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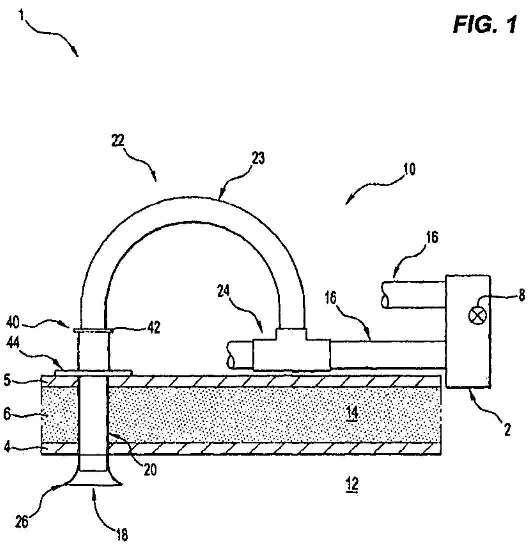
(54) Title: SAMPLING POINT

FIG. 1



(57) Abstract: An air sampling system (10, 110) for a low-temperature space (12) is disclosed. The air sampling system (10, 110) includes: an air sampling pipe (16) for passing sampling air to an air sampling device (2); and a sampling conduit (20, 120) extending from the low-temperature space (12) to outside the low-temperature space (12). The sampling conduit (20, 120) is connected to the sampling pipe (16), wherein the sampling conduit (20, 120) is selectively accessible from outside the low-temperature space (12) for removal of ice build-up within the sampling conduit (20, 120). Also disclosed is a kit for an air sampling system. Also disclosed is a method, computing system, air-sampling device and air monitoring system that evaluates an air sampling network.

WO 2014/127397 A1

Sampling Point

Field of the invention

The present invention relates to an air monitoring and/or sampling for a low-temperature space. In a preferred form, although not exclusively, the invention relates to an aspirating smoke detection system for a refrigerated storage facility. However, it will be understood that the invention may have application to other types of air monitoring systems eg. gas detection systems, aerosol detection of biological material or other types of smoke detection systems that may be used in low temperature spaces. The invention also relates to a kit for an air sampling system for a low-temperature space.

Background of the invention

Cold environments, and in particular refrigerated storage facilities, are unique and challenging environments for any smoke detection system. They are characterised by varying low temperatures and frequent traffic flow from workers transporting machinery in and out of the rooms. While most have some form of fast acting automatic doors or plastic barrier curtains to limit warm air ingress, it is inevitable that warm air will enter the room. This constant traffic flow with regular warm air ingress often creates condensation within the rooms and, in situations where the surrounding temperature is below 0 degrees Celsius icing occurs. Icing tends to form on any and all ceiling mounted equipment and structures, generally within close proximity to the entry points.

Smoke detection systems in refrigerated storage facilities are known. Aspirating smoke detection systems generally have a sampling pipe network with a number of sampling points to draw sampling air for testing. These sampling points are generally positioned on the ceiling or walls of the refrigerated space. However, over time, with warm air ingress, the sampling points and associated pipes can become blocked with ice. This causes air flow issues and inoperative detection of smoke.

The maintenance required to rectify this problem (ie. unblocking of holes or pipes) can be very costly. In some instances, the simplest known solution is to remove the section of pipe closest to the sampling point and fit a new pipe section. In addition, access to equipment within the refrigerated storage facility may become inconvenient during repairs.

Similar problems exist for air sampling systems for other low-temperature environments, such as cold outdoor environments. Some of the condensation related problems begin to arise at temperatures about 4 degrees Celsius (or possibly higher if certain conditions exist), and typically get worse as the temperature drops down to, or below the freezing point of water, 0 degrees Celsius. It is therefore an object of the present invention to provide an air sampling system and a kit for an air sampling system which overcomes or at least ameliorates one of the abovementioned problems associated with low-temperature environments, especially refrigerated environments.

Reference to any prior art in the specification is not, and should not be taken as, an acknowledgment or any form of suggestion that this prior art forms part of the common general knowledge in Australia or any other jurisdiction or that this prior art could reasonably be expected to be ascertained, understood and regarded as relevant by a person skilled in the art.

Summary of the invention

In accordance with a first aspect of the present invention there is provided, an air sampling system for a low-temperature space, the air sampling system including: an air sampling pipe for passing sampling air to an air sampling device; a sampling conduit extending from an entry port from the low-temperature space to outside the low-temperature space; the sampling conduit being connected to the sampling pipe, wherein the sampling conduit is selectively accessible from outside the low-temperature space for removal of ice build up within the sampling conduit.

The sampling conduit is preferably a straight length of conduit of sufficient length to extend through a partition, wall or ceiling defining a boundary of the low-temperature space, as the case may be. Thus, the conduit has an entry port within the low-temperature space and an exit port external to the low-temperature space. The entry port may be "within" the low-temperature space by being at the boundary of the low-temperature space, for example by being a hole in the partition that faces the low-temperature space.

The access to the sampling conduit is preferably in line with the longitudinal axis of the sampling conduit to enable line-of-sight visual inspection and also to enable the insertion of a rod or similar instrument to remove ice build up, which typically occurs at the entry port of the sampling conduit inside the low-temperature space, i.e. at the sampling point. For this reason, the entry port of the sampling conduit is preferably at least the same dimension (in terms of cross-section) as the access opening. Typically, for ease of construction and cleaning-access, the sampling conduit will have a continuous cross-section. Another feature is a bell or dome shaped nozzle at the entry port of the sampling conduit. Typically the sampling conduit is formed of cylindrical pipe, preferably plastic and typically of about 25 mm in diameter. The entry port may be coated with silicone to prevent ice build up. Insulation of the sampling conduit is also possible. The sampling conduit may be a one-piece construction but this need not be the case.

Preferably, the air sampling system includes a restrictor, such as a small entry port or restriction fitting, which is outside the low-temperature space. Most preferably the restrictor is positioned proximate an end of the sampling conduit, or downstream thereof. In some cases the restrictor may be located in or near the sampling pipe.

The sampling conduit may be selectively accessible from outside the low-temperature space through the use of an access opening. This may be in the form of an access hatch such as a sliding or hinged closure. Preferably any such access hatch has a self-closing feature.

In one form of the invention, the sampling conduit is connected to the sampling pipe with an access opening formed therein. In a preferred form of the invention, the sampling pipe connects to an exit port on the outside of the sampling conduit by means of a connection assembly on the downstream end of the sampling conduit such that the connection assembly which is selectively removable from the exit port of the sampling conduit. In this embodiment, it will be understood that the sampling pipe may have a number of connection assemblies and sampling conduits arranged at spaced intervals along the sampling pipe to draw air from the low-temperature space at a number of respective spaced sampling points. The invention may include more than one sampling pipe. For example, there may be a sampling pipe network arranged in spaced rows, establishing a grid pattern of sampling points within the low-temperature space.

The selectively removable connection assembly may be or include a flexible connector pipe. The connection assembly preferably either additionally or alternatively includes a fitting, such as an adaptor, union or T-piece, that fits to the sampling pipe and also joins directly or indirectly to the sampling conduit. The connection assembly has a restriction fitting at a mating portion or end which is connectable with the exit port of the sampling conduit and selectively removable therefrom. The restriction fitting may be defined by a separate or separable end piece of the connection assembly or may be integrally formed with the connection assembly.

The restriction fitting of the connection assembly includes a restrictor, for example in the form of a small entry port, for sampling air and defining the flow rate from the low-temperature space, through the sampling conduit, to the sampling pipe. The restrictor may be located at an end of the restriction fitting which mates with the sampling conduit. For example, the restrictor may be comprised of a hole or holes forming a small entry port at the end of the restriction fitting, whereby the end is closed but for the hole(s). Alternatively, the restrictor may be downstream from the end of the connection assembly that mates with the sampling conduit. In either case, it will be understood that the restrictor is selectively removable with the connection assembly from the sampling conduit, enabling access to the full cross-section of the sampling conduit to allow for cleaning of the conduit by pushing debris and/or ice through the upstream end of the sampling conduit, i.e. the end that faces the low-temperature space.

The sampling conduit is preferably shaped so that the cross section of the sampling conduit's duct remains substantially constant (or increases rather than decreases) from its downstream end to its upstream end, so that the ice or debris does not clog at its upstream end when pushed through the sampling conduit during cleaning.

It is appreciated that since the restrictor forms part of the connection assembly, the restrictor may be easily inspected and, if necessary, cleaned or replaced. This is in contrast with arrangements in which the restrictor is integral to the sampling conduit or only is accessible only from within the low-temperature space (eg by forming at least part of the sampling hole in the low-temperature space).

It is also appreciated that the restrictor may be a collection of apertures, rather than a single aperture, forming the small entry port. The restrictor may cause restriction, at least in part, by increasing turbulent flow in comparison with flow either side of the restrictor.

The restriction fitting may include one or more apertures which are closable when the connection assembly is assembled correctly to the sampling conduit. Preferably these apertures are large in comparison to the small entry port. The relatively large apertures which are closed when the connection assembly and sampling conduit are properly reassembled, enable detection of mis-assembly of the connection assembly with the sampling conduit. If the connection assembly and the sampling conduit are not properly reassembled then the apertures simulate a broken pipe condition which should trigger an urgent flow fault in the air sampling device, e.g. the smoke detector unit. This safeguards against inadvertent removal of the connection assembly from the sampling conduit, improper reassembly or simply the act of forgetting to reassemble the sampling conduit with the connection assembly.

In a preferred form of the invention, the one or more large apertures are formed in the side wall of the restriction fitting, being closed by contact with the inside of the side wall of the sampling conduit. Preferably, there are two diametrically opposed apertures. The apertures may be round although other shapes are possible.

In one embodiment, the restriction fitting also includes a flanged end opposite the closed end of the connection assembly. This preferably acts as a stop for insertion of the connection assembly into the sampling conduit, to ensure that the connection assembly and sampling conduit are correctly reassembled.

In one form of the invention, the restriction fitting includes a fitting portion that is formed by any union or coupling part or assembly for joining one pipe to another. However, preferably, the fitting portion has a first component that seals with the sampling conduit, a second component that seals with either a sampling pipe or a component such as a connector pipe that is in fluid communication with the sampling pipe. The restriction fitting also includes a fastening component that seals together the first and second components. Preferably the fastening is by a threaded connection to one of the first and second components. Preferably the seal between the first and second components is provided by at least one O-ring, gasket etc. that is between the first and second components.

Preferably, the restrictor is integral to or held by the fitting portion. Preferably, the restrictor acts as to limit flow through the sampling conduit to a pre-determined flow-rate. Preferably the restrictor is held between the first component and the second component when the fitting portion is assembled. In one embodiment the restrictor is a flow-restricting washer or orifice-plate, which preferably has an inner diameter that is less than the inner diameter of the sampling conduit and of the connection assembly downstream and upstream from the restrictor.

In accordance with a second aspect of the present invention there is provided air sampling system for a low-temperature space, the air sampling system including: an air sampling pipe for passing sampling air to an air sampling device; a sampling conduit extending from the low-temperature space to outside of the low-temperature space, the sampling conduit being connectable to the sampling pipe through a connection assembly which is removably connectable with an exit port of the sampling conduit, outside of the low-temperature space, wherein the removable connection assembly includes: (i) a restrictor for restricting flow of sampling air, the restrictor having a first characteristic flow-impedance, and (ii) a passageway between the restrictor and the sampling pipe, wherein the passageway has a second characteristic flow-impedance that is less than the first characteristic flow impedance.

Preferably, the location of the restrictor in a removable connection assembly facilitates inspection and any necessary clearing of the small entry port. Any of the other features described above in connection with the first aspect of the invention may also be applied. For example, the removable connection assembly may include one or more relatively larger apertures and/or a flanged end opposite the substantially closed end. The connection assembly may include a connector pipe extending between the air sampling pipe and the sampling conduit. In another embodiment, the connection assembly may directly connect the sampling conduit to the sampling pipe, without including an intermediate connector pipe.

In a third aspect of the present invention there is provided an air sampling system for a low-temperature space, the air sampling system including: an air sampling pipe for passing sampling air to an air sampling device; a sampling conduit extending from the low-temperature space to outside of the low-temperature space, the sampling conduit being connectable to the sampling pipe through a connection assembly which is removably connectable with an exit port of the sampling conduit, outside of the low-temperature space, wherein the removable connection assembly includes: (i) a restrictor having an opening having a first cross-sectional area for restricting flow of sampling air, and (ii) a passageway between the restrictor and the sampling pipe, wherein the passageway has a minimum cross-sectional area that is greater than the first cross-sectional area.

In accordance with a fourth aspect of the present invention, there is provided an air sampling system for a low-temperature space, the air sampling system including:

an air sampling pipe that runs outside the low-temperature space for passing sampling air to an air sampling device, wherein when the sampled air is in the sampling pipe the sampled air is above a temperature that is above the freezing point of water and also above the temperature of the low-temperature space; and

a sampling conduit extending from the low-temperature space to the sampling pipe, for collecting air sample from the low-temperature space;

a restrictor having a characteristic flow impedance for determining a flow-rate of the sampled air through the sampling conduit, wherein the restrictor is situated between the low-temperature space and the sampling pipe, at a location sufficiently warm to prevent water vapour from causing a temperature-related blockage at the restrictor..

In one embodiment the restrictor is part of the sampling conduit. In another embodiment the air sampling system further includes a connection assembly that connects the sampling conduit to the sampling pipe, wherein the restrictor is part of the connection assembly. The restrictor may be integrally formed with the sampling conduit or connection assembly.

The temperature-related blocking could be blocking caused by condensation, and especially freezing, of the water vapour on the restrictor.

Preferably for this and all other aspects of the invention, the low-temperature space is a space having a temperature of +4 degrees Celsius or below. Such a low-temperature space may advantageously be a refrigerated space, preferably enclosed by surrounding walls, a floor and a ceiling.

In the case of the low-temperature space being a refrigerated space, the temperature of the low-temperature space is preferably between -40 degrees Celsius and +4 degrees Celsius, but generally is at or around -25 degrees Celsius. Whereby the low-temperature space is below 0 degrees Celsius, it is preferable for the restrictor to be placed in a warmer environment at a location sufficiently far from the low-temperature space so as to prevent water vapour, sampled from the low-temperature space, from freezing on the restrictor. In one embodiment, the restrictor is situated at least 30 cm from the interior of the refrigerated space. Preferably, the restrictor is situated at least 15cm, and preferably between 15 and 25cm, from an outside surface of a wall panel or partition that insulates the low-temperature space. In addition to the flow rate being determined by the characteristic impedance of the flow restrictor, the flow rate may also determined by a pressure controlled by a pump or fan. However, optionally, the characteristic flow impedance of the restrictor may be such that the restrictor acts a flow-limiting device.

In accordance with a fifth aspect of the present invention, there is provided a kit for an air sampling system for a low-temperature space, the kit including: a sampling conduit to extend from the low-temperature space to outside the low-temperature space, the sampling conduit having an entry port and an exit port; and a connection assembly which is removably connectable with the exit port, at least one of the connection assembly and the sampling conduit having one or more apertures which are closable by the side wall(s) of the other of the connection assembly and the sampling conduit when the connection assembly is correctly connected with the sampling conduit.

Any of the features described above in connection with other aspects of the invention may be applied to the fourth aspect of the invention.

In accordance with a sixth aspect of the present invention, there is provided, a kit for an air sampling system for a low-temperature space, the kit including:

a sampling conduit to extend from the low-temperature space to outside the low-temperature space, the sampling conduit having an entry port and an exit port; and

a connection assembly which is removably connectable with the exit port for connecting the sampling conduit to a sampling pipe, the connection assembly having: (i) a restrictor for restricting flow of sampling air, the restrictor having a first characteristic flow-impedance, and (ii) a passageway between the restrictor and the sampling pipe, wherein the passageway has a second characteristic flow-impedance that is less than the first characteristic flow impedance.

Preferably, restrictor has an opening having a first cross-sectional area for determining first characteristic impedance and the passageway has a minimum cross-sectional area that is greater than the first cross-sectional area, so that the second characteristic impedance is less than the first characteristic impedance

In one embodiment the restrictor is a substantially closed end of the connection assembly that has a small entry port for sampling air.

In a seventh aspect of the present invention, there is provided a kit for an air sampling system for a low-temperature space, the kit including:

a sampling conduit to extend from the low-temperature space to outside the low-temperature space, the sampling conduit having an entry port and an exit port; and

a connection assembly which is removably connectable with the exit port for connecting the sampling conduit to a sampling pipe, the connection assembly having: (i) a restrictor having an opening having a first cross-sectional area for restricting flow of sampling air, and (ii) a passageway between the restrictor and the sampling pipe, wherein the passageway has a minimum cross-sectional area that is greater than the first cross-sectional area.

It will be appreciated that any of the first to seventh aspects of the invention may also include a mounting system for mounting the sampling conduit through a side wall, floor or ceiling that insulates the refrigerated space.

In an eighth aspect of the present invention, there is provided a method of evaluating assembly of an air sampling network in an network portion between (a) a sampling point for sampling air from a space being or to be monitored by an air sampling device, and (b) a sampling pipe outside the space, wherein the method comprises:

measuring a flow parameter;

determining, based on the flow parameter, the presence or absence of a flow restrictor component of the network portion; and

indicating a condition of assembly based on the determined presence or absence of the flow restrictor.

Preferably, the sampling device is a particle detector.

Preferably, when the measured flow parameter is above a predetermined threshold, the method determines a fault condition. In one embodiment, the predetermined threshold is between a first flow rate that is normal for the network portion being correctly assembled, and a second flow rate that is expected for the network being assembled without the flow restrictor component. In another embodiment, the predetermined threshold is between a first flow rate that is normal for the network portion being correctly assembled, and a second flow rate that is expected when the sampling point is disconnected from the sampling pipe.

In one embodiment, the method evaluates the assembly between (a) the sampling pipe, the sampling pipe being configured for passing air from the connection assembly toward the particle detector, and (b) an exit port of a sampling conduit, the sampling conduit being configured for passing air from the monitored space to the connection assembly, wherein in correct assembly of the sampling network, the flow restrictor component forms part of the connection assembly.

Preferably, the method includes comparing a measured flow parameter with a threshold flow value that is selected to be greater than an expected rate when the restrictor is connected. In one embodiment, the threshold flow value is additionally selected to be less than an expected flow rate when the air sampling pipe and sampling conduit are connected, but without a restrictor in the connection. Advantageously, this provides the method with a sensitivity to detect that the connection has been made but that the restrictor is absent. The threshold may be derived empirically or may be calculated from the known characteristic flow-impedances of the respective sampling conduit, restrictor and sampling pipe.

Preferably, the connection is provided by a connection assembly in accordance with any of the other aspects of the invention.

As would be understood by a person skilled in the art, the characteristic flow impedance of the restrictor is preferably selected to be greater than the characteristic impedance of the sampling conduit and all portions of the connection assembly other than at the restrictor. In this manner, it is easy to measure the restrictor's effect on the overall impendence of the sampling conduit and connection assembly, and the consequential sample air flow.

In a ninth aspect of the present invention, there is provided a computing system having: a memory for storing a set of instructions that are executable by a processing system; and a processing system configured to read and execute the instructions, wherein upon executing the instructions the computing system performs the method according to the eighth aspect of the present invention. Preferably the flow sensor is an ultrasonic flow sensor, but other types of flow sensors may be used, eg. a thermal flow sensor, an anemometer or the like.

In a tenth aspect of the present invention, there is provided an air sampling device having a computing system in accordance with the ninth aspect of the present invention. Preferably, the air sampling device is (or includes) a particle detector, more preferably a smoke detector.

