mouse trap or substantially U-shape spring.

[0006] There is therefore a need to provide improvement to electrical connectors for providing reliable electrical connection with an improved CPA device.

SUMMARY

[0007] The present disclosure can help address or mitigate at least some of the issues discussed above.

[0008] Example embodiments of the present technique can provide an electrical connector for coupling to a squib holder along a mating axis to provide an electrical connection in a motorised vehicle. The electrical connector comprises

a connector position assurance, CPA, part configured to provide a locking position assurance. The electrical connector comprises a spring formed by a wire with one or more ends of the wire extending to form a respective one or more engagement rods. The electrical connector comprises a body having a cover part, a connecting part, and a locking part configured to lock with the squib holder. The locking part is connected to the cover part by the connecting part and the CPA part is configured with the body to move along the mating axis along the connecting part between a position proximate the locking part and a position distal the locking part. The spring is mounted on the CPA part or the cover part such that the engagement rods are configured in a plane defined by the mating axis to engage with an engagement surface of the other of the CPA part or the cover part, and the spring is configured to exert a biasing force on the CPA part to retain the CPA part in the proximate position. The electrical connector is configured in a first coupling stage, in which the CPA part is retained in the proximate position by the biasing force of the spring to prevent the locking part from engaging with the squib holder. The electrical connector is configured in a second coupling stage, in which the CPA part is moved along the mating axis along the connecting part against the biasing force of the spring between the proximate position and the distal position allowing the locking part to engage with the squib holder. The electrical connector is configured in a third coupling stage, in which the CPA part is held in the distal position against the biasing force of the spring, which allows the locking part to lock with the squib holder. The electrical connector is configured in a fourth coupling stage, in which the CPA part returns to the proximate position by the biasing force of the spring, which allows the CPA part to provide the locking position assurance of the locking part and the squib holder.

[0009] As will be appreciated from the following description, example embodiments can provide an improvement to electrical connectors, which can eliminate or reduce a chance of incomplete mating by providing a CPA which provides a Go/No-Go mating using a wire spring which includes one or more ends extending to form a respective one or more engagement rods which engage with an engagement surface. The spring may be mounted on or in the CPA such that the engagement rods engaging with the engagement surface forming part of the cover part of the body of the electrical connector. Alternatively the spring may be inverted so that the spring is mounted on or in the cover part of the electrical connector with the engagement rods engaging an engagement surface formed in the CPA. For either example, a biasing force provide by the engagement rods and the one or more coils is provided in a plane of the mating axis. The spring can therefore provide a biasing force with reduced dimensions, thereby saving space. Furthermore the spring is more easily mounted either on the CPA or the cover part with a mounting opposing movement of the spring to provide the biasing force in the same plane as the mating axis.

[0010] Respective aspects and features of the present disclosure are defined in the appended claims.

[0011] It is to be understood that both the foregoing general description and the following detailed description are exemplary, but are not restrictive, of the present technology. The described embodiments, together with further advantages, will be best understood by reference to the following detailed description taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] A more complete appreciation of the disclosure and many of the attendant advantages thereof will be readily obtained as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein like reference numerals designate identical or corresponding parts throughout the several views, and:

Figure 1 is an exploded diagram illustrating a 180 degrees electrical connector according to example embodiments; Figure 2 is a schematic diagram illustrating a 180 degrees electrical connector and a squib holder according to example embodiments;

Figure 3A is a schematic diagram illustrating the configuration of a pocket forming part of a squib holder according to example embodiments;

Figure 3B is a schematic diagram illustrating the configuration of a squib holder according to example embodiments;

Figure 4A is a schematic diagram illustrating spring without coils according to example embodiments;

Figure 4B is a schematic diagram illustrating a spring with coils according to example embodiments;

Figure 5A is a schematic diagram illustrating a spring mounted on a connector position assurance (CPA) part according to example embodiments;

Figure 5B is a schematic diagram illustrating a spring mounted on a CPA part according to example embodiments;

Figure 6 is a schematic diagram illustrating a cut-away view of a 180 degrees electrical connector and a squib holder in a first coupling stage according to example embodiments;

Figure 7 is a schematic diagram illustrating a cut-away view of a 180 degrees electrical connector and a squib holder in a second coupling stage according to example embodiments;

Figure 8 is a schematic diagram illustrating a cut-away view of a 180 degrees electrical connector and a squib holder in a third coupling stage according to example embodiments;

Figure 9 is a schematic diagram illustrating a cut-away view of a 180 degrees electrical connector and a squib holder in a fourth coupling stage according to example embodiments;

Figure 10 is a schematic diagram illustrating a 180 degrees electrical connector and a squib holder after the fourth coupling stage according to example embodiments;

Figure 11 is an exploded diagram illustrating a 90 degrees electrical connector according to example embodiments;

Figure 12 is a schematic diagram illustrating a cut-away view of a 90 degrees electrical connector and a squib holder in a first coupling stage according to example embodiments;

Figure 13 is a schematic diagram illustrating a cut-away view of a 90 degrees electrical connector and a squib holder in a second coupling stage according to example embodiments;

Figure 14 is a schematic diagram illustrating a cut-away view of a 90 degrees electrical connector and a squib holder in a fourth coupling stage according to example embodiments.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0013] As explained above embodiments can provide an alternative electrical connector for providing reliable electrical connections with an improved spring mounting procedure. An example of such an electrical connector is provided in Figure 1 as explained below.

[0014] Figure 1 is an exploded diagram illustrating an electrical connector 100 according to example embodiments. The electrical connector 100 includes a cover part 20, a connector position assurance (CPA) part 30, a spring 50, a connecting part 60 and a locking part 70, which together form a female housing. In some embodiments, the electrical connector 100 includes a secondary cover part 40.

[0015] As shown in Figure 1, electrical cables 2 terminate in electrical terminals 10. Typically, electrical connectors for which the electrical cables 2 and a mating axis 300 are parallel (as in Figure 1 & 2) are referred to as "180 degrees electrical connectors" whereas electrical connectors for which the electrical cables 2 and the mating axis 300 are perpendicular (see Figure 11 & 12 for example) are referred to as "90 degrees electrical connectors". The electrical terminals 10 are configured to be received by terminal receiving sections 16 in the connecting part 60 to enable connection with electrical pins 260 in a squib holder 200 (see Figure 2). Although two electrical terminals 10 are shown in Figure 1, it will be appreciated that more or fewer electrical terminals could be used.

[0016] The cover part 20, the connecting part 60 and the locking part 70 form a body of the electrical connector 100. For example, as shown in Figure 1, the connecting part 60 may extend from an upper surface of the locking part 70. In Figure 1, the locking part 70 and the connecting part 60 are separated by a platform 68 of the connecting part 60. Although the connecting part 60 and locking part 70 are shown as integrated at the platform 68 in Figure 1, it will be appreciated that the locking part 70 and the connecting part 60 may be separate components, which may be attached together.

[0017] The locking part 70 is connected to the cover part 20 by the connecting part 60. As shown in Figure 1, the connecting part 60 and the cover part 20 may be attached by means of a latch 64 on the connecting part 60, although other means of attachment will be known to one skilled in the art.

[0018] In some embodiments, the secondary cover part 40 may also be configured to attach to the connecting part 60 by means of a latch 66 on the connecting part 60. For example, the secondary cover part 40 may include a latch receiving gap 46 for connecting with the latch 66 on the connecting part 60. Similarly, the secondary cover part 40 may include another latch receiving gap 44 for connecting with a latch 24 on the cover part 20. Therefore, in some embodiments, the secondary cover part 40 is configured in combination with the cover part 20 and the connecting part 60 to provide a protective housing for the electrical connector 100 as shown in Figure 2. The secondary cover part 40 may also include through sections 48 for receiving the electrical cables 2.

[0019] The CPA part 30 is configured with the body of the electrical connector 100 to move along a mating axis 300 along the connecting part 60 between a position proximate the locking part 70 and a position distal the locking part 70. The "position proximate the locking part 70" is referred to herein as the "proximate position 500" and the "position distal the locking part 70" is referred to herein as the "distal position 600". Examples of the proximate position 500 and the distal position 600 are illustrated indicated by horizontal dashed lines in Figures 6 to 9. In Figures 6 to 9, the CPA part 30 is in the proximate position 500 when it is resting on the platform 68 separating the connecting part 60 and the locking part 70, and the CPA part 30 is in the distal position 600 when it engages with an engagement surface 22 of the cover part 20. It will be appreciated however that the proximate position 500 and the distal position 600 are not restricted to the positions shown in Figures 6 to 9 as long as the CPA part 30 is further away from the locking part 70 in the distal position 600 than in the proximate position 500.

[0020] It will be appreciated that references to the CPA part 30 moving "along" the connecting part 60 do not necessarily imply that the CPA part 30 is in direct physical contact with the connecting part 60 during the movement, but only that the CPA part 30 is moving along a direction which is approximately parallel to the connecting part 60. In some embodiments, as is clearly visible from Figure 2, the CPA part 30 may be in physical contact with the cover part 20 when the

CPA part 30 moves along the connecting part 60.

[0021] The CPA part 30 may comprise guiding features which guide the movement of the CPA part 300 along the mating axis 300. For example, the CPA part 30 may be T-shaped, L-shaped or have a dovetail shape to guide the CPA part 30 along the mating axis 300.

[0022] Figure 2 is a schematic diagram illustrating the electrical connector 100 and a squib holder 200 according to example embodiments. The electrical connector 100 is shown with the secondary cover part 40 attached to the cover part 20. The CPA part 30 is shown in the position proximate the locking part 70. Figure 2 additionally shows a squib holder 200 to which the electrical connector 100 is configured to couple in order to provide an electrical connection. The squib holder 200 may include a pocket 210 and a retainer 220. The retainer 220 may include an electrical pin housing 240 which houses the electrical pins 260. Although not shown in Figure 2, the electrical terminals 10 may be configured to be received by the electrical pin housing 240 such that the electrical pins 260 are inserted into the electrical terminals 10, thereby forming an electrical connection. It will be appreciated that although Figure 2 shows two electrical pins 260, fewer or more electrical pins 260 may be used. In some embodiments, the number of electrical terminals 10 is the same as the number of electrical pins 260. The electrical pins 260 may form part of an initiator 262 as explained in more detail with respect to Figure 3A below. The electrical connector 100 and the squib holder 200 are coupled along a mating axis 300 as indicated in Figure 2.

[0023] Figures 3A and 3B illustrate various configurations of the squib holder 200 in accordance with example embodiments. As shown in Figure 3A, the pocket 310 of the squib holder 200 may be formed from a receptacle 264 and an initiator 262. The initiator 262 includes the electrical pins 260 (which may alternatively be referred to as "male contacts"). As will be appreciated by one skilled in the art, the initiator 262 is a pyrotechnical device with one or more male contacts. As shown in Figure 3B, the squib holder 200 may be formed from the pocket 210, the retainer 220 and, optionally, a shunt 270a. The shunt 270a is a shorting clip comprised of two conductive strips 272 which are connected by a third conductive strip 274. The shunt 270a is configured to provide an electrical connection between the electrical pins 260. In some embodiments, the shunt 270a may additionally have a ground electrical contact. In some embodiments, the squib holder 200 is formed from the pocket 210 and the retainer 220 with no shunt 270a.

[0024] It will be appreciated that the term "coupling" is used herein to mean an attempt at engaging the electrical connector 100 with the squib holder 200. For example, a user may "couple" the electrical connector with the squib holder by pushing the electrical connector 100 into the squib holder 200 along the mating axis 300 or by otherwise attempting to force the electrical connector 100 and the squib holder 200 together.

