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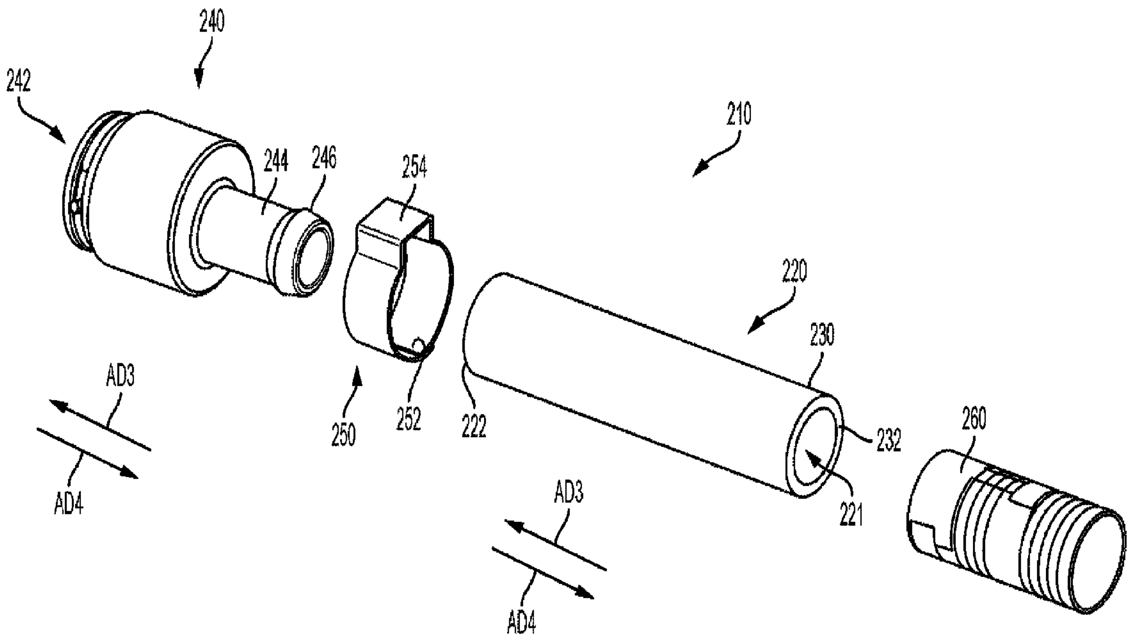

FIG. 12

(57) Abrégé/Abstract:
A radio-frequency identification (RFID) fluid connection, including a tube or hose (220), the tube or hose including a radially outward facing surface, a RFID assembly or label (260) connected the radially outward facing surface, including a RFID tag, and at least one contact electrically connected to the RFID tag.

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Abstract:

A radio-frequency identification (RFID) fluid connection, including a tube or hose (220), the tube or hose including a radially outward facing surface, a RFID assembly or label (260) connected the radially outward facing surface, including a RFID tag, and at least one contact electrically connected to the RFID tag.

RADIO-FREQUENCY IDENTIFICATION FLUID CONNECTION

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit under Articles 4 and 8 of the Stockholm Act of the Paris Convention for the Protection of Industrial Property of U.S. Provisional Patent Application No. 62/907,758, filed on September 30, 2019, which application is hereby incorporated by reference in its entirety.

FIELD

[0002] The present disclosure relates to a connection verifier for a fluid connection, and, more particularly, to a fluid connection comprising a radio-frequency identification (RFID) tag that indicates the status of a connection via wireless transmission.

BACKGROUND

[0003] As is known in the art, a "fluid" is a substance that continually deforms (flows) under an applied shear stress, or external force. Fluids are a phase of matter and include liquids, gases, and plasmas.

[0004] Fluid connectors are integral components for many applications, and especially for automotive applications. Since an automotive system is made up of various components such as a radiator, transmission, and engine, fluid must be able to travel not only within each component but also between components. An example of fluid traveling between components is the transmission fluid traveling from the transmission to the transmission oil cooler in order to lower the temperature of the transmission fluid. Fluid predominantly moves between components via flexible or rigid hoses which connect to each component by fluid connectors and/or a clamp/clamping element. Such fluid connectors typically include a retaining ring, retaining clip, snap ring, clamp, or other clamping element carried on the fluid connector which is adapted to snap behind a raised shoulder of a tube end form when the tube end form is fully inserted into the fluid connector. If the tube end form or hose is not fully inserted into the fluid connector or clamped to the connector, the fluid connection may fail causing fluids to leak out and other more serious consequences. It should be appreciated that fluid connectors extend not only to liquid connections but also to gas and plasma connections. For example, fluid connectors used for the transfer of propane, butane, natural gas, etc. are widely used commercially and non-commercially. Failure of a gas connection, as with liquid connectors, may have serious consequences.

[0005] RFID uses electromagnetic fields to automatically identify and track tags attached to objects. The tags contain electronically stored information. Passive RFID tags collect energy from a nearby RFID reader's interrogating radio waves. Active RFID tags have a local power source (such as a battery) and may operate hundreds of meters from the RFID reader. Unlike a barcode, RFID tags don't need to be within the line of sight of the reader, so they may be embedded in the tracked object. RFID is one method of automatic identification and data capture (AIDC). RFID tags are used in many industries. For example, a RFID tag attached to an automobile during production can be used to track its progress through the assembly line, RFID-tagged pharmaceuticals can be tracked through warehouses, and implanting RFID microchips in livestock and pets enables positive identification of animals.

[0006] Thus, there has been a long-felt need for a connection verifier that utilizes RFID to ensure that a fluid connection is securely connected.

SUMMARY

[0007] According to aspects illustrated herein, there is provided a radio-frequency identification (RFID) fluid connection, comprising a tube, including a radially outward facing surface, a RFID assembly connected the radially outward facing surface, including a RFID tag, and at least one contact electrically connected to the RFID tag.

[0008] In some embodiments, the tube further comprises a shoulder connected to the radially outward facing surface and the RFID assembly is arranged proximate the shoulder. In some embodiments, the RFID assembly is arranged on a first layer and the first layer is connected to the radially outward facing surface. In some embodiments the at least one contact comprises a first contact electrically connected to the RFID tag and a second contact electrically connected to the RFID tag, the second contact being separated from the first contact to form an open state of the RFID assembly. In some embodiments, in a closed state, the first contact is electrically connected to the second contact. In some embodiments, the first contact is operatively arranged to be electrically connected to the second contact via a retaining ring when the tube is connected to a fluid connector. In some embodiments, the at least one contact comprises a pressure sensitive contact electrically connected to the RFID tag via a first conductor and a second conductor. In some embodiments, the pressure sensitive contact comprises a first conductive layer electrically connected to the first conductor, a second conductive layer electrically connected to the second conductor, and an insulating layer separating the first and second conductive layers to form an open state of the RFID assembly. In some embodiments, in a closed state, the first conductive layer is electrically connected to the second conductive layer via a force applied to the first conductive layer. In some embodiments, the force is applied to the first conductive layer via a retaining ring of a fluid connector when the tube is connected to the fluid connector. In some embodiments, the RFID tag comprises an antenna, in an open state of the RFID tag, the antenna circuit is open, and in a closed state of the RFID tag, the antenna circuit is closed.

[0009] According to aspects illustrated herein, there is provided a radio-frequency identification (RFID) fluid connection, comprising a fluid connector, a retaining ring operatively arranged to engage the fluid connector, a tube operatively arranged to be connected to the fluid connector, the tube including a first radially outward facing surface, and a RFID assembly arranged on the first radially outward facing surface, including a RFID tag, and at least one contact electrically connected to the RFID tag.

[0010] In some embodiments, the tube further comprises a shoulder (or designated hose location or hose engagement surface) connected to the first radially outward facing surface, the shoulder arranged to interact with the retaining ring to lock the tube within the fluid connector and the at least one contact is operatively arranged proximate the shoulder to engage with the retaining ring. In some embodiments, the at least one contact comprises a first contact electrically connected to the RFID tag and a second contact electrically connected to the RFID tag, the second contact being separated from the first contact to form an open state of the RFID assembly. In some embodiments, when the tube is properly secured to the fluid connector, the retaining ring engages the first contact and the second contact, and the first contact is electrically connected to the second contact to form a closed state of the RFID assembly. In some embodiments, the retaining ring is a clamp. In some embodiments, the fluid connector comprises a second radially outward facing surface, and the tube and the retaining ring are operatively arranged to engage the second radially outward facing surface. In some embodiments, the RFID assembly is arranged on a layer and the layer is connected to the first radially outward facing surface. In some embodiments, the RFID tag comprises an antenna, in an open state of the RFID tag, the antenna circuit is open, and in a closed state of the RFID tag, the antenna circuit is closed.

[0011] According to aspects illustrated herein, there is provided a radio-frequency identification (RFID) fluid connection, comprising a fluid connector, a retaining ring operatively arranged to engage the fluid connector, a tube operatively arranged to be connected to the fluid connector, the tube including a radially outward facing surface, and a RFID assembly arranged on the radially outward facing surface and including a RFID tag including an antenna and an integrated circuit, and at least one contact electrically connected to the integrated circuit, wherein when the integrated circuit is open, the RFID tag indicates an improper connection of the RFID fluid connection, and when the integrated circuit is closed, the RFID tag indicates a proper connection of the RFID fluid connection.

[0012] These and other objects, features, and advantages of the present disclosure will become readily apparent upon a review of the following detailed description of the disclosure, in view of the drawings and appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] Various embodiments are disclosed, by way of example only, with reference to the accompanying schematic drawings in which corresponding reference symbols indicate corresponding parts, in which:

Figure 1 is a perspective view of a RFID fluid connection;

Figure 2 is an exploded perspective view of the RFID fluid connection shown in Figure 1;

Figure 3 is a top planar view of a RFID assembly, in accordance with some embodiments of the present disclosure;

Figure 4 is a perspective view of the RFID assembly shown in Figure 3 arranged on a tube end form;

Figure 5 is a cross-sectional view of the RFID assembly arranged on the tube end form taken generally along line **5-5** in Figure 4;

Figure 6 is a top planar view of a RFID assembly, in accordance with some embodiments of the present disclosure;

Figure 7 is a perspective view of the RFID assembly shown in Figure 6 arranged on a tube end form;

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Figure 8 is a cross-sectional view of the RFID assembly arranged on the tube end form taken generally along line **8-8** in Figure 7;

Figure 9A is a partial cross-sectional schematic view of a RFID assembly in an open state, in accordance with some embodiments of the present disclosure;

Figure 9B is a partial cross-sectional schematic view of the RFID assembly shown in Figure 9A, in a closed state;

Figure 10 is a perspective view of a RFID fluid connection, in a closed state;

Figure 11 is a perspective view of the RFID fluid connection shown in Figure 10, in an open state;

Figure 12 is an exploded perspective view of the RFID fluid connection shown in Figure 10;

Figure 13 is a top planar view of a RFID assembly, in accordance with some embodiments of the present disclosure;

Figure 14 is a cross-sectional view of the RFID fluid connection taken generally along line **14-14** in Figure 11, in an open state; and,

Figure 15 is a cross-section view of the RFID fluid connection taken generally along line **15-15** in Figure 10, in a closed state.

DETAILED DESCRIPTION

[0014] At the outset, it should be appreciated that like drawing numbers on different drawing views identify identical, or functionally similar, structural elements. It is to be understood that the claims are not limited to the disclosed aspects.

[0015] Furthermore, it is understood that this disclosure is not limited to the particular methodology, materials and modifications described and as such may, of course, vary. It is also understood that the terminology used herein is for the purpose of describing particular aspects only, and is not intended to limit the scope of the claims.

[0016] Unless defined otherwise, all technical and scientific terms used herein have the same meaning as commonly understood to one of ordinary skill in the art to which this disclosure pertains. It should be understood that any methods, devices or materials similar or equivalent to those described herein can be used in the practice or testing of the example embodiments. The assembly of the present disclosure could be driven by hydraulics, electronics, pneumatics, and/or springs.

[0017] It should be appreciated that the term “substantially” is synonymous with terms such as “nearly,” “very nearly,” “about,” “approximately,” “around,” “bordering on,” “close to,” “essentially,” “in the neighborhood of,” “in the vicinity of,” etc., and such terms may be used interchangeably as appearing in the specification and claims. It should be appreciated that the term “proximate” is synonymous with terms such as “nearby,” “close,” “adjacent,” “neighboring,” “immediate,” “adjoining,” etc., and such terms may be used interchangeably as appearing in the specification and claims. The term “approximately” is intended to mean values within ten percent of the specified value.

[0018] It should be understood that use of “or” in the present application is with respect to a “non-exclusive” arrangement, unless stated otherwise. For example, when saying that “item x is A or B,” it is understood that this can mean one of the following: (1) item x is only one or the other of A and B; (2) item x is both A and B. Alternately stated, the word “or” is not used to define an “exclusive or” arrangement. For example, an “exclusive or” arrangement for the statement “item x is A or B” would require that x can be only one of A and B. Furthermore, as used herein, “and/or” is intended to mean a grammatical conjunction used to indicate that one or more of the elements or conditions recited may be included or occur. For example, a device comprising a first element, a second element and/or a third element, is intended to be construed as any one of the following structural arrangements: a device comprising a first element; a device comprising a second element; a device comprising a third element; a device comprising a first element and a second element; a device comprising a first element and a third element; a device comprising a first element, a second element and a third element; or, a device comprising a second element and a third element.

