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(54) ELECTRICAL CONNECTOR WITH A TERMINAL POSITION ASSURANCE DEVICE

(57) An electrical connector (10) including electrical terminals (36) along with a connector housing (14) defining a first and second cavity (28), the first and second cavities configured to receive the terminals (36). The connector housing (14) further defines a third internal cavity (28) extending along a lateral axis (Y). The electrical connector (10) includes a terminal position assurance (TPA) device (34) received within the third internal cavity (28). The TPA device (34) is moveable from an terminal insertion position (39) to a terminal locking position (41). The TPA device (34) has flexible first and second primary locking features (40a, 40b) configured to engage locking features of the terminals (36). The TPA device (34) also includes rigid first and second secondary locking features (42a, 42b). The second secondary locking feature (42b) and the first and second primary locking features (40a, 40b) are configured to engage the corresponding locking feature of an electrical terminal (36) effective to secure the second electrical terminal (36b) within the second internal cavity (16b) when the TPA device (34) is in the terminal locking position (41).

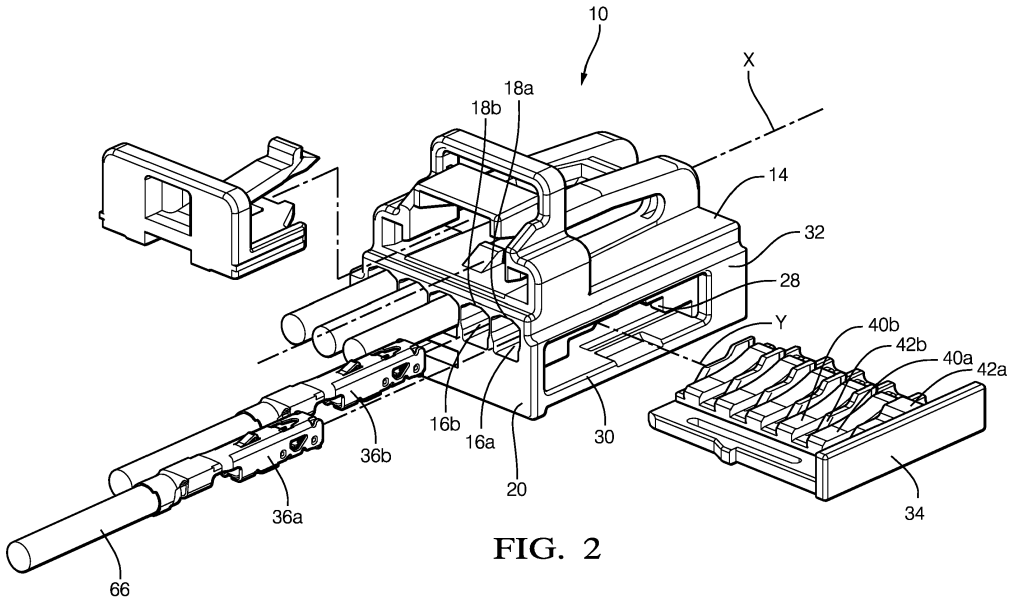

FIG. 2

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Description

TECHNICAL FIELD OF THE INVENTION

[0001] The invention relates to electrical connectors, and more particularly relates to an electrical connector including a terminal position assurance device having two sets of terminal locking features.

BACKGROUND OF THE INVENTION

[0002] Electrical terminals locked into a connector housing are subject to retention strength performance issues, especially with the smaller size categories of terminals (e.g. less than 2.8 mm). These smaller terminals historically have used scaled down locking features, which inherently have reduced locking retention strength and allow excessive terminal float. An excessively floating terminal can stub during mating, resulting in the terminal pushing out, and/or terminal damage especially if the retention strength within the connector housing is low. Within the automotive industry, inadequately locked terminals which pull out or push out, are recognized as the second highest root cause for failure of electrical connector systems within the vehicle warranty period.

[0003] Electrical connectors typically comprise internal cavities that are intended to accommodate electrical (male and/or female) terminals inserted from a rear face of the electrical connector. To ensure a well and safe functioning of the connector, it has to be ensured that the electrical terminals are locked in place within the electrical connector.

[0004] A solution known in the art includes providing a primary locking feature in form of a resilient retaining shoulder for preventing rearward withdrawal of the electrical terminals. The retaining shoulder, which is formed in the electrical connector, is designed to make a snap fit into a corresponding recess of the electrical connector at the end of the insertion of the electrical connector. A flexible retaining member is thereby disposed contiguously between the internal cavity and a slot, into which the retaining member can deflect. The retaining shoulder is formed on the face of the flexible retaining member that communicates with the internal cavity, such that on inserting the electrical terminal into the internal cavity, the retaining member first deflects in the slot before the retaining shoulder engages the recess of the electrical terminal.

[0005] In order to secure the primary locking, it is known, e.g. from U.S. Patent No. 6,132,252, to insert an additional locking member built as a rail into the slot next to the retaining member as a secondary locking. The electrical terminal being fully inserted into the internal cavity and the primary locking being engaged, the locking member is inserted into the slot from a front face of the electrical connector according to a direction corresponding to the loading direction of the electrical terminal. The retaining member is thus prevented from being flexed away from the internal cavity, thereby firmly retaining the electrical terminal. If the electrical terminal is incompletely inserted into the internal cavity, the retaining member is maintained in a deflected position into the slot, such that the locking member cannot be mounted.

[0006] The secondary locking mechanism known in the art requires a locking member being inserted frontward of the electrical connector in the direction opposite to that of the insertion of the electrical terminal. However, the configuration of the electrical connector may be such that a frontward insertion of the locking member is not possible, e.g. because there is not enough space at the front face side. In addition, the retaining members in connectors used with smaller terminals may easily buckle, terminal tangs may bend, and secondary locking mechanism may provide limited additional strength due to packaging constraints with terminals smaller than 2.8 mm. These solutions to date have only met the minimum terminal retention requirements, in many cases, all with little to no performance margin.

[0007] The subject matter discussed in the background section should not be assumed to be prior art merely as a result of its mention in the background section. Similarly, a problem mentioned in the background section or associated with the subject matter of the background section should not be assumed to have been previously recognized in the prior art. The subject matter in the background section merely represents different approaches, which in and of themselves may also be inventions.

