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(71) Applicant: **LINDE AKTIENGESELLSCHAFT** [DE/DE]; Klosterhofstrasse 1, 80331 Munich (DE).

(72) Inventors: **COWLES, Christopher John**; 49 Parkstead Road, London Greater London SW15 5AN (GB). **HILTON, Derrick Ernest**; 7 Loriners Close, Cobham Surrey KT11 1BE (GB). **KANDZIORA, Christine**; Oberes Strassfeld 8, 82056 Baierbrunn (DE).

(74) Agent: **CHRISTIE, Gemma**; The Priestley Centre, 10 Priestley Road, Surrey Research Park, Guildford Surrey GU2 7XY (GB).

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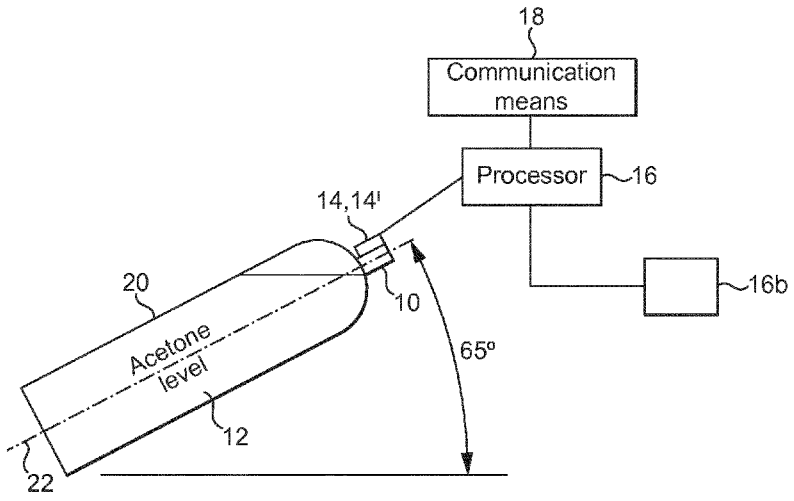


FIG. 1C

(57) Abstract: A cylinder valve having a body and a valve member moveable between a closed position, for preventing escape of fluid, and an open position, for allowing escape of fluid. The valve also has an orientation sensor for measuring the orientation of the valve relative to a reference axis. A processor is configured to detect if the valve is orientated at or below a threshold angle based on the orientation, determine whether the valve has been orientated above the threshold angle for a predetermined length of time, and prevent the valve member from moving from the closed position to the open position if the valve axis has not been orientated above the threshold angle for the predetermined length of time.

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ANGULAR ORIENTATION SENSING VALVE

BACKGROUND OF THE INVENTION

The present invention relates to an orientation sensing valve. In particular, the valve is applicable for use with cylinders containing acetylene.

Although reference is made to a "cylinder", it will be understood that the invention is applicable broadly to all portable pressurised gas containers whether they are strictly in the form of a cylinder or not.

Such cylinders are used to supply gas for a range of applications including welding and cutting hoses and torches, gas packaging machines and laboratory equipment.

Acetylene (C_2H_2) is a widely used gas for fuel and in chemical reactions. It is highly flammable and can decompose explosively if the absolute pressure of the gas exceeds about 200 kPa. It is therefore commonly shipped and stored dissolved at low pressure in a carrier liquid such as acetone ($(CH_3)_2CO$) or DimethylFormaldehyde (DMF) in a cylinder with a porous filling.

The typical use flow rate of acetylene is low enough that it is used as it evolves from the acetone. This is important as if the acetone escapes the cylinder into the gas delivery line it can have deleterious effects on certain rubbers and plastics which are commonly used in the process equipment such as in regulators and torches. This will cause the lines to rot and leak. Acetone is also itself highly flammable and can destabilise a flame generated by burning

acetylene. It is therefore very important to ensure no acetone leaves the cylinder.