In an eleventh aspect of the present invention there is provided an air monitoring system, having and an air sampling system in accordance with any one of the first, second, third or fourth aspects of the present invention, wherein the air sampling system feeds into said sampling device. Preferably the particle detector is a particle detector in accordance with the tenth aspect of the present invention. Preferably, the air monitoring system is a particle detection system, more preferably a smoke detection system.

It will be understood that the invention disclosed and defined in this specification extends to all alternative combinations of two or more of the individual features mentioned or evident from the text or drawings. All of these different combinations constitute various alternative aspects of the invention.

As used herein, except where the context requires otherwise, the term "comprise" and variations of the term, such as "comprising", "comprises" and "comprised", are not intended to exclude further additives, components, integers or steps.

Brief description of the drawings / figures

In order that the invention may be more fully understood, one embodiment will now be described by way of example, with reference to the figures in which:

Figure 1 is a schematic illustration of a particle detection system having an air sampling system according to an embodiment of the present invention;

Figure 2 is a detailed view of part of the air sampling system of Figure 1;

Figure 3 is a detail of an alternative embodiment of the air sampling system illustrated in Figure 1;

Figure 4 is a perspective view of another part of the air sampling system of Figure 1, corresponding to the view shown in Figure 3; and

Figure 5 is a detailed view of an end piece, corresponding to the embodiment illustrated in Figure 2;

Figure 6 is an illustration of a portion of an air sampling system in accordance with another embodiment of the present invention;

Figure 7 is a longitudinal sectional view through the air sampling system illustrated in Figure 6;

Figure 8 is an enlarged view of a restriction fitting illustrated in the air sampling system of Figures 6 and 7; and

Figure 9 is a schematic illustration of an air sampling system according to a another embodiment of the present invention.

Detailed description of the embodiments

The exemplary embodiments of the invention are described hereinafter with reference to use for a refrigerated space. However, the present invention may alternatively be applied to other low-temperature environments, such as cold outdoor environments.

The exemplary embodiments are also described with reference to a particle detection system in which monitoring of sampled air is performed by an air sampling device that is a particle detector. However, the air monitoring system or sampling device may additionally or alternatively be adapted to analyse and/or detect other characteristics or components of the air. For example the air monitoring system or sampling device may be a gas detector or other device capable of detecting the presence and or concentration of one or more target gasses. An example of such an air sampling device is sold by Xtralis Technologies Ltd under the product name Vesda Eco.

Figure 1 illustrates an air monitoring system in the form of a particle detection system 1 for a refrigerated space 12. The refrigerated space 12 is typically enclosed by a floor, walls and a ceiling including ceiling panel 14. The ceiling and the walls may be insulating partitions or of an insulated sandwiched construction, as is known in the prior art. Typically, however, the sandwiched construction includes internal and external metallic panels 4 and 5, respectively, with foam insulation 6 between the metallic panels 4,5.

The particle detection system 1 includes a particle detector 2 in the form of an aspirating smoke detector, and an air sampling system 10 for drawing air from the refrigerated space 12. Thus, externally of the refrigerated space 12 is a network of sampling pipes 16, two of which are shown in figure 1. The sampling pipes connect to a sampling device - in this case, the aspirating smoke detector 2 - above the ceiling panel 14. The sampling pipes 16 run along the outside of the refrigerated space 12 to connect to the sampling device 2, either directly or via a manifold (not shown) proximate the sampling device 2. A fan 8 may be provided within the aspirating smoke detector unit or elsewhere in the sample pipe network to draw air from the refrigerated space 12, through the sampling system 10, to the smoke detector 2. Additionally, it is also possible for the outlet of the smoke detector unit to feed back into the refrigerated space 12 to create a closed loop system (not shown) to avoid the introduction of warm and humid air into the refrigerated space 12 when the detector unit is powered down for any reason.

Each sampling pipe 16 may include a number of sampling points 18 at spaced locations within the refrigerated space 12. Each of the sampling points exists at an entry port of a corresponding sampling conduit 20 which is connected to the sampling pipe 16 by means of a connector assembly 22. The connection assembly 22 includes a flexible connector pipe 23 intermediate a restriction fitting 40, that fits to the sampling conduit 20, and a T-junction fitting 24 that fits to the sampling pipe 16. Thus, the connection assembly forms a branch that stems from the sampling pipe, the branch including the sampling conduit.

There may be a number of such T-junctions 24 along a single length of sampling pipe 16, thereby providing a number of sample points 18 along a single length of sampling pipe 16. Furthermore, it will be appreciated that a number of lengths of sampling pipe 16 can be arranged side by side to create a grid (or other geometry) of sampling points 18.

The sampling conduit 20 is of a sufficient length to extend across the width of the ceiling panel 14 or a wall panel, as the case may be. The sampling conduit 20 extends from the inside of the refrigerated space to outside the refrigerated space as most clearly illustrated in figures 2 and 3. As shown in figure 1, the inside end (entry port) of the sampling conduit 20 may be provided with a bell-shaped sample nozzle 26.

At the other end of the sampling conduit 20, the connection assembly 22 is received in the exit port 30 of the sampling conduit 20. In figures 3 and 4, the flexible connection assembly 22 has an integral end construction, such that the end portion 29 of the flexible connector pipe 23 acts like the restriction fitting 40. The restriction fitting 29 in this embodiment includes a small entry port 32, to restrict sample flow, and two relatively larger side apertures 34. The small entry port 32 is disposed in a central location in a substantially closed end 36 of the restriction fitting 29. The two larger apertures 34 are disposed in the side walls of the restriction fitting 29. As will be understood from figure 3, when the end of the restriction fitting 29 is inserted correctly into the exit port 30 of the sampling conduit 20, the large apertures 34 will be closed by sealing against the inside surface of the wall of the sampling conduit 20. However, as will be understood from figure 4, if the restriction fitting 29 of the connection assembly 22 is not properly inserted back into the sampling conduit 20 then the large apertures 34 are able to draw in a large quantity of air, sufficient to trigger a fault within the detector unit 2.

Preferably the leakage through the large apertures 34 approximates the leakage of a broken pipe. Thus, aperture 34 may be of a similar sectional area as the pipe 16.

Figures 2 and 5 illustrate an alternative embodiment whereby the connection assembly 22 is comprised of multiple component parts which preferably are separable from each other. One of the components is a connector pipe 23. In this embodiment, the connector pipe is advantageously flexible, but it is appreciated that a rigid connector pipe may be used. Attached to one end of the connector pipe 23 is a restriction fitting 40 in the form of an adaptor. The restriction fitting 40 constitutes a second component of the connection assembly 22, and fits the flexible pipe 23 to the sampling conduit 20. Thus, the restriction fitting 40 acts as an end piece of the connection assembly 22. The restriction fitting 40 includes the small entry port 32 at the substantially closed end 36, with two diametrically opposed, relatively larger apertures 34, all of which serve a similar purpose as described above. Additionally, the restriction fitting 40 includes a peripheral flange 42 which serves to locate the restriction fitting 40 in its properly installed position within the sampling conduit 20. The restriction fitting 40, including the flange 42, peripheral side wall and substantially closed end 36 is preferably of one piece, integral construction. The restriction fitting 40 may be an integrally moulded piece. It will be appreciated that the provision of a separate restriction fitting 40 is a simpler construction than machining or forming the small entry port 32 and apertures 34 into the end of a flexible pipe 22.

An embodiment of an alternative air sampling system 110 is illustrated in figure 6. The air sampling system 110 uses an alternative connection assembly 122 which is similar to, and may be used interchangeably with, the connection assembly 22 in air sampling system 10. In this embodiment, the connector pipe 123 includes a flexible pipe segment 123a terminated with upstream and downstream rigid pipe pieces 125a and 125b, respectively. It is, however, appreciated, that the pipe 123 may be interchanged with a pipe that is either flexible or rigid across its entire length or for any portion thereof, as desired. Connection assembly 122 includes an alternative restriction fitting 140 for fitting the connection assembly 122 to the sampling conduit 120.

Figure 7 illustrates a longitudinal sectional view through the connection assembly 122 and sampling conduit 120. The connection assembly 122 may alternatively be attached to the sampling conduit 20 of figures 1 to 3.

An enlarged view of the restriction fitting 140 joined to the sampling conduit 120 and connector pipe 123 is illustrated in Figure 8. Restriction fitting 140 includes a fitting portion in the form of a union fitting having a first component 150, which is in this case configured to seal with the sampling conduit 120, and a second component 152, which is in this case configured to seal with a connector pipe 123. It is appreciated, however, that the orientation of the restriction fitting may be reversed so the first component 150 and second component 152 mate with the connector pipe 123 and sampling conduit 120, respectively.

The first component 150 (in this case the upstream component) includes collar 154 having a tight fit with the sampling conduit 120. The top (downstream end) of the collar has an inner flange 156 for sitting on the edge 158 of the sampling conduit 120. The top of the collar 150 also includes an outward flange 160 for interferingly abutting with a bottom inner flange 161 of a fastening member 162. This prevents the fastening member 162 from being removed from the sampling conduit 129 when the first component 150 is attached to the sampling conduit 120. Extending upwardly from the fastening member's inner flange 161 is a fastening ring 163 having an inner thread 166, which can be screwed onto thread 168 on the bottom outside surface of the second component 152 to tighten the second component 152 towards the first component 150 and to create a seal therebetween. The second component has an inner flange collar 170 having a tight fit with the connector pipe 123 and an inner flange 172 to sit beneath and abut the bottom edge 174 of the connector pipe 123.

Between the first and second components 150, 152 is a restrictor 132 in the form of an orifice plate. However, the restrictor 132 is also shaped to fit on the sampling conduit in a self-locating manner. This is achieved by a central portion 134 of the restrictor 132 being sunken from the restrictor's periphery 135. In this embodiment the restrictor is metallic, but in other embodiments non-metallic materials, such as plastic or rubber, may be used.

A seal is created between the first and second components 150, 152 by a rubber O-ring seals 136 and a ring-shaped self-adhesive foam seal 137 on the respective sides of the restrictor 132. This creates seals between the first component 150 and the restrictor 132, and between the restrictor 132 and the second component 152.

The restrictor has an inner diameter (i.e. the diameter of the O-ring hole 133) which is less than the inner diameter of the downstream flow path to the sampling pipe 16. Thus, the diameter of hole 133 is less than the inner diameter of the second component 152 and also less than the inner diameter of the connector pipe 123. The diameter of hole 133 is similarly less than the inner diameter of the entire sampling conduit (including the sampling point at the end of the sampling conduit). The precise diameter of the hole 133 is selected to provide a desired flow-restriction that is dictated by the dimensions and configuration of the sampling system 10 and detector 2, and the characteristics of the fan 8. The diameter can be determined in any known fashion including using software that has been specialised for this purpose, such as Xtralis Technologies Ltd's VESDA ASPIRE2 pipe network design software. Typically, the hole has a diameter of between 2mm and 10mm. As would be appreciated by a person skilled in the art, restrictor 132 may allow restrictive flow of air by having a plurality of holes, rather than a single hole 132. In this case, the combined cross section of all the restrictor's holes is the same as cross section of the single hole 132. By comparison the respective minimum (and in this case constant) inside diameters of the sampling conduit and connector pipe are both 25mm.

By this design, the characteristic flow-impedance of the restrictor 132 dominates the overall impedance to flow of air sampled from the refrigerated space to the sampling pipe 16. Accordingly, if the restrictor 132 is absent (for example if the sampling system

110 is not correctly assembled), there will be an increase in flow rate through the sampling network 110. The flow rate is measured by a flow-rate meter having a transducer (not shown) either at the particle detector 2 or elsewhere in the sampling system 110. In one arrangement, the flow is measured in either the sampling conduit 120 or the connection assembly 122, but preferably at a downstream end of the connection assembly. Alternatively, an accurate measurement can be acquired by including flow measurement transducers in the sampling pipe 16, upstream and downstream from the sampling conduit 122. The difference in flow between the two transducer measurements is attributable to the flow through the sampling conduit 120 and connection assembly 122. In this embodiment, flow is measured by an ultrasonic transducer, but in other embodiments other types of flow sensor may be used, e.g. a thermal flow sensor.

It is appreciated that part of the restriction fitting may be integrally formed or permanently connected with the sampling conduit 120. However, the restrictor component 133 should preferably, even in this case, still be removable (or at least displaceable) from the sampling conduit 120, so as to provide good access to the sampling conduit for cleaning. To account for such variations, as used herein the term "sampling conduit" is intended to mean the part of the sampling network from the refrigerated space up to, but not including, the restrictor. The restrictor itself is part of the "restriction fitting", which is a separate integer from the sampling conduit, even in cases where the sampling conduit 120 includes a portion, part or parts which interact with the restrictor to enable its removal, displacement, placement or fastening.

In another embodiment of the invention, or as an additional feature of the embodiments hereinbefore described, the restrictor is positioned in the sampling network at a location sufficiently downstream from the sampling point so as to be at a temperature above the freezing point of water, i.e. above 0 degrees Celsius. In such an arrangement, it is not necessary that the restrictor be part of the connection assembly. An embodiment of such an arrangement is illustrated in figure 9, which shows restrictor fitting 240 being removable from a first opening 250 in the sampling conduit 220. The sampling conduit has a second opening 252 which forms the sampling conduit's output to the sampling pipe, and fluidly connects to the connection assembly 222. The restriction fitting restricts the sample flow between the sampling point 254 of the conduit 222 and the output at the second opening 252.

It is appreciated that the restriction fitting 250 may alternatively be located at other locations between the sampling conduit's sampling point 254 and output 252. While it is advantageous for the restriction fitting 250 to be removable from the sampling conduit 220, in some embodiments a restrictor is permanently fixed to or integrally formed with the sampling conduit 220. The placement of the restrictor is nonetheless advantageous by being placed at a location where the sampled air (and the temperature of the sampling conduit) has sufficiently been warmed by the ambient environment so as to be above the freezing point of water. Thus the restrictor does not become clogged with ice. This can reduce the need or regularity for servicing of the sampling network.

For embodiments in which the restrictor may be mistakenly omitted during initial assembly of the sampling pipe network, or during reassembly after servicing, a method may be employed to evaluate the assembly. The method comprises measuring a flow parameter and indicating a condition of assembly that is determinant of the presence or absence of the flow restrictor 40, 140, 240 in an evaluated portion of the network. The method evaluates the assembly at the portion of the air sampling network between (a) the sampling point 18, 118, 254 and (b) a sampling pipe 16 outside the space. In the embodiments of figures 1 to 7, the restrictor forms part of a connection assembly between the sampling conduit 20, 120 and the sampling pipe 16. Thus, the method is used to evaluate the assembly of the connection between the sampling conduit 10, 120 and the sampling pipe 16.

Details of various embodiments of the sampling conduit and its mount to the ceiling 14 are now described. Figures 7 and 9 illustrate a sampling conduit 120 mounted to ceiling panel 14. The sampling conduit 120 is held on the metal panel 4 on the top side of the ceiling 14 by top flange assembly 184. The flange assembly 184 has upstanding sprung fingers 185 which retain the sampling conduit 120 in position during and after installation. A lower end 186 of sampling conduit 120 defines the sampling point hole 118. The bottom portion the sampling conduit flanges outwardly from the sampling point 118 and then downwardly to form a dome-shaped cover 187 for the sampling point 118.

In the illustrated embodiment this bottom portion of the sampling conduit is formed as a separate part from the main pipe 188 of the sampling conduit. This bottom portion or lower flange 187 locks onto mount 189 which is held onto the bottom metal panel 4 of the ceiling 14 by screws 190. During assembly, sealant is placed between the top and bottom flanges and their corresponding ceiling panel to provide an air-tight seal, avoid leakage at each sampling point and thus prevent air leakage from the refrigerated space 12 through the ceiling 14. Similarly, in the embodiment of figure 1, the sampling conduit 20 is preferably surrounded by a suitable sealant within the ceiling panel 14 to eliminate leakage. A sealing grommet 44 may also surround the sampling conduit 20 where it exits the ceiling panel 14.

The foregoing describes only exemplary embodiments of the present invention and modifications may be made thereto without departing from the scope of the invention.

Claims

1. An air sampling system for a low-temperature space, the air sampling system including: an air sampling pipe for passing sampling air to an air sampling device; a sampling conduit extending from an entry port from the low-temperature space to outside the low-temperature space; the sampling conduit being connected to the sampling pipe, wherein the sampling conduit is selectively accessible from outside the low-temperature space for removal of ice build-up within the sampling conduit.

2. The air sampling of claim 1, wherein the selective accessibility to the sampling conduit, from outside the low-temperature space, is in line with a longitudinal axis of the sampling conduit to enable (i) line-of-sight visual inspection through the sampling conduit and (ii) insertion of a rod through the sampling conduit to remove ice build up from the entry port.

3. The air sampling system of claim 1 or 2, wherein the sampling conduit has a cross-section that is substantially constant, or increases rather than decreases, from its downstream end to its upstream end.

4. The air sampling system of claim 1, 2 or 3, wherein the sampling conduit is selectively accessible from outside the low-temperature space through the use of an access opening.

5. The air sampling system of any one of claim 4 wherein the entry port of the sampling conduit is at least the same dimension, in terms of cross-section, as the access opening.

6. The air sampling system of claim 4 or 5, wherein the access opening is an access hatch.

7. The air sampling system of claim 6, wherein the access hatch has a self-closing feature.

8. The air sampling system of any one of the preceding claims, wherein the sampling pipe connects to an exit port of the sampling conduit via a connection assembly on a downstream end of the sampling conduit such that the connection assembly is selectively removable from the exit port of the sampling conduit.

9. The air sampling system of claim 8, wherein the selectively removable connection assembly is, or includes, a flexible connector pipe.

10. The air sampling system of claim 8 or 9, wherein the connection assembly has a restriction fitting at a mating portion or end of the connection assembly, the mating portion or end being connectable with and selectively removable from the exit port of the sampling conduit, and wherein the restriction fitting of the connection assembly includes a restrictor for restricting flow of sampling air from the low-temperature space, through the sampling conduit, to the sampling pipe.

11. The air sampling system of claim 10, wherein the restrictor is comprised of a hole or holes forming a small entry port at an end of the restriction fitting that mates with the sampling conduit, whereby the end is closed but for the hole or holes.

12. The air sampling system of claim 10 or 11, wherein the restriction fitting includes one or more apertures which are closed when the connection assembly is assembled correctly to the sampling conduit, to enable detection of mis-assembly of the connection assembly with the sampling conduit.

13. The air sampling system according to claim 12 or 13, wherein the one or more apertures are formed in the side wall of the restriction fitting, being closed by contact with an inside of a side wall of the sampling conduit.

14. The air sampling system of any one of claims 10 to 13, wherein the restriction fitting includes a fitting portion that has:

a first component that seals with the sampling conduit, a second component that seals with either the sampling pipe or a component such as a connector pipe that is in fluid communication with the sampling pipe, and

a fastening component that seals together the first and second components.

15. The air sampling system according to claim 14, wherein fastening of the fastening component is by a threaded connection to one of the first and second components.

16. The air sampling system according to claim 14 or 15, wherein the seal between the first and second components is provided by at least one O-ring or gasket between the first and second components.

17. The air sampling system according to any one of claims 14 to 16, wherein the restrictor is integral to or held by the fitting portion.

18. The air sampling system according to any one of claims 14 to 17, wherein the restrictor is held between the first component and the second component when the fitting portion is assembled.

19. The air sampling system of any one claims 1 to 9, wherein the air sampling system includes a restrictor outside the low-temperature space.

20. The air sampling system according to claim 19, wherein the restrictor is positioned proximate an end of the sampling conduit.

21. The air sampling system according to any one of claim 10 to 20, wherein the restrictor is a flow-restricting washer or orifice-plate.

22. The air sampling system according to any one of claim 10 to 21, wherein the restrictor acts as to limit flow through the sampling conduit to a pre-determined flow-rate.

23. The air sampling system according to any one of claim 10 to 21, wherein flow through the sampling conduit is defined by the flow restrictor and a pressure controlled by a pump or fan.

