(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
11 March 2021 (11.03.2021)

WIPO | PCT

(10) International Publication Number
WO 2021/045761 A1

(51) International Patent Classification:
B01D 53/94 (2006.01) *F01N 3/20* (2006.01)

(21) International Application Number:
PCT/US2019/049690

(22) International Filing Date:
05 September 2019 (05.09.2019)

(25) Filing Language: English

(26) Publication Language: English

(71) Applicant: **VOLVO TRUCK CORPORATION** [SE/SE]; SE405-08, Göteborg (SE).

(72) Inventor; and

(71) Applicant *(for US only)*: **RICHARDSON, Benjamin** [US/US]; 920 Reynold's Price Drive, Kernersville, North Carolina 27284 (US).

(74) Agent: **MONAGHAN, Joseph, G.**; Withrow & Terranova, PLLC, 106 Pinedale Springs Way, Cary, North Carolina 27511 (US).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report (Art. 21(3))*

(54) **Title:** TANK WITH INTEGRATED SIPHON

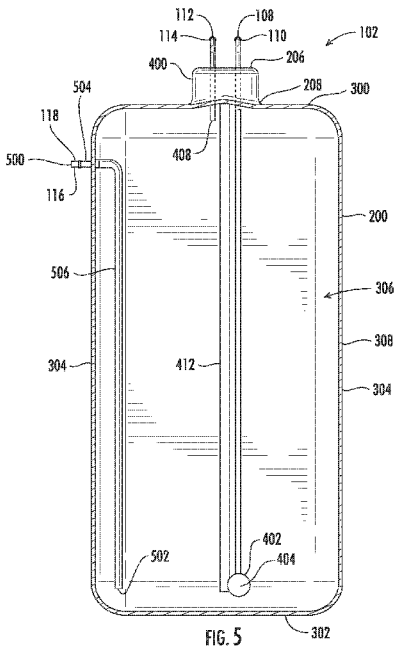


FIG. 5

(57) **Abstract:** Aspects of the disclosure relate to a diesel exhaust fluid tank for a vehicle. An exemplary diesel exhaust fluid tank includes a tank body to store diesel exhaust fluid, a tank supply line to deliver the diesel exhaust fluid to a Selective Catalytic Reduction (SCR) device, and a tank siphon line to drain the diesel exhaust fluid from the tank body. The tank siphon line is mounted to the tank body and includes a siphon inlet (e.g., devoid of a filter) at or proximate to a bottom wall of the tank body. The integrated tank siphon line avoids any need to remove tank components to feed a siphon tube into a tank. Further, the tank siphon line leverages preexisting components in the diesel exhaust fluid tank and/or the vehicle to siphon diesel exhaust fluid as needed.

WO 2021/045761 A1

TANK WITH INTEGRATED SIPHON

FIELD OF THE DISCLOSURE

[0001] The disclosure relates generally to tanks for trucking vehicles. In particular aspects, the disclosure relates to a diesel exhaust fluid tank with an integrated siphon.

BACKGROUND

[0002] Diesel Exhaust Fluid (DEF), commonly referred to as AdBlue in Europe, is an aqueous urea solution of 32.5% high-purity urea and 67.5% deionized water. DEF is consumed as a reactant in selective catalytic reduction (SCR) systems to lower the nitrogen oxides (NOx) content in the diesel exhaust emissions from diesel engines. DEF is typically carried on the vehicle in a DEF tank (i.e., supply tank), and a dosing apparatus draws DEF from the tank and injects it into the exhaust upstream of an SCR catalyst. The urea is converted via thermolysis and hydrolysis into ammonia. Inside the SCR catalyst body, the ammonia then reduces the NOx into water and nitrogen.

[0003] In certain situations, the DEF tank may need to be drained. Some DEF tanks include a drain plug in a bottom of the DEF tank. However, such a design may be restrictive or impractical in certain applications, such as where the bottom of the DEF tank is not accessible. An alternative is to simply feed a siphoning tube into the DEF tank. However, doing so requires removal of components of the DEF tank, which can be cumbersome. Further, such a configuration may require carrying additional components dedicated to draining (e.g., a siphoning tube), which may not always be available (e.g., because of the infrequency with which the component may be used).

SUMMARY

[0004] Aspects of the disclosure relate to a diesel exhaust fluid tank for a vehicle. An exemplary diesel exhaust fluid tank includes a tank body to store diesel exhaust fluid (e.g., urea), a tank supply line to deliver the diesel exhaust fluid to a Selective Catalytic Reduction (SCR) device, and a tank siphon line to drain the diesel exhaust fluid from the tank body. The diesel exhaust fluid tank further includes a fill port, a

tank supply port of the tank supply line, and a tank siphon port of the tank siphon line, which are all at or proximate to a top wall of the tank body. The tank siphon line is mounted to the tank body and includes a siphon inlet (e.g., devoid of a filter) at or proximate to a bottom wall of the tank body. The integrated tank siphon line avoids any need to remove tank components to feed a siphon tube into a tank. Further, the tank siphon line leverages preexisting components in the diesel exhaust fluid tank and/or the vehicle to siphon as needed.

[0005] In one aspect, a diesel exhaust fluid tank includes a tank body, a fill port, a tank supply line, and a tank siphon line. The tank body is configured to store diesel exhaust fluid, includes a top wall, a bottom wall, and at least one sidewall therebetween, and defines a tank interior and a tank exterior. The fill port is at or proximate to the top wall of the tank body. The fill port is in fluid communication with the tank interior of the tank body. The tank supply line is mounted to the tank body and extends from the tank interior to the tank exterior. The tank supply line includes a tank supply port at or proximate to the top wall of the tank body. The tank supply port includes a supply connection interface configured to connect to a pump supply line to deliver the diesel exhaust fluid to an SCR device. The tank supply line includes a supply inlet at or proximate to the bottom wall of the tank body. The tank siphon line is mounted to the tank body and extends from the tank interior to the tank exterior. The tank siphon line includes a tank siphon port at or proximate to the top wall of the tank body. The tank siphon port includes a siphon connection interface. The tank siphon line is configured to drain the diesel exhaust fluid from the tank body. The tank siphon line includes a siphon inlet at or proximate to the bottom wall of the tank body.

[0006] In certain embodiments, the tank siphon line in a draining configuration is configured to drain the diesel exhaust fluid from the tank body, and in a delivery configuration is configured to connect to a pump return line for returning the diesel exhaust fluid undelivered to the SCR device.

[0007] In certain embodiments, the diesel exhaust fluid tank includes a tank return line mounted to the tank body and extending from the tank interior to the tank exterior. The tank return line includes a tank return port at or proximate to the top wall of the tank body. The tank return port includes a return connection interface configured to connect to a pump return line for returning the diesel exhaust fluid undelivered to the SCR device.

[0008] In certain embodiments, the siphon connection interface has a same configuration as the supply connection interface for interchangeable attachment of the pump supply line.

[0009] In certain embodiments, the tank siphon line is devoid of a valve.

[0010] In certain embodiments, the tank siphon line is devoid of a filter.

[0011] In certain embodiments, the diesel exhaust fluid tank includes an internal filter positioned within the tank interior of the tank body. The internal filter is in fluid communication with the tank supply line.

[0012] In certain embodiments, the diesel exhaust fluid tank includes a flow port and a sending unit. The flow port is at or proximate to the top wall of the tank body. The flow port is in fluid communication with the tank interior of the tank body. The sending unit includes a sending interface configured to removably attach to the flow port, the tank supply line permanently mounted to and extending through the sending interface, and the internal filter attached to the tank supply line.

[0013] In certain embodiments, the sending unit further includes the tank siphon line permanently mounted to and extending through the sending interface.

[0014] In certain embodiments, the tank siphon line is permanently mounted to the tank body and extends through the top wall or the at least one sidewall of the tank body.

[0015] In certain embodiments, the tank body is devoid of a drain plug at or proximate to the bottom wall of the tank body.

[0016] In another aspect, a vehicle includes an SCR device, a pump supply line in fluid communication with the SCR device, a pump return line in fluid communication with the pump supply line, and a diesel exhaust fluid tank. The diesel exhaust fluid tank includes a tank body, a fill port, a tank supply line, and a tank siphon line. The tank body is configured to store diesel exhaust fluid. The tank body includes a top wall, a bottom wall, and at least one sidewall therebetween. The tank body defines a tank interior and a tank exterior. The fill port is at or proximate to the top wall of the tank body. The fill port is in fluid communication with the tank interior of the tank body. The tank supply line is mounted to the tank body and extending from the tank interior to the tank exterior. The tank supply line includes a tank supply port at or proximate to the top wall of the tank body. The tank supply port includes a supply connection interface configured to connect to the pump supply line to deliver the diesel exhaust fluid to the SCR device. The tank supply line includes a supply inlet at

or proximate to the bottom wall of the tank body. The tank siphon line is mounted to the tank body and extends from the tank interior to the tank exterior. The tank siphon line includes a tank siphon port at or proximate to the top wall of the tank body. The tank siphon port includes a siphon connection interface. The tank siphon line is configured to drain the diesel exhaust fluid from the tank body. The tank siphon line includes a siphon inlet at or proximate to the bottom wall of the tank body.

[0017] In certain embodiments, the tank siphon line in a draining configuration is configured to drain the diesel exhaust fluid from the tank body, and in a delivery configuration is configured to connect to the pump return line for returning the diesel exhaust fluid undelivered to the SCR device.