[0025] The mating axis 300 is a virtual line along which the electrical connector 100 and the squib holder 200 are configured to be coupled together. In Figure 2, the electrical connector 100 and the squib holder 200 are configured to be coupled in the mating axis 300 which is a mutual axis when the electrical connector 100 and the squib holder 200 are aligned. The mating axis 300 may therefore be represented by a vertical line approximately through the centre of the electrical connector 100 and the squib holder 200. In some embodiments, the mating axis 300 may be defined by a direction of approach between the electrical connector 100 and the mating connection 200 during coupling. In some embodiments, the mating axis 300 may be defined by the direction along which the electrical terminals 260 extend. For a 180 degrees electrical connector, the mating axis 300 is approximately parallel to the electrical cables 2 (see Figure 2) and for a 90 degrees electrical connector, the mating axis 300 is approximately perpendicular to the electrical cables 402 (see Figure 11).

[0026] The phrase "a plane defined by the mating axis" as used herein means any plane which contains the mating axis 300. It will therefore be appreciated that "a plane defined by the mating axis" is any plane in which the electrical connector 100 and the squib holder 200 are configured to be coupled together.

[0027] Figure 4A is a schematic diagram illustrating a spring 50a with no coils according to example embodiments. The spring 50a is formed by a wire with first and second ends of the wire extending from the wire to form a respective one or more engagement rods 54. For example, a first end of the wire may extend to form a first engagement rod 54 and a second end of the wire may extend to form a second engagement rod 54 as depicted in Figure 4A. The engagement rods 54 may be connected by a straight segment of the wire, which will be referred to herein as "connecting rod 58". In some embodiments, as shown in Figure 4A, the engagement rods 54 form an acute angle with the connecting rod 58. In other embodiments, the engagement rods 54 may form an obtuse angle with the connecting rod 58. If the engagement rods 54 are angled with respect to the connecting rods 58 in either an acute or obtuse manner as described above, then the dimensions of the spring 50a as measured along the mating axis 300 can be reduced compared to a helical spring extending parallel to the mating axis, which provides a similar biasing force.

[0028] Figure 4B is a schematic diagram illustrating the spring 50b with one or more according to example embodiments. The spring 50b is formed by a wire with first and second coils 52 connected by the wire and with first and second ends of the wire extending from the respective coils 52 to form engagement rods 54. For example, a first end of the wire extending from the first coil 52 may extend to form a first engagement rod 54 and a second end of the wire extending from the second coil 52 may extend to form a second engagement rod 54 as depicted in Figure 4B. Each of the coils 52 may be formed by one or more turns in the wire. As will be appreciated, the larger the number of turns per coil, the

larger the biasing force that can be provided by the spring 50b. The coils 52 may be connected by a straight segment of the wire, which will be referred to herein as "connecting rod 58". In some embodiments, as shown in Figure 3, the engagement rods 54 form an acute angle with the connecting rod 58. In other embodiments, the engagement rods 54 may form an obtuse angle with the connecting rod 58. If the engagement rods 54 are angled with respect to the connecting rods 58 in either an acute or obtuse manner as described above, then the dimensions of the spring 50b as measured along the mating axis 300 can be reduced compared to a helical spring extending parallel to the mating axis, which provides a similar biasing force.

[0029] References to "spring 50" are used throughout the present disclosure when it is not necessary to distinguish between "spring 50a" which does not have coils or "spring 50b" which has one or more coils as described above. Accordingly, although Figures 1, 6 to 9 and 11 to 14 depict a spring with one or more coils, it will be appreciated that a spring without coils could be used.

[0030] In some embodiments, each of the engagement rods 54 may be folded at one end to form an engagement tab 56 extending perpendicularly to a plane defined by mating axis 300. Specifically, the coils 52, the connecting rod 54 and the engagement rods 54 may be configured in a plane containing the mating axis 300, but the ends of the engagement rods 54 are folded to form the engagement tabs 56 which are perpendicular to the plane containing the mating axis 300. In some embodiments, the engagement tabs 56 are folded in the same direction as shown in Figure 4B.

[0031] The engagement rods 54 of the spring 50 are configured, during the coupling of the electrical connector 100 and the squib holder 200, to transition between a more relaxed position and a more tensioned position. The transition between the more relaxed position and the more tensioned position may occur because the engagement rods 54 of the spring 50 engage with an engagement surface 22 of the cover part 20 during coupling. For example, the engagement surface 22 may bend or compress the engagement rods 54 during coupling as will be explained in more detail below. If an acute angle is formed between the engagement rods 54 and the connecting rod 58 when the engagement rods 54 are in the more relaxed position, then the acute angle is reduced in magnitude when the engagement rods 54 are in the more tensioned position. It will be appreciated that references to a "more relaxed position" and a "more tensioned position" as used herein are to be interpreted as meaning that the spring 50 is under a greater tension in the more tensioned position than in the more relaxed position. Therefore the spring 50 may or may not be under tension in the "more relaxed position". In example embodiments, the spring 50 may be pre-loaded with tension when in the more relaxed position. Springs which are pre-loaded with tension may have an increased lifetime compared with springs which are not pre-loaded with tension.

[0032] Although the spring 50b is depicted as including first and second coils 52, it will be appreciated by one skilled in the art that the effects of the present invention may be achieved using a spring with fewer or more coils. For example, the spring 50b may have one coil from which two engagement rods extend. In that example, the engagement rods may extend from the coil, which may be from opposite sides. For a spring with three coils, an engagement rod may extend from each coil.

[0033] As will be appreciated from the example embodiments the spring 50 can be formed as a single piece and from single piece of wire.

[0034] Figure 5A is a schematic diagram illustrating the spring 50 mounted on a CPA part 30a with a plurality of posts 32 according to example embodiments. Although Figure 5A shows that the CPA part 30a may include a plurality of posts 32, a plurality of cantilevered position assurance beams 34 and a plurality of cantilevered blocking beams 36, it will be appreciated that fewer or more posts 32, position assurance beams 34 or blocking beams 36 may be used.

[0035] The posts 32 may be projections of the CPA part 30a which extend approximately perpendicularly to a plane defined by the mating axis 300 when the CPA part 30a is configured in the electrical connector 100. The coils 52 are configured to mount the spring 50 on the CPA part 30a. For example, the coils 52 may be mounted onto the posts 32 as shown in Figure 5A. Therefore the number of posts may correspond with the number of coils on the spring. Furthermore, because the one or more coils are mounted on the posts 32 which are approximately perpendicular to the mating axis 300, a biasing force can be provided by the spring against the post with a reduced likelihood of the spring becoming loose from the CPA part 30a.

[0036] The position assurance beams 34 may be substantially straight extensions of the CPA part 30a which are parallel to the mating axis 300 when the CPA part 30a is configured in the electrical connector 100. The position assurance beams 34 are configured to engage with cantilevered locking beams 72 of the locking part 70 to hold latch portions 74 of the locking beams 72 in grooves 280 on an inner surface of the squib holder 200 to provide a locking position assurance between the locking part 70 and the squib holder 200.

[0037] The blocking beams 36 may be substantially straight extensions of the CPA part 30a which are parallel to the mating axis 300 when the CPA part 30a is configured in the electrical connector 100. Each of the blocking beams 36 may terminate in blocking stubs 38 which extends inwards towards the mating axis 300. The blocking stubs 38 are configured to engage with a blocking portion 250 of the retainer 220 to block movement of the CPA part 30a into the retainer 220 as will be explained in more detail below.

[0038] Figure 5B is a schematic diagram illustrating the spring 50 mounted on a CPA part 30b with a spring holding

section 39 according to example embodiments. In Figure 5B, the spring 50 is arranged in the spring holding section 39 of the CPA part 30b. The spring holding section 39 is a receptacle configured to hold the spring 50. The spring 50 is arranged in the spring holding section 39 so that the engagement rods 54 are in the plane defined by the mating axis 300, thereby allowing the engagement rods 54 to be engaged in the plane defined by the mating axis 300. The spring 50 may be slotted into the spring holding section 39. In some embodiments, the spring 50 may be attached or connected to the spring holding section 39 to prevent movement of the spring 50 during engagement. Although not shown in Figure 5B, the CPA part 30b may include position assurance beams 34 and/or blocking beams 36 as described for the CPA part 30b in Figure 5A.

[0039] References to "CPA part 30" are used throughout the present disclosure when it is not necessary to distinguish between "CPA part 30a" which includes a plurality of posts 32 or "CPA part 30b" which includes a spring receiving section 39 as described above. Accordingly, although Figures 1, 6 to 9 and 11 to 14 depict a CPA part with one or more posts, it will be understood that a CPA part with a spring receiving section could be used. In some embodiments, the spring 50 may have a single engagement rod extending from one end of the connecting rod 58. However, if the spring 50 has two engagement rods 54 (as shown in Figures 4A and 4B), a greater compressive force may be generated in the direction of compression. As will be explained in more detail below, the spring 50 is configured to exert a biasing force on the CPA part 30 to retain the CPA part in the proximate position 500. Figures 6 to 9 describe four stages which occur during the coupling of the electrical connector 100 and the squib holder 200 which may be achieved in an example by a user applying a force to push the electrical connector 100 into the squib holder 200.

[0040] Each of Figures 6 to 9 are cut-away sectional views depicting the coupling in a plane defined by the mating axis 300. As will be appreciated from Figures 6 to 9, the spring 50 is mounted on the CPA part 30 such that the engagement rods 54 are configured in the plane defined by the mating axis 300. In other words, the spring 50 is configured to be compressed in a plane in which the electrical connector 100 and the squib holder 200 are coupled together.

[0041] Figure 6 is a schematic diagram illustrating a cut-away view of the electrical connector 100 and the squib holder 200 in a first coupling stage according to example embodiments. In the first coupling stage, the electrical connector 100 contacts with the squib holder 200. The spring 50 is mounted on the CPA part 30 and, at the instant shown in Figure 6, the CPA part 30 is in the proximate position 500 and the spring 50 is configured with the engagement rods 54 in a more relaxed position. As explained above, when the CPA part 30 is in the proximate position and the spring 50 is in the more relaxed position, the spring may be pre-loaded with tension in some embodiments. The CPA part 30 is being retained in the proximate position 500 by a biasing force of the spring 50. Furthermore, Figure 6 shows the blocking stubs 38 of the blocking beams 36 of the CPA part 30 in contact with a blocking portion 250 of the retainer 220 which prevents the CPA part 30 from moving into the retainer 220 in the first coupling stage. Consequently, the locking part 70 is prevented from engaging with the squib holder 200 in the first coupling stage. The blocking portion 250 may be any object in the retainer 220 or otherwise in the squib holder 200 which is configured to prevent the CPA part 30 from entering the squib holder 200.

[0042] Figure 7 is a schematic diagram illustrating a cut-away view of the electrical connector 100 and the squib holder 200 in a second coupling stage according to example embodiments. In the second coupling stage, the CPA part 30 is moved along the mating axis 300 along the connecting part 70 against the biasing force of the spring 50 between the proximate position 500 and the distal position 600 allowing the locking part 70 to engage with the squib holder 200. The electrical connector 100 may be transitioned from the first coupling stage to the second coupling stage as the electrical connector 100 is further forced into the squib holder 200 by a user for example. As the electrical connector 100 is forced into the squib holder 200 during the second coupling stage, the blocking stubs 38 of the blocking beams 36 of the CPA part 30 engage with the blocking portion 250 of the retainer 220. The CPA part 30 is therefore prevented from moving further into the retainer 220 in the second coupling stage. At the same time, the cover part 20, the secondary cover part 40, the connecting part 60 and the locking part 70 move along the mating axis 300 towards the squib holder 200. Therefore, as the CPA part 30 is prevented from moving towards the squib holder 200 by the blocking portion 250 of the retainer 220, the CPA part 30 moves along the connecting part 60 and along the mating axis 300 from the proximate position 500 to the distal position 600 in the second coupling stage. At the instant shown in Figure 7, the CPA part 30 is in a position intermediate between the proximate position 500 and the distal position 600.

