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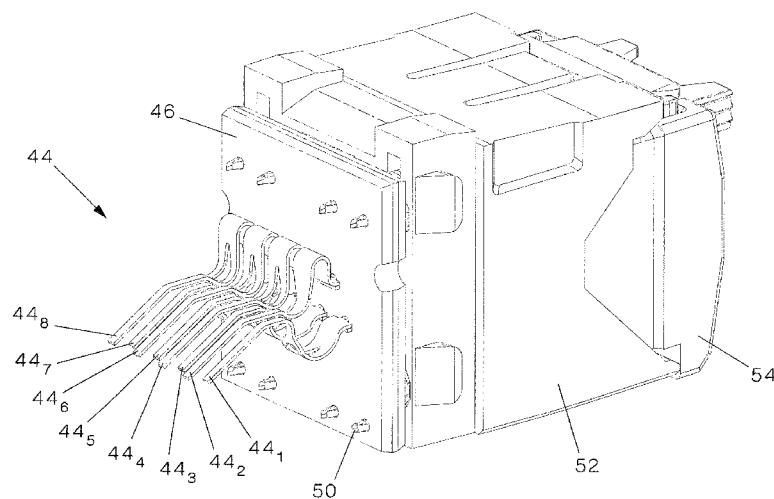


FIG. 4

(57) **Abstract:** The present invention generally relates to communication connectors and internal components thereof. In one embodiment, the present invention is a communication jack comprising back-rotated plug interface contacts having variable cross-sectional widths. In another embodiment, the present invention is a communication jack having back-rotated plug interface contacts where at least two of the plug interface contacts have a differing beam length. In yet another embodiment, the present invention is a communication jack having back-rotated plug interface contacts where at least two of the plug interface contacts have opposing bends in a deflection zone.

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COMMUNICATION CONNECTORS AND SYSTEMS**CROSS-REFERENCE TO RELATED APPLICATIONS**

[0001] This application claims the benefit of U.S. Provisional Patent Application No.: 61/771,600, filed on March 1, 2013, which is incorporated herein by reference in its entirety.

FIELD OF INVENTION

[0002] The present invention generally relates to the field of communication connectors, and more specifically to plug interface contact arrangements, and communication jacks which employ such plug interface contact arrangements.

BACKGROUND

[0003] Communication connectors, such as RJ45 jacks, have been and continue to be readily employed in the communication industry. These jacks generally comprise a housing having an aperture for receiving a corresponding plug at one end, a means for terminating a communication cable at another end, and a means for transferring electrical signals between the plug and the communication cable.

[0004] In an RJ45 jack, the means for transferring the electrical signals typically include eight plug interface contacts (PICs). While the eight PICs are designed to interface eight plug contacts positioned in an eight-position RJ45 plug, respectively, it is also possible to connect a six-position plug (e.g., RJ12, RJ25) or a four-position plug (e.g., RJ9) to an RJ45 jack. However, when compared to an eight-position plug, plug contacts 1 and 8 do not exist in a six-position plug, and plug contacts 1, 2, 7, and 8 do not exist in a four-position plug. Therefore, in the locations where the plug contacts are not present, the jack PICs must deflect approximately an additional 0.027 inches as compared to locations where the plug contacts do exist. This additional deflection can cause the outer PICs to plastically deform and cause damage (or otherwise prevent operation within certain specifications) to the jack if the deformation is significant enough. Additionally, in some instances

the positioning/arrangement of the PICs may have some effect on the amount of undesired crosstalk produced within the jack and/or how the undesired crosstalk is compensated for.

[0005] Thus there exists a need for communication jacks with improved designs.

SUMMARY

[0006] Accordingly, embodiments of the present invention are directed to communication connectors and/or internal components thereof.

[0007] In one embodiment, the present invention is a communication jack having back-rotated plug interface contacts where at least one plug interface contact has a non-uniform cross-sectional width.

[0008] In another embodiment, the present invention is a communication jack having back-rotated plug interface contacts where at least two of the plug interface contacts have a differing beam length.

[0009] In yet another embodiment, the present invention is a communication jack having back-rotated plug interface contacts where at least two of the plug interface contacts have opposing bends in a deflection zone.

[0010] In still yet another embodiment, the present invention is a communication connector comprising a housing with an aperture for receiving a plug, and a plurality of plug interface contacts (PICs) at least partially received in the aperture. The plurality of plug interface contacts include respective ends proximal the aperture and ends distal the aperture, the distal ends fixed within the connector, the proximal ends rotating relative to the distal ends, wherein at least some of the plurality of plug interface contacts have a non-uniform cross-sectional width. In a variation of this embodiment, the connector is included in a communication system.

[0011] In still yet another embodiment, the present invention is a communication connector comprising a housing with an aperture for receiving a plug and a plurality of plug interface contacts (PICs) at least partially received in the aperture. The plurality of plug interface contacts include respective ends proximal the aperture and respective ends distal the aperture, the distal ends fixed within the connector, the proximal ends rotating relative to the distal ends, the proximal ends

configured, when the connector being mated to the plug, such that some of the proximal ends are deflected more than other of the proximal ends.

[0012] In still yet another embodiment, the present invention is a communication connector comprising a housing with an aperture for receiving a plug and a plurality of plug interface contacts (PICs) at least partially received in the aperture. The plurality of plug interface contacts include respective ends proximal the aperture and respective ends distal the aperture, the distal ends fixed within the connector, the proximal ends rotating relative to the distal ends, the distal end being hemmed.

[0013] These and other features, aspects, and advantages of the present invention will become better-understood with reference to the following drawings, description, and any claims that may follow.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] Fig. 1 illustrates a communication system according to an embodiment of the present invention.

[0015] Fig. 2 illustrates a plug and jack combination according to an embodiment of the present invention.

[0016] Fig. 3 illustrates an exploded view of a communication jack according to an embodiment of the present invention.

[0017] Fig. 4 illustrates the jack of Fig. 3 with the front housing removed.

[0018] Fig. 5 illustrates a side view of the jack of Fig. 4.

[0019] Fig. 6 illustrates the PICs of the jack from Fig. 3.

[0020] Fig. 7A illustrates some of the PICs assembled to the printed circuit board of the jack of Fig. 3.

[0021] Fig. 7B illustrates a side view of the jack of Fig. 3 mated with a plug, with the front housing removed.

[0022] Fig. 8 illustrates the assembly of a PIC to the printed circuit board of the jack of Fig. 3.

[0023] Fig. 9 illustrates a rear isometric view of the front housing of the jack of Fig. 3.

[0024] Fig. 10 illustrates a front isometric partial section view of Fig. 2.

[0025] Fig. 11 illustrates a jack having a PIC arrangement/form according to another embodiment of the present invention.

[0026] Fig. 12 illustrates the PICs of the jack of Fig. 11.

[0027] Fig. 13 illustrates an exploded view of a communication jack according to yet another embodiment of the present invention.

[0028] Fig. 14 illustrates the jack of Fig. 13 with the front housing removed and the PICs exploded.

[0029] Fig. 15 illustrates the jack of Fig. 13 with the front housing removed.

[0030] Fig. 16 illustrates a side vide of Fig. 15.

DETAILED DESCRIPTION

[0031] An exemplary embodiment of the present invention is illustrated in Fig. 1, which shows a communication system 30, which includes a patch panel 32 with jacks 34 and corresponding RJ45 plugs 36. Respective cables 38 are terminated to plugs 36, and respective cables 40 are terminated to jacks 34. Once a plug 36 mates with a jack 34 data can flow in both directions through these connectors. Although the communication system 30 is illustrated in Fig. 1 as having a patch panel, alternative embodiments can include other active or passive equipment. Examples of passive equipment can be, but are not limited to, modular patch panels, punch-down patch panels, coupler patch panels, wall jacks, etc. Examples of active equipment can be, but are not limited to, Ethernet switches, routers, servers, physical layer management systems, and power-over-Ethernet equipment as can be found in data centers and or telecommunications rooms; security devices (cameras and other sensors, etc.) and door access equipment; and telephones, computers, fax machines, printers, and other peripherals as can be found in workstation areas. Communication system 30 can further include cabinets, racks, cable management and overhead routing systems, and other such equipment.

[0032] The jack and plug combination of Fig. 1 is also shown in Fig. 2 which illustrates the network jack 34 mated with the RJ45 plug 36. Note that in this figure, the orientation of the network jack 34 and the RJ45 plug 36 is rotated 180° about the central axis of cable 40 as compared to the orientation of Fig. 1.

[0033] Fig. 3 illustrates an exploded view of the network jack 34, which includes a front housing 42, plug interface contacts (PICs) 44, a printed circuit board (PCB) 46 (which in some embodiments may have crosstalk compensation components thereon), an insulation displacement contact (IDC) support 48, IDCs 50, a rear housing 52, and a wire cap 54. In the currently described embodiment, the PICs may be referred to as “back-rotated” which implies that the PICs are fixed at the (PCB) and generally flex about the location where each respective PIC connects to the PCB. Fig. 4 illustrates the assembled state of PICs 44 to PCB 46 of the network jack 34 with the front housing 42 removed for clarity. The subscript number for each PIC 44 corresponds to the RJ45 pin positions as defined by ANSI/TIA-568-C.2. A side view of Fig. 4 is depicted in Fig. 5, and PICs 44 are illustrated individually in Fig. 6.

[0034] As noted previously, when an RJ45 jack is mated with a six-position or a four-position plug, the outer PICs (PICs 44₁ and 44₈ for a six-position plug, and PICs 44₁, 44₂, 44₇, and 44₈ for a four-position plug) must be able to deflect an additional 0.027" over PICs 44₃, 44₄, 44₅, and 44₆, and have sufficient elasticity to return to an unloaded state once the six-position or the four-position plug is removed. This can help provide proper future functionality by ensuring that sufficient normal force exists to mate with all corresponding plug contact 56 of an RJ45 plug (see Fig. 10). In order to reduce at least some amount of plastic deformation of the PICs, it is beneficial to distribute the mechanical stresses over at least a significant portion of the deflection zone, which in the current embodiment spans between the plug contact zone 58 and the PCB 46 as shown in Figs. 6 and 7A. This may avoid localized stress peaks and may result in an increased material yield.

