(19) IPOS INTELLECTUAL PROPERTY OFFICE OF SINGAPORE

(11) Publication number: **SG 194254 A1**
(43) Publication date: **29.11.2013**
(51) Int. Cl: ;

(12) Patent Application

(21) Application number: **2012030052**
(22) Date of filing: **24.04.2012**

(71) Applicant: **HISOTECH PTE LTD. BLOCK 50, SERANGOON NORTH AVENUE 4, #09-16, FIRST CENTRE, SINGAPORE 555856 SG SG**

(72) Inventor: **CHIA, QING LONG CLEMENT 520 SERANGOON NORTH AVENUE 4, #06-176, SINGAPORE 550520 SG**
CHIA, KOON HING JEFFREY 520 SERANGOON NORTH AVENUE 4, #06-176, SINGAPORE 550520 SG

(54) **Title:**
AUTO BALL CHECK NON RETURN VALVE FOR SENSOR INSERTION IN CHILLED WATER SYSTEMS

(57) **Abstract:**
AUTO BALL CHECK NON RETURN VALVE FOR SENSOR INSERTION IN CHILLED WATER SYSTEMS ABSTRACT Embodiments of the invention provide an assembly configured to be fitted onto a wall of a pipe of an HVAC system, for inserting and removing a sensor probe, such that the probe is in direct contact with a fluid in the pipe. The assembly includes a central bore, and a thermowell configured to have an open end within the pipe, such that when the probe is inserted through the central bore, an end of the probe extends from the open end of the thermowell and is in direct contact with the fluid in the pipe. The assembly also includes 0-rings arranged along the central bore, and a ball bearing adapter valve including a groove and a ball bearing, wherein the groove is arranged along the central bore such that the ball bearing may be moved into a position within the groove that permits the sensor probe to pass through the central bore when the probe is inserted, and automatically move back into a position blocking the central bore when the probe is withdrawn. (FIG. 1)

AUTO BALL CHECK NON RETURN VALVE FOR SENSOR INSERTION IN CHILLED WATER SYSTEMS

FIELD OF THE INVENTION

[0001] Embodiments of the invention relate a non-leak valve assembly for inserting and removing temperature sensors in building chilled water heating, ventilation, and air conditioning (HVAC) systems, and other similar applications.

BACKGROUND OF THE INVENTION

[0002] Temperature sensors in chilled water systems and other HVAC systems have typically been inserted using thermal wells, which form an environment sealed off from the liquid in the pipes that are being monitored, into which temperature sensors can be placed. These "thermowells" have heat transfer characteristics that permit the temperature sensor to obtain a reasonably accurate measurement of the temperature of the fluid that surrounds the thermo well, without coming into contact with the fluid in the pipe, or providing an opening through which such fluid could leak.

[0003] At present, building authorities, including the Building and Construction Authority of Singapore (BCA) are promulgating new requirements that require that the temperature sensors in a chilled water system be in direct contact with the medium in the pipe. This will provide for more accurate measurement of the temperature of the fluid in a chilled water system, but will also make it more difficult to insert and remove temperature sensors, e.g., for calibration and maintenance, without pressurised fluid from the pipes leaking. Leakage in such systems could cause serious water-based damage to the surrounding areas, which often contain a variety of expensive industrial equipment that could be damaged by leakage. Worse, temperature sensors in chilled water systems are often installed in areas where high voltage equipment may be nearby, so leakage may pose a serious safety risk.

[0004] To address the requirement that the sensor be in direct contact with the fluid, some have attempted to use a pipe compressed fitting that is normally used in conjunction with measurement of pressure, by inserting a 3mm needle-like protuberance used by pressure sensors. By using this same 3mm compressed fitting insertion opening for temperature sensors, the temperature sensor is restricted to 3mm or less. These 3mm temperature sensors are relatively fragile, and have a high rate of failure due to the nature of their manufacture and the demanding conditions in which they are installed. If these sensors are physically damaged, it can be extremely difficult to remove the sensor without also damaging the compressed fitting, possibly resulting in leaks or worse.

[0005] Other attempts to address the requirements have relied on a series of O-rings to prevent leakage when the sensor is inserted. While using a series of O-rings is proven technology, there is no way to ensure that the sensor will stay in position during high pressure operations. Such systems also do not close the water outlet should the sensor pop out of the fitting, e.g., under such high pressure operations. Installation and removal of the sensor from a fitting relying only on a series of O-rings also poses significant risk to the installer and to the surrounding high-cost equipment.

SUMMARY OF THE INVENTION

[0006] In accordance with embodiments of the invention, an assembly that can be fitted to a wall of a pipe of an HVAC system is provided that permits a robust temperature sensor probe to be inserted into the pipe and withdrawn from the pipe, such that at least a part of the sensor probe is in direct contact with the fluid or medium in the pipe, while providing only minimal risk of leakage. Use of such an assembly may provide compliance with requirements that the sensor probe be in contact with the fluid or medium in the pipe, a higher mean time between failure of the sensor due to an ability to use more robust sensor probes than in previously known systems, minimal or no leakage, reduction of human error that may lead to

leakage during insertion and/or removal of the sensor probe, and relatively easy replacement of faulty sensors.

[0007] This is achieved in accordance with some embodiments of the invention using an assembly configured to be fitted onto a wall of a pipe of an HVAC system, for inserting and removing a sensor probe, such as a temperature sensor probe, such that at least a part of the sensor probe is in direct contact with a fluid in the pipe. The assembly includes a central bore passing through components of the assembly, the central bore configured for the sensor probe to be inserted through the central bore. The assembly further includes a thermowell having an open end, configured such that when the sensor probe is inserted through the thermowell, a distal end of the sensor probe is in contact with a fluid in the pipe. Numerous O-rings are arranged along the central bore of the assembly, the O-rings configured to hold back pressure from the fluid in the pipe and to prevent leakage when the sensor probe is inserted through the plurality of O-rings. The assembly also includes a ball bearing adapter valve, including a groove and a ball bearing, wherein the ball bearing has a size that permits it to block the central bore, and wherein the groove is arranged along the central bore such that the ball bearing may be moved within the groove. The ball bearing adapter valve is configured such that the ball bearing is pushed into a position within the groove that permits the sensor probe to pass through the central bore when the sensor probe is inserted, and automatically moves into a position within the groove to block the central bore to prevent leakage when the sensor probe is removed. In some embodiments, the assembly also includes a compression fitting configured to be tightened around the sensor probe when the sensor probe is inserted, to hold the sensor probe in place and to prevent leakage.

[0008] In some embodiments, the assembly includes a manual valve that can be closed to prevent leakage when the sensor probe is removed from the assembly. In some embodiments, the assembly also includes a hot-tap adapter, configured to prevent leakage when the assembly is installed on a live running HVAC system.

[0009] In some embodiments, the ball bearing adapter valve includes a retainer screw that is configured to be tightened and loosened, such that when the sensor probe is inserted, tightening the retainer screw assists in holding the sensor probe in

place. During removal of the sensor probe, loosening the retainer screw helps to create a pressure differential that causes the ball bearing to block the central bore.

[0010] In some embodiments, the ball bearing adapter valve includes two of the plurality of O-rings, one of which is disposed in the central bore at a position above the groove, and one of which is disposed in the central bore at a position below the groove. In some embodiments, the assembly further includes a connection fitting, and two of the O-rings are disposed in the central bore within the connection fitting.

[0011] It should be noted that as used herein, the terms "above" and "proximal" refer to a direction or position towards the compression fitting end of the assembly. The terms "below" and "distal" refer to a direction or position towards the thermowell end of the assembly, within the pipe.

