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(54) **CONNECTOR MATING SENSOR ASSEMBLY FOR POWER CONNECTOR SYSTEM**

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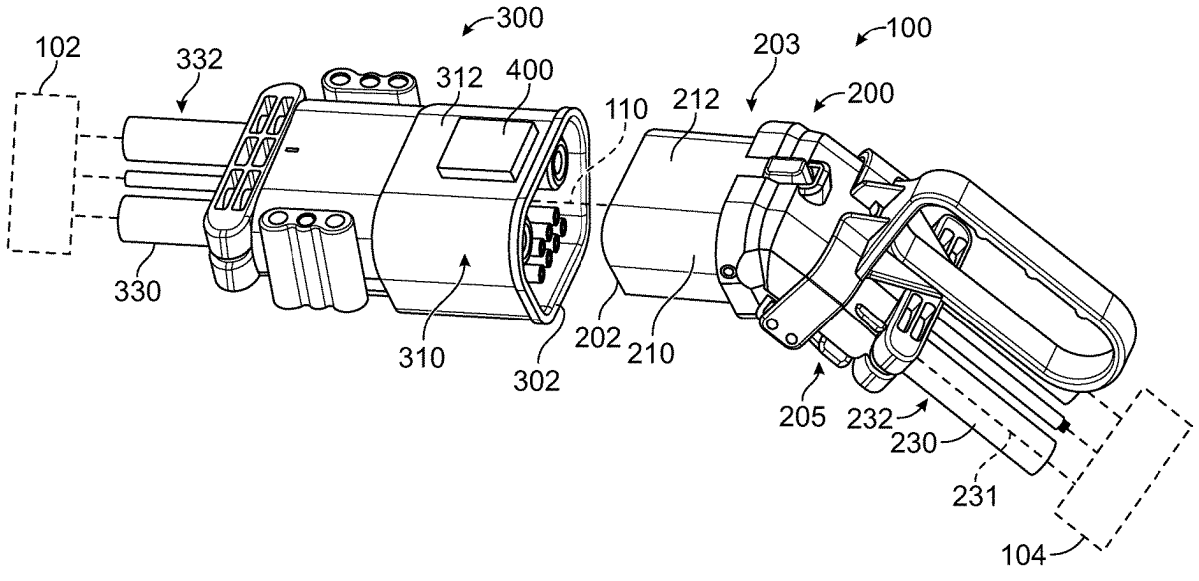
(57) **ABSTRACT**

A receive charging device includes a receive power connector having a receive housing with a mating end at a front having a receptacle configured to receive a supply power connector. The receive charging device includes receive power contacts for mating with supply power contacts of the supply power connector. The receive charging device includes a connector mating sensor assembly configured to be operably coupled to the supply power connector to indicate a mating status of the receive power connector with the supply power connector. The mating status is one of connected or disconnected.



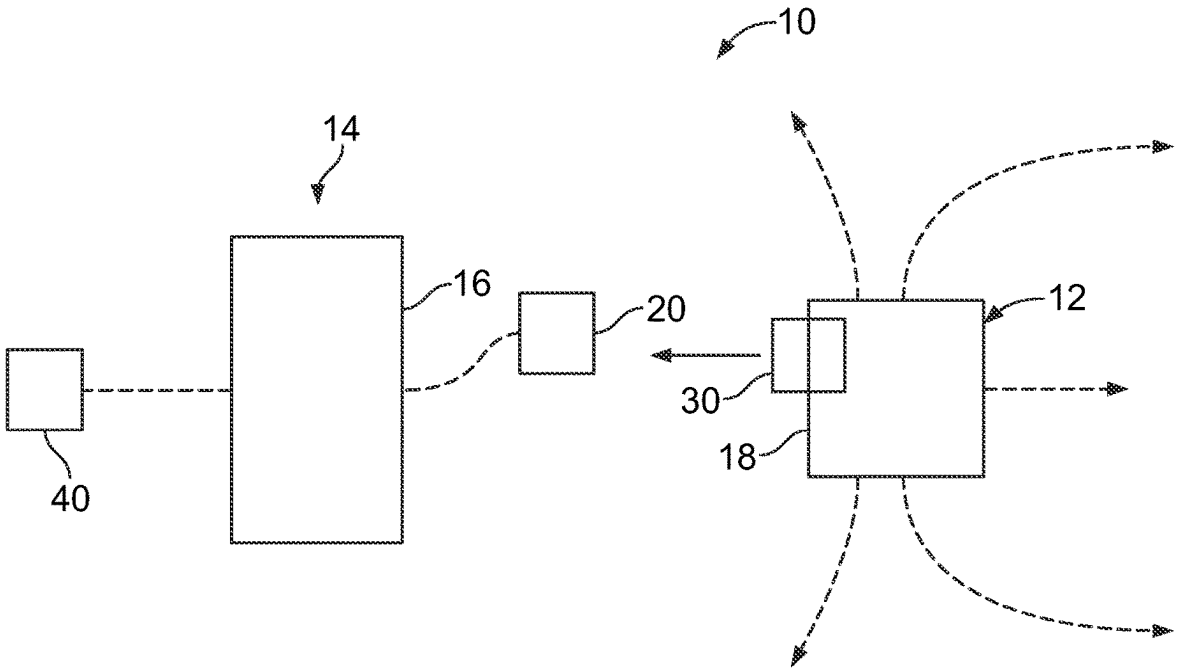


FIG. 1

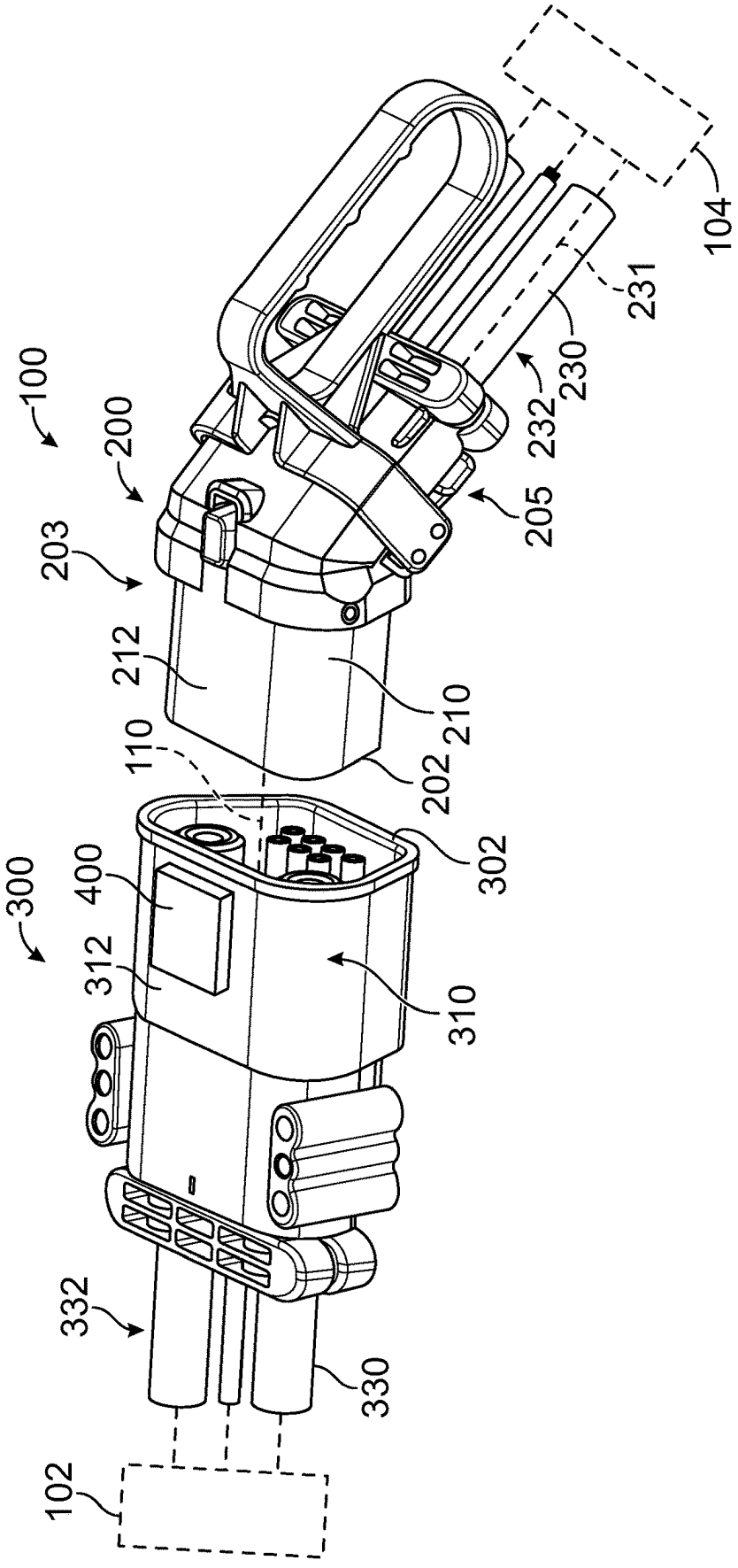

100
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FIG. 2

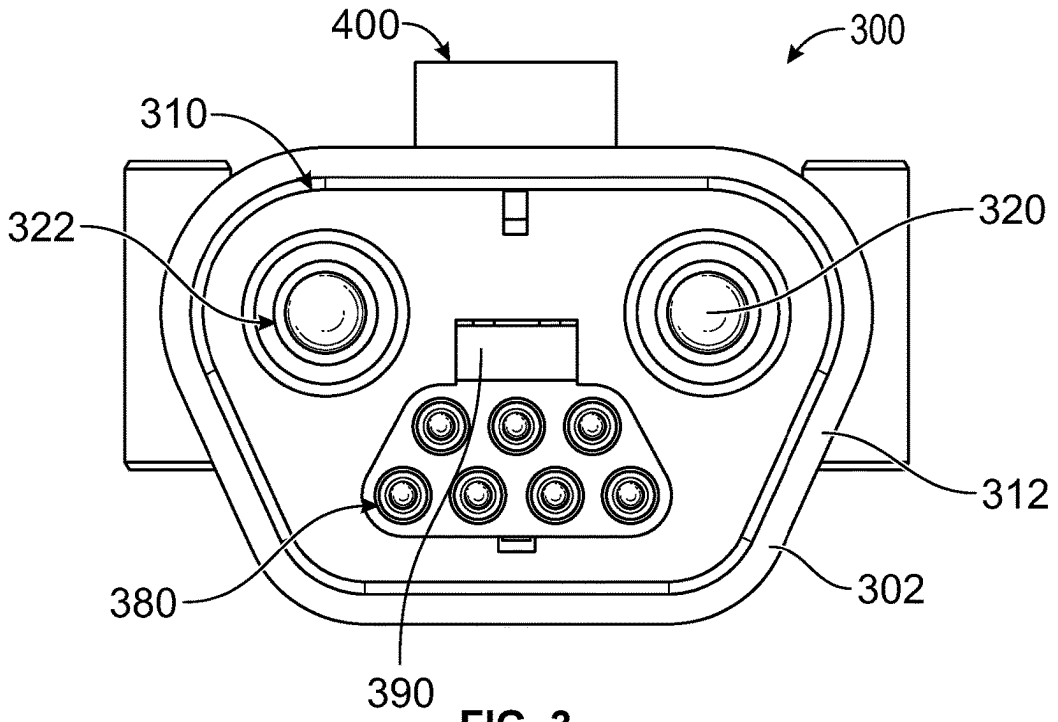
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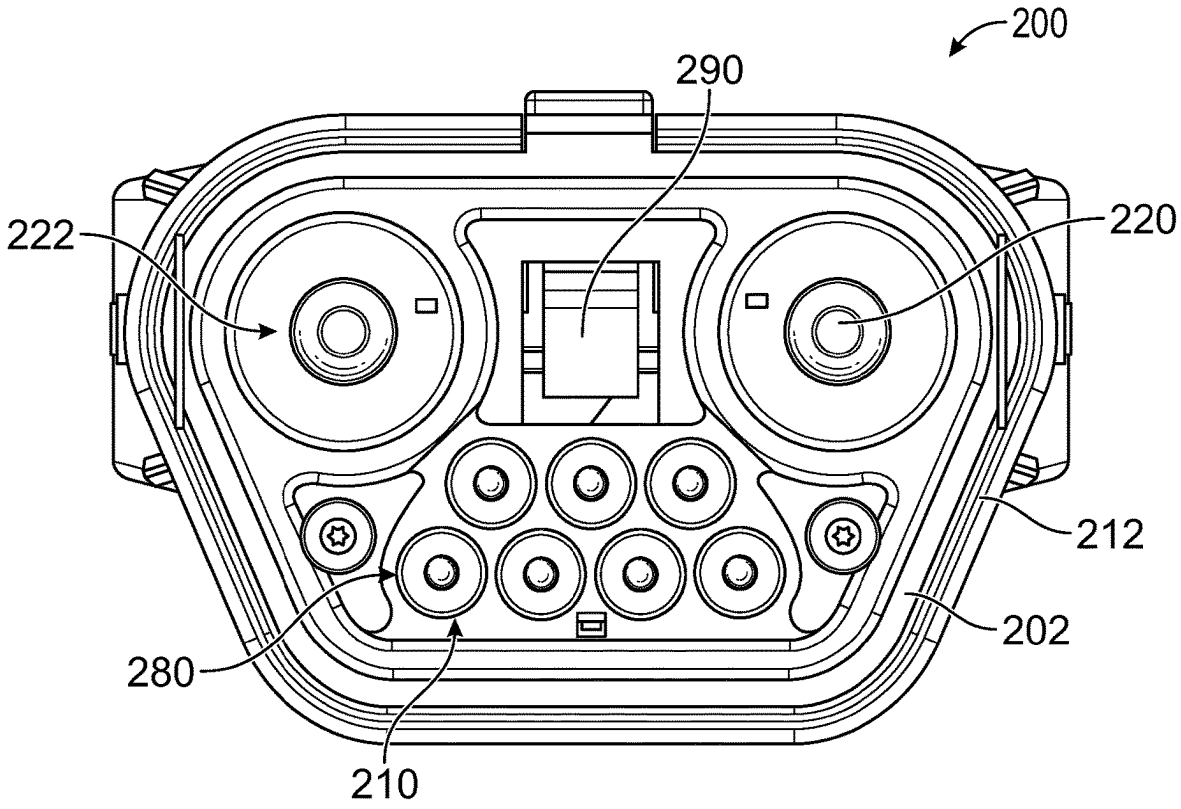
FIG. 3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222
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FIG. 4

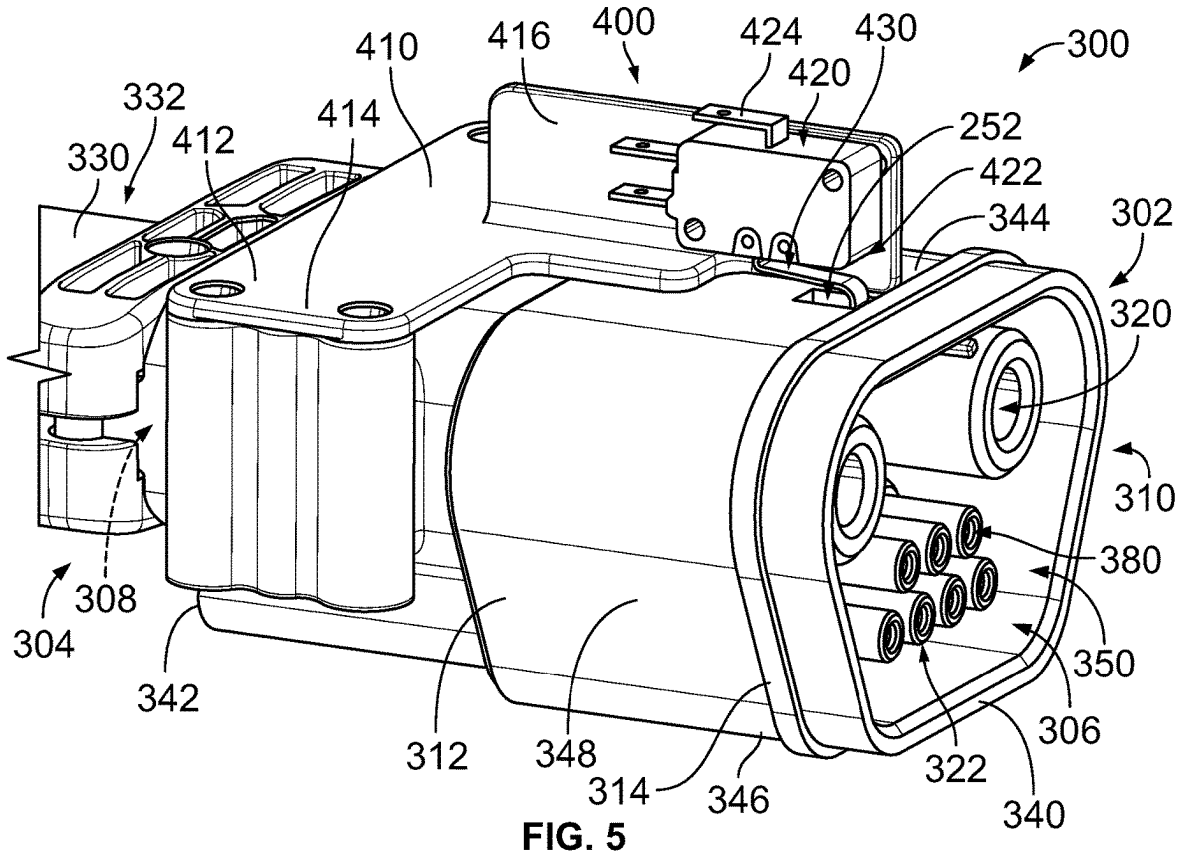
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FIG. 5

