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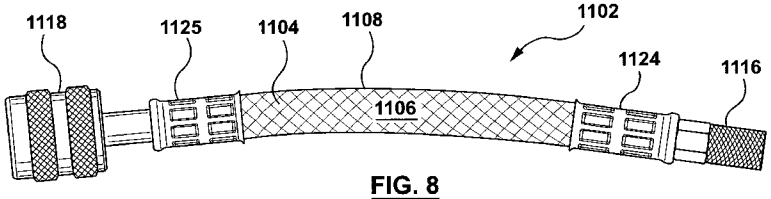

FIG. 8

(57) Abstract: A device for introducing a fluid into a refrigeration or air conditioning system comprising a container containing the fluid to be dispensed and a connector for connecting the barrel to facilitate injection of the fluid into suitable ports fitted to the refrigeration or air conditioning system.

WO 2015/135081 A1

METHOD OF AND DEVICE FOR INTRODUCING FLUIDS INTO AIR CONDITIONING AND REFRIGERATION SYSTEMS

This application claims priority and the benefit of the following previously filed applications, the contents of which are incorporated herein by reference:

(1) U.S. Provisional Application Serial No. 61/953,518 filed March 14, 2014;

(2) International Patent Application Serial No. PCT/CA2014/050331 filed April 2, 2014;

(3) U.S. Provisional Application Serial No. 61/975,468 filed April 4, 1014; and

(4) U.S. Provisional Application Serial No. 62/119,101 filed Feb. 20, 2015.

BACKGROUND

[0001] This description relates to a device and method for storing a fluid and introducing that fluid into a refrigeration or air conditioning system.

SUMMARY

[0002] According to one example there is provided a device for introducing a reactive fluid into a refrigeration or air conditioning system comprising: a syringe comprising a barrel containing the reactive fluid to be dispensed and a plunger fitting into a first end of the barrel so that it forms a seal against an interior wall of the barrel, and a separate connector for connecting to a second end of the barrel to facilitate injection of the fluid into a port of the refrigeration or air conditioning system.

[0003] According to another example there is provided a device for introducing a reactive fluid into a refrigeration or air conditioning system comprising: a syringe comprising a barrel containing the reactive fluid to be dispensed and a plunger fitting into the barrel and having a seal formed thereon for engaging against an interior wall of the barrel; and a connector for connecting the barrel to facilitate injection of the fluid into suitable ports fitted to the refrigeration or air conditioning

system, wherein the seal is formed integrally with and of the same material as the plunger.

[0004] According to another example there is provided method of providing a device for introducing a reactive fluid into a refrigeration or air conditioning system comprising: providing a syringe that includes a barrel and a plunger for fitting into the barrel so that it forms a seal against an interior wall of the barrel; providing a reactive fluid in the barrel with ambient air excluded from the barrel; providing a connector to connect between the syringe and a port of the refrigeration or air conditioning system to facilitate injection of the reactive fluid into the refrigeration or air conditioning system.

[0005] According to another example there is provided device for introducing a fluid into a refrigeration or air conditioning system comprising: a fluid container containing the fluid, and having an energy storing element and a connector to facilitate discharge of the fluid into a port of the refrigeration or air conditioning system, wherein the energy storage element relies on a pressure differential in the refrigeration or air conditioning system to assist discharge of the fluid from the container.

[0006] According to another example there is provided method for providing a fluid for introduction to an air conditioning or refrigeration system comprising: providing a tube having a normally closed two-way valve fitting at one end thereof; filling the flexible tube with the fluid and evacuating ambient air from the flexible tube; and connecting the flexible tube to a service port of the air conditioning or refrigeration system and relying on a pressure differential between a service mode and an operating mode of the air conditioning or refrigeration system to assist the the fluid to enter the air conditioning or refrigeration system.

[0007] According to another example there is provided device for introducing a fluid into a refrigeration or air conditioning system comprising a fluid container

containing the fluid within a reservoir, and having a first valve fitting at an end of the container and a second valve fitting at an opposite end of the container, the first valve fitting and the second valve fitting each being configured for attachment to a different size or type of port of a refrigeration or air conditioning system.

BRIEF DESCRIPTION OF THE FIGURES

[0008] For a more complete understanding of this disclosure, reference is now made to the following description taken in conjunction with the accompanying drawings listed below.

[0009] Figure 1 is plan view of a kit that includes the components of a device for introducing a reactive fluid into a refrigeration or air conditioning system, according to an example embodiment;

[0010] Figure 2 is a schematic representation of a syringe of the device of Figure 1.

[0011] Figure 3 is a perspective view of a connector hose of the device of Figure 1.

[0012] Figure 4 is a side view of a syringe fitting of the connector hose of Figure 3.

[0013] Figure 5 is an exploded view of a discharge fitting of the connector hose of Figure 3.

[0014] Figure 6 is a perspective view of a bleeder fitting of the device of Figure 1.

[0015] Figure 7 is a diagram showing visual instructions for using the device of Figure 1.

[0016] Figure 8 is perspective view of a device for introducing a fluid into a refrigeration or air conditioning system, according to a further example embodiment;

[0017] Figure 9 is an exploded view of a fill/discharge fitting of the device of Figure 8;

[0018] Figure 10 is a side view of a bleed valve fitting of the device of Figure 8;

[0019] Figure 11 is a schematic diagram of a plurality of the fluid introducing devices of Figure 8 at a device filling station according to an example embodiment;

[0020] Figure 12 is a schematic diagram illustrating the use of the device of Figure 8 to introduce a fluid to a refrigeration or air conditioning system;

[0021] Figure 13 is a perspective view of a further embodiment of a device for introducing a fluid into a refrigeration or air conditioning system;

[0022] Figure 14 is a perspective view of another embodiment of a device for introducing a fluid into a refrigeration or air conditioning system; and

[0023] Figure 15 is a perspective view of another embodiment of a device for introducing a fluid into a refrigeration or air conditioning system.

[0024] Like reference numerals are used throughout the Figures to denote similar elements and features. While aspects of the present disclosure will be described in conjunction with the illustrated embodiments, it will be understood that it is not intended to limit the present disclosure to such embodiments.

DESCRIPTION

[0025] Accoridng to one aspect, example embodiments described herein relate to a device for introducing a reactive fluid into a refrigeration or air conditioning system. This device is aimed at excluding ambient air from contact with the reactive fluid during storage or injection into the refrigeration or air conditioning system.

[0026] In this regard, Figure 1illustrates an example of a kit 100 that contains such a device 102 contained within transparent plastic packaging 110. In an example embodiment, the device 102 includes a syringe 104 that is pre-filled with a reactive fluid 106, and a delivery hose 108. In the example embodiment, the components of the device 102 are contained within packaging 110 with the connector hose 108 detached from the pre-filled syringe 104. Instructions for use of the device 102 may be applied to or contained within the packaging 110. In example embodiments, a bleed fitting 112 is also enclosed in packaging 110.

[0027] Referring to Figure 2, in an example embodiment, the syringe 104 is a two-part syringe that includes a barrel 5 and a plunger 8. The barrel 5 defines an internal chamber, which as noted above is pre-filled with fluid 106 to a predetermined fill level 12. The barrel 5 includes an open end that receives a forward end of the plunger 8 and that is provided with one or more radially extending finger grips 11. The forward discharge end of the plunger 8 includes a nozzle 4 that defines a nozzle lumen. In an example embodiment, the nozzle 4 is externally threaded to provide a Luer lock fitting 3. In example embodiments, the barrel 5 is translucent or transparent and includes graduated markings 14 to provide a visual indication of changes in volume of fluid 106 contained within the barrel 5. A removable cap 2 may be provided for covering the nozzle 4.

[0028] The plunger 8 includes a push-button interface 9 for pushing a piston 6 of the plunger 8 into the barrel 5, and the opposite end of the plunger 8 includes one or

more seals 7 on the piston 6 that engage the interior wall of the barrel 5. In an example embodiment the seal 7 is integrally formed with and from the same material as the rest of the plunger 8. In one example, the plunger 8, including seal 7, is formed from is Polyethylene (PE) and the barrel 5 is formed from transparent Polypropylene (PP). By way of non-limiting example, in some applications a suitable syringe may be the disposable HSW NORM-JECT™ 50ml (60ml) Luer Lock 2-part syringe.

[0029] As noted above, in example embodiments, the one or more seals 7 provided on the plunger 8 are formed from the same material (PE) as the rest of the plunger. In at least some applications, such a unitary construction can improve the storage life of the reactive fluid filled syringe as the seals 7 may be less prone to breakdown. However, in at least some example embodiments, the seals 7 may be made from elastomeric material that is mounted on the plunger piston 6 rather than integrally formed with the piston 6 – for example seals 7 could be elastomeric o-ring seals.

[0030] In example embodiments, the fluid 106 includes a lubricant and lubricant additives. The lubricant, may for example, be a refrigeration lubricant, and the lubricant additives selected from one or more of an organosilane, orthoester, antioxidant or anticorrosion additive. The lubricant additives are the reactive compounds which with the lubricant component of fluid 106 produce a functional fluid. In the example, the primary purposes of the additives are as leak sealant and as hydrolytic drying agent, to prevent lubricant breakdown and to prevent corrosion of the system respectively.

[0031] In some examples, a suitable orthoester that is included in the fluid as a lubricant additive could be triethylorthoformate. In some example embodiments, organosilane components comprise 0-20 wt% of the fluid 106. In some example embodiments, the orthoester component or components comprise 0-50 wt% of the total amount injected.

[0032] As the reactive fluid 106 includes reactive compounds, in example embodiments, device 102 is configured to isolate the reactive fluid 106 until it is introduced into an air conditioning or refrigeration system. In this respect, the syringe 104 is configured as described herein to minimize contact between reactive fluid 106 and external elements such as ambient air that may contaminate the fluid 106, and the connector hose is configured to minimize contact of the reactive fluid 106 with any external elements during introduction of the fluid to an air conditioning or refrigeration system.