[0035] One way of achieving a desired distribution of mechanical stress is by varying the width of the PICs. An example of this is shown in PIC 44₄, which has a pocket 60₄ which serves to assist in distributing stresses by varying the cross-sectional width of PIC 44₄. The cross-section is varied by adding more material to PIC 44₄ as the distance is increased from the plug contact zone 58. This effectively causes the stiffness of PIC 44₄ to increase as distance is increased from the plug contact zone 58, resulting in a distribution of stresses over an increased portion of the deflection zone. Although PIC 44₄ is shown as an example, this varying cross-section is also applied to the remaining PICs 44₁, 44₂, 44₃, 44₅, 44₆, 44₇, and 44₈. However, PICs 44₂, 44₃, and 44₇ vary their cross-sectional width by adjusting respective outer faces 62, while PICs 44₁, 44₄, 44₅, 44₆, and 44₈ vary their cross-sectional width with an internal pocket 60.

[0036] PICs 44 vary their cross-sectional widths differently in order to control the relative amount of crosstalk as well as account for their full range of deflection. For example, PICs 44₁, 44₂, 44₇, and 44₈ deflect more than PICs 44₃, 44₄, 44₅, and 44₆ if a four position plug is inserted. Such a difference in deflection may cause the distance between PICs 44₂ and 44₃, and 44₆ and 44₇ to become sufficiently small to cause a risk of an electrical short or a hipot failure. To reduce the potential of these risks, the cross sectional width of the PICs can be varied such that sufficient distance remains between adjacent PICs even in the event of varying levels of deflection. For example, referring to Fig. 6, one will notice that the outer face 62₂ of PIC 44₂ and the outer face 62₃ of PIC 44₃ are tapered towards the contact zone 58. Such tapering may increase the minimum distance between the respective PICs when these PICs are deflected differently.

[0037] In addition to a varying cross-sectional width, the PICs 44 employ different bend profiles. This can be seen in the side view of Fig. 5. PICs 44₁ and 44₇ have a first bend profile, PICs 44₃ and 44₅ have a second bend profile, and PICs 44₂, 44₄, 44₆, and 44₈ have a third bend profile. Because PICs 44₁ and 44₇ may deflect more than PICs 44₃ and 44₅ in the event of mating with a four-position

plug, PICs 44₁ and 44₇ have a longer deflection zone (than PICs 44₃ and 44₅) which may allow them to sustain additional deflection without plastic deformation.

[0038] In addition to having mechanical resiliency, in certain cases it may be important to focus on the electrical performance of the PIC arrangement. For example, compensating for the crosstalk that occurs between differential signal pairs 4:5 and 3:6 is typically more difficult to achieve because the plug pair combination 4:5-3:6 is required by the ANSI/TIA-568-C.2 standard to have the largest magnitude of crosstalk out of all pair combinations in the plug. The reason for this is that pair 4:5 runs between split pair 3:6 for a distance that starts in the RJ45 plug 36 and ends at the first compensation zone in the jack 34. Therefore, the ensuing discussion focuses on the ability of PICs 44 to assist in obtaining the desired electrical performance, particularly for signal pairs 4:5 and 3:6.

[0039] The capacitive and inductive coupling that occurs between signal line 3 and signal line 4 in the RJ45 plug 36 adds crosstalk between differential pair combinations 4:5 and 3:6. Similarly, the capacitive and inductive coupling that occurs between signal line 5 and signal line 6 also adds crosstalk between differential pair combinations 4:5 and 3:6. It is possible to reduce the negative effects of crosstalk via several ways. First, it is advantageous to reduce the initial amount of capacitive and inductive crosstalk coupling occurring between the 3:4 and 5:6 signal lines. This can be achieved by having PICs 44₃ and 44₅ bend down (relative to orientation shown in Fig. 7A) and having PICs 44₄ and 44₆ bend up between the plug contact zone 58 and the PCB 46. Because PIC 44₃ bends down and PIC 44₄ bends up, distance 57 (see Fig. 5) between the two PICs is increased, resulting in a decreased amount of crosstalk coupling. An equivalent relationship exists between PICs 44₅ and 44₆.

[0040] Another example of reducing the initial amount of crosstalk is illustrated in Fig. 7B where the network jack 34 (with front housing removed), is shown with PICs 44 having respective proximal ends 47 and distal ends 43. When a plug 36 is mated to the jack 34, some proximal ends 47 (e.g., corresponding to PICs 44₁, 44₃, 44₅, and 44₇) deflect more than other proximal ends 47 (e.g.,

corresponding to PICs 44₂, 44₄, 44₆, and 44₈). Consequently electrical coupling between adjacent PICs 44 can be reduced in the vicinity of proximal ends 47.

[0041] Second, it is advantageous to provide a compensation signal. To compensate for the offending crosstalk between the 3:4 and 5:6 pairs, compensative capacitive coupling is required between signal lines 3 and 5, and signal lines 4 and 6, respectively. The closer the compensative capacitive coupling is to the offending crosstalk (e.g., the RJ45 plug contacts 56) the more effective the compensation and therefore better performance may be attainable. At least some of the desired compensative capacitive coupling can be achieved by placing PICs 44₄ and 44₅ within a near proximity of PICs 44₆ and 44₃, respectively. The increase in the cross-sectional width in the deflection zone allows the outer face 62₄ of PIC 44₄ to be closer to outer face 62₆ of PIC 44₆ (shown crosshatched) than if PICs 44 were of uniform width. This relative closeness results in increased compensative capacitive coupling between signal lines 4 and 6. Similarly the increased width of PICs 44₃ and 44₅ results in increased compensative capacitive coupling between signal lines 3 and 5.

[0042] While additional compensation may be required to further reduce the offending crosstalk between signal lines 3:4 and 5:6 (this additional compensation can occur on PCB 46), the compensation provided by PICs 44 lessens the amount of compensation that may be needed on the PCB 46. It also brings the effective compensation region closer to plug contacts 56, which may result in higher electrical performance potential.

[0043] Referring to Fig. 8, a compliant pin 64 is used on PIC 44₁ to provide a mechanical retention as well as an electrical bond between the PIC 44₁ and the PCB 46. Compliant pin 64 has an “eye of the needle” shape, having an elongated oval slit, and is hemmed back upon itself to effectively double the material thickness as shown in the detail view of Fig. 8. PIC 44₁ is fabricated from a sufficiently thin material to obtain the necessary deflection while not incurring plastic deformation. Hemming the compliant pin 64 may increase the strength of the hemmed region and provides a more

robust interface to PCB 46. Although Fig. 8 illustrates only PIC 44₁, the same compliant pin 64 may be used on any of the remaining PICs.

[0044] Besides ensuring proper vertical movement and resiliency of the PICs 44, it may also be advantageous to at least partially restrain their lateral movement. Fig. 9 illustrates a rear isometric view of the front housing 42. Front combs 66 are integrated into the front housing 42 to control the relative spacing among PICs 44 and prevent PICs 44 from crossing, electrically shorting, and/or getting sufficiently close to one another where a hipot failure can occur. Front combs 66 are large enough to ensure that PICs 44 are combed during the entire state of deflection, including solid plug insertion if a four or six position plug is inserted. Fig. 10 illustrates the deflection of the PICs 44 during normal operation via a front isometric partial section view of Fig. 2. In this figure, an exemplary RJ45 plug housing 68 is shown in dashed lines for clarity. When an RJ45 plug 36 is inserted into the network jack 34, plug contacts 56 interface with PICs 44 as shown. PICs 44 deflect downward within front combs 66 and create pressure at the interface between respective plug contacts 56 and PICs 44, resulting in an electrical bond sufficient for data to flow.

[0045] A variation of the currently described embodiment of the network jack 34 and its PICs is shown in Figs. 11 and 12. Fig. 11 illustrates the alternate PICs 70 assembled to PCB 46, and Fig. 12 illustrates the alternate PICs 70 individually. As seen in these figures, PICs 70 do not contain pockets 60. Instead, at least in some cases, the cross-sectional width is varied by adjusting the overall width of the respective PICs as measured from one side to the other. The omission of pockets may simplify the manufacture of PICs 70 while still providing a similar effect of distributing bending stresses over the deflection zone and reducing plastic deformation.

[0046] Another embodiment of a jack having PICs in accordance with an embodiment of the present invention is shown in Fig. 13. This figure shows an exploded view of a jack 134, which includes a front housing 142, back-rotated PICs 144, a PCB 146 (which in some embodiments may have

crosstalk compensation components thereon), an IDC support 148, IDCs 150, a rear housing 152, and a wire cap 154.

[0047] As shown more clearly in the perspective views illustrated in Figs. 14 and 15, and the side profile view illustrated in Fig. 16, the PICs 144 are comprised of four different types of PICs 160, 162, 162, and 164. These PICs 144 are attached to a PCB 146 via a top and bottom row. The top row includes PICs 162 and 166, and the bottom row includes PICs 160 and 164.

[0048] As shown in Fig. 16, PICs 160 and 162 include downward-facing concave loops 170 and 172, respectively, positioned near the point of attachment to the PCB (which is also the pivot point for the PICs when said PICs are deflected during mating). These loops 170 and 172 may increase the mechanical performance of the jack 134. In particular, when the jack 134 is mated with an eight-position plug, PICs 160 interface plug contacts 2 and 8, PICs 162 interface plug contacts 1 and 7, PICs 164 interface with plug contacts 4 and 6, and PICs 166 interface plug contacts 3 and 5. However, when the jack 134 is mated with a four-position plug, PICs 160 and 162 make contact with the plug body and are subject to a higher degree of deformation than PICs 164 and 166 which mate with plug contacts 1, 2, 3 and 4. Loops 170 and 172 provide PICs 160 and 162 with an increased beam length, which helps accommodate the additional displacement and also helps provide the necessary normal force to potentially prevent at least some plastic deformation. Similar benefits can be realized during the insertion of a six-position plug which causes the outer-most PICs to undergo the greatest degree of deflection.

[0049] Since PICs 164 and 166 are not expected to withstand the same degree deflection as PICs 160 and 162, their beam length can be shorter than the beam length of PICs 160 and 162. The shorter beam length may simplify the manufacturing process and may also improve the electrical performance of the jack 134 as it may help bring any crosstalk compensation components which may be present on the PCB 146 closer to the origin of any offending crosstalk.

[0050] Note that while this invention has been described in terms of several embodiments, these embodiments are non-limiting (regardless of whether they have been labeled as exemplary or not), and there are alterations, permutations, and equivalents, which fall within the scope of this invention. Furthermore, the described embodiments should not be interpreted as mutually exclusive, and should instead be understood as potentially combinable if such combinations are permissive. It should also be noted that there are many alternative ways of implementing the methods and apparatuses of the present invention. It is therefore intended that claims that may follow be interpreted as including all such alterations, permutations, and equivalents as fall within the true spirit and scope of the present invention.

