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Fink et al.

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[54] **ELECTRICAL CONNECTOR**

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[73] Assignee: **General Motors Corporation**, Detroit, Mich.

[*] Notice: This patent is subject to a terminal disclaimer.

[21] Appl. No.: **09/009,820**

[22] Filed: **Jan. 20, 1998**

Related U.S. Application Data

[63] Continuation-in-part of application No. 08/716,958, Sep. 23, 1996, Pat. No. 5,775,957.

[51] **Int. Cl.**[6] **H01R 13/436**

[52] **U.S. Cl.** **439/752**; 439/595

[58] **Field of Search** 439/752, 595, 439/701

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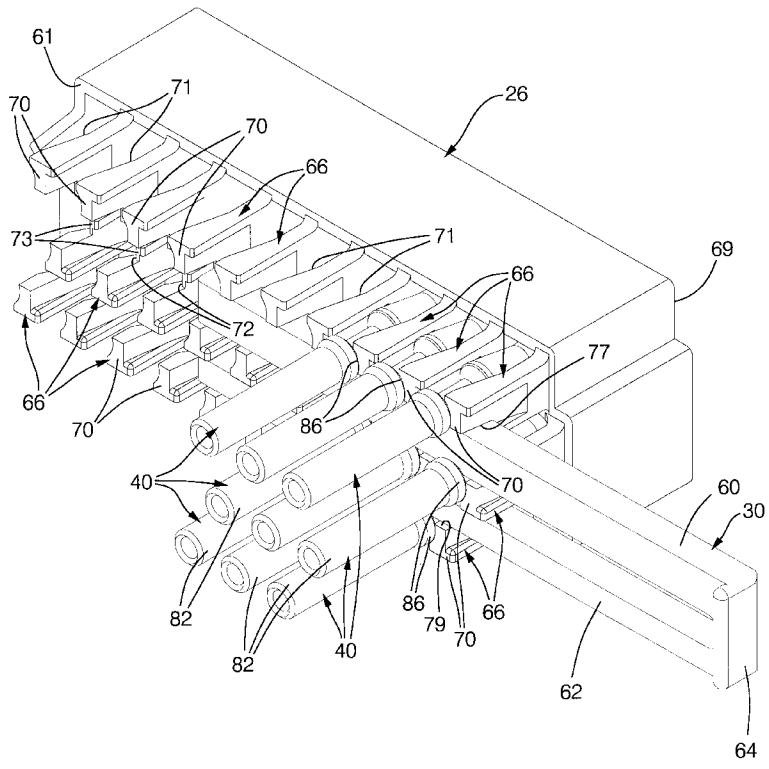
Primary Examiner—Gary Paumen

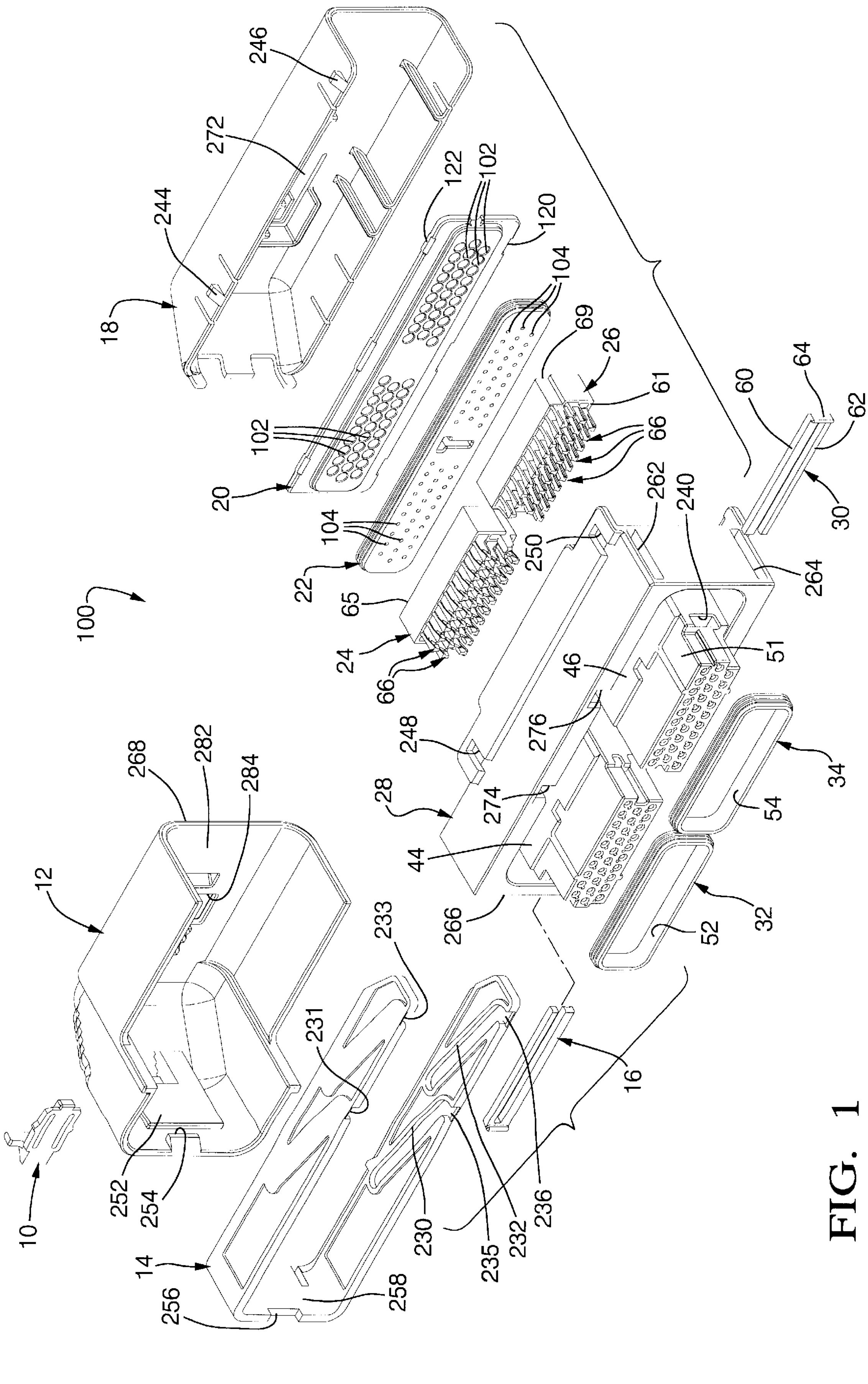
Attorney, Agent, or Firm—Patrick M. Griffin

[57] **ABSTRACT**

An electrical connector comprising: an outer housing including a plurality of receptacles; a cavity within the outer housing; a first inner housing within the cavity, wherein the first inner housing includes a first plurality of flexible extensions on a first end of the first inner housing; a first plurality of cylindrical openings within the first inner housing; a first plurality of conductive terminals, wherein a portion of each conductive terminal of the first plurality of conductive terminals extends through one of the cylindrical openings of the first plurality of cylindrical openings and out of the first inner housing and is received in one of the receptacles of the plurality of receptacles, wherein each conductive terminal of the first plurality of conductive terminals is maintained locked in place by a corresponding one flexible extension of the first plurality of flexible extensions; and a plurality of access holes on the outer housing, wherein each receptacle has located proximate thereto one of the access holes, wherein each flexible extension of the first plurality of flexible extensions includes a first deflection ramp aligned with one of the access holes, wherein, when a tool is inserted through one of the access holes and forced against the aligned first deflection ramp, the corresponding conductive terminal of the first plurality of conductive terminals is released and no longer maintained locked in place by the corresponding one flexible extension of the first plurality of flexible extensions.