[0018] In certain embodiments, the diesel exhaust fluid tank further includes a tank return line mounted to the tank body and extending from the tank interior to the tank exterior. The tank return line includes a tank return port at or proximate to the top wall of the tank body. The tank return port includes a return connection interface configured to connect to the pump return line for returning the diesel exhaust fluid undelivered to the SCR device.

[0019] In certain embodiments, the pump supply line is configured to be removed from fluid communication with the SCR device and the supply connection interface of the tank body, and configured to be attached to the siphon connection interface and a pump for draining the diesel exhaust fluid from the tank body. The pump return line is configured to be removed from fluid communication with the SCR device and the return connection interface of the tank body, and configured to be attached to the siphon connection interface and the pump for draining the diesel exhaust fluid from the tank body.

[0020] In another aspect, a method of forming a diesel exhaust fluid tank includes forming a tank body configured to store diesel exhaust fluid. The tank body includes a top wall, a bottom wall, and at least one sidewall therebetween. The tank body defines a tank interior and a tank exterior. The method further includes forming a fill port at or proximate to the top wall of the tank body. The fill port is in fluid communication with the tank interior of the tank body. The method further includes mounting a tank supply line to the tank body to extend from the tank interior to the tank exterior. The tank supply line includes a tank supply port at or proximate to the top wall of the tank body. The tank supply port includes a supply connection interface configured to connect to a pump supply line to deliver the diesel exhaust

fluid to an SCR device. The tank supply line includes a supply inlet at or proximate to the bottom wall of the tank body. The method further includes mounting a tank siphon line to the tank body to extend from the tank interior to the tank exterior. The tank siphon line includes a tank siphon port at or proximate to the top wall of the tank body. The tank siphon port includes a siphon connection interface. The tank siphon line is configured to drain the diesel exhaust fluid from the tank body. The tank siphon line includes a siphon inlet at or proximate to the bottom wall of the tank body.

[0021] In certain embodiments, the tank siphon line in a draining configuration is configured to drain the diesel exhaust fluid from the tank body, and in a delivery configuration is configured to connect to a pump return line for returning the diesel exhaust fluid undelivered to the SCR device.

[0022] In certain embodiments the method further includes mounting a tank return line to the tank body to extend from the tank interior to the tank exterior. The tank return line includes a tank return port at or proximate to the top wall of the tank body. The tank return port includes a return connection interface configured to connect to a pump return line for returning the diesel exhaust fluid undelivered to the SCR device.

[0023] In certain embodiments, the siphon connection interface has a same configuration as the supply connection interface for interchangeable attachment of the pump supply line.

[0024] In certain embodiments, the method further includes positioning an internal filter within the tank interior of the tank body. The internal filter is in fluid communication with the tank supply line. The tank siphon line is devoid of a filter.

[0025] In certain embodiments, the method further includes forming a flow port at or proximate to the top wall of the tank body. The flow port is in fluid communication with the tank interior of the tank body. The method further includes forming a sending unit. The sending unit includes a sending interface configured to removably attach to the flow port, the tank supply line permanently mounted to and extending through the sending interface, the tank siphon line permanently mounted to and extending through the sending interface, and the internal filter permanently attached to the tank supply line. The method further includes attaching the sending unit to the flow port.

[0026] Additional features and advantages will be set forth in the detailed description which follows, and in part will be readily apparent to those skilled in the art from that description or recognized by practicing the embodiments as described

herein, including the detailed description which follows, the claims, as well as the appended drawings.

[0027] It is to be understood that both the foregoing general description and the following detailed description are merely exemplary, and are intended to provide an overview or framework to understanding the nature and character of the claims. The accompanying drawings are included to provide a further understanding, and are incorporated in and constitute a part of this specification. The drawings illustrate one or more embodiment(s), and together with the description serve to explain principles and operation of the various embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

[0028] The accompanying drawing figures incorporated in and forming a part of this specification illustrate several aspects of the disclosure, and together with the description serve to explain the principles of the disclosure.

[0029] **FIG. 1A** is a diagram of a vehicle including a diesel exhaust fluid (DEF) tank in a delivery configuration to deliver DEF through a DEF pump to a Selective Catalytic Reduction (SCR) device;

[0030] **FIG. 1B** is a diagram of the vehicle of **FIG. 1A** including the DEF tank in a draining configuration to drain DEF from the DEF tank through an external pump to a drainage tank;

[0031] **FIG. 2** is a perspective view of the DEF tank of **FIGS. 1A** and **1B**;

[0032] **FIG. 3** is a perspective view of a tank body of the DEF tank of **FIG. 2**;

[0033] **FIG. 4** is a perspective view of a sending unit of the DEF tank of **FIG. 2**;

[0034] **FIG. 5** is a cross-sectional side view of the DEF tank of **FIG. 2** illustrating the sending unit and a tank siphon line mounted to the tank body;

[0035] **FIG. 6** is a cross-sectional close up side view of a quick connect clamp attached to a tank siphon port of the tank siphon line of the DEF tank of **FIG. 2**;

[0036] **FIG.** 7 is a perspective view of another embodiment of a sending unit including a tank siphon line mounted to a sending interface of the sending unit;

[0037] **FIG. 8** is a diagram of another embodiment of a vehicle illustrating using a convertible line which can be used as a tank return line or a tank siphon line depending on the configuration;

[0038] **FIG. 9** is a perspective view of another embodiment of the sending unit using the convertible line of **FIG. 8**; and

[0039] **FIG. 10** is a flowchart illustrating steps of a method of forming the DEF tank of **FIGS. 1A-9**.

DETAILED DESCRIPTION

[0040] The embodiments set forth below represent the necessary information to enable those skilled in the art to practice the embodiments and illustrate the best mode of practicing the embodiments. Upon reading the following description in light of the accompanying drawing figures, those skilled in the art will understand the concepts of the disclosure and will recognize applications of these concepts not particularly addressed herein. It should be understood that these concepts and applications fall within the scope of the disclosure and the accompanying claims.

[0041] It will be understood that, although the terms first, second, etc. may be used herein to describe various elements, these elements should not be limited by these terms. These terms are only used to distinguish one element from another. For example, a first element could be termed a second element, and, similarly, a second element could be termed a first element, without departing from the scope of the present disclosure. As used herein, the term "and/or" includes any and all combinations of one or more of the associated listed items.

[0042] It will be understood that when an element is referred to as being "connected" or "coupled" to another element, it can be directly connected or coupled to the other element or intervening elements may be present. In contrast, when an element is referred to as being "directly connected" or "directly coupled" to another element, there are no intervening elements present.

[0043] Relative terms such as "below" or "above" or "upper" or "lower" or "horizontal" or "vertical" may be used herein to describe a relationship of one element, layer, or region to another element, layer, or region as illustrated in the Figures. It will be understood that these terms and those discussed above are intended to encompass different orientations of the device in addition to the orientation depicted in the Figures.

[0044] The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of the disclosure. As used herein,

the singular forms "a," "an," and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms "comprises," "comprising," "includes," and/or "including" when used herein specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof.

[0045] Unless otherwise defined, all terms (including technical and scientific terms) used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this disclosure belongs. It will be further understood that terms used herein should be interpreted as having a meaning that is consistent with their meaning in the context of this specification and the relevant art and will not be interpreted in an idealized or overly formal sense unless expressly so defined herein.

[0046] **FIG. 1A** is a diagram of a vehicle **100** including a diesel exhaust fluid (DEF) tank **102** in a delivery configuration to deliver DEF through a DEF pump **104** to a Selective Catalytic Reduction (SCR) device **106**. The DEF tank **102** includes a tank supply line **108** (which may also be referred to herein as a supply line) with a tank supply port **110** (which may also be referred to herein as a supply port), a tank return line **112** (which may also be referred to herein as a return line) with a tank return port **114** (which may also be referred to herein as a return port), and a tank siphon line **116** (which may also be referred to herein as a siphon line) with a tank siphon port **118** (which may also be referred to herein as a siphon port). The vehicle **100** includes a pump supply line **120** (which may also be referred to as a dosing supply line) in fluid communication with the tank supply port **110** of the DEF tank **102** and the DEF pump **104**, and a pump return line **122** (which may also be referred to herein as a dosing return line) in fluid communication with the tank return port **114** of the DEF tank **102** and the DEF pump **104**. In other words, the pump supply line **120** is in fluid communication with the SCR device **106**. Further, the pump return line **122** is in fluid communication with the pump supply line **120**. The vehicle **100** further includes a pump delivery line **124** (which may also be referred to herein as a dosing delivery line) in fluid communication with the DEF pump **104** and the SCR device **106**.

[0047] The DEF pump **104** draws DEF from the DEF tank **102** through the tank supply port **110** to the pump supply line **120** to the DEF pump **104**, which then

delivers the DEF through the pump delivery line **124** to the SCR device **106**. Any DEF drawn by the DEF pump **104** that was undelivered to the SCR device **106** is returned to the DEF tank **102** through the pump return line **122** to the tank return port **114** to the DEF tank **102**.