We claim:

1. A communication connector comprising:
 - a housing with an aperture for receiving a plug; and
 - a plurality of plug interface contacts (PICs) at least partially received in said aperture, said plurality of plug interface contacts including respective ends proximal said aperture, said plurality of plug interface contacts having respective ends distal said aperture, said distal ends fixed within said connector, said proximal ends rotating relative to said distal ends, wherein at least some of said plurality of plug interface contacts have a non-uniform cross-sectional width.
2. The communication connector of claim 1, wherein at least some of said plurality of plug interface contacts have variation in cross-section while maintaining uniform coupling between predetermined PICs.
3. The communication connector of claim 1, wherein at least some of said plurality of plug interface contacts have a wider distal end than said proximal end.
4. The communication connector of claim 3, wherein at least some of the plurality of plug interface contacts with said wider distal end include a cutout in said wider distal end.
5. The communication connector of claim 3, wherein at least some of the plurality of plug interface contacts include extra length in said wider distal end.
6. The communication connector of claim 5, wherein said wider distal end distributes mechanical stresses over said extra length.

7. The communication connector of claim 1, wherein at least some of the plurality of plug interface contacts include extra length with beneficial coupling between predetermined PICs.

8. A communication system comprising:
communication equipment; and
a communication connector connected to said communication equipment, said communication connector including a housing with an aperture for receiving a plug, a plurality of plug interface contacts (PICs) at least partially received in said aperture, said plurality of plug interface contacts including respective ends proximal said aperture, said plurality of plug interface contacts having respective ends distal said aperture, said distal ends fixed within said connector, said proximal ends rotating relative to said distal ends, wherein at least some of said plurality of plug interface contacts have a non-uniform cross-sectional width.

9. The communication system of claim 8, wherein at least some of said plurality of plug interface contacts have variation in cross-section while maintaining uniform coupling between predetermined PICs.

10. The communication system of claim 8, wherein at least some of said plurality of plug interface contacts have a wider distal end than said proximal end.

11. The communication system of claim 10, wherein at least some of the plurality of plug interface contacts with said wider distal end include a cutout in said wider distal end.

12. The communication system of claim 10, wherein at least some of the plurality of plug interface contacts include extra length in said wider distal end.

13. The communication system of claim 12, wherein said wider distal end distributes mechanical stresses over said extra length.

14. The communication system of claim 8, wherein at least some of the plurality of plug interface contacts include extra length with beneficial coupling between predetermined PICs.

15. A communication connector comprising:

a housing with an aperture for receiving a plug; and

a plurality of plug interface contacts (PICs) at least partially received in said aperture, said plurality of plug interface contacts including respective ends proximal said aperture, said plurality of plug interface contacts having respective ends distal said aperture, said distal ends fixed within said connector, said proximal ends rotating relative to said distal ends, said proximal ends configured, when said connector being mated to said plug, such that some of said proximal ends are deflected more than other of said proximal ends.

16. A communication connector comprising:

a housing with an aperture for receiving a plug; and

a plurality of plug interface contacts (PICs) at least partially received in said aperture, said plurality of plug interface contacts including respective ends proximal said aperture, said plurality of plug interface contacts having respective ends distal said aperture, said distal ends fixed within said connector, said proximal ends rotating relative to said distal ends, said distal end being hemmed.

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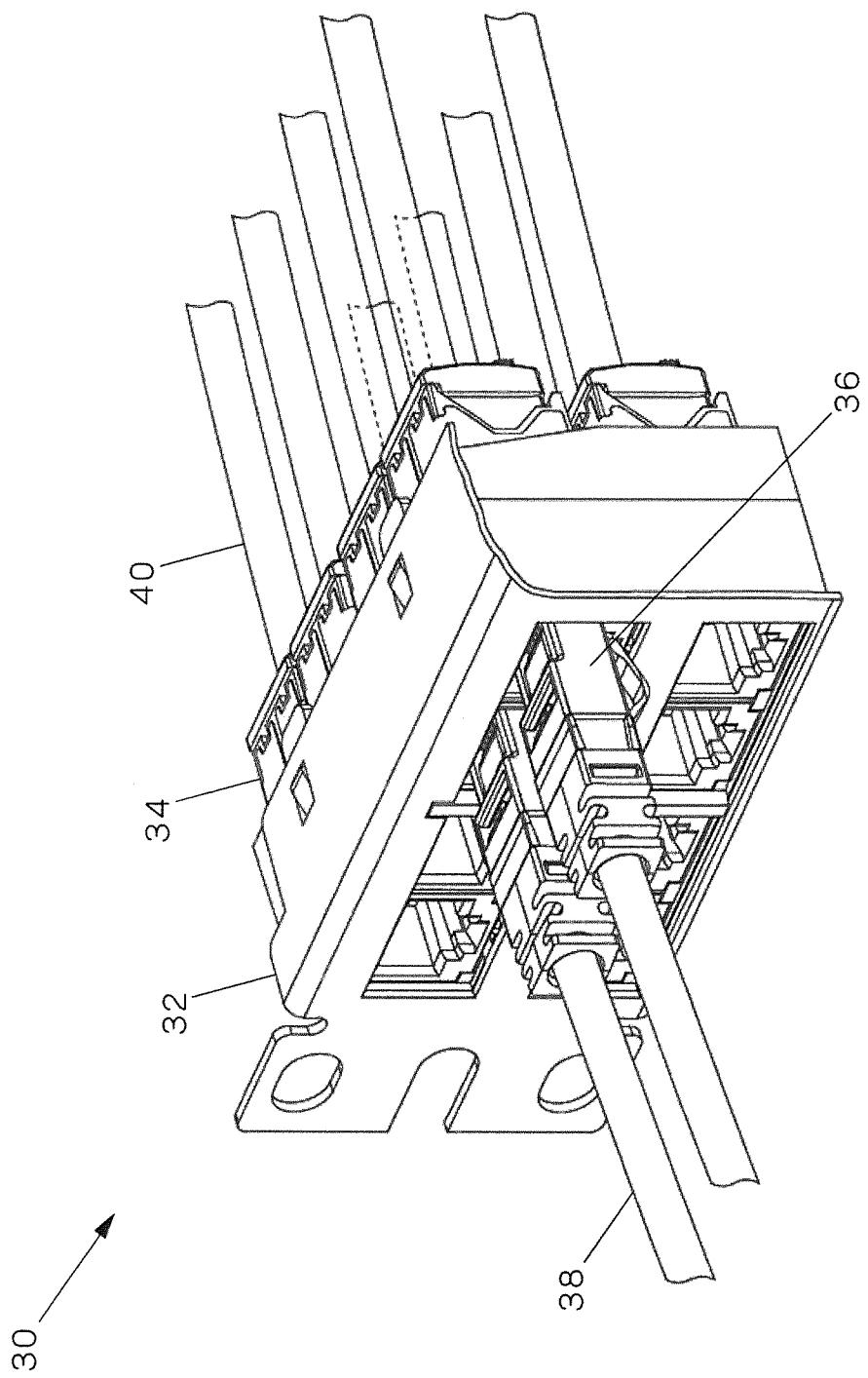


FIG. 1

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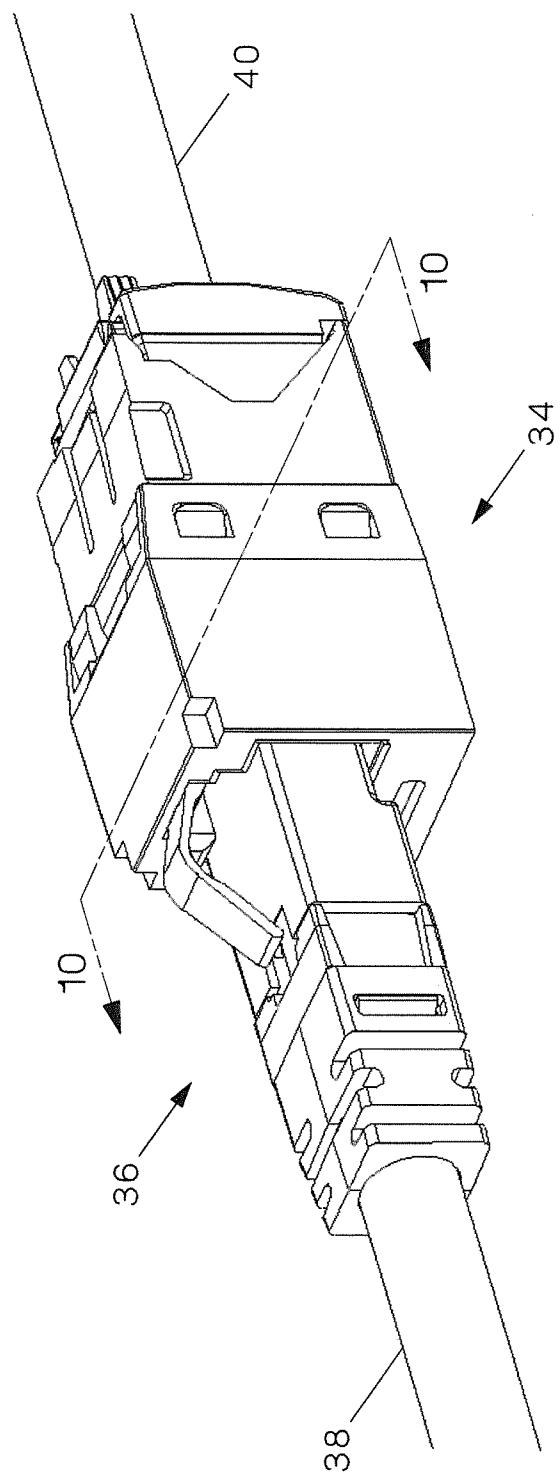