[0033] In at last some example embodiments the fluid 106 includes a colorant that allows the fluid to be easily seen through transparent barrel 5 to allow easy visual confirmation of the presence of and amount of fluid 106 present in barrel 5. In example embodiments, such colorant is not a florescent dye such as used to allow leaks to be detected in refrigerant systems, although in some applications, such a dye could also be included in the fluid 106. A suitable non-dye colorant could for example be Chromatint Blue HF.

[0034] It will be appreciated that at least some of the additives noted above function as a drying agent to reduce the moisture level of the lubricant that is included in the fluid 106, which in some applications can increase the storage life of fluid 106 by mitigating against polymerization.

[0035] In at least some applications, the lubricant in fluid 106 can function to stop leaks in air-conditioning and refrigeration systems that it is injected into.

[0036] A number of different compositions are possible for fluid 106. One possible composition consists of a polyolester lubricant, triethyl orthoformate, Vinyltrimethoxysilane, N-(3-(trimethoxysilyl)propyl)ethylenediamine, methyltrimethoxysilane, and tint solution.

[0037] As noted above, the device 100 includes a connector hose 108. As shown in Figure 3, connector hose 108 includes a central section formed from transparent or translucent flexible tubing 114 that is reinforced with fiber braiding. Connector hose 108 includes a syringe fitting 116 at one end of tubing 114 for connecting the hose 108 to the lock fitting 3 of syringe 104, and a discharge fitting 118 at the other end of tubing 114 for connecting the hose 108 to an air conditioning or refrigeration system.

[0038] As seen in Figure 4, the syringe fitting 116 includes an externally threaded Luer lock connector 120 for engaging the corresponding internally threaded Luer lock fitting 3 provided on syringe nozzle 4. In at least one example embodiment the Luer lock threading on fitting 116 extends helically around the fitting 116 for at least two turns to provide a multi-turn thread 126. A barb connector 122 is provided at the opposite of fitting 116 for attaching the fitting 116 to tubing 114, and a crimp fastener 124 (Fig. 3) is used to secure the fitting 116 in place on tube 114. In an example embodiment, the syringe fitting 116 includes a check valve 128 (represented in dashed lines in Fig.4) so that fluid can move from the syringe 104 into the hose tubing 114, but not in the reverse direction. In at least one example, the check valve 128 takes the form of a spring loaded ball valve that is biased against a valve seat to prevent backflow out of the Luer lock connector 120 into the syringe. In an example embodiment, the body of fitting 116 is formed from a metal such as aluminum or brass.

[0039] Referring to Figure 5, the discharge fitting 118 is a low loss fitting that is configured to connect to the service port of an air conditioning or refrigerant system. In this regard, the discharge fitting 118 can be a conventional low loss fitting that threads onto a conventional service port that includes an valve mechanism that cooperates with the service port. As shown in the exploded view of Figure 5, the fitting 118 can include, in an example embodiment, internally threaded valve housing130 for threading onto the service port, upper valve sleeve 132, depressor 134, spring 135, lower valve sleeve with barb 138 and snap ring 140. When valve housing 130 is screwed onto a service port, the depressor 134

interacts with a corresponding valve activator in the service port to displace the lower valve sleeve 138 from its valve seat and permit two way fluid flow through fitting 118. In an example embodiment, a novel feature of the fitting 118 is the height of nub 142 that is provided on the end of depressor 134 – in particular, in an example embodiment, the nub height is 0.9mm +/- .08mm. Such nub height will reduce refrigerant loss during connection and disconnection to a service port. A crimp clamp 125 (Fig. 3) can be used to secure the barbed end of valve sleeve 138 to hose tube 114.

[0040] The clear or translucent nature of hose tube 114 allows visual confirmation of when fluid 106 is present within the connector hose 108.

[0041] Figure 6 shows an example of a bleeder fitting 112 that can be attached to the discharge connector 118 of connector hose 108 to allow for purging air from the device 102. The bleeder fitting includes a threaded end 146 for engaging the valve housing 130 of discharge connector 118. Threaded end 146 includes a beveled annular interface 148 for engaging depressor 134 to open the valve of discharge connector 118.

[0042] As noted above, in at least some example embodiments, instructions for using the device 102 are included in kit 100. By way of example, such instructions could include illustrations such as those shown in Figure 7, together with written instructions such as the following (reference numerals consistent with those used in the previous Figures are added for clarity):

EXAMPLE INSTRUCTIONS:

1. Connect bleed fitting 112 to hose fitting 118 (Figure 7A)
2. Remove syringe cap & connect hose fitting 116 (Figure 7B)
3. Push down plunger 8 to remove air from hose 108
& then remove bleed fitting 112

4. Connect hose fitting 118 ONLY to the low pressure
service port of air conditioning or refrigerant system (Figure 7C)
5. Turn system on & immediately inject fluid 106 by pushing plunger 8
6. Disconnect hose fitting 118 from system
7. After injection, fully charge system if necessary

REUSABLE HOSE WITH LOW-LOSS FITTING – KEEP FOR NEXT APPLICATION

[0043] Although the instructions above refer to connection of the hose fitting to the low pressure service port of an air conditioning or refrigerant system, in some embodiments the hose may be fitted to a high pressure service port.

[0044] It will thus be appreciated that according to at least one example embodiment there is provided a device 102 for introducing a fluid 106 into a refrigeration or air conditioning system comprising a syringe 104. The syringe 104 includes a barrel 5 containing the reactive fluid 106 to be dispensed and a plunger 8 fitting into the barrel 5 so that it forms a seal against the interior wall and so that the barrel is pre-filled to capacity with the fluid 106 to be injected. A connector 108 is provided to facilitate injection into suitable ports fitted to the refrigeration or air conditioning system. In some embodiments the seal 7 between barrel 5 and plunger 8 is facilitated by an elastomeric o-ring seal, although in some embodiments, the seal could be integrally formed with the plunger 8. In some embodiments the barrel 5 is sufficiently transparent to allow visual observation of the fluid 106. In some embodiments the barrel 5 is marked so to allow measurement of the quantity of fluid injected. In some embodiments the fluid 106 to be injected allows measurement of the quantity of fluid injected by the means of colorants as required. In some embodiments the device 102 is disposable. In some embodiments the connector 108 is reusable while the syringe 104 is disposable. In some embodiments the connector 108 includes a hose and releasable fittings at each end.

[0045] In some applications, the device 102 facilitates injection of only the reactive fluid 106 to be injected to the exclusion of ambient air. In this regard, use of bleeder fitting 112 allows air to be removed from the device prior to use.

[0046] In some embodiments, the fluid 106 includes or consists of a lubricant and lubricant additives. The lubricant may be a refrigeration lubricant. The lubricant additives may include one or more of an organosilane, orthoester, antioxidant or anticorrosion additive. In an example embodiment the orthoester is triethylorthoformate.

[0047] In at least some example embodiments, the connector hose 108 is reusable with a new syringe 104. Between uses, the connector hose can be stored with fluid 106 inside of it as low loss fitting 118 and the check valve of syringe fitting 116 effectively seal the fluid.

[0048] In some example embodiments, devices and methods decribed herein can also be applied to non-reactive fluids. In this regard, Figures 8-15 relate to further example embodiments of a device for storing a fluid, which may be a reactive fluid or a non-reactive fluid, and subsequently introducing that fluid into a refrigeration or air conditioning system.

[0049] In this regard, Figure 8 illustrates an example of a fluid storage and introducing device 1102. In an example embodiment, the device 1102 is pre-filled with a fluid 1106 that is formulated for introduction into the compressor of a refrigeration or air conditioning system.

[0050] In one example embodiment, the device 1102 includes a fluid storage container 1104 that defines a fluid storage reservoir. The container 114 can be a unitary piece of resilient flexible tubing 1108 that is formed from transparent or translucent elastomer or plastic or other polymer tubing reinforced with fiber

braiding. In some example embodiments, tubing 1108 may not be reinforced with fiber braiding, and in some embodiments it may be opaque rather than transparent. The device 1102 includes a bleed valve fitting 1116 at one end of tubing 1108 and a discharge/fill fitting 1118 at the other end of the tubing 1108 for connecting the device 1102 to a fluid filling station and to an air conditioning or refrigeration system, respectively.

[0051] Referring to Figure 9, in an example embodiment, the fill/discharge fitting 1118 is a female low loss fitting that is configured to connect to a service port of an air conditioning or refrigerant system. In this regard, the fill/discharge fitting 1118 can be a conventional low loss fitting configured to thread onto a conventional service port, and which includes a normally closed valve mechanism that cooperates with the service port. As shown in the exploded view of Figure 9, the fitting 1118 can include, in an example embodiment, internally threaded valve housing 1130 for threading onto the service port, upper valve sleeve 1132 with valve seat 1133, depressor 1134, spring 1136, lower valve sleeve 1138 with valve seal 1137 and hose barb 1139 and snap ring 1140. When valve housing 1130 is screwed onto a service port, the depressor 1134 interacts with a corresponding valve activator in the service port to displace the valve seal 1137 of lower valve sleeve 1138 from the valve seat 1133 defined by the upper valve sleeve 1132 and permit two way fluid flow through fitting 1118. The height of nub 1142 that is provided on the end of depressor 1134 defines the size of the flow opening through the fitting 1118 and can be calibrated to provide a desired fluid flow rate in accordance with the intended application of the device 1102. A crimp clamp 1125 (Fig. 8) is used to secure fitting 1118 to tubing 1108 by securing barbed end 1138 of the valve sleeve 1138 to tube 1114.

[0052] Fill/discharge fitting 1118 can take a number of different configurations. In one example embodiment the fill/discharge fitting 1118 is a ¼" SAE low loss fitting. In another example embodiment, fill/discharge fitting 1118 is a 5/16" SAE low loss fitting. In other example embodiments, fill/discharge fitting 1118 is a 1134A ½" ACME automotive fitting , or any other suitable automotive A/C fitting.