24. The air sampling system according to any one of claims 10 to 23, wherein the restrictor is at a location warmer than and sufficiently far from the low-temperature space to prevent water vapour, sampled from the low-temperature space, from freezing on the restrictor.

25. The air sampling system according to claim 24, wherein the restrictor is situated at least 30 cm from the low-temperature space and/orat least 15cm from an outside surface of a wall panel or partition that insulates the low-temperature space.

26. The air sampling system according to any one of the preceding claims, wherein the low-temperature space is a refrigerated space.

27. The air sampling system of any one of claims 1 to 26, wherein the entry port within the low-temperature space is at the boundary of the low-temperature space.

28. The air sampling system of any one of claims 1 to 27, wherein the entry port is coated with silicone to prevent ice build up.

29. The air sampling system of any one of claims 1 to 28, wherein the sampling system further includes a bell or dome shaped nozzle at the entry port of the sampling conduit.

30. An air sampling system for a low-temperature space, the air sampling system including:

an air sampling pipe that runs outside the low-temperature space for passing sampling air to an air sampling device, wherein when the sampled air is in the sampling pipe the sampled air is above a temperature that is above the freezing point of water and also above the temperature of the low-temperature space; and a sampling conduit extending from the low-temperature space to the sampling pipe, for collecting air sample from the low-temperature space;

a restrictor having a characteristic flow impedance for determining a flow-rate of the sampled air through the sampling conduit, wherein the restrictor is situated between the low-temperature space and the sampling pipe, at a location sufficiently warm to prevent water vapour from causing a temperature-related blockage at the restrictor.

31. The air sampling system according to claim 30, wherein the restrictor is part of the sampling conduit.

32. The air sampling system according to claim 30, wherein the air sampling system further includes a connection assembly that connects the sampling conduit to the sampling pipe, wherein the restrictor is part of the connection assembly.

33. The air sampling system according to claim 30, 31 or 32, wherein the temperature-related blockage is blocking caused by condensation or freezing of the water vapour on the restrictor.

34. The air sampling system according to any one of claims 30 to 33, wherein the restrictor is a small entry port.

35. The air sampling system according to any one of the claims 30 to 34, wherein the sampling conduit is connectable to the sampling pipe through a connection assembly which is removably connectable with an exit port of the sampling conduit, outside of the low-temperature space, wherein the removable connection assembly includes: (i) a restrictor for restricting flow of sampling air, the restrictor having a first characteristic flow-impedance, and (ii) a passageway between the restrictor and the sampling pipe, wherein the passageway has a second characteristic flow-impedance that is less than the first characteristic flow impedance.

36. The air sampling system according to claim 35, wherein the restrictor has an opening having a first cross-sectional area for restricting flow of sampling air, and the

passageway has a minimum cross-sectional area that is greater than the first cross-sectional area.

37. The air sampling system according to any one of claim 30 to 36, wherein the sampling conduit is connectable to the sampling pipe through a connection assembly which is removably connectable with an exit port of the sampling conduit, outside of the low-temperature space, wherein the removable connection assembly includes: (i) a restrictor having an opening having a first cross-sectional area for restricting flow of sampling air, and (ii) a passageway between the restrictor and the sampling pipe, wherein the passageway has a minimum cross-sectional area that is greater than the first cross-sectional area.

38. An air sampling system for a low-temperature space, the air sampling system including: an air sampling pipe for passing sampling air to an air sampling device; a sampling conduit extending from the low-temperature space to outside of the low-temperature space, the sampling conduit being connectable to the sampling pipe through a connection assembly which is removably connectable with an exit port of the sampling conduit, outside of the low-temperature space, wherein the removable connection assembly includes: (i) a restrictor for restricting flow of sampling air, the restrictor having a first characteristic flow-impedance, and (ii) a passageway between the restrictor and the sampling pipe, wherein the passageway has a second characteristic flow-impedance that is less than the first characteristic flow impedance.

39. An air sampling system for a low-temperature space, the air sampling system including: an air sampling pipe for passing sampling air to an air sampling device; a sampling conduit extending from the low-temperature space to outside of the low-temperature space, the sampling conduit being connectable to the sampling pipe through a connection assembly which is removably connectable with an exit port of the sampling conduit, outside of the low-temperature space, wherein the removable connection assembly includes: (i) a restrictor having an opening having a first cross-sectional area for restricting flow of sampling air, and (ii) a passageway between the restrictor and the sampling pipe, wherein the passageway has a minimum cross-sectional area that is greater than the first cross-sectional area.

40. The air sampling system according to any one of the preceding claims, wherein the low-temperature space is a space having a temperature of +4 degrees Celsius or below.

41. The air sampling system according to any one of the preceding claims, wherein the low-temperature space is a refrigerated space.

42. The air sampling system according to any one of the preceding claims, wherein the sampling pipe has a plurality of connection assemblies and sampling conduits arranged at spaced intervals along the sampling pipe to draw air from the low-temperature space at a number of respective spaced sampling points.

43. The air sampling system according to any one of the preceding claims, wherein the sampling system comprises sampling pipe network in which a plurality of said sampling pipes are arranged in spaced rows, wherein the sampling pipe network is connected to a plurality of said sampling conduits establishing a grid pattern of sampling points within the low-temperature space.

44. A kit for an air sampling system for a low-temperature space, the kit including: a sampling conduit to extend from the low-temperature space to outside the low-temperature space, the sampling conduit having an entry port and an exit port; and a connection assembly which is removably connectable with the exit port, at least one of the connection assembly and the sampling conduit having one or more apertures which are closable by the side wall(s) of the other of the connection assembly and the sampling conduit when the connection assembly is correctly connected with the sampling conduit.

45. A kit for an air sampling system for a low-temperature space, the kit including:

a sampling conduit to extend from the low-temperature space to outside the low-temperature space, the sampling conduit having an entry port and an exit port; and

a connection assembly which is removably connectable with the exit port for connecting the sampling conduit to a sampling pipe, the connection assembly having:

(i) a restrictor for restricting flow of sampling air, the restrictor having a first characteristic flow-impedance, and (ii) a passageway between the restrictor and the sampling pipe, wherein the passageway has a second characteristic flow-impedance that is less than the first characteristic flow impedance.

46. A kit for an air sampling system for a low-temperature space, the kit including:

a sampling conduit to from the low-temperature space to outside the low-temperature space, the sampling conduit having an entry port and an exit port; and

a connection assembly which is removably connectable with the exit port for connecting the sampling conduit to a sampling pipe, the connection assembly having: (i) a restrictor having an opening having a first cross-sectional area for restricting flow of sampling air, and (ii) a passageway between the restrictor and the sampling pipe, wherein the passageway has a minimum cross-sectional area that is greater than the first cross-sectional area.

47. A method of evaluating assembly of an air sampling network in network portion between (a) a sampling point for sampling air from a space being or to be monitored by an air sampling device, and (b) a sampling pipe outside the space, wherein the method comprises:

measuring a flow parameter;

determining, based on the flow parameter, the presence or absence of a flow restrictor component of the network portion; and

indicating a condition of assembly based on the determined presence or absence of the flow restrictor.

48. A computing system having:

a memory for storing a set of instructions that are executable by a processing system;

a processing system configured to read and execute the instructions, wherein upon executing the instructions the computing system performs the method according to claim 47.

49. An air sampling device having a computing system in accordance with claim 56.

50. An air monitoring system having an air sampling device and an air sampling system in accordance with any one of claims 1 to 43, wherein the air sampling system feeds into said sampling device.

51. An air monitoring system according to claim 50 wherein the air sampling device is an air sampling device according to claim 49.

52. An air monitoring system according to claim 50 or 51 wherein the air monitoring system is an aspirating smoke detection system.