2 Claims, 8 Drawing Sheets

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44
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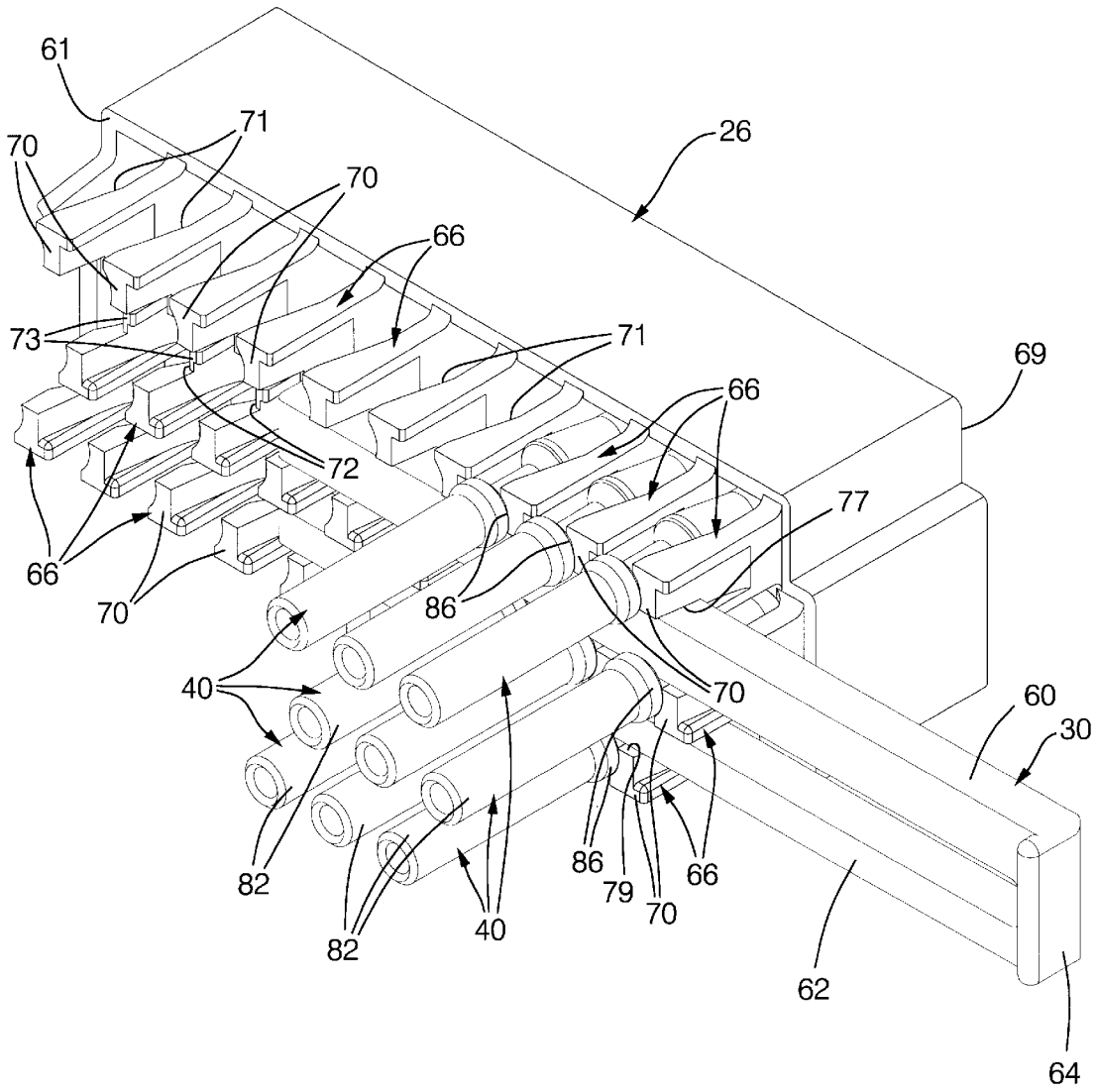
FIG. 1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71
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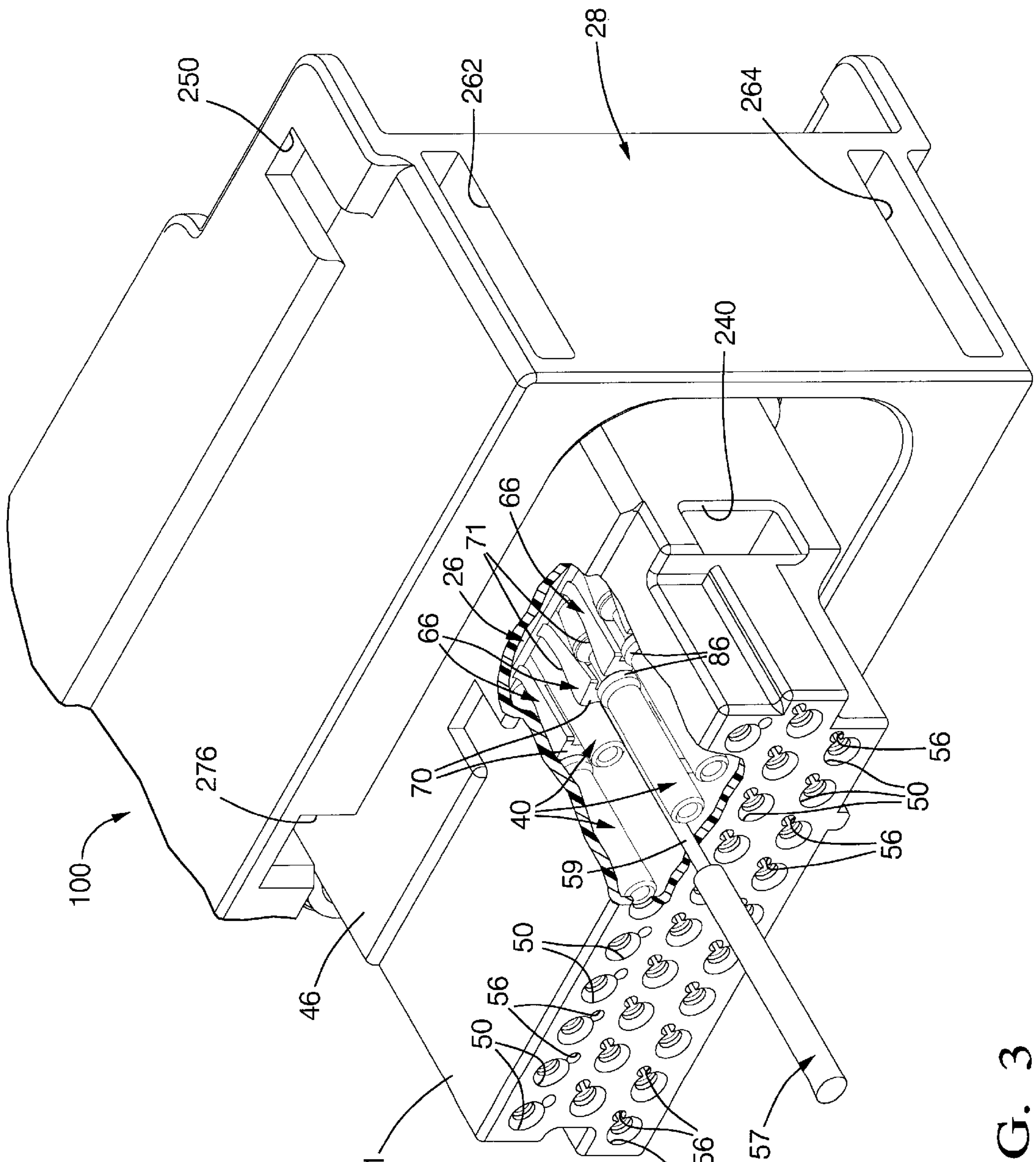
62
64