[0053] In an example embodiment the bleed valve fitting 1116 is a normally closed valve configured to seal the opposite end of tubing 1108 to prevent any fluid 1106 from escaping once the device 1102 is filled with fluid, but to allow air to escape from the device 1102 when the device is being filled with fluid through the fill/discharge valve 1118. As seen in Figure 10, in one example embodiment the bleed valve fitting 1116 includes a ball check valve 1121 that takes the form of a spring loaded ball valve 1128 that is biased by a spring 1129 against a valve seat 1127 to prevent fluid flow out of the tubing 1108. The bleed valve fitting 1116 includes a cylindrical opening 1128 to allow the ball valve 1128 to be depressed such that air (or other residual fluid) can leave the tubing 1108 when fluid 1106 is added to the tubing 1108 through the fill/discharge fitting 1118. A barb connector 1122 is provided at the opposite of fitting 1116 for attaching the fitting 1116 to tubing 1108, and a crimp fastener 1124 (Fig. 8) is used to secure the fitting 1116 in place on tubing 1108. Any number of alternative valve configurations can be used for fitting 1116, including for example a Schrader or other pin valve configuration.

[0054] The clear or translucent nature of hose tubing 1108 allows visual confirmation of when fluid 1106 is present within the container 1104.

[0055] Referring to Figure 11, an example of a method for inserting fluid 1106 into a reservoie defined by container 1104 of device 1102 will now be described. In an example embodiment, a filling station 400 is employed to simultaneously fill a plurality of devices 1102 with fluid 1106. For example 10 to 30 devices 1101 may be filled simultaneously using fill station 400, although in some embodiments each device 1102 may be filled individually, or more than 30 devices 1102 could be filled at a time, or fewer than 30 devices could be filled at a time. The filling station 400 includes a fill manifold 402 that includes number of threaded male low loss fittings 406 that are each adapted to mate with the fill/discharge fitting 1118 of a respective device 1102. The manifold 402 defines a number of internal flow passages to allow fluid 1106 to be pumped from a reservoir through fittings 406 and into the tubing 1108 of each of the devices 1102. The filling station also include a bleed valve actuator 404 that includes a plurality of actuator pins 408 that are

each aligned with the bleed valve fitting 1116 of a respective device 1102. In some embodiments, each device 1102 may be secured to a support structure (not shown) at or near its fitting 1116 to align the fittings with respective actuator pins 408.

[0056] During a fill cycle, fluid 1106 is pumped from manifold 401 thorough fittings 406 into the tubing 1108 of the respective devices 1102. In order to facilitate filling of the devices 1102, the valves 1121 of the bleed valve fittings 1116 are activated through depression by the activator pins of actuator 404 so that any air or other residual fluid in the device tubing 1108 will be displaced from the bleed fitting end of the device 1106 as fluid 1106 enters through the fill/discharge fitting 1118. At or near the completion of the fill cycle, actuator 404 releases bleed valves 1121, and the fill discharge fitting 1118 of each device is decoupled from manifold 402.

[0057] In at least some example embodiments, substantially all air or other residual fluids are removed from each device 1102 during the fill cycle such that the tubing 1108 is substantially entirely filled with fluid 1106 from the bleed valve 1121 end to the fill/discharge valve 1118 end, such that the fluid 1106 stored in the device 1102 is retained in an isolated storage state where it is not exposed to any contaminating or potentially reactive elements. In an example embodiment, the pressure exerted by fluid 1106 on the tubing 1108 in the device 1102 is at or near atmospheric pressure such that the contents of the tubing 1108 neither pressurized or under a vacuum. However, in some applications the fluid 1106 may be pressurized within the tubing 1108.

[0058] Once the devices 1102 are filled with fluid 1106 they can be stored and placed in a distribution chain for distribution to end users. In an example embodiment, the pressure exerted by fluid 1106 on the tubing 1108 in the device 1102 is at or near atmospheric pressure such that the contents of the tubing 1108 neither pressurized or under a vacuum in normal storage conditions. However, in some applications the fluid 1106 may be pressurized within the tubing 1108.

[0059] The fluid 1106 placed in a device 1102 could be selected from any number of possible fluids that are required or useful for maintenance of air conditioning or refrigerant systems. In some example embodiments, fluid 1106 could include an oil, sealant or leak detection dye, among other things. In some example embodiments, the fluid 1106 includes a lubricant and lubricant additives. The lubricant, may for example, be a refrigeration lubricant, and the lubricant additives selected from one or more of an organosilane, orthoester, antioxidant or anticorrosion additive. In some examples, a suitable orthoester that is included in the fluid as a lubricant additive could be triethylorthoformate. In some example embodiments, organosilane components comprise 0-20 wt% of the fluid 1106. In some example embodiments, the orthoester component or components comprise 0 to 100wt% of the total amount in device 1102.

[0060] In at least some example embodiments the fluid 1106 includes a colorant that allows the fluid to be easily seen through transparent tubing 1108 to allow easy visual confirmation of the presence of and amount of fluid 1106 present in tubing 1108. In example embodiments, such colorant is not a florescent dye such as used to allow leaks to be detected in refrigerant systems, although in some applications, such a 75dye could also be included in the fluid 1106. A suitable non-dye colorant could for example be Chromatint Blue HF.

[0061] It will be appreciated that at least some of the additives noted above function as a drying agent to reduce the moisture level of the lubricant that is included in the fluid 1106, which in some applications can increase the storage life of fluid 1106 by mitigating against breakdown of the chemical components of fluid 1106.

[0062] In at least some applications, the lubricant in fluid 1106 can function to stop leaks in air-conditioning and refrigeration systems that it is injected into.

[0063] A number of different compositions are possible for fluid 1106. One possible composition consists of a polyolester lubricant, triethyl orthoformate,

Vinyltrimethoxysilane, N-(3-(trimethoxysilyl)propyl)ethylenediamine, methyltrimethoxysilane, and tint solution.

[0064] In some example embodiments, the fluid 1106 can include small or micron sized particles like Teflon.

[0065] An example of a method for using device 1102 during maintenance or repair of a refrigeration or air conditioning system will now be described with reference to Figure 12, which shows a compressor 500 of a refrigeration or air conditioning system. The compressor 500 has a low pressure service fitting or port 502 that is connected to the refrigerant circulatory system of the compressor 500. In an example embodiment, when using the device 1102, the following steps are taken:

(1) The compressor 500 is turned off or otherwise put into a "service mode";
(2) The discharge fitting 1118 of the device 1102 is coupled to the low pressure service port 502 of the compressor, and the tubing 1108 manipulated so that its extending end is positioned in a substantially upright or vertical position;
(3) The compressor 500 is tuned on or otherwise put into an "operational mode";
(4) Once fluid 1106 empties from tubing 1108 into the compressor 500, the fitting 1118 of the device 1102 is decoupled from the low pressure service port 502.

[0066] In at least some example embodiments, the device 1102 is distributed as a kit that includes instructions similar to those provided above directing how the device 1102 be used for maintenance or repair of a refrigeration or air conditioning system.

[0067] It will be appreciated that in typical air conditioning or refrigeration systems there is a differential in pressure at the low pressure service port between the on and off states (out-of-service or in-service states), with the pressure at the port being higher when the system compressor 500 is off and than when it is on. Thus

when the device 1102 is first connected to the service port 502, fluid 1106 is initially subjected to a higher pressure that then drops once the compressor is turned on. In some example embodiments, the elastomeric nature of resilient tubing 1108 results in the hose 1108 functioning as a mechanical energy storage element in that the tubing 1108 momentarily expands or stores energy when subjected to the higher "off" pressure level, and then subsequently contracts or releases the stored energy when subjected to the lower "on" pressure level. Such a mechanism may in some embodiments assist in the introduction of fluid 1106 into the compressor 500. Accordingly, in some embodiments, the discharge of fluid 1106 from the device 1102 is assisted by the impact of the characteristic pressure differential of an air conditioning or refrigeration system between its high pressure out-of-service state and its low pressure condition when in-service.

[0068] It will be appreciated that other systems for adding fluid to air conditioning or refrigerant systems typically rely on either stored energy or externally added energy to inject the fluid into the system. For example, in stored energy systems, containers that include fluids can be pre-energized by either creating a vacuum in the container or by pressurizing the container. In added energy systems, an injector system such as a syringe or other mechanical mechanism is used to force fluid from its storage container. In at least some example embodiments, the device 1102 does not store fluid 1106 in either a pressurized or vacuum state, and thus does not rely on energy stored within the device 1102, which can mitigate against leakage or contamination concerns at the integrity of the container is not under constant force in the storage state. Furthermore, the device 1102 does not require the application of external force or energy to discharge fluid 1106, but rather relies simply on connection to the refrigeration or air conditioning system to supply the forces required to displace fluid 1106 into the air conditioning or refrigeration system

[0069] As illustrated in Figure 12, as the fluid 1106 enters the compressor 500 from tubing 1108, refrigerant 504 from the system bubbles up into the tubing 1108 to replace the departing fluid 1106. In at least some examples, the refrigerant 504

may be in a gaseous state wherein it expands into the tubing 1108 and bubbles towards the sealed end of the tubing 1108, thereby facilitating the displacement of fluid 1106 from the tubing. Accordingly, in some example embodiments, volumetric displacement of fluid 1106 by system refrigerant 504 can provide a force for introducing the fluid 1106 into the system it is connected to.

[0070] In some example embodiments, the turbulence of refrigerant within a system to which the device 1102 is connected may create a venturi effect that assists in the evacuation of fluid 1106 from the device and into the air conditioning or refrigeration system.

[0071] Accordingly, in at least some example embodiments, rather than a using stored or externally added force to add fluid 1106 to a system, the device 1102 relies on one or a combination of the following effects: a change in stored energy in the device 1102 caused by the change in pressure between an out-of service and in service states of the system; volumetric displacement of the fluid 1106 by refrigerant entering the device 1102; and venturi forces resulting from movement of the refrigerant past the service port in the system.