Acetone cylinders are normally stored and transported upright, so that no acetone comes into contact with the valve entrance. However, the cylinder could be transported or placed onto its side accidentally or unavoidably and the acetone would then come into contact with the valve entrance. It may also be easiest and safest to transport the cylinder in this manner for certain purposes. If the cylinder was then used in such a position the acetone would flow out through the valve and cause the problems described above.

Currently, there is nothing preventing the user from using an acetylene cylinder whilst it is lying down, or immediately afterwards. Less skilled workers may not know that it is a safety risk, or decide to take a risk in order to use the cylinder quickly to save time. As explained above, this can have disastrous consequences.

SUMMARY OF THE INVENTION

According to the present invention there is provided a valve defined by claim 1.

When such a valve is connected to a cylinder containing pressurised fluid, the valve can prevent a user from operating the cylinder when it is located at particular orientations or has been orientated above the threshold angle for a predetermined length of time. This is useful in instances where the cylinder contains particular chemicals, for instance acetone which contains acetylene.

The valve may be an electro-mechanical valve. This allows electronic control of the flow through the valve which helps automate the process, and improve safety.

By holding the valve in the closed position in addition to communicating the warning signal, the user is physically prevented from missing or ignoring the communicated warning, but is aware of why the valve is not open.

The orientation sensor may comprise at least one of: an accelerometer; a tilt sensor; or any appropriate microelectromechanical sensor (MEMS) whose output allows for the determination of the orientation of the valve axis.

The valve may comprise a screen and the warning signal may then be displayed on the screen, to help display the warning signal in a visual way.

The predetermined reference axis may be the horizontal. However, the comparison of the measured orientation with the predetermined threshold angle simply needs to represent the amount by which a cylinder, to which the valve is attached, is tilted relative to its normal upright orientation when resting on its base.

According to a second aspect of the invention, there is provided a cylinder for pressurised fluid comprising the valve according to the first aspect of the present invention. Such a cylinder may contain acetylene.

BRIEF DESCRIPTION OF THE FIGURES

The invention will now be described with reference to the accompanying Figures in which:

Figures 1A, 1B and 1C depict gas cylinders at various orientations.

Figure 2 shows a flow diagram of the control structure.

DETAILED DESCRIPTION

With reference to Figures 1A, 1B and 1C there is shown a valve 10 connected to an acetylene cylinder 20 with an elongate axis 22. The acetylene is delivered in the form of liquid acetone 12, filled to a level below the capacity of the cylinder such that there is a gap 11 of non-liquid cylinder space. Acetylene is dissolved in the liquid acetone 12, and evolves from the liquid acetone 12 into the space 11. In normal use the evolution happens at a rate such that acetylene is evolved at least as quickly as it is dispensed from the cylinder.

The valve 10 comprises a valve body and a valve member.

The valve member is moveable between an open and closed position. In the closed position escape of acetylene from the cylinder is prevented, while in the open position escape of acetylene from the cylinder is allowed.

The valve 10 comprises an orientation sensor 14 for detecting the orientation of the valve body with respect to the horizontal 24. When the valve 10 is installed on a cylinder 20, the orientation of the valve body will indicate the orientation of an elongate axis 22 of the cylinder 20.

Preferably, the orientation sensor 14 comprises at least one of an accelerometer, a tilt sensor or any appropriate microelectromechanical sensor whose output allows for the determination of the orientation of the elongate axis 22.

In Figure 1A the cylinder 20 is shown in the correct storage and use position, wherein the angle between the horizontal 24 and the elongate axis 22 is 90°.

Figure 1B depicts the cylinder 20 with its elongate axis 22 substantially parallel to the horizontal 24, as can be the case during transit.

Figure 1C shows the cylinder 20 orientated with a threshold angle of, for example, 65° between the elongate axis 22 and the horizontal 24. At this orientation the acetone 12 is just below contact with the entrance of the valve 10. Any angle smaller than this threshold angle and the acetone 12 will contact the valve 10.

The valve further comprises a processor 16, connected to a communication means 18.