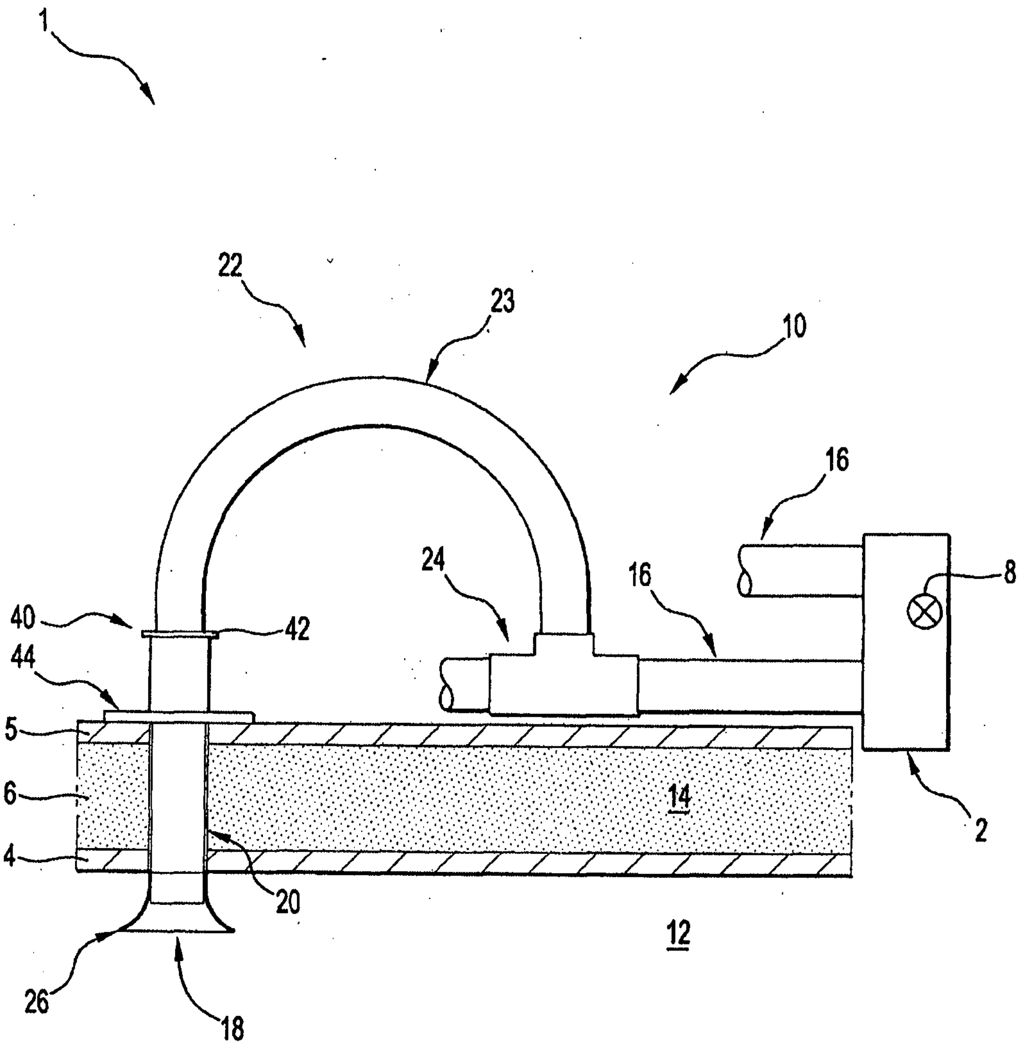


FIG. 1

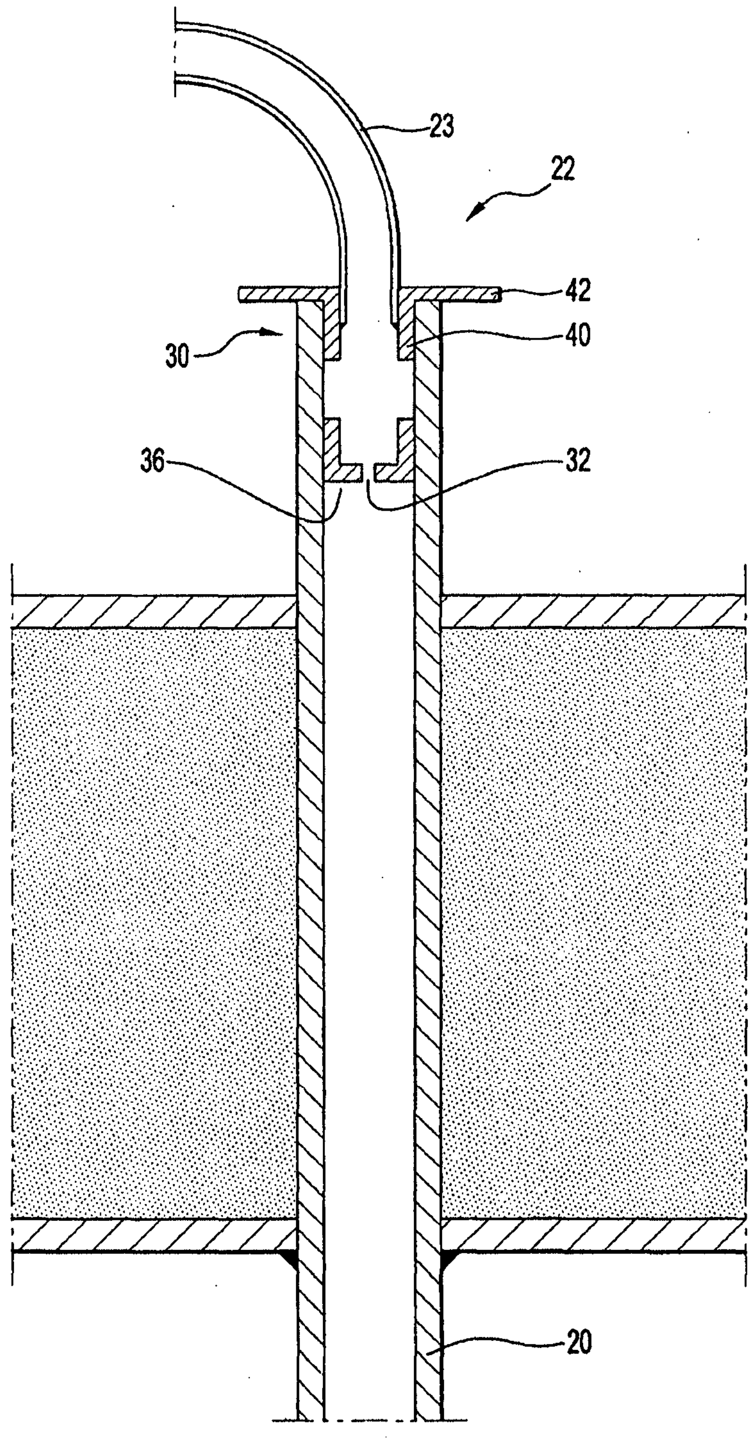


FIG. 2

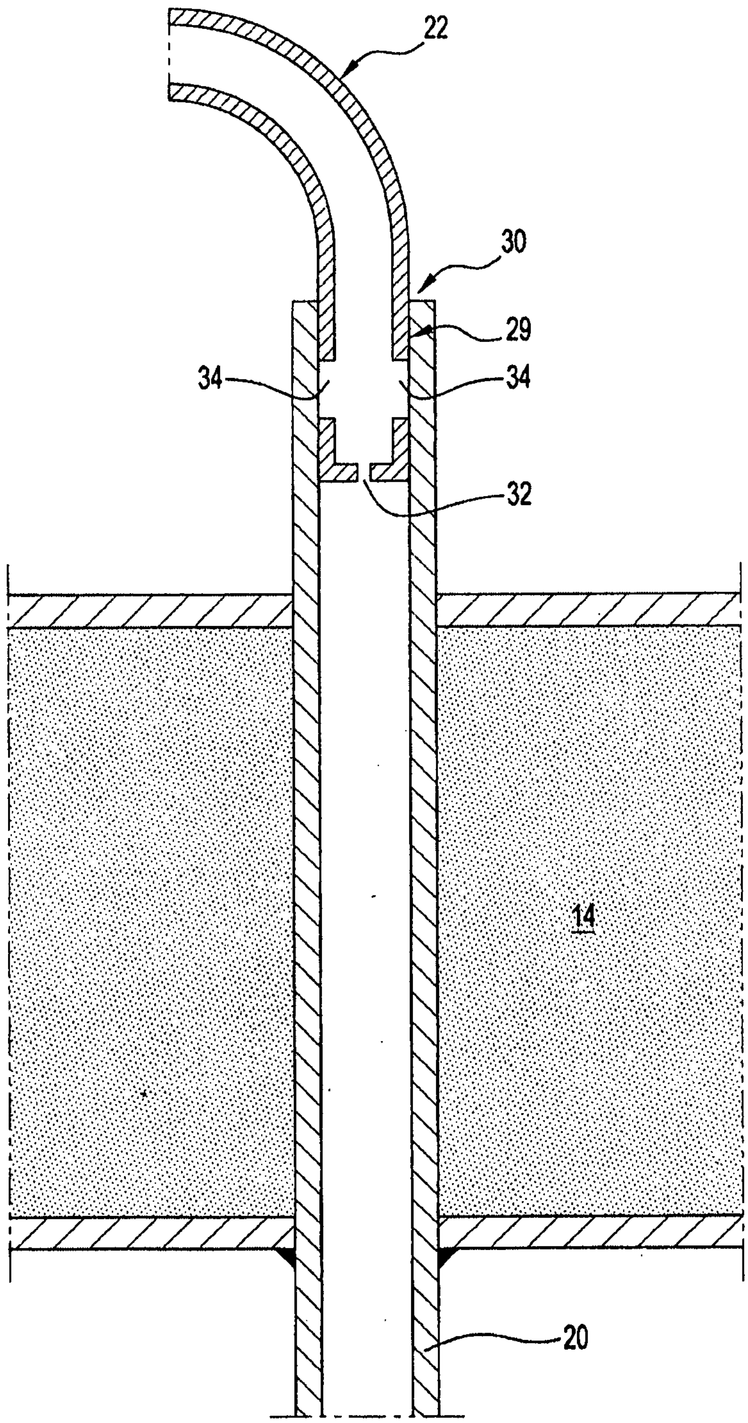


FIG. 3

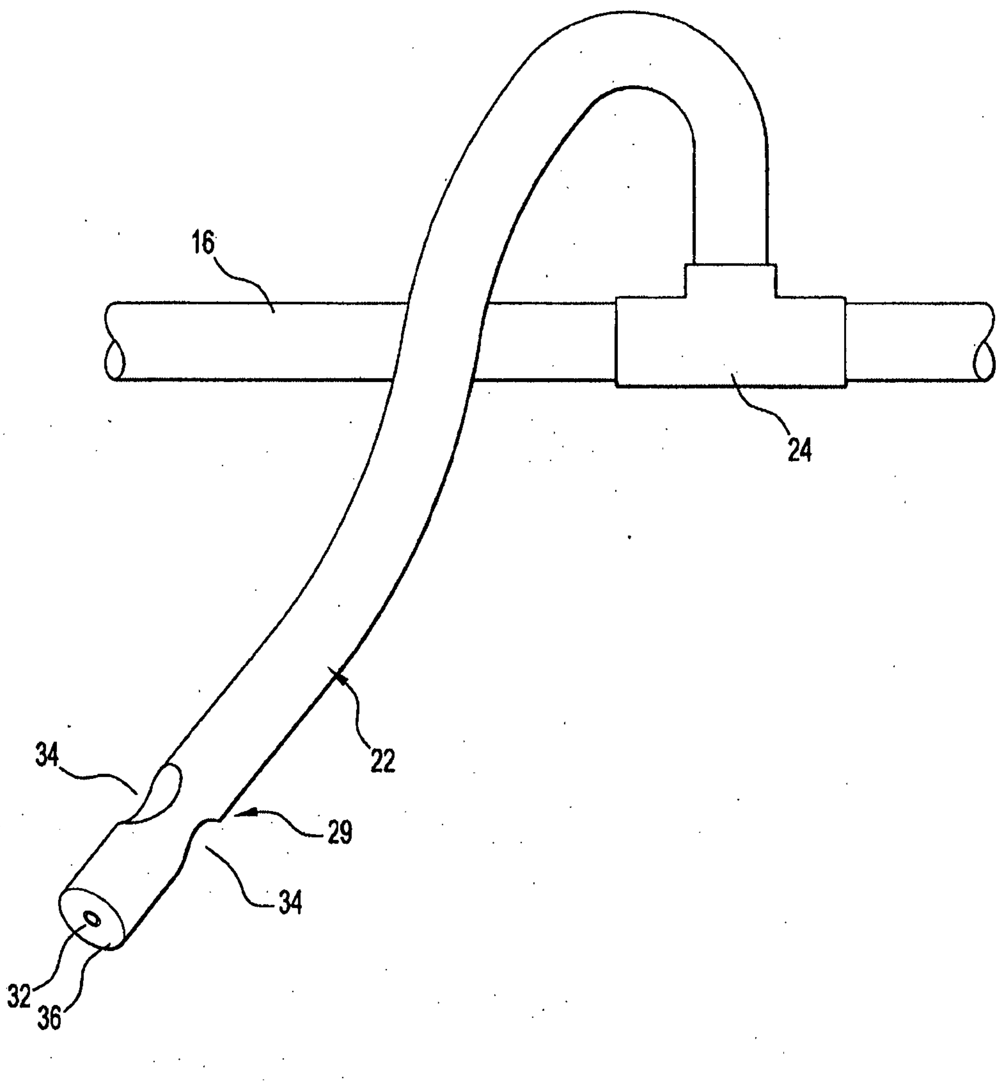


FIG. 4

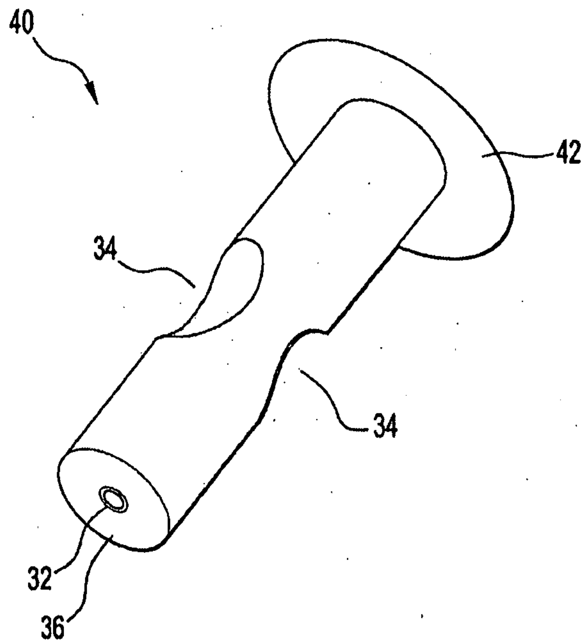


FIG. 5

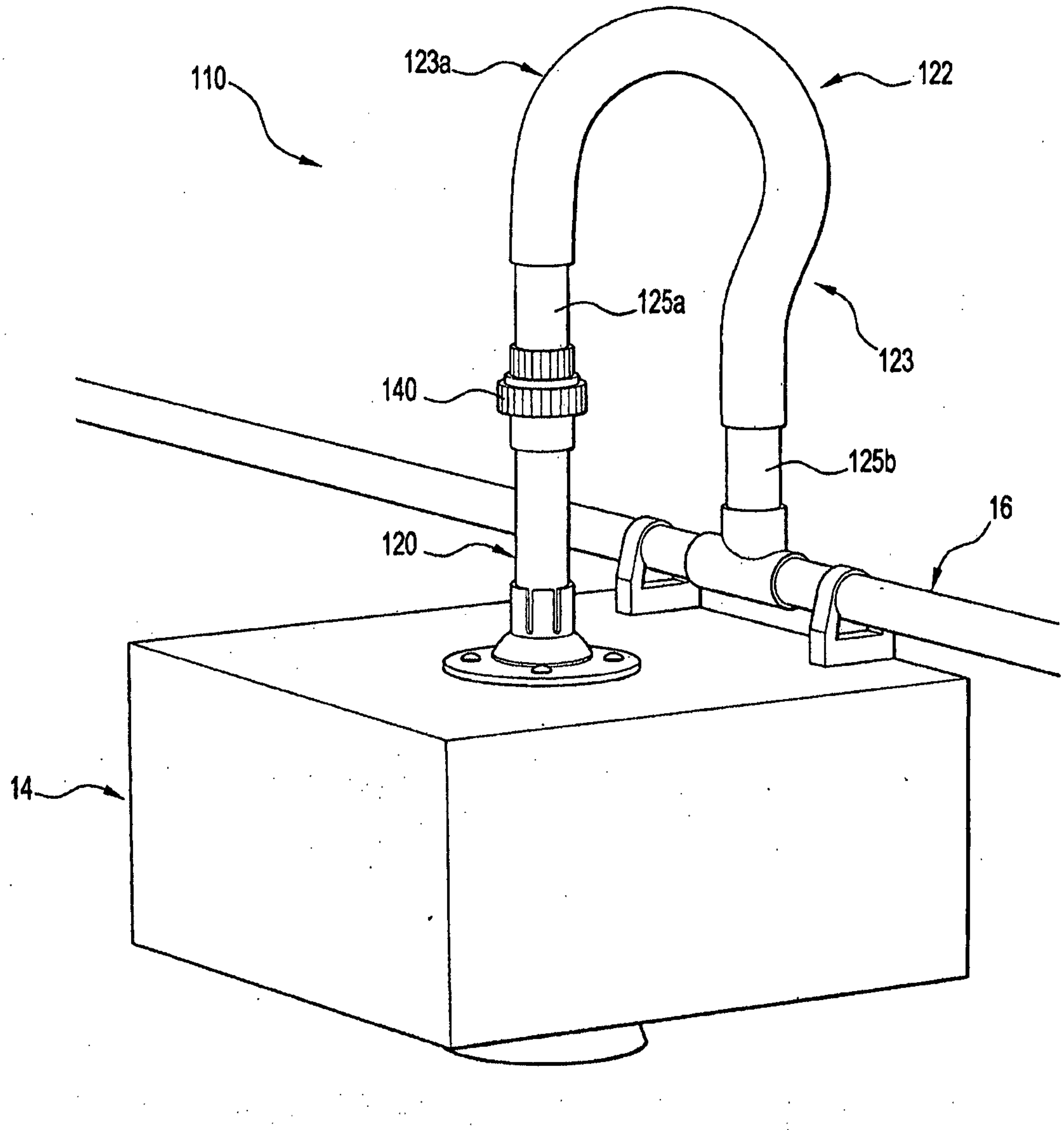


FIG. 6

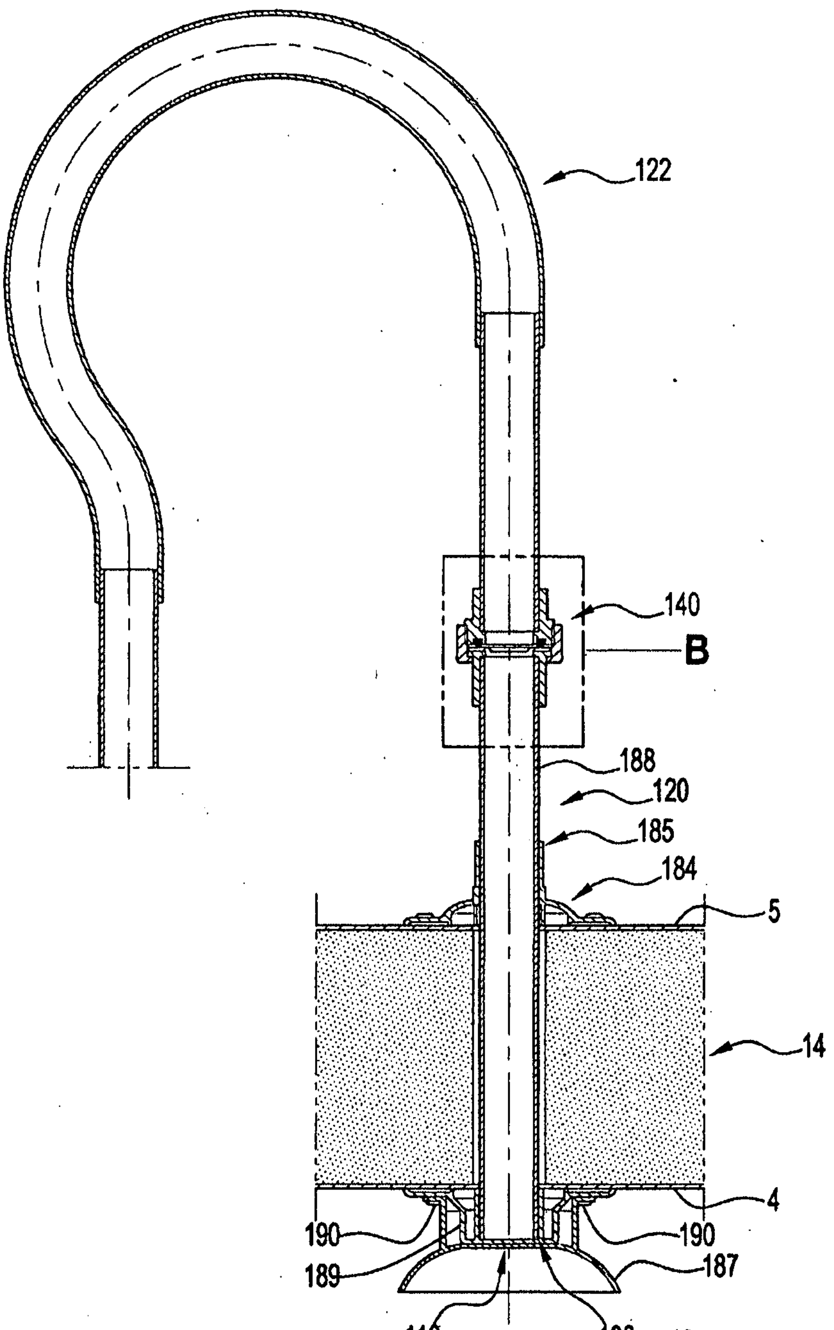
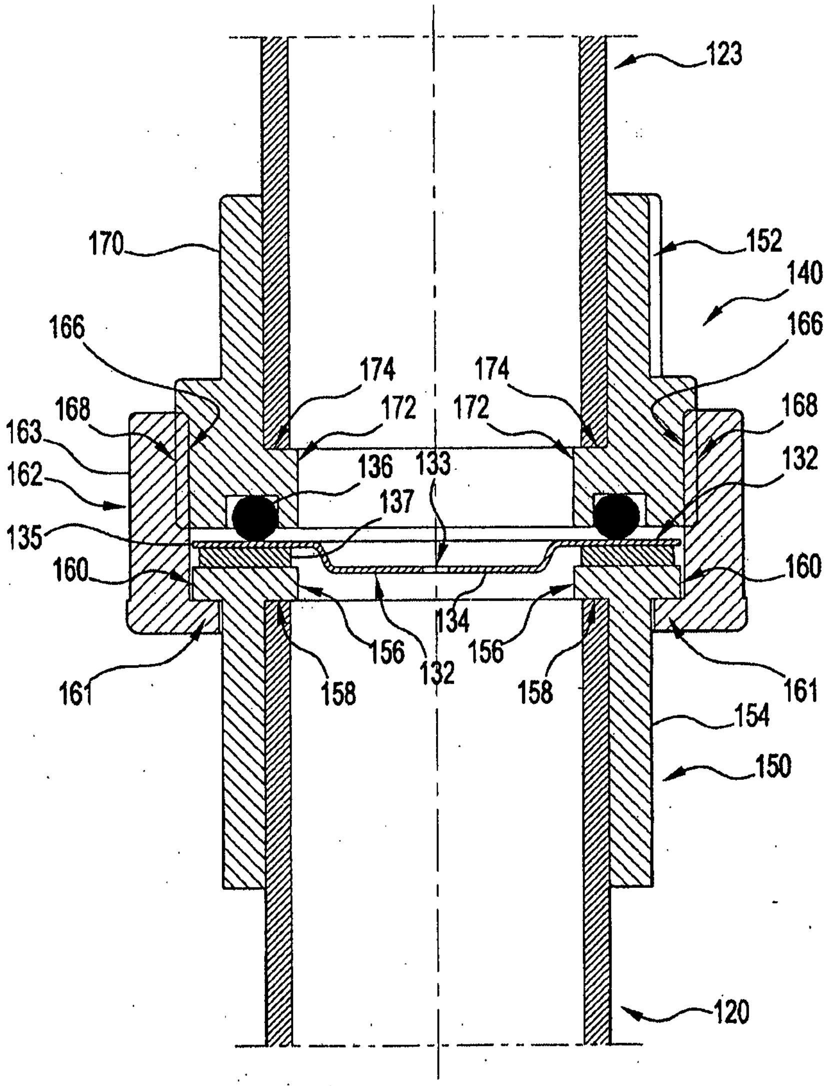


FIG. 7



DETAIL B

FIG. 8

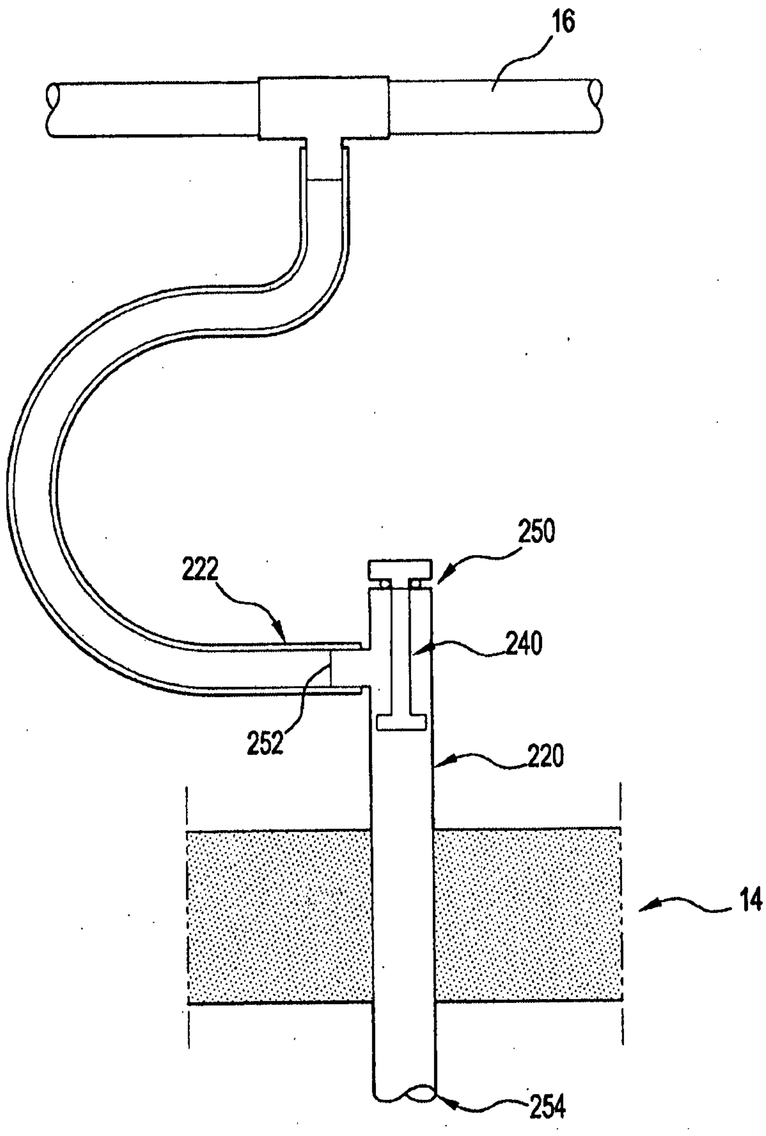


FIG. 9

INTERNATIONAL SEARCH REPORT	International application No. PCT/AU2013/001121

A. CLASSIFICATION OF SUBJECT MATTER

G08B 17/10 (2006.01) G05D 7/00 (2006.01) G05D 23/00 (2006.01) G01N 1/22 (2006.01)

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

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

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

Databases: ESPACENET, GOOGLE PATENTS, EPODOC, WPI

Keywords: Air, gas, smoke, detector, analyser, sampling, low temperature, freezing, cold, defrost, opening, access, hatch, disassemble, refrigeration, condensation, network, enclosure, impedance, aspiration, inlet, aperture and similar terms

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	Documents are listed in the continuation of Box C	

[X] Further documents are listed in the continuation of Box C   [X] 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	Date of mailing of the international search report
12 December 2013	12 December 2013
Name and mailing address of the ISA/AU	**Authorised officer**
AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA Email address: pct@ipaustralia.gov.au Facsimile No.: +61 2 6283 7999	ISAAC TAN AUSTRALIAN PATENT OFFICE (ISO 9001 Quality Certified Service) Telephone No. 0262832814

INTERNATIONAL SEARCH REPORT	International application No.
C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT	PCT/AU2013/001121

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 1893970 B1 (AIRCUITY INCORPORATED) 27 July 2011 [0009 - 0010], [0050 - 0051], [0063 - 0070], [0078 - 0081]	1, 3 - 4, 6 - 29, 50 - 52
A	US 4571079 A (KNOLLENBERG) 18 February 1986 Whole Document	1 - 29, 50 - 52
A	CA 1186915 A (BABCOCK & WILCOX COMPANY) 14 May 1985 Whole Document	1 - 29, 50 - 52

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of 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. ☐ Claims Nos.:

   because they relate to subject matter not required to be searched by this Authority, namely:

   the subject matter listed in Rule 39 on which, under Article 17(2)(a)(i), an international search is not required to be carried out, including

2. ☐ Claims 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. ☐ Claims 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:

See Supplemental Box for Details

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 claims 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 claims Nos.:

   1 - 29, 50 - 52

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.

Supplemental Box

Continuation of: Box III

This International Application does not comply with the requirements of unity of invention because it does not relate to one invention or to a group of inventions so linked as to form a single general inventive concept.

This Authority has found that there are different inventions based on the following features that separate the claims into distinct groups:

- Claims 1 - 29, 50 - 52. The feature of the sampling conduit being selectively accessible from outside the low temperature space for removal of ice build-up within the sampling conduit is specific to this group of claims.

- Claims 30 - 37. The feature of the sampling air when in the sampling pipe is above the freezing point of water and also above the temperature of the low-temperature space & a restrictor having a characteristic flow impedance for determining a flow-rate of the sampled air and is situated at a location sufficiently warm to prevent water vapour from causing a temperature-related blockage at the restrictor is specific to this group of claims.

- Claims 38, 39 - 43, 45, 46. The feature of a restrictor for restricting flow of sampled air and a passageway between the restrictor and the sampling pipe, wherein the passageway has a second characteristic flow-impedance/minimum crosssectional area that is greater than the first characteristic flow impedance/first cross-sectional area is specific to this group of claims.

- Claims 44. The feature of the sampling conduit having one or more apertures which are closable by the side wall(s) of the other of the connection assembly and the sampling conduit when the connection assembly is correctly connected with the sampling conduit is specific to this claim.

- Claims 47 - 48 & 49. The feature evaluating assembly of an air sampling network in network portion between (a) a sampling point for sampling air from a space being or to be monitored by an air sampling device, and (b) a sampling pipe outside the space, wherein the method comprises; measuring a flow parameter; determining, based on the flow parameter, the presence or absence of a flow restrictor component of the network portion; and indicating a condition of assembly based on the determined presence or absence of the flow restrictor is specific to this group of claims.

PCT Rule 13.2, first sentence, states that unity of invention is only fulfilled when there is a technical relationship among the claimed inventions involving one or more of the same or corresponding special technical features. PCT Rule 13.2, second sentence, defines a special technical feature as a feature which makes a contribution over the prior art.