[0043] Since there is relative motion which results in the CPA part 30 and the cover part 20 moving towards each other, an engagement surface 22 of the cover part 20 engages with the engagement rods 54 of the spring 50. For example, the engagement surface 22 may engage with the engagement tabs 56 of the engagement rods 54 to compress or bend the engagement rods 54 from the more relaxed position to a more tensioned position as shown in Figure 7. In some embodiments, the engagement surface 22 may comprise a plurality of angled surfaces as shown in Figure 7. In Figure 7, each of the angled surfaces are approximately parallel to and engage with a respective one of the engagement rods 54 of the spring 50. However, it will be appreciated that the engagement surface 22 may be any surface configuration or shape of the cover part 20 which is configured to engage with the engagement rods 54 of the spring 50. In another example embodiment, the engagement surface 22 may be a horizontal surface or the "V" shape of the surface may be inverted so that the engagement rods 54 are splayed outwards under tension.

[0044] As the CPA part 30 is moved towards the distal position 600, the locking part 70 is allowed to engage with the squib holder 200 during the second coupling stage. As shown in Figure 7, the locking part 70 may comprise a plurality of cantilevered locking beams 72. Each of the plurality of locking beams 72 may terminate in a latch portion 74 which extends outwards away from the mating axis 300. The latch portion 74 may have a shape which is complementary to a

shape of a groove 280 on an inner surface of the squib holder 200.

[0045] In the second coupling stage, the latch portions 74 of the locking beams 72 are forced against the inner surface of the squib holder 200. If the second coupling stage is the final coupling stage (for example, because a user ceases the attempt to couple the electrical connector 100 and the squib holder 200), the biasing force of the spring 50 causes the electrical connector 100 and the squib holder 200 to be forced apart. In other words, the electrical connector 100 and the squib holder 200 are separated such that they are both physically and electrically disconnected, thereby avoiding the possibility of a "false positive" electrical connection as explained above.

[0046] Figure 8 is a schematic diagram illustrating a cut-away view of the electrical connector 100 and the squib holder 200 in a third coupling stage according to example embodiments. In the third coupling stage, the CPA part 30 is held in the distal position 600 against the biasing force of the spring 50 which allows the locking part 70 to lock with the squib holder 200. The electrical connector 100 may be transitioned from the second coupling stage to the third coupling stage as the electrical connector 100 is forced into the squib holder 200 by a user as explained above. In the third coupling stage, the engagement rods 54 of the spring 50 may be compressed or bent as shown in Figure 8. The latch portions 74 of the locking beams 72 are received by the grooves 280 on the inner surface of the squib holder 200 to lock the electrical connector 100 and the squib holder 200. At the instant shown in Figure 8, a plunger part 76 of the locking part 70 is engaging with the blocking stubs 38 of the blocking beams 36 of the CPA part 30 to push the blocking stubs 38 outwards away from the mating axis 300 such that the blocking stubs 38 are no longer engaged with the blocking portion 250 of the retainer 220.

[0047] Figure 9 is a schematic diagram illustrating a cut-away view of the electrical connector 100 and the squib holder 200 in a fourth coupling stage according to example embodiments.

[0048] In the fourth coupling stage, the CPA part 30 returns to the proximate position by the biasing force of the spring 50, which allows the CPA part 30 to provide the locking position assurance of the locking part 70 and the squib holder 200. For example, the CPA part 30 may no longer be blocked by the blocking portion 250 of the retainer 220 because the plunger part 76 pushed the blocking stubs 38 outwards away from the mating axis 300 in the third coupling stage. Accordingly, as the CPA part 30 is no longer blocked by the blocking portion 250, the biasing force of the spring 50 forces the CPA part 30 from the distal position 600 back to the proximate position 500. Therefore, as shown in Figure 9, the position assurance beams 34 of the CPA part 30 move into the retainer 220 and each engage with a respective one of the plurality of locking beams 72 of the locking part 70 to hold the latch portions 74 of the locking beams 72 in the respective grooves 280 on the inner surface of the squib holder 200. In other words, the position assurance beams 34 prevent the latch portions 74 of the locking beams 72 from disengaging with the respective grooves 280 on the inner surface of the squib holder 200, which therefore provides the locking position assurance. Therefore, if the fourth coupling stage is the final coupling stage, then electrical connector and the squib holder remain securely locked together.

[0049] Figure 10 is a schematic diagram illustrating the electrical connector 100 and the squib holder 200 after the fourth coupling stage according to example embodiments. In Figure 10, the electrical connector 100 and the squib holder 200 are securely locked together with the CPA part 30 in the proximate position 500 to provide the locking position assurance. Furthermore, the electrical terminals 10 of the electrical connector 100 are electrically connected to the electrical pins 260 of the squib holder 200 which means electricity can flow through the electrical connector 100 and the squib holder 200 to or from the electrical cables 2. Accordingly, if the cables 2, the electrical connector 100 and the squib holder 200 form part of an electrical system which governs airbag deployment, then the electrical connector 100 and the squib holder 200 are likely to remain locked during a collision, thereby improving a likelihood of successful airbag deployment. Furthermore, during assembly, if an operator is required to move the CPA part 30 under tension of the spring to the proximate position in order for the electrical connector 100 to engage with the squib holder 200 and then release the CPA part again for mating and locking to occur. If the electrical connector 100 and the squib holder 200 do not engage then locking will not occur.

[0050] As will be appreciated from the above description with reference to Figures 6 to 9, the spring 50 is compressed in a plane defined by the mating axis 300. In other words, the spring 50 is compressed in a same plane in which the electrical connector 100 and the squib holder 200 are coupled together. Furthermore, the spring 50 can be mounted in the plane in which the electrical connector 100 and the squib holder 200 are coupled together. For example, the spring 50 may be mounted on the CPA part 30 by the coils 52 of the spring as shown in Figures 6 to 9. By contrast, existing squib connectors in the automobile industry typically use helical springs. A minimum of two helical springs are typically used in existing squib connectors to provide a sufficient biasing force. Consequently, the use of helical springs creates technical challenges in meeting the standardised dimensions of the squib connector. Other existing connectors use a mouse-trap/ "U-shape" style spring which may reduce spring dimensions compared with helical springs but create additional technical difficulties in spring mounting procedures. For example, for existing U shaped springs, the spring

must be deformed in planes other than the plane in which the electrical connector and the squib holder are coupled in order to mount the spring in the electrical connector. By contrast, a spring according to example embodiments of the present disclosure (such as spring 50) can provide reduced dimensions compared with existing U shaped springs, and, since the spring 50 is can be compressed in a same plane in which the electrical connector 100 and the squib connector 200 are coupled together, there is a reduced risk of unintentional deformation during spring mounting. Embodiments can therefore provide an electrical connector for providing reliable electrical connections with a reduced risk of unintentional deformation of the spring during a spring mounting procedure.

[0051] The coupling of the electrical connector 100 and the squib holder 200 has been described above with reference to four distinct stages for explanatory purposes. It will be appreciated however that the four coupling stages may overlap such that some of the processes described above with reference to one stage may occur in another stage or during a transition between two stages.

[0052] Although embodiments have been described above in connection with a 180 degrees electrical connector, it will be appreciated by one skilled in the art that the embodiments described above are equally applicable to a 90 degrees electrical connector. A 90 degrees electrical connector in accordance with example embodiments will now be briefly described.

[0053] Figure 11 is an exploded diagram illustrating an electrical connector 400 according to example embodiments. For the electrical connector 400 in Figure 11, the electrical cables 2 and the mating axis 300 are approximately perpendicular. The electrical connector 400 may therefore be referred to as a 90 degrees electrical connector. The electrical connector 400 includes a CPA part 430, a spring 450, and a locking part 470 which may broadly correspond to the CPA part 30, the spring 50, and the locking part of the 180 degrees electrical connector 100 respectively. The electrical connector 400 also includes a cover part 420 and a connecting part 460. The cover part 420 may comprise a plurality of latch receiving gaps 424 which are configured to receive latches 462 on the connecting part 460 for attaching the cover part 420 to the connecting part 460. The connecting part 460 therefore connects the locking part 470 and the cover part 420 to form a body of the electrical connector 420. The cover part 420 and the connecting part 406 may perform at least the functions of the cover part 20 and the connecting part for the 180 degrees electrical connector 100 as described above. However, the cover part 420 and the connecting part 460 may be configured without a secondary cover part to provide a housing for the electrical connector 400 as shown in Figure 11.

[0054] Figures 12 to 14 illustrate a first, second and fourth coupling stages respectively for the 90 degrees electrical connector 400 which broadly correspond to the first, second and fourth coupling stages described with reference to Figures 6, 7 and 9 for the 180 degrees electrical connector 100 above. It will be appreciated that the description of the four coupling stages with respect to Figures 6 to 9 apply equally to the 90 degrees electrical connector 400, and so Figures 12 and 14 will only be described in outline to avoid unnecessary repetition.

[0055] It will be appreciated from Figure 12 to 14 that the CPA part 430 is configured to move between a position proximate the locking part 470 and a position distal the locking part 470 during the coupling of the electrical connector 400 and the squib holder 200. The proximate position and the distal position are not labelled on Figures 12 to 14 for clarity but broadly correspond to the proximate position 500 and the distal position 600 shown in Figures 6 to 9.

[0056] Figure 12 is a schematic diagram illustrating a cut-away view of the electrical connector 400 and the squib holder 200 in a first coupling stage according to example embodiments. In the first coupling stage, the CPA part 430 is retained in the proximate position by the biasing force of the spring 50 to prevent the locking part 470 from engaging with the squib holder 200.

[0057] Figure 12 is a schematic diagram illustrating a cut-away view of the electrical connector 400 and the squib holder 200 in a second coupling stage according to example embodiments. In the second coupling stage, the CPA part 430 is moved along the mating axis 300 along the connecting part 460 against the biasing force of the spring 450 between the proximate position and the distal position allowing the locking part 470 to engage with the squib holder 200.

[0058] Figure 14 is a schematic diagram illustrating a cut-away view of the electrical connector 400 and the squib holder 200 in a fourth coupling stage according to example embodiments. In the fourth coupling stage, the CPA part 430 returns to the proximate position by the biasing force of the spring 450, which allows the CPA part 430 to provide the locking position assurance of the locking part 470 and the squib holder 200.

[0059] Although the foregoing disclosure has described that the spring 50 is mounted on the CPA part 30 and the engagement rods 54 of the spring 50 are configured to engage with an engagement surface 22 of the cover part 20, it will be appreciated by one skilled in the art that this is just one example of achieving the effects of the present technique. It will be appreciated that that, in another example, the spring 50 is mounted on the cover part 20 and the engagement rods 54 of the spring 50 are configured to engage with an engagement surface of the CPA part 30. For example, the spring 50 may be inverted such that the coils 52 are slotted onto posts extending from the cover part 20, and the engagement rods 54 extend towards the CPA part 30 and are configured to engage with an engagement surface on the CPA part 30.

[0060] As will be appreciated the electrical connector according to example embodiments provide a more compact and robust connector when compared with known connectors such as those disclosed in US 7 238 039 B2, JP

2015-041618 A, US 8 968 021 B1 and EP 3 047 545 B1.