[0072] The effect of the above mechanisms on fluid 1106 can be controlled by a number of factors, including the volume and dimensions (e.g. length and internal diameter) of tubing 1108, and the size of the valve opening defined by fitting 1118 when it is in an open state, and the characteristics of fluid 1106 itself such as its viscosity. In example embodiments, these factors are calibrated according to the intended use of the device 1102 such that the design of device 1102 can be adapted to accommodate a wide range of fluids and air conditioning/refrigeration systems.

[0073] In some applications, the device 1102 facilitates the introduction of fluid 1106 to the exclusion of ambient air.

[0074] In embodiments where fluid 1106 is coloured the increase of refrigerant 504 in the tubing 1108 and departure of the fluid 1106 is easily observed. The flexible nature of the tubing 1108 allows the device to be manipulated for use in tight areas.

[0075] It will thus be appreciated that according to at least one example embodiment there is provided a device 1102 for storing a fluid and introducing the fluid 1106 into a refrigeration or air conditioning system. The device 1102 can in at least some examples be cost efficient to make and ship as it comprises a unitary piece of tubing having fittings at each end, rather than a multi-component system. The discharge fitting 1118 is directly connected to container 1104 that stores fluid 1106 such that no intermediate hoses or fittings are required to move fluid 1106 from its storage location in tubing 1108 to the fitting 1118. Thus, the fitting 1118 provides direct fluid communication between the fluid storage region of container 1104 (as defined by tubing 1108) and the service port 502. In at least some example embodiments a feature of having fluid 1106 stored in the device 1102 immediately adjacent the discharge fitting 1118 is that no bleeding of air or other contaminants from intermediate components is required prior to connecting the fitting 1118 to the service port 502 of the air conditioning or refrigeration system as such bleeding has already occurred back at the filling station 400 before the device 1102 was placed in the sales and distribution channel.

[0076] In one non limiting example, a sample device 1102 comprised a 21cm length of elastomeric tubing 1108 formed from an elastomer material with mesh lining, having one end blocked/sealed, and one end of the tubing having a sealed end, with two way flow capability provided at the opposite end by a low loss fitting 1118. Tubing 1108 had a wall thickness of 3.0mm, an outside diameter of 12mm, an inside diameter 5.9mm, and 4.3 grams of fluid 1106. During use, the device was attached to the low side of a system having a system static pressure of 198psig during off cycle; after system turn on, a drop in static pressure occurs from 198psig to a suction operating pressure of 65psig, providing a pressure differential of 133

psi (Low Side) during which the fluid 1106 emptied completely from device 102 and was displaced by refrigerant gas pressure of 65psi.

[0077] Although the example methods described above relate to the use of device 1102 on the low pressure service port of an air conditioning or refrigerant system, the device 1102 may be used differently in some example embodiments. For example, the device may in some embodiments be used with the high pressure service port of a refrigeration or air conditioning system rather than the low pressure service port. Furthermore, in some embodiments, the device 1102 may be used by connecting to a low pressure service port or a high pressure service port without taking the receiving system out-of service, in which case the pressure differential between in-service and out-of service would not play a role in fluid discharge. Alternatively, in some embodiments, the device 1102 may be used by connecting to a low pressure service port or a high pressure service port of an out-of-service system that is not turned on at all while the device 1102 is connected.

[0078] In some example embodiments, the device 1102 may be reusable. In such an application, the bleed fitting 1116 may, for example, also function as a refill fitting to allow the tubing 1108 to be refilled. For example, the bleed fitting 1116 could include a luer lock to allow it to be connected to a syringe that contains replacement fluid 1106 for refilling the device 1102. In such a configuration, a mechanical bleed fitting may be provided for connection to discharge fitting 1118 to allow any residual fluid to be ejected through fitting 1118 during the refill process.

[0079] Many modifications can be made to device 1102. Figure 13 shows an alternative embodiment 1102A that is similar to the embodiment described above, except that the bleed valve 1116 on one end of tubing 1108 has been replaced with a low loss female fitting 1118A. Fitting 1118A is similar or identical to fitting 1118 except that fitting 1118A is made for mating with a different diameter service port such that device 1102A can be used to service refrigeration or air conditioning systems that have different size service ports simply by reversing the orientation of

the device 1102A. By way of example, fitting 1118 could be a ¼" SAE low loss fitting and fitting 1118A a 5/16" SAE low loss fitting. In another example embodiment, fill/discharge fitting 1118 is a ACME automotive 1134A ½" fitting, with fitting 1118A being either a ¼" SAE low loss fitting or an 1118A a 5/16" SAE low loss fitting.

[0080] When device 1102A is filled, at filling station 400, one fitting 1118 can be used as the fill fitting, while the other fitting 1118A is used to bleed out any residual air or other fluids from tubing 1108.

[0081] Figure 14 shows yet another alternative embodiment 1102B that is similar to the embodiments described above, except that the bleed valve 1116 on one end of tubing 1108 has been replaced with a no-valve seal 701. In such an embodiment, provision is made at the filling station 400 to allow the air or other gas contained in tubing 1108 to escape from fitting 1118 (the same fitting through which fluid 1106 enters) during filling.

[0082] Figure 15 shows yet another alternative embodiment 1102C that is similar to the embodiments described above, except that flexible tubing 1108 has been replaced with a rigid tube 802, which may be transparent or translucent or opaque. In an example embodiment, a compressible member 801, which could for example be a sphere, is provided at the bleed valve end of the device 1102C. Compressible member 801 may in at least some example embodiments function as a mechanical energy storage element to provide a pressure absorbing function when device 1102C is attached to the low pressure compressor port during the off cycle, and a pressure or energy release function when the compressor is subsequently turned on. In some embodiments, compressible member 801 helps provide additional seal to bleed valve 1121.

[0083] In some example embodiments that use a rigid tube 802, compressible member 801 may be omitted. In some example embodiments, a compressible

meber 801 may be included within the flexible elastomeric tubing 1108 of devices 1102, 1102A or 1102B to enhance the energy absorption and release features of such devices. In one example embodiment, the lubricant additive composition for improving miscibility and performance of the refrigeration or air-conditioning system is located in a flexible expanding hose or tube that is sealed at one end and at the other end includes a two-way flow fitting that can be attached to the refrigeration or air-conditioning system.

[0084] The present disclosure may be embodied in other specific forms without departing from the subject matter of the claims. The described example embodiments are to be considered in all respects as being only illustrative and not restrictive. Selected features from one or more of the above-described embodiments may be combined to create alternative embodiments not explicitly described, features suitable for such combinations being understood within the scope of this disclosure.

CLAIMS

1. A device for introducing a reactive fluid into a refrigeration or air conditioning system comprising:

a syringe comprising a barrel containing the reactive fluid to be dispensed and a plunger fitting into a first end of the barrel so that it forms a seal against an interior wall of the barrel, and

a separate connector for connecting to a second end of the barrel to facilitate injection of the fluid into a port of the refrigeration or air conditioning system.

2. A device of claim 1 such that the seal between barrel and plunger is facilitated by an elastomeric o-ring seal.

3. A device of claim 1 in which the barrel is sufficiently transparent to allow visual observation of the fluid

4. A device of claim 1 in which the barrel is marked so to allow measurement of the quantity of fluid injected.

5. A device of claim 1 wherein the fluid to be injected allows measurement of the quantity of fluid injected by the means of colorants as required.

6. A device of claim 1 that is disposable.

7. A device of claim 1 that is reusable.

8. A device according to claim 1 where the connector is configured a one end to provide a sealed fit to a nozzle at the second end of the syringe barrel and the connector is configured at the other end to provide a sealed fit to the port of to refrigeration or air conditioning system.

9. A device of claim 8 wherein the connector comprises a hose with fittings at each end thereof.

10. A device of claim 6 that facilitates introduction of only the fluid to the port to the exclusion of ambient air.

11. A device of claim 10 in which the fluid consists of or includes a lubricant and lubricant additives.

12. A device of claim 11 in which the lubricant is refrigeration lubricant.

13. A device of claim 11 in which the lubricant additives are selected from one or more of an organosilane, orthoester, antioxidant or anticorrosion additive.

14. A device of claim 12 in the lubricant additive includes an orthoester that is triethylorthoformate.

15. A device for introducing a reactive fluid into a refrigeration or air conditioning system comprising:

a syringe comprising a barrel containing the reactive fluid to be dispensed and a plunger fitting into the barrel and having a seal formed thereon for engaging against an interior wall of the barrel; and

a connector for connecting the barrel to facilitate injection of the fluid into suitable ports fitted to the refrigeration or air conditioning system, wherein the seal is formed integrally with and of the same material as the plunger.

16. The device of claim 15 wherein the connector and syringe include a Luer lock interface therebetween.

17. A method of providing a device for introducing a reactive fluid into a refrigeration or air conditioning system comprising:

providing a syringe that includes a barrel and a plunger for fitting into the barrel so that it forms a seal against an interior wall of the barrel;

providing a reactive fluid in the barrel with ambient air excluded from the barrel;

providing a connector to connect between the syringe and a port of the refrigeration or air conditioning system to facilitate injection of the reactive fluid into the refrigeration or air conditioning system.

18. The method of claim 17 wherein providing a syringe comprises providing seal integrally formed with the plunger.

19. The method of claim 17 comprising providing a bleeder valve for bleeding air out of the connector prior to connecting the connector to the port.

20. The method of claim 17 wherein the fluid consists of a lubricant and lubricant additives, the lubricant additives comprising one or more of an organosilane, orthoester, antioxidant or anticorrosion additive.

21. The method of claim 17 wherein the fluid consists of a lubricant and lubricant additives, the lubricant additive comprising triethylorthoformate.

22. A device for introducing a fluid into a refrigeration or air conditioning system comprising:

a fluid container containing the fluid, and having an energy storing element and a connector to facilitate discharge of the fluid into a port of the refrigeration or air conditioning system, wherein the energy storage element relies on a pressure differential in the refrigeration or air conditioning system to assist discharge of the fluid from the container.

23. The device of claim 22, wherein the connector comprises a first valve fitting at an end of the container, the device comprising a second valve fitting at an

opposite end of the container, the first valve fitting and the second valve fitting each being configured for attachment to a different size or type of port.