When there is no special technical feature common to all the claimed inventions there is no unity of invention.

In the above groups of claims, the identified features may have the potential to make a contribution over the prior art but are not common to all the claimed inventions and therefore cannot provide the required technical relationship. The only feature common to all of the claimed inventions and which provides a technical relationship among them is the inclusion of a sampling conduit and sampling pipe.

However it is considered that this feature is generic in this particular art. See EP 1893970 B1 (AIRCUITY INCORPORATED) 27 July 2011.

Therefore in this light this common feature cannot be a special technical feature. Hence there is no special technical feature common to all the claimed inventions and the requirements for unity of invention are consequently not satisfied *a posteriori*.

INTERNATIONAL SEARCH REPORT Information on patent family members	International application No. **PCT/AU2013/001121**

This Annex lists known patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document/s Cited in Search Report		**Patent Family Member/s**	
Publication Number	**Publication Date**	**Publication Number**	**Publication Date**
EP 1893970 B1	27 Jul 2011	CN 101248345 B	06 Feb 2013
		EP 1800106 A1	27 Jun 2007
		EP 1893970 A1	05 Mar 2008
		EP 1893970 B1	27 Jul 2011
		JP 2008545990 A	18 Dec 2008
		JP 4955667 B2	20 Jun 2012
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		WO 2006034303 A1	30 Mar 2006
		WO 2006135575 A1	21 Dec 2006
US 4571079 A	18 Feb 1986	None	
CA 1186915 A	14 May 1985	None	

End of Annex

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.

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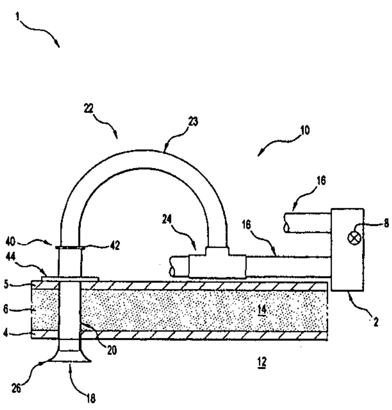
权利要求书5页 说明书10页 附图9页

(54)发明名称

抽样点

(57)摘要

公开了用于低温空间(12)的空气抽样系统(10、110)。所述空气抽样系统(10、110)包括：用于将抽样空气传给空气抽样设备(2)的空气抽样管道(16)；以及从低温空间(12)向低温空间(12)的外侧延伸的抽样导管(20、120)。抽样导管(20、120)连接到抽样管道(16)，其中抽样导管(20、120)从低温空间(12)的外侧是选择性地可接入的，以移除积聚在抽样导管(20、120)内的冰。还公开了用于空气抽样系统的设备。还公开了评估空气抽样网络的方法、计算系统、空气抽样设备和空气监测系统。



1. 一种用于低温空间的空气抽样系统，所述空气抽样系统包括：用于将抽样空气传给空气抽样设备的空气抽样管道；从低温空间的进入端口到所述低温空间的外侧延伸的抽样导管；所述抽样导管连接到所述抽样管道，其中所述抽样导管从所述低温空间的外侧是选择性地可接入的，以移除积聚在所述抽样导管内的冰。

2. 根据权利要求1所述的空气抽样系统，其特征在于，从所述低温空间的外侧向所述抽样导管的选择性的接入与所述抽样导管的纵向轴线相一致，以能够(i)实现穿过所述抽样导管的视线视觉检查并且(ii)将杆穿过所述抽样导管插入以从所述进入端口移除积聚的冰。

3. 根据权利要求1或2所述的空气抽样系统，其特征在于，所述抽样导管具有从其下游端部到其上游端部基本恒定的或者增加而不是减小的截面。

4. 根据权利要求1、2或3所述的空气抽样系统，其特征在于，通过使用接入开口，所述抽样导管从所述低温空间的外侧是选择性地可接入的。

5. 根据权利要求4所述的空气抽样系统，其特征在于，所述抽样导管的进入端口与所述接入开口至少在横截面方面是相同尺寸的。

6. 根据权利要求4或5所述的空气抽样系统，其特征在于，所述接入开口是接入舱口。

7. 根据权利要求6所述的空气抽样系统，其特征在于，所述接入舱口具有自关闭特征。

8. 根据前述任意一项权利要求所述的空气抽样系统，其特征在于，所述抽样管道通过所述抽样导管的下游端部上的连接总成连接到所述抽样导管的退出端口，由此所述连接总成从所述抽样导管的退出端口是选择性地可移除的。

9. 根据权利要求8所述的空气抽样系统，其特征在于，所述选择性可移除的连接总成是或者包括柔性连接件管道。

10. 根据权利要求8或9所述的空气抽样系统，其特征在于，所述连接总成在所述连接总成的配合部分或端部处具有限制配件，所述配合部分或端部与所述抽样导管的退出端口相连接并且是从所述抽样导管的退出端口选择性地可移除的，以及其中所述连接总成的限制配件包括限流器，所述限流器用于限制从所述低温空间穿过所述抽样导管到达所述抽样管道的抽样空气流。

11. 根据权利要求10所述的空气抽样系统，其特征在于，所述限流器包括在与所述抽样导管配合的所述限制配件的端部处形成小的进入端口的一个孔或多个孔，由此所述端部除了该孔或这些孔外是闭合的。

12. 根据权利要求10或11所述的空气抽样系统，其特征在于，所述限制配件包括一个孔或多个孔，所述孔在所述连接总成被正确地组装到所述抽样导管时是闭合的，从而能够探测所述连接总成与所述抽样导管的错误组装。

13. 根据权利要求12或13所述的空气抽样系统，其特征在于，所述一个孔或多个孔形成于所述限制配件的侧壁中，通过接触所述抽样导管的侧壁的内侧以闭合。

14. 根据权利要求10至13中任意一项所述的空气抽样系统，其特征在于，所述限制配件包括装配部分，所述装配部分具有：

用所述抽样导管密封的第一组件，

用所述抽样管道或例如是与所述抽样管道流体连通的连接件管道的组件密封的第二组件，以及

将所述第一组件和所述第二组件密封在一起的紧固组件。

15. 根据权利要求 14 所述的空气抽样系统，其特征在于，所述紧固组件的紧固通过螺纹连接到所述第一和第二组件中的一个来实现。

16. 根据权利要求 14 或 15 所述的空气抽样系统，其特征在于，所述第一与第二组件之间的密封由所述第一与第二组件之间的至少一个 O 形环或垫圈来提供。

17. 根据权利要求 14 至 16 中任意一项所述的空气抽样系统，其特征在于，所述限流器与所述装配部分是一体的或者被所述装配部分固定。

18. 根据权利要求 14 至 17 中任意一项所述的空气抽样系统，其特征在于，所述限流器在所述装配部分被组装时被固定在所述第一组件与所述第二组件之间。

19. 根据权利要求 1 至 9 中任意一项所述的空气抽样系统，其特征在于，所述空气抽样系统包括所述低温空间外侧的限流器。

20. 根据权利要求 19 所述的空气抽样系统，其特征在于，所述限流器被置于靠近所述抽样导管的端部。

21. 根据权利要求 10 至 20 中任意一项所述的空气抽样系统，其特征在于，所述限流器是流动限制垫圈或孔板。

22. 根据权利要求 10 至 21 中任意一项所述的空气抽样系统，其特征在于，所述限流器用于将穿过所述抽样导管的流限制到预定的流速。

23. 根据权利要求 10 至 21 中任意一项所述的空气抽样系统，其特征在于，穿过所述抽样导管的流由所述限流器和泵或风扇控制的压力来限定。

24. 根据权利要求 10 至 23 中任意一项所述的空气抽样系统，其特征在于，所述限流器被放置在比所述低温空间更温暖且足够远离所述低温空间的位置处，从而防止从所述低温空间抽样的水蒸气在所述限流器上结冰。

25. 根据权利要求 24 所述的空气抽样系统，其特征在于，所述限流器位于距离所述低温空间至少 30cm 处，以及／或者距离隔离所述低温空间的壁面板或隔离物的外侧表面至少 15cm 处。

26. 根据前述任意一项权利要求所述的空气抽样系统，其特征在于，所述低温空间是冷藏空间。

27. 根据权利要求 1 至 26 中任意一项所述的空气抽样系统，其特征在于，所述低温空间内的进入端口在所述低温空间的边界处。

28. 根据权利要求 1 至 27 中任意一项所述的空气抽样系统，其特征在于，所述进入端口涂有硅树脂以防止结冰。

29. 根据权利要求 1 至 28 中任意一项所述的空气抽样系统，其特征在于，所述抽样系统还包括在所述抽样导管的进入端口处的钟罩形或圆顶形的管嘴。

30. 一种用于低温空间的空气抽样系统，所述空气抽样系统包括：

用于将抽样空气传给空气抽样设备的空气抽样管道，所述空气抽样管道在所述低温空间的外侧排布，其中当所述抽样的空气在所述抽样管道中时，所述抽样的空气的温度高于水的结冰点并且还高于所述低温空间的温度；以及

抽样导管，所述抽样导管从所述低温空间延伸到所述抽样管道，用于从所述低温空间收集空气样品；

限流器，所述限流器具有用于确定所述抽样的空气穿过所述抽样导管的流速的特征流动阻抗，其中所述限流器位于所述低温空间与所述抽样管道之间，在足够温暖的位置处以防止水蒸气在所述限流器处造成与温度相关的堵塞。

31. 根据权利要求 30 所述的空气抽样系统，其特征在于，所述限流器是所述抽样导管的一部分。

32. 根据权利要求 30 所述的空气抽样系统，其特征在于，所述空气抽样系统还包括将所述抽样导管连接到所述抽样管道的连接总成，其中所述限流器是所述连接总成的一部分。

33. 根据权利要求 30、31 或 32 所述的空气抽样系统，其特征在于，所述与温度相关的堵塞是由所述限流器上的水蒸气的冷凝或结冰产生的堵塞。

34. 根据权利要求 30 至 33 中任意一项所述的空气抽样系统，其特征在于，所述限流器是小的进入端口。

35. 根据权利要求 30 至 34 中任意一项所述的空气抽样系统，其特征在于，所述抽样导管通过连接总成与所述抽样管道相连接，所述连接总成与所述低温空间外侧的所述抽样导管的退出端口可移除地相连接，其中所述可移除的连接总成包括 :(i) 用于限制抽样空气流的限流器，所述限流器具有第一特征流动阻抗，以及 (ii) 所述限流器与所述抽样管道之间的通道，其中所述通道具有小于所述第一特征流动阻抗的第二特征流动阻抗。

36. 根据权利要求 35 所述的空气抽样系统，其特征在于，所述限流器包括具有用于限制抽样空气流的第一横截面区域的开口，以及所述通道具有大于所述第一横截面区域的最小横截面区域。

37. 根据权利要求 30 至 36 中任意一项所述的空气抽样系统，其特征在于，所述抽样导管通过连接总成与所述抽样管道相连接，所述连接总成与所述低温空间外侧的所述抽样导管的退出端口可移除地相连接，其中所述可移除的连接总成包括 :(i) 限流器，所述限流器包括具有用于限制抽样空气流的第一横截面区域的开口，以及 (ii) 所述限流器与所述抽样管道之间的通道，其中所述通道具有大于所述第一横截面区域的最小横截面区域。

38. 一种用于低温空间的空气抽样系统，所述空气抽样系统包括 :用于将抽样空气传给空气抽样设备的空气抽样管道 ;从所述低温空间到所述低温空间的外侧延伸的抽样导管，所述抽样导管在所述低温空间的外侧通过连接总成连接到所述抽样管道，所述连接总成与所述抽样导管的退出端口可移除地相连接，其中所述可移除的连接总成包括 :(i) 用于限制抽样空气流的限流器，所述限流器具有第一特征流动阻抗，以及 (ii) 所述限流器与所述抽样管道之间的通道，其中所述通道具有小于所述第一特征流动阻抗的第二特征流动阻抗。

39. 一种用于低温空间的空气抽样系统，所述空气抽样系统包括 :用于将抽样空气传给空气抽样设备的空气抽样管道 ;从所述低温空间到所述低温空间的外侧延伸的抽样导管，所述抽样导管在所述低温空间的外侧通过连接总成连接到所述抽样管道，所述连接总成与所述抽样导管的退出端口可移除地相连接，其中所述可移除的连接总成包括 :(i) 限流器，所述限流器包括具有用于限制抽样空气流的第一横截面区域的开口，以及 (ii) 所述限流器与所述抽样管道之间的通道，其中所述通道具有大于所述第一横截面区域的最小横截面区域。

40. 根据前述任意一项权利要求所述的空气抽样系统，其特征在于，所述低温空间是具有 +4 摄氏度或以下温度的空间。

41. 根据前述任意一项权利要求所述的空气抽样系统，其特征在于，所述低温空间是冷藏空间。

42. 根据前述任意一项权利要求所述的空气抽样系统，其特征在于，所述抽样管道具有多个连接总成和沿着所述抽样管道被间隔地布置的抽样导管，以在多个相应的间隔开的抽样点处从所述低温空间抽取空气。

43. 根据前述任意一项权利要求所述的空气抽样系统，其特征在于，所述抽样系统包括抽样管道网络，多个所述的抽样管道以间隔的行被布置在所述抽样管道网络中，其中所述抽样管道网络连接到建立所述低温空间内的抽样点的网格样式的多个所述的抽样导管。

44. 一种用于针对低温空间的空气抽样系统的设备，所述设备包括：从所述低温空间向所述低温空间的外侧延伸的抽样导管，所述抽样导管具有进入端口和退出端口；以及连接总成，所述连接总成与所述退出端口可移除地相连接，所述连接总成和所述抽样导管中的至少一个具有一个孔或多个孔，所述的一个孔或多个孔在所述连接总成被正确地连接到所述抽样导管时由所述连接总成和所述抽样导管中的另一个的侧壁闭合。

45. 一种用于针对低温空间的空气抽样系统的设备，所述设备包括：

抽样导管，所述抽样导管从所述低温空间延伸到所述低温空间的外侧，所述抽样导管具有进入端口和退出端口；以及

连接总成，所述连接总成可移除地连接到所述退出端口，用于将所述抽样导管连接到所述抽样管道，所述连接总成具有：(i) 用于限制抽样空气流的限流器，所述限流器具有第一特征流动阻抗，以及 (ii) 所述限流器与所述抽样管道之间的通道，其中所述通道具有小于所述第一特征流动阻抗的第二特征流动阻抗。

46. 一种用于针对低温空间的空气抽样系统的设备，所述设备包括：

从所述低温空间向所述低温空间的外侧的抽样导管，所述抽样导管具有进入端口和退出端口；以及

用于将所述抽样导管连接到抽样管道的连接总成，所述连接总成可移除地连接到所述退出端口，所述连接总成具有：(i) 限流器，所述限流器包括具有用于限制抽样空气流的第一横截面区域的开口，以及 (ii) 所述限流器与所述抽样管道之间的通道，其中所述通道具有大于所述第一横截面区域的最小横截面区域。

47. 一种评估网络部分中的空气抽样网络的组装的方法，所述网络部分处于 (a) 用于从正被或将要被空气抽样设备监测的空间抽样空气的抽样点与 (b) 所述空间外侧的抽样管道之间，其中所述方法包括：

测量流动参数；

基于所述流动参数确定所述网络部分的限流器组件的存在或不存在；以及

基于确定的限流器的存在或不存在指示组装的状态。

48. 一种计算系统，具有：

用于存储一组由处理系统执行的指令的存储器；

处理系统，所述处理系统被配置为读取和执行所述指令，其中当执行所述指令时，所述计算系统执行根据权利要求 47 所述的方法。

49. 一种具有根据权利要求 56 的计算系统的空气抽样设备。

50. 一种空气监测系统，所述空气监测系统具有根据权利要求 1 至 43 中任意一项的空气抽样设备和空气抽样系统，其中所述空气抽样系统给入所述抽样设备中。

51. 一种根据权利要求 50 的空气监测系统，其特征在于，所述空气抽样设备是根据权利要求 49 的空气抽样设备。

52. 一种根据权利要求 50 或 51 的空气监测系统，其特征在于，所述空气监测系统是吸气式烟雾探测系统。

抽样点

技术领域

[0001] 本发明涉及针对低温空间的空气监测和/或抽样。优选地非排它地，本发明涉及用于冷藏设施的吸气式烟雾探测系统。然而，可理解地是，本发明可具有针对其它类型的空气监测系统的应用，所述其它类型的空气监测系统例如是可在低温空间中使用的气体探测系统、生物材料的喷雾探测或其它类型的烟雾探测系统。本发明还涉及用于针对低温空间的空气抽样系统的设备。

背景技术

[0002] 对于任意烟雾探测系统来说，寒冷的环境，尤其是冷藏设施是特别的且具有挑战性的环境。他们的特点是多变的低温和工人输送机械进出房间的频繁的运输流。虽然大多数房间具有某种形式的快速作用的自动门或塑料屏障帘子来限制温热空气进入，但是温热空气进入房间是不可避免的。这种伴随着常规温热空气进入的持续的运输流通常会在房间内产生冷凝，并且在周围的温度低于0摄氏度的情况下发生结冰。结冰会在安装装备和结构的任意顶壁以及所有顶壁上形成，通常在靠近入口点附近形成。

[0003] 冷藏设施中的烟雾探测系统是已知的。吸气式烟雾探测系统通常具有抽样管道网络，所述抽样管道网络具有多个抽样点以抽取用于测试的抽样空气。这些抽样点通常被置于冷藏空间的顶壁或侧壁上。然而，随着时间的推移，随着温热空气的进入，抽样点和相关的管道被冰堵塞。这导致了空气流动问题和对烟雾的无效探测。

[0004] 纠正这个问题（即，使孔或管道不堵塞）所需的维护是非常昂贵的。在某些情况下，最简单的已知的解决方案是去除最靠近抽样点的管道部分并安装新的管道部分。此外，维修期间，接近冷藏设施内的装备会变得不方便。

[0005] 针对其它低温环境的空气抽样系统存在类似的问题，所述其它低温环境例如寒冷的室外环境。一些与冷凝相关的问题会在大约4摄氏度（或者如果存在一定的条件，可能更高）的温度时开始出现，以及通常当温度下降到或低于水的冰点0摄氏度时会变得更糟。因此，本发明的目标是提供一种空气抽样系统和用于空气抽样系统的设备，其克服或至少改进上述与低温环境（尤其是冷藏环境）相关的问题中的一个问题。

[0006] 说明书中的现有技术不是，且不应被视为，对下述内容的承认或任意形式的建议，即该现有技术形成了澳大利亚或任意其它管辖区的公知常识部分，或该现有技术能够合理地期望为被确定、理解及认为是本领域技术人员掌握的技术。

发明内容

[0007] 根据本发明的第一方面，提供了用于低温空间的空气抽样系统，所述空气抽样系统包括：用于将抽样的空气传给空气抽样设备的空气抽样管道；从低温空间的进入端口到低温空间的外侧延伸的抽样导管；抽样导管连接到抽样管道，其中抽样导管从低温空间的外侧是选择性地可接入的，以移除积聚在抽样导管内的冰。

[0008] 抽样导管优选地具有一直段导管，其长度足以延伸穿过限定低温空间的边界的隔

离物、侧壁或顶壁，正如示例所示。因此，导管具有低温空间内的进入端口和低温空间外的退出端口。进入端口可通过处于低温空间的边界以在低温空间“内”，例如通过成为面向低温空间的隔离物中的孔。

[0009] 抽样导管的接入优选地与抽样导管的纵向轴线相一致，以能够进行视线视觉检查并且还能够插入杆或类似的工具来移除积聚的冰，所述积聚的冰通常在低温空间内的抽样导管的进入端口处（即，在抽样点处）产生。由于这个原因，抽样导管的进入端口优选地至少具有与接入开口相同的尺寸（在横截面方面）。通常，为了便于构造和清洁接入，抽样导管具有连续的横截面。另一特征是在抽样导管的进入端口处有钟罩形或圆顶形的管嘴。通常，抽样导管由圆柱形管道形成，优选地由塑料形成且通常直径约为25mm。进入端口可涂有硅树脂以防止结冰。抽样导管也可能绝缘。抽样导管可以是一体式构造，但这并不需要成为所述示例。