[0061] The following numbered paragraphs provide further example aspects and features of the present technique:

Paragraph 1. An electrical connector for coupling to a squib holder along a mating axis to provide an electrical connection in a motorised vehicle, the electrical connector comprising:

a connector position assurance, CPA, part configured to provide a locking position assurance;

a spring formed by a wire with one or more ends of the wire extending to form one or more respective engagement rods; and

a body of the electrical connector comprising

a cover part;

a connecting part; and

a locking part configured to lock with the squib holder, the locking part being connected to the cover part by the connecting part and the CPA part being configured with the body to move along the mating axis along the connecting part between a position proximate the locking part and a position distal the locking part, and the spring being mounted on the CPA part or the cover part such that the engagement rods are configured in a plane defined by the mating axis to engage with an engagement surface of the other of the CPA part or the cover part, and the spring being configured to exert a biasing force on the CPA part to retain the CPA part in the proximate position, wherein the electrical connector is configured,

in a first coupling stage, in which the CPA part is retained in the proximate position by the biasing force of the spring to prevent the locking part from engaging with the squib holder,

in a second coupling stage, in which the CPA part is moved along the mating axis along the connecting part against the biasing force of the spring between the proximate position and the distal position allowing the locking part to engage with the squib holder,

in a third coupling stage, in which the CPA part is held in the distal position against the biasing force of the spring which allows the locking part to lock with the squib holder, and

in a fourth coupling stage, in which the CPA part returns to the proximate position by the biasing force of the spring, which allows the CPA part to provide the locking position assurance of the locking part and the squib holder.

Paragraph 2. An electrical connector according to paragraph 1, wherein the one or more ends of the wire comprise first and second ends of the wire, and each of the first and second ends of the wire extend to form a respective one of the engagement rods.

Paragraph 3. An electrical connector according to paragraph 1 or 2, wherein the spring comprises one or more coils, and the one or more ends of the wire extending to form the engagement rods extend from the one or more coils.

Paragraph 4. An electrical connector according to paragraph 3, wherein the one or more coils of the spring include first and second coils connected by the wire, and the one or more ends of the wire comprise first and second ends of the wire each of which extend from the respective first and second coils to form a respective one of the engagement rods.

Paragraph 5. An electrical connector according to paragraph 4, wherein the one or more coils are configured to be mounted onto one or more respective posts on the CPA part or the cover part to mount the spring on the CPA part or the cover part.

Paragraph 6. An electrical connector according to paragraph 5, wherein the one or more posts extend from the CPA part or the cover part in a direction approximately perpendicular to the plane defined by the mating axis in which the engagement rods are configured.

Paragraph 7. An electrical connector according to any of paragraphs 1 to 3, wherein the spring is held in a spring holding section of the CPA part or the cover part to mount the spring on the CPA part or the cover part respectively.

Paragraph 8. An electrical connector according to any of paragraphs 1 to 7, wherein, in the second coupling stage, the engagement surface is configured to engage with the engagement rods in the plane defined by the mating axis to move the spring from a more relaxed position to a more tensioned position.

Paragraph 9. An electrical connector according to paragraph 8, wherein each of the engagement rods are folded at one end to form an engagement tab extending perpendicularly to the plane defined by mating axis, and the engagement surface is configured to move the engagement rods from the more relaxed position to the more tensioned position in the second coupling stage by engaging with the engagement tabs.

Paragraph 10. An electrical connector according to any of paragraphs 1 to 9, wherein the CPA part is configured to engage with a blocking portion of the squib holder

to prevent the locking part from engaging with the squib holder in the first coupling stage,

to move the CPA part along the mating axis along the connecting part against the biasing force of the spring between the proximate position and the distal position in the second coupling stage, and

to hold the CPA part in the distal position in the third coupling stage.

Paragraph 11. An electrical connector according to paragraph 10, wherein the CPA part comprises

a plurality of cantilevered blocking beams each configured to engage with the blocking portion of the squib holder

to prevent the locking part from engaging with the squib holder in the first coupling stage,

to move the CPA part along the mating axis along the connecting part against the biasing force of the spring between the proximate position and the distal position in the second coupling stage,

to hold the CPA part in the distal position in the third coupling stage.

Paragraph 12. An electrical connector according to paragraph 11, wherein an end of each cantilevered blocking beam terminates in a blocking stub which extends inward towards the mating axis to allow engagement with the blocking portion of the squib holder

to prevent the locking part from engaging with the squib holder in the first coupling stage,

to move the CPA part along the mating axis along the connecting part against the biasing force of the spring between the proximate position and the distal position in the second coupling stage,

to hold the CPA part in the distal position in the third coupling stage.

Paragraph 13. An electrical connector according paragraph 11 or 12, wherein the locking part comprises a plunger part which is configured in the third coupling stage to engage with the plurality of cantilevered blocking beams to disengage the plurality of cantilevered blocking beams from the blocking portion of the squib holder allowing the CPA part to return to the proximate position by the biasing force of the spring in the fourth coupling stage.

Paragraph 14. An electrical connector according to any of paragraphs 1 to 13, wherein the locking part comprises a plurality of cantilevered locking beams each of which terminate in a latch portion which extends outwards away from the mating axis and is configured in the third coupling stage to be received by a respective groove on an inner surface of the squib holder to lock the locking part and the squib holder together.

Paragraph 15. An electrical connector according to paragraph 14, wherein the CPA part comprises a plurality of cantilevered position assurance beams each of which are configured in the fourth coupling stage to engage with a respective one of the cantilevered locking beams of the locking part to hold the latch portions of the plurality of cantilevered locking beams into the respective grooves on the inner surface of the squib holder thereby providing

the locking position assurance of the locking part and the squib holder.

Paragraph 16. An electrical connector according to any of paragraphs 1 to 15, comprising one or more electrical terminals configured in the fourth coupling stage to connect with a respective one or more electrical pins in the squib holder to form the electrical connection.

Paragraph 17. A motorised vehicle including an airbag system comprising an airbag and a controller configured to deploy the airbag under predetermined conditions, wherein the airbag is connected to the controller by an electrical connector according to any of paragraphs 1 to 16.

Paragraph 18. A method of coupling an electrical connector to a squib holder along a mating axis to provide an electrical connection in a motorised vehicle, the electrical connector comprising a connector position assurance, CPA, part configured to provide a locking position assurance, a spring formed by a wire with one or more ends of the wire extending to form one or more respective engagement rods; and a body of the electrical connector comprising a cover part; a connecting part; and a locking part configured to lock with the squib holder, the locking part being connected to the cover part by the connecting part and the CPA part being configured with the body to move along the mating axis along the connecting part between a position proximate the locking part and a position distal to the locking part, and the spring being mounted on the CPA part or the cover part such that the engagement rods are configured in a plane defined by the mating axis to engage with an engagement surface of the other of the CPA part or the cover part, and the spring being configured to exert a biasing force on the CPA part to retain the CPA part in the proximate position, the method comprising:

in a first coupling stage, retaining the CPA part of the electrical connector in a position proximate a locking part of the electrical connector by a biasing force of the spring in the electrical connector to prevent the locking part from engaging with the squib holder,

in a second coupling stage, applying a force to the CPA part to move the CPA part along the mating axis along the connecting part, against the biasing force of the spring between the proximate position and the position distal the locking part, and engaging the locking part with the squib holder,

in a third coupling stage, holding the CPA part in the distal position against the biasing force of the spring and locking the locking part with the squib holder, and

in a fourth coupling stage, allowing the CPA part to return to the proximate position by the biasing force of the spring, and the CPA part providing a locking position assurance of the locking part and the squib holder.

Paragraph 19. A method of assembling a motorised vehicle including an airbag system comprising an airbag and a controller comprising connecting the airbag to the controller with an electrical connector in accordance with the method of paragraph 18.

Paragraph 20. A method of mounting a spring formed by a wire on an electrical connector for coupling with a squib holder along a mating axis, the method comprising:

mounting the spring on a CPA part or a cover part of the electrical connector, with one or more ends of the wire extending to form engagement rods being in a plane defined by the mating axis to engage with an engagement surface of the other of the CPA part or the cover part, and the spring being configured to exert a biasing force on the CPA part to retain the CPA part in a position proximate a locking part of the electrical connector configured to lock with the squib holder.

[0062] Various further aspects and features of the present technique are defined in the appended claims.

[0063] Further particular and preferred aspects of the present invention are set out in the accompanying independent and dependent claims. It will be appreciated that features of the dependent claims may be combined with features of the independent claims in combinations other than those explicitly set out in the claims.

[0064] Thus, the foregoing discussion discloses and describes merely exemplary embodiments of the present invention. As will be understood by those skilled in the art, the present invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. Accordingly, the disclosure of the present invention is intended to be illustrative, but not limiting of the scope of the invention, as well as other claims. The disclosure, including any readily discernible variants of the teachings herein, define, in part, the scope of the foregoing claim terminology such that no inventive subject matter is dedicated to the public.

[0065] For ease of reference the following provides a summary of the reference numerals used for each of the parts shown in the drawings:

	2 -	Electrical Cables
5	10 -	Electrical Terminals
	16 -	Terminal Receiving Section
	20, 420 -	Cover Part
	22, 422 -	Engagement Surface
	24 -	Cover Part Latch
10	30, 30a, 30b, 430 -	CPA Part
	32, 432 -	Posts
	34, 434 -	Position Assurance Beams
	36, 436 -	Blocking Beams
	38, 438 -	Blocking Stubs
15	39 -	Spring Holding Section
	40 -	Secondary Cover Part
	44 -	Secondary Cover Part Latch Receiving Gap
	46 -	Secondary Cover Part Latch Receiving Gap
	50, 50a, 50b, 450 -	Spring
20	52, 452 -	Coils
	54, 454 -	Engagement Rods
	56, 546 -	Engagement Tabs
	58, 458 -	Connecting Rod
	60, 460 -	Connecting Part
25	66 -	Connecting Part Latch
	68 -	Platform
	70, 470 -	Locking Part
	72, 474 -	Locking Beams
	74, 474 -	Latch Portions
30	76, 476 -	Plunger Part
	100, 400 -	Electrical Connector
	200 -	Squib holder
	210 -	Pocket
	220 -	Retainer
35	240 -	Electrical Pin Housing
	250 -	Blocking Portion
	260 -	Electrical Pins
	262 -	Initiator
	264 -	Receptacle
40	270a -	Shunt
	272, 274 -	Conductive Strips
	280 -	Grooves
	300 -	Mating Axis

45

Claims

1. An electrical connector for coupling to a squib holder along a mating axis to provide an electrical connection in a motorised vehicle, the electrical connector comprising:

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a connector position assurance, CPA, part configured to provide a locking position assurance;
a spring formed by a wire with one or more ends of the wire extending to form one or more respective engagement rods; and
a body of the electrical connector comprising

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a cover part;
a connecting part; and
a locking part configured to lock with the squib holder, the locking part being connected to the cover part

by the connecting part and the CPA part being configured with the body to move along the mating axis along the connecting part between a position proximate the locking part and a position distal the locking part, and the spring being mounted on the CPA part or the cover part such that the engagement rods are configured in a plane defined by the mating axis to engage with an engagement surface of the other of the CPA part or the cover part, and the spring being configured to exert a biasing force on the CPA part to retain the CPA part in the proximate position, wherein the electrical connector is configured,

in a first coupling stage, in which the CPA part is retained in the proximate position by the biasing force of the spring to prevent the locking part from engaging with the squib holder,
in a second coupling stage, in which the CPA part is moved along the mating axis along the connecting part against the biasing force of the spring between the proximate position and the distal position allowing the locking part to engage with the squib holder,
in a third coupling stage, in which the CPA part is held in the distal position against the biasing force of the spring which allows the locking part to lock with the squib holder, and
in a fourth coupling stage, in which the CPA part returns to the proximate position by the biasing force of the spring, which allows the CPA part to provide the locking position assurance of the locking part and the squib holder.