FIG. 2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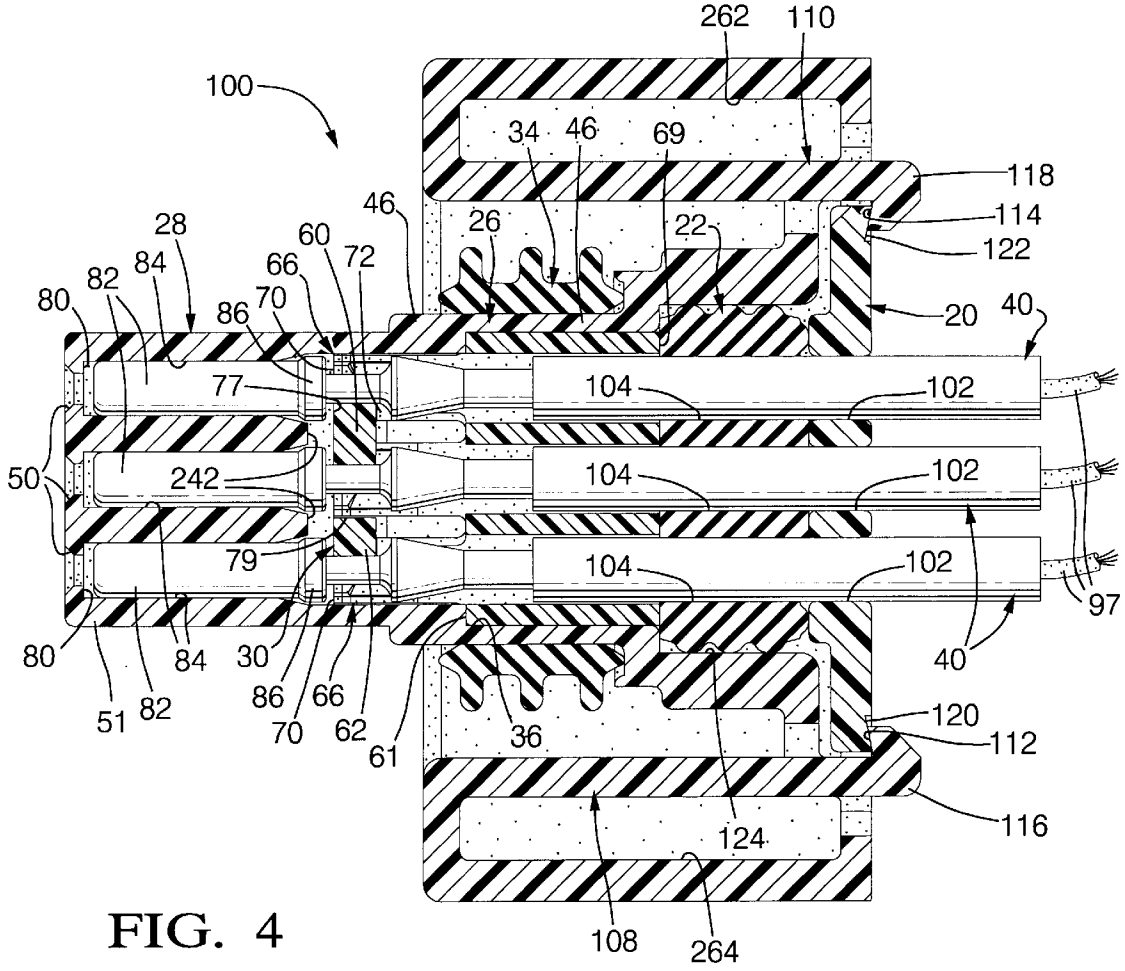
50

FIG. 3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40
77
104
102
50
242
104
102
79
104
102
97
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51
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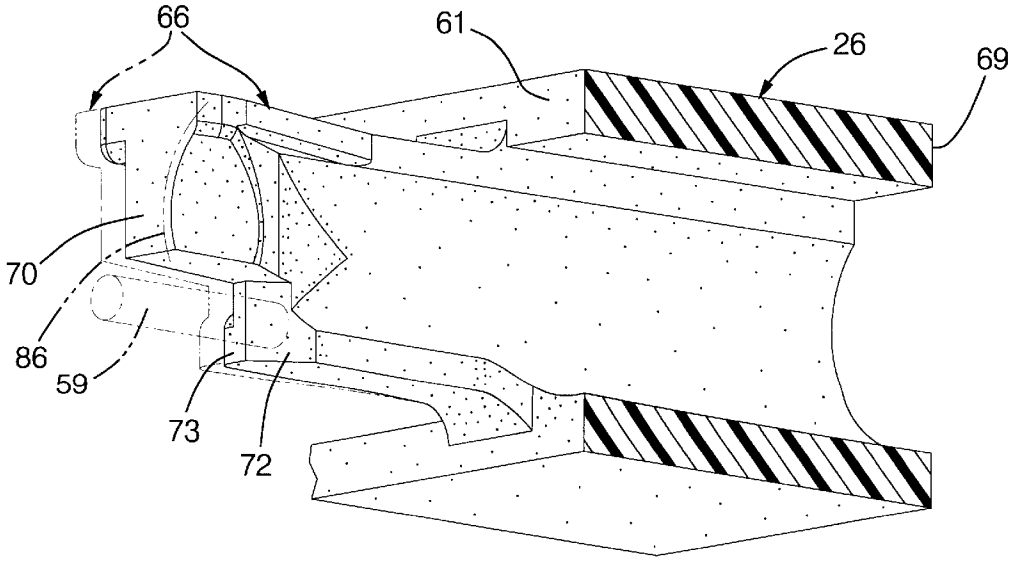
66
70
62
61
36
120
112
116
124
108
264