[0019] Moreover, as used herein, the phrases “comprises at least one of” and “comprising at least one of” in combination with a system or element is intended to mean that the system or element includes one or more of the elements listed after the phrase. For example, a device comprising at least one of: a first element; a second element; and, a third element, is intended to be construed as any one of the following structural arrangements: a device comprising a first element; a device comprising a second element; a device comprising a third element; a device comprising a first element and a second element; a device comprising a first element and a third element; a device comprising a first element, a second element and a third element; or, a device comprising a second element and a third element. A similar interpretation is intended when the phrase "used in at least one of:" is used herein. Furthermore, as used herein, "and/or" is intended to mean a grammatical conjunction used to indicate that one or more of the elements or conditions recited may be included or occur. For example, a device comprising a first element, a second element and/or a third element, is intended to be construed as any one of the following structural arrangements: a device comprising a first element; a device comprising a second element; a device comprising a third element; a device comprising a first element and a second element; a device comprising a first element and a third element; a device comprising a first element, a second element and a third element; or, a device comprising a second element and a third element.

[0020] By "non-rotatably connected" elements, we mean that: the elements are connected so that whenever one of the elements rotate, all the elements rotate; and relative rotation between the elements is not possible. Radial and/or axial movement of non-rotatably connected elements with respect to each other is possible, but not required.

[0021] It should be appreciated that the term "tube" as used herein is synonymous with hose, pipe, channel, conduit, or any other suitable pipe flow used in hydraulics and fluid mechanics. It should further be appreciated that the term "tube" can mean a rigid or flexible conduit of any material suitable for containing and allowing the flow of a gas or a liquid.

[0022] Adverting now to the figures, Figure 1 is a perspective view of RFID fluid connection **10**. Figure 2 is an exploded perspective view of RFID fluid connection **10**. RFID fluid connection **10** generally comprises tube or tube end form or hose **20**, fluid connector **40**, retaining ring **50**, and RFID assembly **60, 160**. The following description should be read in view of Figures 1-2.

[0023] Tube end form **20** comprises end **22**, section **23**, shoulder **27**, section **29**, end **32**, and through-bore **21**. Through-bore **21** extends through tube end form **20** from end **22** to end **32**. Section **23** is arranged between end **22** and shoulder **27** and comprises radially outward facing surface **24**. Radially outward facing surface **24** includes a substantially constant diameter. Shoulder **27** is arranged between section **23** and section **29** and comprises radially outward facing surface **26**. Radially outward facing surface **26** is a linear conical (or frusto-conical) shape and increases in diameter in axial direction **AD2**. Section **29** is arranged between shoulder **27** and end **32** and comprises radially outward facing surface **30**. Radially outward facing surface **30** includes a substantially constant diameter. Shoulder **27** is connected to radially outward facing surface **30** via shoulder surface **28**. Tube end form **20** is arranged to be inserted, specifically with end **22** first, into fluid connector **40**. Tube end form **20** may utilize a straight ramp (i.e., constant linear ramp) or a curvilinear ramp, and is inserted into fluid connector **40**, in axial direction **AD1**, until retaining ring **50** snaps over shoulder **27** and is generally aligned with section **29**. It should be appreciated that tube end form **20** may be any traditional tube end form comprising a ramp, which extends radially outward and axially on the outer surface of the tube end form, to displace a retaining ring, snap ring, or wire clip within the fluid connector to secure the tube end form within the fluid connector. In some embodiments, tube end form **20** comprises any tube end form that might utilize a retaining ring, retaining clip, snap ring etc. For example, instead of a ramp-like shoulder, tube end form **20** may comprise a bead, a notch, a plurality of ramps, threading, a shoulder having a variable diameter portion (ramp) and a constant diameter portion connected thereto, any standard Society of Automotive Engineers (SAE) end form, etc. The present disclosure should not be limited to the use of only the tube end form shown in the figures, but rather any tube end form suitable for fluidly connecting to a fluid connector via a retaining ring. RFID assembly **60, 160** verifies that retaining ring **50** has "snapped" over shoulder **27** (and is arranged adjacent and/or proximate to shoulder surface **28**) in order to determine that RFID fluid connection **10** is properly connected, as will be described in greater detail below.

[0024] Fluid connector **40** comprises through-bore **42**, radially inward facing surface **44**, radially inward facing surface **46** (not shown), and radially outward facing surface **48**. Radially outward facing surface **48** comprises groove **49**. Retaining ring **50** is arranged in groove **49**. Retaining ring **50** comprises protrusions **52A**, **52B**, and **52C** (see Figures 5 and 8). Protrusions **52A-C** extend radially inward through apertures in groove **49** to engage shoulder **27**, specifically, shoulder surface **28**. It should be appreciated that retaining ring **50** may comprise any number of protrusions (e.g., one or more protrusions) suitable for properly connecting tube end form **20** and fluid connector **40** and contacting the one or more contacts of RFID assembly **60, 160** to indicate proper connection, as will be described in greater detail below. In some embodiments, retaining ring **50** has no protrusions. For example, retaining ring **50** may comprises a "C" clip which comprises a ring having a small section removed therefrom such that it is capable of radially expanding and snapping back to engage the one or more contacts.

[0025] Figure 3 is a top planar view of RFID assembly **60**, in accordance with some embodiments of the present disclosure. Figure 4 is a perspective view of RFID assembly **60** arranged on tube end form **20**. Figure 5 is a cross-sectional view of RFID assembly **60** arranged on tube end form **20** taken generally along line **5-5** in Figure 4. RFID assembly **60** generally comprises at least one layer (e.g., adhesive layer **62** and/or layer **64**), RFID tag **70**, and at least one contact (e.g., contact **80A** and/or contact **80B**). In some embodiments, RFID assembly **60** is a RFID label that is connected to a tube or component, wherein the tube or component is arranged to be connected to another component. It should be appreciated that RFID assembly **60** may be used to ensure any type of connection, not just a connection related to the flow of fluid, for example, a constant-velocity (CV) joint, a trailer hitch connection, electrical connections, etc. The following description should be read in view of Figures 1-5.

[0026] Adhesive layer **62** is operatively arranged to be secured to tube end form **20**. In some embodiments, adhesive layer **62** secures layer **64** and/or contacts **80A** and **80B** to tube end form **20**. It should be appreciated that layer **64** need not be connected to tube end form **20** via adhesives (i.e., adhesive layer **62**), but rather can be connected and/or applied using any other suitable means, for example, string, tape, hook and loop fastener, solder, welding, etc. In some embodiments, adhesive layer **62** is wrapped around section **29** of tube end form **20** and is secured to radially outward facing surface **30** proximate to shoulder **27**. In some embodiments, adhesive layer **62** completely circumscribes radially outward facing surface **30** and overlaps at its ends (see Figure 5). In some embodiments, adhesive layer **62** completely circumscribes radially outward facing surface **30** and its ends abut against each other (see Figure 8). In some embodiments, adhesive layer **62** does not completely circumscribe radially outward facing surface **30**.

[0027] RFID assembly **60** may further comprise layer **64**. Layer **64** is connected to the top surface of adhesive layer **62** and is operatively arranged as a platform or base for RFID tag **70** and contacts **80A-B**. In some embodiments, layer **64** comprises ferrite. In some embodiments, RFID tag **70** and contacts **80A-B** are connected directly to the top surface of adhesive layer **62**, without the need for layer **64**. In some embodiments, RFID tag **70** and contacts **80A-B** are connected directly to radially outward facing surface **30** without the need for adhesive layer **62** or layer **64**.

In some embodiments, RFID assembly **60** further comprises layer **66**. Layer **66** is operatively arranged to cover and protect RFID tag **70**. As shown in Figure 3, layer **66** completely covers RFID tag **70** and at least partially covers contacts **80A** and **80B**. However, it is required that at least a portion of contacts **80A** and **80B** are exposed, for example, exposed portions **82A** and **82B**, such that they are capable of engaging retaining ring **50**, as will be described in greater detail below.

[0028] RFID tag **70** comprises integrated circuit (IC) or chip **72** and antenna **74**. In some embodiments, RFID tag **70** comprises a passive RFID tag. In some embodiments, RFID tag **70** comprises an active RFID tag (and further comprises a power source). In some embodiments, RFID tag **70** comprises a semi-passive RFID tag. In some embodiments, RFID tag **70** is preprogrammed such that it transmits information, for example, a unique identification (UID) number, the state of RFID assembly **60** (i.e., open or closed), etc. Antenna **74** is connected at a first end to IC **72** at antenna radio-frequency (RF) input **LA**, and at a second end to IC **72** at antenna RF input **LB**, via conductors **76A** and **76B**, respectively. RFID tag **70** is further connected to contact **80A** and contact **80B**. Specifically, conductor **78A** connects contact **80A** with IC **72** at ground pin **GND** and conductor **78B** connects contact **80B** with IC **72** at detector pin **DP**.

[0029] Contact **80A** is separated from contact **80B** by gap **84** and gap **86** (see Figure 5). In some embodiments, gap **84** is equal to gap **86**. In some embodiments, gap **84** is less than gap **86**. In some embodiments, gap **84** is greater than gap **86**. Contacts **80A** and **80B** are arranged proximate to or abutting against shoulder **27**, specifically shoulder surface **28**. Contacts **80A** and **80B** are operatively arranged to engage with retaining ring **50**. In some embodiments, contacts **80A** and **80B** are electrical conductors. When tube end form **20** is properly secured in fluid connector **40**, retaining ring **50** expands along shoulder **27** and then snaps behind shoulder surface **28** thereby locking tube end form **20** within fluid connector **40**. When retaining ring **50** snaps back behind shoulder **27** and abuts against and/or is arranged proximate to shoulder surface **28**, protrusions **52A-C** engage contacts **80A** and **80B**. For example, and as shown in Figure 5, protrusion **52C** (and protrusion **52B**) is engaged with contact **80B** and protrusion **52A** is engaged with contact **80A**. In some embodiments, retaining ring **50** comprises an electrical conductive material (e.g., metal). As such, retaining ring **50** completes the circuit between contacts **80A-B** and IC **72** and causes RFID tag **70** to become enabled (i.e., RFID tag **70** is capable of being powered by an electromagnetic field generated by an external device (not shown)) or switch to a closed state (from an open state). Prior to completion of the circuit, namely, electrically connecting contact **80B** directly with contact **80A**, RFID tag **70** is not enabled (i.e., RFID tag **70** is not capable of being powered by an electromagnetic field generated by the external device) or in some embodiments, it indicates an open status. When the circuit is completed (i.e., retaining ring **50** directly connects contact **80A** and contact **80B** as shown in Figure 5), an external device such as a RFID reader will detect that RFID tag **70** is enabled, or in a closed state, thereby indicating that RFID fluid connection **10** is properly connected. Put another way, when RFID tag **70** is enabled, the RFID reader will identify that RFID tag **70** exists and thus determine that RFID fluid connection **10** is properly connected. When the circuit is not completed (i.e., contact **80A** is not directly connected to contact **80B**), the RFID reader will not detect an enabled RFID tag **70** thereby indicating that RFID fluid connection **10** is not properly connected. Put in yet another way, when RFID tag **70** is disabled, the RFID reader will not identify that RFID tag **70** exists and thus determine that RFID fluid connection **10** is not properly connected.

[0030] In some embodiments, RFID tag **70** is always enabled and can be detected and read by a RFID reader regardless of whether contacts **80A** and **80B** are connected. In such embodiments, when contacts **80A** and **80B** are not directly connected, for example via retaining ring **50**, RFID tag **70** is capable of transmitting, to a RFID reader, certain information. Such information may include, but is not limited to, a UID number (e.g., for the RFID tag, the tube end form, etc.), size number, model number, serial number, status of RFID tag **70** (i.e., open or closed), uniform resource locator (URL), station identification (i.e., manufacturing LOT number), date/time stamp, description, etc. Put another way, independent of whether contacts **80A** and **80B** are connected, RFID tag **70** will always transmit certain data (e.g., a UID number, a status, etc.) provided it is properly functioning. Thus, RFID tag **70** is preprogrammed to always transmit at least a UID number and a status (i.e., open or closed), for example, using hexadecimal data or a value. This is important because it allows the user to scan a given RFID tag to determine if it is properly functioning (i.e., if the RFID tag is properly transmitting data then it is properly functioning) as well as to determine its current state (i.e., open or closed). When contacts **80A** and **80B** are connected, for example, via retaining ring **50**, RFID tag **70** transmits data indicating a closed status. In some embodiments, RFID tag **70** indicates a first value (e.g., a first hexadecimal value) for an open state and a second value (e.g., second hexadecimal value) for a closed state, the second value being different from the first value. It should be appreciated that RFID tag **70** may include any programming suitable for indicating that it is properly functioning and a differentiation between an open state and a closed state, and that the present disclosure should not be limited to just the use of the hexadecimal system.

[0031] Figure 6 is a top planar view of RFID assembly **160**, in accordance with some embodiments of the present disclosure. Figure 7 is a perspective view of RFID assembly **160** arranged on tube end form **20**. Figure 8 is a cross-sectional view of RFID assembly **160** arranged on tube end form **20** taken generally along line **8-8** in Figure 7. RFID assembly **160** generally comprises at least one layer (e.g., adhesive layer **162** and/or layer **164**), RFID tag **170**, and at least one contact (e.g., contact **180**). In some embodiments, RFID assembly **160** is a RFID label that is connected to a tube or component, wherein the tube or component is arranged to be connected to another component. It should be appreciated that RFID assembly **160** may be used to ensure any type of connection, not just a connection related to the flow of fluid, for example, a constant-velocity (CV) joint, a trailer hitch connection, electrical connections, etc. The following description should be read in view of Figures 1-2 and 6-9B.