2. An electrical connector according to claim 1, wherein the one or more ends of the wire comprise first and second ends of the wire, and each of the first and second ends of the wire extend to form a respective one of the engagement rods.
3. An electrical connector according to claim 1 or claim 2, wherein the spring comprises one or more coils, and the one or more ends of the wire extending to form the engagement rods extend from the one or more coils.
4. An electrical connector according to claim 3, wherein the one or more coils of the spring include first and second coils connected by the wire, and the one or more ends of the wire comprise first and second ends of the wire each of which extend from the respective first and second coils to form a respective one of the engagement rods.
5. An electrical connector according to claim 4, wherein the one or more coils are configured to be mounted onto one or more respective posts on the CPA part or the cover part to mount the spring on the CPA part or the cover part.
6. An electrical connector according to claim 5, wherein the one or more posts extend from the CPA part or the cover part in a direction approximately perpendicular to the plane defined by the mating axis in which the engagement rods are configured.
7. An electrical connector according to any of claims 1 to 3, wherein the spring is held in a spring holding section of the CPA part or the cover part to mount the spring on the CPA part or the cover part respectively.
8. An electrical connector according to any of claims 1 to 7, wherein, in the second coupling stage, the engagement surface is configured to engage with the engagement rods in the plane defined by the mating axis to move the spring from a more relaxed position to a more tensioned position.
9. An electrical connector according to claim 8, wherein each of the engagement rods are folded at one end to form an engagement tab extending perpendicularly to the plane defined by mating axis, and the engagement surface is configured to move the engagement rods from the more relaxed position to the more tensioned position in the second coupling stage by engaging with the engagement tabs.
10. An electrical connector according to any of claims 1 to 9, wherein the CPA part is configured to engage with a blocking portion of the squib holder

to prevent the locking part from engaging with the squib holder in the first coupling stage,
to move the CPA part along the mating axis along the connecting part against the biasing force of the spring between the proximate position and the distal position in the second coupling stage, and
to hold the CPA part in the distal position in the third coupling stage.

11. An electrical connector according to claim 10, wherein the CPA part comprises

a plurality of cantilevered blocking beams each configured to engage with the blocking portion of the squib holder to prevent the locking part from engaging with the squib holder in the first coupling stage,
 to move the CPA part along the mating axis along the connecting part against the biasing force of the spring between the proximate position and the distal position in the second coupling stage,
 to hold the CPA part in the distal position in the third coupling stage.

12. A motorised vehicle including an airbag system comprising an airbag and a controller configured to deploy the airbag under predetermined conditions, wherein the airbag is connected to the controller by an electrical connector according to any of claims 1 to 11.

13. A method of coupling an electrical connector to a squib holder along a mating axis to provide an electrical connection in a motorised vehicle, the electrical connector comprising a connector position assurance, CPA, part configured to provide a locking position assurance, a spring formed by a wire with one or more ends of the wire extending to form one or more respective engagement rods; and a body of the electrical connector comprising a cover part; a connecting part; and a locking part configured to lock with the squib holder, the locking part being connected to the cover part by the connecting part and the CPA part being configured with the body to move along the mating axis along the connecting part between a position proximate the locking part and a position distal to the locking part, and the spring being mounted on the CPA part or the cover part such that the engagement rods are configured in a plane defined by the mating axis to engage with an engagement surface of the other of the CPA part or the cover part, and the spring being configured to exert a biasing force on the CPA part to retain the CPA part in the proximate position, the method comprising:

in a first coupling stage, retaining the CPA part of the electrical connector in a position proximate a locking part of the electrical connector by a biasing force of the spring in the electrical connector to prevent the locking part from engaging with the squib holder,

in a second coupling stage, applying a force to the CPA part to move the CPA part along the mating axis along the connecting part, against the biasing force of the spring between the proximate position and the position distal the locking part, and engaging the locking part with the squib holder,

in a third coupling stage, holding the CPA part in the distal position against the biasing force of the spring and locking the locking part with the squib holder, and

in a fourth coupling stage, allowing the CPA part to return to the proximate position by the biasing force of the spring, and the CPA part providing a locking position assurance of the locking part and the squib holder.

14. A method of assembling a motorised vehicle including an airbag system comprising an airbag and a controller comprising connecting the airbag to the controller with an electrical connector in accordance with the method of claim 13.

15. A method of mounting a spring formed by a wire on an electrical connector for coupling with a squib holder along a mating axis, the method comprising:

mounting the spring on a CPA part or a cover part of the electrical connector, with one or more ends of the wire extending to form engagement rods being in a plane defined by the mating axis to engage with an engagement surface of the other of the CPA part or the cover part, and the spring being configured to exert a biasing force on the CPA part to retain the CPA part in a position proximate a locking part of the electrical connector configured to lock with the squib holder.