FIG. 4


66
61
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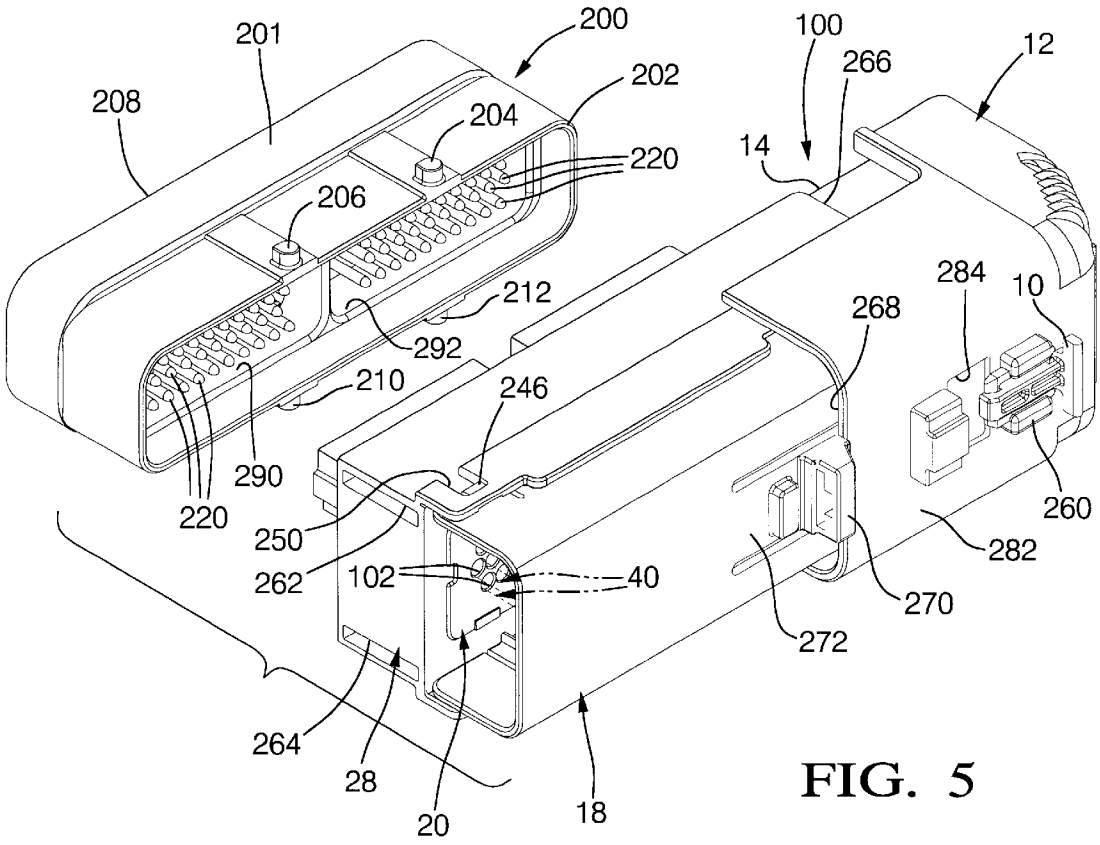
86
59
73
72

FIG. 7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200
208
202
204
220
206
100
266
12
14
284
10
268
212
292
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262
102
40
260
282
270
272
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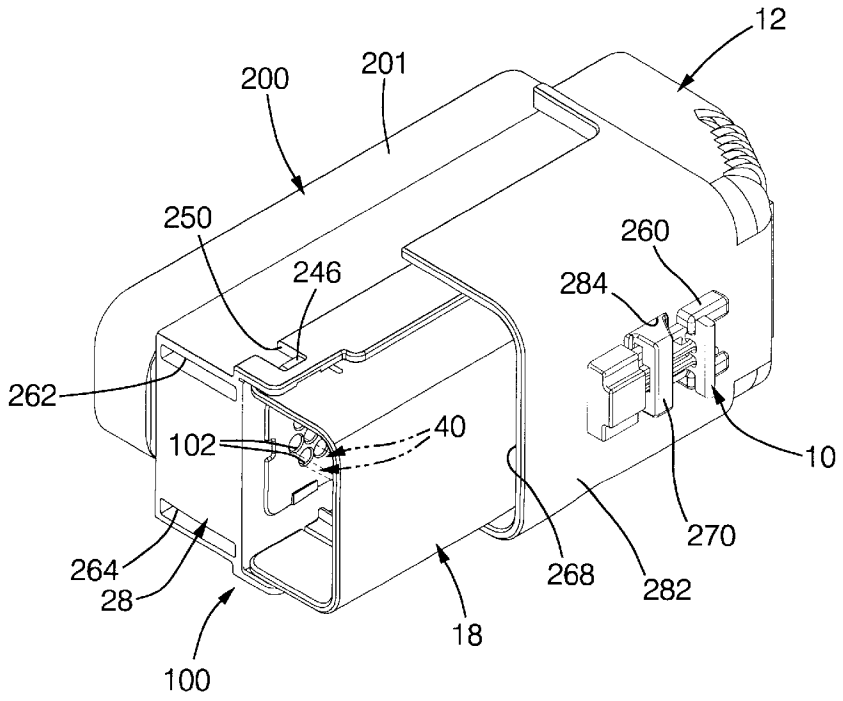
28
20
18

FIG. 5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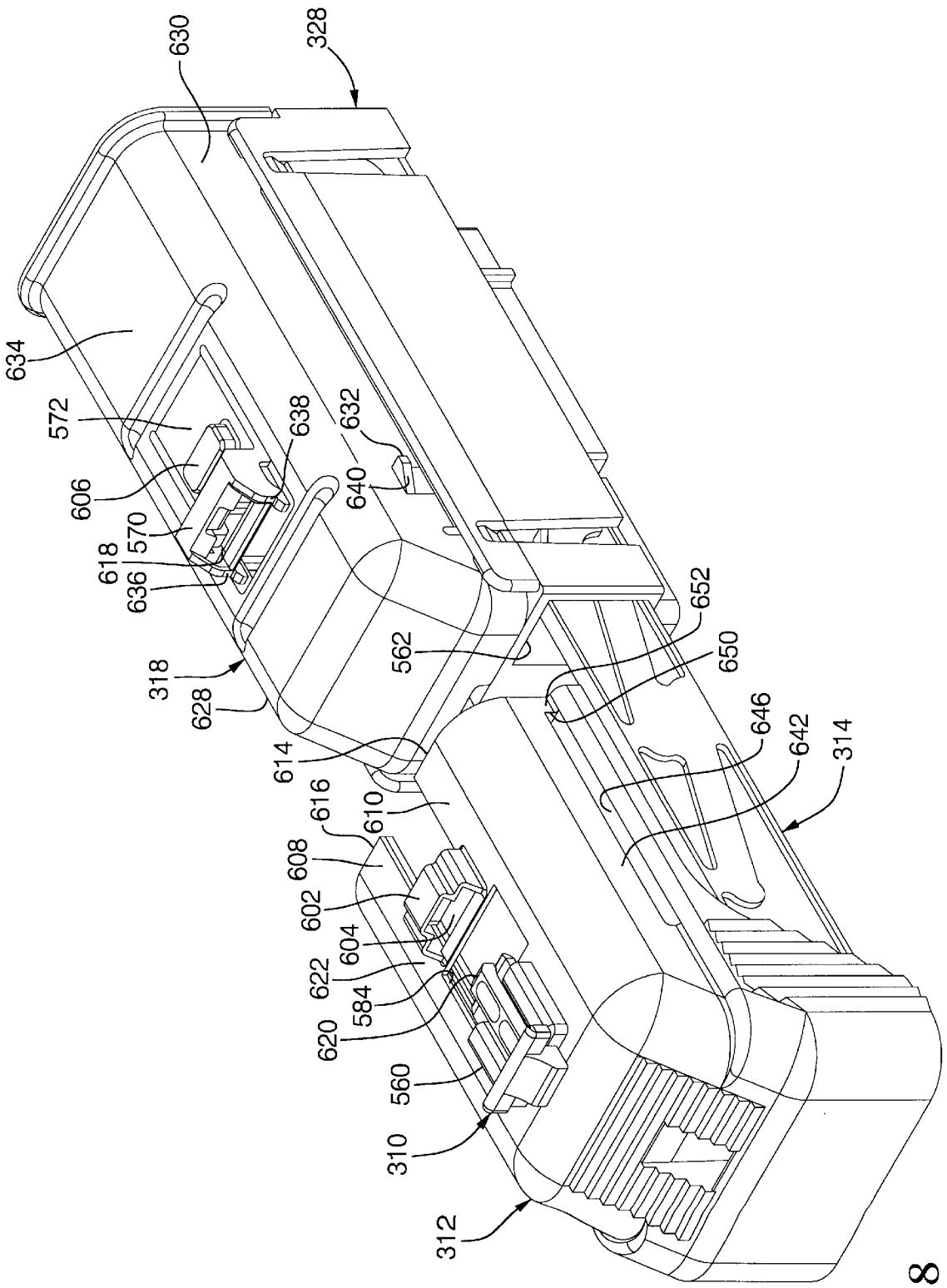
18
100