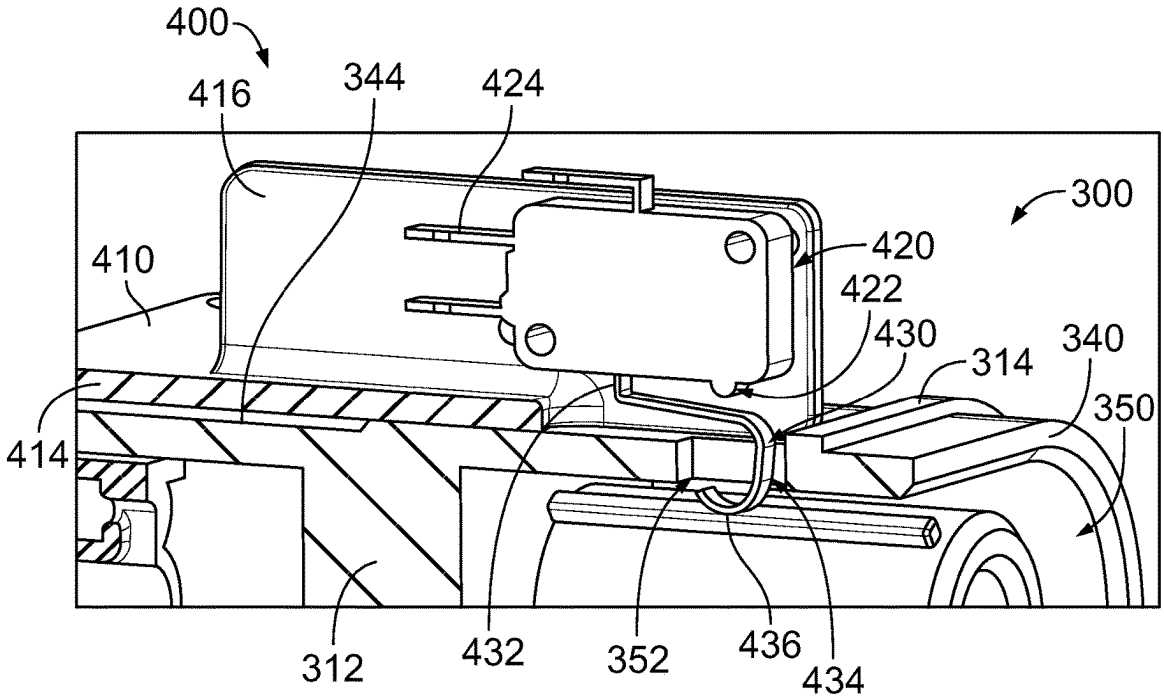
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FIG. 6

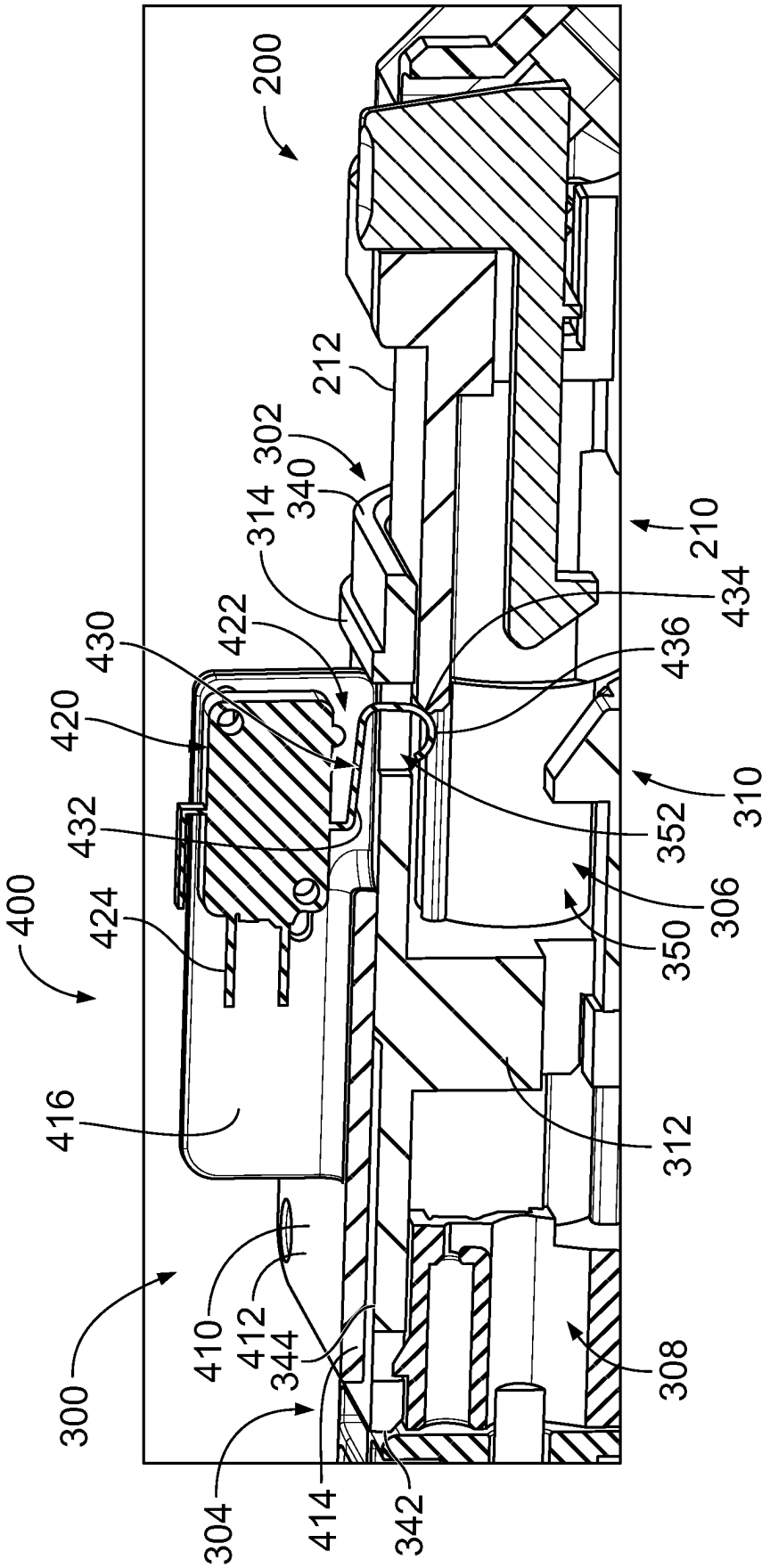
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FIG. 7

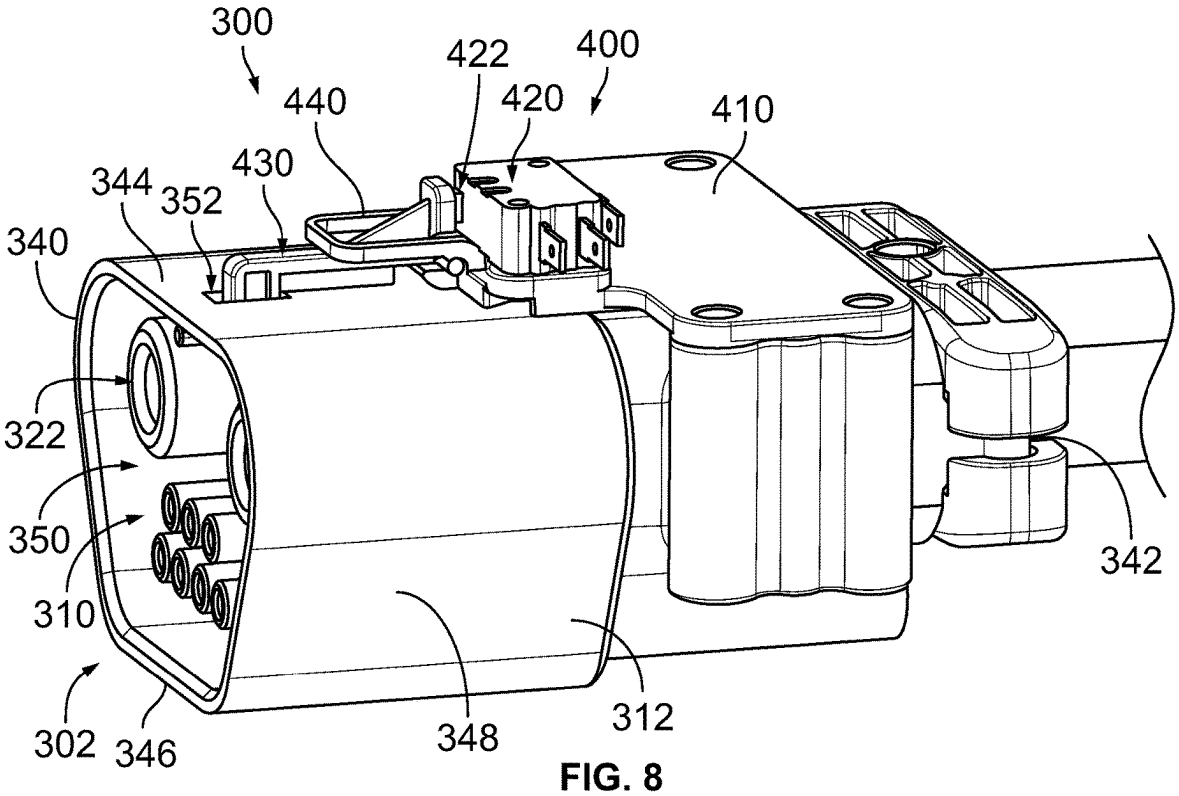
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FIG. 8

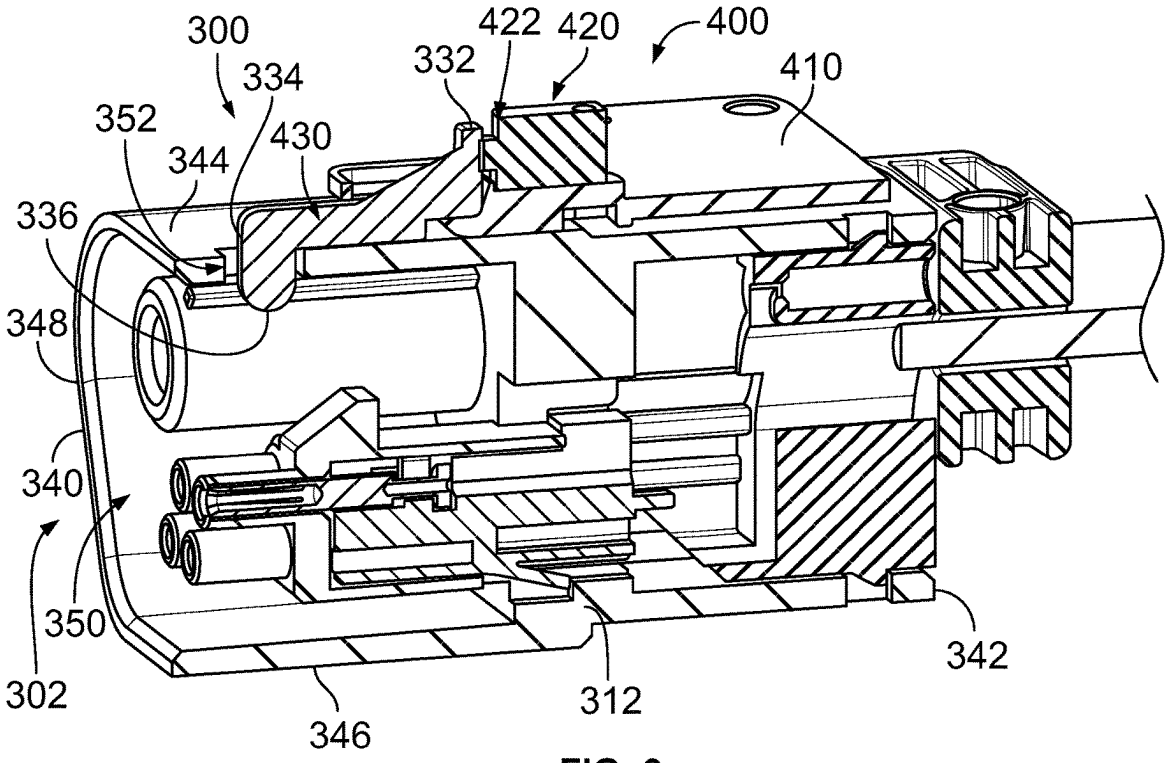
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FIG. 9