BRIEF SUMMARY OF THE INVENTION

[0008] In accordance with an embodiment of the invention, an electrical connector is provided. The electrical connector includes a first electrical terminal, a second electrical terminal and a connector housing defining a first internal cavity and a second internal cavity. Each cavity extends along a longitudinal axis from a first face of the connector housing to a second face of the connector housing. The first and second internal cavities are configured to receive the first and second electrical terminals respectively. The connector housing further defines a third internal cavity extending along a lateral axis transverse to the longitudinal axis. The third internal cavity is in communication with the first and second internal cavities. The electrical connector further includes a terminal position assurance (TPA) device configured to be received within the third internal cavity. The TPA device is moveable from a terminal insertion position within the third internal cavity to a terminal locking position. The TPA device has flexible first and second primary locking features that are configured to engage corresponding locking surfaces of the first and second electrical terminals respectively. The primary locking features are effective to secure the first and second electrical terminals within the first and second internal cavities respectively when the TPA device is in the terminal insertion position within the third internal cavity. The TPA device also has

rigid first and second secondary locking features. The second secondary locking feature and the first and second primary locking features are configured to engage the locking surface of the second electrical terminal effective to secure the second electrical terminal within the second internal cavity when the TPA device is in the terminal locking position.

[0009] The first and second primary locking features engage distal portions of the locking surface of the second electrical terminal and the second secondary locking feature engages a mesial portion of the corresponding locking feature of the second electrical terminal.

[0010] According to one particular embodiment, only the first primary locking feature and the first secondary locking feature is engaged with the locking surface of the first electrical terminal to secure the first electrical terminal within the first internal cavity when the TPA device is in the terminal locking position.

[0011] The first primary locking feature may engage a distal portion of the locking surface of the first electrical terminal and the first secondary locking feature engages a mesial portion of the locking surface of the first electrical terminal. The first secondary locking feature may further engage another distal of the locking surface of the first electrical terminal.

[0012] The TPA device is configured to move from the terminal insertion position to the terminal locking position along the lateral axis and move transversely relative to the longitudinal axis. The TPA device is configured to be inserted in the third internal cavity transversally to the first and second internal cavities through a lateral opening defined by the connector housing.

[0013] Each primary locking feature comprises a flexible beam that is attached at one end to a cross bar of the TPA device. A free end of the flexible beam defines a first lock shoulder. Each secondary locking feature of the TPA device defines a rigid second lock shoulder defined by the cross bar of the TPA device.

[0014] The first lock shoulder of the flexible beam engages the locking surface of the corresponding electrical terminal when the TPA devices is in the terminal insertion position and in the terminal locking position. The second lock shoulder engages the locking surface of the corresponding electrical terminal when the TPA devices is in the terminal locking position.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

[0015] The present invention will now be described, by way of example with reference to the accompanying drawings, in which:

Fig. 1 is a perspective exploded view of a electrical connector including a movable terminal position assurance (TPA) device and a corresponding mating electrical connector in accordance with one embodiment.

Fig. 2 is a exploded perspective view of the electrical connector of Fig. 1 including the TPA device in accordance with one embodiment;

Fig. 3 is a top view of the TPA device of Fig 1 in accordance with one embodiment;

Fig. 4A is a cross sectional front view of the electrical connector of Fig. 1 with the TPA device in a terminal insertion position in accordance with one embodiment;

Fig. 4B is a close-up cross sectional front view of the movable TPA device of Fig. 1 engaging an electrical terminal while the TPA device is in the terminal insertion position of Fig. 4A in accordance with one embodiment;

Fig. 5 is a cross sectional side view of the TPA device of Fig. 1 engaging the electrical terminal while the TPA device is in the terminal insertion position of Fig. 4A in accordance with one embodiment;

Fig. 6A is a cross sectional front view of the electrical connector of Fig. 1 with the TPA device in a terminal locking position in accordance with one embodiment;

Fig. 6B is a close-up cross sectional front view of the TPA device of Fig. 1 engaging the electrical terminal while the TPA device is in the terminal locking position of Fig. 6A in accordance with one embodiment; and

Fig. 7 is a cross sectional side view of the TPA device of Fig. 1 engaging the electrical terminal while the TPA device is in the terminal locking position of Fig. 6A in accordance with one embodiment.

DETAILED DESCRIPTION OF THE INVENTION

[0016] Presented herein is an electrical connector including a moveable terminal position assurance (TPA) device. The TPA device secures the contacts or terminals of the connector within cavities in the connector housing once the terminals are fully inserted within the housing. The TPA device incorporates a flexible primary lock finger to engage a lock ridge of a terminal thus locating and securing the terminal within a cavity as the terminal is inserted into the cavity while the TPA device is in a terminal insertion position. After insertion of all the terminals into the cavities of the connector housing, the TPA device is moved to a terminal locking position. This movement to the terminal locking position engages a rigid secondary lock on the TPA device with the lock ridge of the terminal in addition to the primary lock finger to further secure the terminal within the cavity.

[0017] Cross-referencing Figs. 1-7, details of a non-

limiting example of an electrical connector 10 can be seen. The electrical connector 10 is configured to mate with a corresponding mating connector (not shown). A connector housing 14 of the electrical connector 10 has a first internal cavity 16a, hereinafter referred to as a terminal cavity 16a that extends along a longitudinal axis X of the connector housing 14 from an opening 18a in a first face 20, hereinafter referred to as an insertion end 20, of the connector housing 14 to an opening 22a into an integral socket 24 in a second face 26, hereinafter referred to as a mating end 26, of the connector housing 14. The connector housing 14 has a second internal cavity 16b, hereinafter referred to as an adjacent terminal cavity 16b, that also extends along the longitudinal axis X from an opening 18b in the insertion end 20 to an opening 22b in the mating end 26. The connector housing 14 also has third internal cavity 28 that extends along a lateral axis Y of the connector housing 14 that is transverse, or generally perpendicular, to the longitudinal axis X. As used herein, generally perpendicular is $\pm$ 10° of absolutely perpendicular. This third internal cavity 28 defines an opening 30 in a lateral wall 32 of the connector housing 14 that is configured to receive a terminal position assurance (TPA) device 34 that is configured to secure electrical terminals 36a, 36b within the terminal cavities 16a, 16b once the terminals 36a, 36b are fully inserted within the terminal cavities 16a, 16b.

[0018] The TPA device 34 is formed of a dielectric material, such as polyamide, polypropylene, or polybutylene terephthalate. At least one wall 38 of the terminal cavities 16a, 16b is open to and in communication with the third internal cavity 28, hereinafter referred to as a TPA cavity 28. The TPA device 34 is movable within the TPA cavity 28 from an terminal insertion position 39 in which the TPA device 34 is disposed before the terminal 36 is inserted into the terminal cavity 16 to a terminal locking position 41 in which the TPA device 34 is disposed after the terminal 36 is fully inserted within the terminal cavity 16.