24. The device of claim 22 or 23 wherein the container comprises a flexible tube.

25. The device of any one of claims 22 to 24 wherein the energy storage element is implemented through an elasticity of the container.

26. The device of claim 22 or 23 wherein the container comprises a rigid tube.

27. The device of any one of claims 22 to 25 wherein the connector is a rigid connector configured to directly connect the container to the port such that a reservoir defined by the container and containing the fluid communicates directly with the port.

28. The device of any one of claims 22 to 27 wherein the the fluid is one of or a combination of a UV dye that is visible under UV lighting, a colorant or dye that is visible under natural lighting, oil additives, refrigerant sealant, a suspension comprising micron sized particles, and lubricant.

29. The device of claim 22 wherein the container is a flexible tube, the connector includes a discharge valve and is attached to one end of the flexible tube and a fill valve for filling the container is attached to an opposite end of the flexible tube.

30. A method for providing a fluid for introduction to an air conditioning or refrigeration system comprising:

providing a tube having a normally closed two-way valve fitting at one end thereof;

filling the flexible tube with the fluid and evacuating ambient air from the flexible tube; and

connecting the flexible tube to a service port of the air conditioning or refrigeration system and relying on a pressure differential between a service mode

and an operating mode of the air conditioning or refrigeration system to assist the the fluid to enter the air conditioning or refrigeration system.

31. The method of claim 30 wherein the tube comprises an energy storing element activated by the pressure differential between the service mode and the operating mode of the air conditioning or refrigeration system.

32. The method of claim 31 or 32 wherein the tube is a flexible tube.

33. A device for introducing a fluid into a refrigeration or air conditioning system comprising:

a fluid container containing the fluid within a reservoir, and having a first valve fitting at an end of the container and a second valve fitting at an opposite end of the container, the first valve fitting and the second valve fitting each being configured for attachment to a different size or type of port of a refrigeration or air conditioning system.