FIG. 6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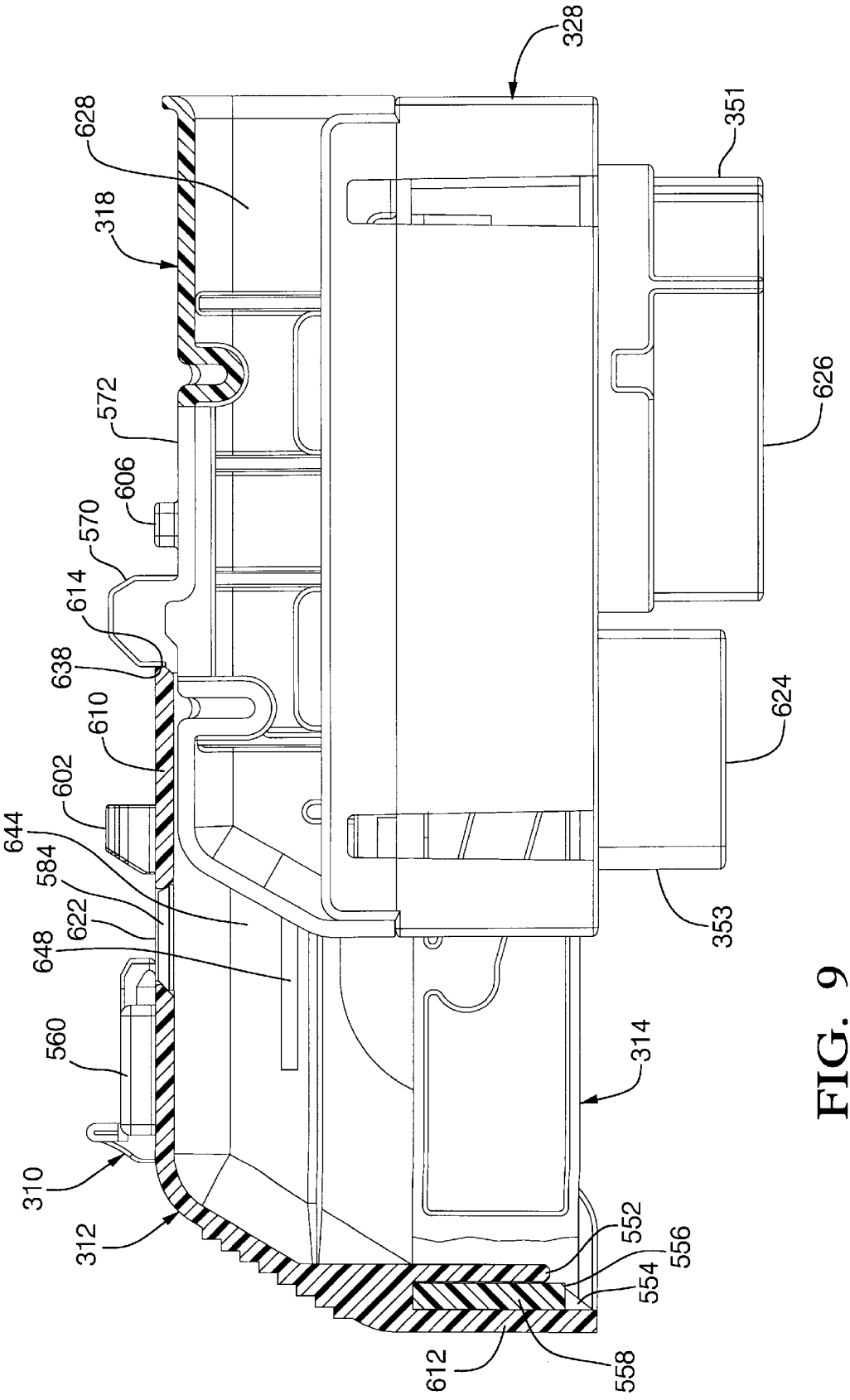
328
634
572
638
632
606
640
570
618
636
652
562
650
318
628
646
642
614
314
616
610
608
602
604
622
584
620
560
310
312

FIG. 8


328
351
628
318
572
606
570
614
638
610
602
644
584
622
648
560
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624
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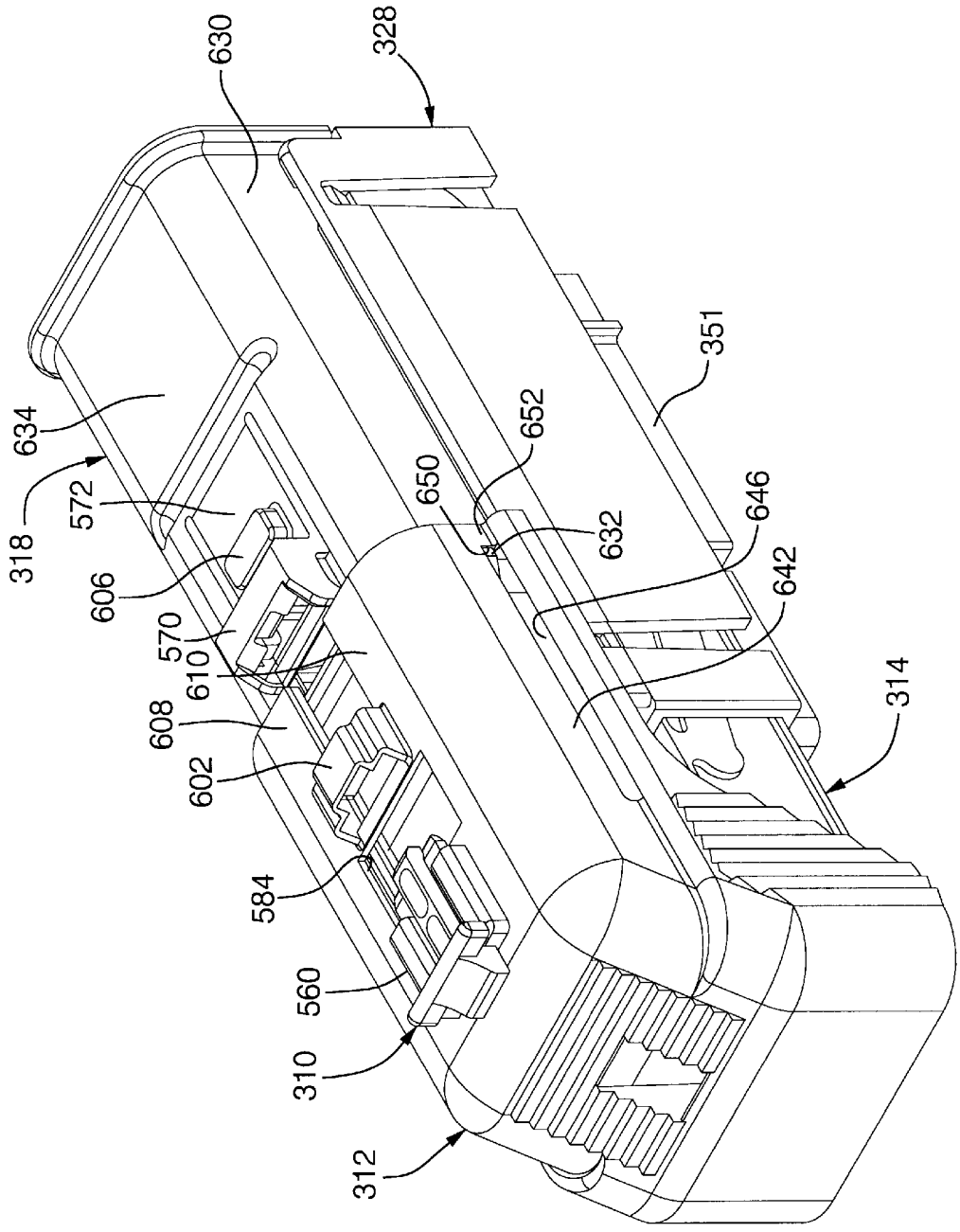
314
552
556
554
612
558