[0019] The TPA device 34 includes flexible primary locking features 40a, 40b and rigid secondary locking features 42a, 42b each configured to secure the terminals 36a, 36b within the terminal cavities 16a, 16b. The secondary locking features 42a, 42b are laterally adjacent the primary locking features 40a, 40b respectively. The TPA device 34 and the TPA cavity 28 are configured to that the TPA device 34 slides laterally within the TPA cavity 28. The primary locking features 40a, 40b include flexible beams 44 that are attached at one end to the TPA device 34. The flexible beams 44 extend along the longitudinal axis X. An unattached end 50 of each flexible beam 44 defines a ramp 52 that slopes toward the insertion end 20 of the connector housing 14. The ramp 52 leads to a first lock shoulder 54 that is preferably, but not necessarily, set at a slight back angle.

[0020] As best shown in Fig. 4B, the primary locking features 40a, 40b are centered within the terminal cavities 16a, 16b when the TPA device 34 is in the terminal insertion position 39.

[0021] The secondary locking feature 42 of the TPA device 34 has a rigid second lock shoulder 56 defined by the TPA device 34. As best shown in Fig. 6B, the secondary locking features 42a, 42b are centered within the terminal cavities 16a, 16b when the TPA device 34 is in the terminal locking position 41.

[0022] Focusing now on a typical electrical terminals 36a, 36b, which generally include a forward contact portion 60, an intermediate body portion 62, and a rearward attachment portion 64 for attaching the terminal 36 to the insulated conductor wire 66. The body portion 62 leads to a locking surface 70. The terminals 36a, 36b are inserted into the terminal cavities 16a, 16b through the openings 18a, 18b at the insertion end 20 of the connector housing 14 when the TPA device 34 is in the terminal insertion position 39. As best shown in Fig. 5, when body portion 62 engages the ramp 52 of the flexible beam 44, the body portion 62 deflects the flexible beam 44 so that the ramp 52 of the flexible beam 44 rides over body portion 62 as the terminal 36 is further inserted within the TPA cavity 28. When the first lock shoulder 54 reaches the locking surface 70, the flexible beam 44 springs back to a generally undeflected position and the first lock shoulder of the flexible beam 44 engages the locking surface 70 of the terminal 36, inhibiting the terminal 36 from being pulled back out of the insertion end 20 of the connector housing 14. The first lock shoulder is generally centered on the locking surfaces 70, i.e. the primary locking features 40a, 40b engage a mesial portion of the lock surfaces.

[0023] After the terminals 36a, 36b are fully inserted into the terminal cavities 16a, 16b and secured within the terminal cavities 16a, 16b by the primary locking features 40a, 40b, the TPA device 34 is laterally moved within the TPA cavity 28 from the terminal insertion position 39 to the terminal locking position 41. The secondary locking features 42a, 42b are moved into the terminal cavities 16a, 16b so that the rigid second lock shoulder 56 now engages the locking surfaces 70 of the terminals 36a, 36b and is generally centered on the locking surfaces 70, i.e. the secondary locking features 42a, 42b engage a mesial portion of the locking surfaces 70.

[0024] As the TPA device slides from and the terminal insertion position 39 to the terminal locking position 41, the first primary locking feature 40a is moved laterally so that it now engages a distal portion of the locking surface 70 of the first terminal 36a. As the first primary locking feature 40a slides laterally with the TPA device, the first primary locking feature 40a enters the adjacent terminal cavity 16 and engages a distal portion of the locking surface 70 of the second adjacent terminal 36b. As the second primary locking feature 40a is moved laterally it now engages an opposing distal portion of the locking surface 70 of the second terminal 36b.

[0025] Terminal cavity 16a as illustrated has only one adjacent terminal cavity 16b. Because there is only one adjacent cavity, primary locking features cannot enter

terminal cavity 16a to engage a distal portion of the lock surface as described for adjacent terminal cavity 16b above. Therefore, to provide adequate securement, the secondary locking feature engages both the mesial portion of the lock surface and a distal portion of the lock surface.

[0026] As illustrated in Figs. 1-7, the connector housing 14 includes multiple terminal cavities 16a, 16b, so the TPA device 34 is positioned in the terminal insertion position 39 where the primary locking feature 40 holds each terminal 36a, 36b within its terminal cavity 16 until all of the terminals 36 are inserted into the terminal cavities 16. Once all of the terminal cavities 16 are filled, the TPA device 34 is moved into the terminal locking position 41 so that the terminals 36 are held within the terminal cavities 16 by the secondary locking feature 42.

[0027] Each terminal 36a, 36b can be removed from its terminal cavity 16a, 16b by inserting a tool (not shown) into an access slot and depressing the primary locking feature 40a, 40b until the locking surface 70 is released by the first lock shoulder 54 when the TPA device 34 is in the terminal insertion position 39.

[0028] While the electrical connector 10 shown in Figs. 1-7 is designed to contain female terminals 36, the TPA device 34 can also be adapted for use in the corresponding mating connector designed to contain male terminals.

[0029] Accordingly an electrical connector 10 including a TPA device 34 is provided. The TPA device 34 has the benefit of rigidly engaging a locking surface 70 of the terminals 36a, 36b when the secondary locking features 42a, 42b are engaged, fully locking the terminals 36a, 36b within the terminal cavities 16a, 16b. The TPA device 34 also provides a reduction of positional float of the terminals 36a, 36b within the terminal cavities 16a, 16b which greatly improves the alignment of the terminals 36a, 36b within the connector housing 14 and reduces the chance of terminal push-out and/or terminal damage during connection with the corresponding mating connector. Because the primary locking features 40a, 40b are only required to hold the terminals 36a, 36b within the terminal cavities 16a, 16b during the terminal insertion process, the primary locking features 40a, 40b may be designed to optimize the terminal insertion force without regard to final retention force since that is separately provided by the secondary locking features 42a, 42b.

[0030] Engineering evaluation of the design of this electrical connector 10 has shown that terminal retention force for 1.5 mm terminals exceeded automotive OEM performance specification requirements by 124% (179 N vs 80 N OEM standard). The performance of the electrical connector 10 exceeded the terminal pull out force performance of prior art electrical connector designs without the TPA device by 56% (179 N vs 115 N). Similar performance improvements for 0.64 mm terminals are also expected.

[0031] The TPA device 34 is compatible with most polarized tangless ("clean body") defined by automotive OEMs as cavity compatible strategy terminals, e.g. Kaizen 0.64, Delphi MTS, OCS 1.5, OCS 2.8.

[0032] While this invention has been described in terms of the preferred embodiments thereof, it is not intended to be so limited, but rather only to the extent set forth in the claims that follow. Moreover, the use of the terms first, second, etc. does not denote any order of importance, but rather the terms first, second, etc. are used to distinguish one element from another. Furthermore, the use of the terms a, an, etc. do not denote a limitation of quantity, but rather denote the presence of at least one of the referenced items.