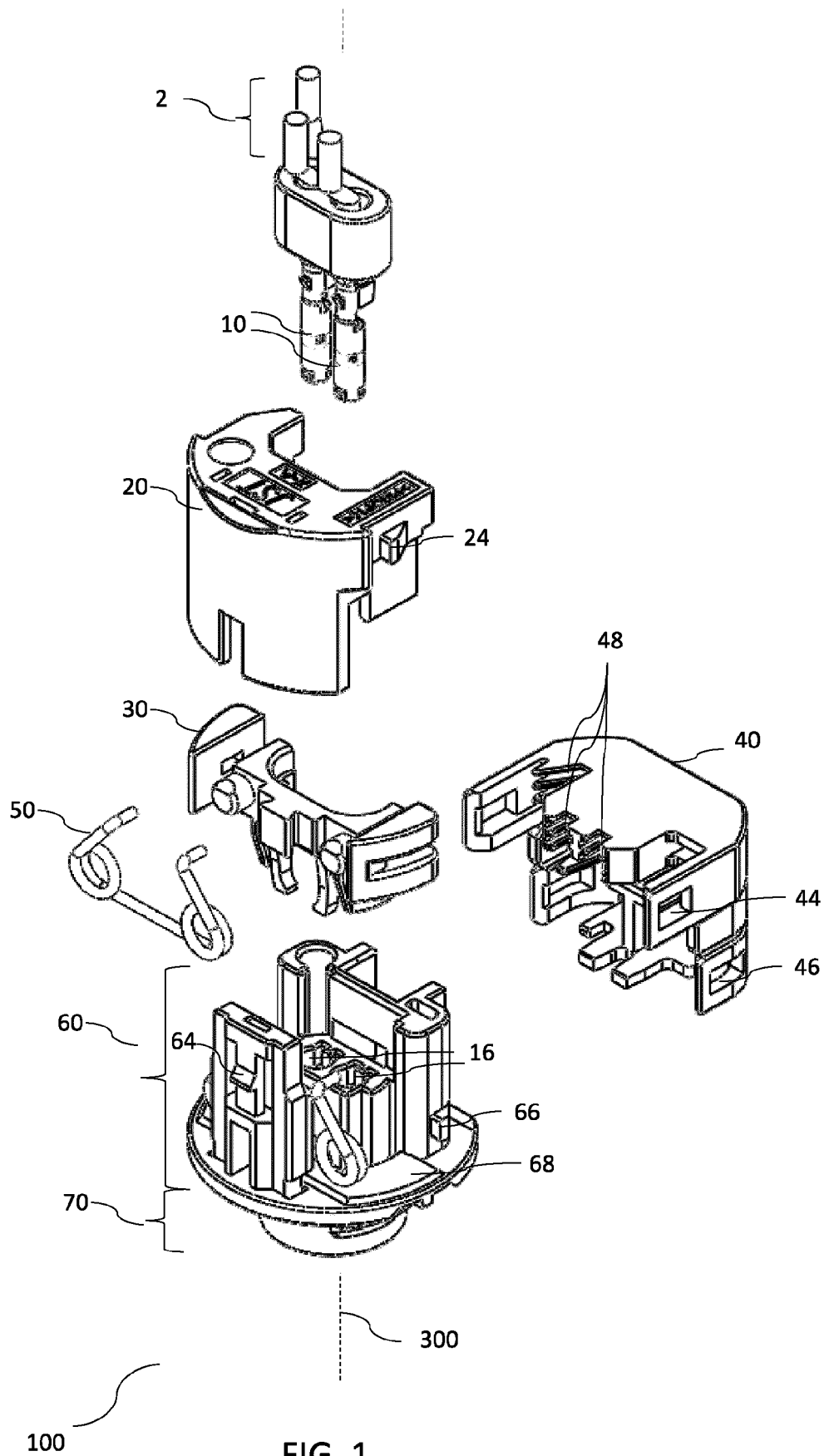


FIG. 1

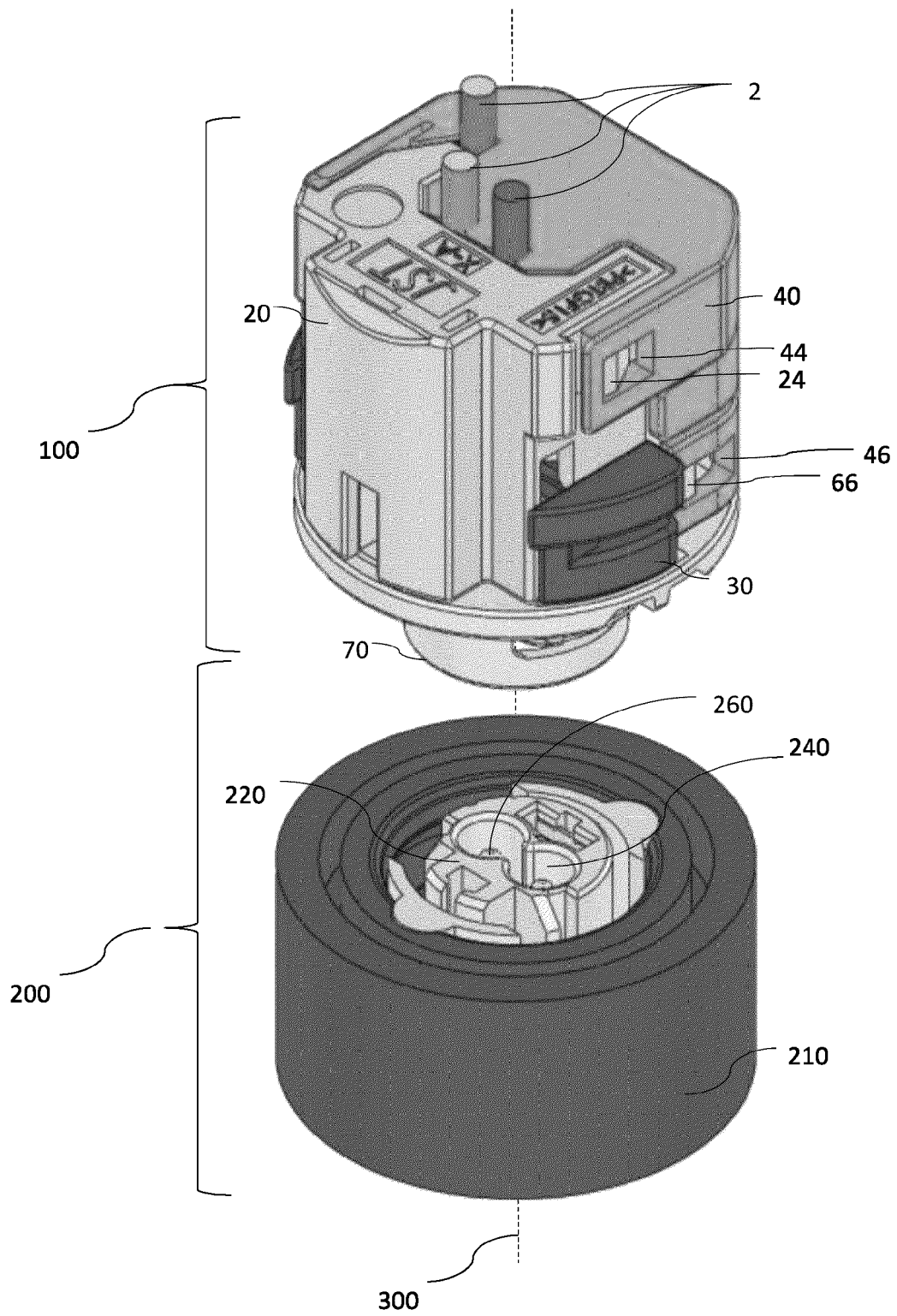


FIG. 2

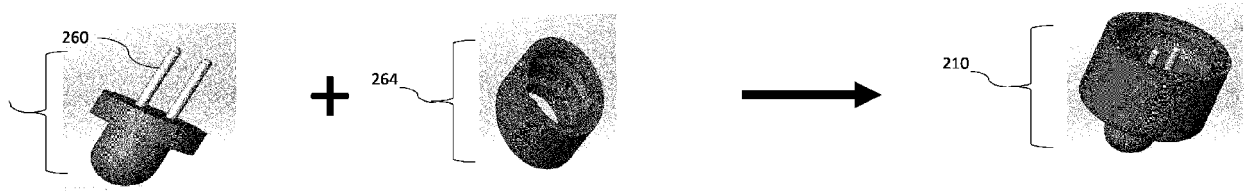


FIG. 3A

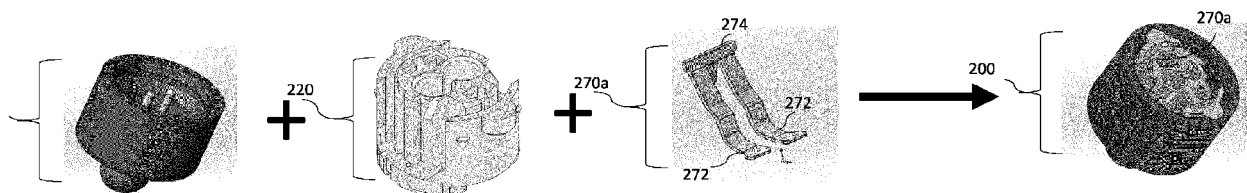


FIG. 3B

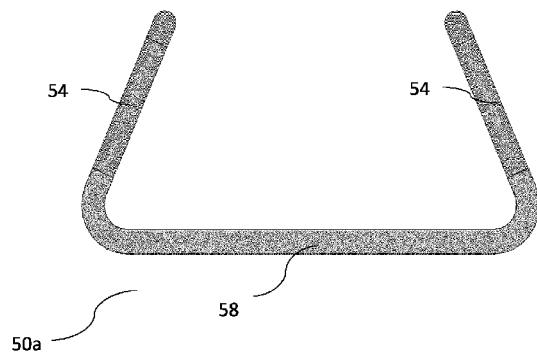


FIG. 4A

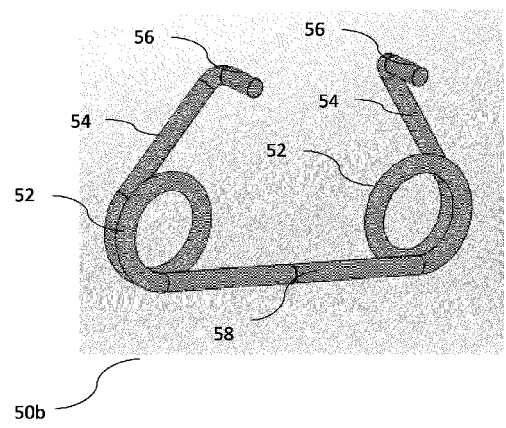


FIG. 4B

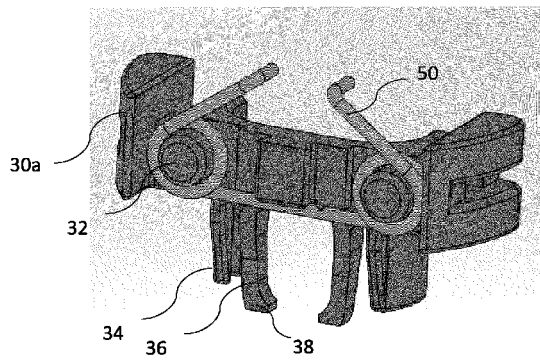


FIG. 5A