[0012] In another embodiment of the invention, a ball bearing adapter valve is provided for use in an assembly configured to be fitted onto a wall of a pipe of an HVAC system, for inserting and removing a sensor probe. The ball bearing adapter valve includes a central bore passing through the ball bearing adapter valve, the central bore configured for the sensor probe to be inserted through the central bore. A ball bearing is disposed within a widened groove portion of the central bore, the ball bearing having a size that permits it to block the central bore. The groove is arranged along the central bore such that the ball bearing may be moved aside into a position within the groove to permit the sensor probe to be inserted through the central bore. The ball bearing adapter valve also includes a position for receiving an O-ring disposed in the central bore at a position above the groove.

[0013] In some such embodiments, the ball bearing adapter valve further includes a retainer screw disposed above the groove. The retainer screw is configured to be tightened and loosened, such that when the sensor probe is inserted, tightening the retainer screw assists in holding the sensor probe in place, and during removal of the sensor probe, loosening the retainer screw helps to create a pressure differential that causes the ball bearing to block the central bore.

[0014] A further embodiment of the invention provides a method of inserting a sensor probe through a wall of a pipe of an HVAC system, such that at least a part of the sensor probe is in direct contact with a fluid in the pipe. The method includes

providing an assembly fitted on the wall of the pipe, the assembly including a central bore passing through components of the assembly, a thermowell disposed at a distal end of the assembly, the thermowell protruding through the wall of the pipe and having an open end within the pipe, numerous O-rings arranged along the central bore of the assembly, and a ball bearing adapter valve including a groove and a ball bearing, wherein the ball bearing has a size that permits it to block the central bore, and wherein the groove is arranged along the central bore such that the ball bearing may be moved within the groove. The sensor probe is inserted into the central bore and advanced through the central bore, and through an O-ring of the ball bearing adapter valve, to reach the ball bearing in the ball bearing adapter valve. The method further includes advancing the sensor probe to push the ball bearing of the ball bearing adapter valve into a position within the groove of the ball bearing adapter valve, so that the sensor probe can continue to be advanced along the central bore of the assembly. The sensor probe is advanced through the central bore of the assembly through additional O-rings, such that the O-rings hold back pressure from the fluid in the pipe and prevent leakage. The sensor probe is advanced through the central bore of the thermowell, so that a distal end of the sensor probe extends from the open end of the thermowell and is in direct contact with the fluid in the pipe.

[0015] In some embodiments, providing an assembly includes providing an assembly having a compression fitting, and the method further includes loosening the compression fitting to an extent that the sensor probe may be inserted into the central bore without substantial leakage around the sensor probe. Once the sensor probe is in place, the method further includes tightening the compression fitting around the sensor probe, to assist in holding the sensor probe in place and preventing leaks.

[0016] In some embodiments, the assembly further includes a manual valve, and the method further includes opening the manual valve prior to advancing the sensor probe through the manual valve. In some embodiments, the ball bearing adapter valve further includes a retainer screw, and the method further includes loosening the retainer screw prior to advancing the sensor probe through the ball bearing adapter valve. In some embodiments, the method further includes tightening the retainer

screw to assist in holding the sensor probe in place. In some embodiments, the sensor probe includes a temperature sensor probe.

[0017] In a further embodiment, a method of safely withdrawing a sensor probe from being in direct contact with a fluid in a pipe of an HVAC system is provided. The method includes providing an assembly fitted on a wall of the pipe, the assembly including a central bore passing through components of the assembly, a thermowell disposed at a distal end of the assembly, the thermowell protruding through the wall of the pipe and having an open end within the pipe, a plurality of O-rings arranged along the central bore of the assembly, and a ball bearing adapter valve including a groove and a ball bearing, wherein the ball bearing has a size that permits it to block the central bore, and wherein the groove is arranged along the central bore such that the ball bearing may be moved within the groove, wherein the sensor probe is inserted through the central bore of the pipe such that a distal end of the sensor probe protrudes from the open end of the thermowell and is in direct contact with fluid in the pipe. The method further includes withdrawing the sensor probe past one or more O-rings and past the groove of the ball bearing adapter valve. The method also includes creating a pressure differential to cause the ball bearing of the ball bearing adapter valve to move within the groove of the ball bearing adapter valve into a position in which the ball bearing blocks the central bore, preventing leakage. Finally, the sensor probe is withdrawn from the assembly.

[0018] In some embodiments, providing an assembly includes providing an assembly having a compression fitting, and the method further includes loosening the compression fitting enough to permit the sensor probe to be withdrawn without permitting substantial leakage around the sensor probe. In some such embodiments, the method further includes tightening the compression fitting after the sensor probe has been withdrawn from the assembly.

[0019] In some embodiments, the assembly further includes a manual valve, and the method further includes closing the manual valve when the sensor probe is withdrawn from the assembly. In some embodiments, the ball bearing adapter valve further includes a retainer screw, and the method further includes loosening the retainer screw to permit the sensor probe to be withdrawn and to assist in the creation

of the pressure differential. In some embodiments, the sensor probe includes a temperature sensor probe.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] In the drawings, like reference characters generally refer to the same parts throughout the different views. The drawings are not necessarily to scale, emphasis instead generally being placed upon illustrating the principles of the invention. In the following description, various embodiments of the invention are described with reference to the following drawings, in which:

[0021] **FIG. 1** shows an assembly with a sensor probe, such as a temperature sensor probe, inserted in accordance with an embodiment of the invention;

[0022] **FIG. 2** shows a detail view of the ball check valve used in accordance with an embodiment of the invention;

[0023] **FIG. 3** shows an assembly in accordance with an embodiment of the invention connected to a pipe using a hot tap adapter; and

[0024] **FIGs 4A and 4B** show outlines of methods for inserting and removing a sensor probe, such as a temperature sensor probe, in accordance with embodiments of the invention.

DESCRIPTION

[0025] In accordance with an example embodiment of the invention, an assembly is provided that attaches to a pipe in an HVAC system, and permits the safe insertion and removal of a sensor probe, such as a temperature sensor probe, such that the sensor probe is in direct contact with the fluid in the pipe, and that there is little or no risk of leakage during insertion or removal of the temperature sensor. An overview of the assembly 100, with a temperature sensor probe 102 inserted and in contact with the fluid in the pipe, is show in in FIG. 1. While a temperature sensor probe is used in the example embodiments, it will be understood that other types of sensor probes could be used instead of a temperature sensor probe. As can be seen, the assembly 100 includes an open-ended thermowell 106 that projects through the pipe

wall 104, permitting a distal end 101 of the sensor probe 102 to be in direct contact with the fluid in the pipe. On the outer side of the pipe wall 104, the assembly 100 is connected to the pipe wall 104 by a flange 108. The thermowell 106 is connected to the assembly 100 by a thermowell head 110, which in turn is connected to a connection fitting 112 which includes first and second O-rings 114a and 114b. The connection fitting 112 is connected to a manual valve 116. A ball-bearing adapter valve 118 connects to the manual valve 116, and includes third and fourth O-rings 114c and 114d, as well as a retainer screw 120, for pressure release control. Finally, a compression fitting 122 is connected to the ball-bearing adapter valve 118. Sensor wires 124 connect to a proximal end 103 of the sensor probe 102, in order to convey electrical signals from the sensor probe 102 to equipment (not shown) that monitors the temperature of the fluid in the pipe. Each of these components of the assembly 100 will be described in greater detail below.