[0032] Adhesive layer **162** is operatively arranged to be secured to tube end form **20**. In some embodiments, adhesive layer **162** secures layer **164** and/or contact **180** to tube end form **20**. It should be appreciated that layer **164** need not be connected to tube end form **20** via adhesives (i.e., adhesive layer **162**), but rather can be connected and/or applied using any other suitable means, for example, string, tape, hook and loop fastener, solder, welding, etc. In some embodiments, adhesive layer **162** is wrapped around section **29** of tube end form **20** and is secured to radially outward facing surface **30** proximate to shoulder **27**. In some embodiments, adhesive layer **162** completely circumscribes radially outward facing surface **30** and overlaps at its ends (see Figure 5). In some embodiments, adhesive layer **162** completely circumscribes radially outward facing surface **30** and its ends abut against each other (see Figure 8). In some embodiments, adhesive layer **62** does not completely circumscribe radially outward facing surface **30**.

[0033] RFID assembly **160** may further comprise layer **164**. Layer **164** is connected to the top surface of adhesive layer **162** and is operatively arranged as a platform or base for RFID tag

170 and contact **180**. In some embodiments, layer **164** comprises ferrite. In some embodiments, RFID tag **170** and contact **180** are connected directly to the top surface of adhesive layer **162**, without the need for layer **164**. In some embodiments, RFID tag **170** and contact **180** are connected directly to radially outward facing surface **30** without the need for adhesive layer **162** or layer **164**. In some embodiments, RFID assembly **160** further comprises layer **166**. Layer **166** is operatively arranged to cover and protect RFID tag **170**. As shown in Figure 6, layer **166** completely covers RFID tag **170** and at least partially covers contact **180**. However, it is required that at least a portion of contact **180** is exposed, for example exposed portion **182**, such that it is capable of engaging retaining ring **50**, as will be described in greater detail below.

[0034] RFID tag **170** comprises integrated circuit (IC) or chip **172** and antenna **174**. In some embodiments, RFID tag **170** comprises a passive RFID tag. In some embodiments, RFID tag **170** comprises an active RFID tag (and further comprises a power source). In some embodiments, RFID tag **170** comprises a semi-passive RFID tag. In some embodiments, RFID tag **170** is preprogrammed such that it transmits information, for example, a UID number, the state of RFID assembly **160** (i.e., open or closed), etc. Antenna **174** is connected at a first end to IC **172** at antenna radio-frequency (RF) input **LA**, and at a second end to IC **172** at antenna RF input **LB**, via conductors **176A** and **176B**, respectively. RFID tag **170** is further connected to contact **180**. Specifically, conductor **178A** connects contact **80** with IC **172** at ground pin **GND** and conductor **178B** connects contact **80** with IC **172** at detector pin **DP**.

[0035] Contact **180** circumscribes radially outward facing surface **30**. In some embodiments, and as shown in Figure 8, the ends of contact **180** may be separated by gap **184**. In some embodiments, the ends of contact **180** abut against each other. In some embodiments, the ends of contact **180** overlap each other. Contact **180** is arranged proximate to or abutting against shoulder **27**, specifically shoulder surface **28**. Contact **180** is operatively arranged to engage with retaining ring **50**. In some embodiments, contact **180** is a pressure sensitive contact. When tube end form **20** is properly secured in fluid connector **40**, retaining ring **50** expands along shoulder **27** and then snaps behind shoulder surface **28** thereby locking tube end form **20** within fluid connector **20**. When retaining ring **50** snaps back behind shoulder **27** and abuts against shoulder surface **28**, protrusions **52A-C** engage contact **180** and apply a pressure thereto. For example, and as shown in Figure 8, protrusions **52A-C** are engaged with contact **180**. In some embodiments, retaining ring **50** comprises metal. In some embodiments, retaining ring **50** comprises a non-metallic material such as a polymer or an elastomer. It should be appreciated that retaining ring **50** may comprise any material suitable to snap over shoulder **27** and apply pressure to contact **180**. Once a sufficient pressure is applied to contact **180**, the circuit is completed between conductors **178A** and **178B** and IC **172** and causes RFID tag **170** to become enabled (i.e., RFID tag **170** is capable of being powered by an electromagnetic field generated by an external device (not shown)) or indicate a closed state. Prior to completion of the circuit, namely, electrically connecting the ends of conductors **178A** and **178B**, RFID tag **170** is not enabled (i.e., RFID tag **170** is not capable of being powered by an electromagnetic field generated by the external device) or indicates an open state. When the circuit is completed (i.e., retaining ring **50** applies a sufficient pressure to contact **180** thereby electrically connecting conductor **178A** directly with conductor **178B**), an external device such as a RFID reader will detect that RFID tag **170** is enabled or in a closed state thereby indicating that RFID fluid connection **10** is properly connected. Put another way, when RFID tag **170** is enabled, the RFID reader will identify that RFID tag **170** exists and thus determine that RFID fluid connection **10** is properly connected. When the circuit is not completed (i.e., the ends of conductors **178A** is not directly connected to contact **178B**), the RFID reader will not detect an enabled RFID tag **170** thereby indicating that RFID fluid connection **10** is not properly connected. Put in yet another way, when RFID tag **170** is disabled, the RFID reader will not identify that RFID tag **170** exists and thus determine that RFID fluid connection **10** is not properly connected.

[0036] In some embodiments, RFID tag **170** is always enabled and can be detected and read by a RFID reader regardless of whether conductive layers **190** and **194** are in direct contact. In such embodiments, and as previously discussed, when conductive layers **190** and **194** are not directly connected, for example from the force of retaining ring **50**, RFID tag **170** is capable of transmitting, to a RFID reader, certain information. Such information may include, but is not limited to, a UID number, size number, model number, serial number, status of RFID tag **170** (i.e., open or closed), URL, station identification, date/time stamp, description, etc. Put another way, independent of whether conductive layers **190** and **194** are connected, RFID tag **170** will always transmit data (e.g., a UID number, a status, etc.) provided it is properly functioning. Thus, RFID tag **170** is preprogrammed to always transmit at least a UID number and a status (i.e., open or closed), for example, using hexadecimal data or a value. This is important because it allows the user to scan a given RFID tag to determine if it is properly functioning (i.e., if the RFID tag is properly transmitting data then it is properly functioning) as well as to determine its current state (i.e., open or closed). When conductive layers **190** and **194** are connected, for example, by applying a suitable force **F** to layer **194** via retaining ring **50**, RFID tag **170** transmits data indicating a closed status. In some embodiments, RFID tag **170** indicates a first value (e.g., a first hexadecimal value) for an open state and a second value (e.g., a second hexadecimal value) for a closed state, the second value being different from the first value. It should be appreciated that RFID tag **170** may include any programming suitable for indicating that it is properly functioning and a differentiation between an open state and a closed state, and that the present disclosure should not be limited to just the use of the hexadecimal system.

[0037] Figure 9A is a partial cross-sectional schematic view of RFID assembly **160** in an open (or disabled) state, in accordance with some embodiments of the present disclosure. It should be appreciated that this is only one embodiment of a pressure sensitive contact, and that various other pressure sensitive contacts that are known in the art or developed in the future may be used. Contact **180** comprises conductive layer **190**, insulating layer **192**, and conductive layer **194**. Conductive layer **190** is arranged on the top surface of **164**. In some embodiments, conductive layer **190** is arranged on the top surface of adhesive layer **162** (when layer **164** is not included). In some embodiments, conductive layer **190** is arranged on radially outward facing surface **30** of tube end form **20** (when layers **162** and **164** are not included). Insulating layer **192** is arranged on top of layer **190**. Conductive layer **194** is arranged on top of insulating layer **192**. Insulating layer **192** is operatively arranged to separate conductive layers **190** and **194** until a sufficient force **F** is applied to conductive layer **194**, as will be described in greater detail below. Conductor **178A** connects ground pin **GND** with conductive layer **190** and conductor **178B** connects detection pin **DP** with conductive layer **194**. In some embodiments, conductor **178A** connects ground pin **GND** with conductive layer **194** and conductor **178B** connects detection pin **DP** with conductive layer **190**. As shown in Figure 9A, conductors **178A** and **178B** remain unconnected and thus RFID tag **170** will indicate an open state or remains disabled (i.e., a RFID reader would not detect that RFID tag **170** exists). As such, in either case, the RFID reader will indicate that RFID fluid connection **10** is not properly secured.

[0038] Figure 9B is a partial cross-sectional schematic view of RFID assembly **160** shown in Figure 9A, in an closed (or enabled) state. When a sufficient force **F** is applied to conductive layer **194**, for example via retaining ring **50**, conductive layer **194** is displaced through insulating layer **192** and contacts conductive layer **190**. When conductive layer **194** contacts conductive layer **190**, conductors **178A** and **178B** are electrically connected completing the circuit and RFID tag **170** indicates a closed state or is enabled (i.e., RFID tag **170** is capable of being powered by an electromagnetic field generated by the RFID reader). As such, in either case, the RFID reader will indicate that RFID fluid connection **10** is properly secured.

[0039] Figure 10 is a perspective view of RFID fluid connection **210** in a closed (i.e., secured) state. Figure 11 is a perspective view of RFID fluid connection **210** in an open (i.e., unsecured) state. Figure 12 is an exploded perspective view of RFID fluid connection **210**. RFID fluid connection **210** generally comprises tube or hose **220**, fluid connector **240**, retaining ring or clamp **250**, and RFID assembly **260**. The following description should be read in view of Figures 10-12.

[0040] Tube **220** comprises end **222**, end **232**, radially outward facing surface **230**, and through-bore **221**. Through-bore **221** extends through tube **220** from end **222** to end **232**. Radially outward facing surface **230** includes a substantially constant diameter. In some embodiments, radially outward facing surface **230** varies in diameter. In some embodiments, tube **220** further comprises a shoulder or a bead connected to radially outward facing surface **230**. Tube **220** is arranged to engage fluid connector **240**. Specifically, tube **220** is slid over barb **246** and radially outward facing surface **244** in axial direction **AD3**. It should be appreciated that in some embodiments, fluid connector **240** does not comprise barb **246**. Once tube **220** is properly engaged with fluid connector **240**, retaining ring **250** is slid over tube **220** in axial direction **AD3**, as shown in Figure 11. Once properly positioned with the designated clamp location of tube **220**, retaining ring **250** is crimped to secure tube **220** to fluid connector **240**, as will be described in greater detail below. In some embodiments, tube **220** comprises rubber or another elastic or flexible material suitable to be securable to a fluid connector via a retainer ring or clamp. The present disclosure should not be limited to the use of only the tube shown in the figures, but rather any tube suitable for fluidly connecting to a fluid connector via a retaining ring or clamp. RFID assembly **260** verifies that retaining ring **250** has adequately tightened around tube **220** and fluid connector **240**

in order to determine that RFID fluid connection **210** is properly connected, as will be described in greater detail below.

[0041] Fluid connector **240** comprises through-bore **242**, radially outward facing surface **244**, and barb **246**. Radially outward facing surface **244** and barb **246** are arranged to engage through-bore **221** of tube **220**. Retaining ring **250** is arranged to align with radially outward facing surface **244**, as shown in Figures 10-11. Retaining ring **250** comprises radially inward facing surface **252** and crimp section **254**. When crimp section **254** is "crimped" or squeezed, the radius of radially inward facing surface **252** decreases which allows retaining ring **250** to secure tube **220** to fluid connector **240**. While the figures show a "crimp" style retaining ring or clamp, it should be appreciated that any clamp suitable for securing a tube or a hose to a fluid connector and contacting one or more contacts of RFID assembly **260** to indicate proper connection may be utilized, as will be described in greater detail below. Some examples of various retaining rings and clamps that may be used are rigid clamps, U-bolt clamps, flat cushion clamps, U-Bolt with cushion clamps, P style clamps, swivel bolt clamps, worm gear hose clamps, OETIKER® crimp, stepless ear hose clamps, OETIKER® band clamps, OETIKER® ear clamps, OETIKER® STEPLESS® Ear Clamps PEX Series (e.g., PEXGRIP® series ear clamps), OETIKER® spring hose clamps, OETIKER® snap grip clamps, etc.

[0042] Figure 13 is a top planar view of RFID assembly **260**, in accordance with some embodiments of the present disclosure. Figure 14 is a cross-sectional view of RFID fluid connection **210** taken generally along line **14-14** in Figure 11, in an open state. Figure 15 is a cross-section view of RFID fluid connection **210** taken generally along line 15-15 in Figure 10, in a closed state. RFID assembly **260** generally comprises at least one layer (e.g., adhesive layer **262** and/or layer **264**), RFID tag **270**, and at least one contact (e.g., contact **280A** and/or contact **280B**). In some embodiments, RFID assembly **260** is a RFID label that is connected to a tube or component, wherein the tube or component is arranged to be connected to another component. It should be appreciated that RFID assembly **260** may be used to ensure any type of connection, not just a connection related to the flow of fluid, for example, a constant-velocity (CV) joint, a trailer hitch connection, electrical connections, etc. The following description should be read in view of Figures 10-15.