FIG.2

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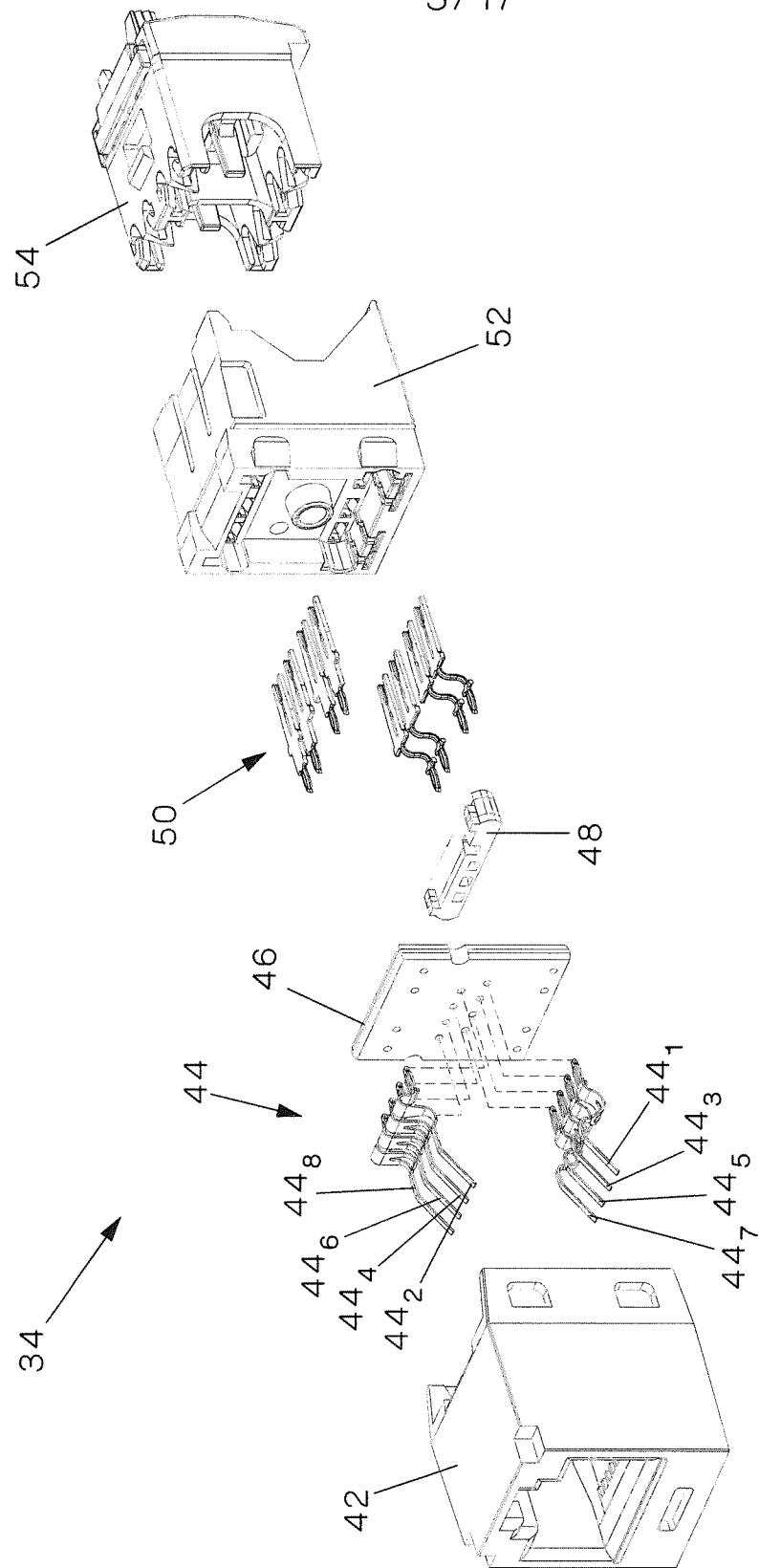


FIG. 3

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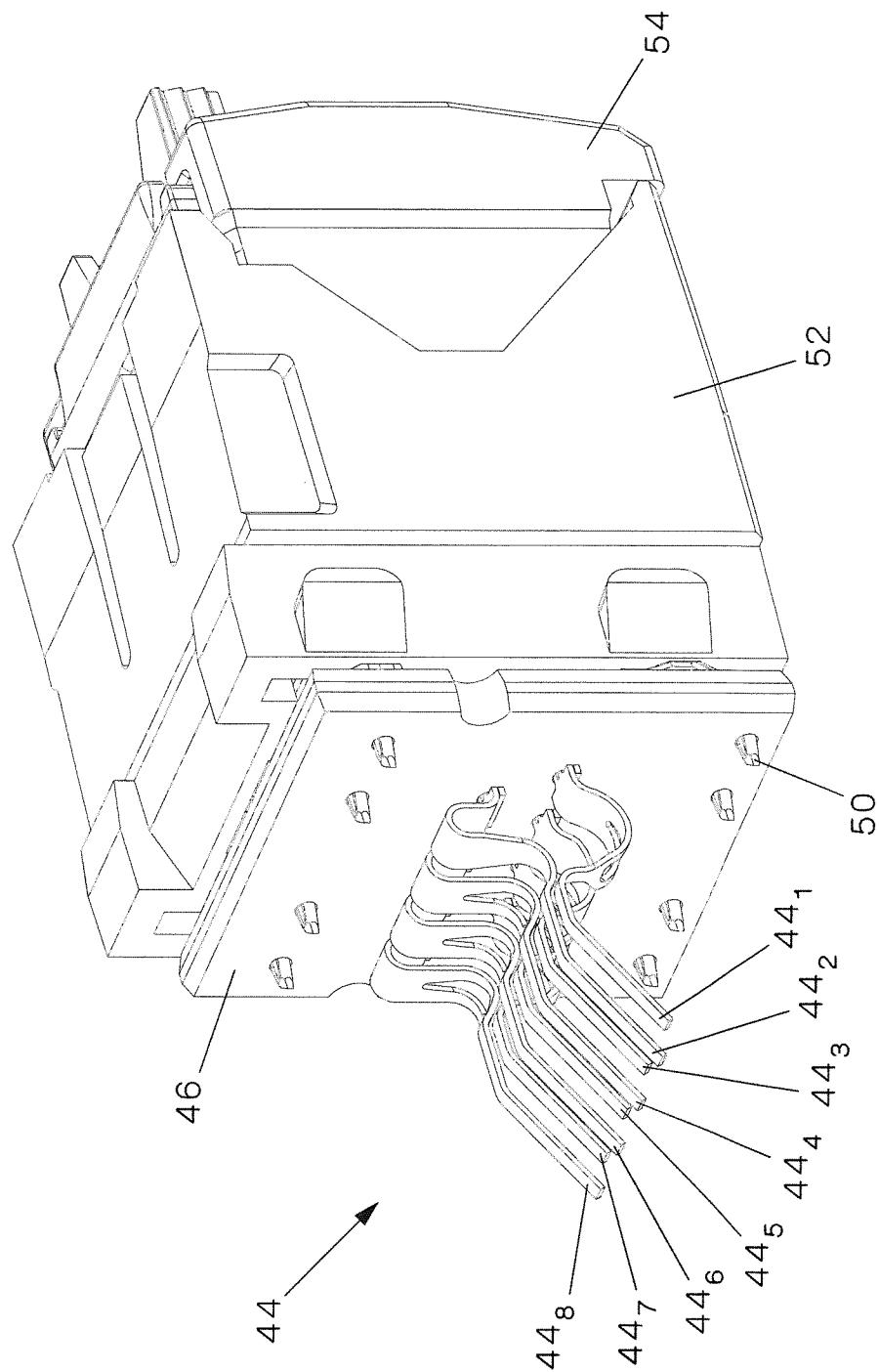


FIG. 4

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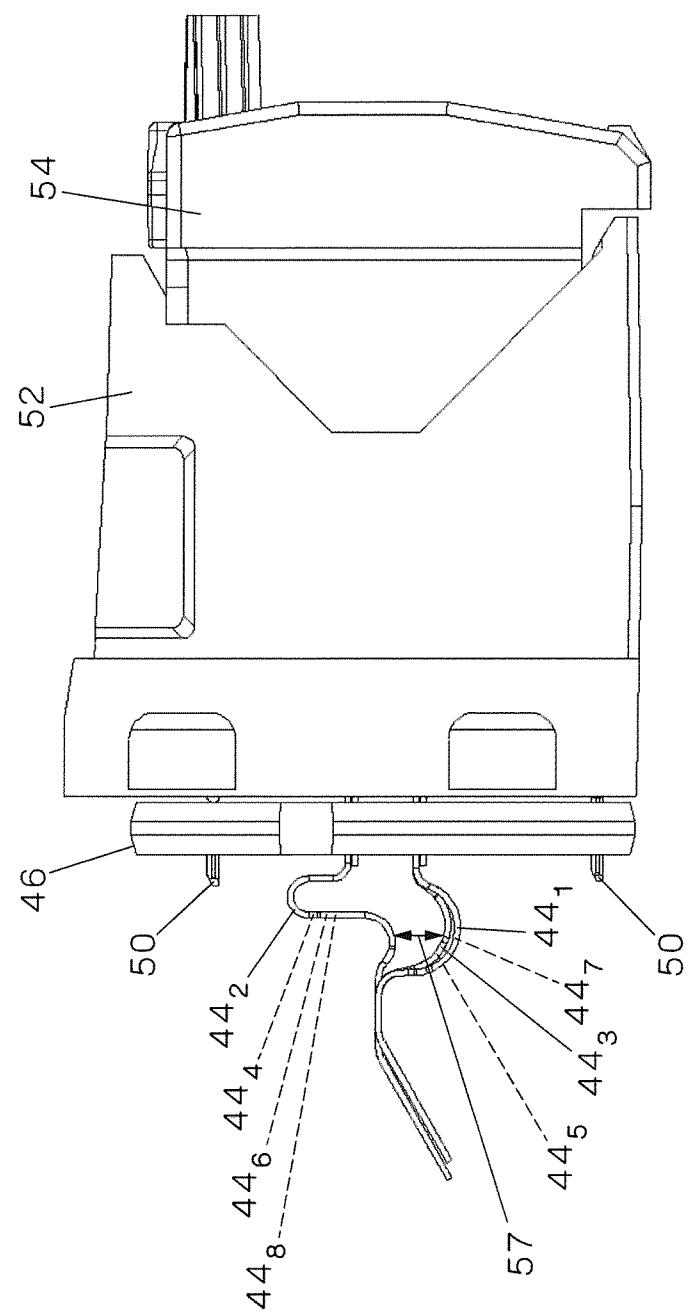