[0026] The temperature sensor probe 102 may be a standard platinum resistance thermometer probe, of a commonly commercially available type. Such temperature sensor probes are generally available in a variety of lengths and diameters. In some embodiments, a temperature sensor probe having the standard diameter of 6mm may be used, in order to provide adequate durability in high pressure environments. As noted above, other types of probes, including pressure sensor probes, chemical sensors, and most any other type of sensor probe that should be in direct contact with the fluid or medium in a pipe may be used.

[0027] Within the pipe, a distal end 101 of the temperature sensor probe 102 emerges from an end of the thermowell 106, and is in direct contact with the fluid in the pipe. Unlike conventional thermowells, which are designed to completely surround a temperature sensor, preventing it from directly contacting the fluid in the pipe, the thermowell 106 has no end portion, and allows the distal end 101 of the temperature sensor probe 102 to be in direct contact with the fluid or medium in the pipe. Of course, when the temperature sensor probe 102 is removed, this opening will allow pressurised fluid in the pipe to flow through the thermowell 106 and in to

the rest of the system, which therefore needs to be configured to prevent leakage of the fluid.

[0028] The thermowell 106 is connected to the thermowell head 110, which is fitted to the flange 108. The flange 108 may be connected to an outer surface of the pipe wall 104, for example, by welding. In some embodiments, the flange 108 may include a female screw threaded portion into which a male screw threaded portion of the thermowell head 110 is threaded. The thermowell head 110 may also include a female screw threaded portion into which a male screw threaded portion of the connection fitting 112 is connected, such that a central bore of the thermowell 106 and thermowell head 110 (through which the temperature sensor probe 102 passes) is aligned with a central bore of the connection fitting 112.

[0029] The connection fitting 112 includes the first and second O-rings 114a and 114b, which hold back the pressure in the pipeline when the temperature sensor probe 102 is in place, and also help to hold the temperature sensor probe 102 in position. The connection fitting 112 may include a second male threaded portion that is used to connect the connection fitting 112 to a corresponding female threaded portion of the manual valve 116, such that the central bore of the connection fitting 112 is aligned with a central bore of the manual valve 116.

[0030] The manual valve 116 is included as a safeguard should any parts of the assembly 100 that are above the manual valve (i.e., the ball bearing adapter valve 118 or compression fitting 122) need to be replaced. The temperature sensor probe 102 can be withdrawn safely and the manual valve 116 can be shut off for maintenance purposes, without any system interruption of the HVAC system, and without any substantial risk of leakage through the assembly 100. The manual valve 116 may include a second female threaded portion into which a threaded male portion of the ball-bearing adapter valve 118 (or an optional second threaded connection fitting (not shown – see below)) may be threaded, such that a central bore of the manual valve 116 is aligned with a central bore of the ball-bearing adapter valve 118.

[0031] The ball-bearing adapter valve 118, which will be described in greater detail below, includes a retainer screw 120, an interior ball bearing, and a groove in the central bore of the ball bearing adapter valve 118, such that when the temperature sensor probe 102 is inserted through the central bore, the ball-bearing is pushed within the groove into a position that permits the temperature sensor probe 102 to pass through the central bore, and when the temperature sensor probe is withdrawn, pressure automatically causes the ball bearing to move within the groove to a position to block a portion of the central bore, preventing the fluid or medium from flowing past the ball bearing adapter valve 118. The retainer screw 120 is used both to retain the temperature sensor probe 102 in place, and to provide for controllable pressure release, to assist in creating a pressure differential so that the ball bearing will automatically block the central bore of the ball bearing adapter valve 118.

[0032] The ball bearing adapter valve also includes third and fourth O-rings, which serve the purpose of negating pressure and of holding the temperature sensor probe 102 in place. In some embodiments, one or both of the third and fourth O-rings may be within threaded connection fittings (not shown) that may be threaded or welded to the ball bearing adapter valve – one such fitting optionally being threaded or welded between the manual valve 116 and the ball bearing adapter valve 118, and a second such fitting optionally being threaded or welded between the ball bearing adapter valve 118 and the compression fitting 122.

[0033] The ball bearing adapter valve 118 may include a female threaded portion that is connected to a male threaded portion of the compression fitting 122, such that the central bore of the ball bearing adapter valve 118 is aligned with a central bore of the compression fitting 122. Alternatively, this female threaded portion may be part of a threaded connection fitting that is threaded or welded to the ball bearing adapter valve.

[0034] The compression fitting 122, which may be an adjustable screw-tight compression fitting with a rubber ferrule, carries the last line of defence against any possible leakage through the central bore of the assembly 100. The compression

fitting 122 may also be tightened to hold the temperature sensor probe 102 in place, and tightened or loosened to control the amount of friction applied when removing the temperature sensor probe 122 in a safe manner. It will be understood that the compression fitting is optional, and may be omitted in some embodiments.

[0035] Referring now to FIG. 2, the ball bearing adapter valve 118 is described in greater detail. FIG. 2 shows a cross-sectional view of the ball bearing adapter valve 118, including a first threaded portion 202, a second threaded portion 204, a central bore 206 with a groove 208, a retainer screw 210, O-rings 212a and 212b, and a ball bearing 214.

[0036] The first threaded portion 202 is used for connecting the ball bearing adapter valve to the manual valve 116, as shown and discussed above with reference to FIG. 1. In some embodiments, the first threaded portion may be a separate threaded connection fitting that is welded or threaded (not shown) onto the rest of the ball bearing adapter valve 118. The central bore 206 in the first threaded portion 202 includes the O-ring 212a, which serves to reduce pressure and to hold the temperature sensor probe in place.

[0037] The second threaded portion 204 is used for connecting the ball bearing adapter valve to the compression fitting 122, as shown and described above with reference to FIG. 1. In some embodiments, the second threaded portion 202 may be a separate threaded connection fitting that is welded or threaded (not shown) onto the rest of the ball bearing adapter valve 118. The O-ring 212b, which serves to reduce pressure and to hold the temperature sensor probe in place, may be within the bore either in or near the second threaded portion 204. It will be understood that the O-rings 212a and 212b may be replaceable or may be sold separately from the rest of the ball bearing adapter valve 118, such that prior to installation of the O-rings, there are positions for receiving an O-ring where the O-rings 212a and 212b are indicated in FIG. 2.

[0038] The central bore 206 has a diameter sufficient to permit the temperature sensor probe that is used with the system to be inserted through the bore 206. The

diameter of the bore 206 and the size of the ball bearing 214 are configured such that the ball bearing 214 can block the bore 206, but is unable to fit through the bore 206. In a central portion of the ball bearing adapter valve, the bore 206 widens into a groove 208, which is configured to be large enough to hold the ball bearing 214 when the temperature sensor probe is inserted through the ball bearing adapter valve 118. In some embodiments, the groove 208 may include sides that are slanted to permit the ball bearing to easily move into position blocking a portion of the bore 206 that is nearest the retainer screw 210 and the second threaded portion 204 when the temperature sensor probe 102 is removed.

[0039] As indicated above, the ball bearing 214 is configured to have a diameter that permits it to block the central bore 206, and to fit within the groove 208 of the ball bearing adapter valve. The ball bearing 214 permits the temperature sensor probe to be inserted through the ball bearing adapter valve, and serves to automatically prevent leakage when the temperature sensor probe is withdrawn. In some embodiments, the ball bearing may be formed of plastic, nylon, metal, or other suitable materials.

[0040] The retainer screw 210 may be tightened and loosened, and is used to retain the temperature sensor probe in place. The retainer screw 210 may also be used to help in creating a controllable pressure release, creating a pressure differential when the temperature sensor probe is being withdrawn, so that the ball bearing will automatically block the bore 206, preventing leaks when withdrawing the temperature sensor probe. Of course, when the temperature sensor probe is completely withdrawn, e.g. unintentionally or by accident, a pressure differential will be produced without operation of the retainer screw 210 once the temperature sensor probe is no longer present, causing the ball bearing to automatically block the bore 206, and preventing any further leakage. Thus, in some embodiments, the retainer screw may be omitted, which may lead to a small (but acceptable) amount of leakage before the ball bearing blocks the bore.