[0048] **FIG. 1B** is a diagram of the vehicle **100** of **FIG. 1A** including the DEF tank **102** in a draining configuration to drain DEF from the DEF tank **102** through an external pump **126** (may also be referred to as a draining pump) to a drainage tank **130**. In this configuration, the pump supply line **120** is detached from the tank supply port **110** and the DEF pump **104** and reattached to the tank siphon port **118** and the external pump **126**. In other words, the pump supply line **120** is configured to be removed from fluid communication with the SCR device **106** and a supply connection interface of the tank supply port **110** of the DEF tank **102**, and configured to be attached to a siphon connection interface of the tank siphon port **118** of the DEF tank **102** and an external pump **126** for draining the DEF from the DEF tank **102**. Accordingly, the external pump **126** draws DEF from the DEF tank **102** through the tank siphon port **118** to the pump supply line **120**, which then delivers the DEF through an external pump delivery line **128** to the drainage tank **130**. The supply connection interface of the tank supply port **110** is the same as the siphon connection interface of the tank siphon port **118**. Thus, the DEF tank **102** leverages preexisting components in the DEF tank **102** and/or the vehicle **100** to siphon DEF as needed.

[0049] In certain embodiments, the pump return line **122** is configured to be removed from fluid communication with the SCR device **106** and a return connection interface of the tank return port **114** of the DEF tank **102**, and configured to be attached to a siphon connection interface of the tank siphon port **118** of the DEF tank **102** and the external pump **126** for draining the DEF from the DEF tank **102**. The return connection interface of the tank return port **114** is the same as the siphon connection interface of the tank siphon port **118**.

[0050] **FIG. 2** is a perspective view of the DEF tank **102** of **FIGS. 1A** and **1B**. The DEF tank **102** includes a tank body **200**, a fill cap **204**, a sending unit **206**, and a tank siphon line **116**. The tank body **200** is configured to store DEF. The tank body **200** includes a fill port **202** with the fill cap **204** removably attachable to the fill port **202**. The fill port **202** is configured to receive a portion of a fill pump to fill up the tank body **200** with DEF. The tank body **200** further includes a flow port **208** with the sending unit **206** removably attachable to the flow port **208**. The sending unit **206**

includes a tank supply line **108** and a tank return line **112**. The tank supply line **108** is configured to attach to the pump supply line **120** of **FIGS. 1A** and **1B** to deliver DEF to the SCR device **106**. The tank return line **112** is configured to attach to the pump return line **122** of **FIGS. 1A** and **1B** to return DEF undelivered to the SCR device **106**.

[0051] The tank siphon line **116** is permanently mounted in the tank body **200** to drain DEF from the tank body **200**. The integrated tank siphon line **116** avoids any need to remove tank components to feed a siphon tube into the DEF tank **102**. Further, the tank siphon line **116** leverages preexisting components integrated into the DEF tank **102** and/or the vehicle **100** to siphon as needed. For example, as discussed above, the pump supply line **120** can be detached from the tank supply line **108** and attached to the tank siphon line **116**. In this way, existing components of the DEF tank **102** and/or the vehicle **100** can be rearranged for multiple purposes.

[0052] **FIG. 3** is a perspective view of the tank body **200** of the DEF tank **102** of **FIG. 2**. The tank body **200** includes a top wall **300**, a bottom wall **302**, and one or more sidewalls **304** therebetween. The tank body **200** defines a tank interior **306** and a tank exterior **308**. The fill port **202** is at or proximate to the top wall **300** of the tank body **200**. The fill port **202** is in fluid communication with the tank interior **306** of the tank body **200**. The flow port **208** is also at or proximate to the top wall **300** of the tank body **200**. The flow port **208** is in fluid communication with the tank interior **306** of the tank body **200**. In certain embodiments, the tank body **200** is devoid of a drain plug at or proximate to the bottom wall **302** of the tank body **200**. For example, in certain vehicle designs it may not be possible to access a bottom of the tank body **200** in which case a drain plug can be omitted (e.g., to reduce manufacturing costs).

[0053] **FIG. 4** is a perspective view of the sending unit **206** of the DEF tank **102** of **FIG. 2**. The sending unit **206** includes a sending interface **400** (e.g., sending cap) configured to removably attach to the flow port **208**, the tank supply line **108** permanently mounted to and extending through the sending interface **400**, and an internal filter **402** attached to the tank supply line **108**. The tank supply line **108** includes a tank supply port **110** at one end and a supply inlet **404** at an opposite end. In particular, the tank supply port **110** is proximate one side of the sending interface **400** (e.g., at a top of the sending interface **400**), and the supply inlet **404** is proximate an opposite side of the sending interface **400**. The tank supply port **110** includes a supply connection interface **406** configured to connect to the pump supply line **120** to

deliver the DEF to the SCR device **106**. The internal filter **402** is attached to the tank supply line **108** proximate the supply inlet **404** and is in fluid communication with the tank supply line **108**.

[0054] The sending unit **206** further includes the tank return line **112** permanently mounted and extending through the sending interface **400**. The tank return line **112** includes the tank return port **114** at one end and a return outlet **408** at an opposite end. In particular, the tank return port **114** is proximate one side of the sending interface **400** (e.g., at a top of the sending interface **400**), and the return outlet **408** is proximate an opposite side of the sending interface **400**. The tank return port **114** includes a return connection interface **410** configured to connect to the pump return line **122** for returning the DEF undelivered to the SCR device **106**.

[0055] The sending unit **206** further includes a sensor **412**. In certain embodiments, the sensor **412** includes a level sensor, temperature sensor, and/or a fuel quality sensor (e.g., measuring fuel concentration of one or more constituents of the DEF), etc. In certain embodiments, the sending unit **206** further includes a heating element that extends into the tank interior **306** of the tank body **200**.

[0056] **FIG. 5** is a cross-sectional side view of the DEF tank **102** of **FIG. 2** illustrating the sending unit **206** and the tank siphon line **116** mounted to the tank body **200**. The sending unit **206** is removably attached to the flow port **208** with the supply inlet **404**, internal filter **402**, return outlet **408**, and sensor **412** (which may also be referred to as a probe) positioned within the tank body **200**. Accordingly, the tank supply line **108**, the tank return line **112**, and the tank siphon line **116** are mounted to the tank body **200** and extend from the tank interior **306** to the tank exterior **308**.

[0057] The tank supply line **108** includes the tank supply port **110** at or proximate to the top wall **300** of the tank body **200**. The tank supply line **108** includes the supply inlet **404** at or proximate to the bottom wall **302** of the tank body **200**. However, the tank supply line **108** is not suitable for use for draining because of inclusion of the internal filter **402**. For example, using the tank supply line **108** as a siphoning tube may present a design vulnerability as the DEF tank **102** may need to be drained because of a problem with the internal filter **402** (e.g., the internal filter **402** or tank supply line **108** is clogged).

[0058] The tank return line **112** includes the tank return port **114** at or proximate to the top wall **300** of the tank body **200**. The tank return line **112** includes the return outlet **408** at or proximate to the top wall **300** of the tank body **200**. In other words, a

length of the tank return line **112** is shorter than the tank supply line **108**. As a result, the tank return line **112** is not suitable for draining because the return outlet **408** is generally in the headspace above the DEF and cannot draw DEF out from the tank body **200**.

[0059] The tank siphon line **116** is permanently mounted to the tank body **200** and extends through the sidewall **304** of the tank body **200**. In certain embodiments, the tank siphon line **116** extends through the top wall **300** of the tank body **200**. The tank siphon line **116** includes the tank siphon port **118** with a siphon connection interface **500** at or proximate to the top wall **300** of the tank body **200**. The tank siphon port **118** may be male or female. In certain embodiments, the siphon connection interface **500** has a same configuration as the supply connection interface **406** for interchangeable attachment of the pump supply line **120** and/or the same configuration as the return connection interface **410** for interchangeable attachment of the pump return line **122**.

[0060] The tank siphon line **116** includes a siphon inlet **502** at or proximate to the bottom wall **302** of the tank body **200**. Accordingly, the tank siphon line **116** is configured to drain the DEF from the tank body **200**. In certain embodiments, the tank siphon line **116** is devoid of a valve and/or a filter, which facilitates draining of the DEF tank **102,** reduces the cost of the tank siphon line **116** (and as a result the DEF tank **102**), and/or avoids design vulnerabilities, etc. Such a configuration may be advantageous where the DEF tank **102** cannot be drained from the bottom, such as because of a lack of access or because there are vehicle components positioned beneath the DEF tank **102**.

[0061] In certain embodiments, the tank siphon line **116** includes a first portion **504** extending through the sidewall **304** of the tank body **200**, and a second portion **506** (which may also be referred to herein as a pick up tube, pick up tubing, etc.) attached to the first portion **504**. In other embodiments, the tank siphon line **116** is a unitary construction (e.g., metal, plastic, etc.). In particular, in certain embodiments, the first portion **504** includes a rigid material (e.g., metal), such as to facilitate mounting to the sidewall **304** of the tank body **200**. For example, in certain embodiments, the first portion **504** is overmolded into the tank body **200**. The first portion **504** could be linear or at a right angle. In certain embodiments, the second portion **506** includes a flexible material (e.g., rubber) or rigid material that extends from or proximate the top wall **300** of the tank body **200** to proximate the bottom wall

302 of the tank body **200**. In certain embodiments, the second portion **506** is fit over a section of the first portion **504**.