Claims

1. Electrical connector (10), comprising:

a first electrical terminal (36) and a second electrical terminal (36b);

a connector housing (14) defining a first internal cavity (16a) and a second internal cavity (16b), each extending along a longitudinal axis (X) from a first face (20) of the connector housing (14) to a second face (26) of the connector housing (14), said first and second internal cavities (16a, 16b) configured to receive the first and second electrical terminals (36a, 36b) respectively, the connector housing (14) further defining a third internal cavity (28) extending along a lateral axis (Y) transverse to the longitudinal axis (X), wherein the third internal cavity (28) is in communication with the first and second internal cavities (16a, 16b); and

a terminal (36) position assurance (TPA) device (34) configured to be received within the third internal cavity (28) and moveable from an terminal insertion position (39) within the third internal cavity (28) to a terminal locking position (41), the TPA device (34) further comprising:

flexible first and second primary locking features (40a, 40b) configured to engage corresponding locking surfaces (70) of the first and second electrical terminals (36a, 36b) respectively effective to secure the first and second electrical terminals (36a, 36b) within the first and second internal cavities (16a, 16b) respectively when the TPA device (34) is in the terminal insertion position (39) within the third internal cavity (28), and

rigid first and second secondary locking features (42a, 42b), wherein the second secondary locking feature (42b) and the first and second primary locking features (40a, 40b) are configured to engage the locking surface (70) of the second electrical terminal (36b) effective to secure the second electrical terminal (36b) within the second

internal cavity (16b) when the TPA device (34) is in the terminal locking position (41).

2. Electrical connector (10) according to claim 1, wherein the first and second primary locking features (40a, 40b) engage distal portions of the locking surface (70) of the second electrical terminal (36b) and the second secondary locking feature (42b) engages a mesial portion of the corresponding locking feature of the second electrical terminal (36b).

3. Electrical connector (10) according to one of the preceding claims, wherein only the first primary locking feature (40a) and the first secondary locking feature (42a) is engaged with the locking surface (70) of the first electrical terminal (36a) to secure the first electrical terminal (36a) within the first internal cavity (16a) when the TPA device (34) is in the terminal locking position (41).

4. Electrical connector (10) according to one of the preceding claims, wherein the first primary locking feature (40a) engages a distal portion of the locking surface (70) of the first electrical terminal (36a) and the first secondary locking feature (42a) engages a mesial portion of the locking surface (70) of the first electrical terminal (36a).

5. Electrical connector (10) according to one of the preceding claims, wherein the first secondary locking feature (42a) further engages another distal of the locking surface (70) of the first electrical terminal (36a).

6. Electrical connector (10) according to one of the preceding claims, wherein the TPA device (34) is configured to move from the terminal insertion position (39) to the terminal locking position (41) along the lateral axis (Y) and move transversely relative to the longitudinal axis (X).

7. Electrical connector (10) according to one of the preceding claims, wherein the TPA device (34) is configured to be inserted in the third internal cavity (28) transversally to the first and second internal cavities (16a, 16b) through a lateral opening (18a) defined by the connector housing (14).

8. Electrical connector (10) according to one of the preceding claims, wherein each primary locking feature (40) comprises a flexible beam (44) that is attached at one end to a cross bar of the TPA device (34), wherein a free end of the flexible beam (44) defines a first lock shoulder (54).

9. Electrical connector (10) according to one of the preceding claims, wherein each secondary locking feature (42) of the TPA device (34) defines a rigid second lock shoulder (56) defined by the cross bar of the TPA device (34).

10. Electrical connector (10) according to one of the preceding claims, wherein the first lock shoulder (54) of the flexible beam (44) engages the locking surface (70) of the corresponding electrical terminal (36) when the TPA devices is in the terminal insertion position (39) and in the terminal locking position (41).

11. Electrical connector (10) according to one of the preceding claims, wherein the second lock shoulder (56) engages the locking surface (70) of the corresponding electrical terminal (36) when the TPA device (34) is in the terminal locking position (41).

12. Wire harness assembly, comprising:

a plurality of insulated conductor wires (66); and an electrical connector (10) according to one of the preceding claims.