[0041] In operation, when the temperature sensor probe is inserted, it pushes the ball bearing 214 out of a position in which the ball bearing 214 is blocking the bore 206 and into a position within the groove 208 that permits the temperature sensor probe to pass through the central bore. Once the temperature sensor probe is in place, the retainer screw 210 (when present) may be tightened to help hold the temperature sensor probe in place. When the temperature sensor probe is withdrawn, the retainer screw 210 (when present) may be loosened, which makes it easier to withdraw the temperature sensor probe, and helps to create a pressure differential that causes the ball bearing 214 to move within the groove 208 into a position in which it blocks the bore 206, once the temperature sensor probe is withdrawn past the retainer screw 210. This prevents leakage when the temperature sensor probe is withdrawn.

[0042] FIG. 3 shows an assembly 300 with a temperature sensor probe 302 inserted, in accordance with a second embodiment of the invention. The assembly 300 includes a hot-tap adapter 305, which is used when installing the assembly 300, to permit the assembly 300 to be installed without substantial leakage when the HVAC system is operating. As in the embodiment of FIG 1, which is generally installed when the HVAC system is installed or is not in operation, the assembly 300 includes an open-ended thermowell 306 that projects through the pipe wall 304, permitting a distal end 301 of the temperature sensor probe 302 to be in direct contact with the fluid in the pipe. On the outer side of the pipe wall 304, the assembly 300 is connected to the pipe wall 304 by a flange 308 and by the hot-tap adapter 305. The thermowell 306 is connected to the assembly 300 by a thermowell head 310, which in turn is connected to a connection fitting 312 that includes first and second O-rings 314a and 314b. The connection fitting 312 is connected to a manual valve 316. A ball-bearing adapter valve 318 connects to the manual valve 316, and includes third and fourth O-rings 314c and 314d, as well as a retainer screw 320, for pressure release control. Finally, a compression fitting 322 is connected to the ball-bearing adapter valve 318. Sensor wires 324 connect to a proximal end 303 of the sensor probe 302, in order to convey electrical signals from the sensor probe 302 to equipment (not shown) that monitors the temperature of the fluid in the pipe.

The various components of the adapter 300 are similar to those of the adapter 100 as described with reference to FIG. 1, with the exception of the hot-tap adapter 305, which permits the assembly 300 to be installed while the system is operating, and is described in greater detail below. It should also be noted that because of the extra length of the hot-tap adapter, a longer thermowell 306 and temperature sensor probe 302 should be used with the assembly 300, to permit the distal end 301 of the temperature sensor probe 302 to extend from the thermowell into direct contact with the fluid or medium in the pipe.

[0043] The hot-tap adapter 305 includes a male threaded portion that connects to the flange 308, and a female threaded portion into which the thermowell head 310 is threaded. A central bore of the hot-tap adapter 305 has a diameter configured to permit the open-ended thermowell 306 to pass through the hot-tap adapter for insertion through the flange 308 and the pipe wall 304. O-rings (not shown) and an isolation valve (not shown) are typically used in the hot-tap adapter 305 to prevent leakage during installation.

[0044] During installation, the flange 308 is welded to the outer surface of the pipe wall 304, and the hot-tap adapter is installed on the flange 308. A drilling unit (not shown) is typically installed on the hot-tap adapter 305, and the isolation valve of the hot-tap adapter 305 is opened to permit drilling through the pipe wall 304, to create an opening in the pipe wall 304 that is large enough to permit the thermowell 306 to be inserted through the hot-tap adapter 305, the flange 308, and the pipe wall 304. The drilling unit is then withdrawn, and the isolation valve is closed, to prevent leakage once the drilling unit is removed. Next, the thermowell 306 is installed into the top of the hot-tap adapter 305, and the isolation valve is opened to permit the thermowell 306 to be inserted through the hot-tap adapter 305, the flange 308, and the pipe wall 304, while O-rings (not shown) in the hot-tap adapter prevent significant leakage during the insertion operation. Preferably, when the thermowell 306 is installed, the connection fitting 312 and manual valve 316 are already installed on the thermowell head 310, so that the manual valve 316 can be used to

prevent leakage until the ball bearing adapter valve and other parts of the assembly 300 can be installed.

[0045] Thus, use of the hot-tap adapter 305 permits the assembly 300 to be used in retrofit applications, allowing the assembly 300 to be installed on a live running HVAC system without the need for costly shutdown. The operation and design of hot-tap adapters, such as the hot-tap adapter 305, are known in the art, and a suitable hot-tap adapter for use with the assembly 300 may be assembled from readily available components.

[0046] Referring now to FIGs. 4A and 4B, methods are described for inserting and removing a temperature sensor probe from a pipe of an HVAC system, such that the probe is in direct contact with the fluid or medium in the pipe, using an assembly as described above with reference to FIGs. 1 and 3.

[0047] FIG. 4A shows the outline of a method 400 for inserting a temperature sensor probe. In step 402, the manual valve is opened. Once the manual valve is opened, fluid from the pipe may enter the system as far as the ball bearing adapter valve, where the ball bearing will prevent substantial leakage.

[0048] At step 404, the compression fitting (if it is present) is loosened enough to permit the temperature sensor probe to be inserted but preferably not so much as to allow substantial leakage to occur around the temperature sensor probe. At step 406, the retainer screw of the ball bearing adapter valve (if it is present) is loosened, to make it easier for the temperature sensor probe to be inserted.

[0049] At step 408, the temperature sensor probe is inserted into the bore at the compression fitting or (if the compression fitting has been omitted) at the ball bearing adapter valve. The temperature sensor probe is advanced through the central bore, and through an O-ring of the ball bearing adapter valve, to reach the ball bearing in the ball bearing adapter valve.

[0050] At step 410, the temperature sensor probe pushes the ball bearing in the ball bearing adapter valve within the groove into a position that permits the

temperature sensor probe to pass through the central bore, and is inserted through the ball bearing adapter valve, including through another O-ring of the ball bearing adapter valve. Once the temperature sensor probe pushes the ball bearing aside within the groove, then the O-rings, the compression fitting (if present), and the temperature sensor probe itself are primarily responsible for prevention of leakage.

[0051] At step 412, the temperature sensor probe is advanced through the manual valve, and through the additional O-rings of the connection fitting. At step 414, the temperature sensor probe is advanced through the thermowell, so that a distal end of the temperature sensor probe extends from the open end of the thermowell, and is in direct contact with the fluid or medium in the pipe.

[0052] At step 416, the retainer screw (if present) is tightened, to help hold the temperature sensor probe in place. At step 418, the compression fitting (if present) is tightened around the temperature sensor probe, to further assist in holding the temperature sensor in place, and to assist in preventing leaks, as described above.

[0053] FIG. 4B shows a method 450 for safely withdrawing the temperature sensor from being in direct contact with the fluid or medium in the pipe of an HVAC system using an assembly such as is described above with reference to FIGs. 1 and 3.

[0054] In step 452, the compression fitting (if present) is loosened enough to permit the temperature sensor probe to be removed, but preferably not so much as to allow substantial leakage to occur around the temperature sensor probe.

[0055] In step 454, the retainer screw of the ball bearing adapter valve (if present) is loosened enough to permit the temperature sensor probe to be removed, and to assist in creating a pressure differential that will cause the ball bearing in the ball bearing adapter vale to automatically block the valve when the temperature sensor probe is removed, as described above.