The processor 16 will be described with reference to Figure 2. In use of the valve 10, when it is connected to a cylinder 20, the processor 16 uses the orientation sensor 14 to detect the orientation of the valve body relative to a predetermined reference axis. By selecting an appropriate predetermined reference axis, the processor 16 can thereby detect if the elongate axis 22 of the cylinder is orientated at less than a predetermined threshold angle from the horizontal, for example 65° (step 100).

If this is the case, the processor 16 may communicate a warning signal to the communication means 18 in the form of a displayed warning 104.

In a preferred embodiment, if the elongate axis 22 is not orientated at or below the predetermined threshold angle (step 100), then the processor 16 determines if the elongate axis 22 has been orientated at more than this angle for a predetermined period of time, for example for the previous 30 minutes (step 102). If this is not the case, it is possible that there may be acetone residue on the valve from the time the acetone was in contact with the valve. If the elongate axis 22 has not been orientated at more than the predetermined threshold angle for the predetermined period of time (step 102), the warning 104 is again displayed. If neither condition is achieved then no warning is displayed (step 106).

It will be appreciated that various modifications and alterations could be made to the drawings. For instance, the valve 10 could be used with not just acetylene cylinders, but any fluid containing cylinder.

It will also be appreciated that the predetermined threshold angle will not always be 65°, but rather would depend upon the amount of fluid in the cylinder, the geometry of the cylinder and the position of the valve on the cylinder. The inventors have found that an angle in the range 65° to 70° is appropriate for most cylinders and appropriate despite variations in the fill level of the cylinder over time. However, different threshold angles can be more appropriate in different circumstances. In this regard, the valve 10 may include a memory on which is stored

the appropriate predetermined threshold angle for each of a plurality of cylinder types. When the valve 10 is installed on a cylinder 20, the assembler may input into the processor 16 the cylinder type and the processor 16 can then select the appropriate predetermined threshold angle.

In certain embodiments the valve is locked in a closed position 108 in addition to or instead of the warning being displayed 104. When no warning is displayed 106 the valve is openable 110.

In these embodiments, the valve 10 could be an electro-mechanical valve which can be electronically controlled. The valve may be held in a closed state by electronically preventing the electro-mechanical valve from being actuated. Alternatively, an electro-mechanical device may be provided on a mechanical valve. The electro-mechanical device may be arranged such that actuation thereof prevents the mechanical valve from being operated by a user (for example, it may physical obstruct the use of the mechanical valve). Thus, the valve may be locked by the electro-mechanical device in a closed state by the actuation of the electro-mechanical device.

The communicating means may comprise a screen on which to display the warning. Alternatively, or additionally, an audible warning could be generated.

In a further preferred embodiment, there is provided a valve 10 for use on a cylinder 20 containing pressurised fluid, the valve 10 comprising a valve body; a valve member, moveable between a closed position for preventing escape of fluid from the cylinder, and an open position for allowing

the escape of fluid from the cylinder; an orientation sensor 14 for measuring the orientation of the valve body relative to a predetermined reference axis; and a processor 16 configured to: detect if the valve body is orientated at or below a predetermined threshold angle from the predetermined reference axis based on the orientation measured by the orientation sensor; determine whether the valve body has been orientated above the threshold angle for a predetermined length of time; and prevent the valve member from moving from the closed position to the open position if the valve axis has not been orientated above the threshold angle for the predetermined length of time.

In this embodiment, the valve 10 additionally comprises a further sensor 14' with which to monitor the amount of acetylene that has been drawn from the cylinder 20.

The inventors have discovered that although the mass of carrier liquid remains unchanged during use of the acetylene, as acetylene is drawn from the cylinder 20, the pressure reduction changes the volume of the carrier liquid, thereby necessitating a different threshold angle and length of time.

In this embodiment, the processor 16 calculates the appropriate threshold angle based on the data received from the further sensor. The valve 10 may include a memory on which is stored the appropriate calculation for each of a plurality of cylinder types and fill levels. When the valve 10 is installed on a cylinder 20, the assembler may input into the processor 16 the cylinder type and, when the cylinder 20 has been filled, can enter the initial fill level. The processor 16 can then select the appropriate

threshold angle and appropriate length of time based upon the signal from the further sensor 14', the initial fill level and, optionally, the cylinder type.