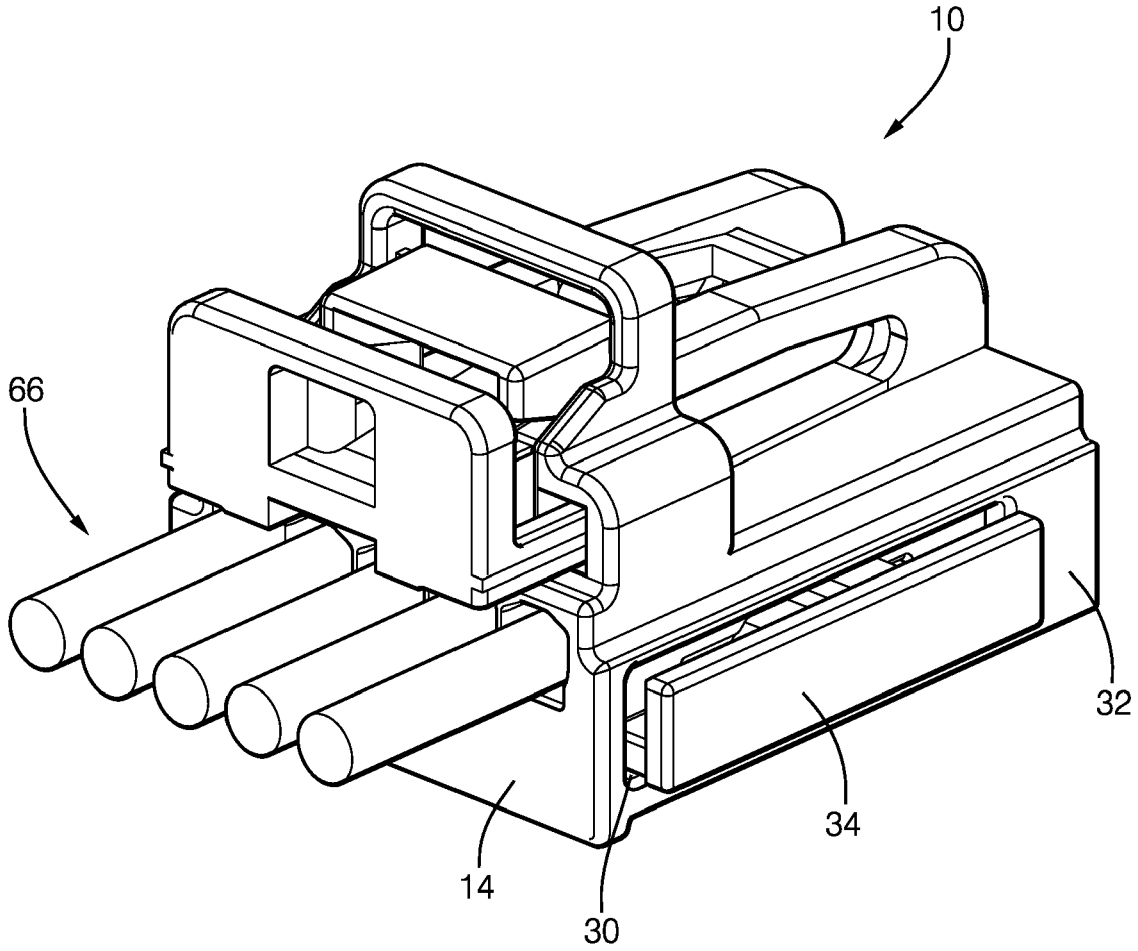

FIG. 1

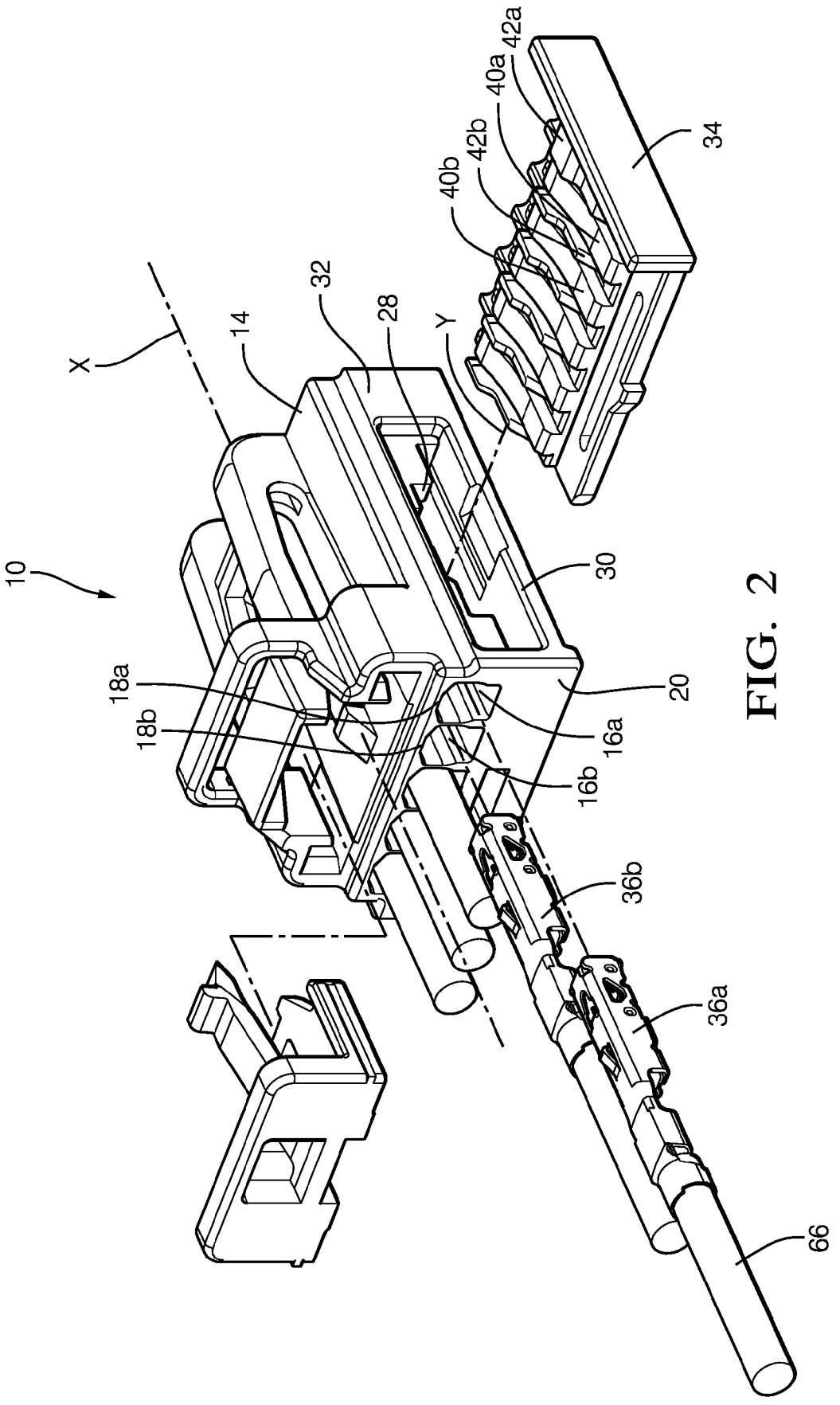

FIG. 2

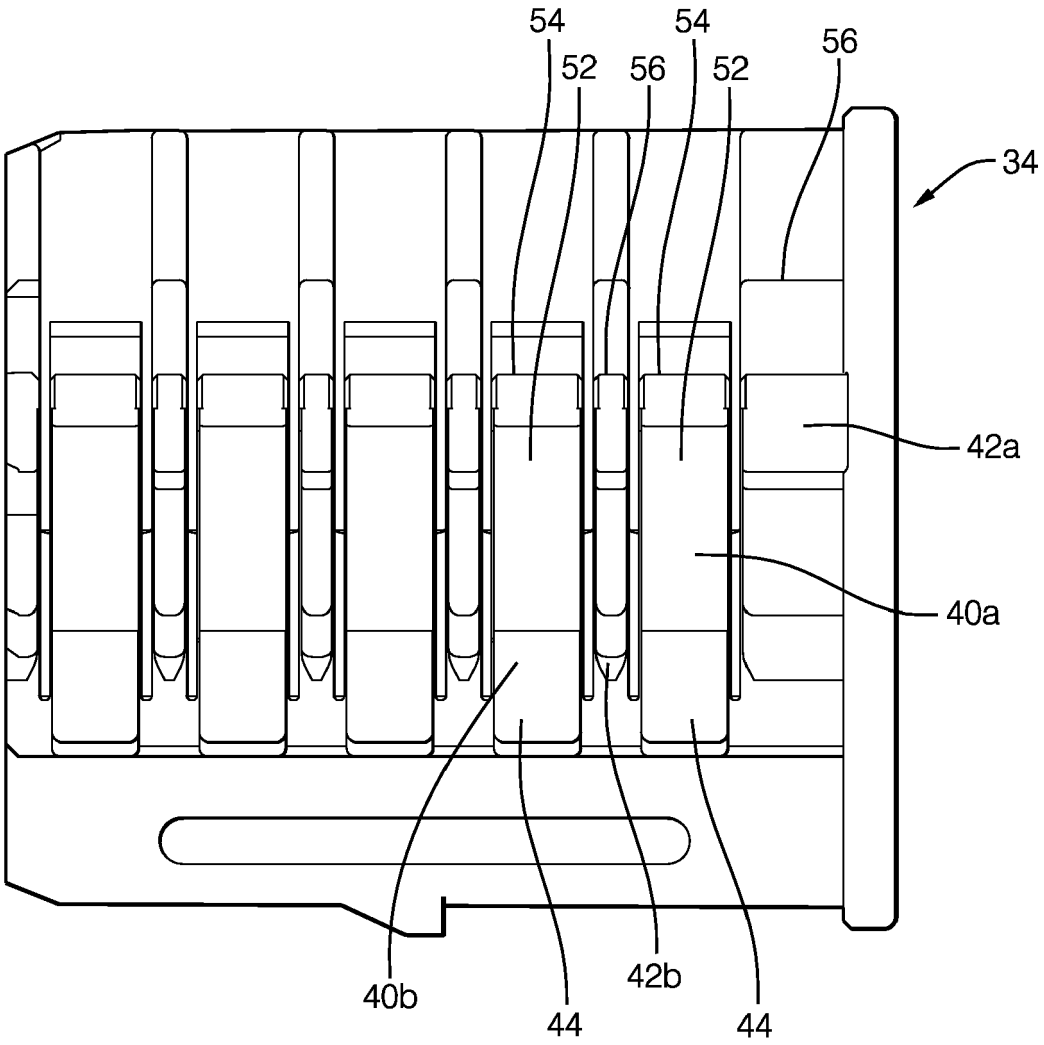

FIG. 3

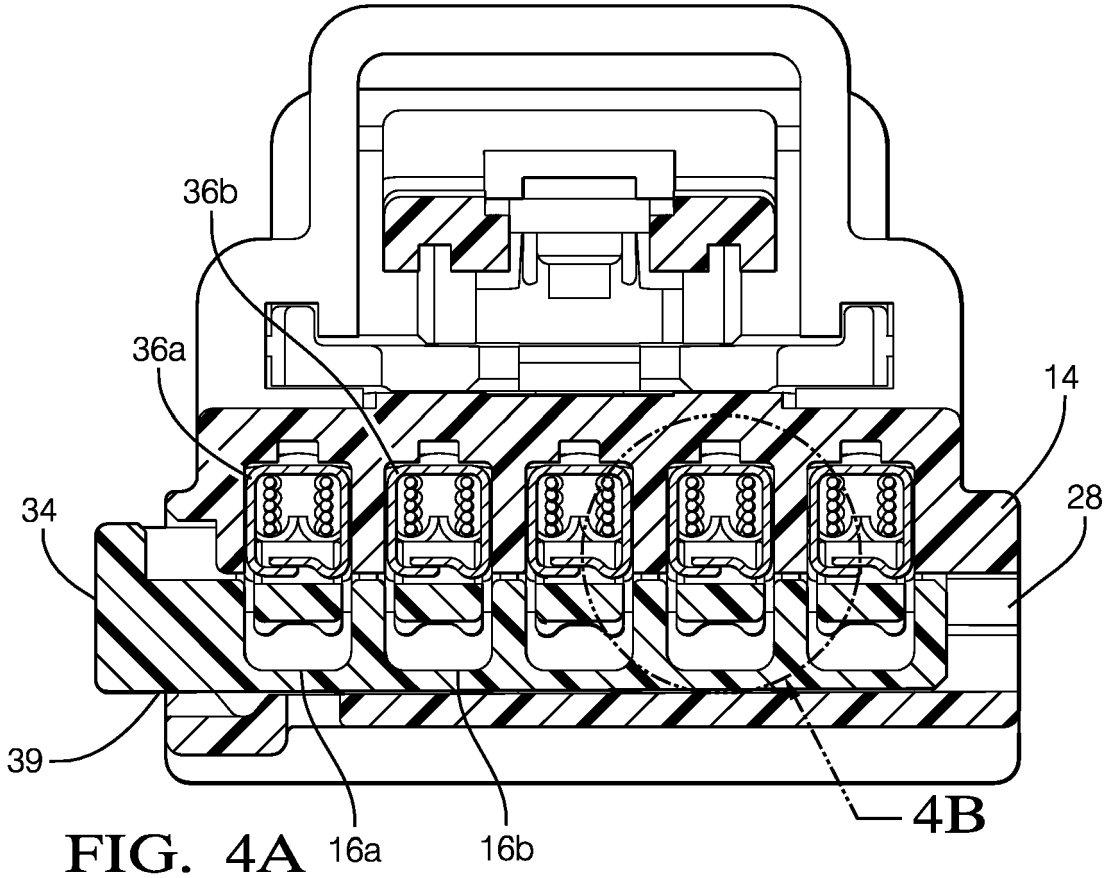

FIG. 4A

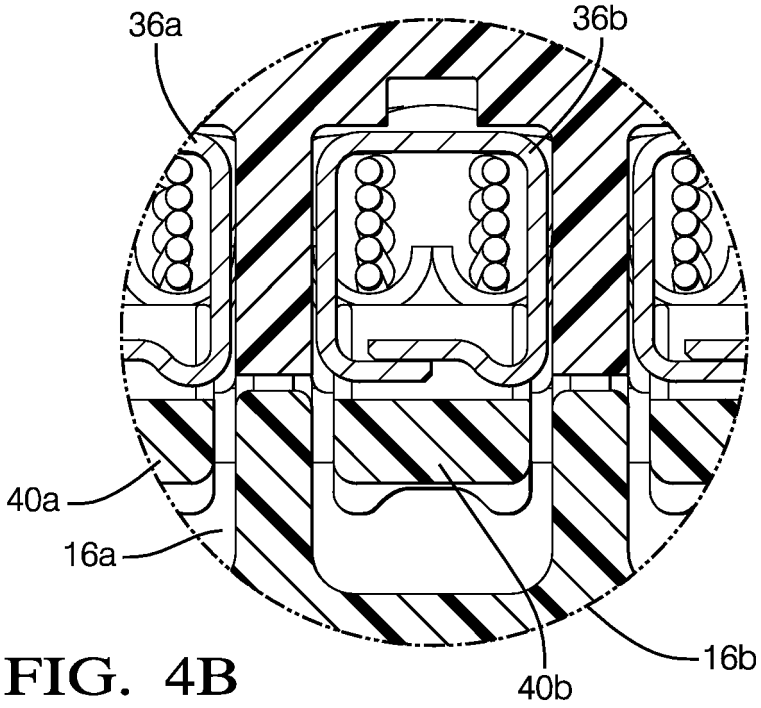

FIG. 4B

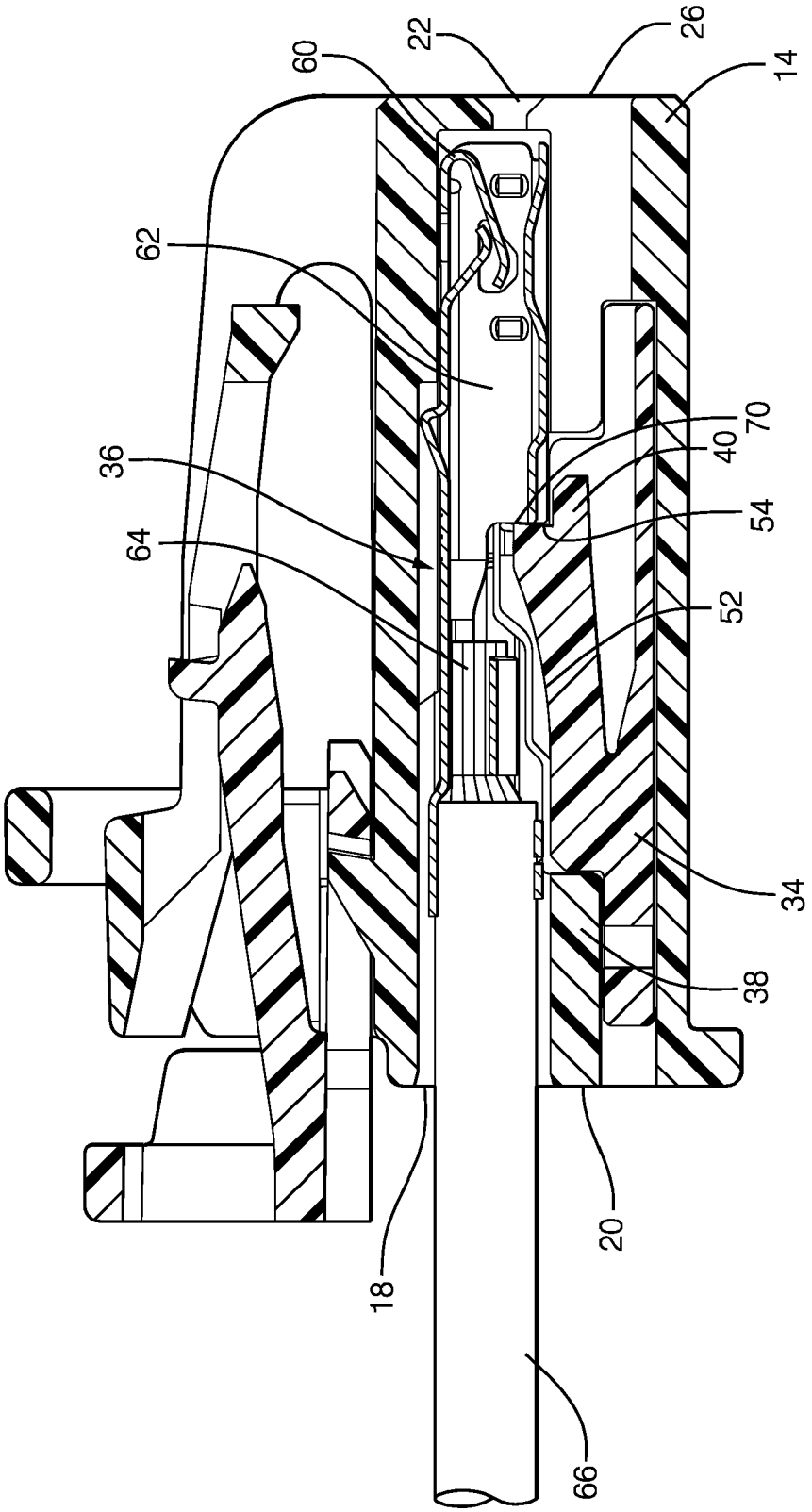

FIG. 5

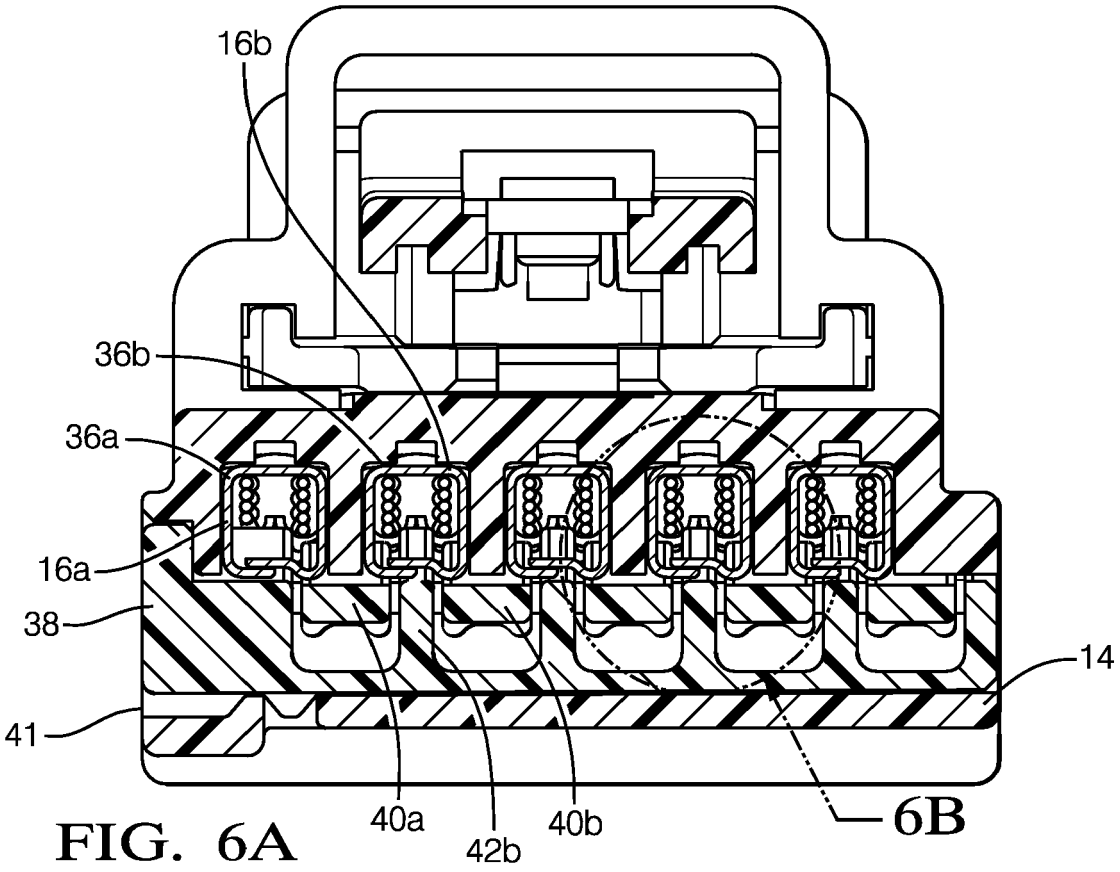
16b
36b