[0062] **FIG. 6** is a cross-sectional close up side view of a quick connect clamp **600** attached to a tank siphon port **118** of the tank siphon line **116** of the DEF tank **102** of **FIG. 2**. In particular, the quick connect clamp **600** is attached to the pump supply line **120**. As noted above, the supply connection interface **406** of the tank supply port **110** of the tank supply line **108** is the same as that of the siphon connection interface **500** of the tank siphon port **118** of the tank siphon line **116**. Accordingly, to put the DEF tank **102** in a draining configuration, the quick connect clamp **600** is removed from connection to the tank supply port **110** of the tank supply line **108** and attached to the tank siphon port **118** of the tank siphon line **116** to form a seal **602** between the quick connect clamp **600** and the tank siphon port **118**.

[0063] Although the quick connect clamp **600** is attached to the pump supply line **120**, the quick connect clamp **600** could similarly be attached to the pump return line **122**. It is further noted that other types of connections could be used. For example, the tank siphon port **118** could be male or female. The tubing of the pump supply line **120** and/or the pump return line **122** could be configured to fit over the tank siphon port **118** of the tank siphon line **116**.

[0064] **FIG. 7** is a perspective view of another embodiment of a sending unit **700** including a tank siphon line **116** mounted to a sending interface **400** of the sending unit **700**. The sending unit **700** includes the same features and functionality as that of the sending unit **206** of **FIG. 4** except where otherwise noted. In particular, the sending unit **700** includes the tank siphon line **116** permanently mounted to and extending through the sending interface 4**00**. The tank siphon line **116** has a length similar to that of the tank supply line **108** and longer than the tank return line **112**. Accordingly, as similarly discussed above, the siphon inlet **502** is proximate a bottom wall **302** of the tank body **200** when the sending unit **700** is mounted to the flow port **208** of the tank body **200**. In such a configuration, the tank siphon line **116** extends through the top wall **300** of the tank body **200**. Such a configuration may be easier to manufacture than including the tank siphon line **116** in the tank body **200**.

[0065] **FIG. 8** is a diagram of another embodiment of a vehicle **800** illustrating using a convertible line **802** with a convertible port **804** which can be used as a tank return line or a tank siphon line depending on the configuration. The vehicle includes the same features and functionality as that of the vehicle of **FIGS. 1A** and **1B** except

where otherwise noted. In particular, the convertible line **802** in a delivery configuration (see, e.g., **FIG. 1A**) acts as a tank return line and is configured to connect to a pump return line **122** for returning the DEF undelivered to the SCR device **106**. The convertible line **802** in a draining configuration (see, e.g., **FIG. 8**) operates as a tank siphon line and is configured to drain the DEF from the tank body **200**. To change the convertible port **804** from the delivery configuration to the draining configuration, the pump return line **122** is detached from the DEF pump **104** and reattached to the external pump **126**. Accordingly, the external pump **126** draws DEF from the DEF tank **102** through the convertible line **802** to the pump return line **122**, which then delivers the DEF through the external pump delivery line **128** to the drainage tank **130**.

[0066] **FIG. 9** is a perspective view of another embodiment of a sending unit **900** using the convertible line **802** of **FIG. 8**. The sending unit **900** includes the same features and functionality as that of the sending unit **206** of **FIG. 4** and/or the sending unit **700** of **FIG. 7** except where otherwise noted. The convertible line **802** is similar to the tank siphon line **116** discussed above. In particular, the sending unit **700** includes a convertible line **802** with a connection interface **902** at one end and a siphon inlet **904** at an opposite end. The convertible line **802** has a length similar to that of the tank supply line **108**. The convertible line **802** is configured for placement of the siphon inlet **904** proximate the bottom wall **302** of the tank body **200**. Accordingly, as similarly discussed above, the siphon inlet **904** is proximate a bottom wall **302** of the tank body **200** when the sending unit **900** is mounted to the flow port **208** of the tank body **200**. In such a configuration, the convertible line **802** extends through the top wall **300** of the tank body **200**. Such a configuration may be easier to manufacture than including the tank siphon line **116** in the tank body **200**, and is easier to manufacture than the sending unit **700** of **FIG. 7** as the tank return line **112** is omitted entirely. Further, such a configuration may be easier to use as only the end of the pump return line **122** attached to the DEF pump **104** is to be removed and attached to the external pump **126**.

[0067] In certain configurations, a filter may be provided external to the DEF tank **102**, but such configurations may be very expensive and potentially cost prohibitive.

[0068] **FIG. 10** is a flowchart **1000** illustrating steps of a method of forming a DEF tank **102** of **FIGS. 1A-9**. Step **1002** includes forming a tank body **200** configured to store diesel exhaust fluid. The tank body **200** includes a top wall **300**, a

bottom wall **302**, and at least one sidewall **304** therebetween. The tank body **200** defines a tank interior **216** and a tank exterior **308**. Step **1004** includes forming a fill port **202** at or proximate to the top wall **300** of the tank body **200**. The fill port **202** is in fluid communication with the tank interior **306** of the tank body **200**.

[0069] Step **1006** includes mounting a tank supply line **108** to the tank body **200** to extend from the tank interior **306** to the tank exterior **308**. The tank supply line **108** includes a tank supply port **110** at or proximate to the top wall **300** of the tank body **200**. The tank supply port **110** includes a supply connection interface **406** configured to connect to a pump supply line **120** to deliver the diesel exhaust fluid to an SCR device **106**. The tank supply line **108** includes a supply inlet **404** at or proximate to the bottom wall **302** of the tank body **200**. In certain embodiments the method further includes mounting a tank return line **112** to the tank body **200** to extend from the tank interior **306** to the tank exterior **308**. The tank return line **112** includes a tank return port **114** at or proximate to the top wall **300** of the tank body **200**. The tank return port **114** includes a return connection interface **410** configured to connect to a pump return line **122** for returning the diesel exhaust fluid undelivered to the SCR device **106**.

[0070] Step **1008** includes mounting a tank siphon line **116** to the tank body **200** to extend from the tank interior **306** to the tank exterior **308**. The tank siphon line **116** includes a tank siphon port **118** at or proximate to the top wall **300** of the tank body **200**. The tank siphon port **118** includes a siphon connection interface **500**. The tank siphon line **116** is configured to drain the diesel exhaust fluid from the tank body **200**. The tank siphon line **116** includes a siphon inlet **502** at or proximate to the bottom wall **302** of the tank body **200**. In certain embodiments, the tank siphon line **116** in a draining configuration is configured to drain the diesel exhaust fluid from the tank body **200**, and in a delivery configuration is configured to connect to a pump return line **122** for returning the diesel exhaust fluid undelivered to the SCR device **106**. In certain embodiments, the siphon connection interface **500** has a same configuration as the supply connection interface **406** for interchangeable attachment of the pump supply line **120**.

[0071] In certain embodiments, the method further includes positioning an internal filter **402** within the tank interior **306** of the tank body **200**. The internal filter **402** is in fluid communication with the tank supply line **108**. The tank siphon line **116** is devoid of a filter. In certain embodiments, the method further includes forming

a flow port **208** at or proximate to the top wall **300** of the tank body **200**. The flow port **208** in fluid communication with the tank interior **306** of the tank body **200**. In certain embodiments, the method further includes forming a sending unit **206, 700, 900**. The sending unit **206, 700, 900** includes a sending interface **400** configured to removably attach to the flow port **208**, the tank supply line **108** permanently mounted to and extending through the sending interface **400**, the tank siphon line **116** permanently mounted to and extending through the sending interface **400**, and the internal filter **402** permanently attached to the tank supply line **108**. The method further includes attaching the sending unit **206** to the flow port **208**.

[0072] Those skilled in the art will recognize improvements and modifications to the preferred embodiments of the present disclosure. All such improvements and modifications are considered within the scope of the concepts disclosed herein and the claims that follow.

Claims

What is claimed is:

1. A diesel exhaust fluid tank, comprising:

a tank body configured to store diesel exhaust fluid, the tank body comprising a top wall, a bottom wall, and at least one sidewall therebetween, the tank body defining a tank interior and a tank exterior;

a fill port at or proximate to the top wall of the tank body, the fill port in fluid communication with the tank interior of the tank body;

a tank supply line mounted to the tank body and extending from the tank interior to the tank exterior, the tank supply line comprising a tank supply port at or proximate to the top wall of the tank body, the tank supply port comprising a supply connection interface configured to connect to a pump supply line to deliver the diesel exhaust fluid to a Selective Catalytic Reduction (SCR) device, the tank supply line including a supply inlet at or proximate to the bottom wall of the tank body; and

a tank siphon line mounted to the tank body and extending from the tank interior to the tank exterior, the tank siphon line comprising a tank siphon port at or proximate to the top wall of the tank body, the tank siphon port comprising a siphon connection interface, the tank siphon line configured to drain the diesel exhaust fluid from the tank body, the tank siphon line including a siphon inlet at or proximate to the bottom wall of the tank body.

2. The diesel exhaust fluid tank of claim 1, wherein the tank siphon line in a draining configuration is configured to drain the diesel exhaust fluid from the tank body, and in a delivery configuration is configured to connect to a pump return line for returning the diesel exhaust fluid undelivered to the SCR device.

3. The diesel exhaust fluid tank of claim 1, further comprising a tank return line mounted to the tank body and extending from the tank interior to the tank exterior, the tank return line comprising a tank return port at or proximate to the top wall of the tank body, the tank return port comprising a return connection interface configured to connect to a pump return line for returning the diesel exhaust fluid undelivered to the SCR device.

4. The diesel exhaust fluid tank of claim 1, wherein the siphon connection interface has a same configuration as the supply connection interface for interchangeable attachment of the pump supply line.