FIG. 5

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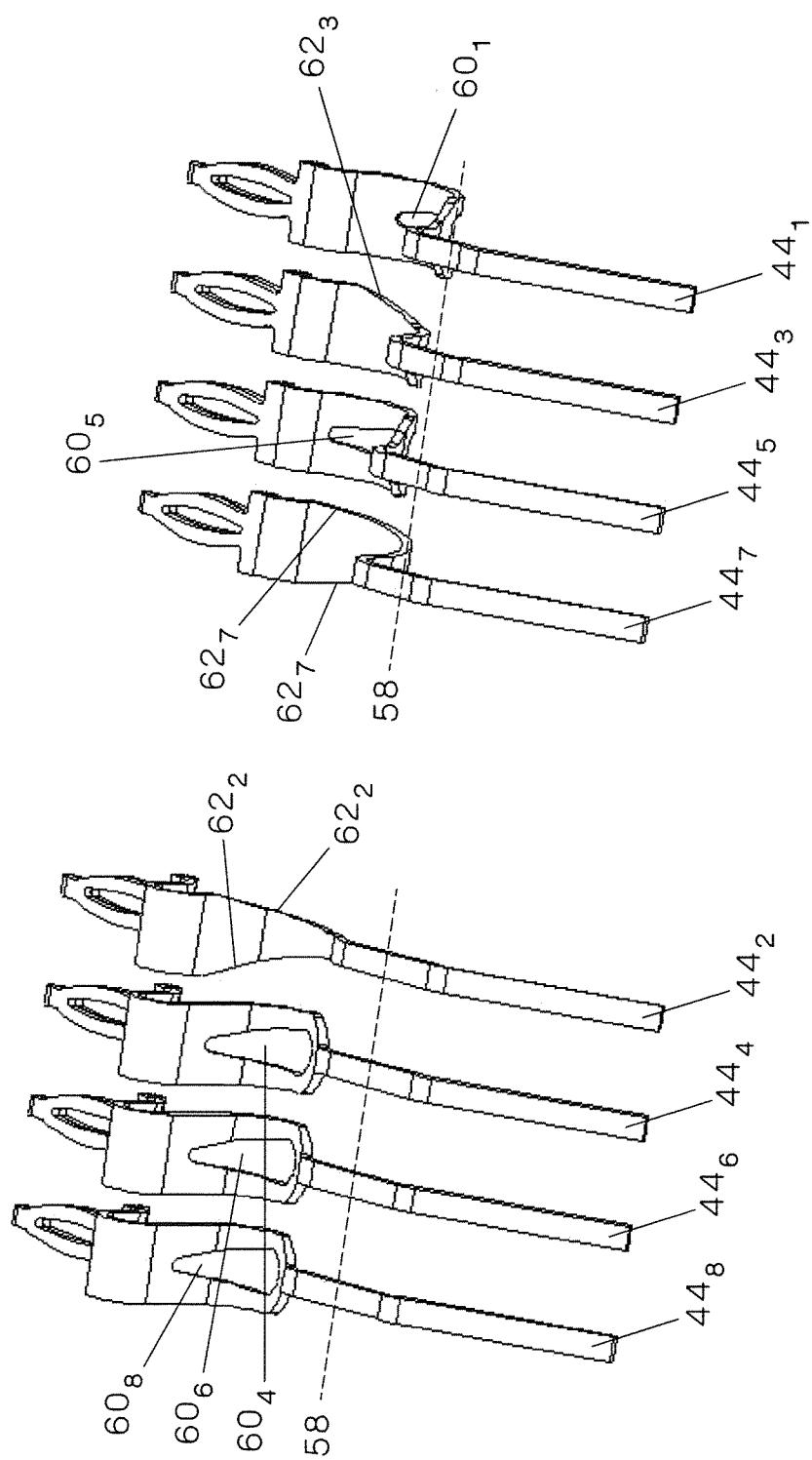


FIG. 6

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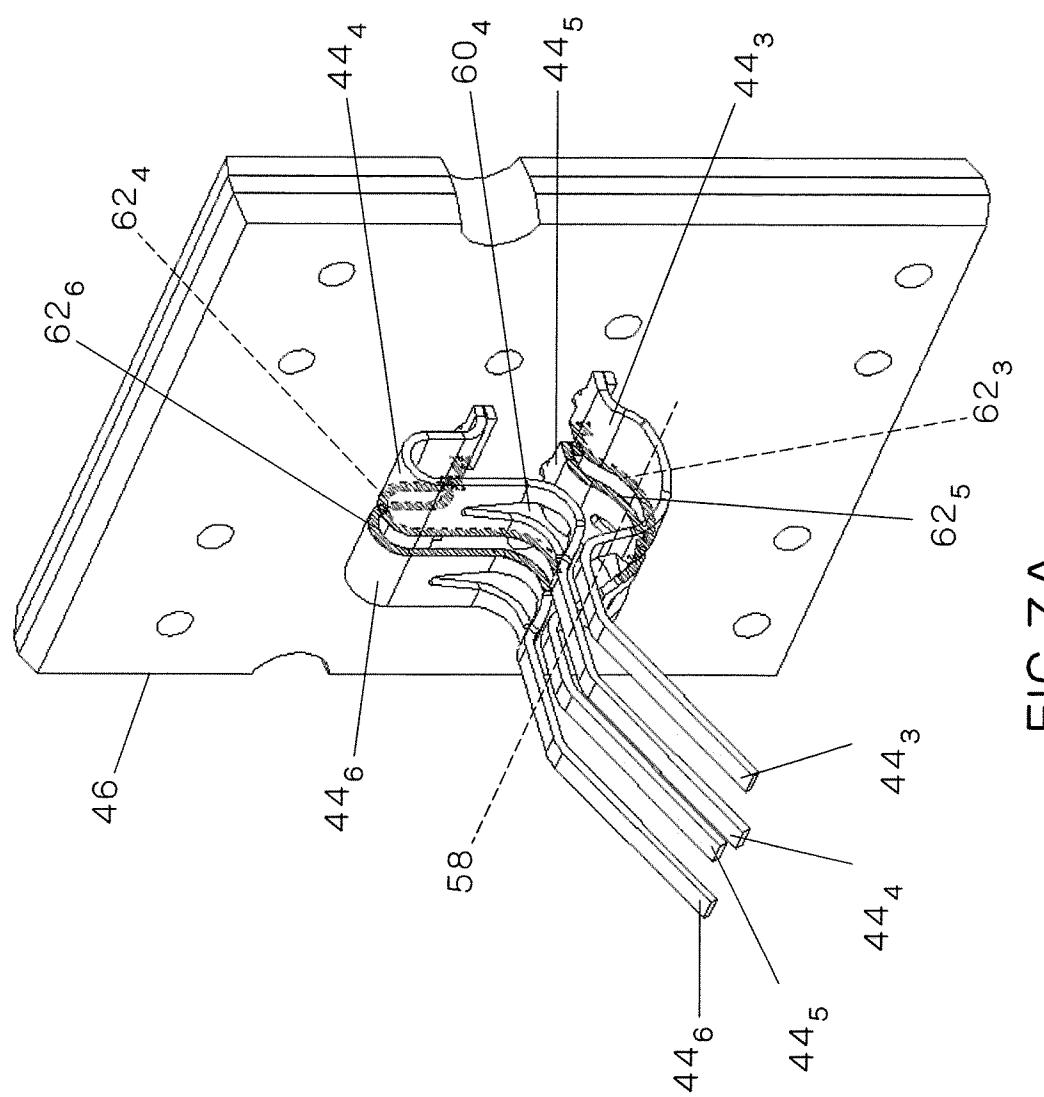


FIG. 7A

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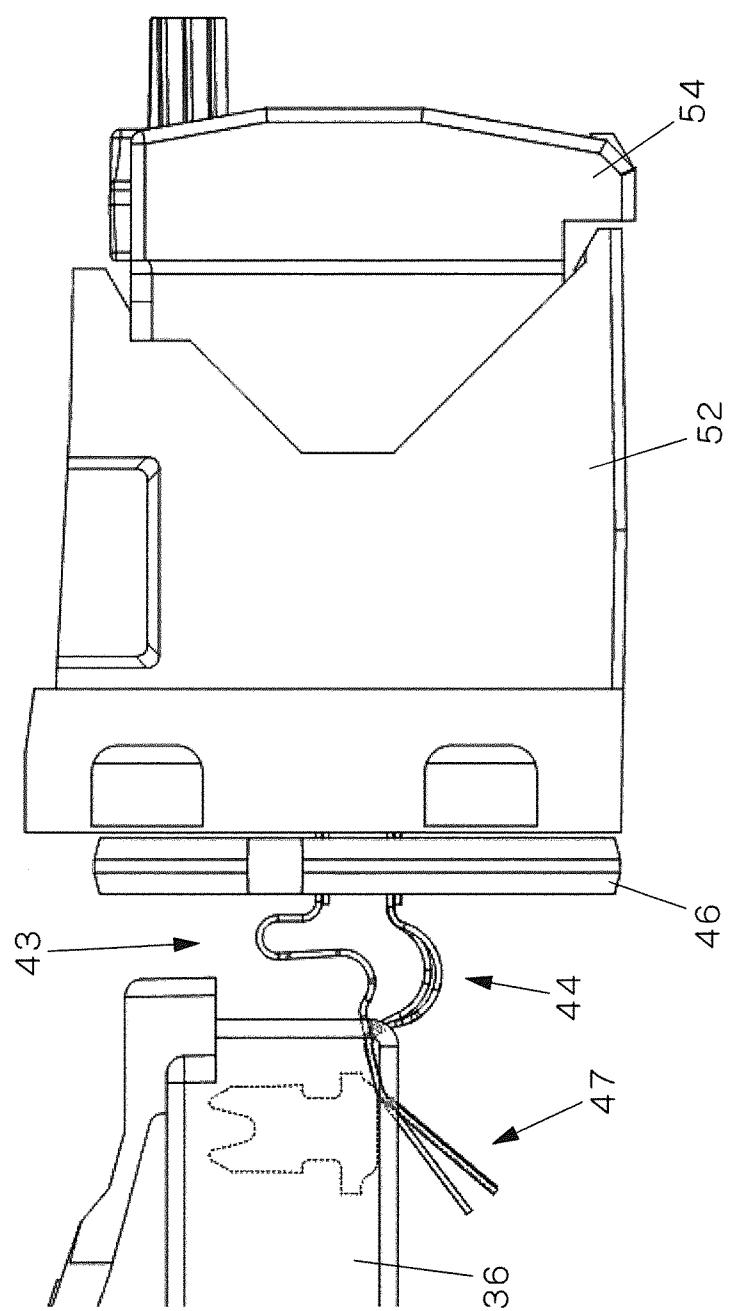