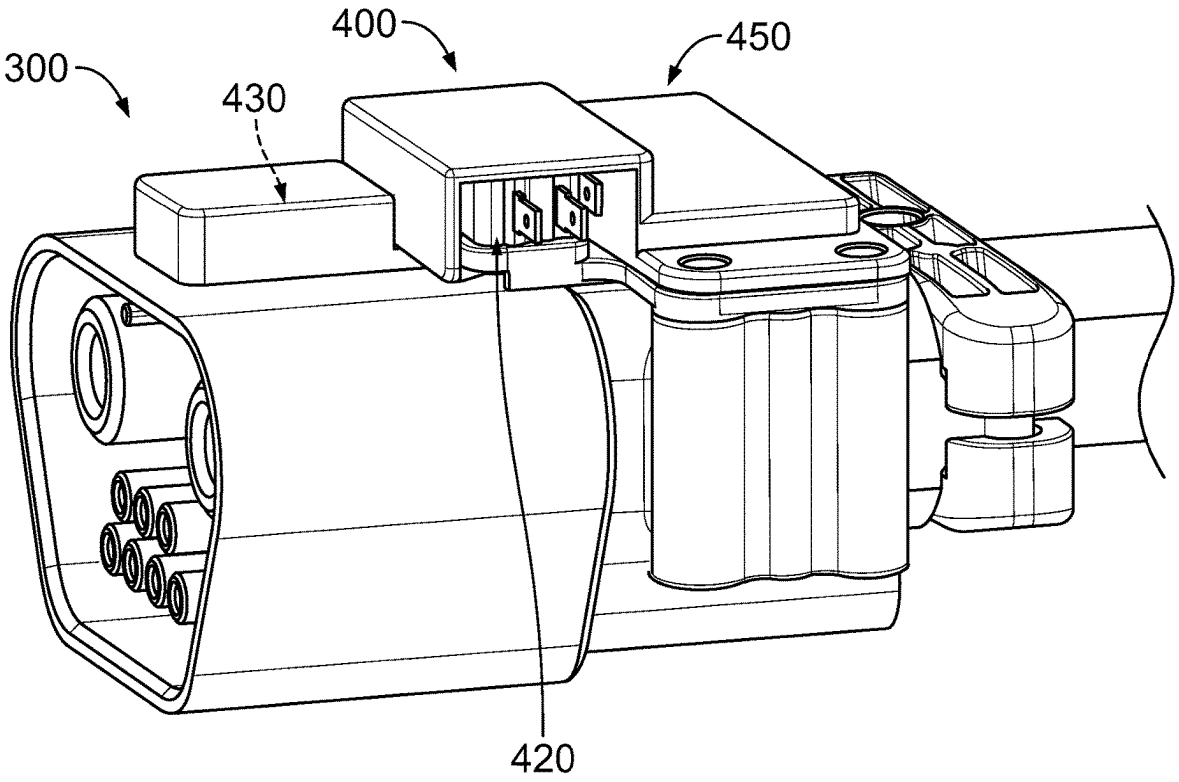

FIG. 10

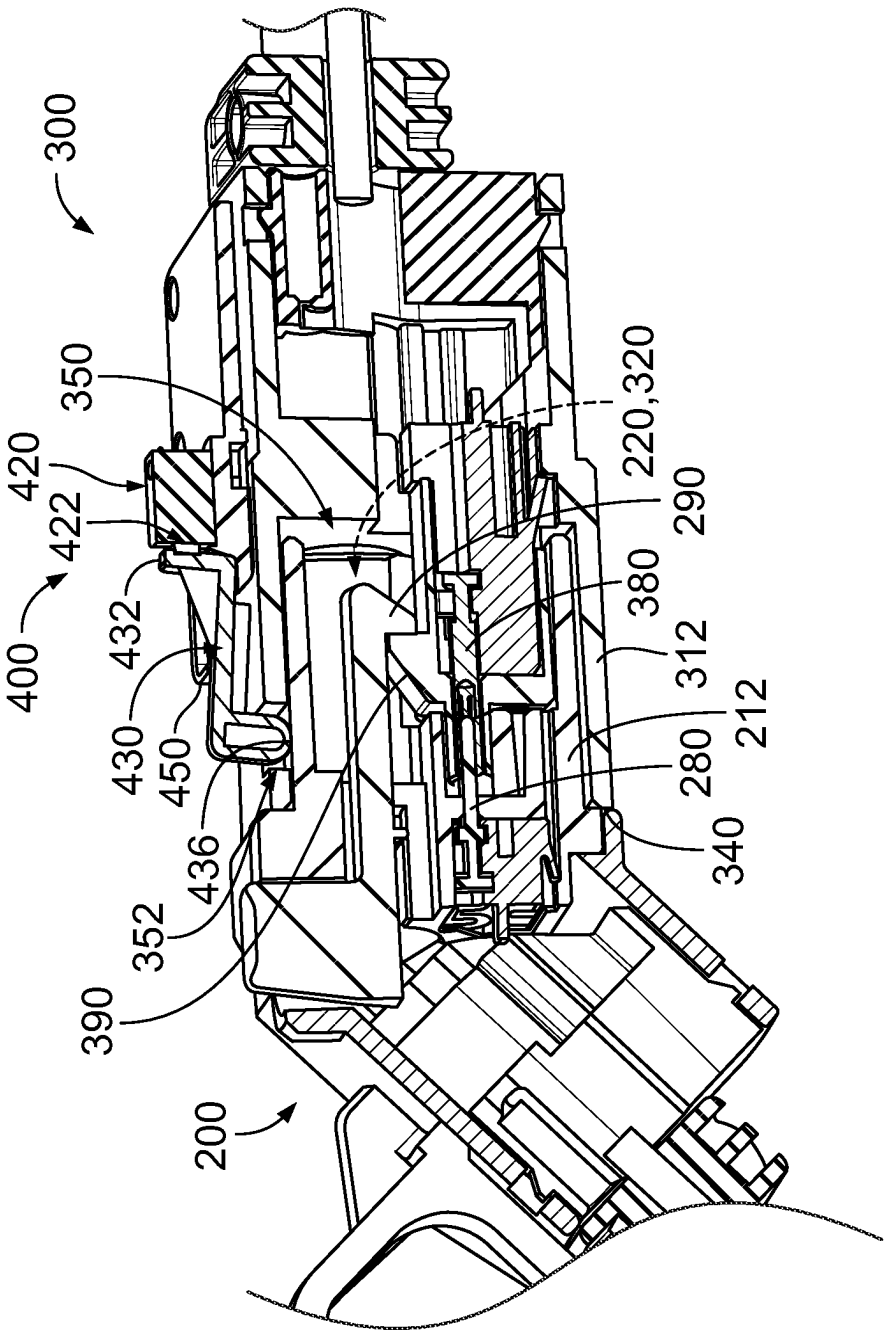
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FIG. 11

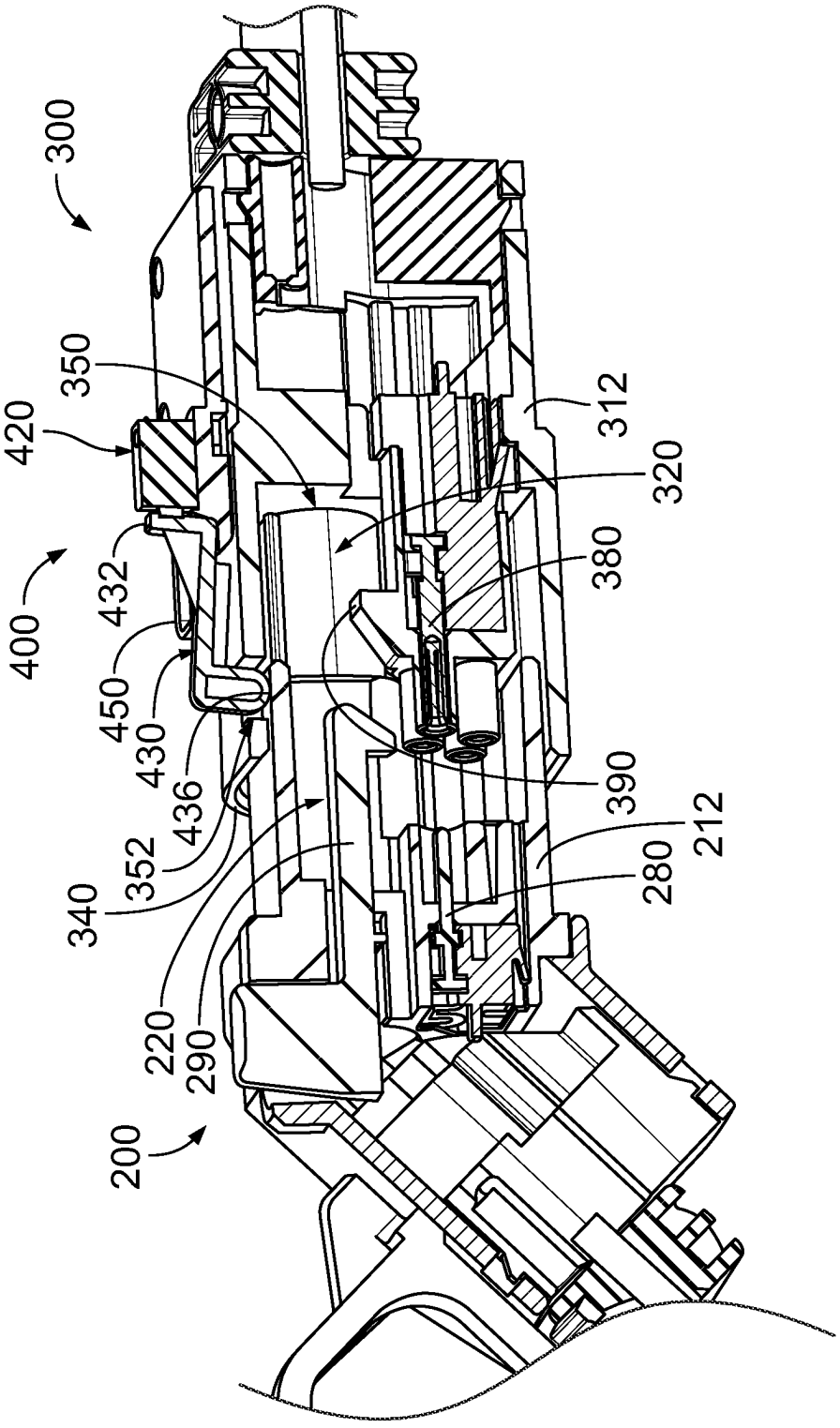
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FIG. 12

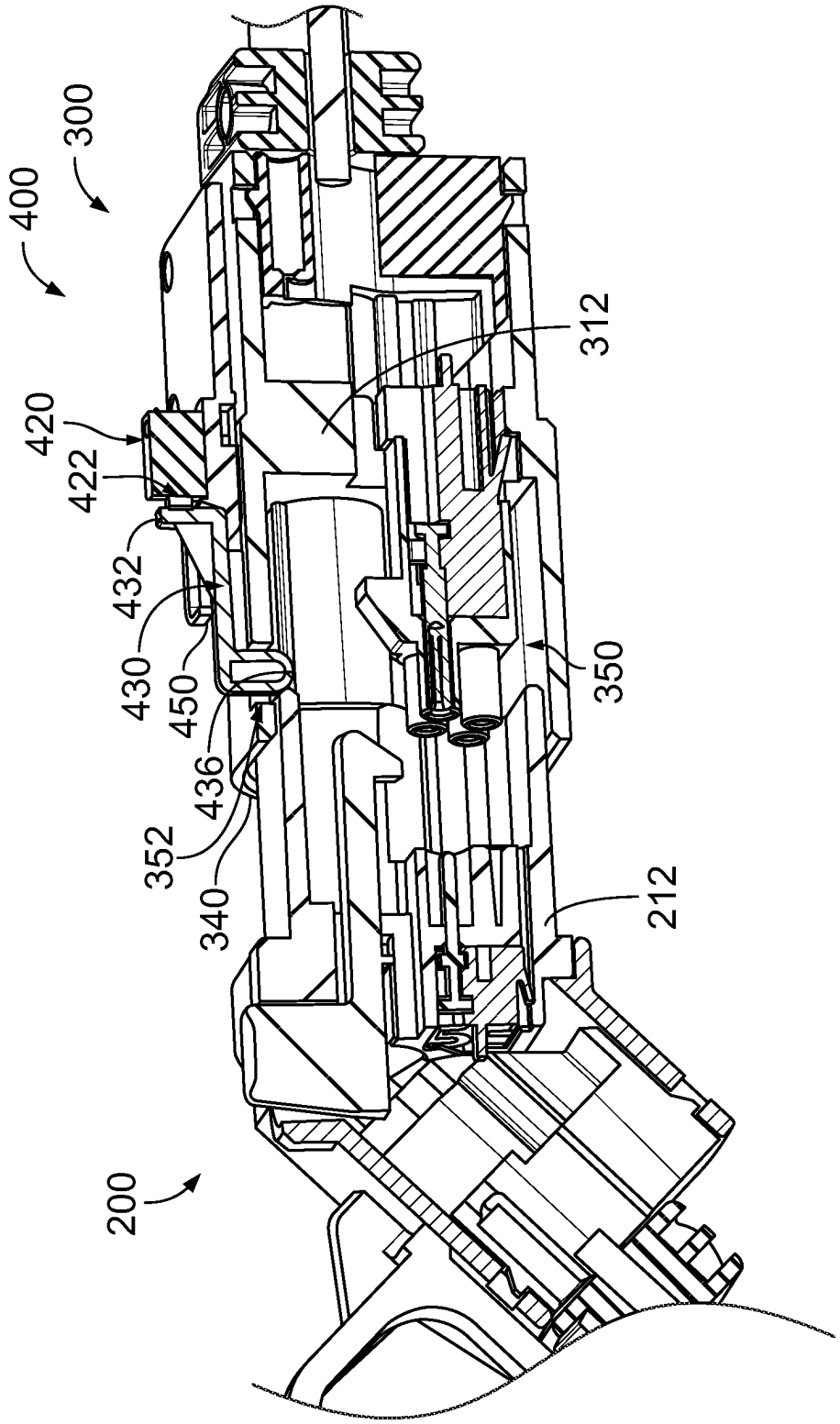

FIG. 13

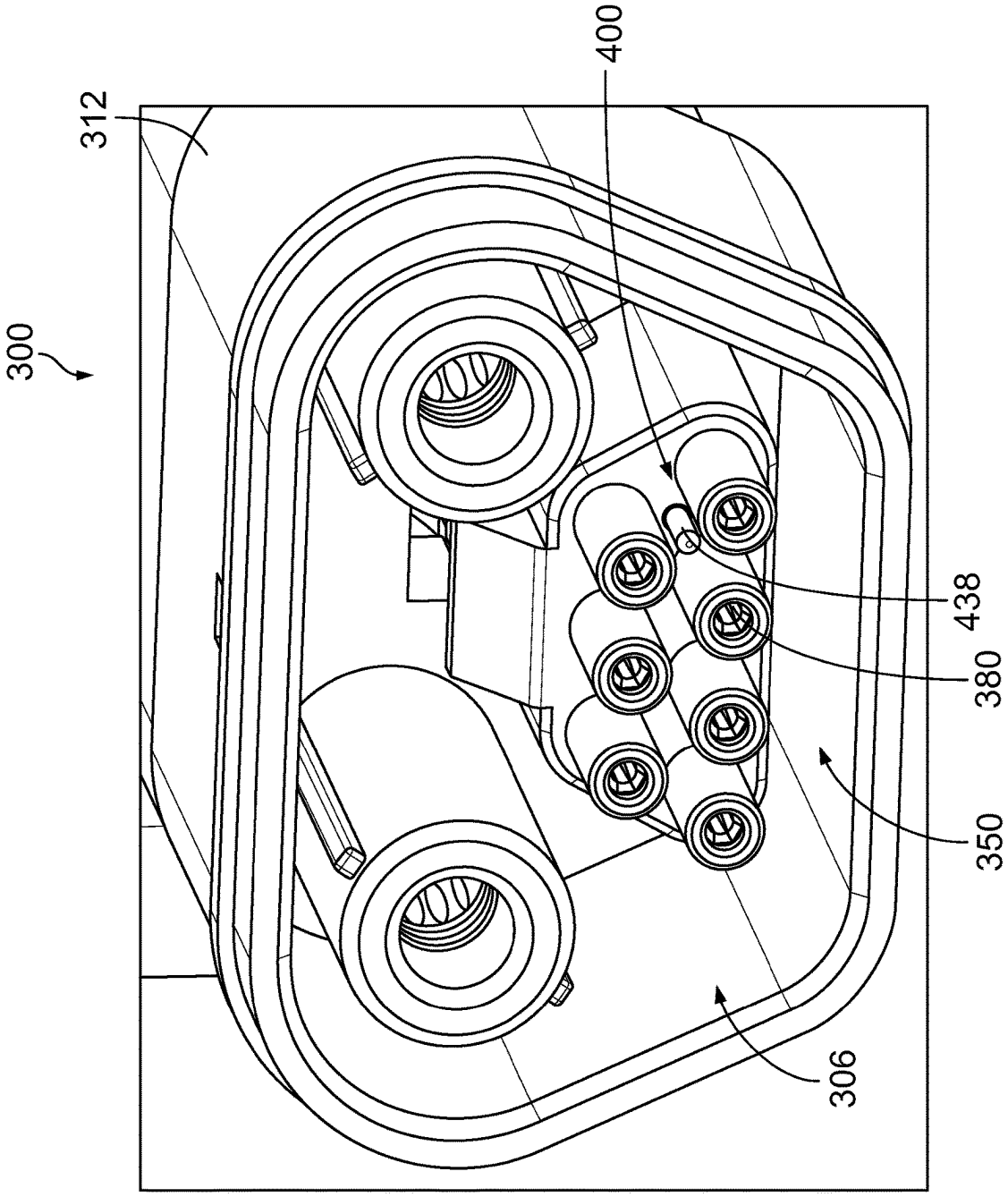

FIG. 14

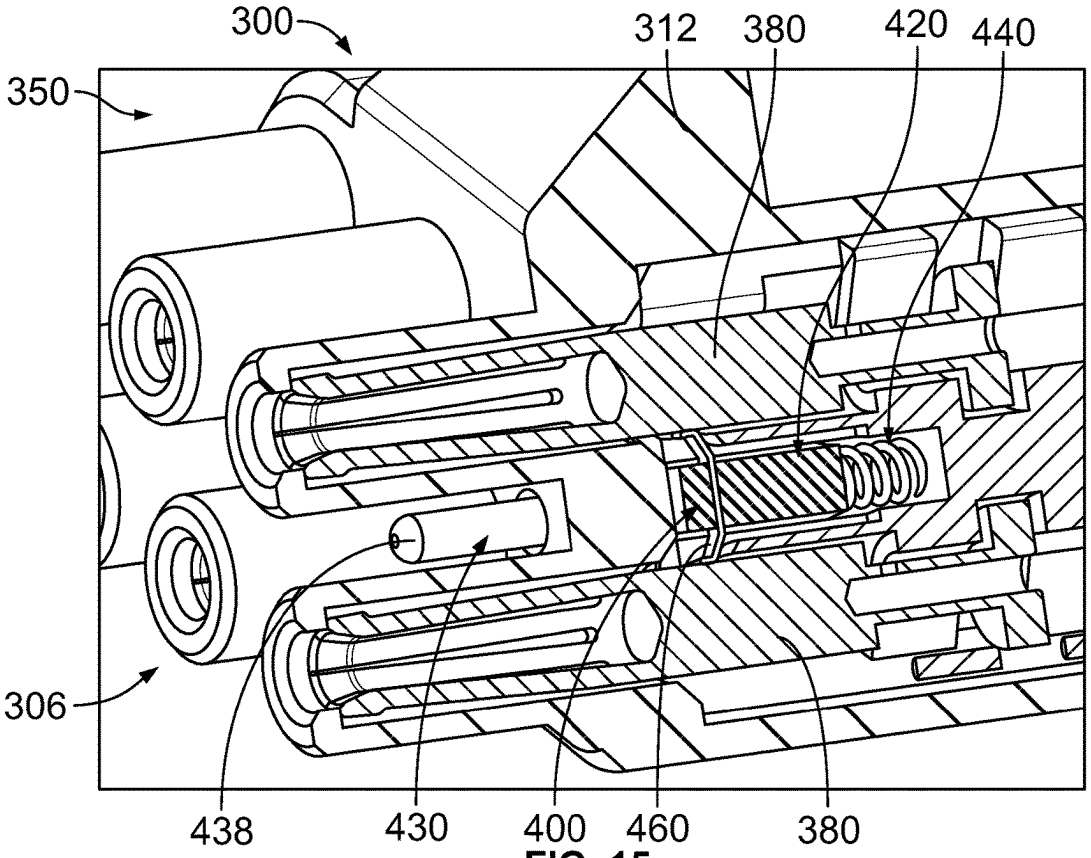
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FIG. 15