[0010] 优选地，空气抽样系统包括低温空间外侧的限流器，例如小的进入端口或限制配件。最优选地，限流器被置于靠近抽样导管的端部，或其下游。在某些情况下，限流器可位于抽样导管中或抽样导管的附近。

[0011] 通过使用接入开口，抽样导管从低温空间的外侧是选择性地可接入的。这可以是接入舱口的形式，例如滑动式关闭或铰链式关闭。优选地，任意的这样的接入舱口具有自关闭特征。

[0012] 在本发明的一种形式中，抽样导管借助于形成于其中的接入开口连接到抽样管道。在本发明的优选的形式中，抽样管道通过抽样导管的下游端部上的连接总成连接到抽样导管的外侧上的退出端口，由此连接总成从抽样导管的退出端口是选择性地可移除的。在该实施例中，可理解地是，抽样管道具有多个连接总成和沿着抽样管道被间隔地布置的抽样导管以在多个相应的间隔的抽样点处从低温空间抽取空气。本发明可包括一个以上的抽样管道。例如，抽样管道网络能够以间隔的行被布置，建立低温空间内的网格样式的抽样点。

[0013] 选择性可移除的连接总成可以是或者包括柔性连接件管道。连接总成优选地进一步地或可替换地包括装配到抽样管道并且还直接地或间接地接合到抽样导管的装配件，例如转接器、结合件或T形件。连接总成在配合部分或端部处具有限制配件，所述配合部分或端部可与抽样导管的退出端口相连接并且是从所述抽样导管的退出端口选择性地可移除的。限制配件可由连接总成的单独的或可分离的端部件限定或者可与连接总成一体形成。

[0014] 连接总成的限制配件包括用于抽样空气以及限定从低温空间穿过抽样导管到达抽样管道的流速的限流器，例如以小的进入端口的形式。限流器可位于与抽样导管配合的限制配件的端部处。例如，限流器可包括在限制配件的端部处形成小的进入端口的一个孔或多个孔，由此所述端部除了该孔（这些孔）外是闭合的。可替换地，限流器可以是与抽样导管配合的连接总成的端部的下游。在任意情况下，可理解地是，限流器是从抽样导管随着连接总成选择性地可移除的，使能够接入抽样导管的整个横截面，从而通过推动碎屑和/或冰穿过抽样导管的上游端部（即，面向低温空间的端部）来实现导管的清洁。

[0015] 抽样导管优选地被塑形，以使得抽样导管的管道的横截面从其下游端部到其上游端部保持基本地恒定（或者增加而不是减小），从而使冰或碎片在清洁期间被推动穿过抽样导管时不会堵塞在其上游端部处。

[0016]　可理解地是，由于限流器形成为连接总成的一部分，因此限流器可被容易地检查、（以及如果有必要）清洁或更换。这与下面的布置相反，在所述布置中，限流器与抽样导管是一整体或者仅从低温空间内是可接入的（例如，通过形成低温空间中的抽样孔的至少一部分）。

[0017]　还可理解地是，限流器可以是形成小的进入端口的多个孔的集合，而不是单个孔。限流器可以至少部分地通过比较限流器任意侧的流量增加湍流来实现限制。

[0018]　限制配件可包括一个孔或多个孔，所述孔在连接总成被正确地组装到抽样导管时是可闭合的。优选地，这些孔与小的进入端口相比是大的。在连接总成和抽样导管被恰当地组装时闭合的相对大的孔能够探测连接总成与抽样导管的错误地组装。如果连接总成和抽样导管没有被恰当地组装，那么孔会模拟破裂的管道状况，在所述状况下应该引发空气抽样设备（例如烟雾探测单元）中的急流故障。这对连接总成被从抽样导管疏忽地移除、不恰当地重新组装或者忘记将抽样导管重新组装到连接总成的简单行为起到防护作用。

[0019]　在本发明的优选的形式中，一个或多个大的孔形成在限制配件的侧壁中，通过与抽样导管的侧壁的内侧相接触以被闭合。优选地，有两个直接相对的孔。孔可以是圆形的，也可以是其它形状。

[0020]　在一个实施例中，限制配件还包括与连接总成的闭合的端部相对的法兰端部。这优选地用作将连接总成插入抽样导管中的止挡，以确保连接总成和抽样导管被正确地重新组装。

[0021]　在本发明的一种形式中，限制配件包括装配部分，所述装配部分由用于将一个管道接合到另一个管道的任意结合或者连结部分或总成形成。然而，优选地，装配部分具有用抽样导管密封的第一组件和用抽样管道或组件（例如与抽样管道流体连通的连接件管道）密封的第二组件。限制配件还包括将第一和第二组件密封在一起的紧固组件。优选地，通过螺纹连接到第一和第二组件中的一个来实现所述紧固。优选地，第一与第二组件之间的密封由第一与第二组件之间的至少一个 O 形环、垫圈等来提供。

[0022]　优选地，限流器与装配部分是一体的或者被装配部分固定。优选地，限流器用作将穿过抽样导管的流限制为预定的流速。优选地，限流器在装配部分被组装时固定在第一组件与第二组件之间。在一个实施例中，限流器是流动限制垫圈或孔板，所述垫圈或孔板优选地具有内直径，所述内直径小于抽样导管的内直径和限流器的上下游的连接总成的内直径。

[0023]　根据本发明的第二个方面，提供了用于低温空间的空气抽样系统，所述空气抽样系统包括：用于将抽样空气传给空气抽样设备的空气抽样管道；从低温空间到低温空间的外侧延伸的抽样导管，所述抽样导管可通过连接总成连接到抽样管道，所述连接总成在低温空间的外侧可移除地连接到抽样导管的退出端口，其中可移除的连接总成包括：(i) 用于限制抽样空气流的限流器，所述限流器具有第一特征流动阻抗，以及 (ii) 限流器与抽样管道之间的通道，其中所述通道具有小于第一特征流动阻抗的第二特征流动阻抗。

[0024]　优选地，在可移除的连接总成中的限流器的位置便于对小的进入端口的检查和任意必要的清洁。上文描述的与本发明的第一个方面关联的任意其它特征也可应用于此。例如，可移除的连接总成可包括一个或多个相对较大的孔和 / 或与大致闭合的端部相对的法兰端部。连接总成可包括在空气抽样管道与抽样导管之间延伸的连接件管道。在另一实施

例中，连接总成可直接地将抽样导管连接到抽样管道，而不包括中间连接件管道。

[0025] 在本发明的第三个方面中，提供了用于低温空间的空气抽样系统，所述空气抽样系统包括：用于将抽样空气传给空气抽样设备的空气抽样管道；从低温空间到低温空间的外侧延伸的抽样导管，所述抽样导管可通过连接总成连接到抽样管道，所述连接总成在低温空间的外侧可移除地连接到抽样导管的退出端口，其中可移除的连接总成包括：(i) 用于限制抽样空气流的限流器，所述限流器具有包含有第一横截面区域的开口，以及 (ii) 限流器与抽样管道之间的通道，其中所述通道具有大于第一横截面区域的最小的横截面区域。

[0026] 根据本发明的第四个方面，提供了一种用于低温空间的空气抽样系统，所述空气抽样系统包括：

[0027] 用于将抽样空气传给空气抽样设备的空气抽样管道，所述空气抽样管道在低温空间的外侧排布，其中当抽样空气在抽样管道中时，抽样的空气的温度高于水的结冰点并且还高于低温空间的温度；以及

[0028] 抽样导管，所述抽样导管从低温空间延伸到抽样管道，用于从低温空间收集空气样品；

[0029] 限流器，所述限流器具有用于确定抽样的空气穿过抽样导管的流速的特征流动阻抗，其中限流器位于低温空间与抽样管道之间，在足够温暖的位置处以防止水蒸气在限流器处造成与温度相关的堵塞。

[0030] 在一个实施例中，限流器是抽样导管的一部分。在另一个实施例中，空气抽样系统还包括将抽样导管连接到抽样管道的连接总成，其中限流器是连接总成的一部分。限流器可以与抽样导管或连接总成整体形成。

[0031] 与温度相关的堵塞可以是由限流器上的水蒸气的冷凝（尤其是结冰）产生的堵塞。

[0032] 对于本发明的这方面以及所有其它方面优选地，低温空间是具有 +4 摄氏度或以下温度的空间。这样的低温空间有利地是冷藏空间，优选地由周围的壁、地板和顶壁封闭。

[0033] 在低温空间是冷藏空间的情况下，低温空间的温度优选地在 -40 摄氏度与 +4 摄氏度之间，但是一般为（或大约为）-25 摄氏度。由此低温空间低于 0 摄氏度，优选地，限流器被放置在足够远离低温空间的位置处的更温暖的环境中，从而防止从低温空间抽样的水蒸气在限流器上结冰。在一个实施例中，限流器位于离冷藏空间的内部至少 30cm 处。优选地，限流器位于距离隔离低温空间的壁面板或隔离物的外侧表面至少 15cm，以及优选地在 15cm 至 25cm 之间。流速除了由限流器的特征阻抗来确定之外，也由泵或风扇控制的压力来确定。然而，可选地，限流器的特征流动阻抗可以如此以使限流器用作流动限制设备。

[0034] 根据本发明的第五个方面，提供了用于针对低温空间的空气抽样系统的设备，所述设备包括：从低温空间向低温空间的外侧延伸的抽样导管，所述抽样导管具有进入端口和退出端口；以及连接总成，所述连接总成可移除地连接到退出端口，连接总成和抽样导管中的至少一个具有一个孔或多个孔，所述的一个孔或多个孔在连接总成被正确地连接到抽样导管时由连接总成和抽样导管中的另一个的侧壁闭合。

[0035] 上文描述的与本发明的其它方面关联的任意特征可应用于本发明的第四个方面。

[0036] 根据本发明的第六个方面，提供了用于针对低温空间的空气抽样系统的设备，所

述设备包括：

[0037] 抽样导管，所述抽样导管从低温空间延伸到低温空间的外侧，所述抽样导管具有进入端口和退出端口；以及

[0038] 连接总成，所述连接总成可移除地连接到退出端口，用于将抽样导管连接到抽样管道，所述连接总成具有：(i) 用于限制抽样空气流的限流器，所述限流器具有第一特征流动阻抗，以及 (ii) 限流器与抽样管道之间的通道，其中所述通道具有小于第一特征流动阻抗的第二特征流动阻抗。

[0039] 优选地，限流器包括具有第一横截面区域的开口，所述第一横截面区域用于确定第一特征阻抗，以及通道具有大于第一横截面区域的最小横截面区域，以使第二特征阻抗小于第一特征阻抗。

[0040] 在一个实施例中，限流器大致是连接总成的闭合端部，所述闭合端部具有用于抽样空气的小的进入端口。

[0041] 在本发明的第七个方面中，提供了用于针对低温空间的空气抽样系统的设备，所述设备包括：

[0042] 从低温空间向低温空间的外侧延伸的抽样导管，所述抽样导管具有进入端口和退出端口；以及

[0043] 用于将抽样导管连接到抽样管道的连接总成，所述连接总成可移除地连接到退出端口，所述连接总成具有：(i) 用于限制抽样空气流的限流器，所述限流器具有包含有第一横截面区域的开口，以及 (ii) 限流器与抽样管道之间的通道，其中所述通道具有大于第一横截面区域的最小横截面区域。

[0044] 可理解地是，本发明的第一个到第七个方面中的任意一个方面还可包括用于将抽样导管穿过隔离冷藏空间的侧壁、地板或顶壁安装的安装系统。

[0045] 在本发明的第八个方面中，提供了评估网络部分中的空气抽样网络的组装的方法，所述空气抽样网络在 (a) 用于从正被或将要被空气抽样设备监测的空间抽样空气的抽样点与 (b) 空间外侧的抽样管道之间，其中所述方法包括：

[0046] 测量流动参数；

[0047] 基于流动参数确定网络部分的限流器组件的存在或不存在；以及

[0048] 基于确定的限流器的存在或不存在指示组装的状态。

[0049] 优选地，抽样设备是颗粒探测器。

[0050] 优选地，当测得的流动参数大于预定阈值时，所述方法确定故障状态。在一个实施例中，预定阈值是第一流速与第二流速之间的值，所述第一流速是网络部分被正确地组装的正常值，所述第二流速是组装为没有限流器组件的网络的期望的值。在另一个实施例中，预定阈值是第一流速与第二流速之间的值，所述第一流速是网络部分被正确地组装的正常值，所述第二流速是当抽样点从抽样管道分离后期望的值。

[0051] 在一个实施例中，所述方法评估 (a) 抽样管道与 (b) 抽样导管的退出端口之间的组装，所述抽样管道被配置为用于将来自连接总成的空气传给颗粒探测器，所述抽样导管被配置为用于将来自监测的空间的空气传给连接总成，其中在抽样网络的正确的组装中，限流器组件形成连接总成的一部分。

[0052] 优选地，所述方法包括将测量的流动参数与阈值流动值进行比较，所述阈值流动

值在限流器被连接时被选择为大于期望的速率。在一个实施例中，阈值流动值在空气抽样管道和抽样导管被连接（但没有连接限流器）时进一步地被选择为小于期望的流速。有利地，这提供了具有灵敏性以探测实现了连接但限流器不存在的方法。可通过经验得到阈值，或者从相应的抽样导管、限流器和抽样管道的已知的特征流动阻抗来计算阈值。

[0053] 优选地，根据本发明的其它方面中的任意一个方面，连接总成提供了连接。

[0054] 本领域技术人员可领会地是，限流器的特征流动阻抗优选地被选择为大于抽样导管和连接总成的限流器以外的所有部分的特征阻抗。以此方式，易于测量限流器对抽样导管和连接总成的总阻抗的影响，以及因此对抽样空气流的影响。

[0055] 在本发明的第九个方面中，提供了计算系统，所述计算系统具有：用于存储一组可由处理系统执行的指令的存储器；以及处理系统，所述处理系统被配置为读取和执行指令，其中当执行指令时，计算系统执行根据本发明的第八个方面的方法。优选地，流动传感器是超声流动传感器，但可使用其它类型的流动传感器，例如热式流动传感器、流速仪等。

[0056] 在本发明的第十个方面中，提供了具有根据本发明的第九个方面的计算系统的空气抽样设备。优选地，空气抽样设备是（或包括）颗粒探测器，更优选地为烟雾探测器。

[0057] 在本发明的第十一个方面中，提供了空气监测系统，所述空气监测系统具有根据本发明的第一、第二、第三或第四个方面中的任意一个方面的空气抽样系统，其中空气抽样系统给入所述抽样设备中。优选地，颗粒探测器是根据本发明的第十个方面的颗粒探测器。优选地，空气监测系统是颗粒探测系统，更优选地是烟雾探测系统。

[0058] 可理解地是，说明书中公开的和限定的本发明延伸到文本或附图中提到的或明示的相应特征中的两个或多个的所有可替换的结合。所有这些不同的结合构建了本发明的多个可替换的方面。

[0059] 正如此处所使用的，除了上下文背景的需要，否则术语“包括”及其变体，例如“包含”，“包括有”和“由……组成”并不排除另外的附加物、组件、整体或步骤。

附图说明

[0060] 为了更全面地理解本发明，现在将参照附图、以示例的方式描述一个实施例，其中：

[0061] 图 1 是根据本发明的实施例的具有空气抽样系统的颗粒探测系统的示意图；

[0062] 图 2 是图 1 的空气抽样系统的部分的详细示图；

[0063] 图 3 是图 1 中所示的空气抽样系统的可替换的实施例的详细示图；

[0064] 图 4 是图 1 的空气抽样系统的另一部分的立体图，对应于图 3 中所示的示图；以及

[0065] 图 5 是对应于图 2 中所示的实施例的端部件的详细示图；

[0066] 图 6 是根据本发明的另一实施例的空气抽样系统的部分的示图；

[0067] 图 7 是穿过图 6 中所示的空气抽样系统的纵向截面图；

[0068] 图 8 是在图 6 和图 7 的空气抽样系统中所示的限制配件的放大示图；以及

[0069] 图 9 是根据本发明的另一实施例的空气抽样系统的示意图。

具体实施方式

[0070] 下文结合针对冷藏空间的使用描述了本发明的示例性实施例。然而，本发明能够

可替换地应用于其它低温环境，例如寒冷的室外环境。

[0071] 还结合颗粒探测系统描述了示例性实施例，在所述颗粒探测系统中，通过空气抽样设备（颗粒探测器）来实现对抽样的空气的监测。然而，空气监测系统或抽样设备可进一步地或可替换地适于分析和/或探测空气的其它特性或组分。例如空气监测系统或抽样设备可以是气体探测器或能够探测一个或多个目标气体的存在和/或浓度的其它设备。这种空气抽样设备的一个示例以Vesda Eco的产品名称由Xtralis Technologies Ltd（艾克利斯技术有限公司）出售。

[0072] 图1以颗粒探测系统1的形式示出用于冷藏空间12的空气监测系统。冷藏空间12通常由地面、侧壁和包括顶壁面板14的顶壁围成。顶壁和墙壁可以是绝缘的隔离物或具有绝缘的夹层构造，正如现有技术中已知的。但是通常，夹层构造相应包括内部和外部的金属面板4和5，在金属面板4、5之间具有泡沫绝缘物6。

[0073] 颗粒探测系统1包括吸气式烟雾探测器形式的颗粒探测器2，以及从冷藏空间12抽取空气的空气抽样系统10。因此，冷藏空间12的外部是抽样管道16的网络，图1中示出了其中两个抽样管道。抽样管道连接到顶壁面板14上方的抽样设备，在这个例子中，抽样设备是吸气式烟雾探测器2。抽样管道16沿着冷藏空间12的外侧排布，从而直接地或通过临近抽样设备2的歧管（未显示）连接到抽样设备2。风扇8可设置在吸气式烟雾探测器单元内或抽样管道网络中的其它位置，以从冷藏空间12抽取空气，使其穿过抽样系统10到达烟雾探测器2。此外，对于烟雾探测器单元的出口，还可以反馈进入冷藏空间12中以创建闭环系统（未显示），从而避免在探测器单元由于任意原因断电时将温暖的和潮湿的空气引入冷藏空间12。

[0074] 每个抽样管道16可包括在冷藏空间12内的间隔排列的位置处的多个抽样点18。每个抽样点存在于相应的抽样导管20的进入端口处，所述抽样导管20通过连接器总成22连接到抽样管道16。连接总成22包括柔性连接件管道23，所述柔性连接件管道23位于配合到抽样导管20的限制配件40和配合到抽样管道16的T接头配件24之间。因此，连接总成形成源自抽样管道的分支，所述分支包括抽样导管。

[0075] 沿着抽样管道16的单根长度可存在多个这样的T接头24，由此提供沿着抽样管道16的单根长度的多个抽样点18。此外，可理解地是，抽样管道16的多根长度能够并排地被布置以创建抽样点18网格（或其它几何结构）。

[0076] 正如示例所示的那样，抽样导管20足够长以延长穿过顶壁面板14或壁面板的宽度。如图2和图3最清楚地示出，抽样导管20从冷藏空间的内侧延伸到冷藏空间的外侧。正如图1中所示的，抽样导管20的内侧端（进入端口）可设置有钟罩形的抽样管嘴26。