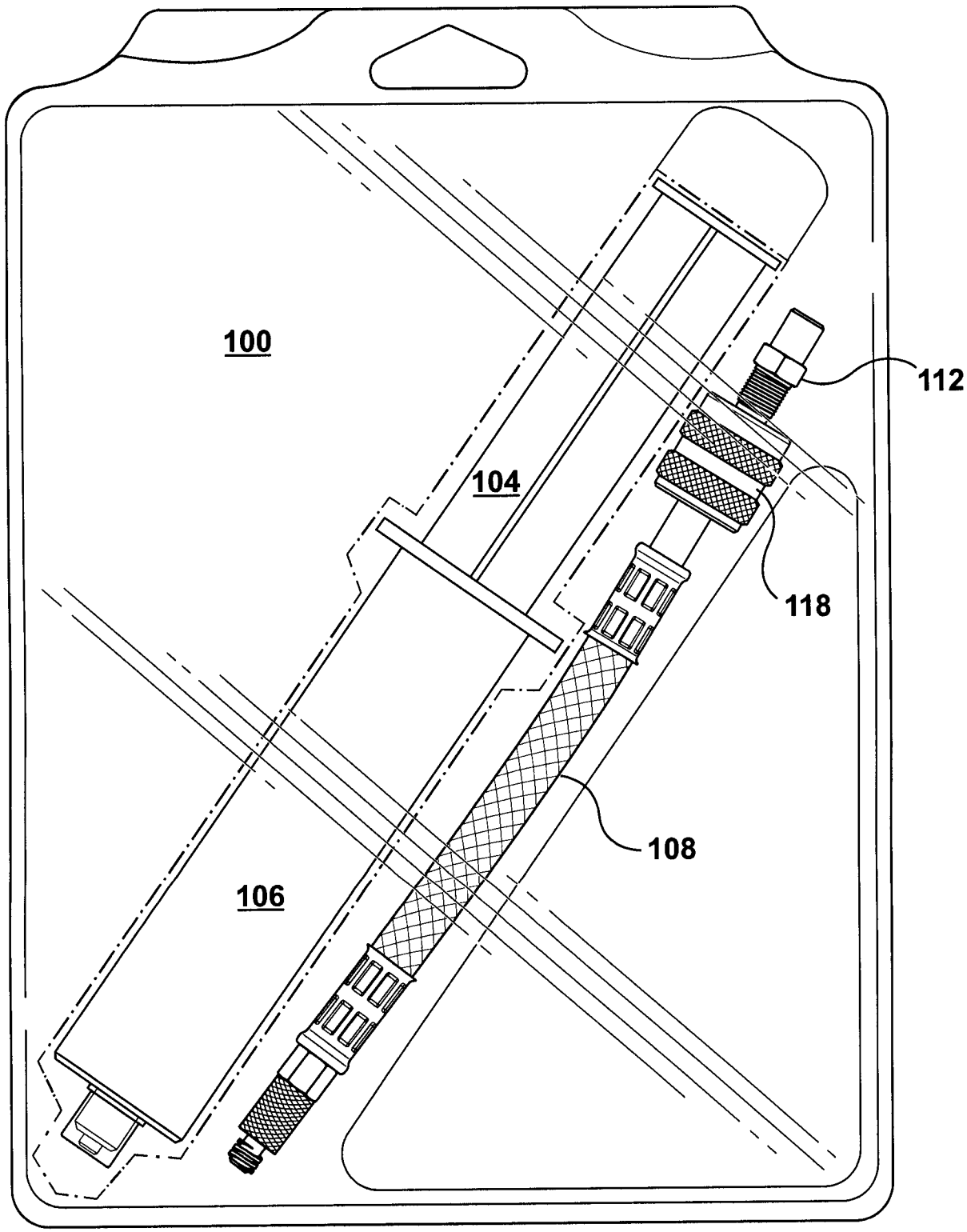

FIG. 1

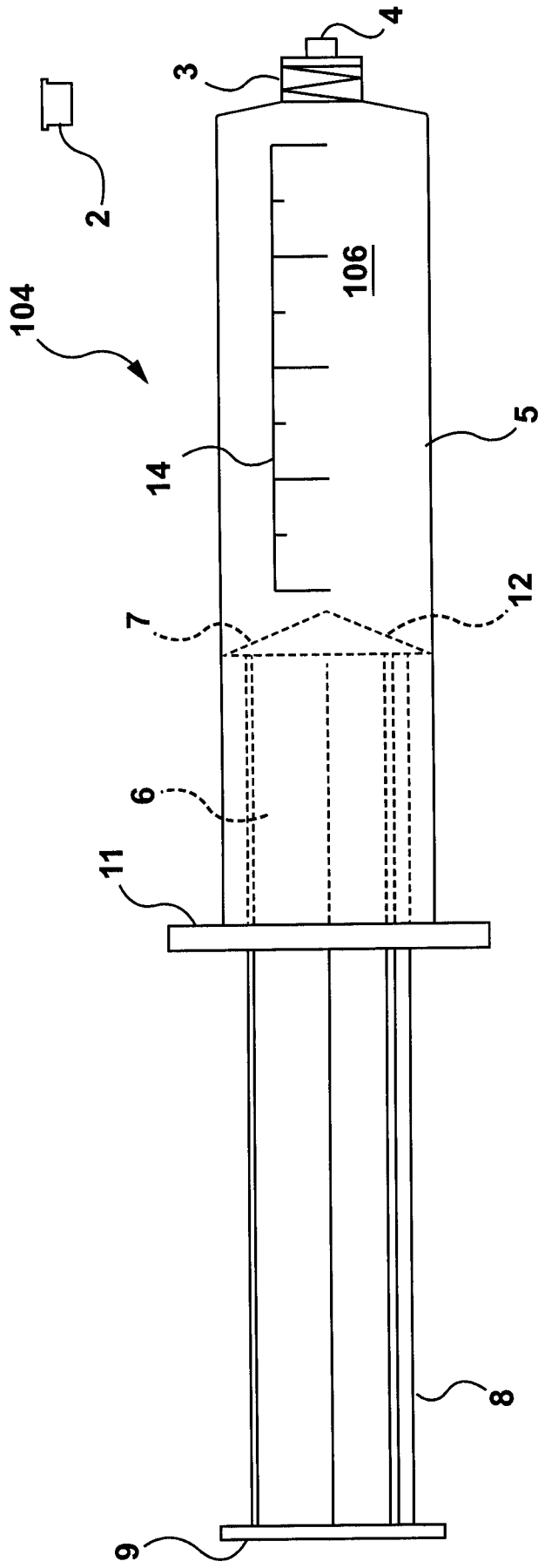

FIG. 2

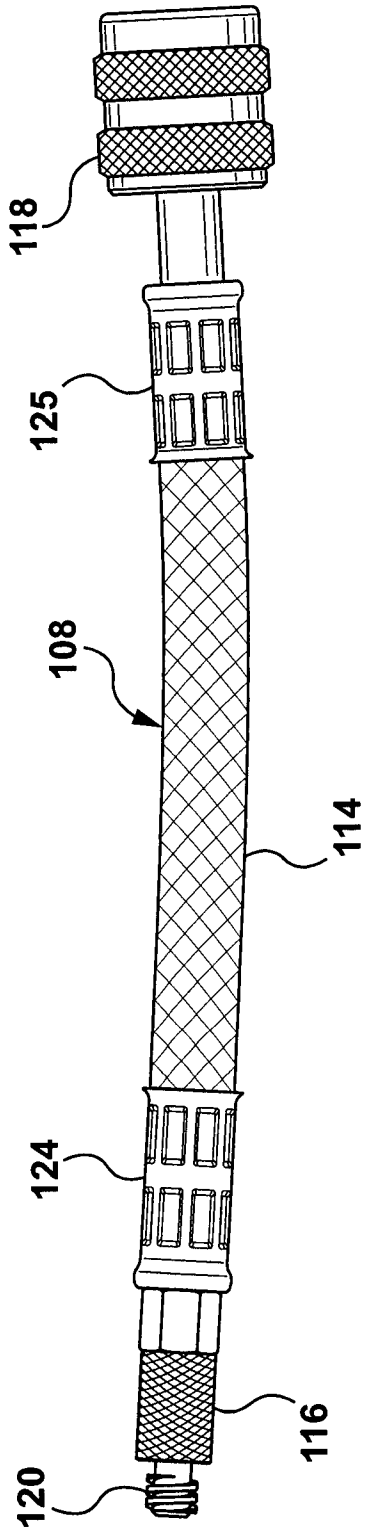

FIG. 3

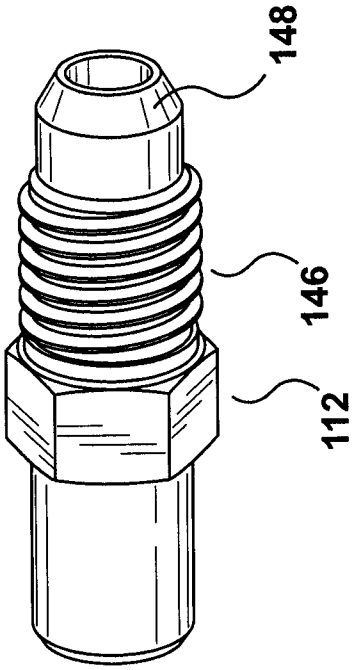

FIG. 6

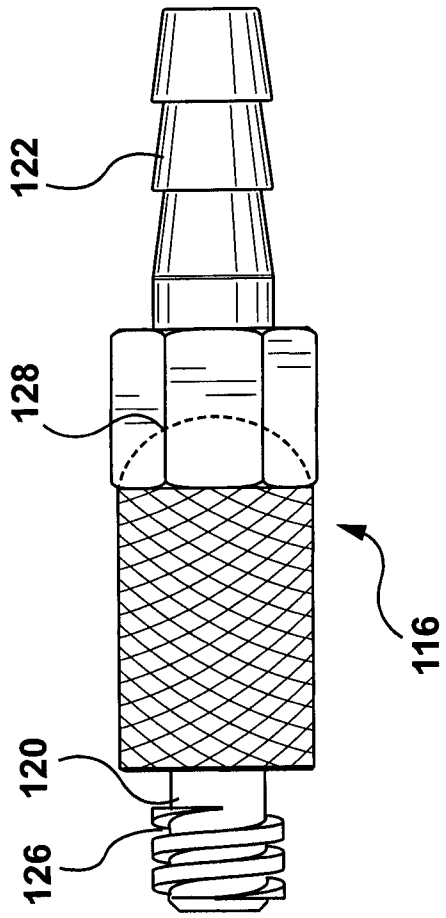

FIG. 4

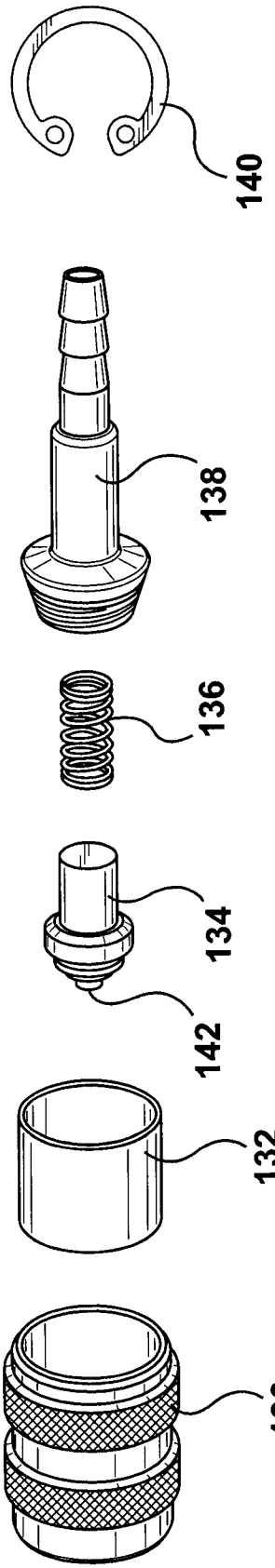

FIG. 5

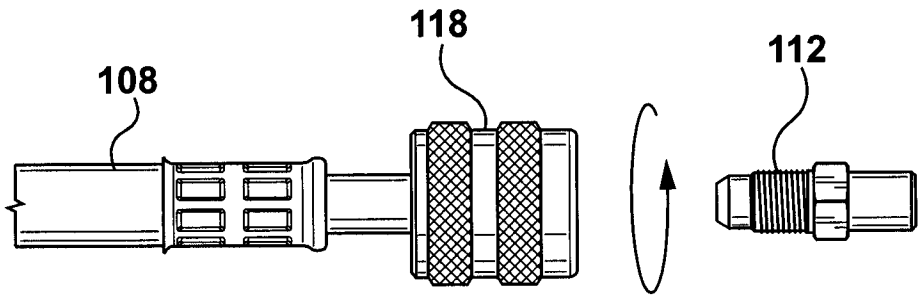

FIG. 7A

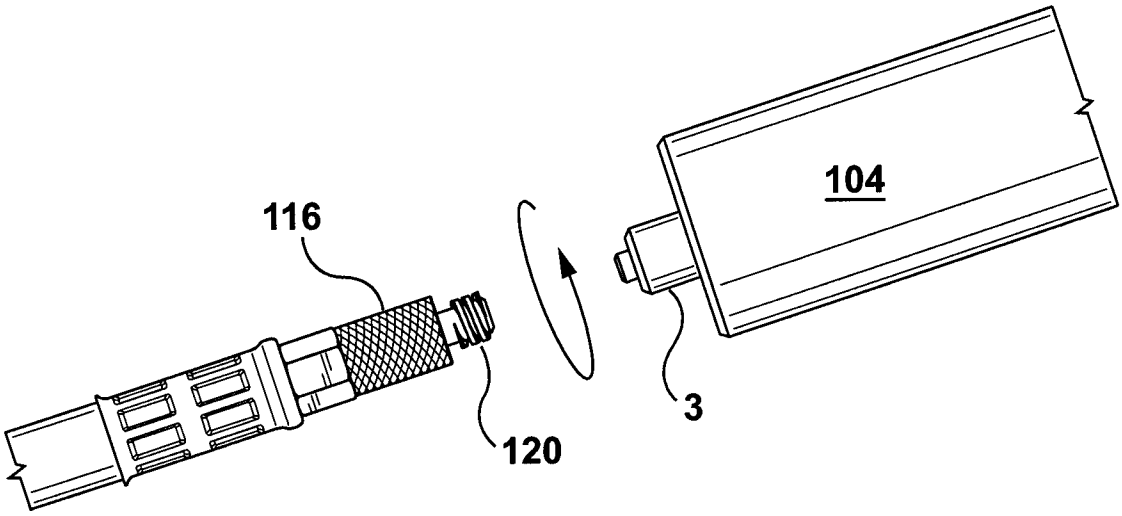

FIG. 7B

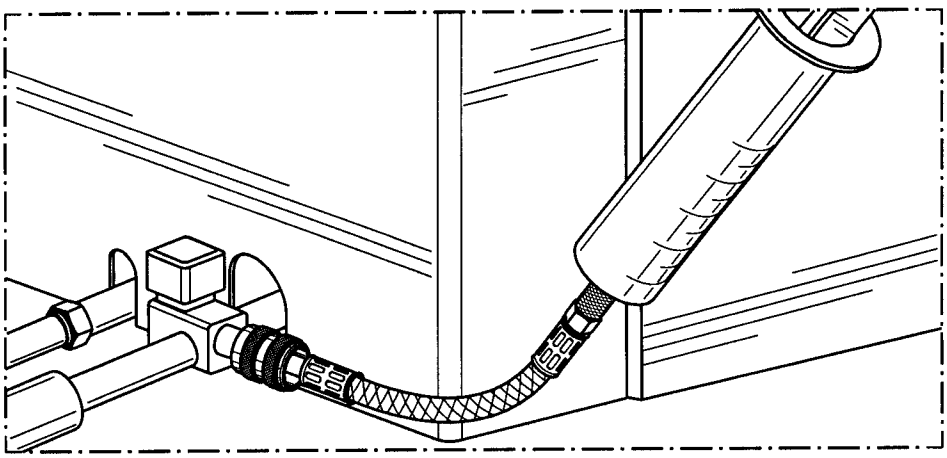

FIG. 7C

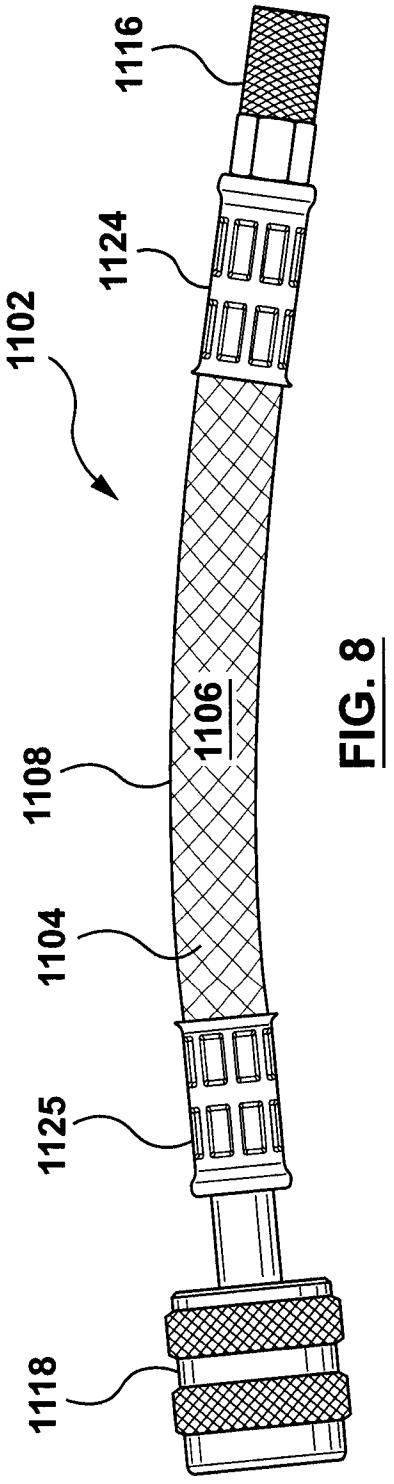

FIG. 8

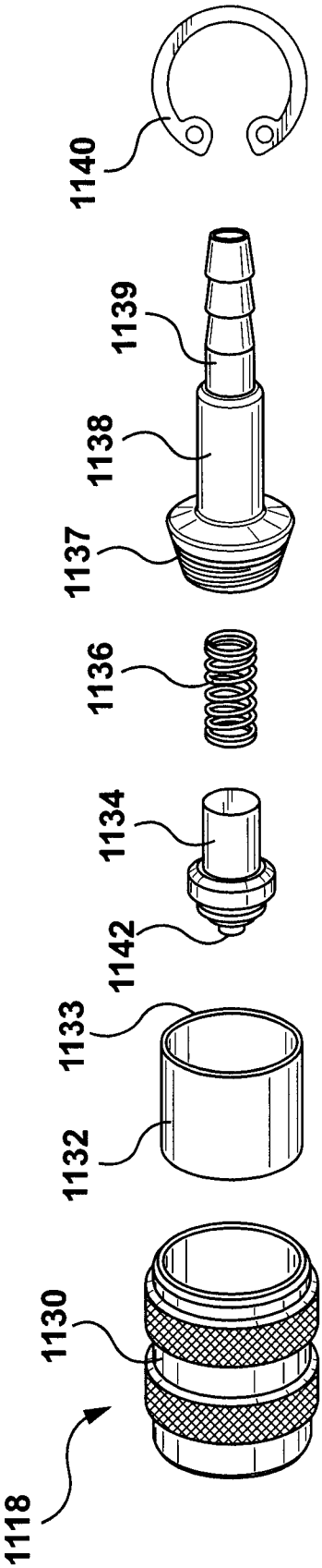

FIG. 9

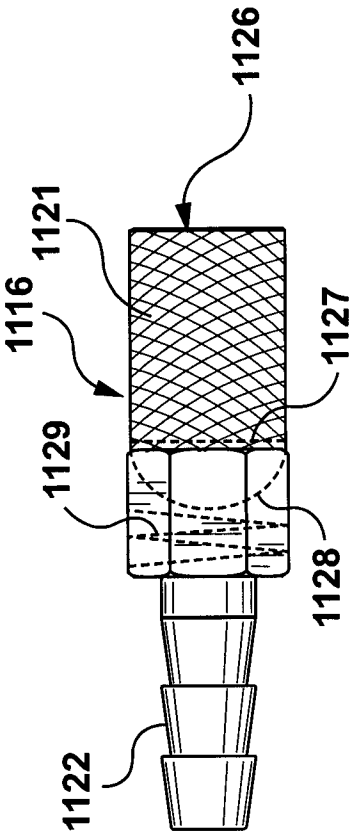

FIG. 10

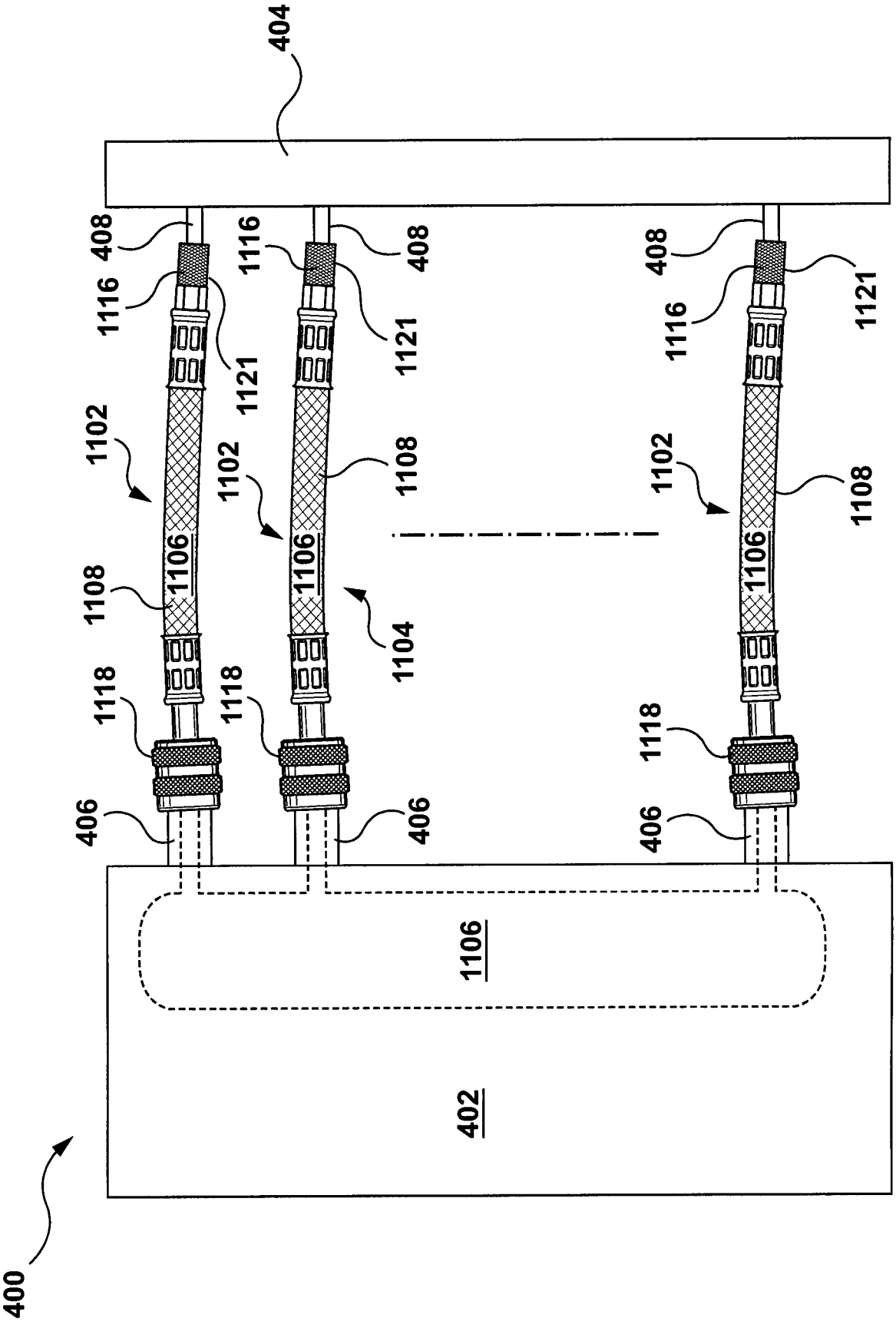

FIG. 11

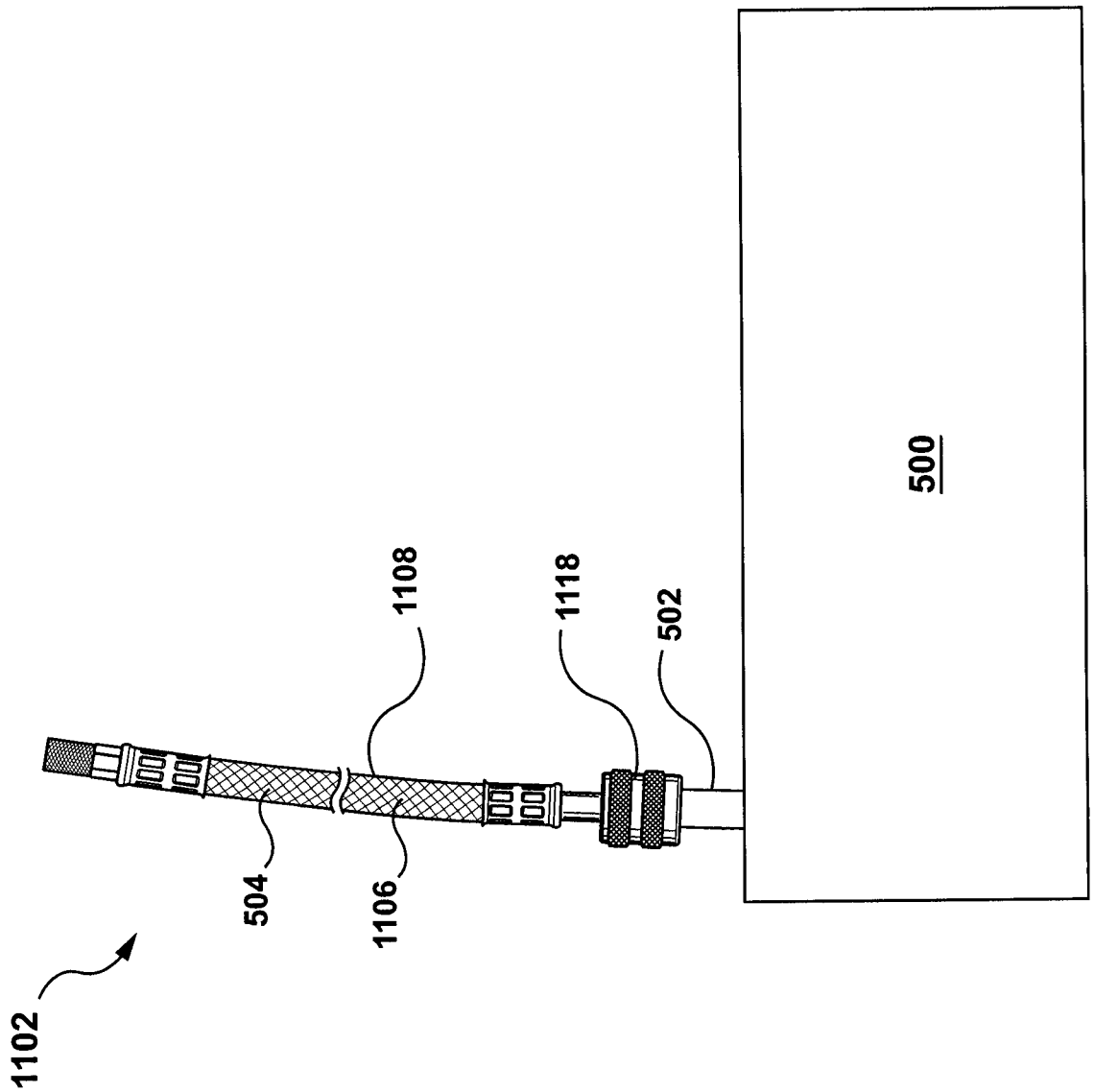

FIG. 12

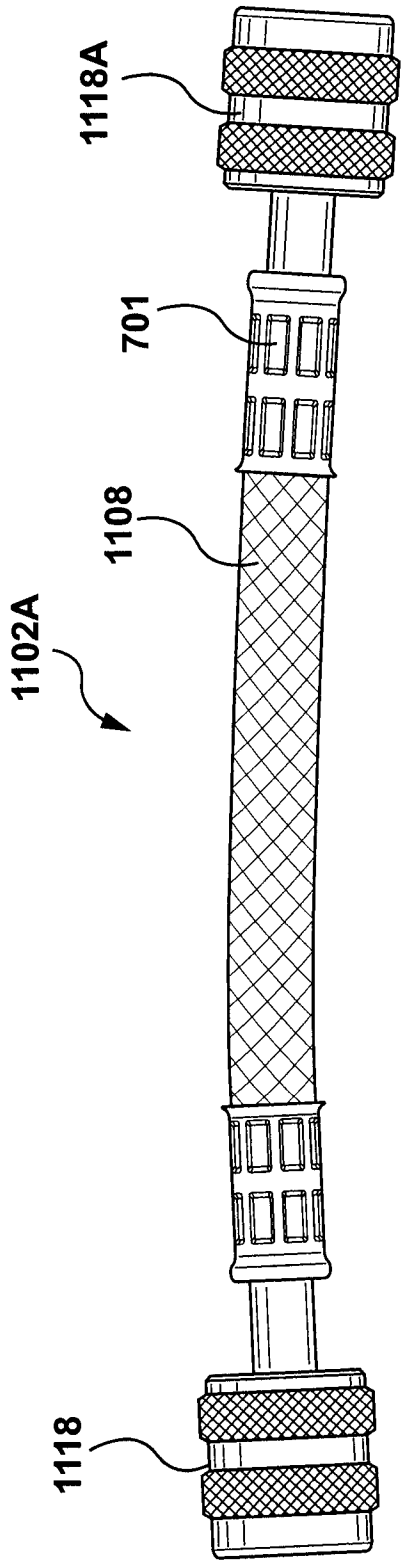

FIG. 13

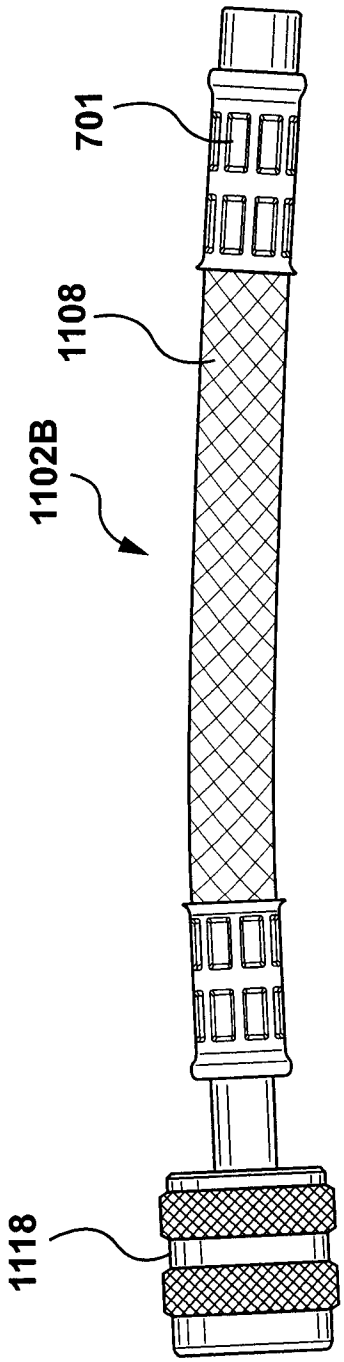

FIG. 14

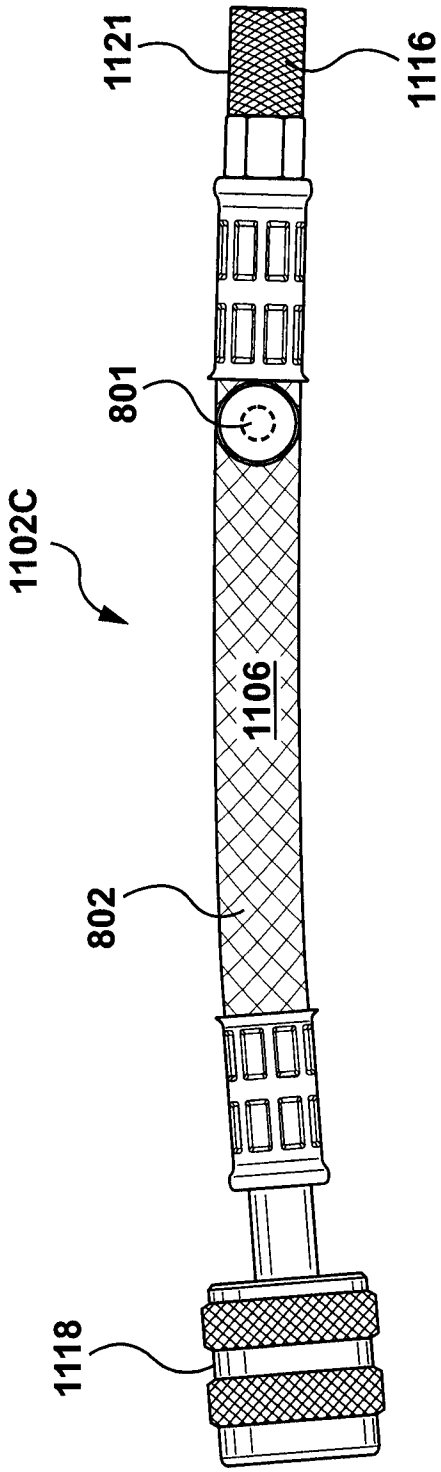

FIG. 15C

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CA2015/050190

A. CLASSIFICATION OF SUBJECT MATTER
IPC: ***F25B 45/00*** (2006.01), ***F16N 21/00*** (2006.01), ***F16N 3/04*** (2006.01), ***F17D 3/12*** (2006.01), ***F25B 47/00*** (2006.01), *C09K 5/04* (2006.01)

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC: ***F25B 45/00*** (2006.01), ***F16N 21/00*** (2006.01), ***F16N 3/04*** (2006.01), ***F17D 3/12*** (2006.01), ***F25B 47/00*** (2006.01), *C09K 5/04* (2006.01)

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

Electronic database(s) consulted during the international search (name of database(s) and, where practicable, search terms used)