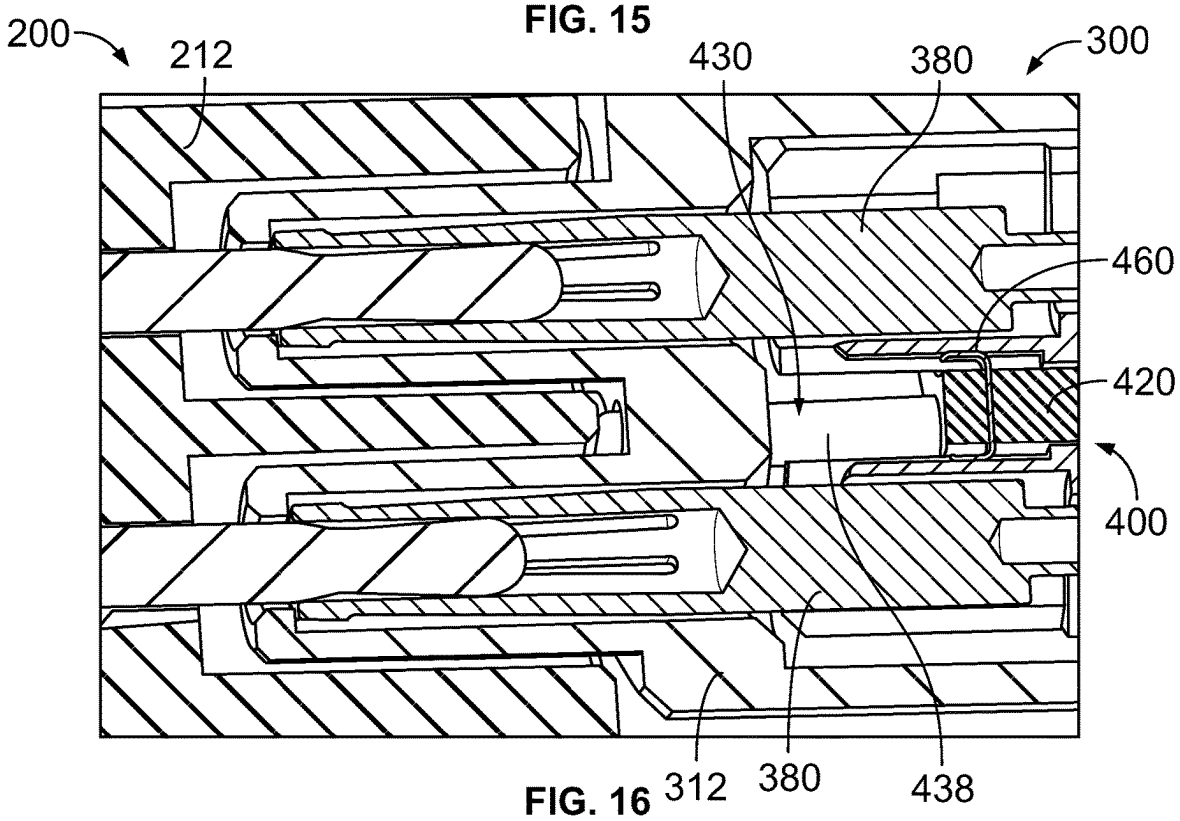
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FIG. 16

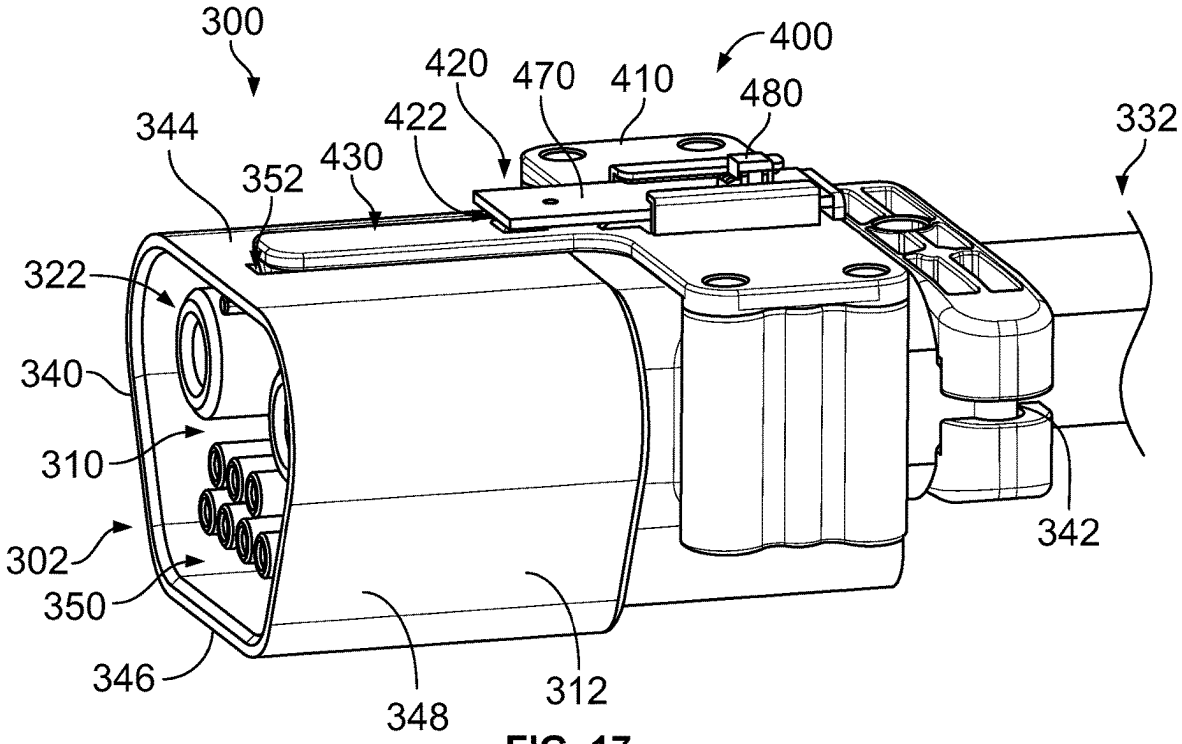
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FIG. 17

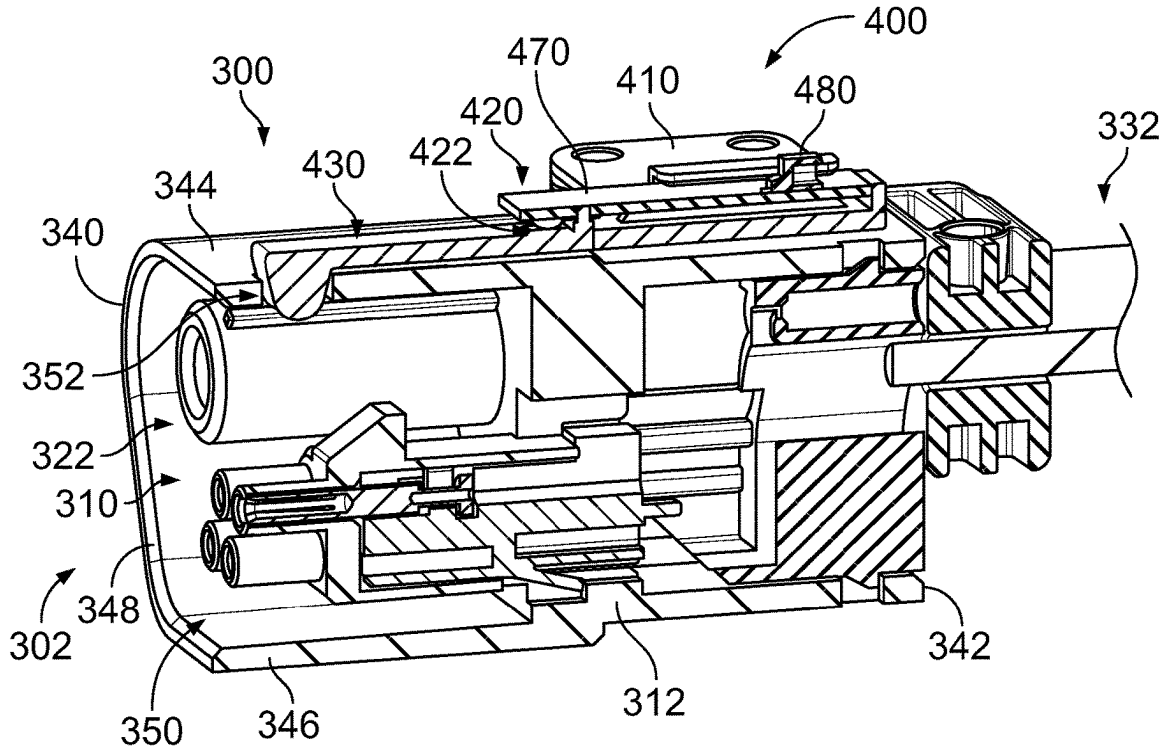
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FIG. 18