[0043] Adhesive layer **262** is operatively arranged to be secured to tube **220**. In some embodiments, adhesive layer **262** secures layer **264** and/or contacts **280A** and **280B** to tube **220**. It should be appreciated that layer **264** need not be connected to tube **220** via adhesives (i.e., adhesive layer **262**), but rather can be connected and/or applied using any other suitable means, for example, string, tape, hook and loop fastener, solder, welding, etc. In some embodiments, adhesive layer **262** is wrapped around tube **220** and is secured to radially outward facing surface **230** proximate to end **222**. In some embodiments, adhesive layer **262** completely circumscribes radially outward facing surface **230** and overlaps at its ends (see Figure 5). In some embodiments, adhesive layer **262** completely circumscribes radially outward facing surface **230** and its ends abut against each other (see Figure 8). In some embodiments, adhesive layer **262** does not completely circumscribe radially outward facing surface **230** (see Figures 14-15).

[0044] RFID assembly **260** may further comprise layer **264**. Layer **264** is connected to the top surface of adhesive layer **262** and is operatively arranged as a platform or base for RFID tag **270** and contacts **280A-B**. In some embodiments, layer **264** comprises ferrite. In some embodiments, RFID tag **270** and contacts **280A-B** are connected directly to the top surface of adhesive layer **262**, without the need for layer **264**. In some embodiments, RFID tag **270** and contacts **280A-B** are connected directly to radially outward facing surface **230** without the need for adhesive layer **262** or layer **264**. In some embodiments, RFID assembly **260** further comprises layer **266**. Layer **266** is operatively arranged to cover and protect RFID tag **270**. As shown in Figure 13, layer **266** completely covers RFID tag **270**. In some embodiments, layer **266** at least partially covers contacts **280A** and **280B**. However, it is required that at least a portion of contacts **280A** and **280B** are exposed such that they are capable of engaging retaining ring **250**, as will be described in greater detail below.

[0045] RFID tag **270** comprises integrated circuit (IC) or chip **272** and antenna **274**. In some embodiments, RFID tag **270** comprises a passive RFID tag. In some embodiments, RFID tag **270** comprises an active RFID tag (and further comprises a power source). In some embodiments, RFID tag **270** comprises a semi-passive RFID tag. In some embodiments, RFID tag **270** is preprogrammed such that it transmits information, for example, a unique identification (UID) number, the state of RFID assembly **260** (i.e., open or closed), etc. Antenna **274** is connected at a first end to IC **272** at antenna radio-frequency (RF) input **LA**, and at a second end to IC **272**

at antenna RF input **LB**, via conductors **276A** and **276B**, respectively. RFID tag **270** is further connected to contact **280A** and contact **280B**. Specifically, conductor **278A** connects contact **280A** with IC **272** at ground pin **GND** and conductor **278B** connects contact **280B** with IC **272** at detector pin **DP**.

[0046] Contact **280A** is separated from contact **280B** by gap **284** and gap **286** (see Figure 14). In some embodiments, gap **284** is equal to gap **286**. In some embodiments, gap **284** is less than gap **286**. In some embodiments, gap **284** is greater than gap **286**. Contacts **280A** and **280B** are arranged proximate to or abutting against end **222**. More specifically, contacts **280A** and **280B** are operatively arranged to, when RFID fluid connection **210** is properly assembled, align with radially outward facing surface **244** of connector body and retaining ring **250**. Contacts **280A** and **280B** are operatively arranged to engage with retaining ring **250**. In some embodiments, contacts **280A** and **280B** are electrical conductors. When tube **220** is properly secured on fluid connector **240**, retaining ring **250** is aligned with radially outward facing surface **244** and contacts **280A** and **280B** and crimped or squeezed, thereby locking tube **220** onto fluid connector **240**. When retaining ring **250** is crimped, radially inward facing surface **252** engages contacts **280A** and **280B**. For example, and as shown in Figure 14, in an unsecured state, radially inward facing surface **252** of retaining ring **250** is not engaged with either of contacts **280A** or **280B**, or alternatively, is only engaged with one of contacts **280A** and **280B**. In the unsecured state, radially inward facing surface **252** is not engaged with both of contacts of **280A** or **280B**. As shown in Figure 15, in a properly secured state, radially inward facing surface **252** is engaged with both of contacts **280A** and **280B**. In some embodiments, retaining ring **250** comprises an electrically conductive material (e.g., metal). As such, retaining ring **250** completes the circuit between contacts **280A-B** and IC **272** and causes RFID tag **270** to switch to a closed state (from an open state). Prior to completion of the circuit, namely, electrically connecting contact **280B** directly with contact **280A**, RFID tag **270** indicates an open status. When the circuit is completed (i.e., retaining ring **250** directly connects contact **280A** and contact **280B** as shown in Figure 15), an external device such as a RFID reader will detect that RFID tag **270** is in a closed state, thereby indicating that RFID fluid connection **210** is properly connected.

[0047] In some embodiments, RFID tag **270** is always enabled and can be detected and read by a RFID reader regardless of whether contacts **280A** and **280B** are connected. In such embodiments, when contacts **280A** and **280B** are not directly connected, for example via retaining ring **250**, RFID tag **270** is capable of transmitting, to a RFID reader, certain information. Such information may include, but is not limited to, a UID number (e.g., for the RFID tag, the tube end form, etc.), size number, model number, serial number, status of RFID tag **270** (i.e., open or closed), URL, station identification (i.e., manufacturing LOT number), date/time stamp, description, etc. Put another way, independent of whether contacts **280A** and **280B** are connected, RFID tag **270** will always transmit certain data (e.g., a UID number, a status, etc.) provided it is properly functioning. Thus, RFID tag **270** is preprogrammed to always transmit at least a UID number and a status (i.e., open or closed), for example, using hexadecimal data or a value. This is important because it allows the user to scan a given RFID tag to determine if it is properly functioning (i.e., if the RFID tag is properly transmitting data then it is properly functioning) as well as to determine its current state (i.e., open or closed). When contacts **280A** and **280B** are connected, for example, via retaining ring **250**, RFID tag **270** transmits data indicating a closed status. In some embodiments, RFID tag **270** indicates a first value (e.g., a first hexadecimal value) for an open state and a second value (e.g., second hexadecimal value) for a closed state, the second value being different from the first value. It should be appreciated that RFID tag **270** may include any programming suitable for indicating that it is properly functioning and a differentiation between an open state and a closed state, and that the present disclosure should not be limited to just the use of the hexadecimal system.

[0048] It should be appreciated that the RFID tags and assemblies described herein, for example, RFID tags **70 170**, and **270** and RFID assemblies **60**, **160**, and **260**, may utilize any suitable radio frequency range. In some embodiments, RFID tags **70 170**, and **270** comprise low frequency (LF) RFID tags operating in the 30 KHz to 300 KHz range, and have a read range of up to 10 cm. While LF RFID tags have a shorter read range and slower data read rate than other technologies, they perform better in the presence of metal or liquids (which can interfere with other types of RFID tag transmissions). Common standards for LF RFID include ISO 14223 and ISO/IEC 18000-2. In some embodiments, RFID tags **70 170**, and **270** comprise high frequency (HF) RFID tags operating in the 3 MHz to 30 MHz range and provide reading distances of 10 cm to 1 m. In such embodiments, RFID tags **70 170**, and **270** may even be near-field communication (NFC) tags since NFC technology is based on HF RFID. Common standards for HF RFID include

ISO 15693, ECMA-340, ISO/IEC 18092 (for NFC), ISO/IEC 14443A and ISO/IEC 14443 (for MIFARE and other smart card solutions). In some embodiments, RFID tags **70** **170**, and **270** comprise ultra-high frequency (UHF) RFID operating in the 300 MHz to 2 GHz range and provide reading distances of up to 12 m. A well-known standard for UHF RFID is EPCglobal Gen2/ISO 18000-6C. Furthermore, in some embodiments, a single RFID reader is capable of detecting and receiving data from a plurality of RFID tags, not just one.

[0049] It will be appreciated that various aspects of the disclosure above and other features and functions, or alternatives thereof, may be desirably combined into many other different systems or applications. Various presently unforeseen or unanticipated alternatives, modifications, variations, or improvements therein may be subsequently made by those skilled in the art which are also intended to be encompassed by the following claims.

REFERENCE NUMERALS

10	RFID fluid connection	**74**	Antenna
20	Tube (or tube end form or hose)	**76A**	Conductor
21	Through-bore	**76B**	Conductor
22	End	**78A**	Conductor
23	Section	**78B**	Conductor
24	Radially outward facing surface	**80A**	Contact
26	Radially outward facing surface	**80B**	Contact
27	Shoulder	**82A**	Exposed portion
28	Shoulder surface	**82B**	Exposed portion
29	Section	**84**	Gap
30	Radially outward facing surface	**86**	Gap
32	End	**160**	RFID assembly (or label)
40	Fluid connector	**162**	Adhesive layer
42	Through-bore	**164**	Layer
44	Radially inward facing surface	**166**	Layer
46	Radially inward facing surface	**170**	RFID tag
48	Radially outward facing surface	**172**	Integrated circuit (or chip)
49	Groove	**174**	Antenna
50	Retaining ring (or snap ring)	**176A**	Conductor
52A	Protrusion	**176B**	Conductor
52B	Protrusion	**178A**	Conductor
52C	Protrusion	**178B**	Conductor
60	RFID assembly (or label)	**180**	Contact
62	Adhesive layer	**182**	Exposed portion
64	Layer	**184**	Gap
66	Layer	**190**	Layer
70	RFID tag	**192**	Layer
72	Integrated circuit (or chip)	**194**	Layer

210	RFID fluid connection	**274**	Antenna
220	Tube (or hose)	**276A**	Conductor
221	Through-bore	**276B**	Conductor
222	End	**278A**	Conductor
230	Radially outward facing surface	**278B**	Conductor
232	End	**280A**	Contact
240	Fluid connector	**280B**	Contact
242	Through-bore	**284**	Gap
244	Radially outward facing surface	**286**	Gap
246	Barb (or tube barb)	**LA**	Antenna RF input
250	Retaining ring (or clamp)	**LB**	Antenna RF input
252	Radially inward facing surface	**GND**	Ground pin
254	Crimp section	**DP**	Detection pin
260	RFID assembly (or label)	**F**	Force
262	Layer	**AD1**	Axial direction
264	Layer	**AD2**	Axial direction
266	Layer	**AD3**	Axial direction
270	RFID tag	**AD4**	Axial direction
272	Integrated circuit (or chip)		

CLAIMS

What Is Claimed Is:

1. A radio-frequency identification (RFID) fluid connection, comprising:
   a tube, including a radially outward facing surface; and,
   a RFID assembly connected to the radially outward facing surface, including:
      a RFID tag; and,
      at least one contact electrically connected to the RFID tag.

2. The RFID fluid connection as recited in Claim 1, wherein:
   the tube further comprises a shoulder connected to the radially outward facing surface; and,
   the RFID assembly is arranged proximate the shoulder.

3. The RFID fluid connection as recited in Claim 1, wherein the RFID assembly is arranged on a first layer and the first layer is connected to the radially outward facing surface.

4. The RFID fluid connection as recited in Claim 1, wherein the at least one contact comprises:
   a first contact electrically connected to the RFID tag; and,
   a second contact electrically connected to the RFID tag, the second contact being separated from the first contact to form an open state of the RFID assembly.

5. The RFID fluid connection as recited in Claim 4, wherein, in a closed state, the first contact is electrically connected to the second contact.

6. The RFID fluid connection as recited in Claim 5, wherein the first contact is operatively arranged to be electrically connected to the second contact via a retaining ring when the tube is connected to a fluid connector.

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7. The RFID fluid connection as recited in Claim 1, wherein the at least one contact comprises a pressure sensitive contact electrically connected to the RFID tag via a first conductor and a second conductor.

8. The RFID fluid connection as recited in Claim 7, wherein the pressure sensitive contact comprises:

a first conductive layer electrically connected to the first conductor;

a second conductive layer electrically connected to the second conductor; and,

an insulating layer separating the first and second conductive layers to form an open state of the RFID assembly.

9. The RFID fluid connection as recited in Claim 8, wherein, in a closed state, the first conductive layer is electrically connected to the second conductive layer via a force applied to the first conductive layer.

10. The RFID fluid connection as recited in Claim 9, wherein the force is applied to the first conductive layer via a retaining ring of a fluid connector when the tube is connected to the fluid connector.

11. The RFID fluid connection as recited in Claim 1, wherein:

the RFID tag comprises an antenna;

in an open state of the RFID tag, the antenna circuit is open; and,

in a closed state of the RFID tag, the antenna circuit is closed.

12. A radio-frequency identification (RFID) fluid connection, comprising:

a fluid connector;

a retaining ring operatively arranged to engage the fluid connector;

a tube operatively arranged to be connected to the fluid connector, the tube including a first radially outward facing surface; and,

a RFID assembly arranged on the first radially outward facing surface, including:

a RFID tag; and,

at least one contact electrically connected to the RFID tag.

13. The RFID fluid connection as recited in Claim 12, wherein:

the tube further comprises a shoulder connected to the first radially outward facing surface, the shoulder arranged to interact with the retaining ring to lock the tube within the fluid connector; and,

the at least one contact is operatively arranged proximate the shoulder to engage with the retaining ring.