FIG. 7B

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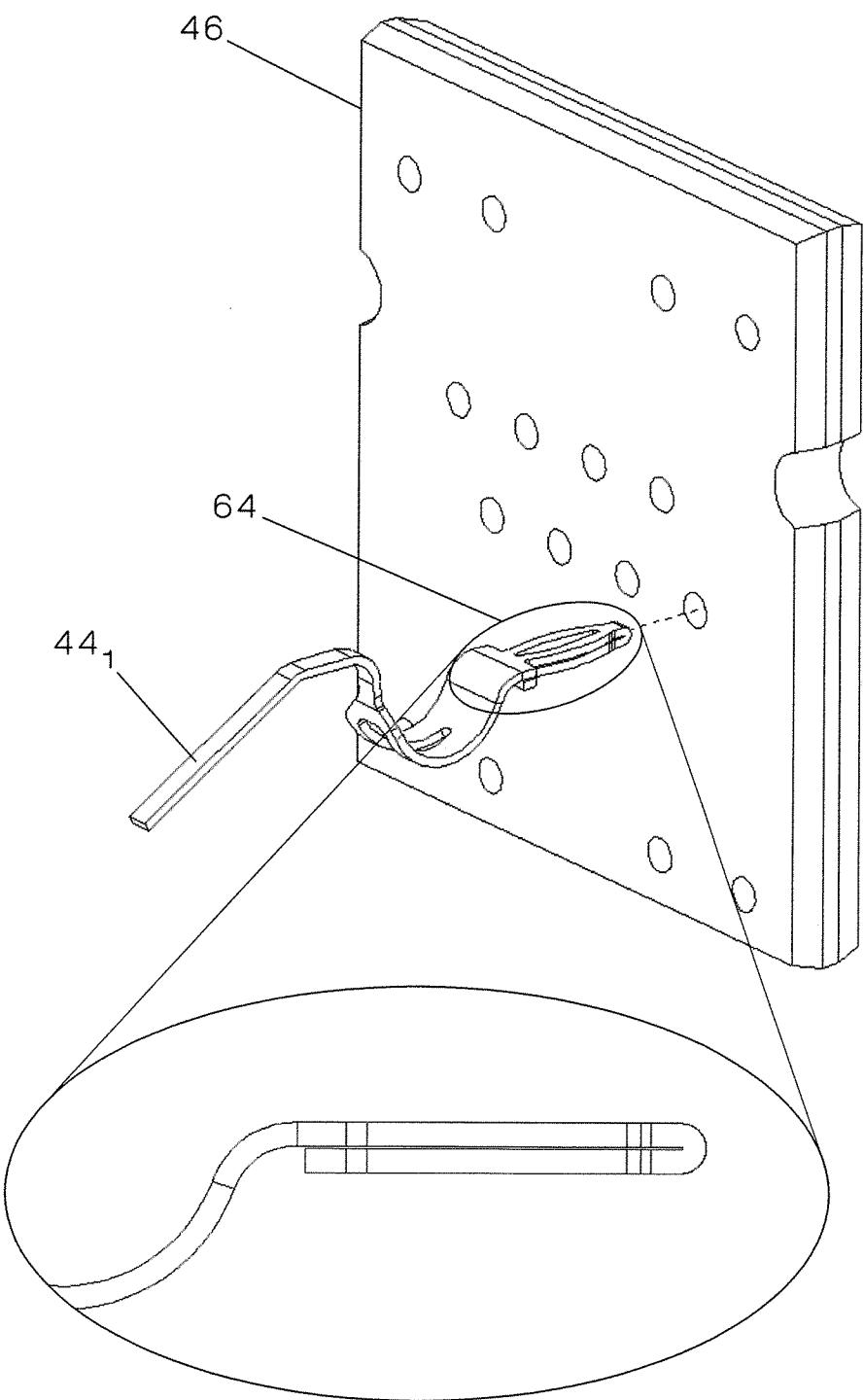


FIG.8

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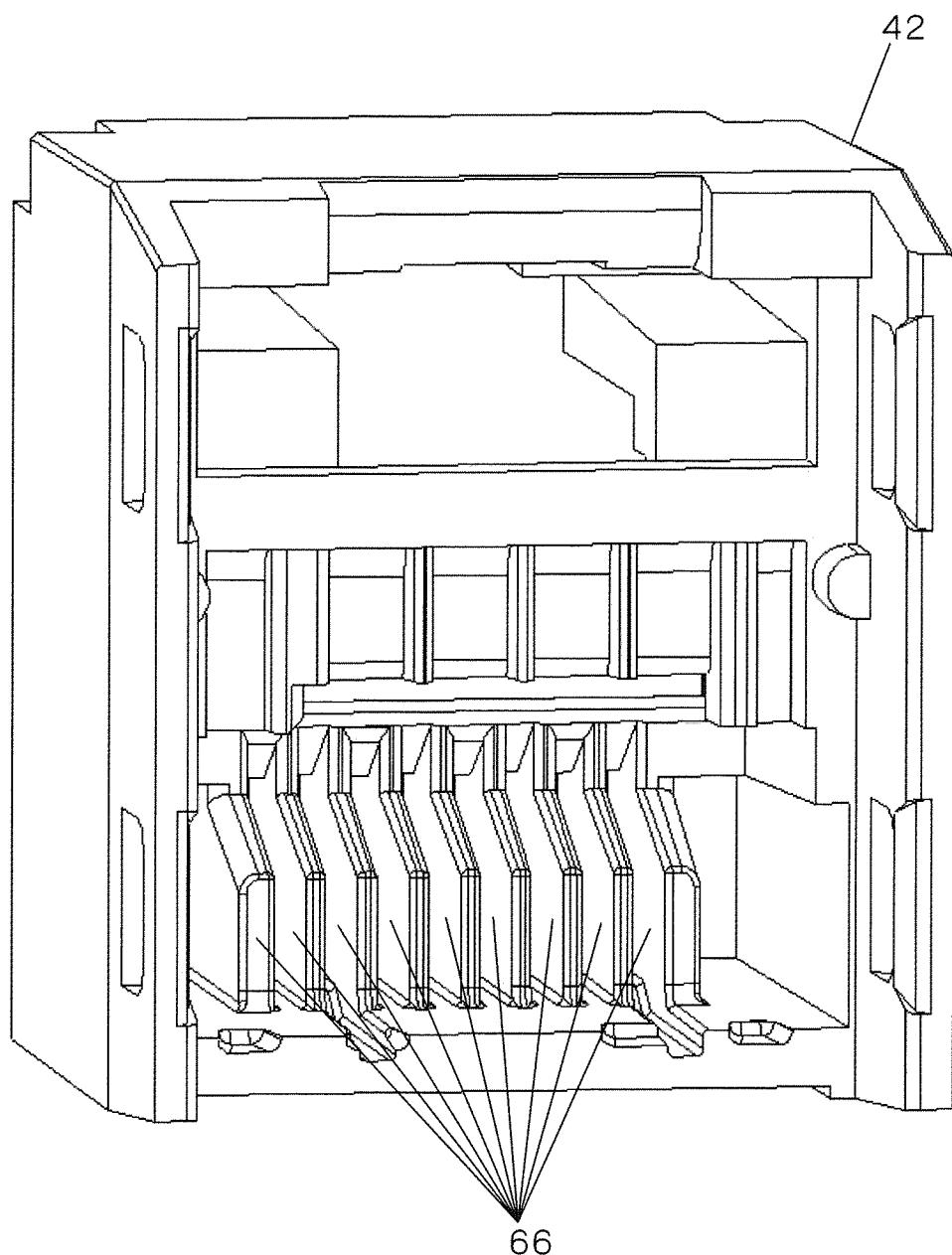


FIG.9

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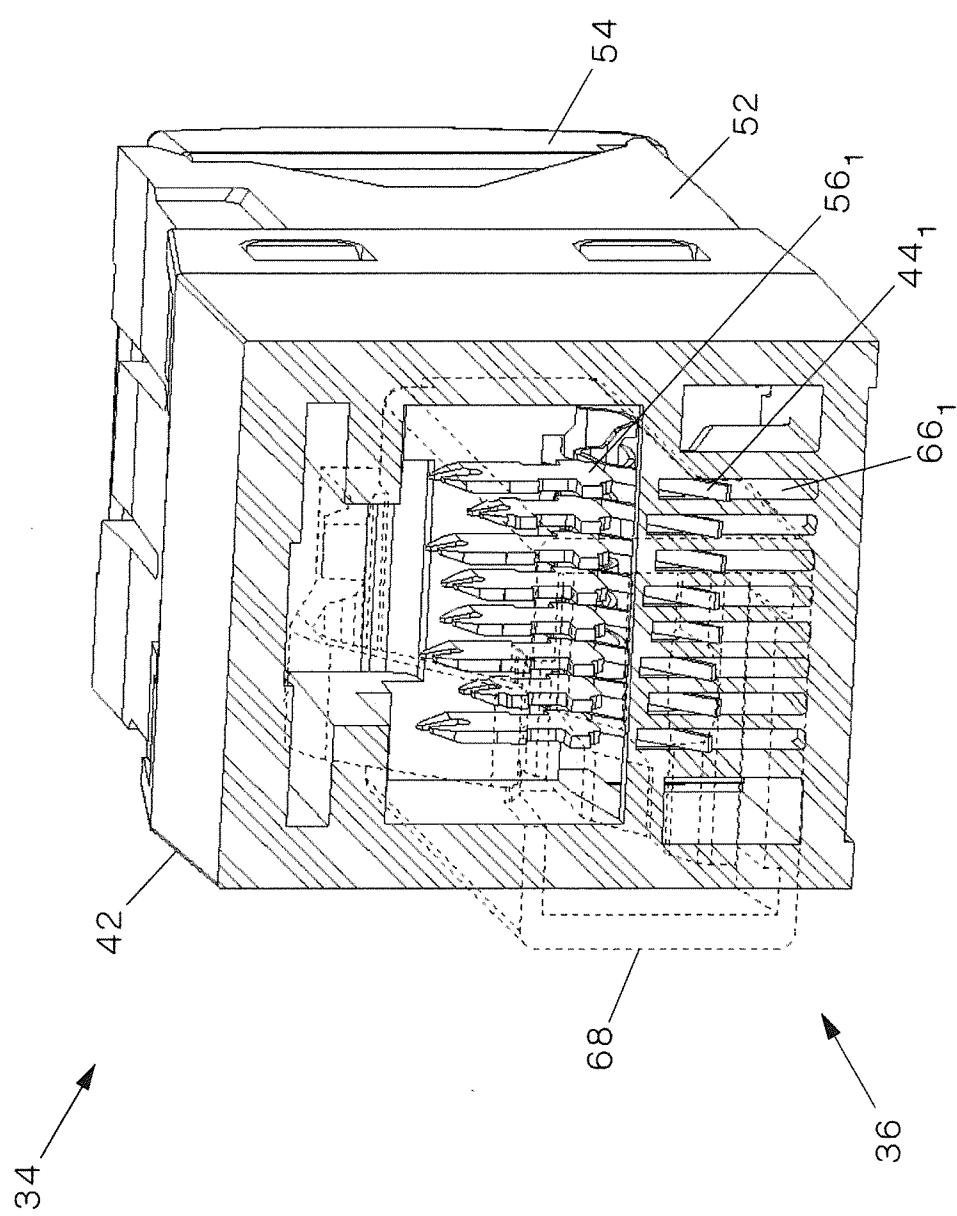