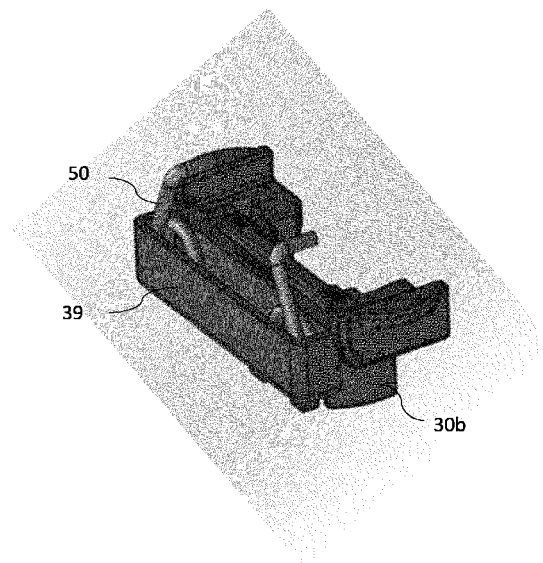


FIG. 5B

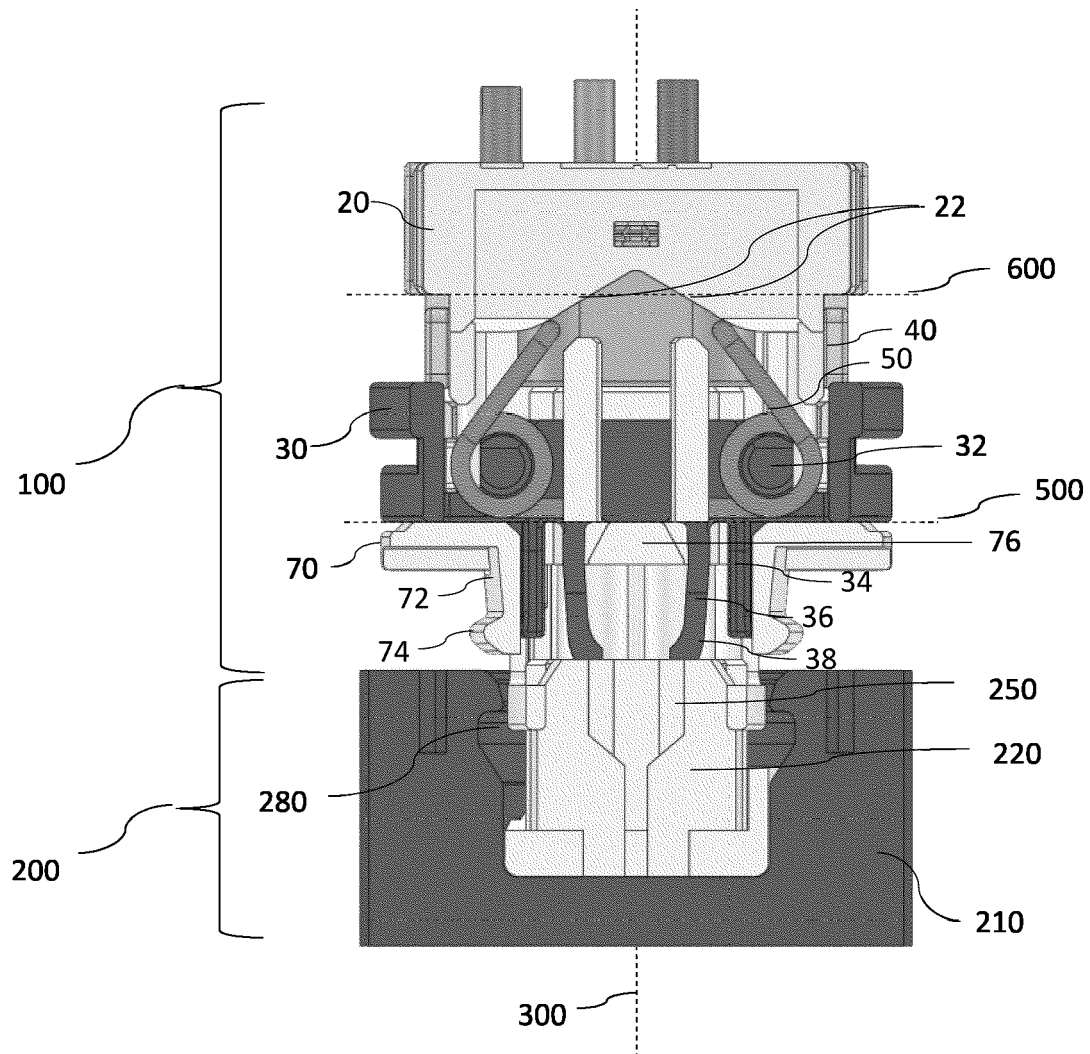


FIG. 6

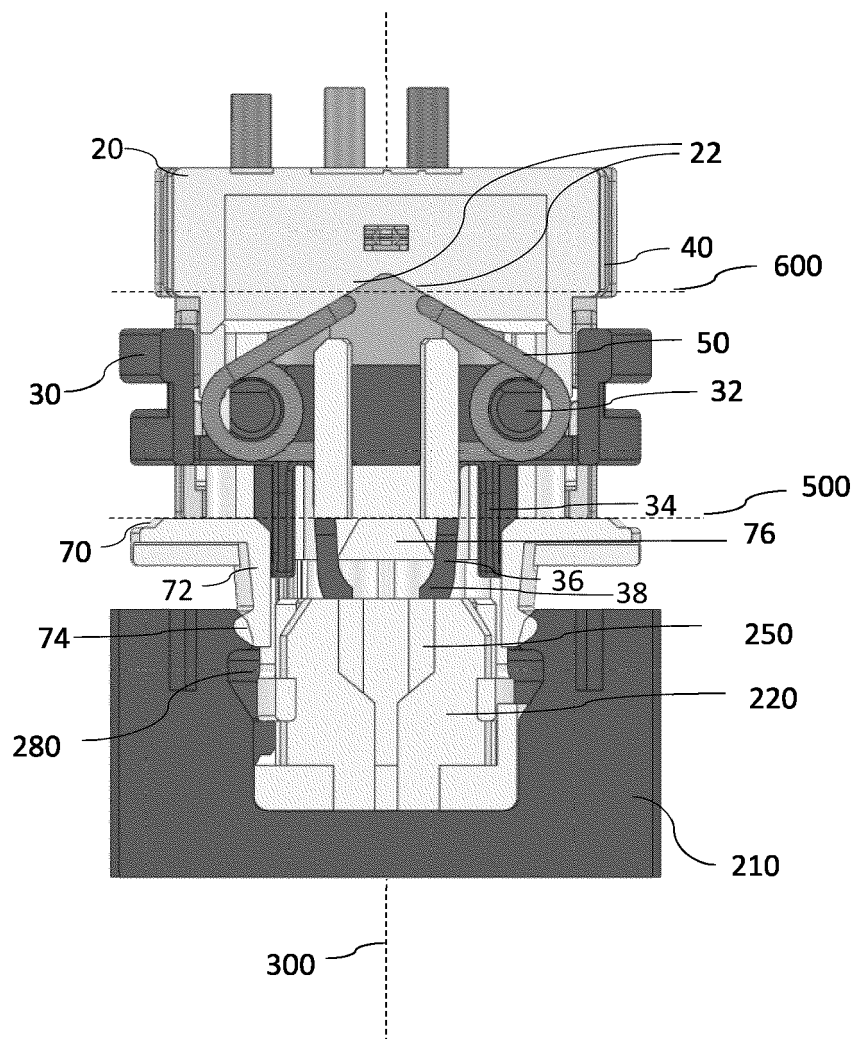


FIG. 7

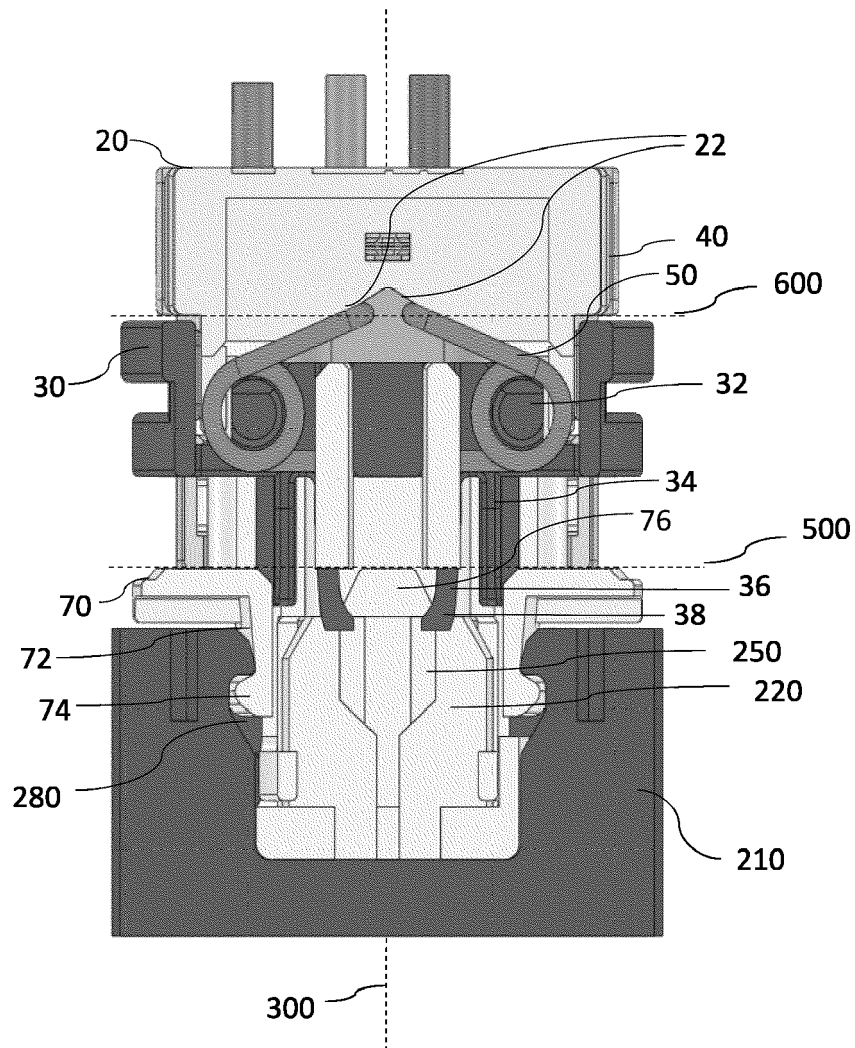


FIG. 8

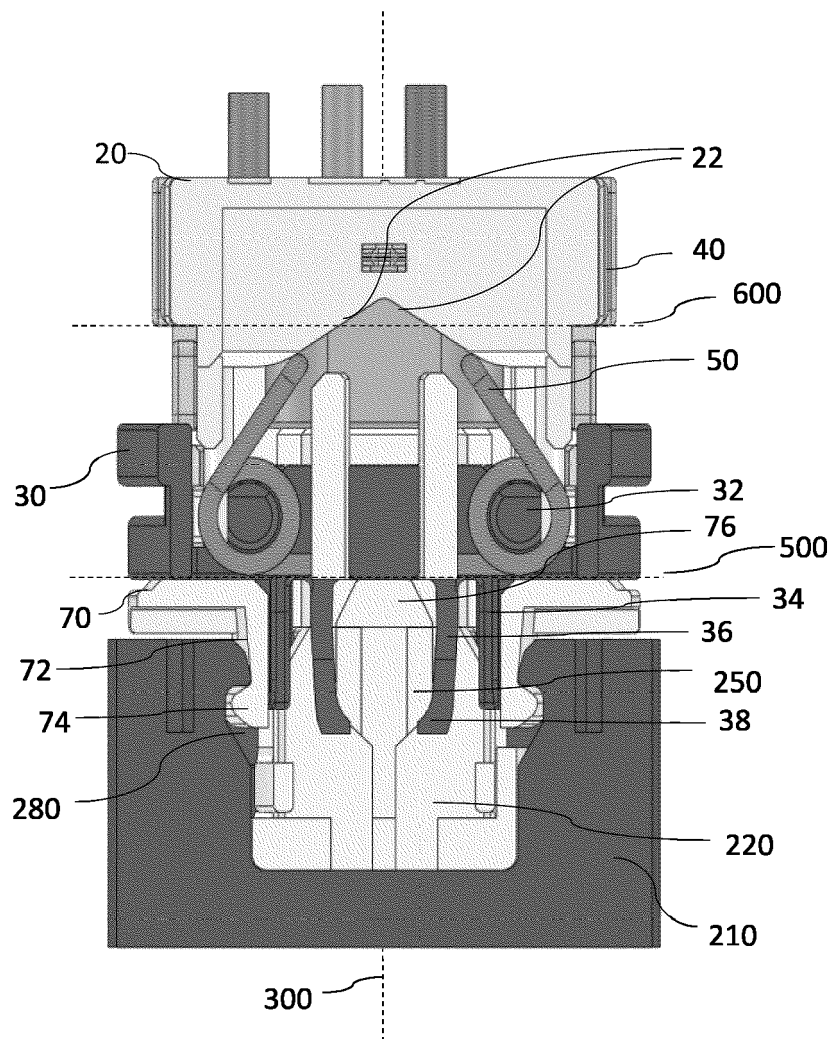


FIG. 9

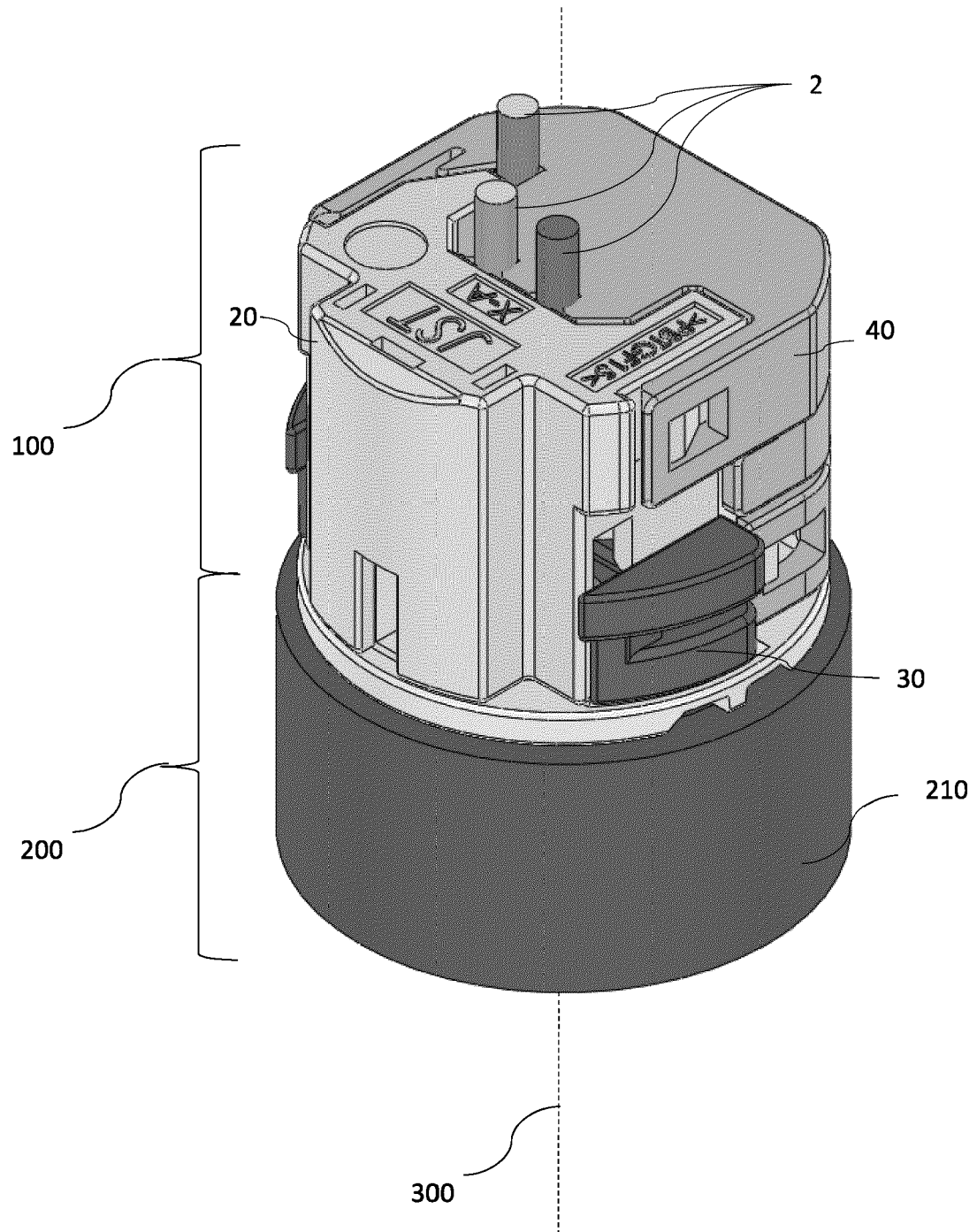


Fig. 10

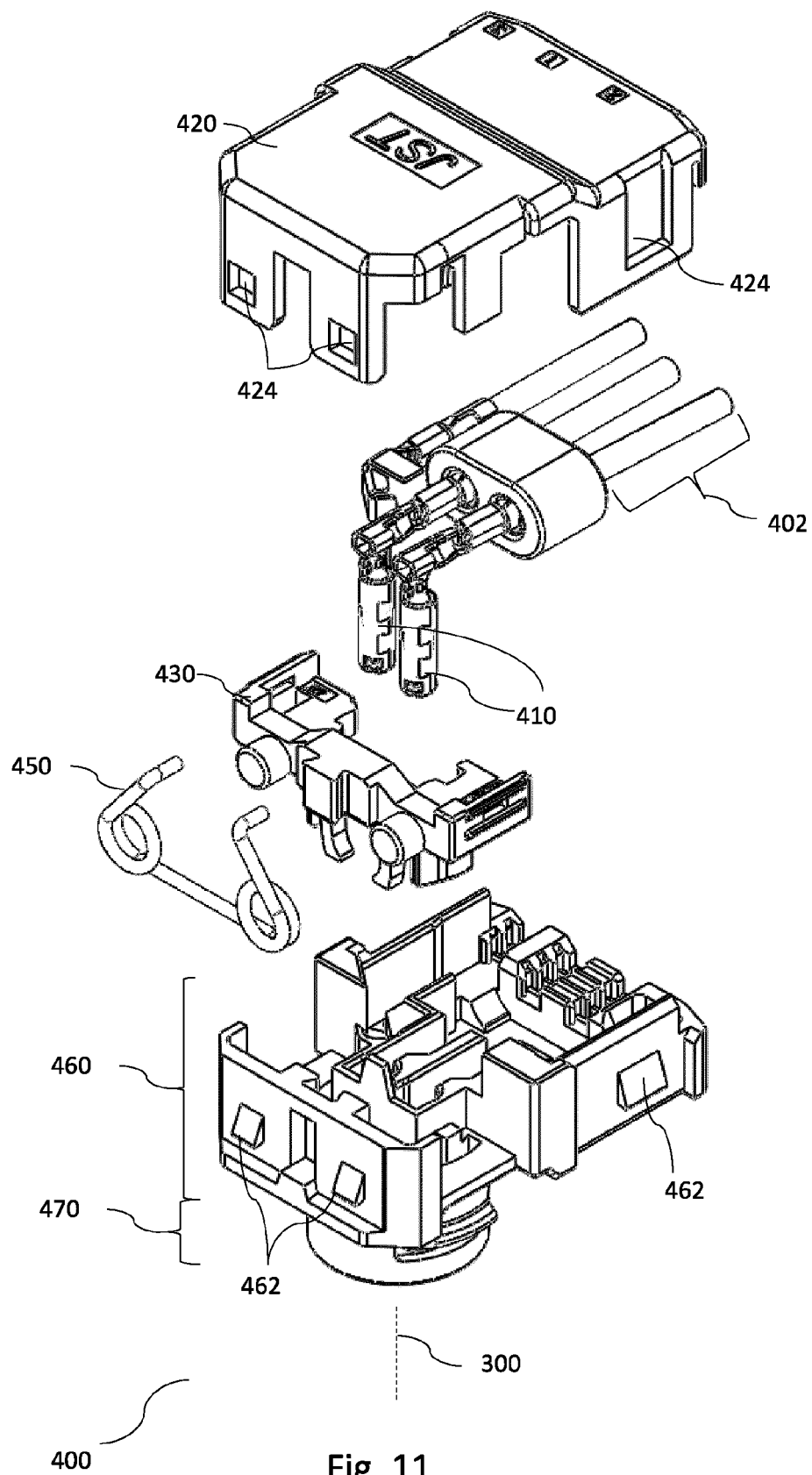


Fig. 11