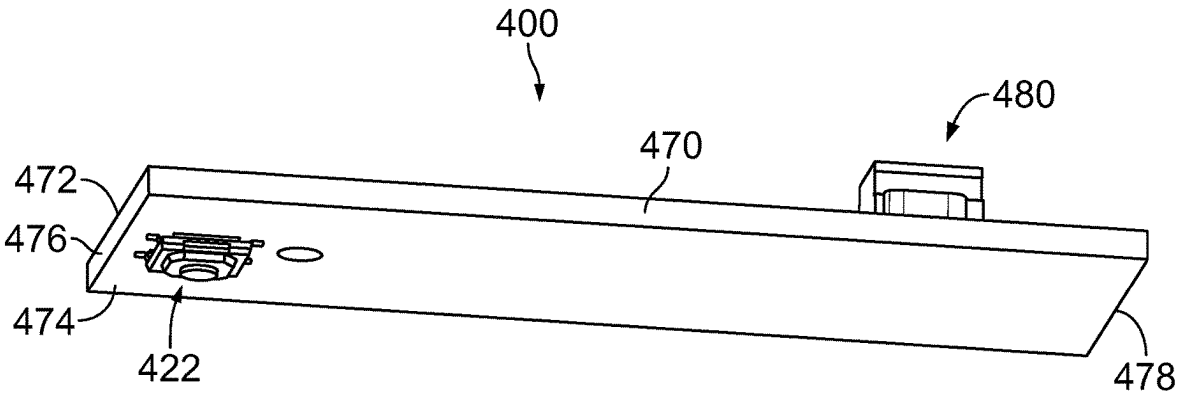

FIG. 19

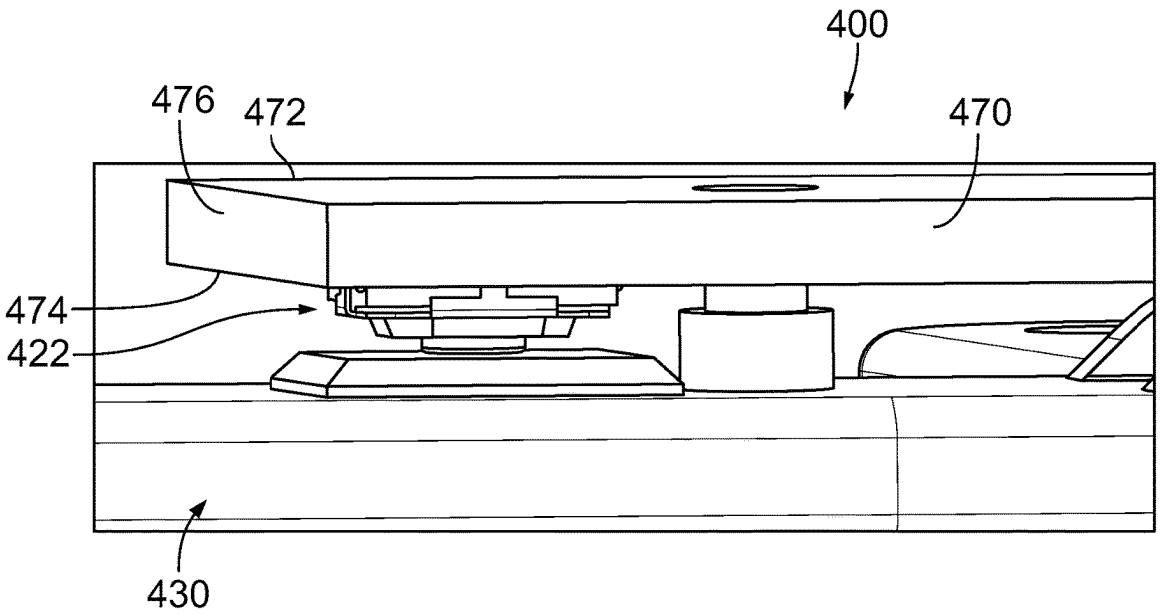

FIG. 20

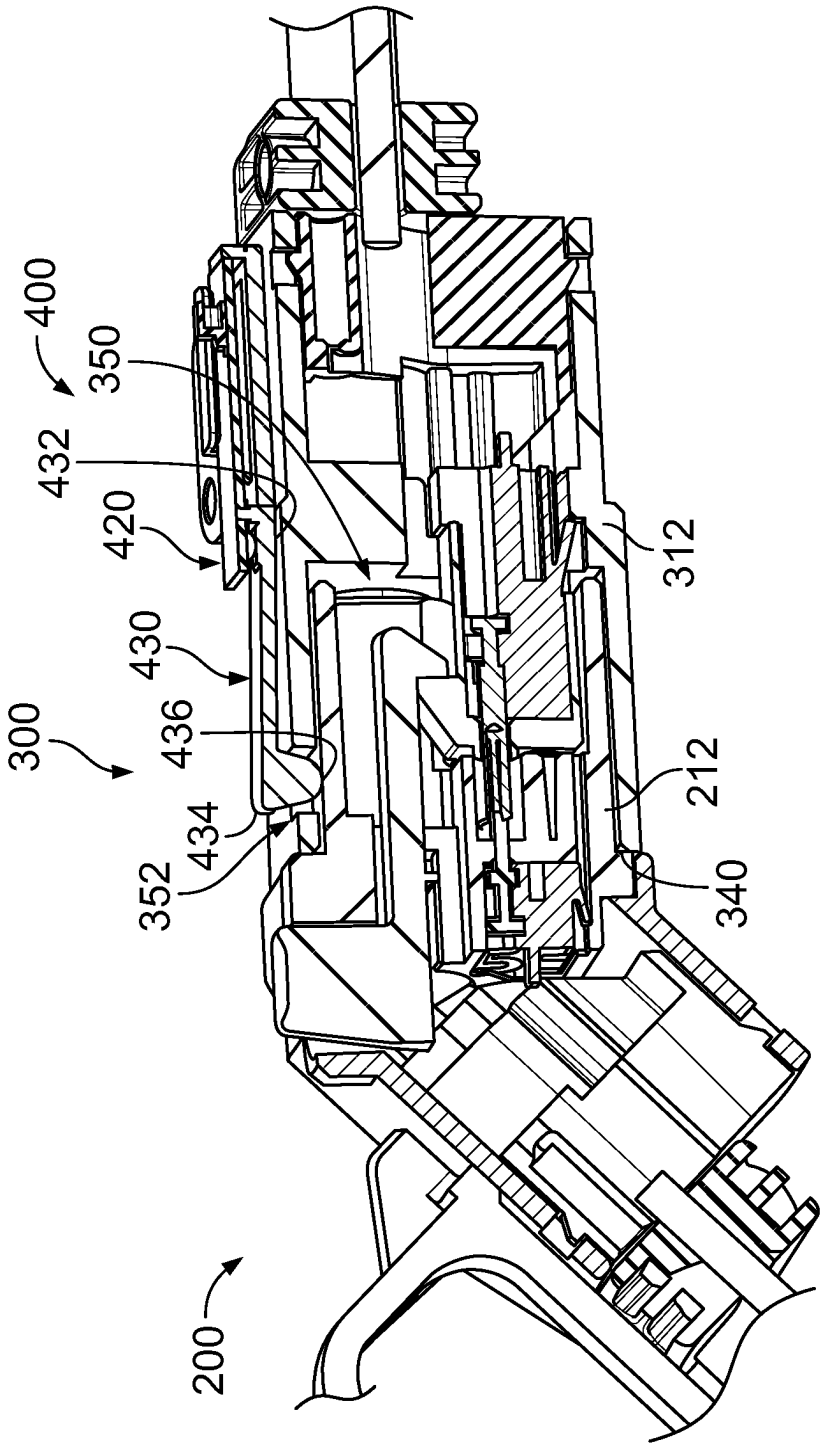

FIG. 21

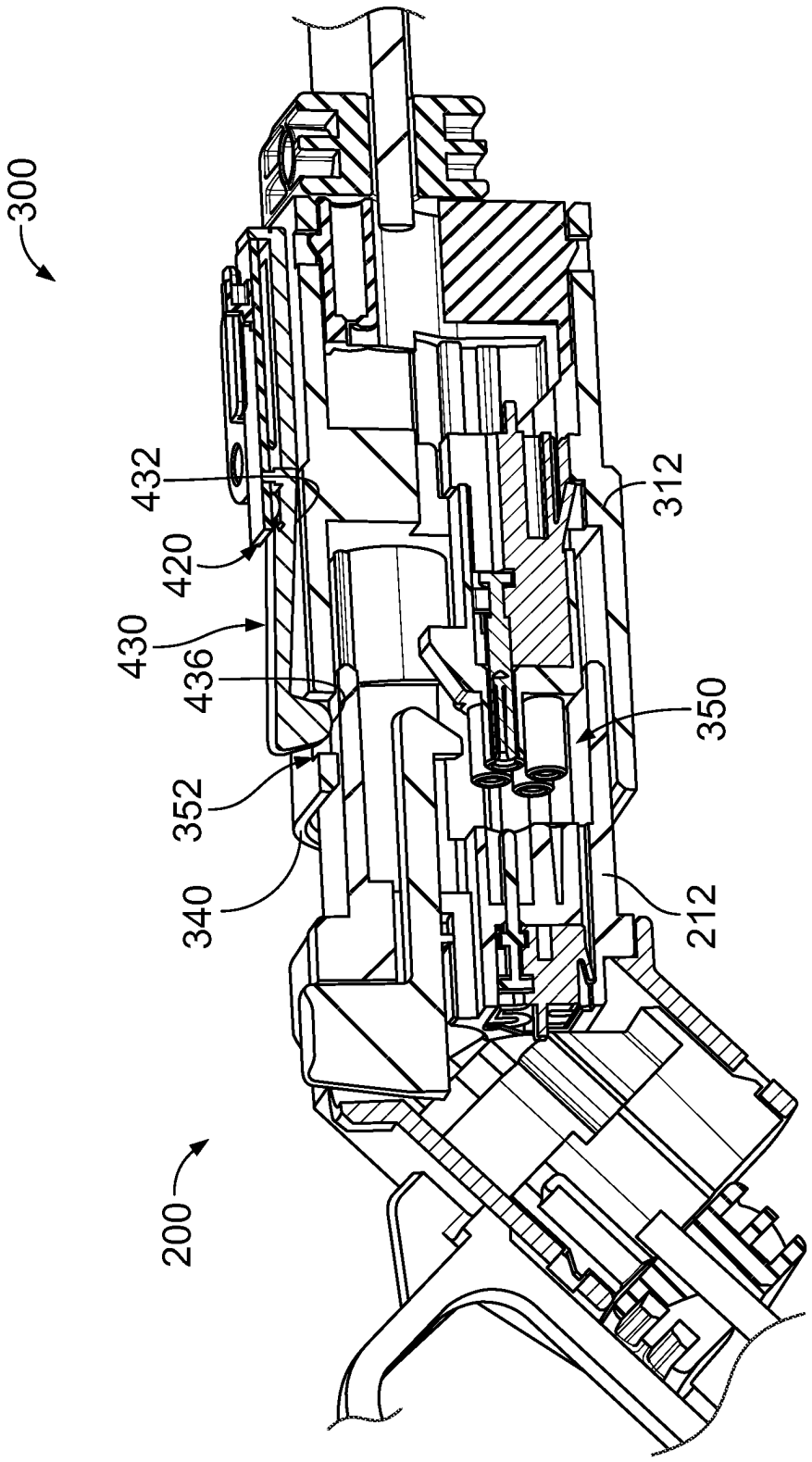

FIG. 22

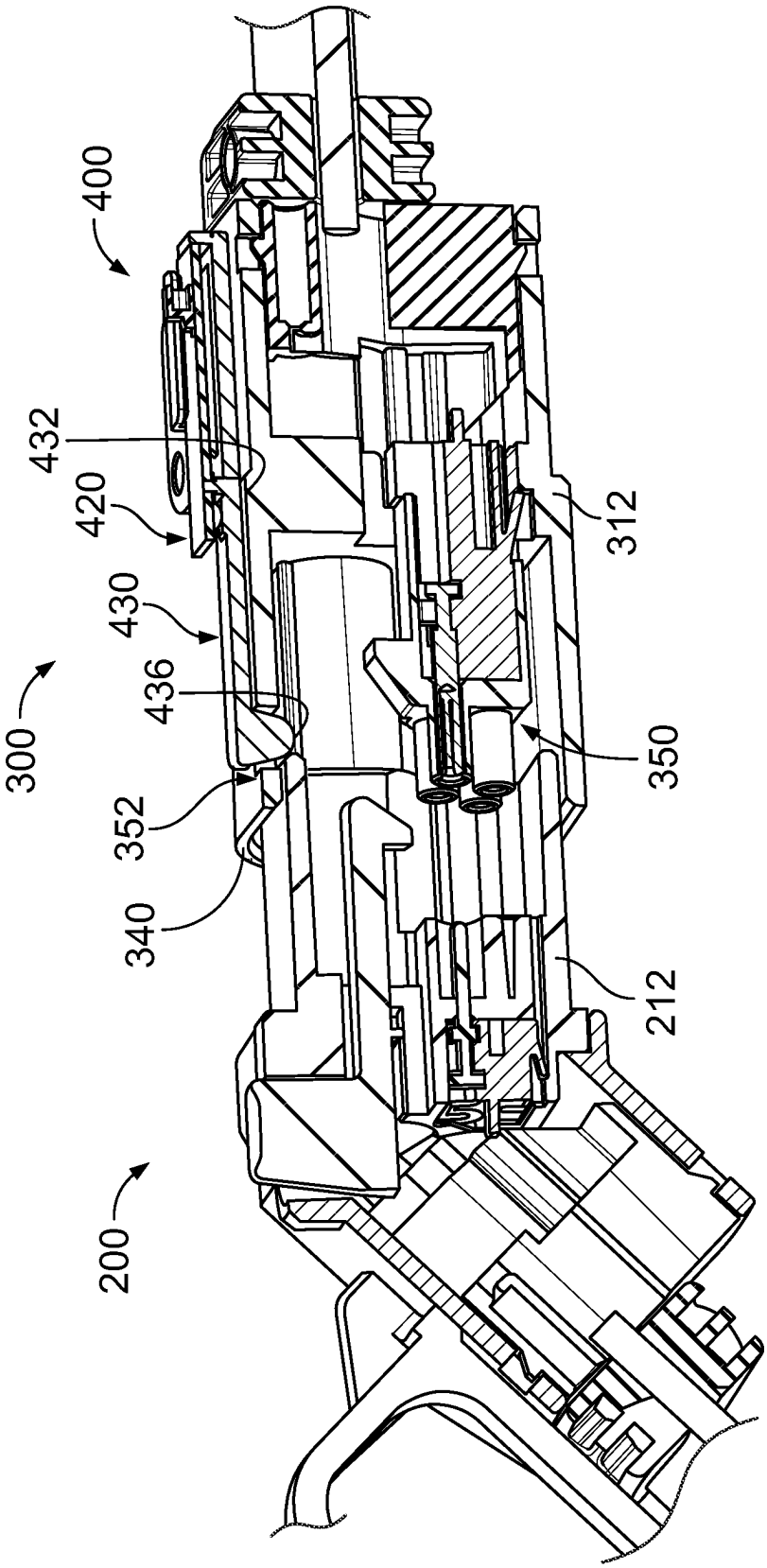

FIG. 23

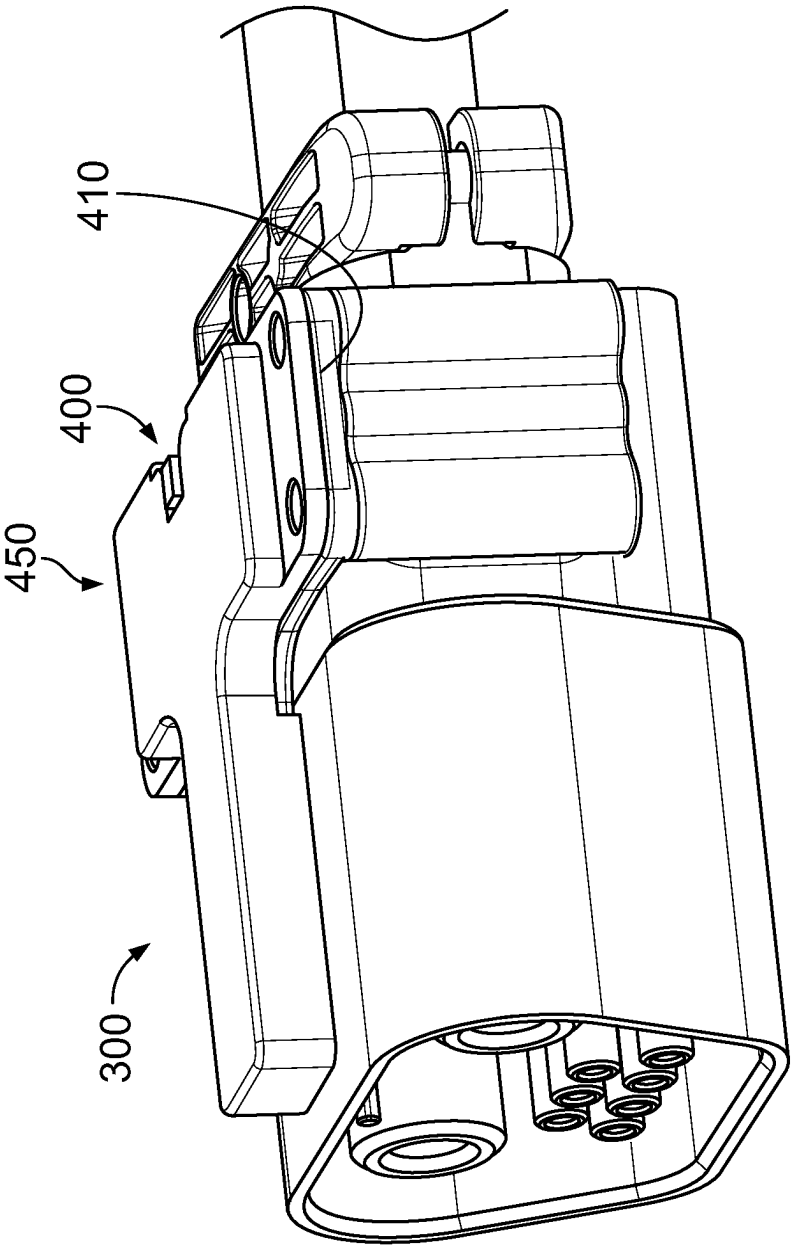

FIG. 24

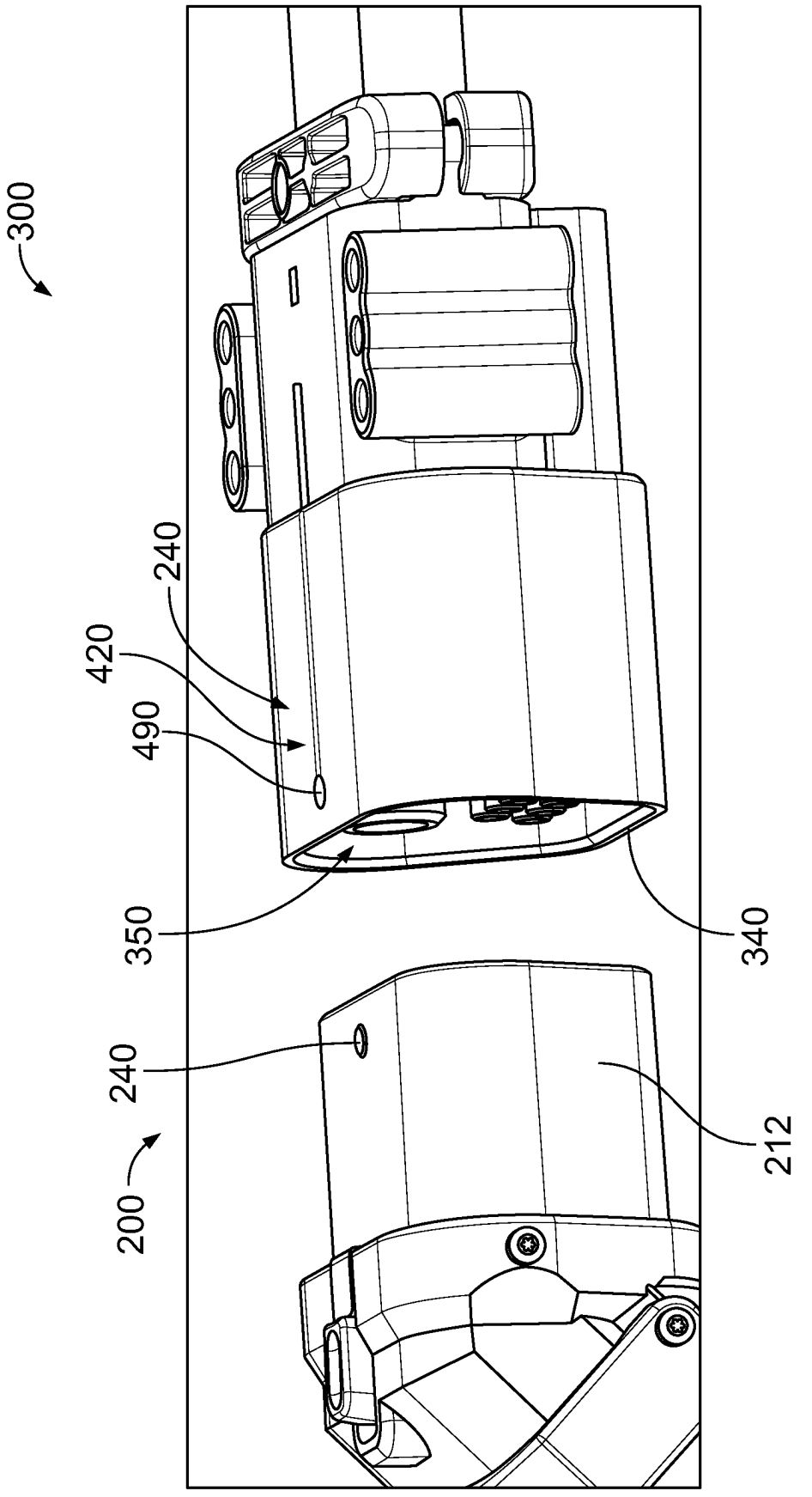

FIG. 25

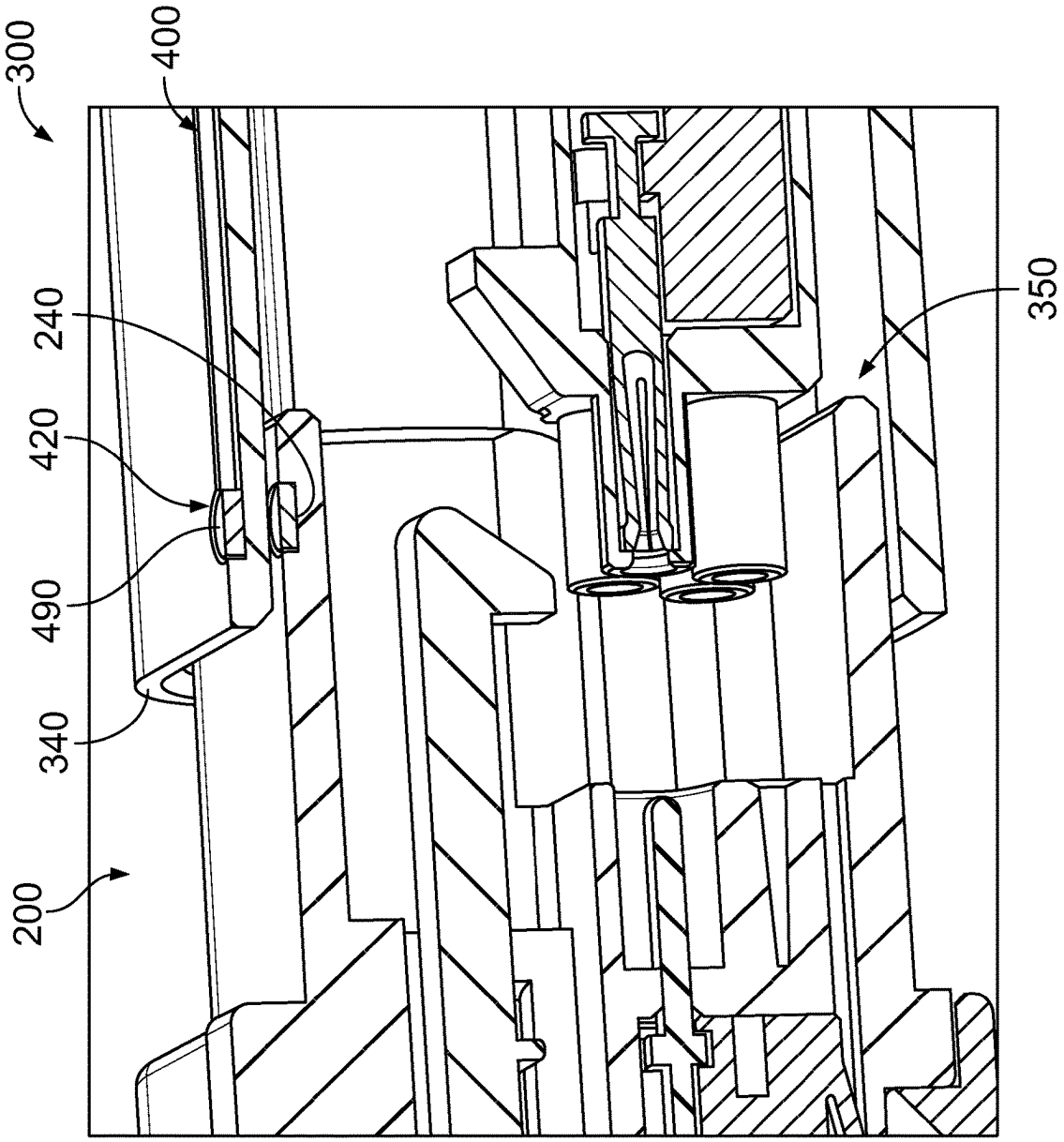

FIG. 26

CONNECTOR MATING SENSOR ASSEMBLY FOR POWER CONNECTOR SYSTEM

BACKGROUND OF THE INVENTION

[0001] The subject matter herein relates generally to power connectors.

[0002] Mobile devices, such as electric vehicles, mobile robots, or other types of rechargeable mobile vehicles are movable within an environment to perform a task. The mobile devices need to be recharged from time to time. The mobile devices are returned to a charging station to supply power to the mobile device and recharge the batteries of the mobile device. A charging connector may be plugged onto a power connector of the mobile device to recharge the batteries of the mobile device. The charging connectors are susceptible to damage if the mobile device moves prior to full disconnection of the charging connectors. Some power connectors include a first mate, last break sensor for the contacts of the connectors to indicate to the system that the contacts are disconnected. However, such systems do not indicate when the housings or other components are fully disconnected.

[0003] A need remains for a charging connector system for mobile devices that indicates full disconnection of the charging connectors.

BRIEF DESCRIPTION OF THE INVENTION

[0004] In one embodiment, a receive charging device for a mobile device is provided. The receive charging device includes a receive power connector that has a receive housing extending between a front and a rear. The receive power connector has a mating end at the front. The receive housing includes a receptacle at the mating end configured to receive a supply power connector along a mating axis. The receive power connector has a cable end at the rear. The receive charging device includes a contact assembly held by the receive housing. The contact assembly includes receive power contacts for mating with supply power contacts of the supply power connector. The receive charging device includes a cable assembly coupled to the contact assembly. The cable assembly includes power cables terminated to the corresponding receive power contacts. The power cables extend from the cable end. The receive charging device includes a connector mating sensor assembly configured to be operably coupled to the supply power connector to indicate a mating status of the receive power connector with the supply power connector. The mating status is one of connected or disconnected.

[0005] In another embodiment, a receive charging device for a mobile device is provided. The receive charging device includes a receive power connector that has a receive housing extending between a front and a rear. The receive power connector has a mating end at the front. The receive housing includes a receptacle at the mating end configured to receive a supply power connector along a mating axis. The receive power connector has a cable end at the rear. The receive charging device includes a contact assembly held by the receive housing. The contact assembly includes receive power contacts for mating with supply power contacts of the supply power connector. The receive charging device includes a cable assembly coupled to the contact assembly. The cable assembly includes power cables terminated to the corresponding receive power contacts. The power cables extend from the cable end. The receive charging device includes a connector mating sensor assembly configured to be operably coupled to the supply power connector to indicate a mating status of the receive power connector with the supply power connector. The mating status is one of connected or disconnected. The connector mating sensor assembly includes a connector mating sensor has a switch element. The connector mating sensor assembly includes an actuator operably coupled to the switch element. The actuator has an engagement tip located in the receptacle to interface with the supply power connector when the supply power connector is in the receptacle to activate the switch element indicating the connected mating status. The actuator is released when the supply power connector is removed from the receptacle to deactivate the switch element indicating the disconnected mating status.

[0006] In a further embodiment, a charging system is provided and includes a supply charging device that includes a supply power connector that has a supply housing extending between a front and a rear. The supply housing has a top and a bottom. The supply power connector has a mating end at the front. The supply power connector has a cable end opposite the mating end. The supply power connector includes supply power contacts held by the supply housing. The supply charging device includes a supply cable assembly coupled to the supply power connector and extends from the cable end. The supply cable assembly includes supply power cables terminated to the corresponding supply power contacts. The charging system includes a receive charging device for a mobile device. The receive charging device includes a receive power connector has a receive housing extends between a front and a rear. The receive power connector has a mating end at the front configured to be mated with the mating end of the supply power connector. The receive housing includes a receptacle at the mating end configured to receive a supply power connector along a mating axis. The receive power connector has a cable end at the rear. The receive charging device includes a receive contact assembly held by the receive housing includes receive power contacts for mating with the supply power contacts of the supply power connector. The receive charging device includes a receive cable assembly coupled to the receive contact assembly and extends from the cable end. The receive cable assembly includes receive power cables terminated to the corresponding receive power contacts. The receive charging device includes a connector mating sensor assembly configured to be operably coupled to the supply power connector to indicate a mating status of the receive power connector with the supply power connector. The mating status is one of connected or disconnected.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] FIG. **1** illustrates a charging system for charging a mobile device in accordance with an exemplary embodiment.

[0008] FIG. **2** illustrates a charging system for charging a mobile device in accordance with an exemplary embodiment.

[0009] FIG. **3** illustrates a front view of the receive charging device in accordance with an exemplary embodiment.

[0010] FIG. **4** illustrates a front view of the supply charging device in accordance with an exemplary embodiment.

[0011] FIG. **5** is a front perspective view illustrating the receive charging device in accordance with an exemplary embodiment.

[0012] FIG. **6** is a cross sectional view of a portion of the receive charging device in accordance with an exemplary embodiment.

[0013] FIG. **7** is a cross sectional view of a portion of the charging system showing the supply charging device partially mated to or partially unmated from the receive charging device in accordance with an exemplary embodiment.

[0014] FIG. **8** is a front perspective view illustrating the receive charging device in accordance with an exemplary embodiment.

[0015] FIG. **9** is a cross sectional view of a portion of the receive charging device in accordance with an exemplary embodiment.

[0016] FIG. **10** is a front perspective view of the receive charging device in accordance with an exemplary embodiment.

[0017] FIG. **11** is a cross sectional view of a portion of the charging system showing the supply charging device fully mated to the receive charging device in accordance with an exemplary embodiment.

[0018] FIG. **12** is a cross sectional view of a portion of the charging system showing the supply charging device partially mated to the receive charging device in accordance with an exemplary embodiment.

[0019] FIG. **13** is a cross sectional view of a portion of the charging system showing the supply charging device unmated from the receive charging device and being removed from the receive charging device in accordance with an exemplary embodiment.

[0020] FIG. **14** is a front perspective view illustrating the receive charging device in accordance with an exemplary embodiment.

[0021] FIG. **15** is a cross sectional view of a portion of the receive charging device in accordance with an exemplary embodiment.

[0022] FIG. **16** is a cross sectional view of a portion of the charging system showing the supply charging device mated to the receive charging device in accordance with an exemplary embodiment.

[0023] FIG. **17** is a front perspective view illustrating the receive charging device in accordance with an exemplary embodiment.

[0024] FIG. **18** is a cross sectional view of a portion of the receive charging device in accordance with an exemplary embodiment.

[0025] FIG. **19** illustrates the connector mating sensor assembly including a printed circuit board having an upper surface and a lower surface in accordance with an exemplary embodiment.

[0026] FIG. **20** illustrates an enlarged view of a portion of the receive charging device showing the connector mating sensor assembly in accordance with an exemplary embodiment.