5. The diesel exhaust fluid tank of claim 1, wherein the tank siphon line is devoid of a valve.

6. The diesel exhaust fluid tank of claim 1, wherein the tank siphon line is devoid of a filter.

7. The diesel exhaust fluid tank of claim 1, further comprising an internal filter positioned within the tank interior of the tank body, the internal filter in fluid communication with the tank supply line.

8. The diesel exhaust fluid tank of claim 7, further comprising:

a flow port at or proximate to the top wall of the tank body, the flow port in fluid communication with the tank interior of the tank body; and

a sending unit comprising:

a sending interface configured to removably attach to the flow port;

the tank supply line permanently mounted to and extending through the sending interface; and

the internal filter attached to the tank supply line.

9. The diesel exhaust fluid tank of claim 8, wherein the sending unit further comprises the tank siphon line permanently mounted to and extending through the sending interface.

10. The diesel exhaust fluid tank of claim 1, wherein the tank siphon line is permanently mounted to the tank body and extends through the top wall or the at least one sidewall of the tank body.

11. The diesel exhaust fluid tank of claim 1, wherein the tank body is devoid of a drain plug at or proximate to the bottom wall of the tank body.

12. A vehicle, comprising:

a Selective Catalytic Reduction (SCR) device;

a pump supply line in fluid communication with the SCR device;

a pump return line in fluid communication with the pump supply line; and

a diesel exhaust fluid tank, comprising:

a tank body configured to store diesel exhaust fluid, the tank body comprising a top wall, a bottom wall, and at least one sidewall therebetween, the tank body defining a tank interior and a tank exterior;

a fill port at or proximate to the top wall of the tank body, the fill port in fluid communication with the tank interior of the tank body;

a tank supply line mounted to the tank body and extending from the tank interior to the tank exterior, the tank supply line comprising a tank supply port at or proximate to the top wall of the tank body, the tank supply port comprising a supply connection interface configured to connect to the pump supply line to deliver the diesel exhaust fluid to the SCR device, the tank supply line including a supply inlet at or proximate to the bottom wall of the tank body; and

a tank siphon line mounted to the tank body and extending from the tank interior to the tank exterior, the tank siphon line comprising a tank siphon port at or proximate to the top wall of the tank body, the tank siphon port comprising a siphon connection interface, the tank siphon line configured to drain the diesel exhaust fluid from the tank body, the tank siphon line including a siphon inlet at or proximate to the bottom wall of the tank body.

13. The vehicle of claim 12, wherein the tank siphon line in a draining configuration is configured to drain the diesel exhaust fluid from the tank body, and in a delivery configuration is configured to connect to the pump return line for returning the diesel exhaust fluid undelivered to the SCR device.

14. The vehicle of claim 12, wherein the diesel exhaust fluid tank further comprises a tank return line mounted to the tank body and extending from the tank interior to the tank exterior, the tank return line comprising a tank return port at or proximate to the top wall of the tank body, the tank return port comprising a return

connection interface configured to connect to the pump return line for returning the diesel exhaust fluid undelivered to the SCR device.

15. The vehicle of claim 14, wherein:

the pump supply line is configured to be removed from fluid communication with the SCR device and the supply connection interface of the tank body, and configured to be attached to the siphon connection interface and a pump for draining the diesel exhaust fluid from the tank body; and

the pump return line is configured to be removed from fluid communication with the SCR device and the return connection interface of the tank body, and configured to be attached to the siphon connection interface and the pump for draining the diesel exhaust fluid from the tank body.

16. A method of forming a diesel exhaust fluid tank, comprising:

forming a tank body configured to store diesel exhaust fluid, the tank body comprising a top wall, a bottom wall, and at least one sidewall therebetween, the tank body defining a tank interior and a tank exterior;

forming a fill port at or proximate to the top wall of the tank body, the fill port in fluid communication with the tank interior of the tank body;

mounting a tank supply line to the tank body to extend from the tank interior to the tank exterior, the tank supply line comprising a tank supply port at or proximate to the top wall of the tank body, the tank supply port comprising a supply connection interface configured to connect to a pump supply line to deliver the diesel exhaust fluid to a Selective Catalytic Reduction (SCR) device, the tank supply line including a supply inlet at or proximate to the bottom wall of the tank body; and

mounting a tank siphon line to the tank body to extend from the tank interior to the tank exterior, the tank siphon line comprising a tank siphon port at or proximate to the top wall of the tank body, the tank siphon port comprising a siphon connection interface, the tank siphon line configured to drain the diesel exhaust fluid from the tank body, the tank siphon line including a siphon inlet at or proximate to the bottom wall of the tank body.

17. The method of claim 16, wherein the tank siphon line in a draining configuration is configured to drain the diesel exhaust fluid from the tank body, and in

a delivery configuration is configured to connect to a pump return line for returning the diesel exhaust fluid undelivered to the SCR device.

18. The method of claim 16, further comprising mounting a tank return line to the tank body to extend from the tank interior to the tank exterior, the tank return line comprising a tank return port at or proximate to the top wall of the tank body, the tank return port comprising a return connection interface configured to connect to a pump return line for returning the diesel exhaust fluid undelivered to the SCR device.

19. The method of claim 16, wherein the siphon connection interface has a same configuration as the supply connection interface for interchangeable attachment of the pump supply line.

20. The method of claim 16:

further comprising positioning an internal filter within the tank interior of the tank body, the internal filter in fluid communication with the tank supply line; and

wherein the tank siphon line is devoid of a filter.

21. The method of claim 20, further comprising:

forming a flow port at or proximate to the top wall of the tank body, the flow port in fluid communication with the tank interior of the tank body; and

forming a sending unit comprising:

a sending interface configured to removably attach to the flow port;

the tank supply line permanently mounted to and extending through the sending interface;

the tank siphon line permanently mounted to and extending through the sending interface; and

the internal filter permanently attached to the tank supply line; and

attaching the sending unit to the flow port.

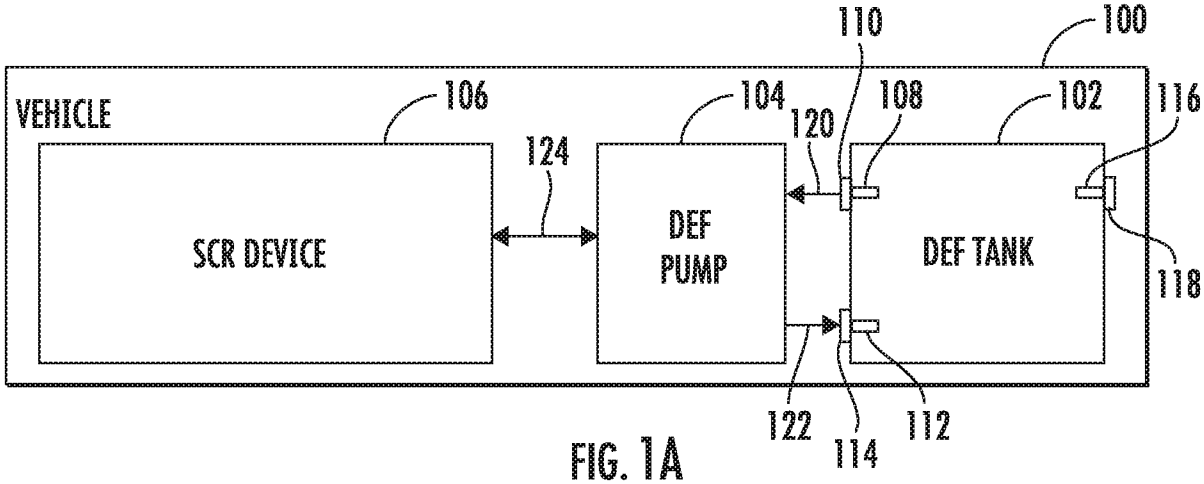

VEHICLE
SCR DEVICE
DEF PUMP
DEF TANK
100
102
104
106
108
110
112
114
116
118
120
122
124

FIG. 1A

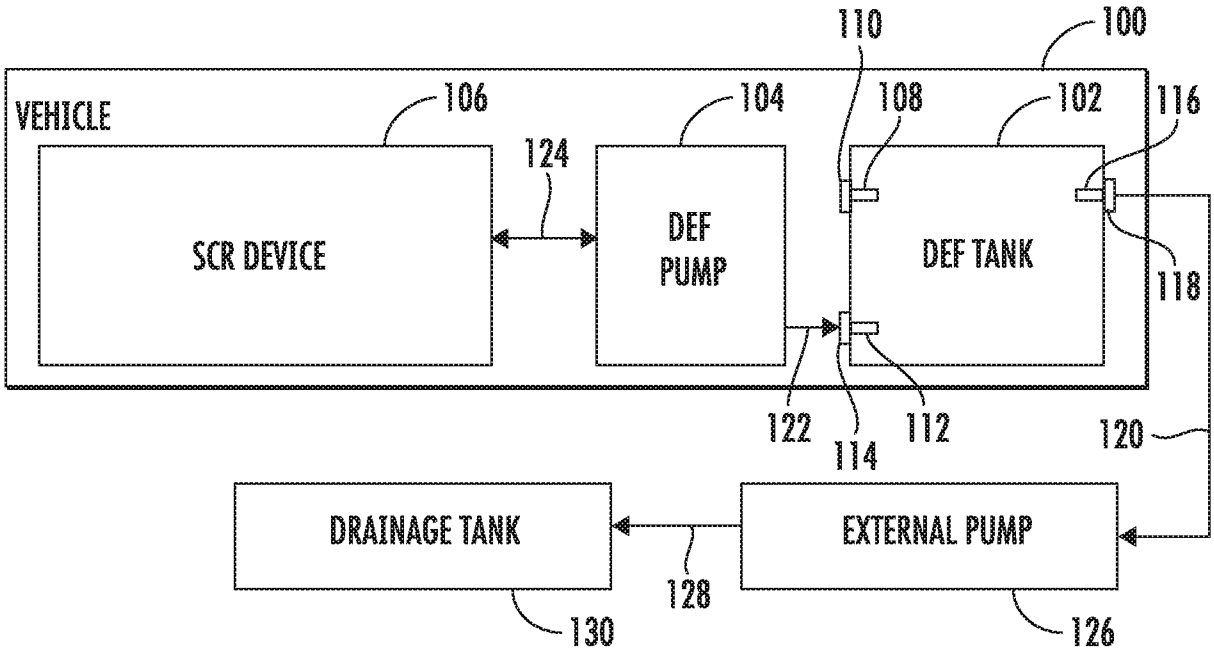

VEHICLE
SCR DEVICE
DEF PUMP
DEF TANK
DRAINAGE TANK
EXTERNAL PUMP
100
102
104
106
108
110
112
114
116
118
120
122
124
126
128
130