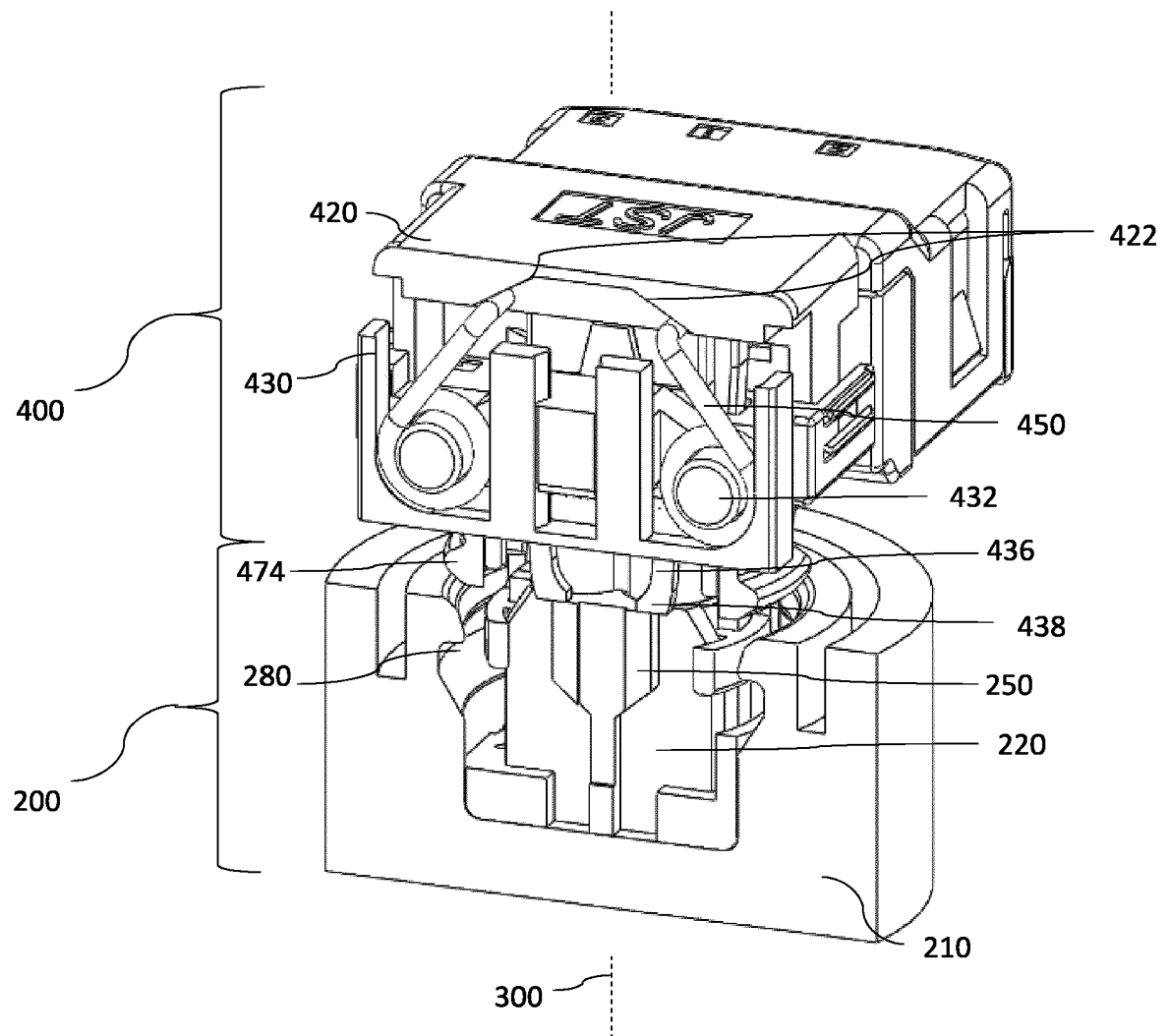


FIG. 12

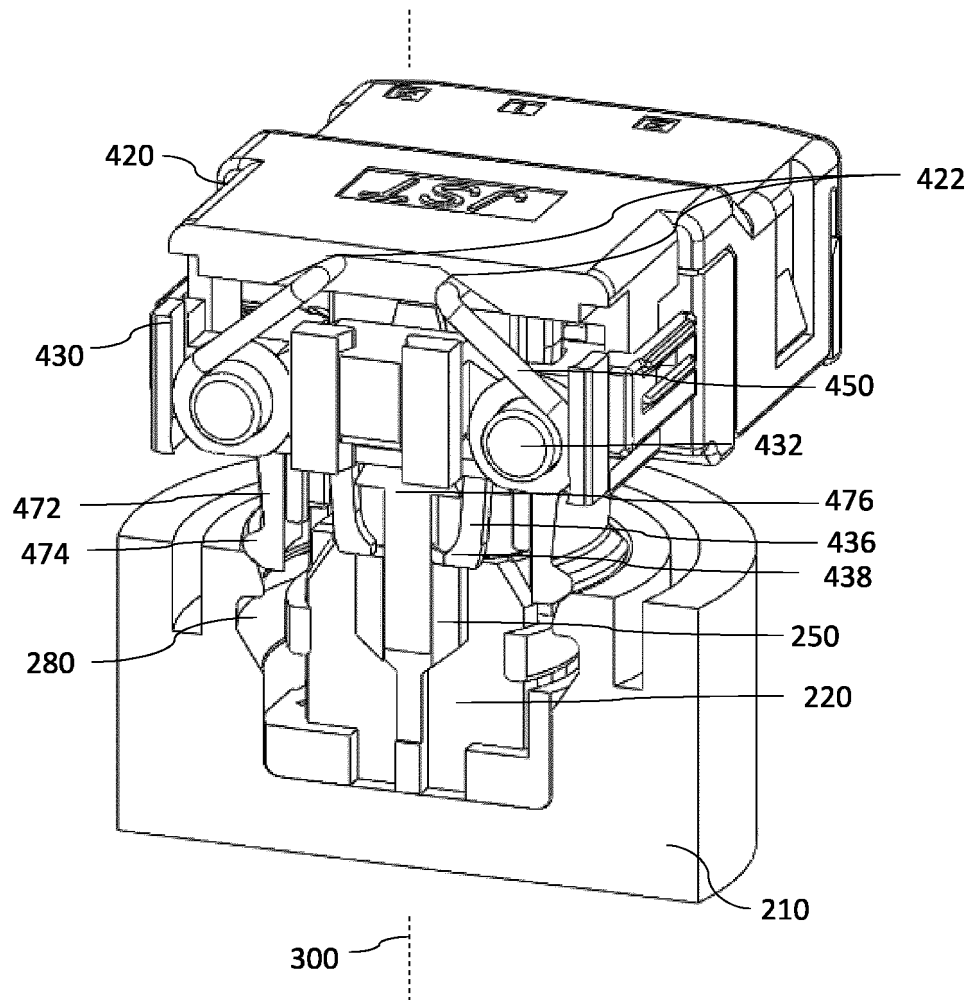


FIG. 13

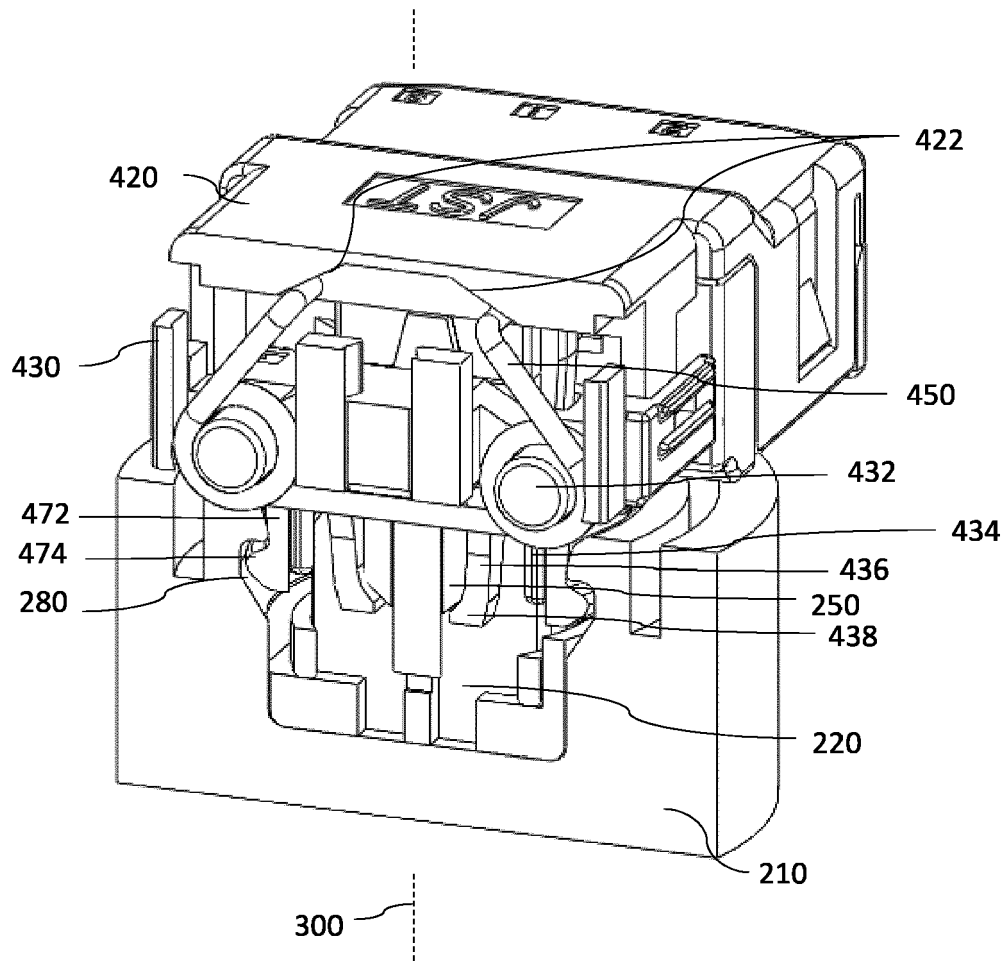


FIG. 14



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Place of search The Hague		Date of completion of the search 15 February 2022	Examiner Gélébart, Yves
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