FIG. 9


630
328
351
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652
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610
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602
584
560
310
312

FIG. 10

ELECTRICAL CONNECTOR

This application is a continuation-in-part of Ser. No. 08/716,958 filed Sep. 23, 1996, now U.S. Pat. No. 5,775,957 issued Jul. 7, 1998.

This invention relates to an electrical connector.

BACKGROUND OF THE INVENTION

Electrical connector systems are known for use in automotive vehicles to facilitating removable connection of electrical harnesses.

SUMMARY OF THE PRESENT INVENTION

Advantageously, this invention provides an electrical connector suitable for implementation as a high-power, multi-row connector.

Advantageously, this invention provides an electrical connector that houses a series of female terminals. The terminals are retained in an inner housing, including a series of flex arms for maintaining the terminals in place. The inner housing is separate from the outer housing and is maintained in a cavity in the outer housing. This combination allows implementation of a secondary lock feature, advantageously incorporated according to this invention, for insuring full engagement of all terminals within the inner and outer housings and increasing retention force of the terminals within the housings. The structure also allows for an advantageous service feature allowing individual disengagement of the terminals using a tool inserted through an appropriate access hole in the outer housing. When the tool is so inserted, it engages a release deflection ramp on the corresponding flex arm to deflect the flex arm and release the terminal from its locked state.

Advantageously then, according to a preferred example, this invention provides an electrical connector comprising: an outer housing including a plurality of receptacles; a cavity within the outer housing; a first inner housing within the cavity, wherein the first inner housing includes a first plurality of flexible extensions on a first end of the first inner housing; a first plurality of cylindrical openings within the first inner housing; a first plurality of conductive terminals, wherein a portion of each conductive terminal of the first plurality of conductive terminals extends through one of the cylindrical openings of the first plurality of cylindrical openings and out of the first inner housing and is received in one of the receptacles of the plurality of receptacles, wherein each conductive terminal of the first plurality of conductive terminals is maintained locked in place by a corresponding one flexible extension of the first plurality of flexible extensions; and a plurality of access holes on the outer housing, wherein each receptacle has located proximate thereto one of the access holes, wherein each flexible extension of the first plurality of flexible extensions includes a first deflection ramp aligned with one of the access holes, wherein, when a tool is inserted through one of the access holes and forced against the aligned first deflection ramp, the corresponding conductive terminal of the first plurality of conductive terminals is released and no longer maintained locked in place by the corresponding one flexible extension of the first plurality of flexible extensions.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will now be described by way of example with reference to the following drawings in which:

FIG. **1** illustrates an exploded view of an example female electrical connector according to this invention;

FIG. **2** illustrates operation of an example secondary lock feature according to this invention;

FIG. **3** illustrates an example feature allowing for removal of the electrical terminals from the electrical connector;

FIG. **4** illustrates a section view of an example electrical connector according to this invention;

FIGS. **5** and **6** illustrate example engagement of male and female electrical connectors according to this invention;

FIG. **7** illustrates an example flex arm of an inner housing for uses with this invention;

FIG. **8** illustrates another example electrical connector according to this invention;

FIG. **9** illustrates a partial section view of the example electrical connector shown in FIG. **8** in a prestage state of the slide assist **12**; and

FIG. **10** illustrates a perspective view of the example electrical connector in the prestage state.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to FIGS. **1–4**, the example female electrical connector **100** shown comprises outer housing **28**, inner housings **24** and **26**, cable seal **22**, strain relief plate **20**, wire dress cover **18**, comb locks **16** and **30**, connector seals **32** and **34**, slide **14**, slide assist **12** and connector position assurance component (CPA) **10**.

The inner housings **24** and **26** each contain a plurality of flex arms (flexible extensions) **66** aligned with the plurality of cylindrical openings **67**. Each flex arm **66** has an end surface **70** at the end of the flex arm **66** and a ramp **71** on the flex arm. Using inner housing **26** as an example, the terminals **40** are inserted into the openings **67** in the inner housing **24** from side **69** of the inner housing **24**. The terminals are pushed through the openings **67** until they project out of the other side **61** of the housing between the various flex arms **66**. Each terminal pushes on the ramp **71** on the flex arm **66**, which flexes in a cantilever motion and then snaps in place behind shoulder **86** of the terminal **40** so that shoulder **86** seats on the seat surface **70**, maintaining the terminal **40** in place.

Referring now also to FIG. **7**, each flex arm **66** also includes a ramp **72** associated therewith, located between the ends of the flex arm **66**. Each ramp **72** has a top surface **73** extending laterally from the flex arm **66** at a point between the ends of the flex arm **66**, providing a seat to the lock bars **60**, **62**, as described below. Each ramp **72** is positioned so that when the inner housing is assembled into the outer housing **28**, each ramp **72** is aligned with one of the access holes **56** (FIG. **3**). The access holes **56** allow access of a small tool **57**, for example, having a 0.8 mm round rod **59**, to extend through the access hole **56** and deflect the flex arm **66** through cam action with the ramp **72**, allowing seat surface **70** to disengage from the shoulder **86** of the terminal **40** and allowing removal of the terminal **40** from the inner and outer housings **26** and **28**, i.e., from the end **69** of the inner housing **26**.

After the terminals **40** are inserted in the inner housing **26**, the housing is inserted into the cavity **36** of outer housing **28** causing terminal ends **82** to extend into the cylindrical cavities **84** of the terminal position portion **51** of outer housing **28**. Each cavity **84** has an inner seat **80** preventing the terminal end **82** from extending out of the opening **50** of outer housing **28**.