[0056] In step 456, the temperature sensor probe is withdrawn past several O-rings, and past the retainer screw in the ball bearing adapter valve. In step 458, a pressure differential, which may be due in part to loosening the retainer screw in the

ball bearing adapter valve, causes the ball bearing in the ball bearing adapter valve to move into a position within the groove in which it blocks the central bore of the valve, preventing leakage.

[0057] In step 460, the temperature sensor probe is withdrawn completely from the assembly. In step 462, the manual valve is closed, to prevent leakage beyond the manual valve, and the compression fitting (if present) is optionally tightened to further prevent any leakage from the assembly.

[0058] While the invention has been particularly shown and described with reference to specific embodiments, it should be understood by those skilled in the art that various changes in form and detail may be made therein without departing from the spirit and scope of the invention as defined by the appended claims. For example, while many of the embodiments are described in terms of inserting a temperature sensor probe, as has been noted above, other types of sensor probes that may be in direct contact with a fluid or medium in a pipe may also be used. The scope of the invention is thus indicated by the appended claims and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced.

CLAIMS

What is claimed is:

1. An assembly (100, 300) configured to be fitted onto a wall (104, 304) of a pipe of an HVAC system, for inserting and removing a sensor probe (102, 302), such that at least a part of the sensor probe (102, 302) is in direct contact with a fluid in the pipe, the assembly comprising:

a central bore passing through components of the assembly, the central bore configured for the temperature sensor probe (102, 302) to be inserted through the central bore;

a thermowell (106, 306) having an open end, configured such that when the sensor probe (102, 302) is inserted through the thermowell (106, 306), a distal end (101, 301) of the sensor probe (102, 302) is in contact with a fluid in the pipe,

a plurality of O-rings (114a-d, 314a-d) arranged along the central bore of the assembly, the plurality of O-rings (114a-d, 314a-d) configured to hold back pressure from the fluid in the pipe and to prevent leakage when the sensor probe (102, 302) is inserted through the plurality of O-rings (114a-d, 314a-d),

a ball bearing adapter valve (118, 318) comprising a groove (208) and a ball bearing (214), wherein the ball bearing (214) has a size that permits it to block the central bore, and wherein the groove (208) is arranged along the central bore such that the ball bearing (214) may be moved within the groove (208), the ball bearing adapter valve (118, 318) configured such that the ball bearing (214) is pushed into a position within the groove (208) that permits passage of the sensor probe (102, 302) when the sensor probe (102, 302) is inserted, and automatically moves into a position within the groove (208) to block the central bore to prevent leakage when the sensor probe (102, 302) is removed.

2. The assembly of claim 1, further comprising a compression fitting (122) configured to be tightened around the sensor probe (102, 302) when the sensor probe (102, 302) is inserted, to hold the sensor probe (102, 302) in place and to prevent leakage.

3. The assembly of claim 1 or claim 2, further comprising a manual valve (116) that can be closed when the sensor probe (102, 302) is removed from the assembly to prevent leakage.

4. The assembly of any of the preceding claims, further comprising a hot-tap adapter (305), configured to prevent leakage when the assembly (300) is installed on a live running HVAC system.

5. The assembly of any of the preceding claims, wherein the ball bearing adapter valve (118, 318) further comprises a retainer screw (120, 210, 320) that is configured to be tightened and loosened, such that when the sensor probe (102, 302) is inserted, tightening the retainer screw (120, 210, 320) assists in holding the sensor probe (102, 302) in place, and during removal of the sensor probe (102, 302), loosening the retainer screw (120, 210, 320) helps to create a pressure differential that causes the ball bearing (214) to block the central bore.

6. The assembly of claim 5, wherein the ball bearing adapter valve (118, 318) includes two of the plurality of O-rings (114c, 114d, 212a, 212b, 314c, 314d), one of which is disposed in the central bore at a position above the groove (208), and one of which is disposed in the central bore at a position below the groove (208).

7. The assembly of any of the preceding claims, wherein the assembly further comprises a connection fitting (112), and wherein two of the plurality of O-rings (114a, 114b, 314a, 314b) are disposed in the central bore within the connection fitting (112).

8. A ball bearing adapter valve (118) for use in an assembly configured to be fitted onto a wall (104, 304) of a pipe of an HVAC system, for inserting and removing a sensor probe (102, 302), the ball bearing adapter valve (118) comprising:

a central bore (206) passing through the ball bearing adapter valve (118), the central bore (206) configured for the sensor probe (102, 302) to be inserted through the central bore (206);

a ball bearing (214) disposed within a widened groove portion (208) of the central bore (206), the ball bearing (214) having a size that permits it to block the central bore

(206), and the groove (208) arranged along the central bore (206) such that the ball bearing (214) may be moved aside into the groove (208) to permit the sensor probe (102, 302) to be inserted through the central bore (206); and

a position for receiving an O-ring (212b) disposed in the central bore (206) at a position above the groove (208).

9. The ball bearing adapter valve (118) of claim 8, further comprising a retainer screw (210) disposed above the groove (208), the retainer screw (210) configured to be tightened and loosened, such that when the sensor probe (102, 302) is inserted, tightening the retainer screw (210) assists in holding the sensor probe (102, 302) in place, and during removal of the sensor probe (102, 302), loosening the retainer screw (210) helps to create a pressure differential that causes the ball bearing (214) to block the central bore (206).

10. A method of inserting a sensor probe (102, 302) through a wall (104, 304) of a pipe of an HVAC system, such that at least a part of the sensor probe (102, 302) is in direct contact with a fluid in the pipe, the method comprising:

providing an assembly (100, 300) fitted on the wall (104, 304) of the pipe, the assembly comprising a central bore passing through components of the assembly, a thermowell (106, 306) disposed at a distal end of the assembly, the thermowell protruding through the wall of the pipe and having an open end within the pipe, a plurality of O-rings (114a-d, 314a-d) arranged along the central bore of the assembly, and a ball bearing adapter valve (118) comprising a groove (208) and a ball bearing (214), wherein the ball bearing (214) has a size that permits it to block the central bore, and wherein the groove (208) is arranged along the central bore such that the ball bearing (208) may be moved within the groove (208);

inserting the sensor probe (102, 302) into the central bore and advancing the sensor probe through the central bore, and through an O-ring (114d, 212b, 314d) of the ball bearing adapter valve, to reach the ball bearing (214) in the ball bearing adapter valve;

advancing the sensor probe (102, 302) to push the ball bearing (214) of the ball bearing adapter valve (118, 318) within the groove (208) of the ball bearing adapter valve

into a position permitting the sensor probe to pass through the central bore, so that the sensor probe can continue to be advanced along the central bore of the assembly;

advancing the sensor probe (102, 302) through the central bore of the assembly through additional O-rings (114a-c, 314a-c), such that the O-rings hold back pressure from the fluid in the pipe and prevent leakage; and

advancing the sensor probe (102, 302) through the central bore of the thermowell (106, 306), so that a distal end (101, 301) of the sensor probe extends from the open end of the thermowell and is in direct contact with the fluid in the pipe.

11. The method of claim 10, wherein providing an assembly comprises providing an assembly having a compression fitting (122, 322), and wherein the method further comprises:

loosening the compression fitting (122, 322) to an extent that the sensor probe (102, 302) may be inserted into the central bore without substantial leakage around the sensor probe; and

tightening the compression fitting (122, 322) around the sensor probe (102, 302), to assist in holding the sensor probe in place and preventing leaks.