The further sensor 14' may be a pressure sensor, arranged to measure the internal pressure in the cylinder 20. The processor 16 is arranged to calculate the appropriate threshold angle and the appropriate length of time based upon the signal from the pressure sensor 14', the initial fill level and, optionally, the cylinder type.

More preferably, however, the further sensor 14' may be a flow sensor. The inventors have discovered that the use of a flow sensor to cumulatively monitor drawn fluid allows a more accurate calculation of the threshold angle and the length of time. In this case, the processor 16 is arranged to calculate the appropriate threshold angle and the appropriate length of time based upon the signal from the flow sensor 14', the initial fill level and, optionally, the cylinder type.

Whereas in the methods set out above, an alarm may always be issued if the relevant safety requirements are not met, embodiments are considered in which no warning is displayed and only the locking functionality is provided.

CLAIMS

1. A valve for use on a cylinder containing pressurised fluid, the valve comprising:

a valve body;

a valve member, moveable between a closed position for preventing escape of fluid from the cylinder, and an open position for allowing the escape of fluid from the cylinder;

an orientation sensor for measuring the orientation of the valve body relative to a predetermined reference axis; and

a processor configured to:

detect if the valve body is orientated at or below a threshold angle from the predetermined reference axis based on the orientation measured by the orientation sensor;

determine whether the valve body has been orientated above the threshold angle for a predetermined length of time; and

prevent the valve member from moving from the closed position to the open position if the valve axis has not been orientated above the threshold angle for the predetermined length of time.

2. The valve of claim 1, wherein the processor is further configured to provide an indication of whether the valve has been orientated above the threshold angle for the predetermined length of time.

3. A valve for use on a cylinder containing pressurised fluid, the valve comprising:

a valve body;

a valve member, moveable between a closed position for preventing escape of fluid from the cylinder, and an open position for allowing the escape of fluid from the cylinder;

an orientation sensor for measuring the orientation of the valve body relative to a predetermined reference axis; and

a processor configured to:

detect if the valve body is orientated at or below a threshold angle from the predetermined reference axis based on the orientation measured by the orientation sensor;

determine whether the valve body has been orientated above the threshold angle for a predetermined length of time; and

provide an indication of whether the valve has been orientated above the threshold angle for the predetermined length of time.

4. The valve of claim 1, wherein the processor is configured to provide an indication of whether the valve has been orientated above the threshold angle for the predetermined length of time by generating a warning if the valve has not been orientated above the threshold angle for the predetermined length of time.

5. The valve of claim 4, wherein the valve comprises a screen and the generated warning is displayed on the screen.

6. The valve of any preceding claim, wherein the predetermined length of time is in the range 20 to 40 minutes.

7. The valve of any preceding claim, wherein the threshold angle is between 65° to 70°.

8. The valve of any preceding claim, wherein the valve is an electro-mechanical valve.

9. The valve of any preceding claim wherein the predetermined reference axis is the horizontal.

10. The valve of any preceding claim, wherein the valve comprises a memory in communication with the processor, the memory storing the threshold angle or a calculation for calculating the threshold angle.

11. The valve of any preceding claim, wherein the valve comprises a memory in communication with the processor, the memory storing the predetermined length of time or a calculation for calculating the predetermined length of time.

12. The valve of claim 10 or claim 11, wherein the memory stores a plurality of predetermined threshold angles, each corresponding to a different cylinder shape, and the processor is configured to select a predetermined threshold angle from the stored plurality of predetermined threshold angles.

13. The valve of claim 11 or claims 11 and 12, wherein the memory stores a plurality of predetermined lengths of time, each corresponding to a different cylinder shape, and the processor is configured to select a predetermined length of time from the stored plurality of predetermined lengths of time.