[0027] FIG. **21** is a cross sectional view of a portion of the charging system showing the supply charging device fully mated to the receive charging device in accordance with an exemplary embodiment.

[0028] FIG. **22** is a cross sectional view of a portion of the charging system showing the supply charging device partially mated to the receive charging device in accordance with an exemplary embodiment.

[0029] FIG. **23** is a cross sectional view of a portion of the charging system showing the supply charging device unmated from the receive charging device and being removed from the receive charging device in accordance with an exemplary embodiment.

[0030] FIG. **24** is a front perspective view of the receive charging device in accordance with an exemplary embodiment.

[0031] FIG. **25** is a front perspective view illustrating the receive charging device in accordance with an exemplary embodiment.

[0032] FIG. **26** is a cross sectional view of a portion of the receive charging device in accordance with an exemplary embodiment.

DETAILED DESCRIPTION OF THE INVENTION

[0033] FIG. **1** illustrates a charging system **10** for charging a mobile device **12** in accordance with an exemplary embodiment. The charging system **10** includes a supply charging device **20** and a mobile charging device **30**. The mobile charging device **30** is provided on the mobile device **12**. The supply charging device **20** is provided on a charging component **14**. The charging component **14** may extend from a wall outlet or charging station **16**. The charging component **14** may be at a docketing station for the mobile device **12**. The charging component **14** may include a charging plug at an end of a cable bundle that is plugged into the mobile charging device **30** to charge a battery of the mobile device **12**. The charging component **14** may be provided in a room or building in a fixed location and the mobile device **12** may be movable within the room or building and returned to the vicinity of the charging station **16** for connection to the charging component **14** to recharge the mobile device **12**. The supply charging device **20** receives power from a power supply **40**.

[0034] In an exemplary embodiment, the mobile device **12** may be an electric vehicle that is movable within an environment to perform tasks and may return to the supply charging device **20** to charge the autonomous mobile device **12**. In various embodiments, the mobile device **12** may be a forktruck. In other various embodiments, the mobile device **12** may be an autonomous mobile device, such as a mobile robot used to perform tasks in a factory, a hotel, a store or another environment. For example, the mobile robot may be used to scan items on shelves, deliver items from one location to another location, or perform other tasks. The mobile charging device **30** is mounted to a body **18** of the mobile device **12**.

[0035] The mobile charging device **30** is a receive charging device **30** configured to receive power from the supply charging device **20**. In an exemplary embodiment, the receive charging device **30** includes a connector mating sensor assembly **50** configured to be operably coupled to a supply power connector of the supply charging device **20** to indicate a mating status. The mating status is a mating status of a receive power connector of the receive charging device **30** with the supply power connector. In an exemplary embodiment, the mating status is one of a connected mating status when the supply power connector is mated or connected with the receive power connector or a disconnected mating status when the supply power connector is unmated or disconnected from the receive power connector. In an exemplary embodiment, operation of the mobile device **12**

may be controlled based on the mating status. For example, during the connected mating status, the mobile device **12** may be unable to move. For example, the electric motor may be unable to operate when in the connected mating status. The mobile device **12** may be able to move only when the connector mating sensor assembly **50** is in the disconnected status.

[0036] FIG. **2** illustrates a charging system **100** for charging a mobile device **102** in accordance with an exemplary embodiment. The charging system **100** includes a supply charging device **200** and a mobile charging device **300**. The mobile charging device **300** receives power from the supply charging device **200** when coupled thereto to charge a battery of the mobile device **102**. The mobile charging device **300** is a receive charging device, and may be referred to hereinafter as a receive charging device **300**, configured to receive power from the supply charging device **20**. FIG. **2** shows an angled version of the supply charging device **200**, wherein the power cables are oriented transverse or non-parallel to a mating axis **110**. In an alternative embodiment, the supply charging device **200** may be a straight version of the supply charging device **200**, wherein the power cables are oriented parallel to a mating axis **110**.

[0037] The receive charging device **300** is provided on the mobile device **102** and includes a mating end **302** configured to be mated with the supply charging device **200**. For example, the receive charging device **300** is configured to be coupled to a body or panel of the mobile device **102**. The supply charging device **200** is part of a charging component **104** and includes a mating end **202** configured to be mated with the receive charging device **300**. The mating end **202** of the supply charging device **200** is configured to be plugged into the mating end **302** of the receive charging device **300**.

[0038] With additional reference to FIGS. **3** and **4**, FIGS. **3** and **4** show front views of the receive charging device **300** and the supply charging device **200**, respectively. The receive charging device **300** (FIG. **3**) includes a receive power connector **310** having a receive housing **312**. The receive housing **312** includes a latching feature **390** to secure the supply charging device **200** to the receive charging device **300**. The receive power connector **310** includes a receive contact assembly **322** having a plurality of receive power contacts **320**. The receive contact assembly **322** is coupled to the receive housing **312**. The receive power connector **310** includes a cable assembly **332** having a plurality of receive power cables **330** terminated to the corresponding receive power contacts **320**.

[0039] The supply charging device **200** (FIG. **4**) includes a supply power connector **210** having a supply housing **212**. The supply housing **212** includes a latching feature **290** to secure the supply charging device **200** to the receive charging device **300**. The supply power connector **210** includes a supply contact assembly **222** having a plurality of supply power contacts **220**. The supply contact assembly **222** is coupled to the supply housing **212**. The supply power connector **210** includes a cable assembly **232** having a plurality of supply power cables **230** terminated to the corresponding supply power contacts **220**.

[0040] The mating end **202** of the supply charging device **200** is coupled to the mating end **302** of the receive charging device **300** along the mating axis **110**. For example, the mating end **202** is plugged into a receptacle **350** at the mating end **302**. The supply power connector **210** is mated with the receive power connector **310**. For example, the supply contacts of the supply contact assembly **222** are mated with the receive contacts of the receive contact assembly **322**. In the illustrated embodiment, the supply contacts are pin contacts and the receive contacts are socket contacts; however, other types of contacts may be used in alternative embodiments. When mated, signal contacts **280** of the supply charging device **200** are mated with the corresponding signal contacts **380** of the receive charging device **300**. When mated, the latching feature **290** of the supply charging device **200** is coupled to the latching feature **390** of the receive charging device **300** to securely couple the supply charging device **200** to the receive charging device **300**.

[0041] In an exemplary embodiment, the receive charging device **300** includes a connector mating sensor assembly **400** configured to be operably coupled to the supply power connector **210** of the supply charging device **200** to indicate a mating status of the devices **200**, **300**. The mating status is a mating status of the receive power connector **310** with the supply power connector **210**. In an exemplary embodiment, the mating status is one of a connected mating status when the supply power connector **210** is mated or connected with the receive power connector **310** or a disconnected mating status when the supply power connector **210** is unmated or disconnected from the receive power connector **310**. In an exemplary embodiment, operation of the mobile device **102** may be controlled by the connector mating sensor assembly **400** based on the mating status. For example, when the mating status is a connected mating status, the mobile device **102** may be unable to move. For example, the electric motor may be unable to operate when in the connected mating status. The mobile device **102** may be able to move only when the connector mating sensor assembly **400** is in the disconnected mating status.