12. The method of claim 10 or claim 11, wherein the assembly further comprises a manual valve (116, 316), and wherein the method further comprises opening the manual valve prior to advancing the sensor probe through the manual valve.

13. The method of any of claims 10 to 12, wherein the ball bearing adapter valve (118, 318) further comprises a retainer screw (120, 210, 320), and wherein the method further comprises loosening the retainer screw prior to advancing the sensor probe through the ball bearing adapter valve.

14. The method of claim 13, further comprising tightening the retainer screw (120, 210, 320) to assist in holding the sensor probe in place.

15. The method of any of claims 10 to 14, wherein the sensor probe is a temperature sensor probe.

16. A method of safely withdrawing a sensor probe (102, 302) from being in direct contact with a fluid in a pipe of an HVAC system, the method comprising:

providing an assembly (100, 300) fitted on a wall (104, 304) of the pipe, the assembly comprising a central bore passing through components of the assembly, a thermowell (106, 306) disposed at a distal end of the assembly, the thermowell protruding through the wall of the pipe and having an open end within the pipe, a plurality of O-rings (114a-d, 314a-d) arranged along the central bore of the assembly, and a ball bearing adapter valve (118, 318) comprising a groove (208) and a ball bearing (214), wherein the ball bearing has a size that permits it to block the central bore, and wherein the groove is arranged along the central bore such that the ball bearing may be moved within the groove, wherein the sensor probe is inserted through the central bore of the pipe such that a distal end (101, 301) of the sensor probe protrudes from the open end of the thermowell and is in direct contact with fluid in the pipe;

withdrawing the sensor probe past one or more O-rings (114a-c, 314a-c) and past the (208) of the ball bearing adapter valve (118, 318);

creating a pressure differential to cause the ball bearing (214) of the ball bearing adapter valve (118, 318) to move into a position within the groove (208) in which the ball bearing (214) blocks the central bore, preventing leakage; and

withdrawing the sensor probe (102, 302) from the assembly.

17. The method of claim 16, wherein providing an assembly comprises providing an assembly having a compression fitting (122, 322), and wherein the method further comprises loosening the compression fitting (122, 322) enough to permit the sensor probe (102, 302) to be withdrawn without permitting substantial leakage around the sensor probe.

18. The method of claim 17, further comprising tightening the compression fitting (122, 322) after the sensor probe has been withdrawn from the assembly.

19. The method of any of claims 16 to 18, wherein the assembly further comprises a manual valve (116, 316), and wherein the method further comprises closing the manual valve when the sensor probe is withdrawn from the assembly.

20. The method of any of claims 16 to 19, wherein the ball bearing adapter valve further comprises a retainer screw (120, 210, 320), and wherein the method further comprises loosening the retainer screw to permit the sensor probe to be withdrawn and to assist in the creation of the pressure differential.

21. The method of any of claims 16 to 20, wherein the sensor probe comprises a temperature sensor probe.

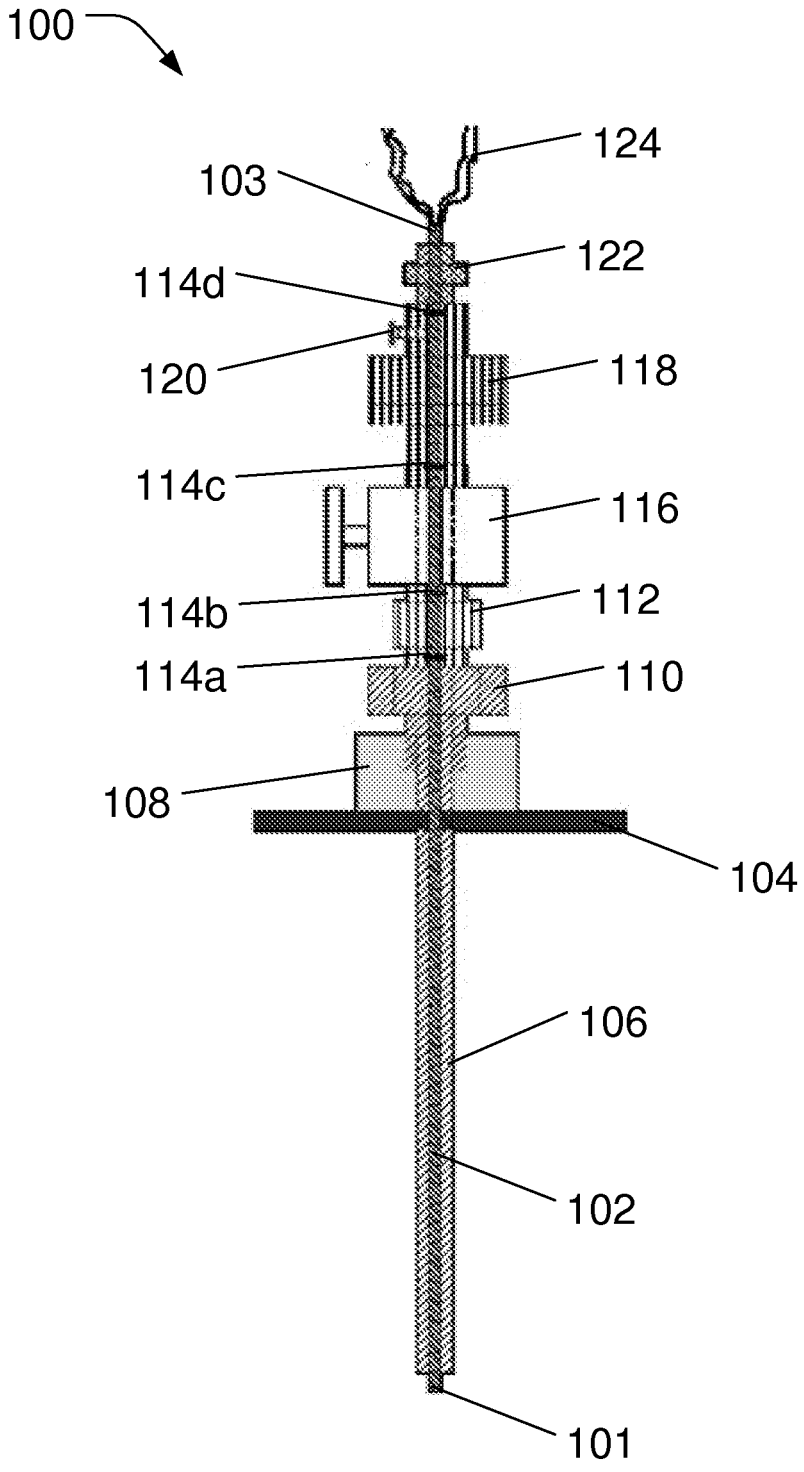
100
124
103
122
114d
120
118
114c
116
114b
112
114a
110
108
104
106
102
101