36a
16a
38
41
14
40a
42b
40b
6B

FIG. 6A

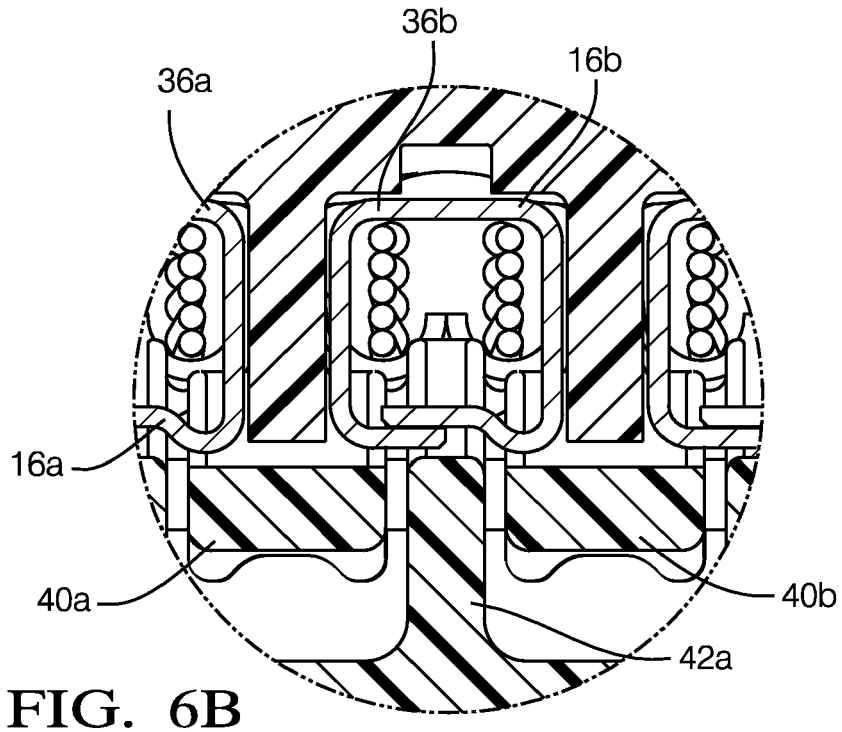
36b
36a
16b
16a
40a
40b
42a

FIG. 6B

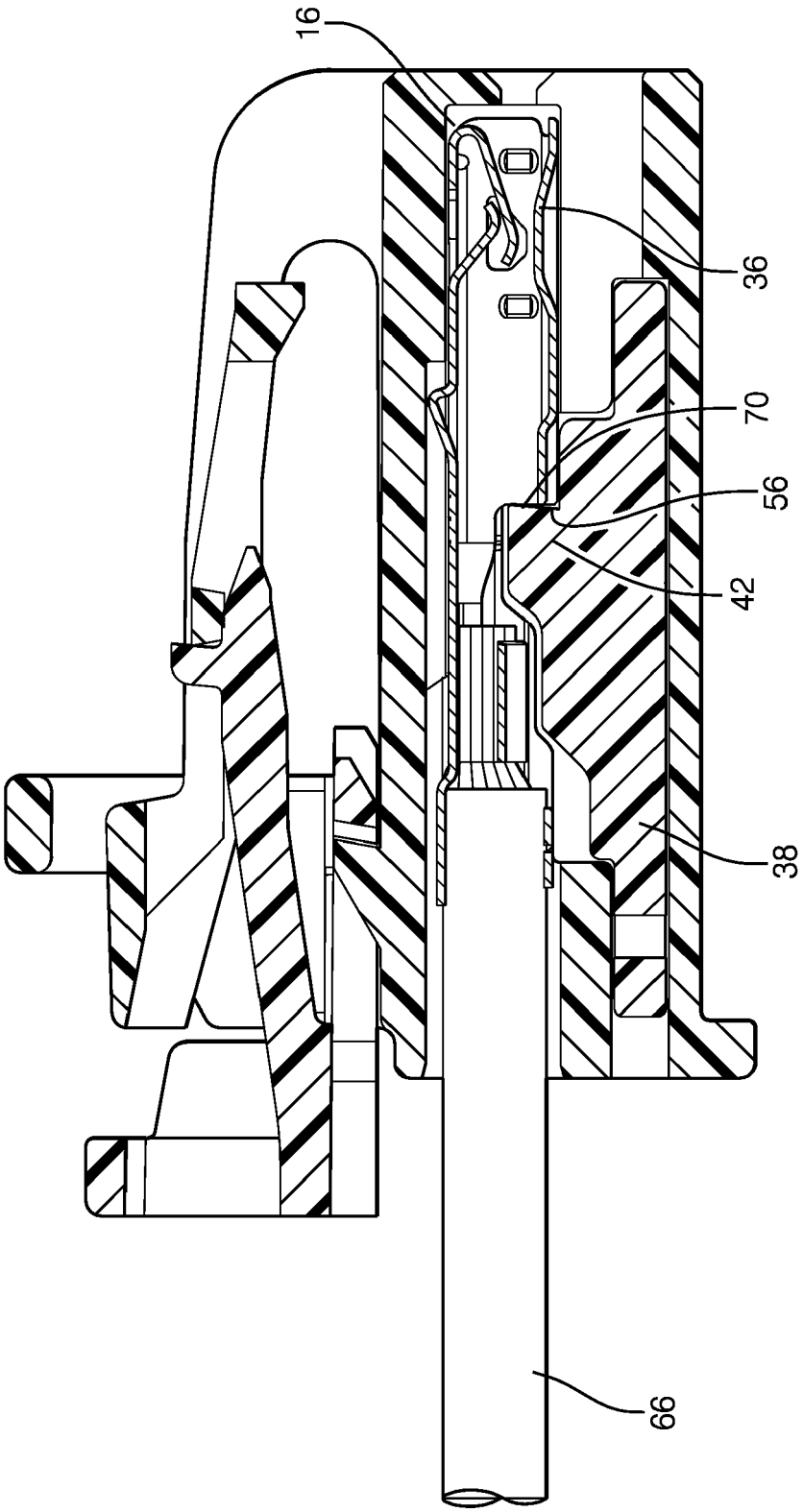

FIG. 7

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EUROPEAN SEARCH REPORT

Application Number
EP 16 19 9420

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 5 830 013 A (SAITO HITOSHI [JP] ET AL) 3 November 1998 (1998-11-03) * column 2, line 31 - line 37; figures 1, 5, 6a, 7a * -----	1-12	INV. H01R13/436 H01R13/424

TECHNICAL FIELDS SEARCHED (IPC)

H01R

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	20 January 2017	Alberti, Michele

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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EPO FORM 1503 03.82 (P04C01)

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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20-01-2017

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5830013 A	03-11-1998	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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