[0042] In an exemplary embodiment, the connector mating sensor assembly **400** determines the mating status of the receive housing **312** with the supply housing **212** of the supply power connector **210**. For example, the connector mating sensor assembly **400** determines when the supply housing **212** is removed from the receive housing **312** indicating that the supply charging device **200** has been fully disconnected from the receive charging device **300**. In an exemplary embodiment, the connector mating sensor assembly **400** determines the mating status of the receive power connector **310** relative to the supply power connector **210** independent of a mating status of the receive power contacts relative to the supply power contacts. For example, because the power contacts are recessed inside the housings **212**, **312**, the power contacts unmate prior to the housings being unmated. The connector mating sensor assembly **400** determines when the housings are unmated and thus it is safe for the mobile device **102** to move without damaging the components of the supply charging device **200** or the receive charging device **300**. In an exemplary embodiment, the connector mating sensor assembly **400** monitors the mating status at the front of the receive housing **312**, such as to determine when the supply housing **212** is removed from the front of the receptacle **350** of the receive housing **312**.

[0043] FIG. **5** is a front perspective view illustrating the receive charging device **300** in accordance with an exemplary embodiment. FIG. **6** is a cross sectional view of a portion of the receive charging device **300** in accordance with an exemplary embodiment. FIG. **7** is a cross sectional view of a portion of the charging system showing the supply

charging device **200** partially mated to or partially unmated from the receive charging device **300**. FIG. **7** shows the supply charging device **200** immediately before activation of the connector mating sensor assembly **400** or immediately after deactivation of the connector mating sensor assembly **400**, depending on the direction of movement of the supply charging device **200**.

[0044] The receive charging device **300** includes the receive power connector **310**, the receive contact assembly **322**, the receive cable assembly **332**, and the connector mating sensor assembly **400**. The receive power connector **310** includes the receive housing **312**. In an exemplary embodiment, the connector mating sensor assembly **400** is mounted to an exterior of the receive housing **312**. The connector mating sensor assembly **400** is configured to monitor presence of the supply charging device **200** in the receptacle **350** of the receive housing **312**.

[0045] The receive housing **312** includes a front **340** and a rear **342**. The receive housing **312** includes a top **344** and a bottom **346**. The receive housing **312** includes sides **348** between the top **344** and the bottom **346**. Optionally, the sides may be angled, such as being non-parallel to each other. For example, the top **344** may be wider than the bottom **346**. In an exemplary embodiment, the receive housing **312** includes a flange **314** at the front **340**, which may be used to secure the receive housing **312** to the mobile device. In an exemplary embodiment, the mating end **302** is at the front **340** of the receive housing **312** and a cable end **304** of the receive power connector **310** is at the rear **342** of the receive housing **312**. The cables **330** enter/exit the receive housing **312** at the cable end **304**.

[0046] In an exemplary embodiment, the receive housing **312** includes a receive contact chamber **306** that receives the receive power contacts **320** and a receive cable chamber **308** that receives the receive power cables **330**. The receive contact chamber **306** is located at the front **340**. The receive cable chamber **308** is located at the rear **342**. The receive cable chamber **308** may be open at the rear **342** to receive the cables **330**. In an exemplary embodiment, the receive power contact **320** is a socket contact.

[0047] The connector mating sensor assembly **400** is provided to determine the mating status of the receive power connector **210**. For example, the connector mating sensor assembly **400** determines when the supply housing **212** (FIG. **7**) is located in the receptacle **350** of the receive housing **312** and when the supply housing **212** is removed from the receptacle **350** of the receive housing **312**. The connector mating sensor assembly **400** determines when the supply charging device **200** has been fully disconnected from the receive charging device **300**. In an exemplary embodiment, the connector mating sensor assembly **400** is mounted to the exterior of the receive housing **312**, such as to the top **344** of the receive housing **312**. However, the connector mating sensor assembly **400** may be mounted to the receive housing **312** at other locations, such as at the bottom **346** or at one of the sides **348**. A portion of the connector mating sensor assembly **400** may extend into the interior of the receptacle **350**, such as to interface with the supply housing **212**. In an exemplary embodiment, the receive housing **312** includes a window **352** therethrough providing access to the receptacle **350**. A portion of the connector mating sensor assembly **400** passes through the window **352** into the receptacle **350**.

[0048] In an exemplary embodiment, the connector mating sensor assembly **400** includes a carrier **410**. The carrier **410** may be mounted to the receive housing **312**, such as using fasteners. In various embodiments, the carrier **410** includes a mounting bracket **412** secured to the receive housing **312** using fasteners. The carrier **410** may include a planar base **414** extending along the exterior of the receive housing **312**, such as along the top **344**. The carrier **410** may include one or more support walls **416** extending from the base **414**. The support walls **416** may be used to support various components of the connector mating sensor assembly **400**. In various embodiments, the connector mating sensor assembly **400** may include a cover (not shown) coupled to the carrier **410**. The cover is used to cover various components of the connector mating sensor assembly **400**, such as to protect the components from the environment, such as from dirt, debris, moisture, and the like.

[0049] In an exemplary embodiment, the connector mating sensor assembly **400** includes a connector mating sensor **420** used to sense or monitor the mating status of the receive charging device **300**. The connector mating sensor **420** may be used as part of a control system for the mobile device **102**, such as a safety interlock to restrict/allow control or operation of the mobile device based on the mating status (for example, connected/disconnected) of the receive charging device **300**. For example, the connector mating sensor **420** may be wired to a control relay, a motor contactor control circuit, or as an input to a programmable logic controller. The connector mating sensor **420** may be mounted to the carrier **410**. In other various embodiments, the connector mating sensor **420** may be directly mounted to the receive housing **312**.

[0050] In an exemplary embodiment, the connector mating sensor **420** includes a switch element **422**. The switch element **422** may switch between different states, such as a first state and a second state. The first state may be an open state forming an open circuit and the second state may be a closed state forming a closed circuit. The switch element **422** may a normally open switch forming an open circuit when the receive charging device **300** is disconnected from the supply charging device **200**. The switch element **422** may change state, for example form a closed circuit, when the supply charging device **200** is mated with (for example, plugged into) the receive charging device **300**. In an exemplary embodiment, the switch element **422** is a limit switch. The switch element **422** may include a button, a lever, a roller, a plunger, a whisker, or other type of activation element. The activation element may be a snap-action switch. The limit switch can be used in rugged environments. The limit switch has ease of installation. The limit switch has reliable operation and can be operated over many cycles, such as over 10,000 mating cycles. Other types of sensors may be used in alternative embodiments, such as proximity sensors, a reed switch, pogo-pin sensors, or other types of sensors.

[0051] In an exemplary embodiment, the connector mating sensor **420** includes one or more terminals or leads **424** for connection to wires, a connector, a controller, a printed circuit board, or other electrical component. In various embodiments, the connector mating sensor **420** may include three leads, such as a common lead, a normally open lead, and a normally closed lead. The connector mating sensor **420** may include a movable contact (not shown) in the

switch body that is movable between the normally open lead and the normally closed lead when the switch is activated and deactivated.

[0052] In an exemplary embodiment, the connector mating sensor **420** includes an actuator **430** operably coupled to the switch element **422**. The actuator **430** is movable relative to the switch body. The actuator **430** is used to activate and deactivate the switch element **422** based on the mating status of the receive charging device **300**. The actuator **430** is configured to be located in the receptacle **350** to interface with the supply housing **212** when the supply charging device **200** is in the receptacle **350** to activate the switch element **422** indicating a connected mating status. The actuator **430** is configured to be released from the supply housing **212** when the supply charging device **200** is removed from the receptacle **350** to deactivate the switch element **422** indicating a disconnected mating status. In an exemplary embodiment, the actuator **430** is pivotable between an actuated position and a released position. The actuator **430** activates the switch element **422** in the actuated position. The switch element **422** is deactivated when the actuator **430** is in the released position.

[0053] The actuator **430** extends between a first end **432** and a second end **434**. The first end **432** is located at the switch element **422**. For example, the first end **432** may be mounted to the switch body of the connector mating sensor **420**. The first end **432** may be used to activate the switch element **422**. The second end **434** is configured to interface with the supply charging device **200**. For example, the actuator **430** may extend into the window **352** into the interior of the receive housing **312** proximate to the front **340** of the receive housing **312**. In an exemplary embodiment, the actuator **430** includes an engagement tip **436** at the second end **434** configured to engage the supply housing **212** when the supply charging device **200** is plugged into the receptacle **350**. In an exemplary embodiment, the actuator **430** is a metal beam that may be stamped and formed into a predetermined shape, such as to include a tab or finger extending through the window **352** into the receptacle **350**. The actuator **430** is deflectable. For example, the actuator **430** may be flexed upward to activate the switch element **422** by the supply housing **212** when the supply charging device **200** is plugged into the receptacle **350**.

[0054] FIG. **8** is a front perspective view illustrating the receive charging device **300** in accordance with an exemplary embodiment. FIG. **9** is a cross sectional view of a portion of the receive charging device **300** in accordance with an exemplary embodiment. FIGS. **8** and **9** show the connector mating sensor assembly **400** in a different orientation. FIGS. **8** and **9** show the connector mating sensor assembly **400** having a different type of actuator **430**, such as a pivot lever.

[0055] The receive charging device **300** includes the receive power connector **310**, the receive contact assembly **322**, the receive cable assembly **332**, and the connector mating sensor assembly **400**. The receive power connector **310** includes the receive housing **312** having the receptacle **350**. The connector mating sensor assembly **400** is mounted to an exterior of the receive housing **312**, such as the top **344** of the receive housing **312**. For example, the carrier **410** is mounted to the receive housing **312**.

[0056] The receive housing **312** includes the front **340**, the rear **342**, the top **344**, the bottom **346**, and the sides **348**. The receptacle **350** is open at the mating end **302**, such as at the front **340**, to receive the supply charging device **200** (shown in FIG. **2**). The connector mating sensor assembly **400** extends into the receptacle **350** to interface with the supply charging device **200**. For example, the actuator **430** of the connector mating sensor assembly **400** passes through the window **352** into the receptacle **350**. The connector mating sensor assembly **400** determines the mating status of the receive power connector **210** by determining when the supply housing **212** is located in the receptacle **350** and when the supply housing **212** is removed from the receptacle **350** of the receive housing **312**.

[0057] The connector mating sensor assembly **400** includes the connector mating sensor **420** to sense or monitor the mating status of the receive charging device **300**. In the illustrated embodiment, the connector mating sensor **420** includes the switch element **422** configured to control an operating circuit. The switch element **422** may be a limit switch.

[0058] The connector mating sensor **420** includes the actuator **430** operably coupled to the switch element **422**. The actuator **430** may be a molded part. In an exemplary embodiment, the actuator **430** is pivotably coupled to the carrier **410**. The actuator **430** is pivotable between an actuated position and a released position. The actuator **430** is movable (for example, pivots) relative to the switch body of the connector mating sensor **420**. In an exemplary embodiment, the connector mating sensor assembly **400** includes a biasing element **440** engaging the actuator **430** and forcing the actuator **430** toward the released position. The biasing element **440** may be a spring arm extending from the carrier **410** to interface with the actuator **430**. The biasing element **440** may be integral with the carrier **410**, such as being co-molded with the carrier **410**. In the illustrated embodiment, the biasing element **440** presses downward on the actuator **430** to pivot the second end **434** downward into the receptacle to interface with the supply housing **212**. The first end **432** of the actuator **430** is configured to engage and activate the switch element **422** based on the mating status of the receive charging device **300**. The second end **434** of the actuator **430** extends through the window **352** and is located in the receptacle **350** to interface with the supply housing **212** when the supply charging device **200** is in the receptacle **350** to activate the switch element **422** indicating a connected mating status. The engagement tip **436** at the second end **434** is configured to engage the supply housing **212** when the supply charging device **200** is plugged into the receptacle **350** to rotate the actuator **430** to the actuated position. The actuator **430** is configured to be released from the supply housing **212** when the supply charging device **200** is removed from the receptacle **350** to deactivate the switch element **422** indicating a disconnected mating status.

[0059] FIG. **10** is a front perspective view of the receive charging device **300** in accordance with an exemplary embodiment. In an exemplary embodiment, the connector mating sensor assembly **400** includes a cover **450** coupled to the carrier **410**. The cover **450** covers the various components of the connector mating sensor assembly **400**, such as the connector mating sensor **420** and the actuator **430**. The cover **450** protects the components from the environment, such as from dirt, debris, moisture, and the like.

[0060] FIG. **11** is a cross sectional view of a portion of the charging system showing the supply charging device **200** fully mated to the receive charging device **300**. FIG. **12** is a

cross sectional view of a portion of the charging system showing the supply charging device **200** partially mated to the receive charging device **300**. FIG. **13** is a cross sectional view of a portion of the charging system showing the supply charging device **200** unmated from the receive charging device **300** and being removed from the receive charging device **300**.

[0061] The connector mating sensor assembly **400** is configured to monitor presence of the supply charging device **200** in the receptacle **350** of the receive housing **312**. The connector mating sensor assembly **400** determines when the supply housing **212** is located in the receptacle **350** of the receive housing **312** and when the supply housing **212** is removed from the receptacle **350** of the receive housing **312**. The connector mating sensor assembly **400** determines when the supply charging device **200** has been fully disconnected from the receive charging device **300** (FIG. **13**).

[0062] When the supply charging device **200** is fully loaded into the receptacle **350** (FIG. **11**), the actuator **430** engages the supply housing **212** and is deflected or actuated outward to activate the switch element **422**. For example, the supply housing **212** engages the engagement tip **436** when the supply housing **212** is loaded into the receptacle **350** to force the actuator **430** outward to the actuated position. The first end **432** is pivoted to activate the switch element **422** indicating a connected mating status, corresponding to the supply charging device **200** being connected to the receive charging device **300** and thus it being unsafe to allow the mobile device **102** to move. In the mated position, the signal contacts **280** of the supply charging device **200** are mated with the corresponding signal contacts **380** of the receive charging device **300**. Similarly, the supply power contacts **220** are mated with the corresponding receive power contacts **320**. In the mated position, the latching feature **290** of the supply charging device **200** is mated with the latching feature **390** of the receive charging device **300**.

[0063] During unmating, the supply charging device **200** is pulled rearward to remove the supply charging device **200** from the receptacle **350** of the receive charging device **300**. During unmating, the signal contacts **280** are unmated from the signal contacts **380** and the supply power contacts **220** are unmated from the receive power contacts **320**. When partially unmated (FIG. **12**), even when the contacts are unmated, the supply housing **212** is still located in the receive housing **312**. If the mobile device **102** were to move when the charging devices **200**, **300** are partially unmated (not fully unmated), the components of the charging devices **200**, **300** may be damaged. In an exemplary embodiment, when the charging devices **200**, **300** are partially unmated, the actuator **430** remains engaged with the supply housing **212**, thus remaining in the deflected or actuated position to maintain the switch element **422** in the activated state indicating that the charging devices **200**, **300** are still in the connected mating status.

[0064] When unmated or disconnected (FIG. **13**), the supply housing **212** is removed from the front **340** of the receive housing **312**. The supply housing **212** releases the actuator **430**. The actuator **430** disengages from the supply housing **212** and is allowed to move or pivot downward to the released position. The biasing element **440** forces the actuator **430** to return to the released position. When the actuator **430** is moved to the released position, the first end **432** moves away from the switch element **422** to deactivate the connector mating sensor **420** indicating a disconnected mating status. In an exemplary embodiment, the window **352**, and thus the engagement tip **436** of the actuator **430**, are located proximate to (at or near) the front **340** of the receive housing **312**. As such, the actuator **430** is released only when the supply housing **212** is moved to the receptacle exit at the front **340** of the receive housing **312** indicating disconnection of the charging devices **200**, **300**.

[0065] FIG. **14** is a front perspective view illustrating the receive charging device **300** in accordance with an exemplary embodiment. FIG. **15** is a cross sectional view of a portion of the receive charging device **300** in accordance with an exemplary embodiment. FIG. **16** is a cross sectional view of a portion of the charging system showing the supply charging device **200** mated to the receive charging device **300**. FIGS. **14-16** show a different type of connector mating sensor assembly **400** in a different location.

[0066] In the illustrated embodiment, the connector mating sensor assembly **400** is located interior of the receive housing **312**. For example, the connector mating sensor assembly **400** is located in the contact chamber **306**, such as in the area of the signal contacts **380**. In an exemplary embodiment, the connector mating sensor **420** of the connector mating sensor assembly **400** includes a shorting contact **460** (FIGS. **15** and **16**) configured to create a short between two of the signal contacts **380**, such as when the charging devices **200**, **300** are disconnected. In an exemplary embodiment, the actuator **430** includes a pin or plunger **438** configured to pass through a wall of the receive housing **312** to interface with the supply charging device **200**. The biasing element **440** is a spring member, such as a coil spring, configured to forward bias the plunger **438**.