[0077] 在抽样导管20的另一端处，连接总成22被收纳在抽样导管20的退出端口30中。在图3和4中，柔性连接总成22具有整体的端部构造，因此柔性连接件管道23的端部29用作限制配件40。该实施例中的限制配件29包括小的进入端口32以限制抽样流，以及两个相对较大的侧孔34。小的进入端口32被布置在限制配件29的大致封闭的端36中的中间位置中。两个较大的孔34被布置在限制配件29的侧壁中。从图3可理解地是，当限制配件29的端部被正确地插入到抽样导管20的退出端口30中时，通过相对于抽样导管20的壁的内侧面进行密封可封闭大孔34。然而，从图4可理解地是，如果连接总成22的限制配件29没有恰当地插回到抽样导管20中时，那么大孔34能够抽进大量的空气，足够引发探

测器单元 2 内的故障。

[0078]　优选地，穿过大孔 34 的泄漏接近于破裂的管道的泄露。因此，孔 34 可能具有与管道 16 相似的截面面积。

[0079]　图 2 和图 5 示出可替换的实施例，由此连接总成 22 包括多个组件部分，所述的多个组件部分优选地是彼此分离的。多个组件之一是连接件管道 23。在该实施例中，连接件管道有利地是柔性的，但可理解地是，也可使用刚性连接件管道。附接到连接件管道 23 的一端的是转接器形式的限制配件 40。限制配件 40 构成连接总成 22 的第二组件，并将柔性管道 23 安装到抽样导管 20。因此，限制配件 40 用作连接总成 22 的端部件。限制配件 40 包括在大致封闭的端部 36 处的小的进入端口 32，还有两个直接相对地、相对较大的孔 34，它们都用于与上文所描述的类似的目的。此外，限制配件 40 包括外围法兰 42，所述外围法兰 42 用于将限制配件 40 定位在抽样导管 20 内它的适当的安装位置中。包括法兰 42、外围侧壁和大致封闭的端部 36 的限制配件 40 优选地为一件式即整体式构造。限制配件 40 可以是整体成型件。可理解地是，与将小的进入端口 32 和孔 34 加工到柔性管道 22 的端部中或在柔性管道 22 的端部中形成小的进入端口 32 和孔 34 相比，提供单独的限制配件 40 是更简单的构造。

[0080]　图 6 中示出了可替换的空气抽样系统 110 的实施例。空气抽样系统 110 采用可替换的连接总成 122，所述连接总成 122 与空气抽样系统 10 中的连接总成 22 相似，并且可与空气抽样系统 10 中的连接总成 22 互换使用。在该实施例中，连接件管道 123 包括柔性管道段 123a，所述柔性管道段 123a 分别在上游和下游结束于刚性管道件 125a 和 125b。然而，可理解地是，管道 123 能够按需与穿过其整个长度或针对整个长度的任意部分的柔性或刚性管道互换。连接总成 122 包括用于将连接总成 122 安装到抽样导管 120 的可替换的限制配件 140。

[0081]　图 7 示出穿过连接总成 122 和抽样导管 120 的纵向截面图。连接总成 122 能够可替换地附接到图 1 至图 3 的抽样导管 20。

[0082]　图 8 中示出了接合到抽样导管 120 和连接件管道 123 的限制配件 140 的放大图。限制配件 140 包括具有第一组件 150 和第二组件 152 的联合配件形式的装配部分，所述第一组件 150 在该示例中被配置为由抽样导管 120 密封，以及所述第二组件 152 在该示例中被配置为由连接件管道 123 密封。然而，可理解地是，限制配件的定向可被反转，从而使第一组件 150 和第二组件 152 分别与连接件管道 123 和抽样导管 120 相配合。

[0083]　第一组件 150（该示例中的上游组件）包括箍环 154，所述箍环 154 与抽样导管 120 紧密配合。箍环的顶部（下游端）具有置于抽样导管 120 的边缘 158 上的内部法兰 156。箍环 150 的顶部还包括用于与紧固件 162 的底部内部法兰 161 干预性地相邻接的向外的法兰 160。这将在第一组件 150 附接到抽样导管 120 处时防止紧固件 162 从抽样导管 129 被移除开。从紧固件的内部法兰 161 向上延伸的是具有内部螺纹 166 的紧固环 163，其能够旋在第二组件 152 的底部外侧表面上的螺纹 168 上，从而将第二组件 152 朝向第一组件 150 收紧并产生它们之间的密封。第二组件具有内部法兰箍环 170 和内部法兰 172，所述内部法兰箍环 170 与连接件管道 123 紧密配合，所述内部法兰 172 置于连接件管道 123 的底部边缘 174 下方且与所述底部边缘相邻接。

[0084]　在第一组件 150 与第二组件 152 之间的是孔板形式的限流器 132。然而，限流器

132 还被塑形从而以自定位的方式装配到抽样导管上。这通过从限流器的外缘 135 凹陷的限流器 132 的中心部分 134 来实现。在该实施例中，限流器是金属的，而在其它实施例中，可以使用非金属材料，例如塑料或橡胶。

[0085] 通过在限流器 132 的相应的侧面上的橡胶 O- 环形密封件 136 和环形自粘的泡沫密封件 137 可产生第一组件 150 与第二组件 152 之间的密封。这产生了第一组件 150 和限流器 132 之间的密封，以及限流器 132 和第二组件 152 之间的密封。

[0086] 限流器具有内直径（即，O- 环形孔 133 的直径），所述内直径小于到抽样管道 16 的下游流动路径的内直径。因此，孔 133 的直径小于第二组件 152 的内直径，并且也小于连接件管道 123 的内直径。孔 133 的直径类似地小于整个抽样导管（包括抽样导管的端部处的抽样点）的内直径。孔 133 的精确直径被选择以提供期望的流动限制，所述流动限制由抽样系统 10 和探测器 2 的尺寸和构造以及风扇 8 的特性来决定。直径能够以任意已知的方式被确定，所述任意已知的方式包括使用专门为该目的设计的软件，例如 Xtralis Technologies Ltd.（艾克利斯技术有限公司）的 VESDA ASPIRE2 管道网络设计软件。通常，孔的直径在 2mm 到 10mm 之间。本领域技术人员可理解的是，限流器 132 可以通过具有多个孔，而非单个孔 132 来实现对空气流的限制。在本示例中，所有限流器的孔的组合的横截面与单个孔 132 的横截面相同。通过比较，抽样导管和连接件管道的各自的最小（并且在本示例中是恒定的）内直径都是 25mm。

[0087] 根据这种设计，限流器 132 的特征流动阻抗控制着对从冷藏空间抽样到抽样管道 16 的空气流的总的阻抗。相应地，如果限流器 132 不存在（例如如果抽样系统 110 没有被正确地组装），那么穿过抽样网络 110 的流速会增加。可通过具有换能器（未示出）的流速仪表来测量流速，所述流速仪表在颗粒探测器 2 处或在抽样系统 110 中的其它位置处。在一个配置中，可在抽样导管 120 中或连接总成 122 中测量流量，但优选地是在连接总成的下游端处。可替换地，通过将流动测量换能器包括在抽样管道 16 中、抽样导管 122 的上游和下游中能够获得精确的测量值。两个换能器测量值之间的流量的差值可归因于穿过抽样导管 120 和连接总成 122 的流。在该实施例中，通过超声换能器来测量流量，而在其它实施例中，可使用其它类型的流动传感器，例如热式流动传感器。

[0088] 可理解地是，限制配件的部分可整体形成或永久地与抽样导管 120 相连接。然而，甚至在该示例中，限流器组件 133 优选地应该仍旧是可以从抽样导管 120 移除的（或至少可替换的），从而方便地接入抽样导管以实现清洁。为了说明这种变化的原因，此处使用的术语“抽样导管”是指抽样网络的从冷藏空间向上到达限流器（但不包括限流器）的部分。限流器本身是“限制配件”的一部分，其是与抽样导管分隔的整体，即使在抽样导管 120 包括与限流器相互作用以使其能被移除、替换、安置或紧固的一部分或多个部分的情况下。

[0089] 在本发明的另一实施例中，或者作为前述实施例的附加特征，限流器被放置在抽样网络中抽样点的足够下游的位置处，从而处于高于水的结冰点的温度，即，高于 0 摄氏度。在这种布置中，限流器无需是连接总成的一部分。图 9 示出了这种布置的实施例，其示出了限流器配件 240 从抽样导管 220 中的第一开口 250 移除。抽样导管具有第二开口 252，所述第二开口 252 形成抽样导管的向抽样管道的输出端，并且流体连接到连接总成 222。限制配件限制导管 222 的抽样点 254 与第二开口 252 处的输出端之间的抽样流。

[0090] 可理解地是，限制配件 250 可替换地被置于抽样导管的抽样点 254 与输出端 252

之间的其它位置处。虽然限制配件 250 可以从抽样导管 220 移除是有利的，但在一些实施例中，限流器被永久地固定到抽样导管 220 或者与抽样导管 220 整体形成。尽管如此，将限流器安置在抽样空气（以及抽样导管的温度）被周围的环境足够地加热从而高于水的结冰点的地方是有利的。因此，限流器不会被冰堵塞。这能够减少抽样网络的维修需要或规律。

[0091]　对于限流器在抽样管道网络的初始组装期间或维修后的组装期间被错误地遗漏的实施例，可使用一种方法来评估该组装。所述方法包括测量流动参数和指示组装的状态，所述组装的状态是网络的评估部分中的限流器 40、140、240 存在或不存在的决定因素。所述方法评估 (a) 抽样点 18、118、254 与 (b) 空间外的抽样管道 16 之间的空气抽样网络的部分处的组装。在图 1 至图 7 的实施例中，限流器形成抽样导管 20、120 与抽样管道 16 之间的连接总成的一部分。因此，所述方法用于评估抽样导管 10、120 与抽样管道 16 之间的连接的组装。

[0092]　现在描述抽样导管以及将其安装到顶壁 14 的多个实施例的细节。图 7 至图 9 示出安装到顶壁面板 14 的抽样导管 120。通过顶部法兰总成 184 将抽样导管 120 保持在顶壁 14 的顶侧上的金属面板 4 上。法兰总成 184 具有直立的装有弹簧的指部 185，所述指部 185 在安装期间和安装后将抽样导管 120 保持在恰当的位置。抽样导管 120 的下端 186 限定抽样点孔 118。底部部分（抽样导管法兰）从抽样点 118 向外以及然后向下形成用于抽样点 118 的圆顶状的盖子 187。

[0093]　在所示的实施例中，抽样导管的该底部部分形成为与抽样导管的主管道 188 分离的部分。该底部部分或底部法兰 187 锁在底座 189 上，所述底座 189 通过螺栓 190 被保持到顶壁 14 的底部金属面板 4 上。在安装期间，密封剂被放置在顶部法兰和底部法兰与它们相应的顶壁面板之间以提供气密密封，避免在每个抽样点处的泄露，以及因此防止从冷藏空间 12 穿过顶壁 14 的空气泄露。类似地，在图 1 的实施例中，抽样导管 20 优选地被顶壁面板 14 内的合适的密封剂环绕以消除泄露。密封垫环 44 还可在抽样导管 20 离开顶壁面板 14 的地方环绕抽样导管 20。