Questel Orbit (Keywords: charge, inject, orthester, lubricant, orifice, syringe, purge, bleed , dye+, differential, delta, rest+, off)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	US20110167841 (Appler et al.) 14 July 2011 (14-07-2011) same applicant**** *whole document*	1, 3, 5, 6-15, 17, 18, 20 and 21 2, 4, 16
X Y	US7077149 (Kalley et al.) 18 July 2006 (18-07-2006) *whole document*	1,3,5,6-12,15,17-19,22-24,26-30 2, 4, 16
X Y	US6155066 (Chandler et al.) 05 December 2000 (05-12-2000) *whole document*	2, 4
X Y	US6164348 (Rodwell et al.) 26 December 2000 (26-12-2000) *whole document*	16

☑ 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
"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
26 May 2015 (26-05-2015)

Date of mailing of the international search report
02 June 2015 (02-06-2015)

Name and mailing address of the ISA/CA
Canadian Intellectual Property Office
Place du Portage I, C114 - 1st Floor, Box PCT
50 Victoria Street
Gatineau, Quebec K1A 0C9
Facsimile No.: 001-819-953-2476

Authorized officer

Jarret Diggins (819) 953-1611

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US6539970, (Knowles et al.) 01 April 2003 (01-04-2003) *whole document*	19, 30
A	US6296228B1,(Knowles et al.), 02 October 2001 (02-10-2001) *whole document*	19, 22-32
A	US6250603B1, (Knowles et al.) 26 June 2001 (26-06-2001) *whole document*	19, 22-32
A	US5967204A, (Ferris et al.) 19 October 1999 (19-10-1999) *whole document*	1-32
A	US5056563A, (Glossop) 15 October 1991 (15-10-1991) *whole document*	19
A	US5975151A, (Packo) 02 November 1999 (02-11-1999) *whole document*	22-32
A	US2002124578A1, (Ferris et al.) 12 September 2002 (12-09-2002) *whole document*	1-21
A	US6186197B1, (Trigiani) 13 February 2001 (13-02-2001) *whole document*	1-32

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CA2015/050190

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of the first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claim Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claim Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claim Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

Group 1 (claims 1-21) Independent claims 7, 15 and 17 are directed towards a device and method for introducing a reactive fluid into a refrigeration system comprising a syringe barrel and plunger, and a separate connector for connecting to a second end of the barrel to facilitate injection of the fluid into a port of the refrigeration or air conditioning device; and

Group 2 (claims 22-32) Independent claims 22 and 30 are directed towards a device and method of introducing a reactive fluid into a refrigeration system comprising a fluid container relying on a pressure differential created by the system to assist discharge of the fluid; and

Group 3 (claim 33) Independent claim 33 is directed towards a device for introducing a fluid into a refrigeration system comprising a fluid container having a first valve fitting at one end of the container, and a second valve fitting at an opposite end of the container, the first and second valve fitting each being configured for attachment to a different size or type of port of a refrigeration or air conditioning system.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☑ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claim Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant=s protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

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