FIG. 1

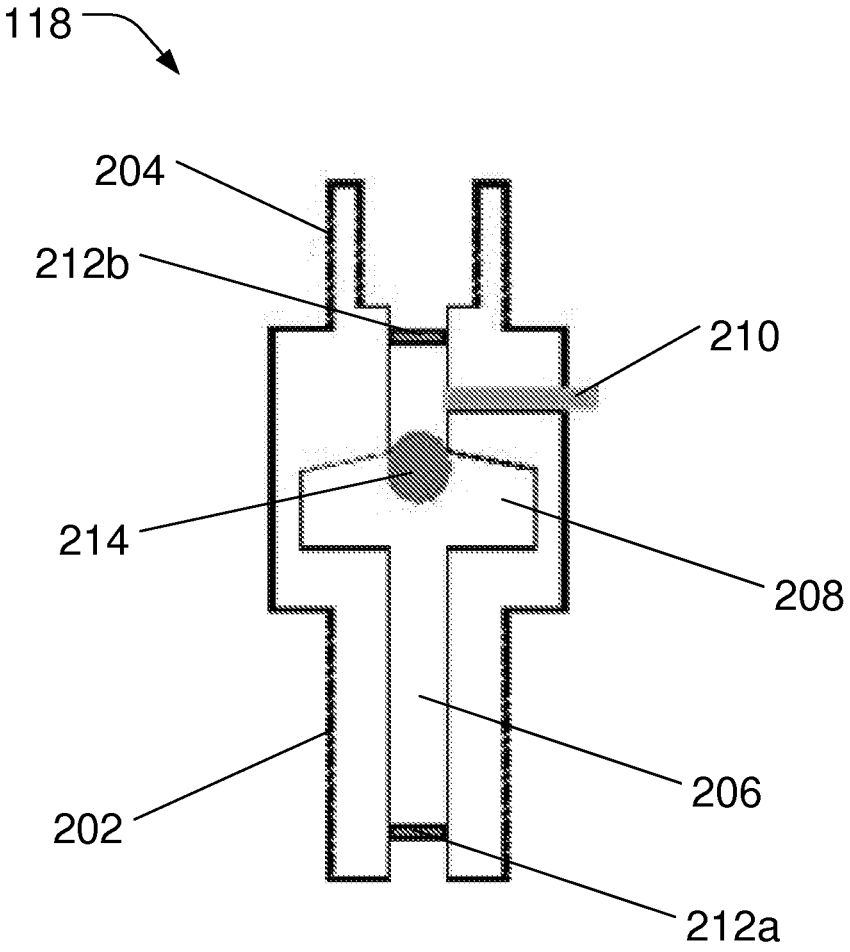

FIG. 2

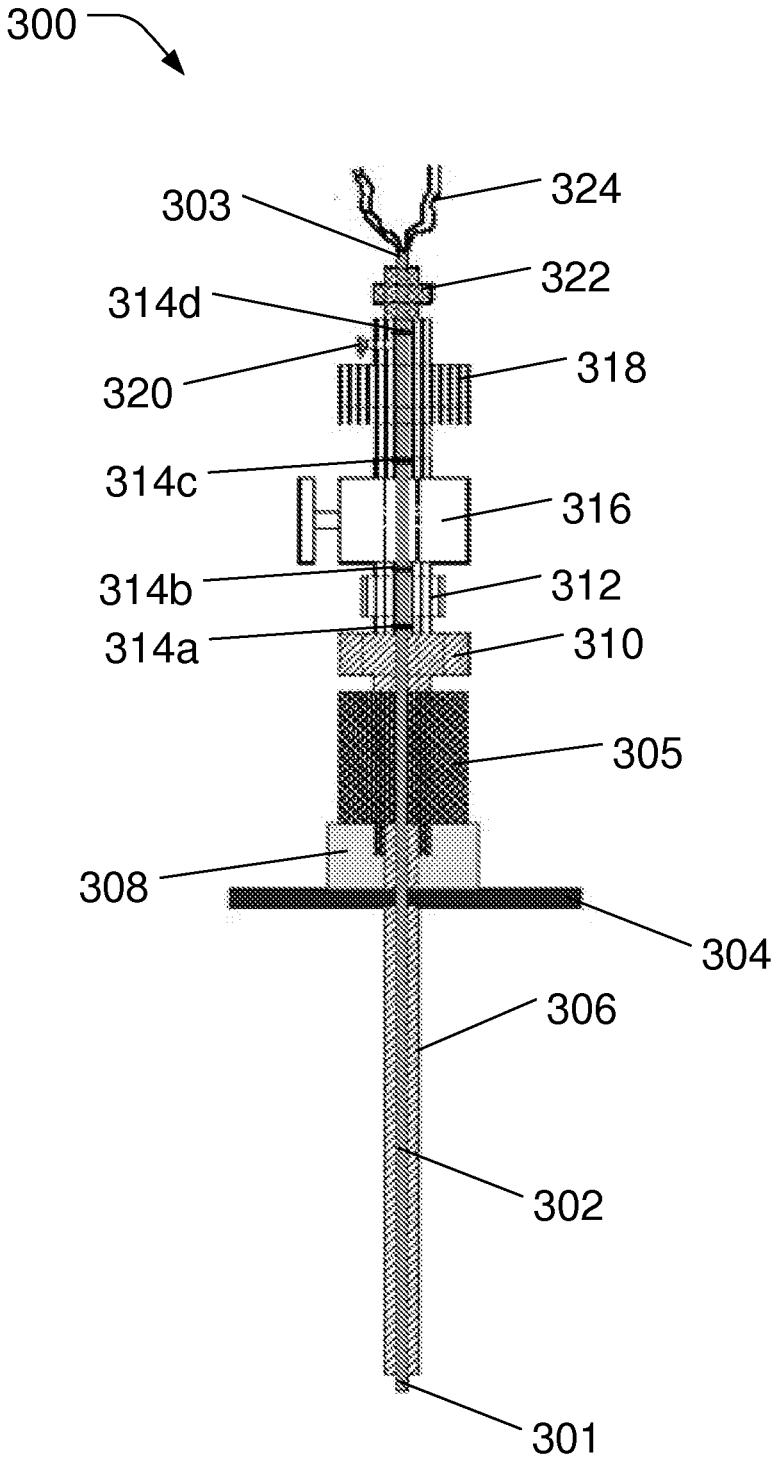
300
303
324
322
314d
320
318
314c
316
314b
312
314a
310
305
308
304
306
302
301