FIG. 1B

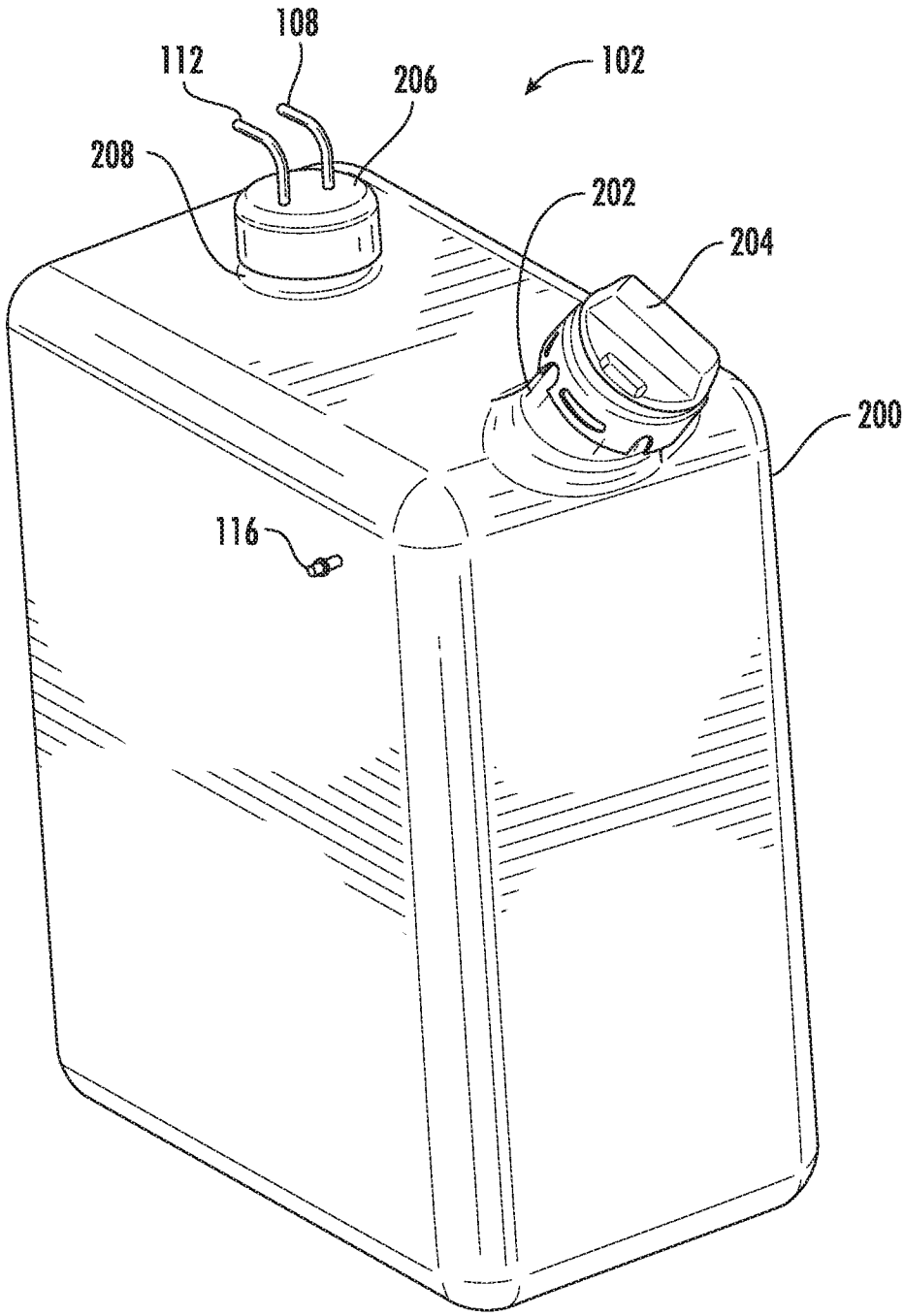


FIG. 2

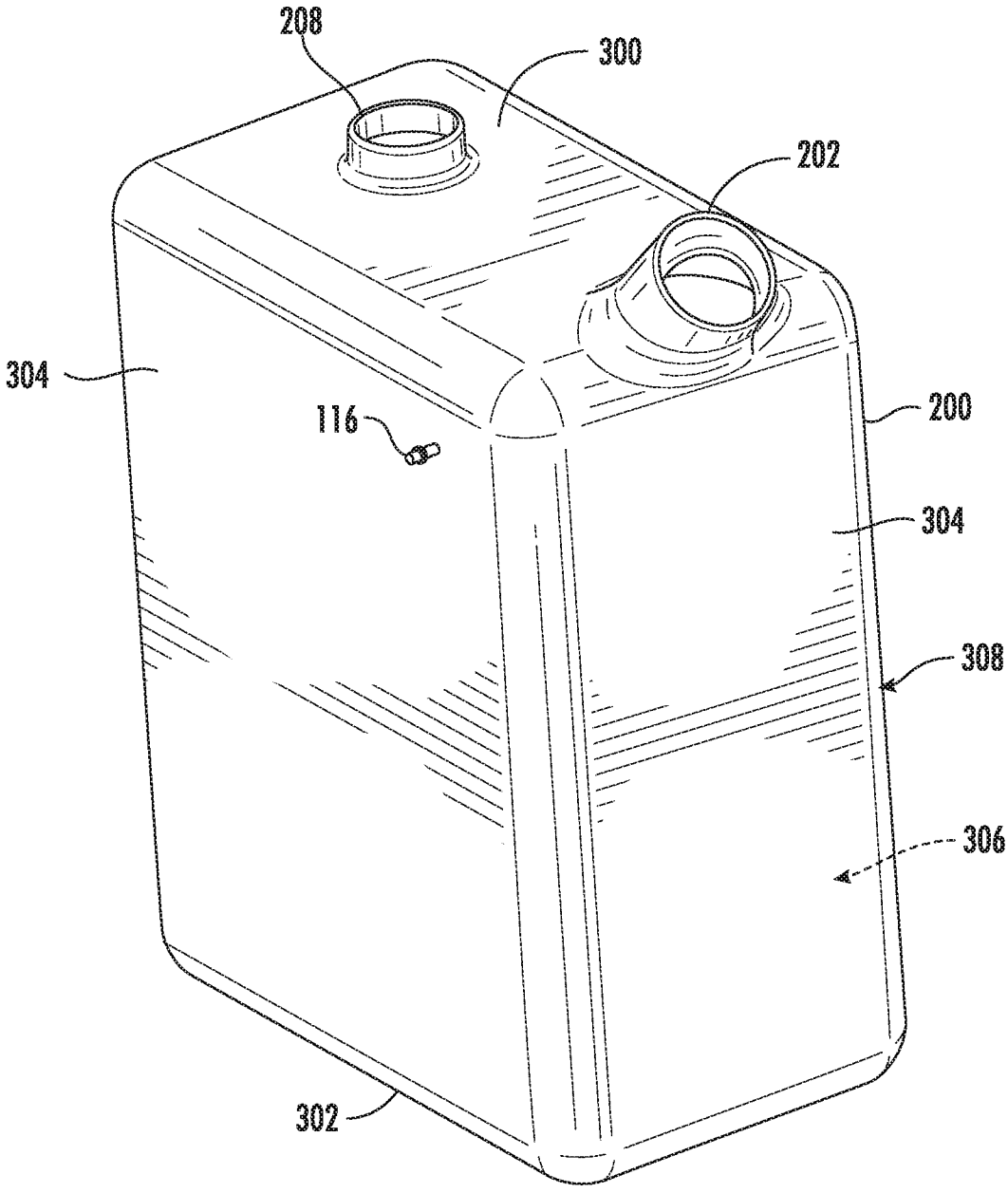


FIG. 3

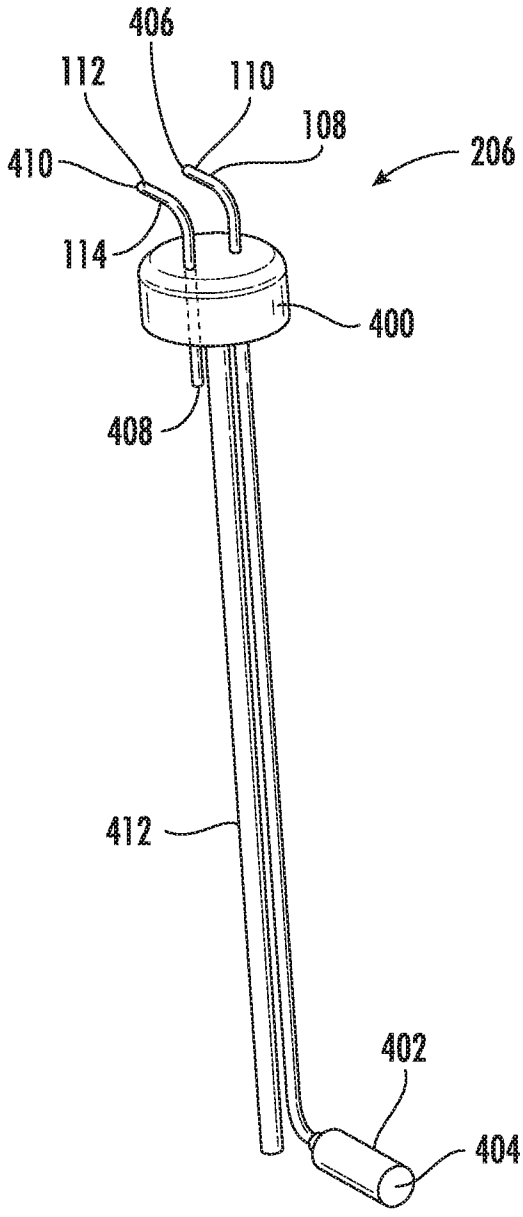