FIG. 10

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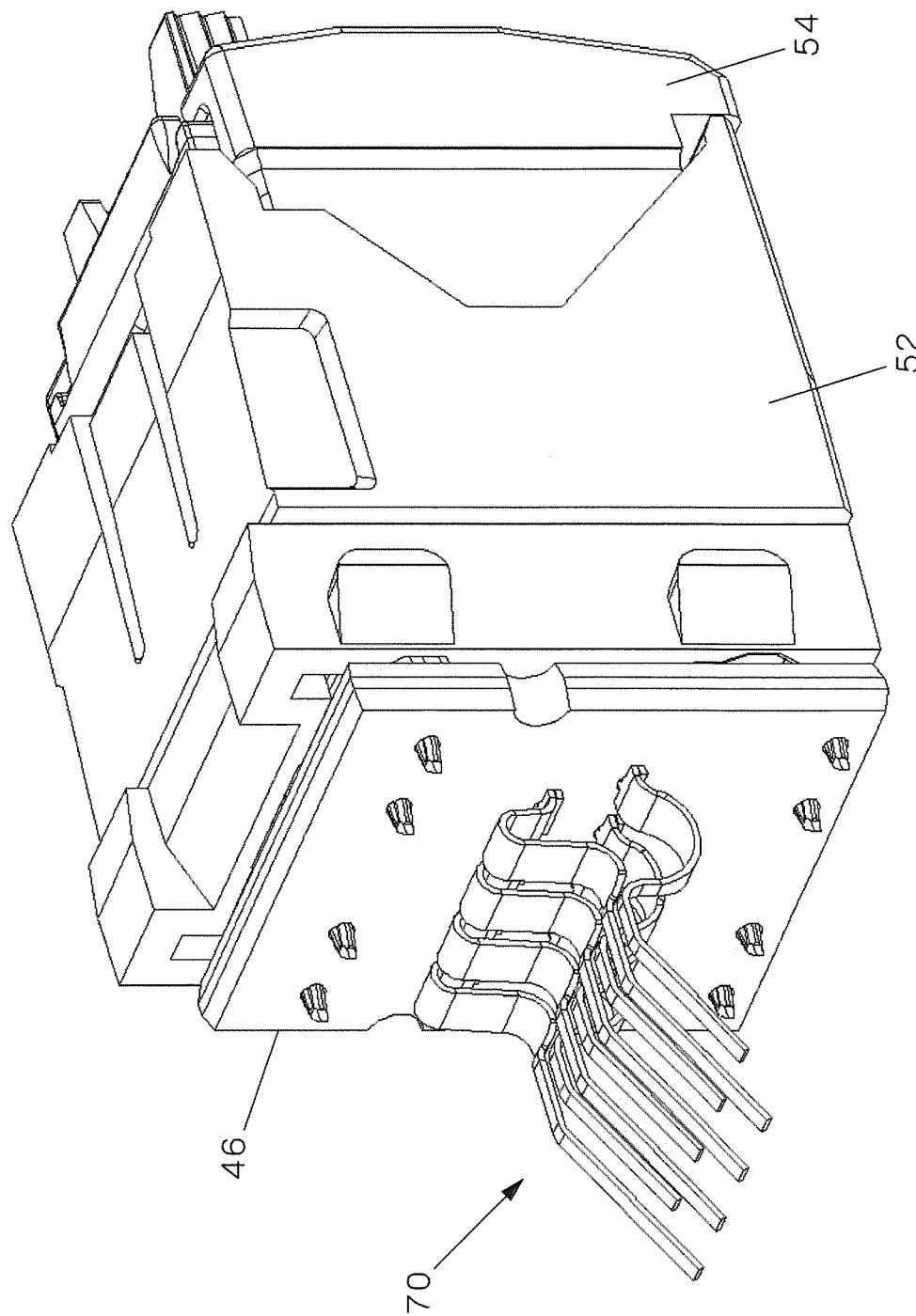


FIG.11

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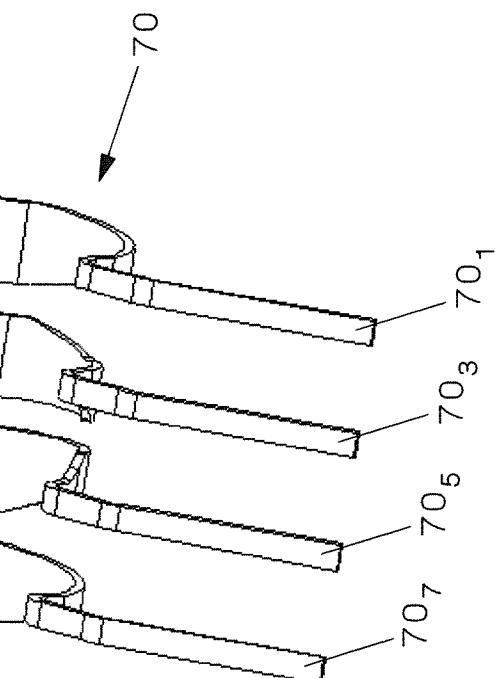
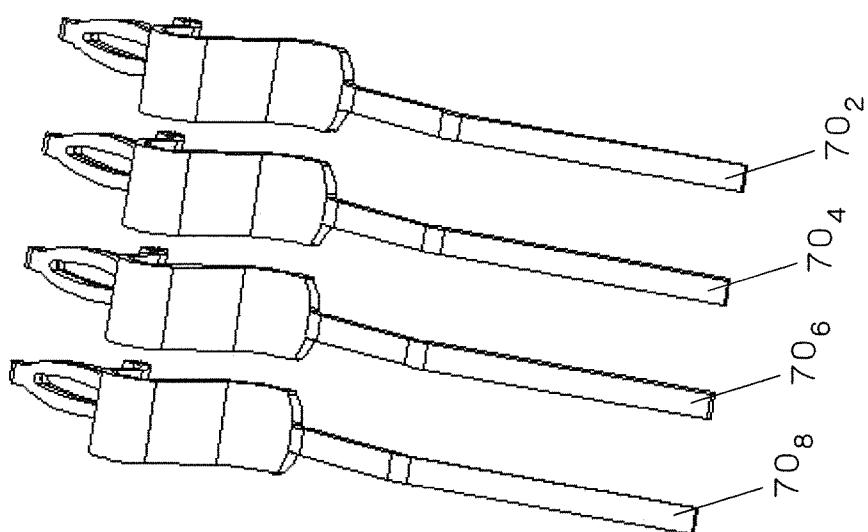