14. The RFID fluid connection as recited in Claim 12, wherein the at least one contact comprises:

a first contact electrically connected to the RFID tag; and,

a second contact electrically connected to the RFID tag, the second contact being separated from the first contact to form an open state of the RFID assembly.

15. The RFID fluid connection as recited in Claim 14, wherein, when the tube is properly secured to the fluid connector:

the retaining ring engages the first contact and the second contact; and,

the first contact is electrically connected to the second contact to form a closed state of the RFID assembly.

16. The RFID fluid connection as recited in Claim 12, wherein the retaining ring is a clamp.

17. The RFID fluid connection as recited in Claim 12, wherein:

the fluid connector comprises a second radially outward facing surface; and,

the tube and the retaining ring are operatively arranged to engage the second radially outward facing surface.

18. The RFID fluid connection as recited in Claim 12, wherein the RFID assembly is arranged on a layer and the layer is connected to the first radially outward facing surface.

19. The RFID fluid connection as recited in Claim 12, wherein:
the RFID tag comprises an antenna;
in an open state of the RFID tag, the antenna circuit is open; and,
in a closed state of the RFID tag, the antenna circuit is closed.

20. A radio-frequency identification (RFID) fluid connection, comprising:
a fluid connector;
a retaining ring operatively arranged to engage the fluid connector;
a tube operatively arranged to be connected to the fluid connector, the tube including a radially outward facing surface; and,
a RFID assembly arranged on the radially outward facing surface and including:
a RFID tag including an antenna and an integrated circuit; and,
at least one contact electrically connected to the integrated circuit;
wherein:
when the integrated circuit is open, the RFID tag indicates an improper connection of the RFID fluid connection; and,
when the integrated circuit is closed, the RFID tag indicates a proper connection of the RFID fluid connection.

21. A radio-frequency identification (RFID) assembly, comprising:
an integrated circuit;
an antenna connected to the integrated circuit; and,
at least one contact connected to the integrated circuit;
wherein:
when the integrated circuit is open, the RFID assembly indicated a first state; and,
when the integrated circuit is closed, the RFID assembly indicates a second state, different from the first state.

22. The RFID assembly as recited in Claim 21, wherein the at least one contact comprises a first contact and a second contact.

23. The RFID assembly as recited in Claim 22, wherein:

when the second contact is not electrically connected to the first contact, the RFID assembly indicates the first state; and,

when the second contact is electrically connected to the first contact, the RFID assembly indicates the second state.

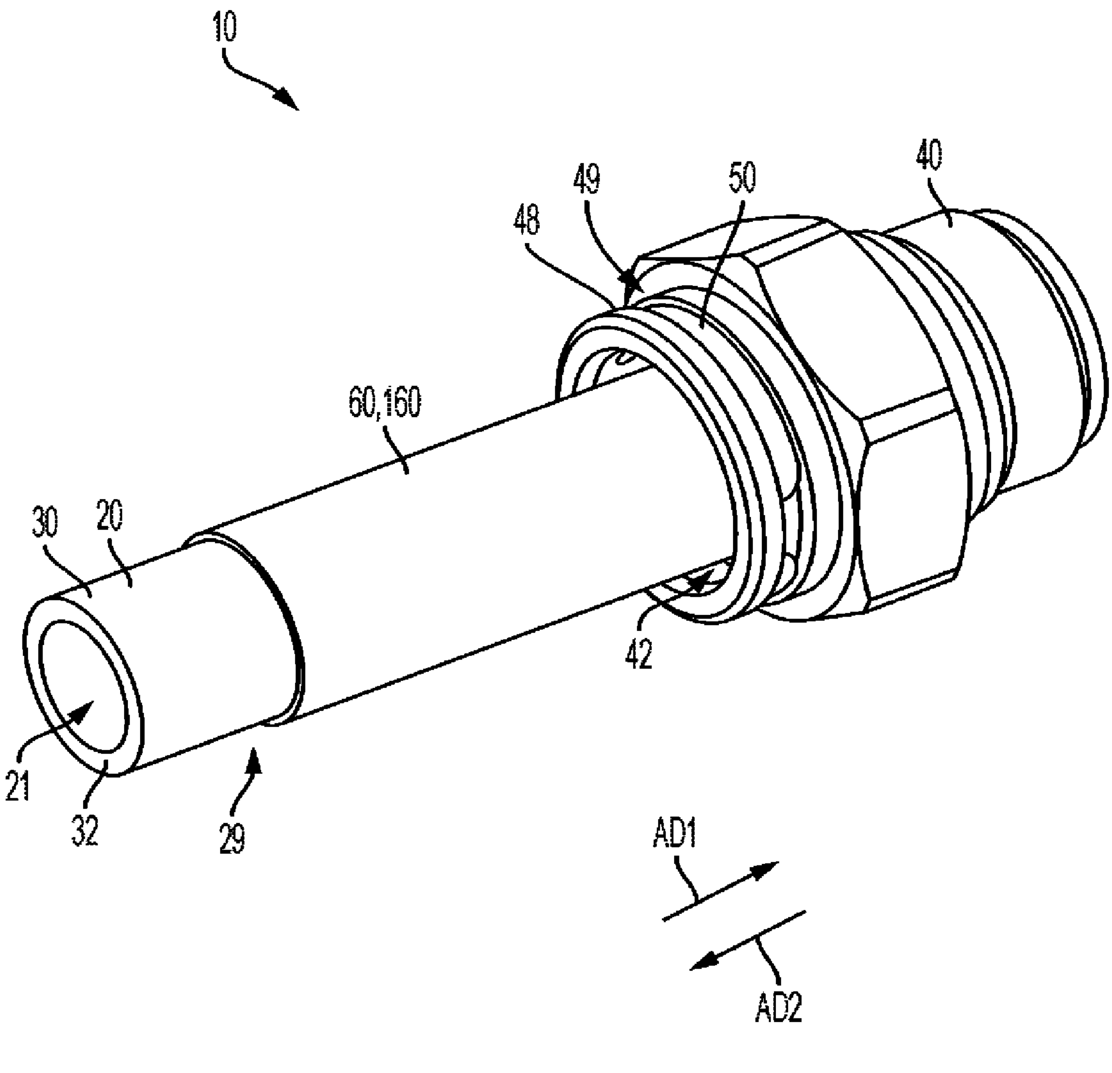
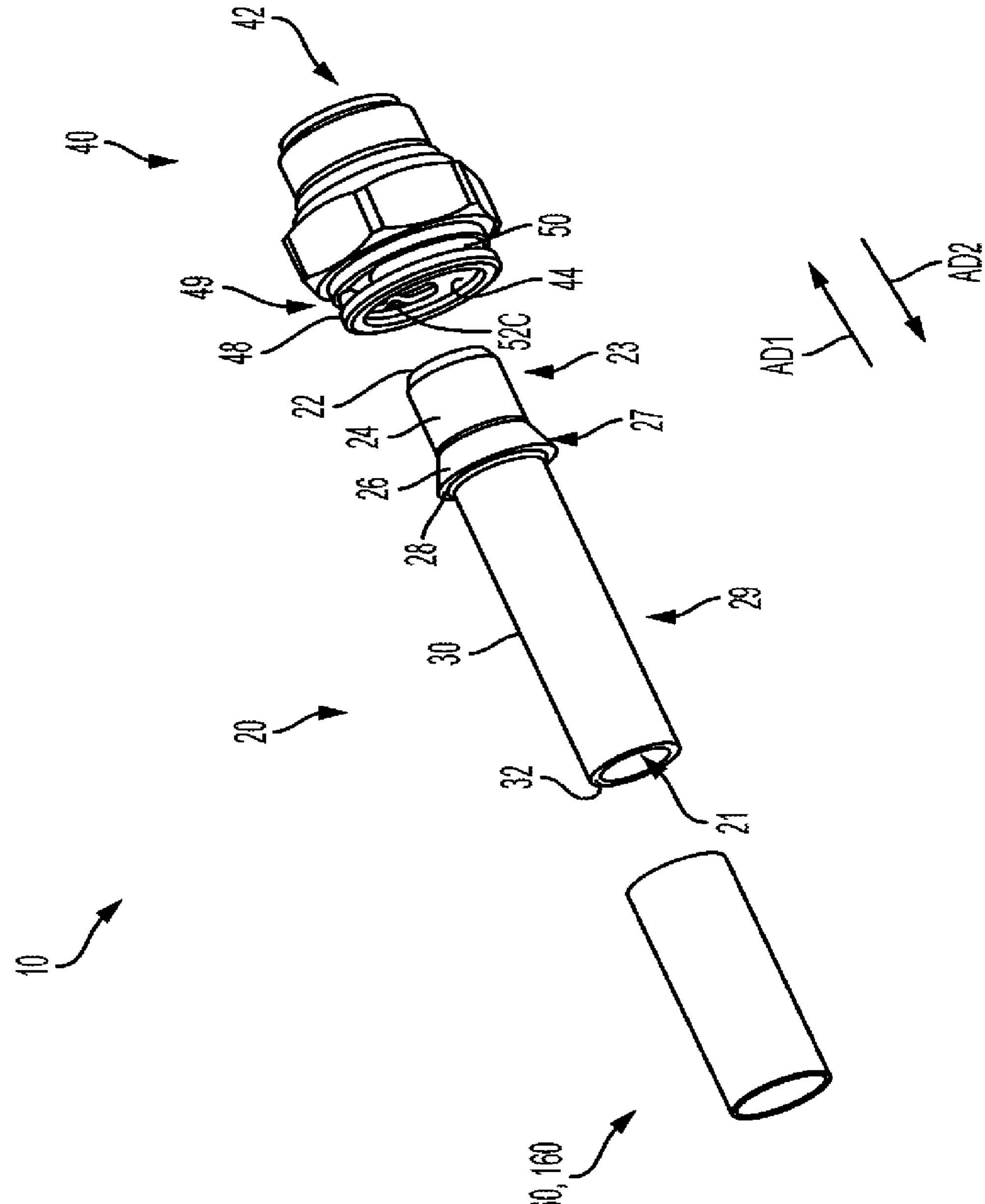


FIG. 1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20
32
21
10
60, 160
AD1
AD2