After the inner housing **26** is inserted in the outer housing **28**, cable seal **22** is inserted in place abutting the inner

housings **24** and **26**, i.e., adjacent end surfaces **69** and **65** of inner housings **26** and **24**. The cable seal **22** has a plurality of openings **104** through which the terminals **40** extend. The cable seal **22** is maintained in place by strain relief plate **20**, also containing a series of openings **102** through which the terminals **40** extend. The strain relief plate is snapped in place by a plurality of cantilever arms **108** and **110** having locking seats **112** and **114** on the ends **116** and **118** thereof locking against seats **120** and **122** of the strain relief plate **20**.

The cable seal **22** is constructed of a resilient material such as an elastomer or rubberized foam and provides a spring force against the end **69** of the inner housing **26** and the similar end **65** of housing **24**. Because the inner housing is separate from the outer housing **28** and is maintained in place by resilient member **22**, there is some free play allowed in position of the inner housing **26** within outer housing **28**.

Comb locks **16** and **30** both operate in the same way to lock the inner housing within the outer housing and ensure that the terminals **40** are appropriately positioned and locked in place. Using comb lock **30** as an example, comb lock **30** has a closed end **64** and two extending locking bars **60** and **62** projecting from the closed end **64** so that the comb lock **30** has a generally elongated U-shape.

The flex arms **66** on the inner housing **26** are arranged in spaced-apart rows that form channels **77, 79** for the lock bars **60** and **62** on the comb lock **30**. Likewise, the terminals **40**, when positioned in inner housing **26**, are aligned in the same three rows as the flex arms **66**. Each row comprises, alternately placed flex arms **66** and terminals **40**. When the inner housing **26** is placed within the outer housing **28** and the terminals **40** are in place, the comb lock **30** is slid through opening **240** in the outer housing and the lock bars **60** and **62** slide down the channels **77, 79**, riding along the top surfaces **73** of the ramps **72** of the flex arms **66**. Once in the channels, the lock bar aids retention of each terminal **40** in place by providing a locking surface for seat **86** on the terminal **40**, preventing terminal **40** from being removed and by engaging with the opening **240** of the outer housing preventing the inner housing from being removed from the outer housing **28**.

The resilient cable seal **22** is under some compression due to the strain relief plate **20** being snapped in place into housing **28**. This provides spring force against the ends **65, 69** of the inner housings **24, 26** pressing inner housings **24, 26** toward the positioning end **51** of the housing **28** and providing friction lock of the lock bars **60** and **62** in place between the surfaces **73** and the inner end wall **242** of the cavity **36**.

As illustrated in FIG. **4**, each terminal **40** has an electrical wire **97** connected thereto in a known manner, for example, through crimping, and the wires **97** generally comprise part of one or more harnesses in an electrical system, for example, for a motor vehicle. The dress cover **18** snaps in place to outer housing **28** with ramp and locks **244** and **246** engaging slots **248** and **250** on the outer housing.

Connector seals **32** and **34** of a known type have inner seal surfaces **52** and **54** that fit snugly on outer surfaces **44** and **46** of the connection end of outer housing **28**. The outer surfaces of the seals **32, 34** engage inner surfaces **290, 292** of the shroud **202** (FIG. **5**) of the male terminal **200**.

Referring now to FIGS. **5** and **6**, the engagement of the female connector **100** with male connector **200** is illustrated. The male connector **200** generally has a structure of a known type and includes housing **201** with extending shroud **202**. Extending out of the extending shroud **202** are four buttons **204, 206, 210, 212** for locking with the female connector **100**. Within the shroud **201** are a plurality of male terminals **220** for engaging the female terminals **40** of the female connector **100** in a known manner. A plurality of cable wires (not shown) are connected to the male terminals **220** and extend out the male connector **200** in a known manner.

To mate the connectors **100** and **200**, the slide **14** is first snapped into position into assist cover **12** with tab **252** engaging end **258** of the slide so that notch **256** is seated behind lock **254** of the assist cover **12**. The CPA **10** is also snapped in place in intermediate holder **260** molded on the exterior of assist cover **12**. With the slide **14**, CPA **10** and the assist cover **12** so assembled, the slide is inserted into the slots **262** and **264** in the outer housing **28** from the end **266** thereof and slid in place until the front surface **268** of assist cover **12** bumps against the front of the CPA lock feature **270**, located on cantilever finger **272** on the top of wire shroud **18**. In this position, the male connector is ready to be assembled to the female connector and the slot inlets **231, 233, 235** and **236** are aligned with the slots **274, 276** and two other slots not shown of the outer housing **28**.

The male connector **200** is then aligned so that the tabs **204, 206, 210** and **212** enter the slots **274, 276** and the two slots not shown beginning engagement of the male terminals **220** to the female terminals **40**. Force is then applied on the assist cover **12** to slide the slide **14** more into the outer housing **28**. Deflection of cantilever arm **272** is necessary to allow surface **268** past feature **270** of the wire shroud **18**. Through the resulting motion, the inner slot ramps **230, 232** (only two shown) act on the tabs **204, 206, 210, 212** of the male connector **200** forcing the connector into full engagement with the female connector and mating the male/female connectors **200** and **100** together.

During this process, the lock feature **270** is forced underneath the side **282** of the cover **12** through cantilever action of finger **272**. The male/female connectors **200** and **100** are not fully engaged until the CPA lock feature **270** pops into position in opening **284** in cover **12**. Once in this position, the CPA **10** can be slid forward from its engagement position in the retainer **260** to a snap-lock position in feature **270**. If CPA **10** cannot slide forward and snap into the snap-lock position in feature **270**, then the terminal is not completely engaged. Once the terminals are completely engaged and the CPA lock is slid into position, the terminals are locked in place and cannot be disengaged until the CPA **10** is removed.

The housings **24, 26** and **28**, the strain relief plate **20**, the wire dress cover **18**, the slide **14**, the slide assist **12**, the comb locks **16** and **30** and the CPA **10** can all be molded out of plastic, vinyl or other suitable material.

Referring now to FIGS. **8, 9** and **10**, the example electrical connector shown has a preferred prestage engagement state illustrated in FIGS. **9** and **10**. More particularly, the example connector includes outer housing **328**, slide **314**, slide assist **312** including CPA **310** and wire dress cover **318**. The connector also includes the various internal components (not shown), including inner housings, a cable seal, a strain relief plate, comb locks, connector seals and terminals such as described above with reference to FIGS. **1–7**. The outer housing **328** and wire dress cover **318** are together referred to as the housing assembly and the slide **314** and slide assist **312** are together referred to as the slide assembly.

The end **558** of slide **314** is located between tab **552** and end wall **612** of slide assist **312** and held in place by lock **554** seated in notch **556**. The CPA **310** is snapped in place in intermediate holder **560** molded on the exterior of slide assist **312**. When the slide assist **312** and slide **314** are

engaged fully in place, the CPA lock feature **570** on cantilever finger **572** of wire dress cover **318** extends into opening **584** on slide assist **312** and tab **606**, molded into the cantilever finger **572**, extends into the portion of cavity **604** formed in the plane of upper surface **622** of slide assist **312** under assurance housing **602**. Assurance housing **602** is molded into the upper surface **622** as shown. When the slide assist **312** and slide **314** are fully engaged to the outer housing **328**, a manually applied force in the locking direction slides CPA **310** forward so that CPA **310** extends through cavity **618** in CPA lock feature **570** and so that end **620** of CPA **310** extends into the portion of cavity **604** furthest from upper surface **622**. When the CPA **310** is so positioned, lock feature **570** is locked in opening **584** and the housing assembly and slide assembly are secured in the fully engaged state.