FIG. 4

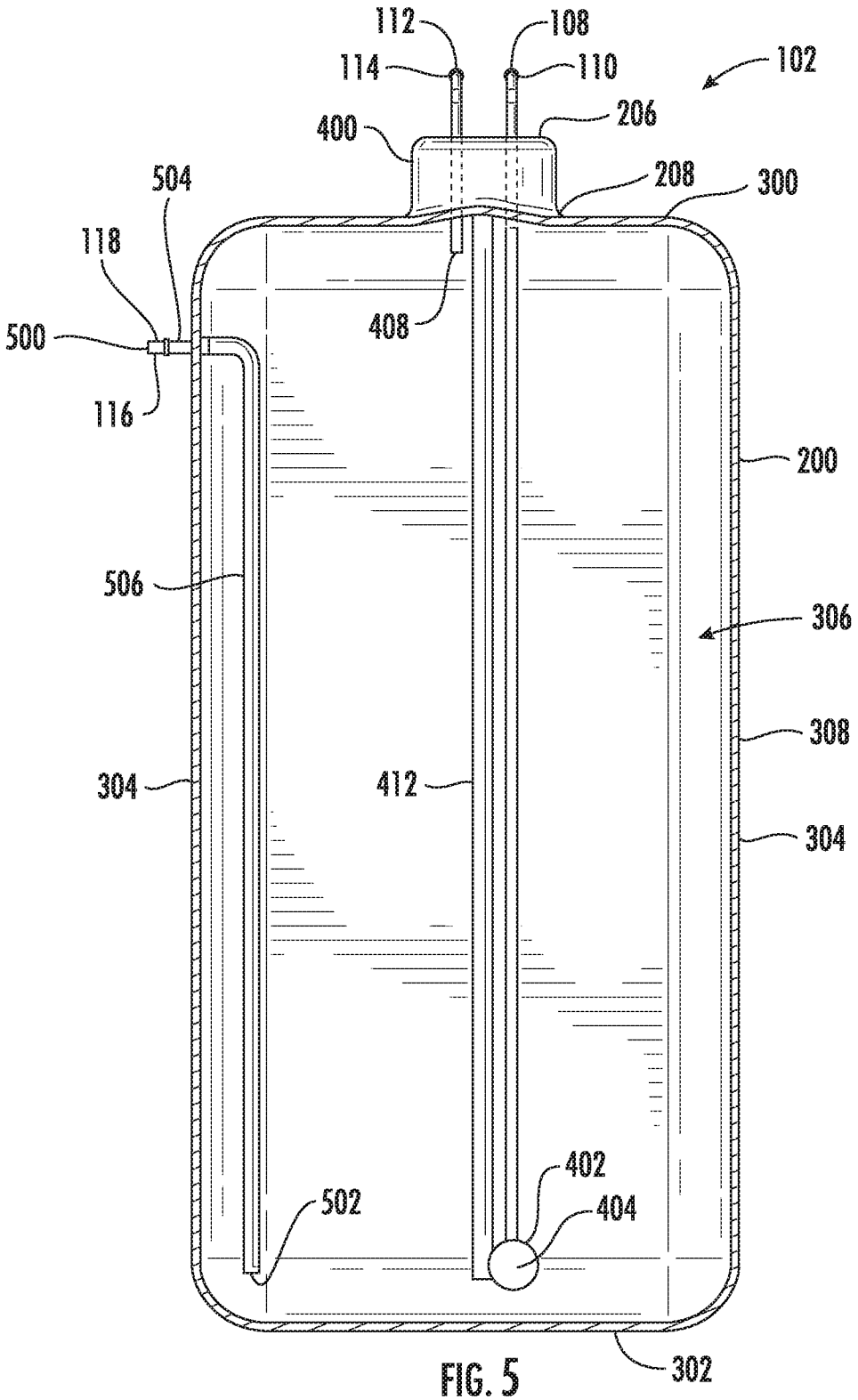

112
108
114
110
102
206
400
504
208
300
118
408
500
116
200
506
306
308
304
412
304
402
502
404
302