FIG. 2

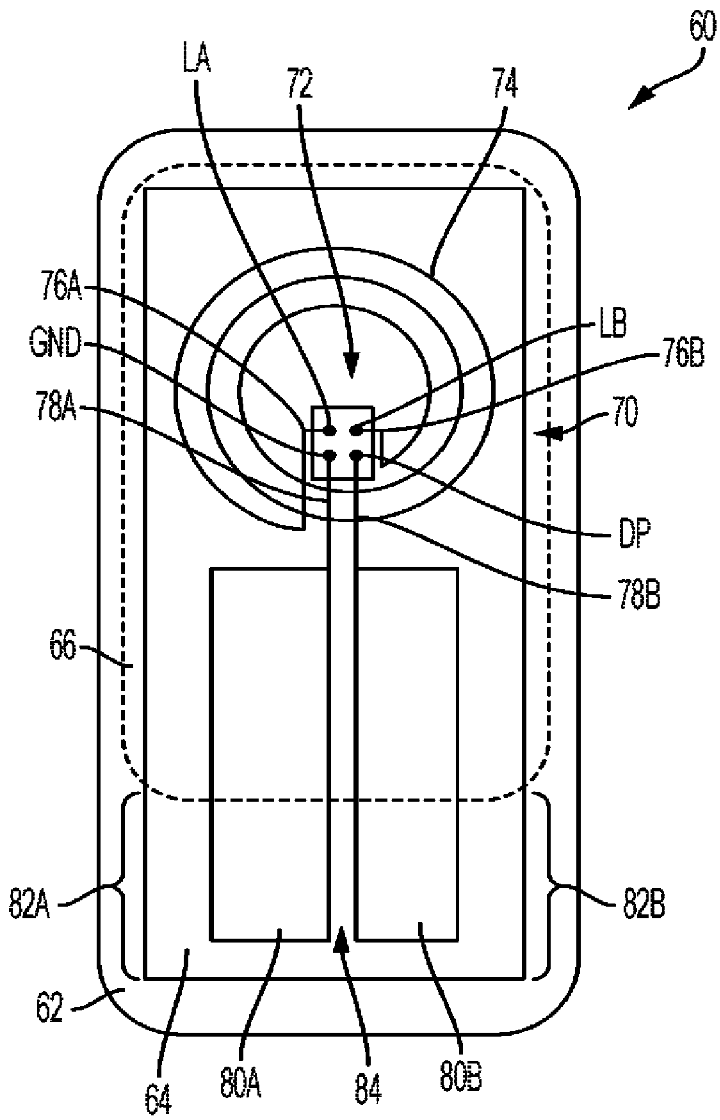

FIG. 3

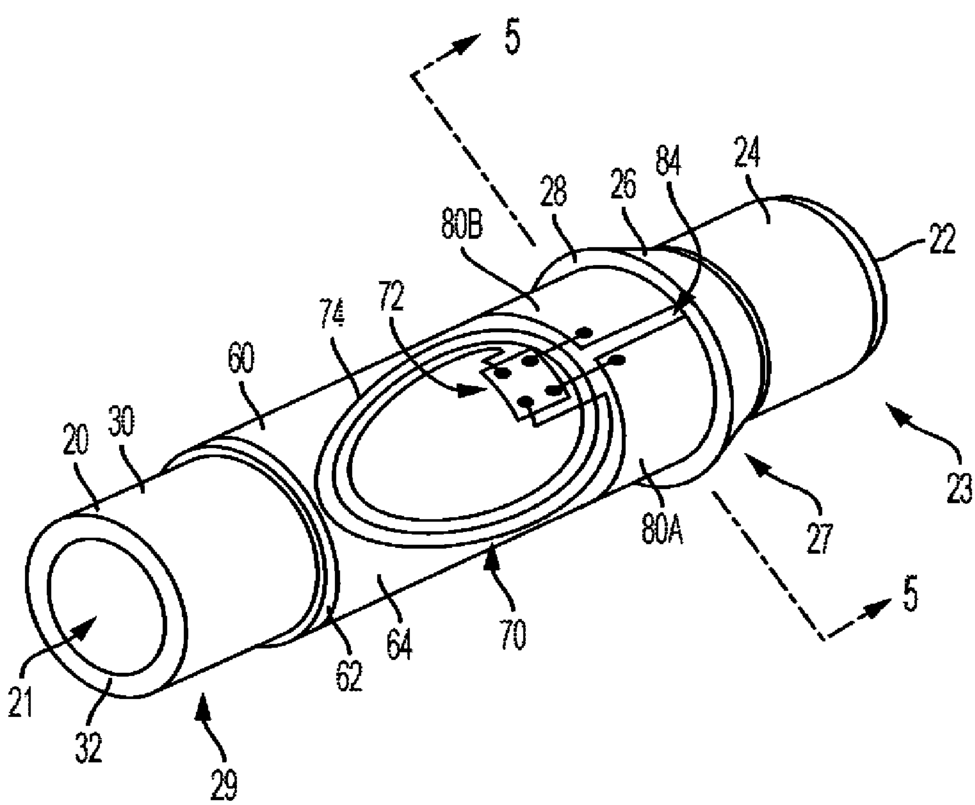

FIG. 4

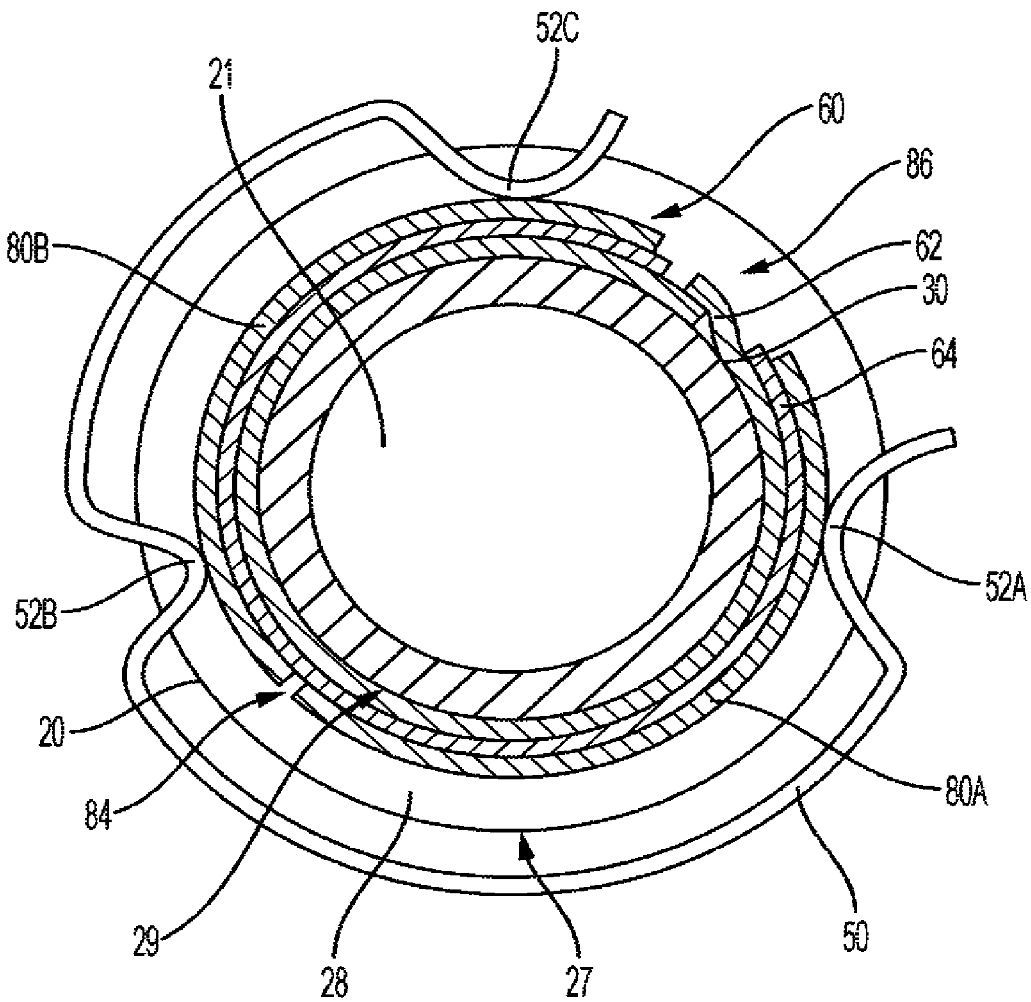

FIG. 5

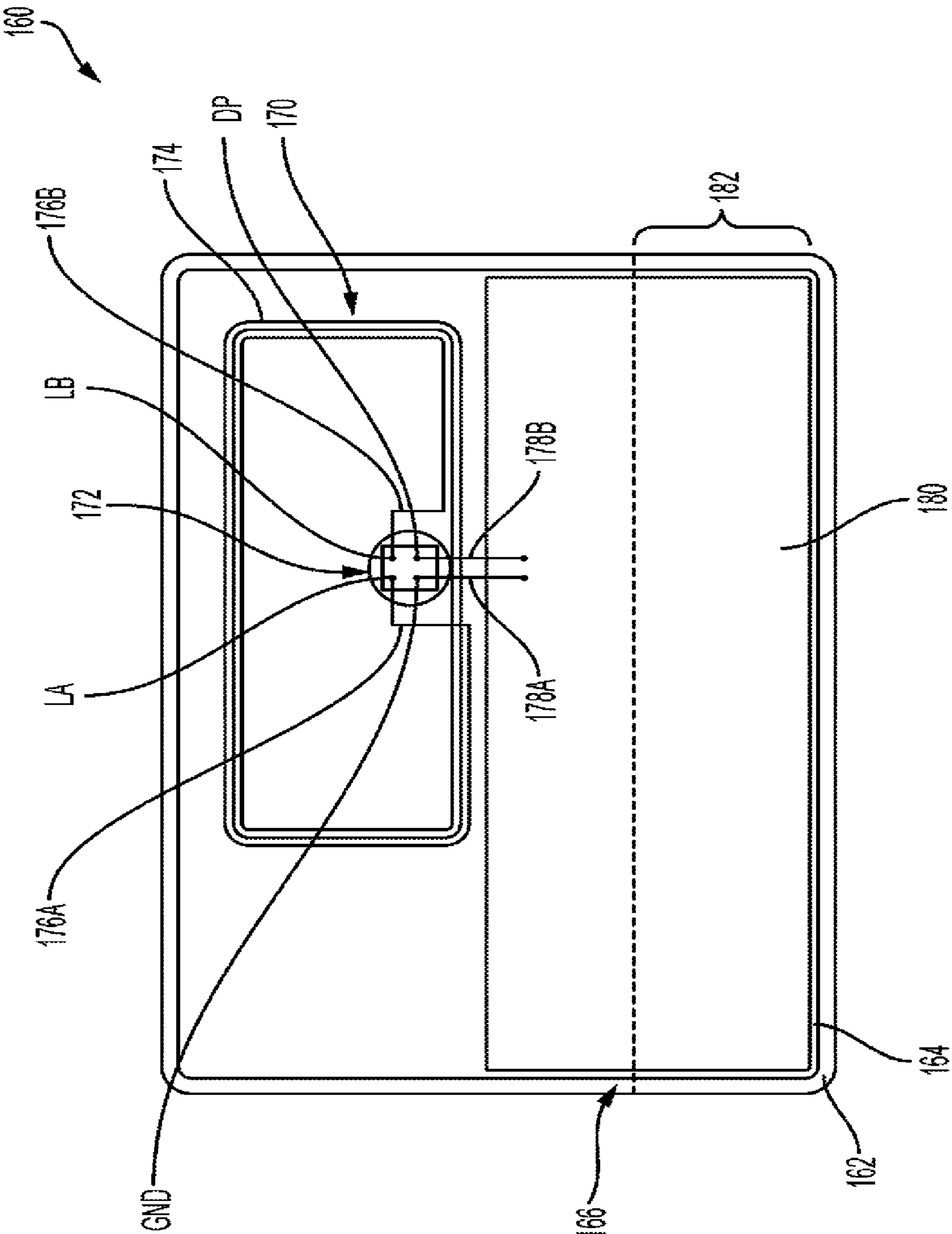
160
176B
174
DP
170
182
LB
172
178B
180
LA
178A
176A
GND
166
162
164

FIG. 6

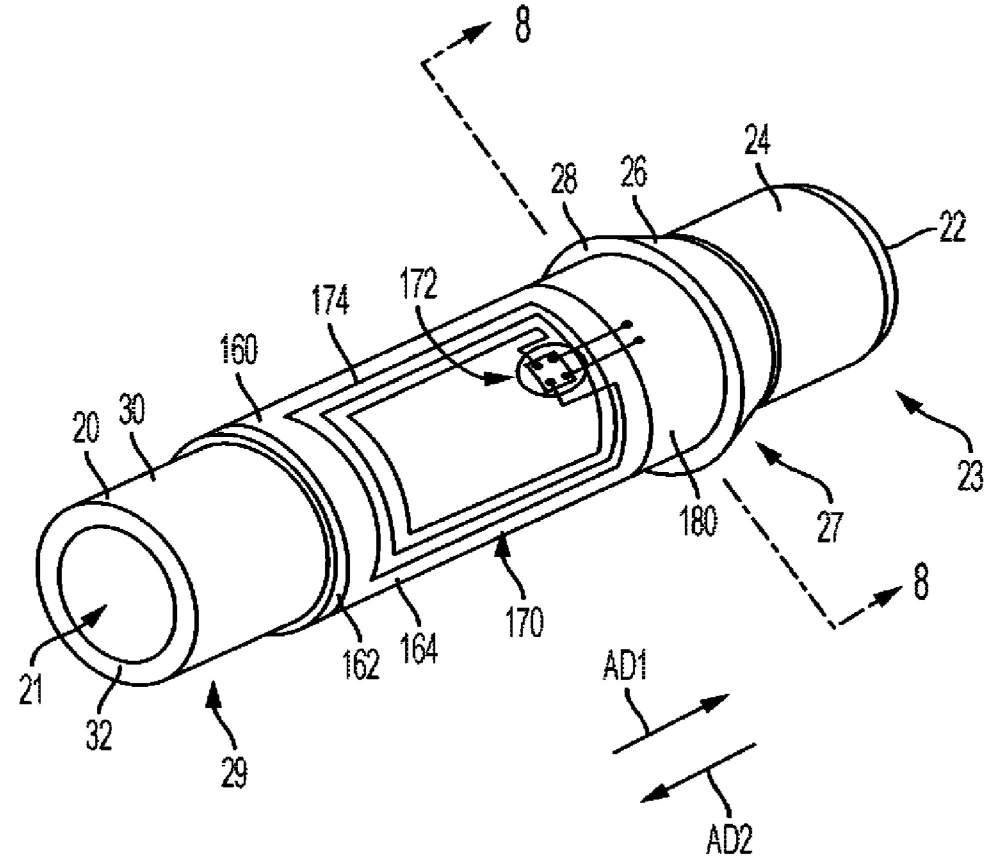
8
24
28
26
22
174
172
160
30
20
23
180
27
8
21
32
162
164
170
29
AD1
AD2