The wire dress cover **318** includes first and second side walls **628** and **630** extending perpendicular to and away from the top surface **634**. Each side wall **628**, **630** has a ramp lock **632** (only one shown) extending perpendicular to the respective side wall **628**, **630** in a direction exterior of wire dress cover **318** with each ramp **640** (only one shown) of ramp locks **632** facing toward the slide assist **312**.

The slide assist **312** has two side walls **642** (FIG. **8**) and **644** (FIG. **9**) perpendicular to and extending away from top surface **622**. Each side wall **642** and **644** is positioned to slide over the outside of the corresponding side wall **630** and **628** of the wire dress cover when the slide assist **312** and wire dress cover **318** are engaged. Each side wall **642**, **644** has an elongated slot **646**, **648** aligned parallel to the direction of sliding engagement of the slide assist **312** and wire dress cover **318**, which is also parallel to the plane of surface **622**. The slots **646** and **648** are also positioned so that when slide **314** is inserted into the slot **562** and the other corresponding slot not shown in FIGS. **8–10** (similar to slots **262** and **264** in FIG. **1**) in outer housing **328**, slots **646** and **648** align, in the direction of sliding motion, with the ramp lock **632** and the other corresponding ramp lock (not shown) on side wall **628**. Each slot **646**, **648** has a locking wall **650** (only one shown) defining the end of the slot **646**, **648** closest to the wire dress cover **318**.

FIG. **8** shows that relative positions of slide assist **312** and slide **314** with respect to the outer housing **328** and wire dress cover **318** when the slide **314** is initially inserted into the outer housing **328**. The state of the example connector shown in FIGS. **9** and **10** is referred to as the shipping prestage state having the slide **314** and slide assist **312** locked into the position shown with respect to the outer housing **328** and the wire dress cover **318**. When an operator progresses the slide assist **312** and slide **314** from the position shown in FIG. **8** in an engagement direction to the position shown in FIGS. **9** and **10**, the front ends **652** (only one shown) of side walls **642** and **644** must pass over the ramp locks **632**. The shape of the slide assist **312** at the front ends **652** allows the side walls **642**, **644** to be deflected by ramps **640** and pass over the ramp locks **632**. Once the front ends **652** have passed over the ramp locks **632**, the side walls return to their undeflected state and ramp locks **632** slide within the slots **646**, **648** as shown in FIG. **10** with respect to slot **646**. The end surfaces **614** and **616** of the first and second stop arms **608** and **610** of the slide assist **312** abut against the surfaces **638** and **636**, respectively, of CPA lock feature **570** to act as a positive stop for engaging the slide assist **312** and slide **314** in the shipping prestage state. Locking wall **650** acts against lock **632** to prevent motion allowing slide assist **312** and slide **314** from disengaging from the shipping prestage state.

In the prestage state, the slide **314** has the slot inlets (not shown) similar to references **231**, **233**, **235** and **236** of FIG. **1** aligned with the slots (not shown) similar to slots **274** and **276** of FIG. **1** and two other corresponding slots in the outer housing **328** to receive the corresponding tabs such as tabs **204**, **206**, **210** and **212** of the male connector **200** in FIG. **5**.

The positive stop formed by surfaces **638** and **636** of CPA lock feature **570** is releasable by manually deflecting cantilever finger **572** so that CPA lock feature **570** is out of the path of slide assist **312**. Once CPA lock feature **570** is out of the path of slide assist **312**, and a male connector (not shown in FIGS. **8–10**) is aligned with the electrical connector, force applied to the slide assembly in the engagement direction moves the slide assembly past the prestage state into full engagement with the housing assembly and forces the male connector into full engagement with the electrical connector as described above with reference to FIGS. **1–7**.

In the even that an operator needs to disengage the slide assist **312** and slide **314** from the outer housing **328** and wire dress cover **318**, the side walls **642** and **644** can be manually deflected outward to release the locking surfaces **650** from the ramp locks **632**.

In the example shown in FIGS. **8**, **9** and **10**, the terminal position portions **351** and **353** of the outer housing **328** are of two different sizes, terminal position portion **351** being larger than portion **353** and adapted to hold more terminals than terminal position portion **353**. Front faces **624** and **626** of the two terminal position portions **351** and **353** are located in different planes illustrating a shorter total overall length for the terminals within terminal position portion **351**. One skilled in the art can easily adapt the inner housing and terminals to correspond to the shorter length of the terminal position portion **351**. The different size and widths of the terminal position portions **351** and **353** illustrates the flexibility available from the electrical connector according to this invention, allowing one skilled in the art to vary the size and length of the terminal position portions of different connectors so that each connector has a unique configuration compared with other connectors that might be used in the same proximity within the vehicle. Adaptation of the necessary features of the mating male connectors to engage terminal position portions **351** and **353** is also within the level of one skilled in the art in view of the teachings herein.

We claim:

1. An electrical connector comprising:

an outer housing including a plurality of receptacles;

a cavity within the outer housing;

a first inner housing within the cavity, wherein the first inner housing includes a first plurality of flexible extensions on a first end of the first inner housing;

a first plurality of cylindrical openings within the first inner housing;

a first plurality of conductive terminals, wherein a portion of each conductive terminal of the first plurality of conductive terminals extends through one of the cylindrical openings of the first plurality of cylindrical openings and out of the first inner housing and is received in one of the receptacles of the plurality of receptacles, wherein each conductive terminal of the first plurality of conductive terminals is maintained locked in place by a corresponding one flexible extension of the first plurality of flexible extensions; and

a plurality of access holes on the outer housing, wherein each receptacle has located proximate thereto one of the access holes, wherein each flexible extension of the first plurality of flexible extensions includes a first

deflection ramp aligned with one of the access holes, wherein, when a tool is inserted through one of the access holes and forced against the aligned first deflection ramp, the corresponding conductive terminal of the first plurality of conductive terminals is released and no longer maintained locked in place by the corresponding one flexible extension of the first plurality of flexible extensions.

2. An electrical connector according to claim **1**, also comprising:

a second inner housing within the cavity, wherein the second inner housing includes a second plurality of flexible extensions on a second end of the second inner housing;

a second plurality of cylindrical openings within the second inner housing;

a second plurality of conductive terminals, wherein a portion of each conductive terminal of the second plurality of conductive terminals extends through one of the cylindrical openings of the second plurality of cylindrical openings and out of the second inner housing and is received in one of the receptacles of the plurality of receptacles, wherein each conductive terminal of the second plurality of conductive terminals is maintained locked in place by a corresponding one flexible extension of the second plurality of flexible extensions, wherein each extension of the second plurality of flexible extensions includes a second deflection ramp aligned with one of the access holes, wherein, when the tool is inserted through one of the access holes and forced against the aligned second deflection ramp, the corresponding conductive terminal of the second plurality of conductive terminals is released and no longer maintained locked in place by the corresponding one flexible extension of the second plurality of flexible extensions.

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