[0067] When the supply charging device **200** is fully loaded into the receptacle **350** (FIG. **16**), the actuator **430** engages the supply housing **212** and is deflected or actuated inward to activate a control signal. The shorting contact **460** is pressed inward into a pocket in the wall to disengage from the signal contacts **380**, opening the short circuit path. For example, a control system may monitor the short circuit path between the signal contacts **380**. When the short circuit path is open, the system indicates a connected mating status, corresponding to the supply charging device **200** being connected to the receive charging device **300** and thus it being unsafe to allow the mobile device **102** to move.

[0068] When unmated or disconnected (FIG. **15**), the supply housing **212** is removed from the receive housing **312**. The actuator **430** is released and allowed to move to the normal, forward biased position. In the released position, the shorting contact **460** engages the signal contacts **380** and creates a short circuit path between the signal contacts **380**. When the short circuit path is closed, the system indicates a disconnected mating status, corresponding to the supply charging device **200** being disconnected from the receive charging device **300** and thus it being safe to allow the mobile device **102** to move.

[0069] FIG. **17** is a front perspective view illustrating the receive charging device **300** in accordance with an exemplary embodiment. FIG. **18** is a cross sectional view of a portion of the receive charging device **300** in accordance with an exemplary embodiment. FIGS. **17** and **18** show the connector mating sensor assembly **400** in a different orientation compared to the embodiments shown in FIGS. **2-16**. FIGS. **17** and **18** show the connector mating sensor assembly **400** having a different type of connector mating sensor **420**.

FIGS. **17** and **18** show the connector mating sensor assembly **400** having a different type of actuator **430**.

[0070] The receive charging device **300** includes the receive power connector **310**, the receive contact assembly **322**, the receive cable assembly **332**, and the connector mating sensor assembly **400**. The receive power connector **310** includes the receive housing **312** having the receptacle **350**. The connector mating sensor assembly **400** is mounted to an exterior of the receive housing **312**, such as the top **344** of the receive housing **312**. For example, the carrier **410** is mounted to the receive housing **312**

[0071] The receive housing **312** includes the front **340**, the rear **342**, the top **344**, the bottom **346**, and the sides **348**. The receptacle **350** is open at the mating end **302**, such as at the front **340**, to receive the supply charging device **200** (shown in FIG. **2**). The connector mating sensor assembly **400** extends into the receptacle **350** to interface with the supply charging device **200**. For example, the actuator **430** of the connector mating sensor assembly **400** passes through the window **352** into the receptacle **350**. The connector mating sensor assembly **400** determines the mating status of the receive power connector **210** by determining when the supply housing **212** is located in the receptacle **350** and when the supply housing **212** is removed from the receptacle **350** of the receive housing **312**.

[0072] With additional reference to FIG. **19**, the connector mating sensor assembly **400** includes a printed circuit board **470** having an upper surface **472** and a lower surface **474**. The printed circuit board **470** extends between a first end **476** and a second end **478**. The connector mating sensor assembly **400** includes the connector mating sensor **420** to sense or monitor the mating status of the receive charging device **300**. In the illustrated embodiment, the connector mating sensor **420** includes the switch element **422** configured to control an operating circuit. The switch element **422** may be a limit switch. In an exemplary embodiment, the switch element **422** is mounted to the printed circuit board **470**. For example, the switch element **422** may be mounted to the lower surface **474** facing the actuator **430**. The switch element **422** may be located proximate to the first end **476**. In an exemplary embodiment, the connector mating sensor assembly **400** includes an electrical connector **480** mounted to the printed circuit board **470**. The electrical connector **480** is electrically connected to the switch element **422** by conductors or traces of the printed circuit board **470**. The electrical connector **480** may be coupled to a plug connector.

[0073] With additional reference to FIG. **20**, which is an enlarged view of a portion of the receive charging device **300** showing the connector mating sensor assembly **400** in accordance with an exemplary embodiment, the connector mating sensor **420** includes the actuator **430** operably coupled to the switch element **422**. The actuator **430** may be a molded part. In an exemplary embodiment, the actuator **430** may be integral with the carrier **410**, such as being co-molded with the carrier **410**. The actuator **430** is pivotable between an actuated position and a released position. The actuator **430** is movable relative to the switch element **422**. For example, the actuator **430** may pivot upward to activate the switch element **422**. The first end **432** of the actuator **430** is configured to engage and activate the switch element **422** based on the mating status of the receive charging device **300**. The second end **434** of the actuator **430** extends through the window **352** and is located in the receptacle **350** to interface with the supply housing **212** when the supply charging device **200** is in the receptacle **350** to activate the switch element **422** indicating a connected mating status. The engagement tip **436** at the second end **434** is configured to engage the supply housing **212** when the supply charging device **200** is plugged into the receptacle **350** to rotate the actuator **430** to the actuated position. The actuator **430** is configured to be released from the supply housing **212** when the supply charging device **200** is removed from the receptacle **350** to deactivate the switch element **422** indicating a disconnected mating status.

[0074] FIG. **21** is a cross sectional view of a portion of the charging system showing the supply charging device **200** fully mated to the receive charging device **300**. FIG. **22** is a cross sectional view of a portion of the charging system showing the supply charging device **200** partially mated to the receive charging device **300**. FIG. **23** is a cross sectional view of a portion of the charging system showing the supply charging device **200** unmated from the receive charging device **300** and being removed from the receive charging device **300**.

[0075] The connector mating sensor assembly **400** is configured to monitor presence of the supply charging device **200** in the receptacle **350** of the receive housing **312**. The connector mating sensor assembly **400** determines when the supply housing **212** is located in the receptacle **350** of the receive housing **312** and when the supply housing **212** is removed from the receptacle **350** of the receive housing **312**. The connector mating sensor assembly **400** determines when the supply charging device **200** has been fully disconnected from the receive charging device **300** (FIG. **13**).

[0076] When the supply charging device **200** is fully loaded into the receptacle **350** (FIG. **21**), the actuator **430** engages the supply housing **212** and is deflected or actuated outward to activate the switch element **422**. For example, the supply housing **212** engages the engagement tip **436** when the supply housing **212** is loaded into the receptacle **350** to force the actuator **430** outward to the actuated position. The first end **432** is elevated to activate the switch element **422** indicating a connected mating status, corresponding to the supply charging device **200** being connected to the receive charging device **300** and thus it being unsafe to allow the mobile device **102** to move.

[0077] During unmating, the supply charging device **200** is pulled rearward to remove the supply charging device **200** from the receptacle **350** of the receive charging device **300**. When partially unmated (FIG. **22**), even when the contacts are unmated, the supply housing **212** is still located in the receive housing **312**. If the mobile device **102** were to move when the charging devices **200**, **300** are partially unmated (not fully unmated), the components of the charging devices **200**, **300** may be damaged. In an exemplary embodiment, when the charging devices **200**, **300** are partially unmated, the actuator **430** remains engaged with the supply housing **212**, thus remaining in the deflected or actuated position to maintain the switch element **422** in the activated state indicating that the charging devices **200**, **300** are still in the connected mating status.

[0078] When unmated or disconnected (FIG. **23**), the supply housing **212** is removed from the front **340** of the receive housing **312**. The supply housing **212** releases the actuator **430**. The actuator **430** disengages from the supply housing **212** and is allowed to move or pivot downward to the released position. The biasing element **440** forces the actuator **430** to return to the released position. When the

actuator **430** is moved to the released position, the first end **432** moves away from the switch element **422** to deactivate the connector mating sensor **420** indicating a disconnected mating status. In an exemplary embodiment, the window **352**, and thus the engagement tip **436** of the actuator **430**, are located proximate to (at or near) the front **340** of the receive housing **312**. As such, the actuator **430** is released only when the supply housing **212** is moved to the receptacle exit at the front **340** of the receive housing **312** indicating disconnection of the charging devices **200**, **300**.

[0079] FIG. **24** is a front perspective view of the receive charging device **300** in accordance with an exemplary embodiment. In an exemplary embodiment, the connector mating sensor assembly **400** includes the cover **450** coupled to the carrier **410**. The cover **450** covers the various components of the connector mating sensor assembly **400**, such as the connector mating sensor **420**, the actuator **430**, and the printed circuit board **470**. The cover **450** protects the components from the environment, such as from dirt, debris, moisture, and the like.

[0080] FIG. **25** is a front perspective view illustrating the receive charging device **300** in accordance with an exemplary embodiment. FIG. **26** is a cross sectional view of a portion of the receive charging device **300** in accordance with an exemplary embodiment. FIGS. **25** and **26** show the connector mating sensor assembly **400** in a different orientation. FIGS. **25** and **26** show the connector mating sensor assembly **400** having a different type of connector mating sensor **420**. In the illustrated embodiment, the connector mating sensor **420** includes a proximity sensor **490**. For example, the connector mating sensor **420** may be a hall effect sensor. The supply charging device **200** includes a sensor element **240** configured to be detected by the proximity sensor **490**. The proximity sensor **490** is located proximate to the front **340** to determine when the supply housing **212** is removed from the receptacle **350**.

[0081] It is to be understood that the above description is intended to be illustrative, and not restrictive. For example, the above-described embodiments (and/or aspects thereof) may be used in combination with each other. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from its scope. Dimensions, types of materials, orientations of the various components, and the number and positions of the various components described herein are intended to define parameters of certain embodiments, and are by no means limiting and are merely exemplary embodiments. Many other embodiments and modifications within the spirit and scope of the claims will be apparent to those of skill in the art upon reviewing the above description. The scope of the invention should, therefore, be determined with reference to the appended claims, along with the full scope of equivalents to which such claims are entitled. In the appended claims, the terms "including" and "in which" are used as the plain-English equivalents of the respective terms "comprising" and "wherein." Moreover, in the following claims, the terms "first," "second," and "third," etc. are used merely as labels, and are not intended to impose numerical requirements on their objects. Further, the limitations of the following claims are not written in means-plus-function format and are not intended to be interpreted based on 35 U.S.C. § 112, sixth paragraph, unless and until such claim limitations expressly use the phrase "means for" followed by a statement of function void of further structure.

What is claimed is:

1. A receive charging device for a mobile device, the receive charging device comprising:

a receive power connector having a receive housing extending between a front and a rear, the receive power connector having a mating end at the front, the receive housing including a receptacle at the mating end configured to receive a supply power connector along a mating axis, the receive power connector having a cable end at the rear;

a contact assembly held by the receive housing, the contact assembly including receive power contacts for mating with supply power contacts of the supply power connector;

a cable assembly coupled to the contact assembly, the cable assembly including power cables terminated to the corresponding receive power contacts, the power cables extending from the cable end; and

a connector mating sensor assembly configured to be operably coupled to the supply power connector to indicate a mating status of the receive power connector with the supply power connector, the mating status being one of connected or disconnected.

2. The receive charging device of claim **1**, wherein the connector mating sensor assembly determines the mating status of the receive housing with a supply housing of the supply power connector.

3. The receive charging device of claim **1**, wherein the connector mating sensor assembly determines the mating status of the receive power connector relative to the supply power connector independent of a mating status of the receive power contacts relative to the supply power contacts.

4. The receive charging device of claim **1**, wherein the connector mating sensor assembly monitors the mating status of the front of the receive housing.

5. The receive charging device of claim **1**, wherein the connector mating sensor assembly includes a connector mating sensor having a switch element, the connector mating sensor assembly including an actuator operably coupled to the switch element, the actuator having an engagement tip located in the receptacle to interface with the supply power connector when the supply power connector is in the receptacle to activate the switch element indicating the connected mating status, the actuator being released when the supply power connector is removed from the receptacle to deactivate the switch element indicating the disconnected mating status.

6. The receive charging device of claim **5**, wherein the actuator is pivotable between an actuated position and a released position, the actuator activating the switch element in the actuated position, the switch element deactivated when the actuator is in the released position.

7. The receive charging device of claim **6**, wherein the connector mating sensor assembly includes a biasing element engaging the actuator and forcing the actuator toward the released position.

8. The receive charging device of claim **5**, wherein the connector mating sensor assembly includes a carrier coupled to an exterior of the receive housing, the receive housing including a window therethrough, the actuator passing through the window to interface the engagement tip with the supply power connector.

9. The receive charging device of claim **5**, wherein the connector mating sensor assembly includes a printed circuit

board, the switch element mounted to the printed circuit board, the connector mating sensor assembly including an electrical connector mounted to the printed circuit board and electrically connected to the switch element through the printed circuit board.

10. The receive charging device of claim **1**, wherein the connector mating sensor assembly includes a limit switch configured to be operably coupled to the supply power connector when the supply power connector is plugged into the receptacle.

11. The receive charging device of claim **1**, wherein the connector mating sensor assembly includes a carrier holding a connector mating sensor, the carrier being coupled to an exterior of the receptacle housing, the connector mating sensor sensing when the supply power connector is located in the receptacle.

12. The receive charging device of claim **11**, wherein the receive housing includes a window therethrough proximate to the front of the receive housing, the connector mating sensor sensing presence of the supply power connector through the window.

13. The receive charging device of claim **1**, wherein the connector mating sensor assembly includes a proximity sensor configured to sense presence of the supply power connector in the receptacle.

14. The receive charging device of claim **1**, wherein the connector mating sensor assembly includes a plunger and a biasing member forward biasing the plunger, the plunger being compressed by the supply power connector when the supply power connector is in the receptacle, the plunger being released from the supply power connector when the supply power connector is removed from the receptacle.

15. The receive charging device of claim **14**, wherein the contact assembly includes signal contacts, the connector mating sensor assembly having a shorting contact coupled to and movable with the plunger, the shorting contact electrically shorting between the signal contacts when the plunger is released, the shorting contact being electrically isolated from the signal contacts when the plunger is compressed by the supply power connector.

16. The receive charging device of claim **1**, further comprising a cover covering the connector mating sensor assembly.

17. A receive charging device for a mobile device, the receive charging device comprising:

a receive power connector having a receive housing extending between a front and a rear, the receive power connector having a mating end at the front, the receive housing including a receptacle at the mating end configured to receive a supply power connector along a mating axis, the receive power connector having a cable end at the rear;

a contact assembly held by the receive housing, the contact assembly including receive power contacts for mating with supply power contacts of the supply power connector;

a cable assembly coupled to the contact assembly, the cable assembly including power cables terminated to the corresponding receive power contacts, the power cables extending from the cable end; and

a connector mating sensor assembly configured to be operably coupled to the supply power connector to indicate a mating status of the receive power connector with the supply power connector, the mating status being one of connected or disconnected, the connector mating sensor assembly including a connector mating sensor having a switch element, the connector mating sensor assembly including an actuator operably coupled to the switch element, the actuator having an engagement tip located in the receptacle to interface with the supply power connector when the supply power connector is in the receptacle to activate the switch element indicating the connected mating status, the actuator being released when the supply power connector is removed from the receptacle to deactivate the switch element indicating the disconnected mating status.

18. The receive charging device of claim **17**, wherein the actuator is pivotable between an actuated position and a released position, the actuator activating the switch element in the actuated position, the switch element deactivated when the actuator is in the released position.

19. The receive charging device of claim **18**, wherein the connector mating sensor assembly includes a biasing element engaging the actuator and forcing the actuator toward the released position.

20. The receive charging device of claim **17**, wherein the connector mating sensor assembly includes a carrier coupled to an exterior of the receive housing, the receive housing including a window therethrough, the actuator passing through the window to interface the engagement tip with the supply power connector.

21. The receive charging device of claim **17**, wherein the connector mating sensor assembly includes a printed circuit board, the switch element mounted to the printed circuit board, the connector mating sensor assembly including an electrical connector mounted to the printed circuit board and electrically connected to the switch element through the printed circuit board.

22. The receive charging device of claim **17**, wherein the connector mating sensor assembly determines the mating status of the receive housing with a supply housing of the supply power connector.

23. A charging system comprising:

a supply charging device including a supply power connector having a supply housing extending between a front and a rear, the supply housing having a top and a bottom, the supply power connector having a mating end at the front, the supply power connector having a cable end opposite the mating end, the supply power connector including supply power contacts held by the supply housing, the supply charging device including a supply cable assembly coupled to the supply power connector and extending from the cable end, the supply cable assembly including supply power cables terminated to the corresponding supply power contacts; and

a receive charging device for a mobile device, the receive charging device including a receive power connector having a receive housing extending between a front and a rear, the receive power connector having a mating end at the front configured to be mated with the mating end of the supply power connector, the receive housing including a receptacle at the mating end configured to receive a supply power connector along a mating axis, the receive power connector having a cable end at the rear, the receive charging device including a receive contact assembly held by the receive housing including receive power contacts for mating with the supply

power contacts of the supply power connector, the receive charging device including a receive cable assembly coupled to the receive contact assembly and extending from the cable end, the receive cable assembly including receive power cables terminated to the corresponding receive power contacts, the receive charging device including a connector mating sensor assembly configured to be operably coupled to the supply power connector to indicate a mating status of the receive power connector with the supply power connector, the mating status being one of connected or disconnected.

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