FIG. 7

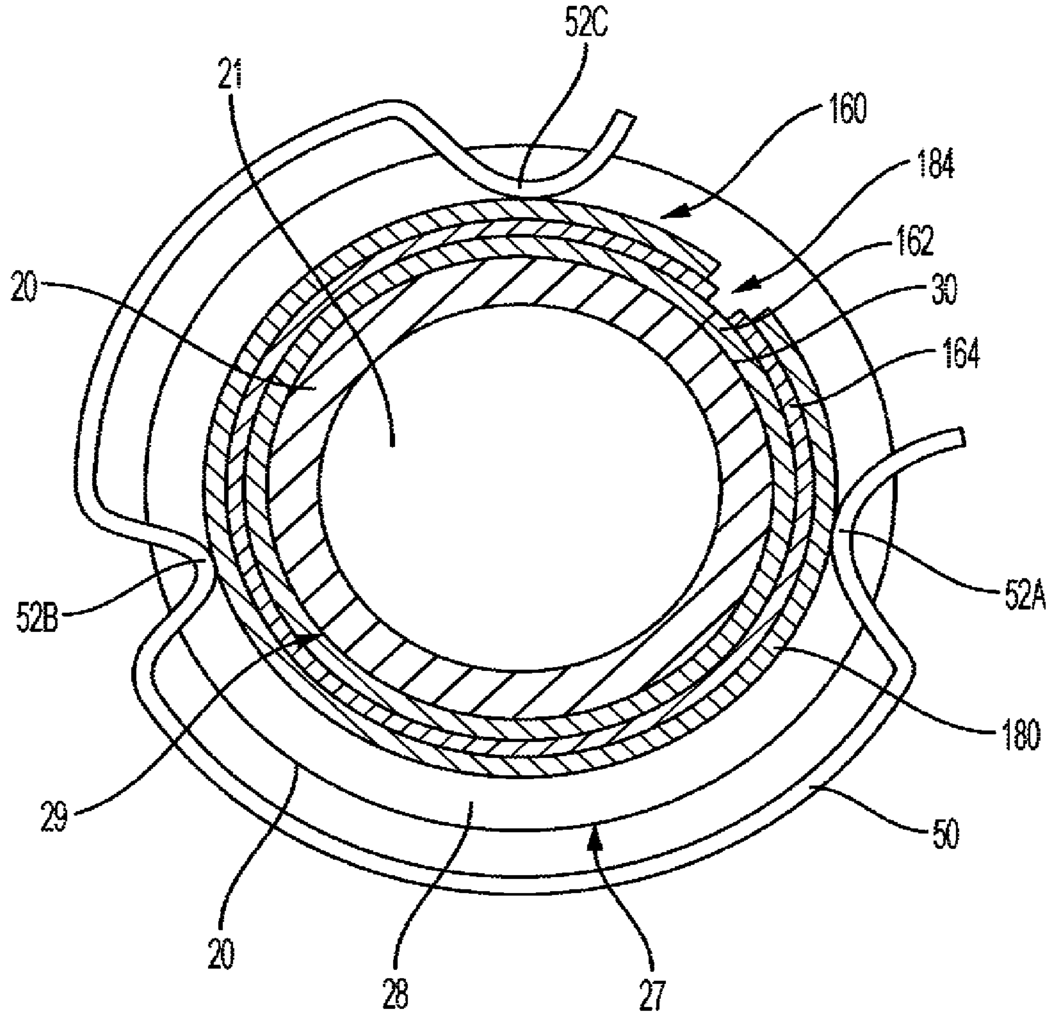

FIG. 8

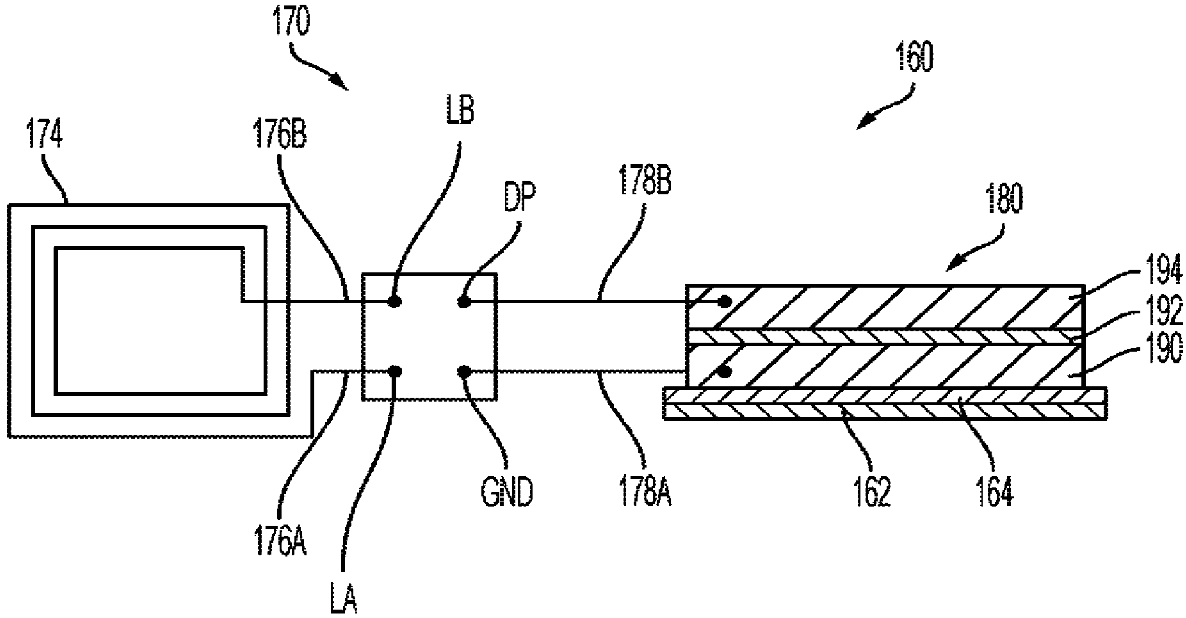
170
160
174
176B
LB
DP
178B
180
194
192
190
176A
LA
GND
178A
162
164

FIG.9A

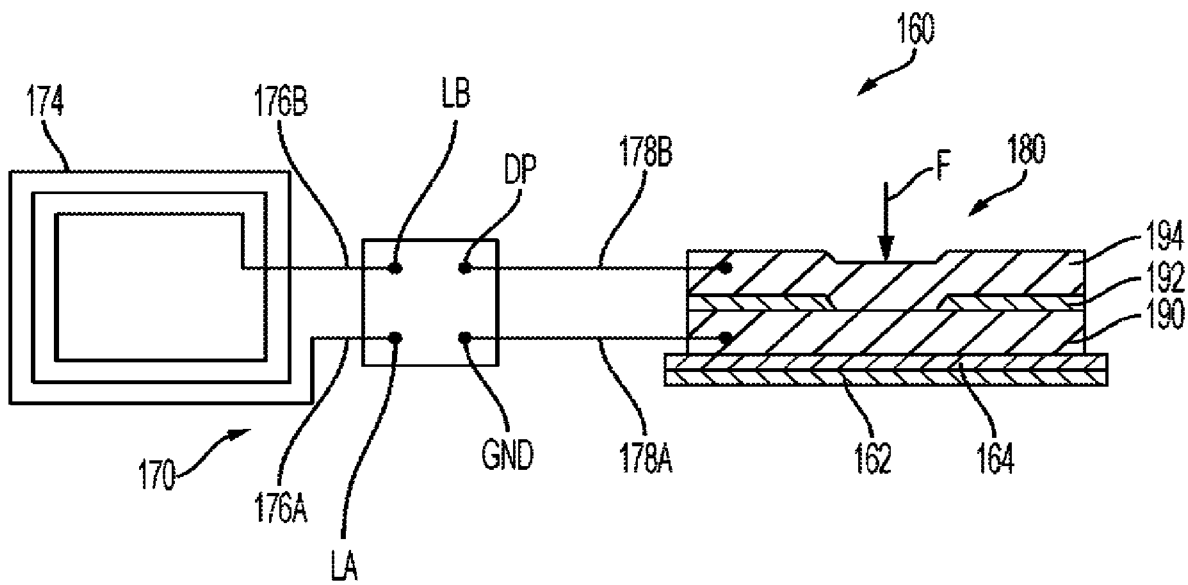
160
174
176B
LB
DP
178B
F
180
194
192
190
170
176A
LA
GND
178A
162
164