FIG. 12



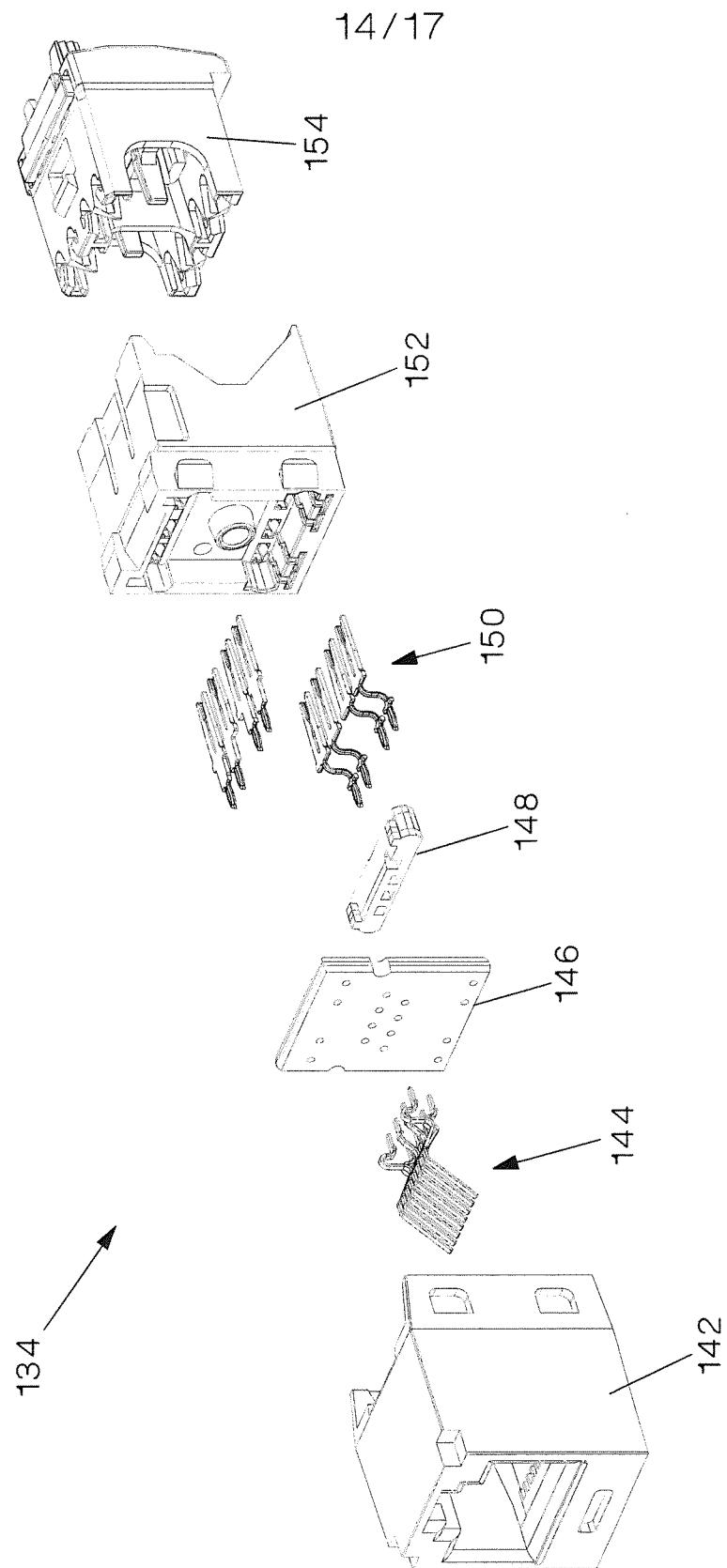


FIG. 13

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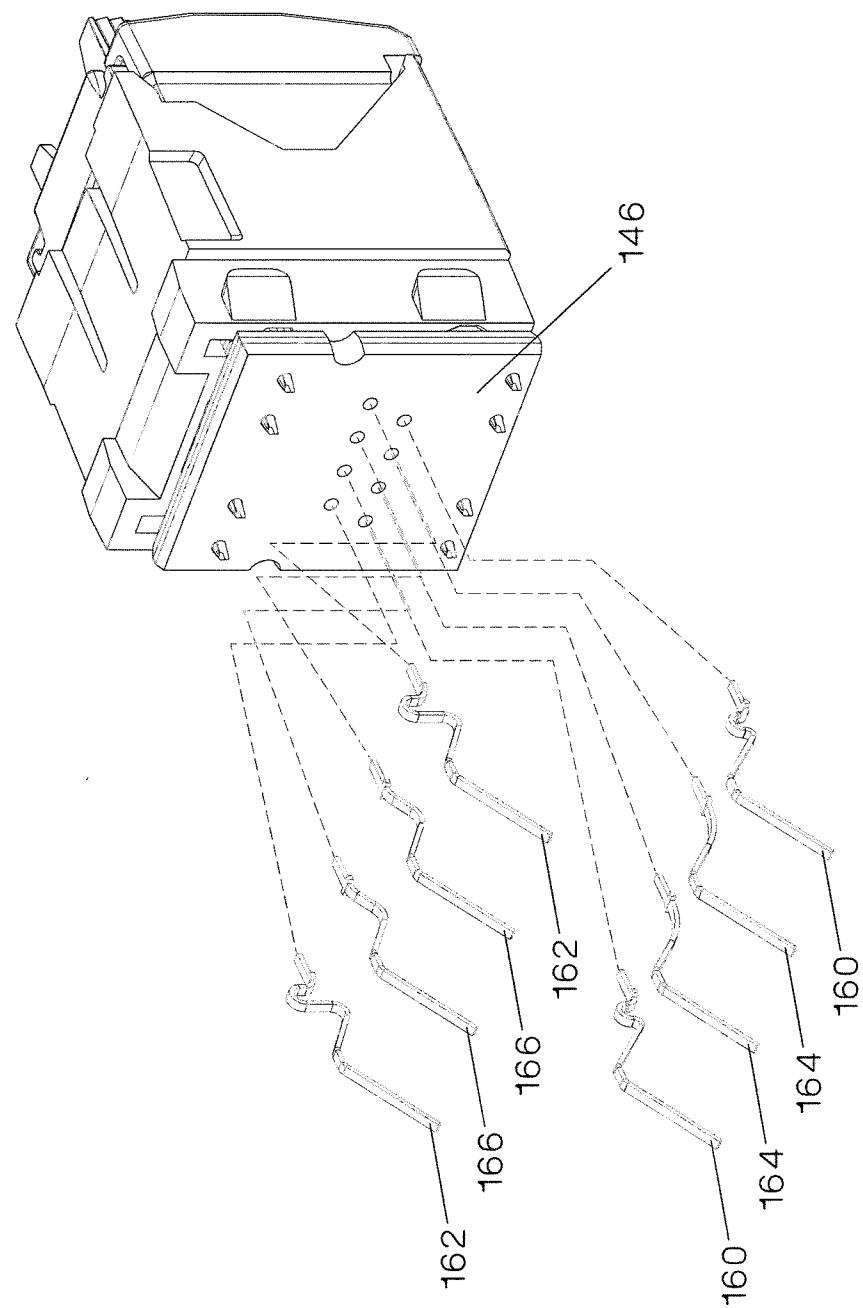


FIG. 14

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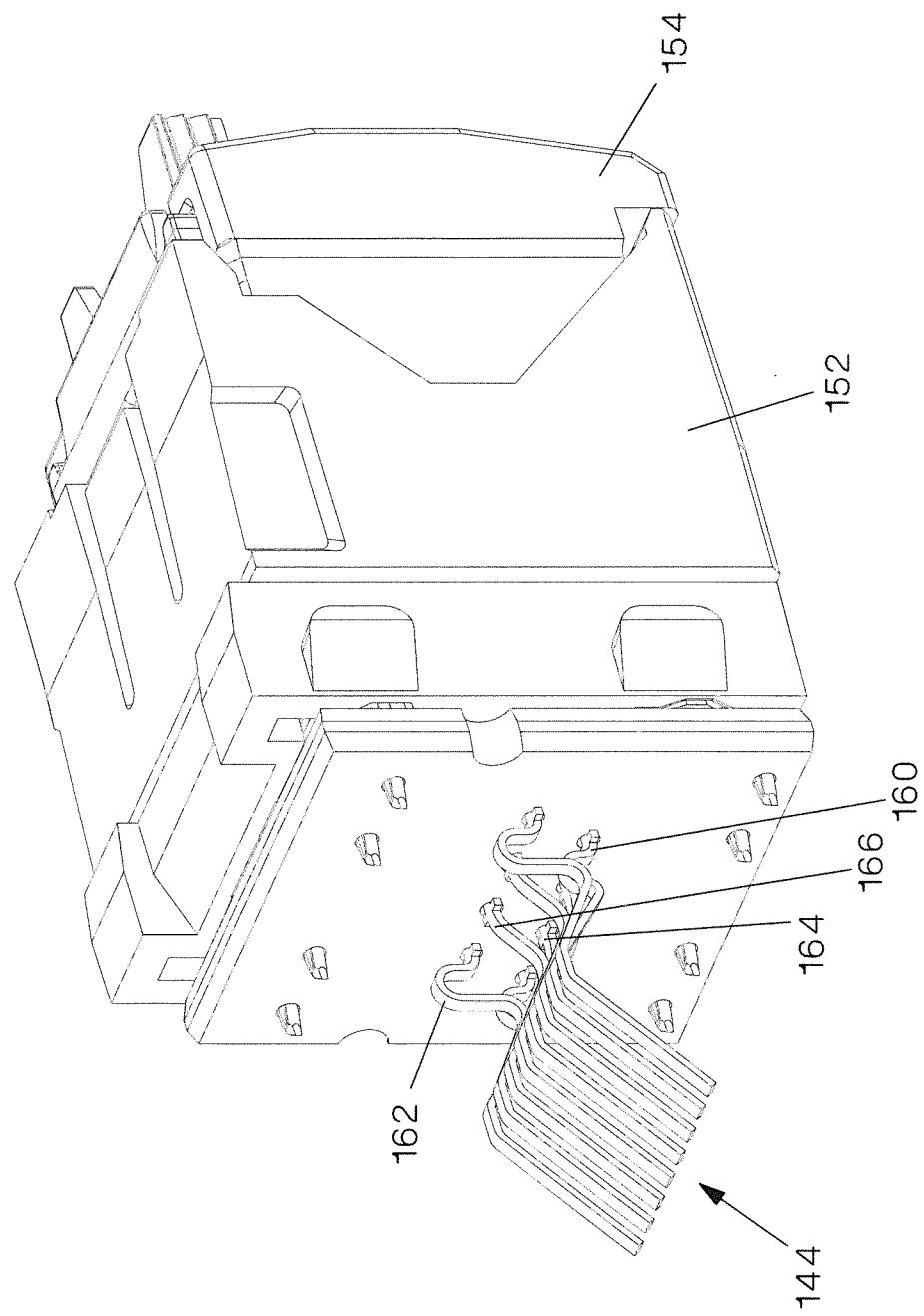


FIG. 15

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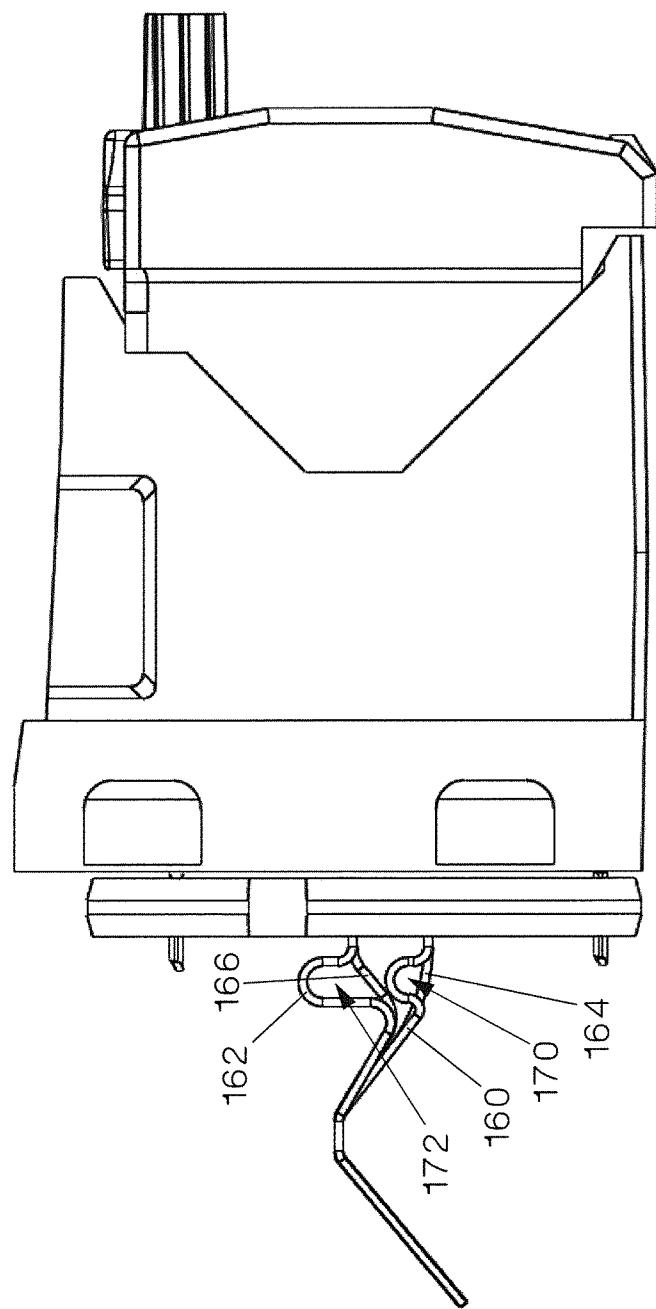


FIG. 16

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2014/018052

A. CLASSIFICATION OF SUBJECT MATTER
INV. H01R13/6461 H01R13/6474 H01R24/64 H01R27/00
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H01R

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 969 569 A2 (MOLEX INC [US]) 5 January 2000 (2000-01-05) paragraphs [0016] - [0030] -----	1-16
X	US 6 017 229 A (TULLEY BRIAN [US] ET AL) 25 January 2000 (2000-01-25) columns 7-9; figures 2a-5b -----	1-16
X	US 2011/136382 A1 (JAOUEN JEAN-MARC [FR] ET AL) 9 June 2011 (2011-06-09) the whole document -----	1-3, 5-10, 12-16
X	US 2008/254685 A1 (MURR KEITH MCQUILKIN [US] ET AL) 16 October 2008 (2008-10-16) the whole document ----- -/-	1-16

Further documents are listed in the continuation of Box C.

See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
21 May 2014	30/05/2014

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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X	US 7 708 603 B1 (LITTLE TERRANCE [US]) 4 May 2010 (2010-05-04) the whole document -----	1-16

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Information on patent family members

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