FIG. 3

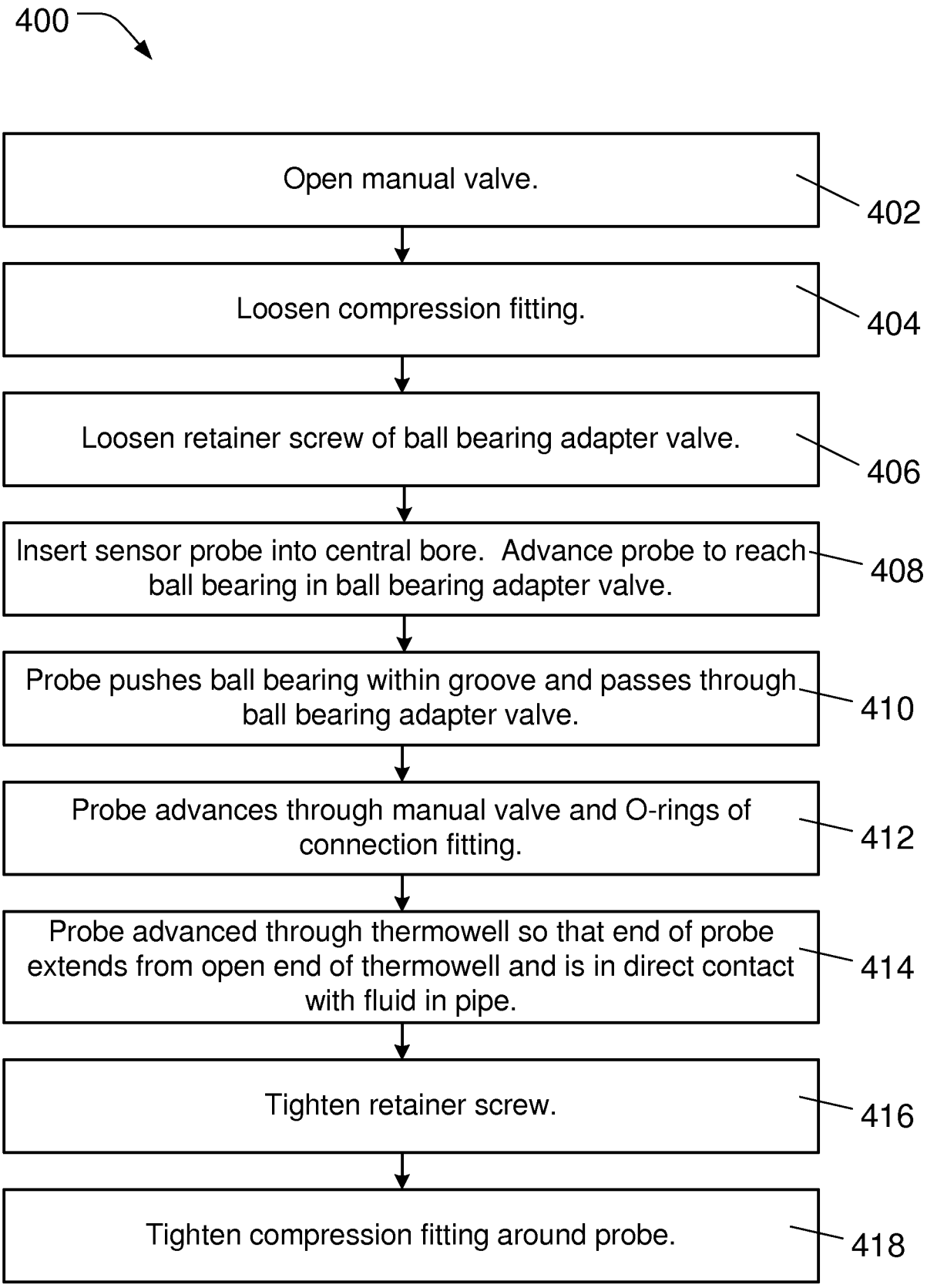
400
Open manual valve.
402
Loosen compression fitting.
404
Loosen retainer screw of ball bearing adapter valve.
406
Insert sensor probe into central bore. Advance probe to reach ball bearing in ball bearing adapter valve.
408
Probe pushes ball bearing within groove and passes through ball bearing adapter valve.
410
Probe advances through manual valve and O-rings of connection fitting.
412
Probe advanced through thermowell so that end of probe extends from open end of thermowell and is in direct contact with fluid in pipe.
414
Tighten retainer screw.
416
Tighten compression fitting around probe.
418

FIG. 4A

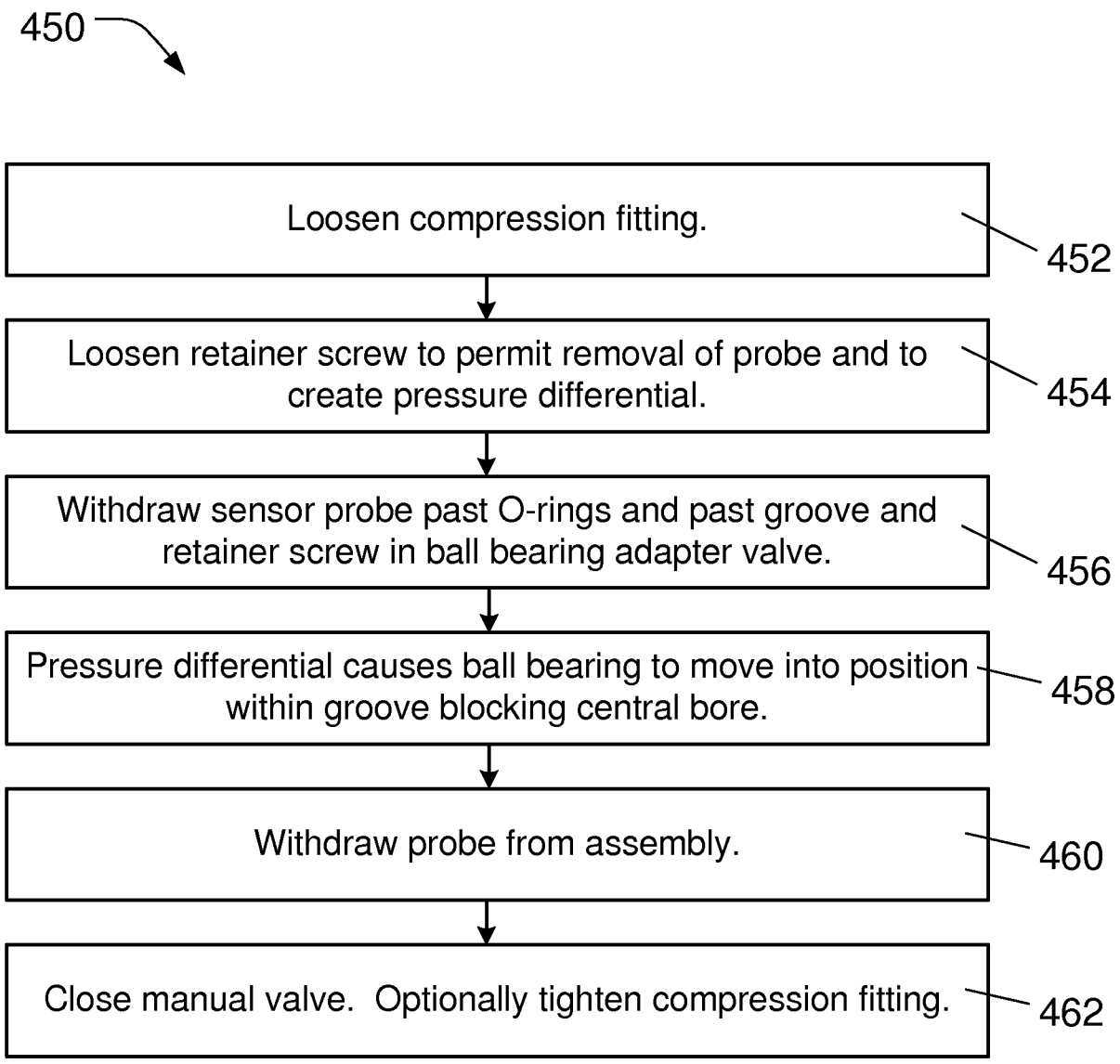
450
Loosen compression fitting.
452
Loosen retainer screw to permit removal of probe and to create pressure differential.
454
Withdraw sensor probe past O-rings and past groove and retainer screw in ball bearing adapter valve.
456
Pressure differential causes ball bearing to move into position within groove blocking central bore.
458
Withdraw probe from assembly.
460
Close manual valve. Optionally tighten compression fitting.
462

FIG. 4B

AUTO BALL CHECK NON RETURN VALVE FOR SENSOR INSERTION IN CHILLED WATER SYSTEMS

ABSTRACT

Embodiments of the invention provide an assembly configured to be fitted onto a wall of a pipe of an HVAC system, for inserting and removing a sensor probe, such that the probe is in direct contact with a fluid in the pipe. The assembly includes a central bore, and a thermowell configured to have an open end within the pipe, such that when the probe is inserted through the central bore, an end of the probe extends from the open end of the thermowell and is in direct contact with the fluid in the pipe. The assembly also includes O-rings arranged along the central bore, and a ball bearing adapter valve including a groove and a ball bearing, wherein the groove is arranged along the central bore such that the ball bearing may be moved into a position within the groove that permits the sensor probe to pass through the central bore when the probe is inserted, and automatically move back into a position blocking the central bore when the probe is withdrawn.

(FIG. 1)