FIG. 9B

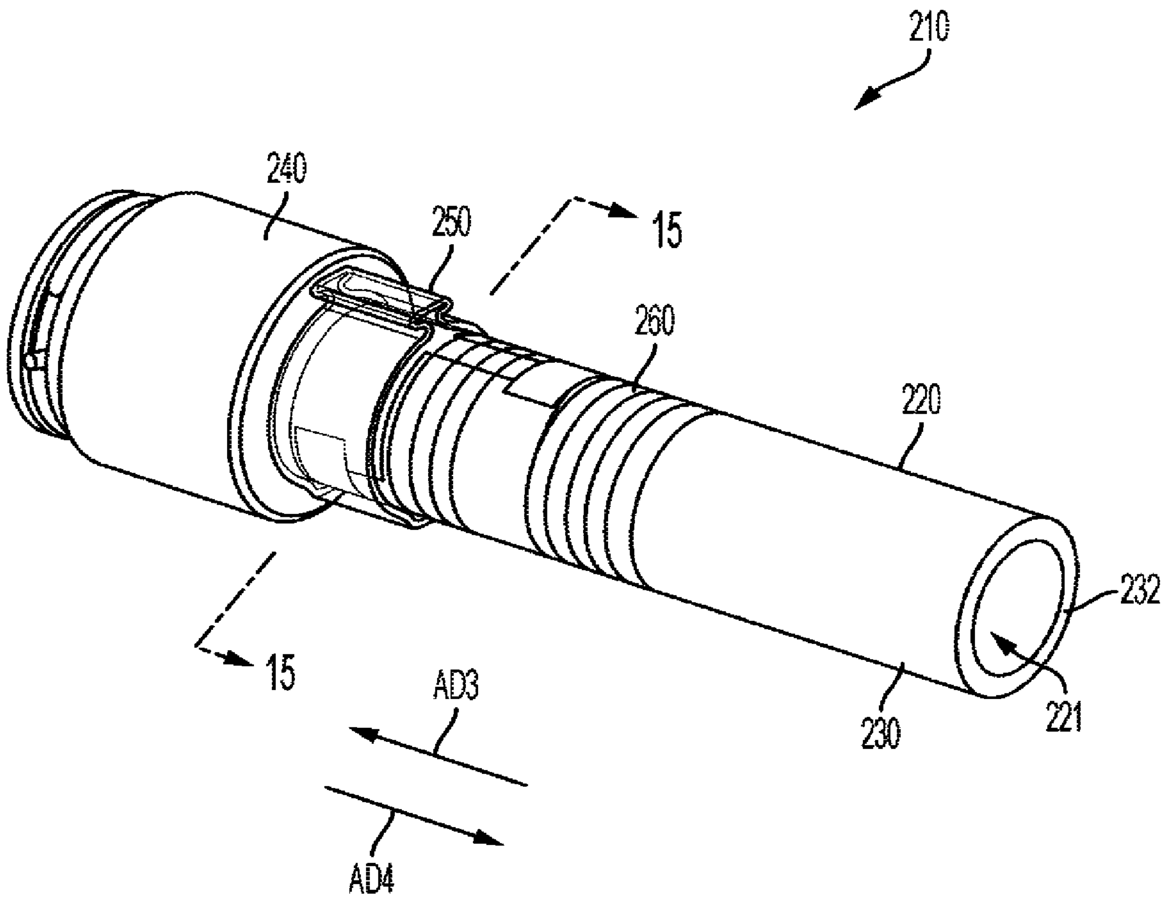

FIG. 10

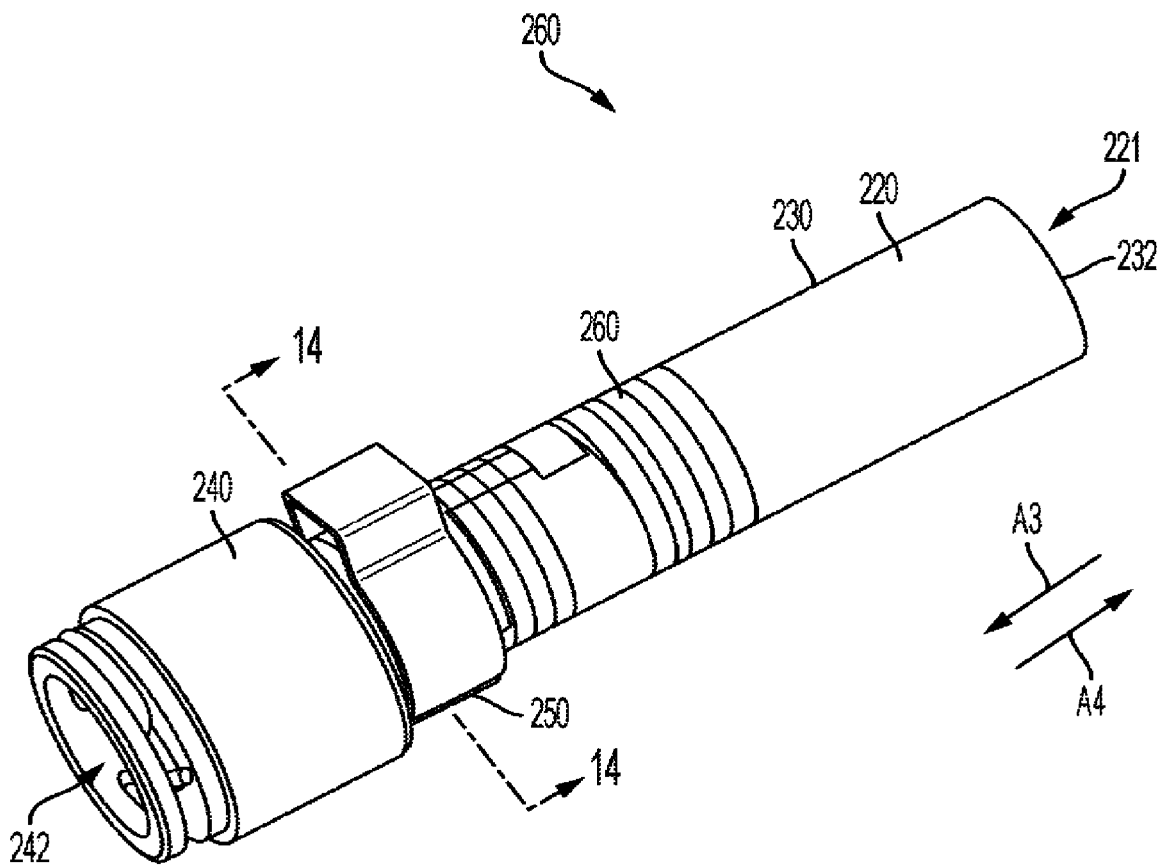

FIG. 11

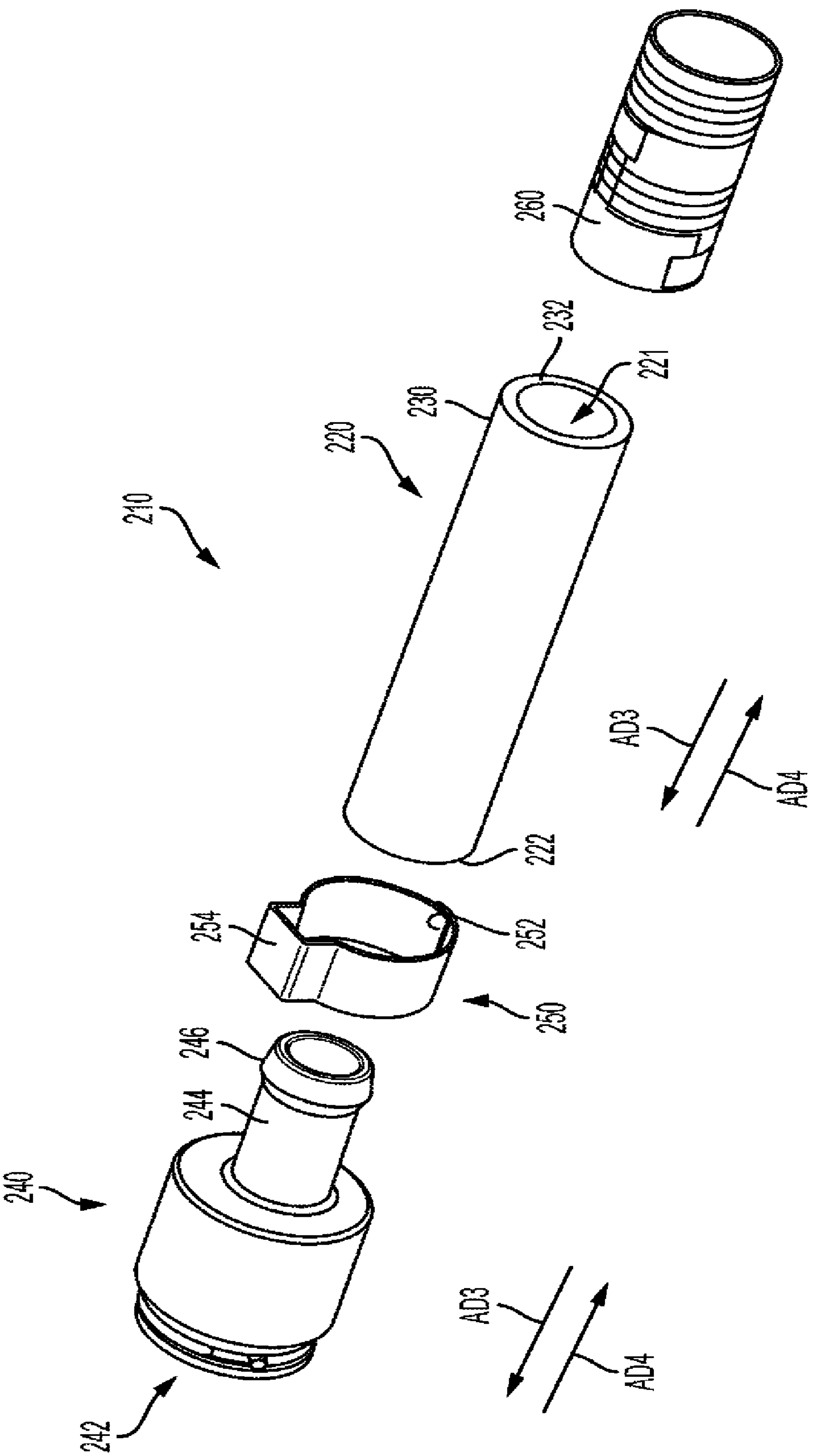
260
232
221
230
220
210
AD3
AD4
222
254
252
250
246
244
240
AD3
AD4
242

FIG. 12

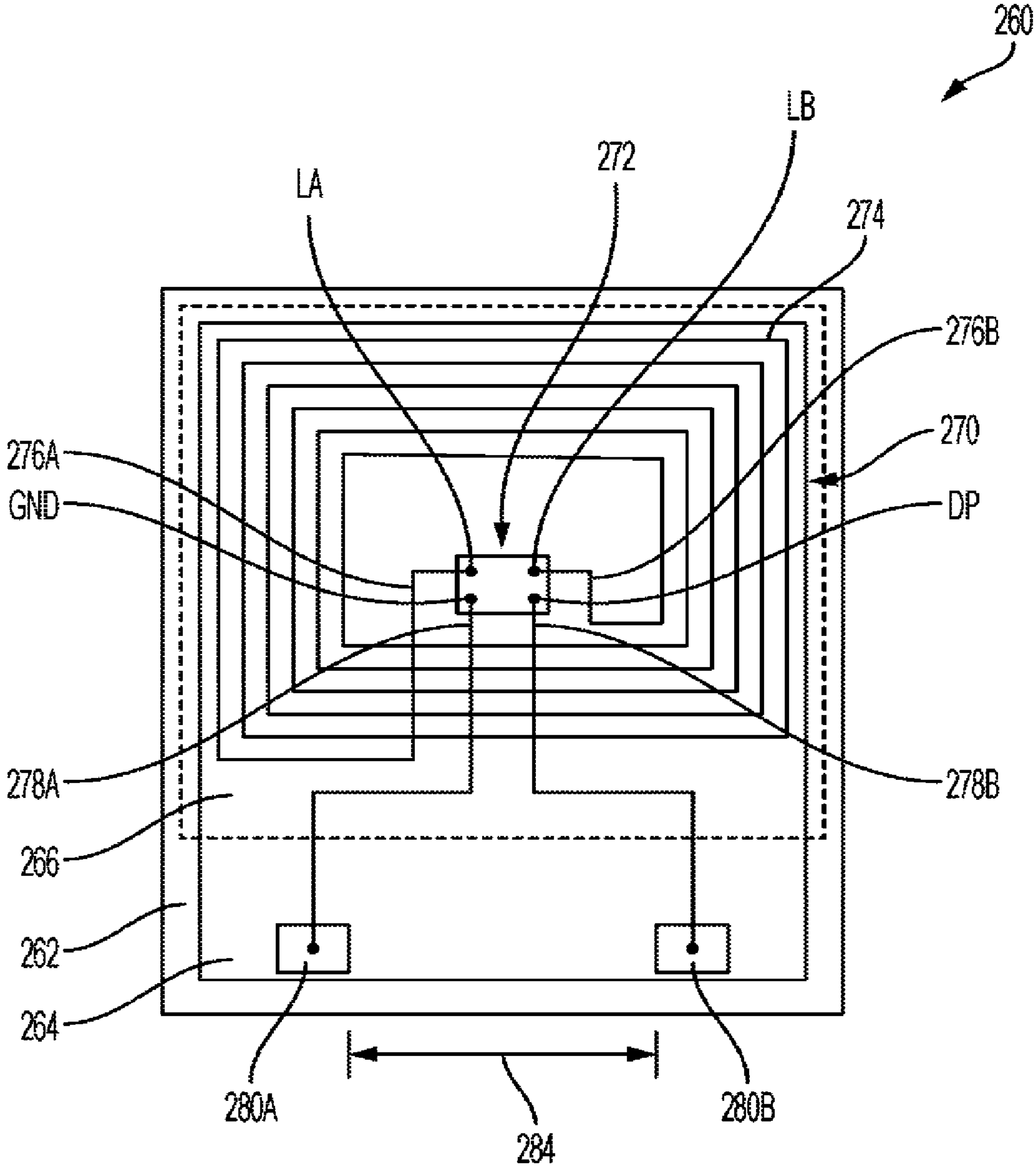
260
LB
272
LA
274
276B
270
276A
GND
DP
278A
278B
266
262
264
280A
280B
284

FIG. 13

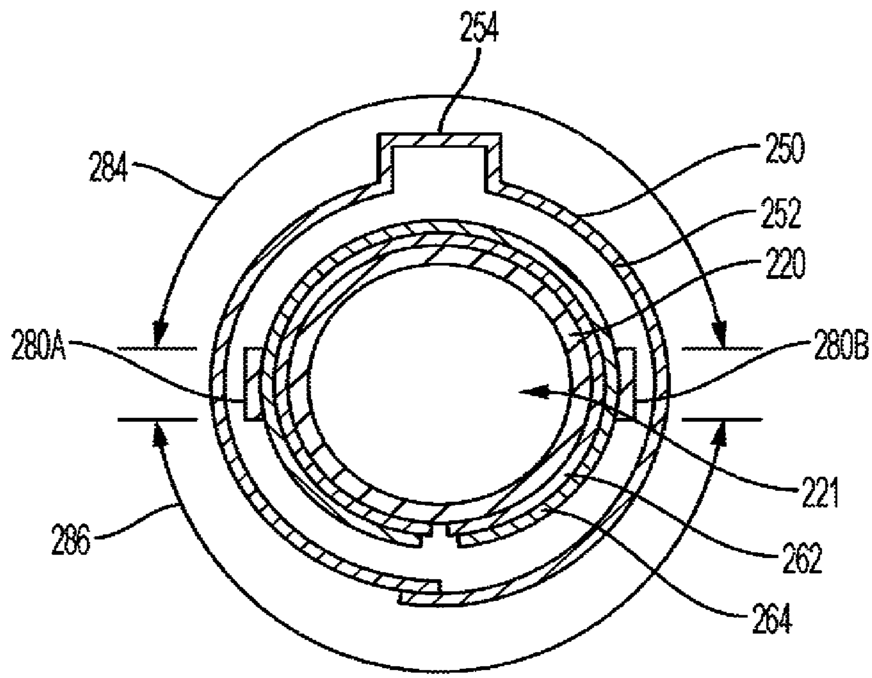
254
284
250
252
220
280A
280B
221
286
262
264

FIG. 14

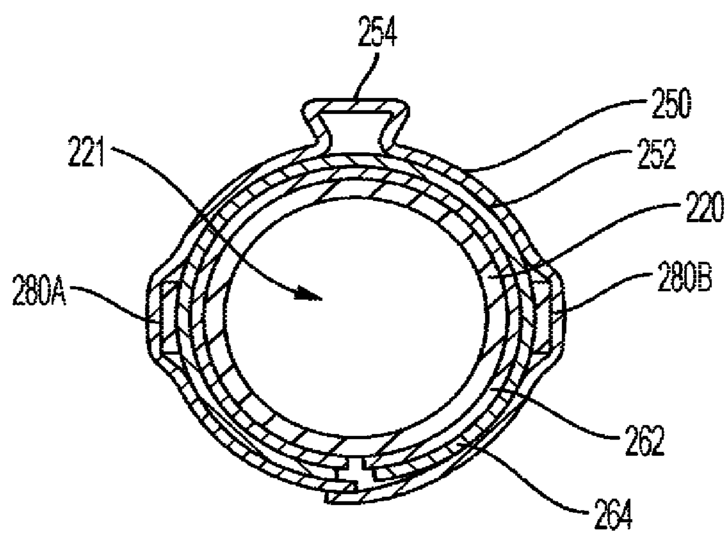
254
250
221
252
220
280A
280B
262
264

FIG. 15

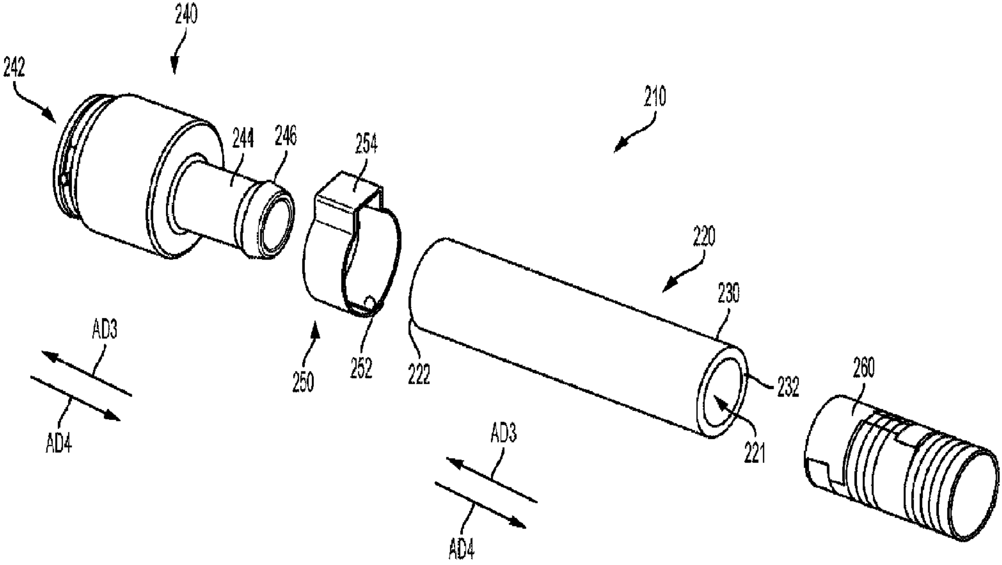
240
242
210
244
246
254
220
230
AD3
AD4
250
252
222
232
260
221
AD3
AD4

FIG. 12