[0094]　上文仅描述了本发明的示例性实施例，可对其进行修改，这将不脱离本发明的范围。

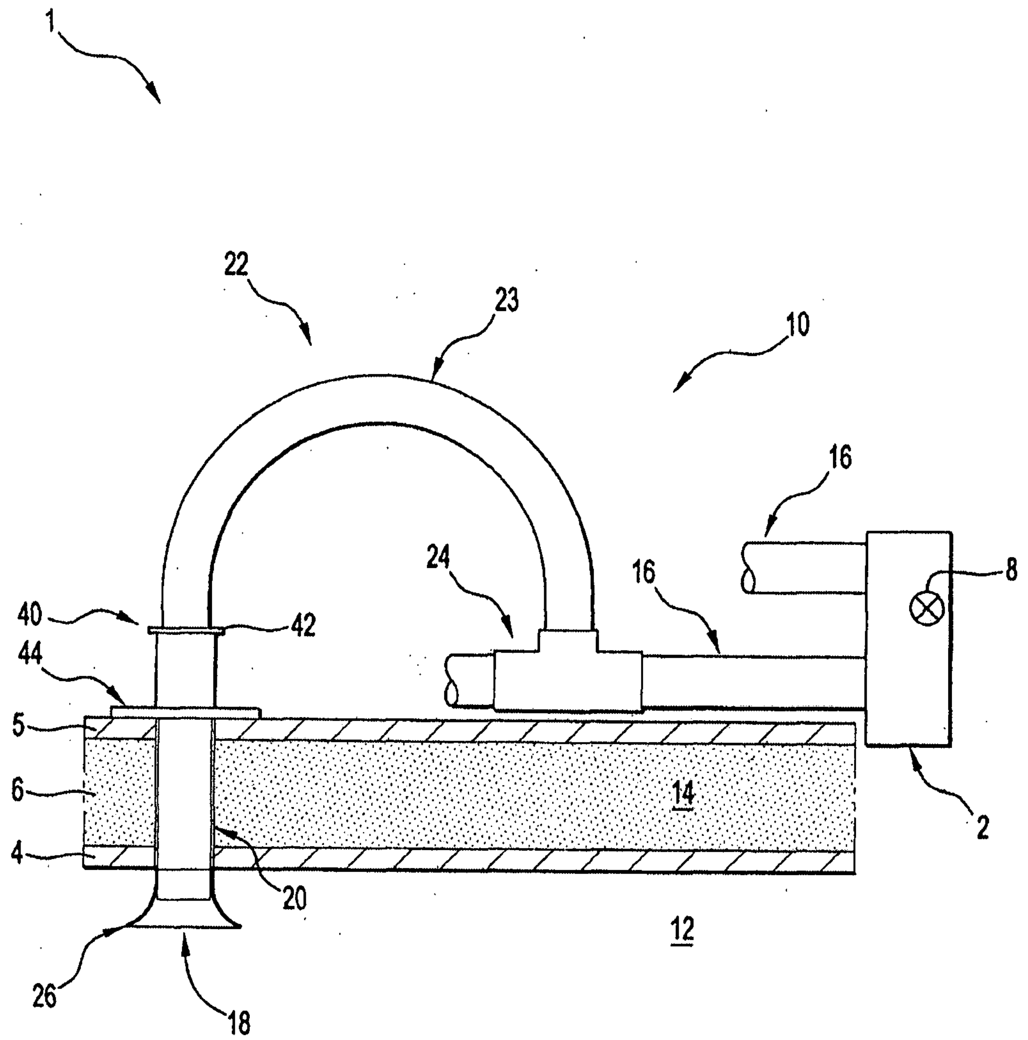


图 1

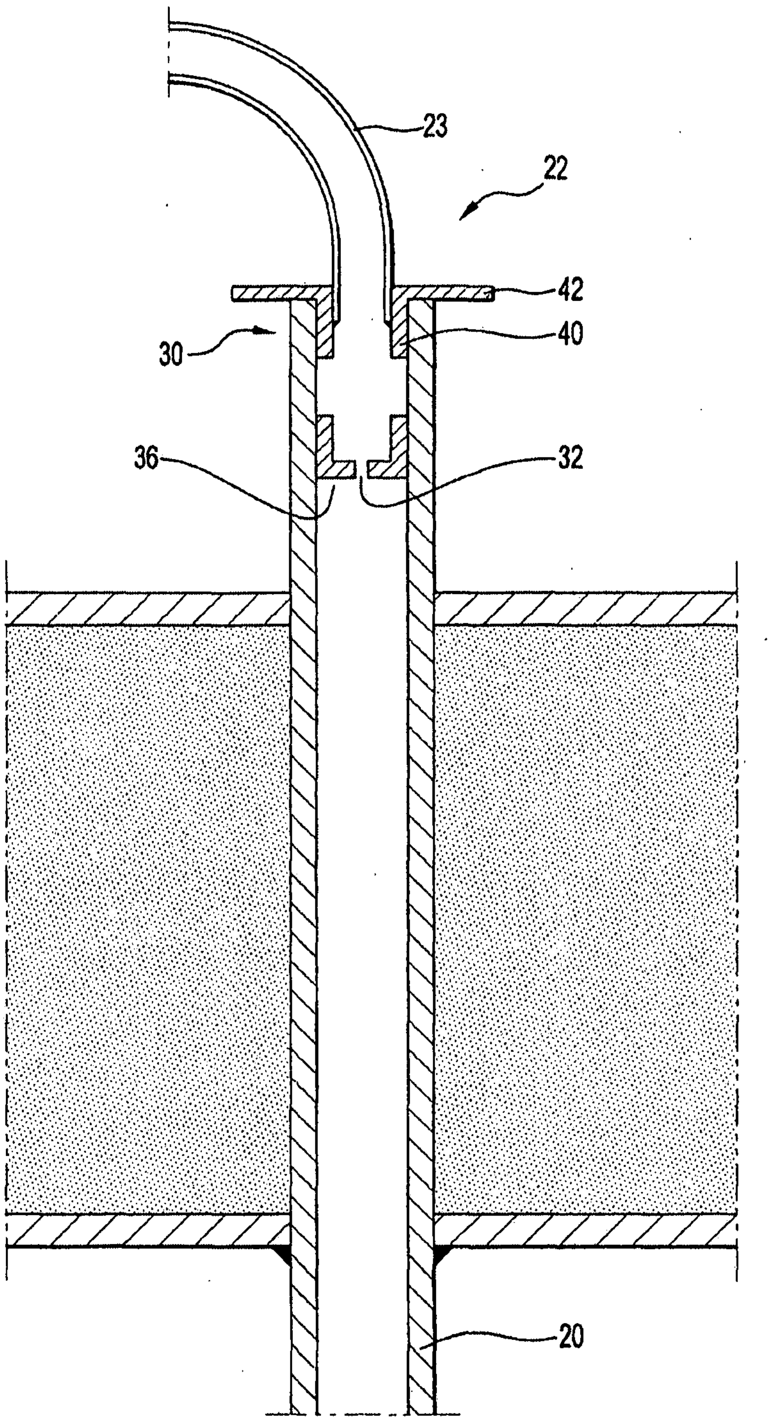


图 2

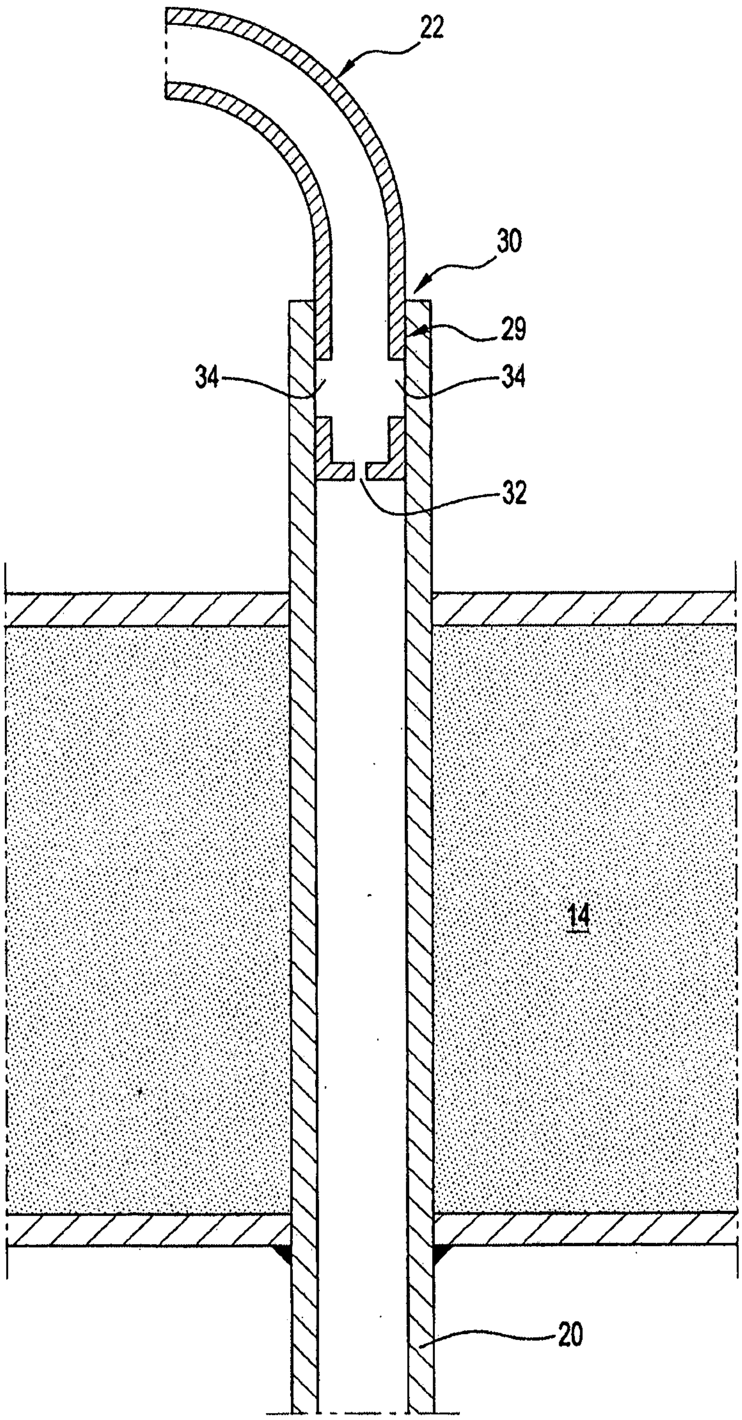


图 3

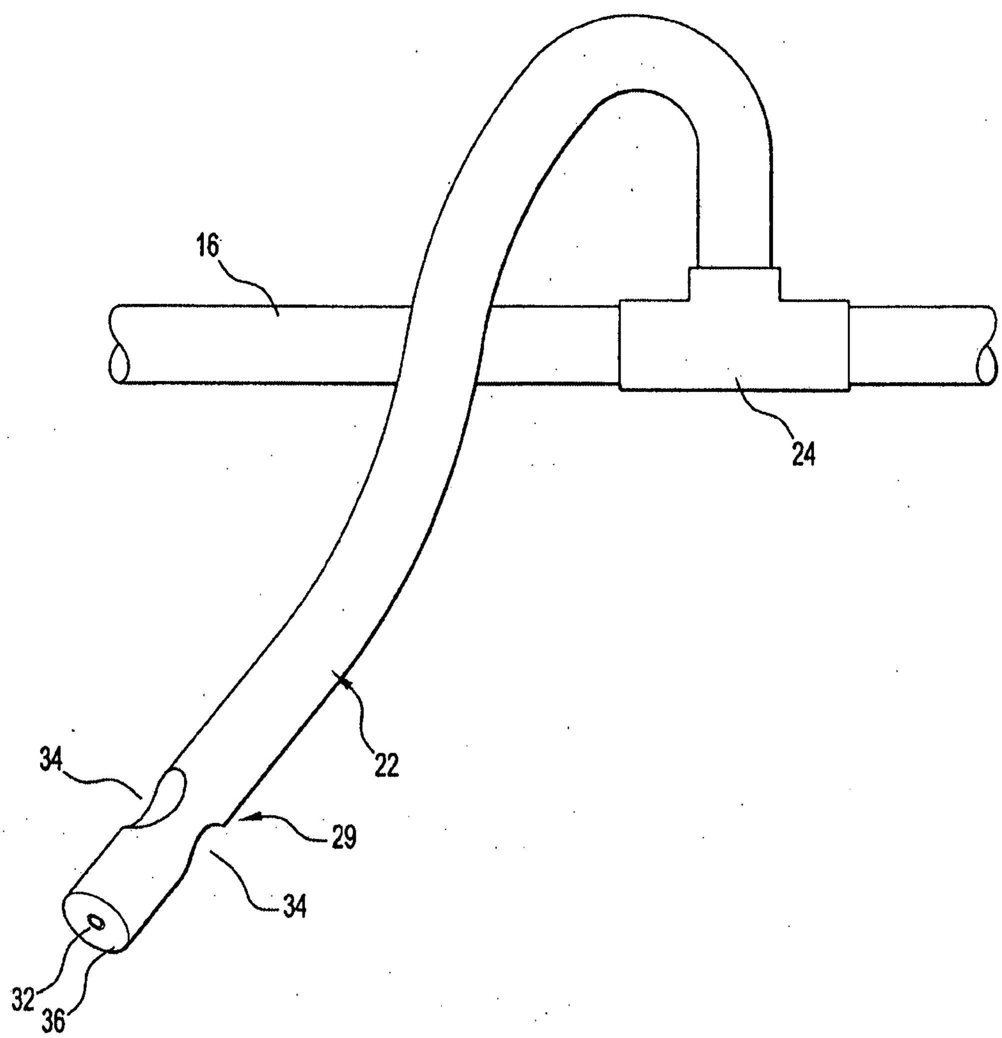


图 4

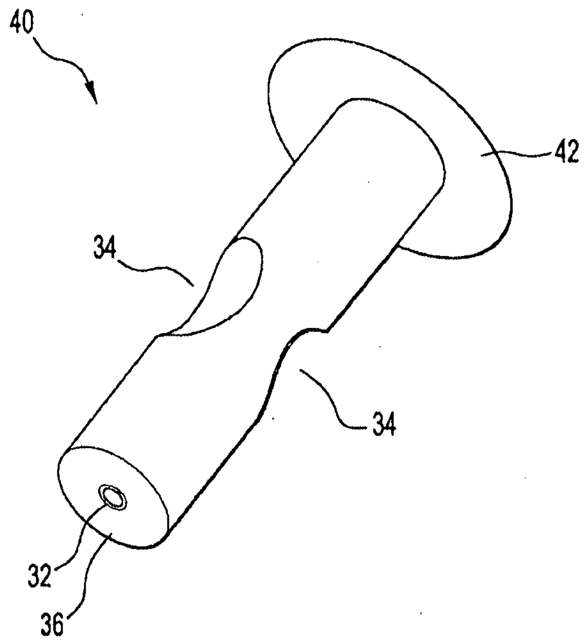


图 5

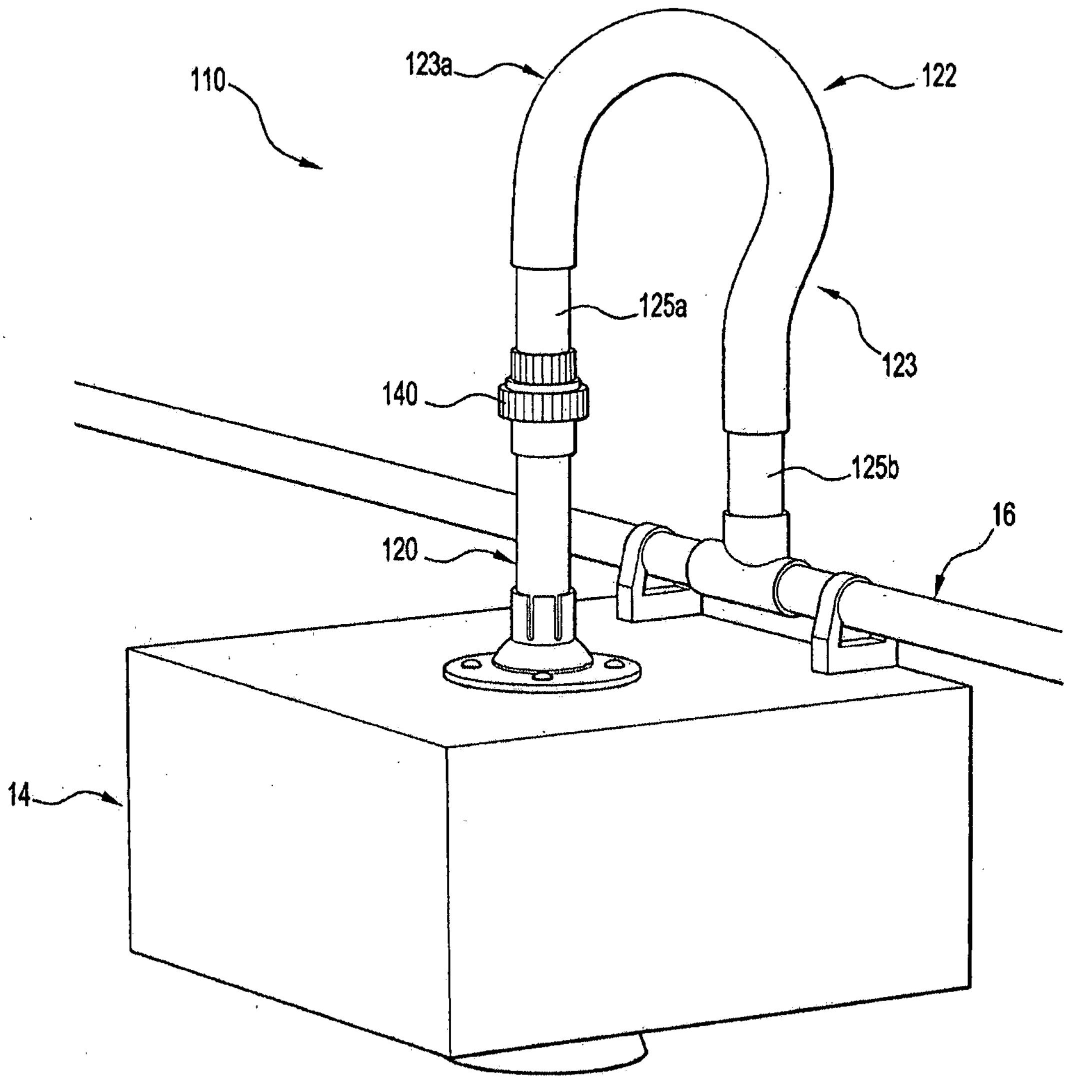


图 6

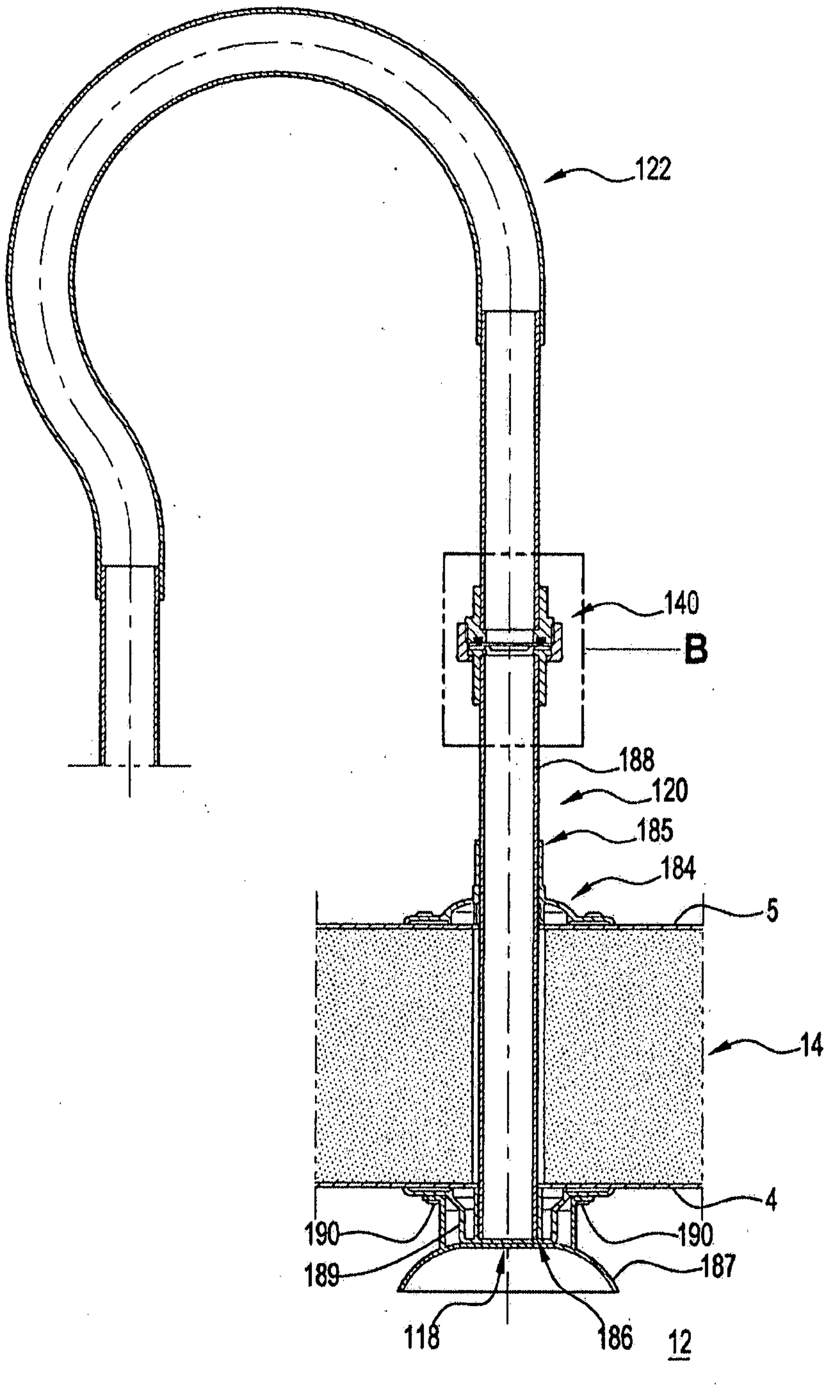
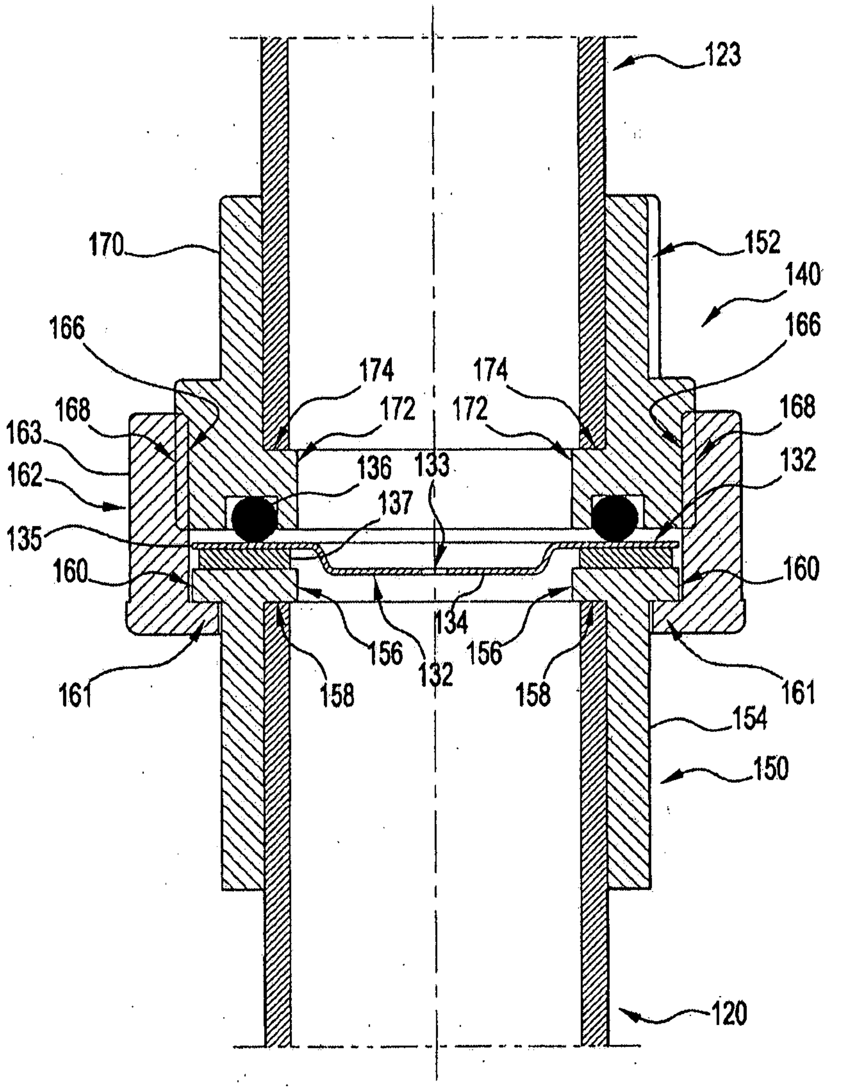


图 7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细节B

图 8

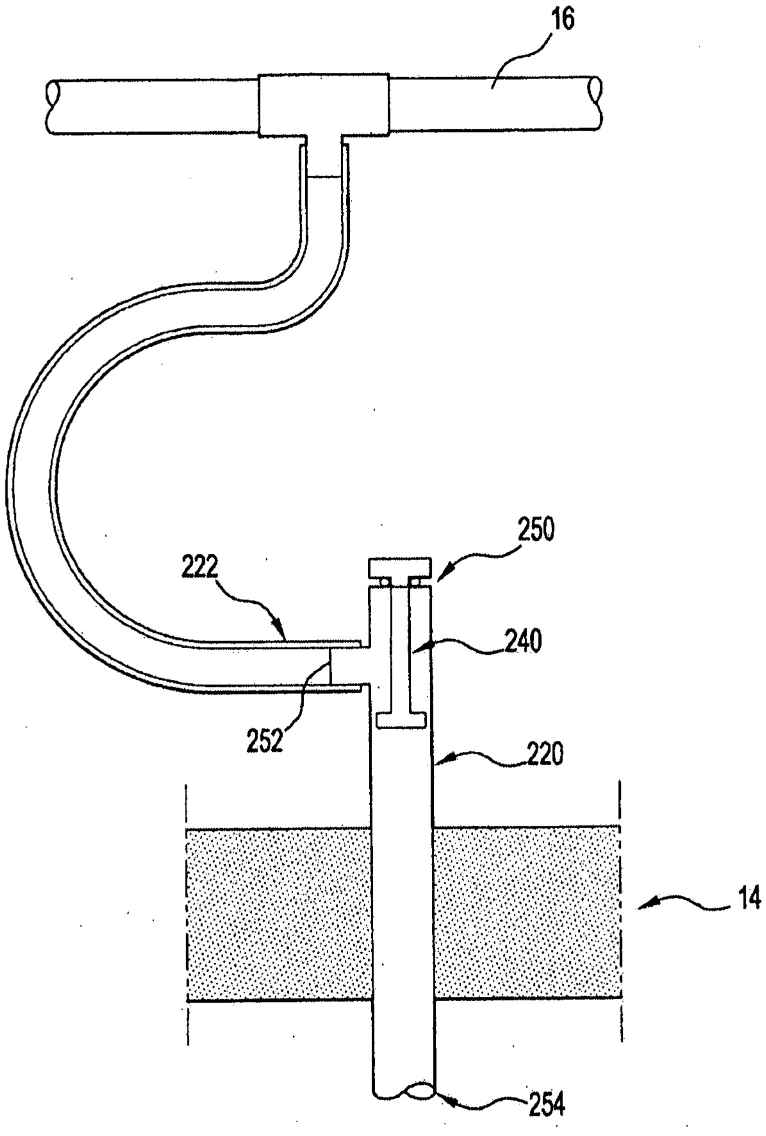

图 9

Abstract:

An air sampling system (10, 110) for a low-temperature space (12) is disclosed. The air sampling system (10, 110) includes: an air sampling pipe (16) for passing sampling air to an air sampling device (2); and a sampling conduit (20, 120) extending from the low-temperature space (12) to outside the low-temperature space (12). The sampling conduit (20, 120) is connected to the sampling pipe (16), wherein the sampling conduit (20, 120) is selectively accessible from outside the low-temperature space (12) for removal of ice build-up within the sampling conduit (20, 120). Also disclosed is a kit for an air sampling system. Also disclosed is a method, computing system, air-sampling device and air monitoring system that evaluates an air sampling network.