FIG. 5

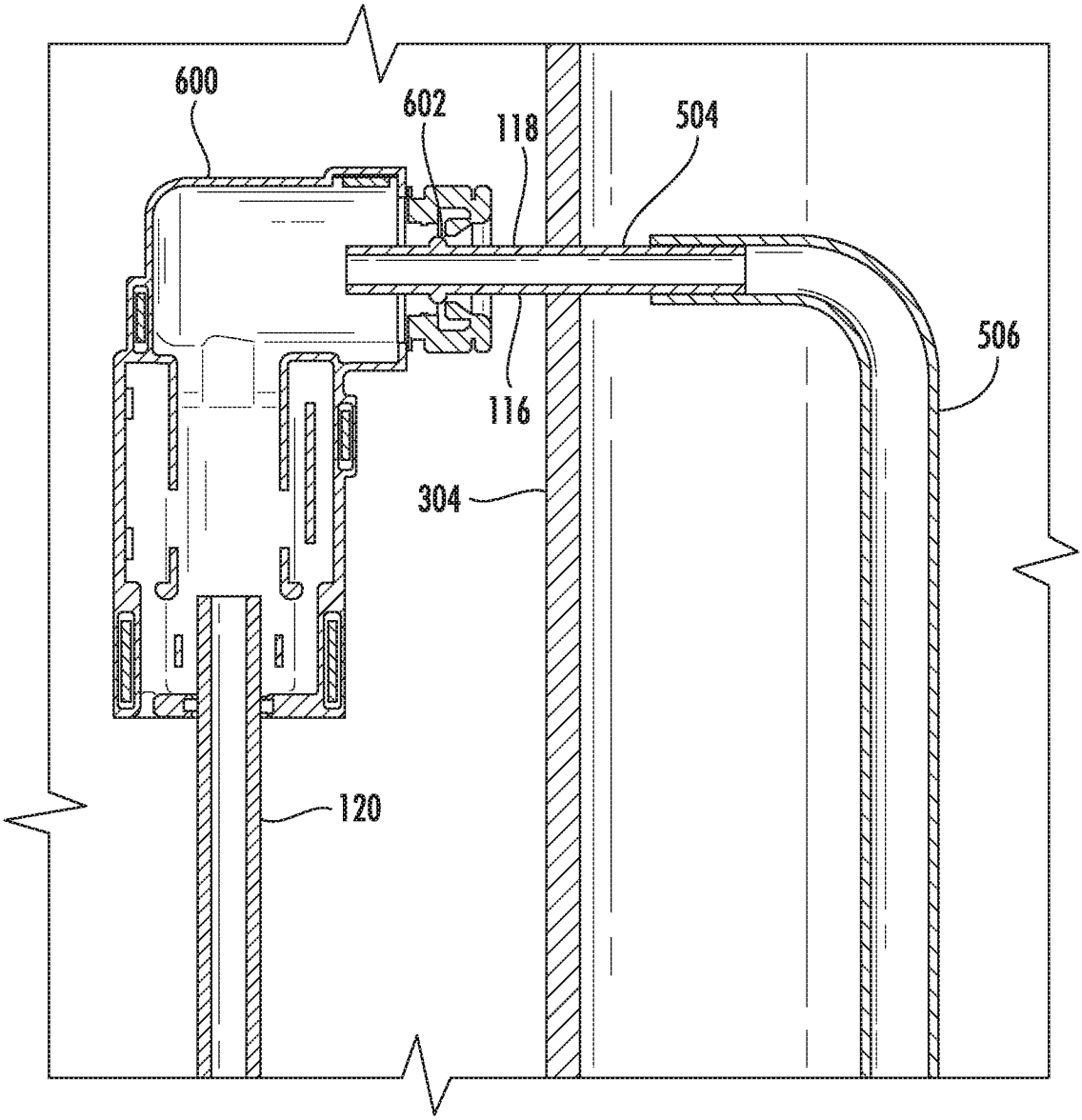


FIG. 6

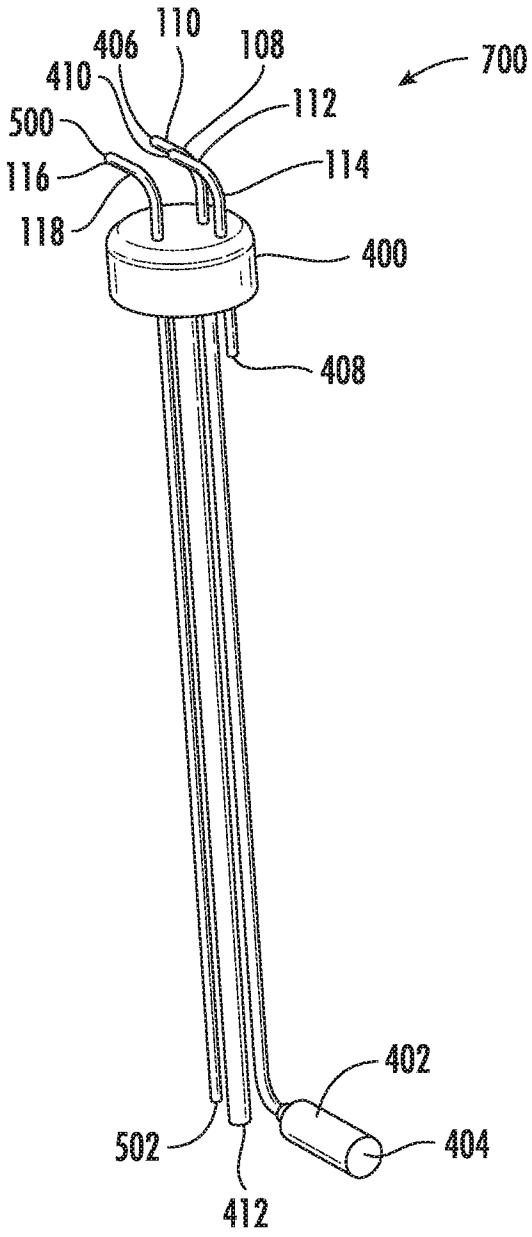


FIG. 7

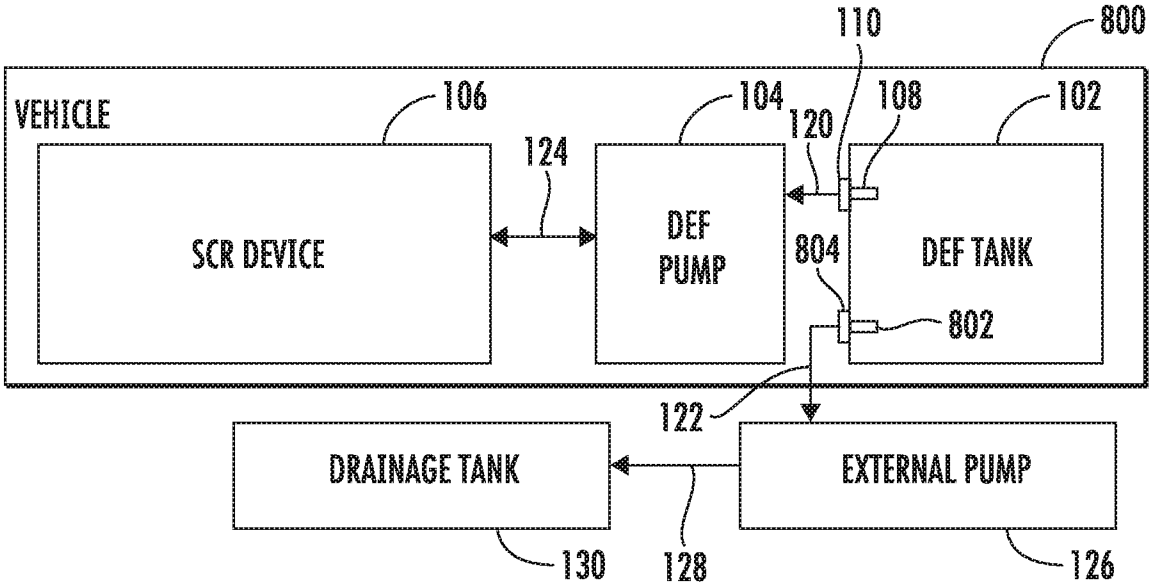

110
800
VEHICLE
106
104
108
102
120
124
SCR DEVICE
DEF PUMP
804
DEF TANK
802
122
DRAINAGE TANK
EXTERNAL PUMP
130
128
126

FIG. 8

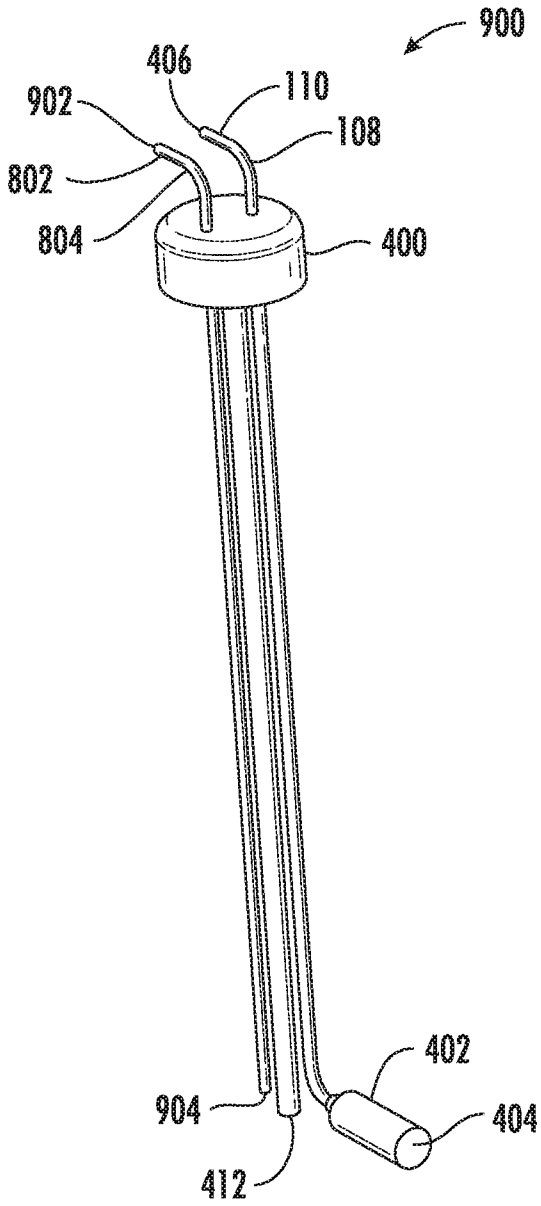


FIG. 9

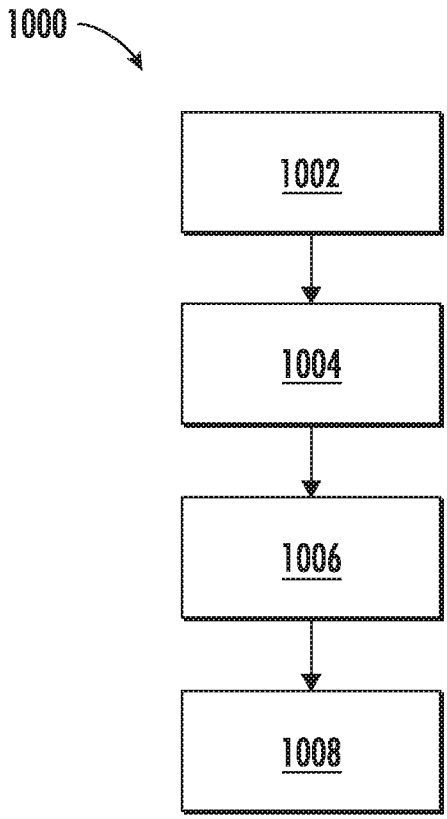


FIG. 10

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US19/49690

A. CLASSIFICATION OF SUBJECT MATTER

IPC - B01D 53/94; F01N 3/20 (2019.01)

CPC - B01D 53/94; F01N 3/2066

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
See Search History document

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y --- A	US 2016/0251130 A1 (NIFCO INC) 1 September 2016; figure 1, paragraphs [0027]-[0035]	1-6, 10, 16-19 ------- 11-13, 20-21 ------- 14-15
X	CN 208918636 U (UNIV NANJING FORESTRY) 31 May 2019; abstract, page 4, third paragraph, eleventh paragraph, figures 1-6	1-2, 4, 7-9, 16
Y --- A	WO 2018/074624 A1 (VOLVO CONSTRUCTION EQUIPMENT) 26 April 2018; abstract; page 5, second and fourth paragraphs from bottom, figure 1	12-13 ------- 14-15
Y	US 2015/0377112 A1 (KOMATSU LTD) 31 December 2015; figures 5-8, paragraphs [0055], [0071]	11, 20-21

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"D" document cited by the applicant in the international application
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
31 October 2019 (31.10.2019)	21 NOV 2019
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-8300	Authorized officer Shane Thomas Telephone No. PCT Helpdesk: 571-272-4300