14. The valve of claim 10 or claim 11, further comprising a flow sensor, wherein the processor is arranged to calculate the threshold angle and/or the predetermined length of time based on data received from the flow sensor.

15. The valve of claim 10 or claim 11, further comprising a pressure sensor, wherein the processor is arranged to calculate the threshold angle and/or the predetermined length of time based on data received from the pressure sensor.

16. A cylinder for pressurised fluid comprising the valve of any preceding claim, wherein an elongate axis of the cylinder is fixed relative to the valve body.

17. The cylinder of claim 16 wherein the cylinder contains acetylene.

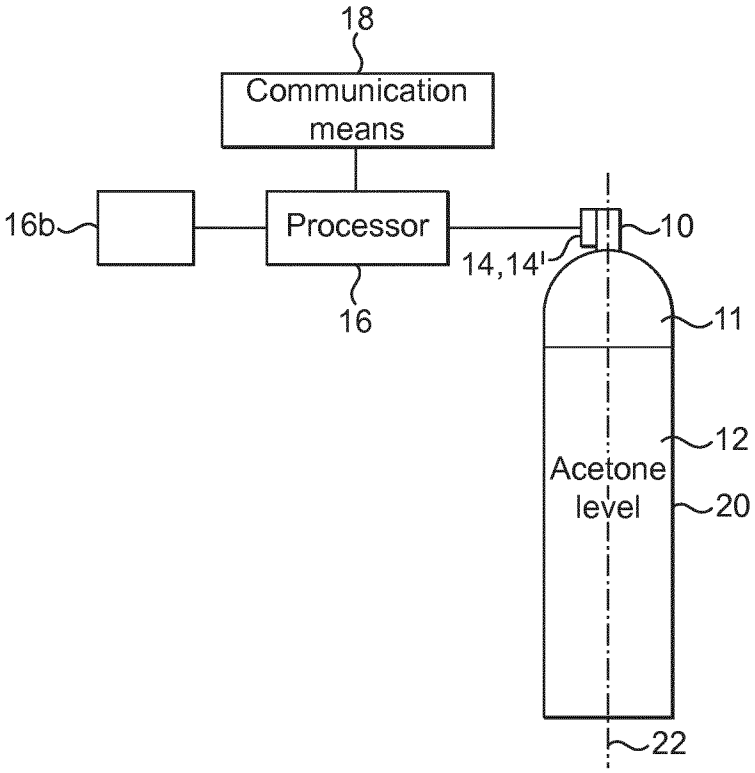

18
Communication means
16b
Processor
16
10
14,14'
11
12
Acetone level
20
22

FIG. 1A

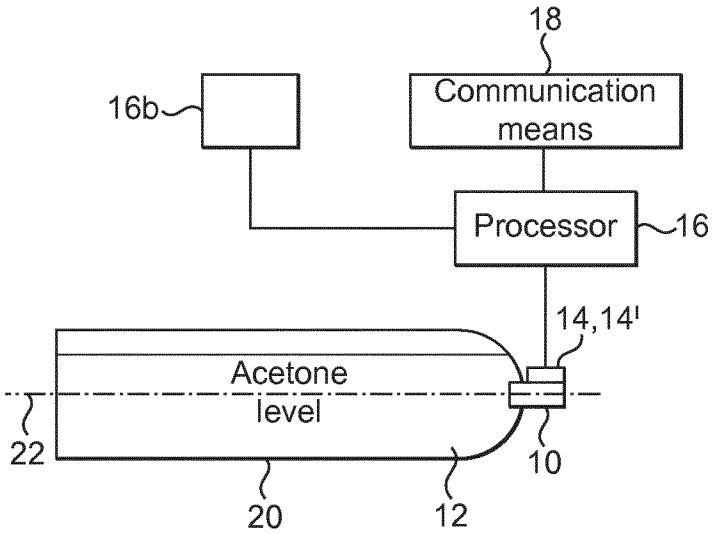

18
16b
Communication means
Processor
16
14,14'
Acetone level
22
10
20
12

FIG. 1B

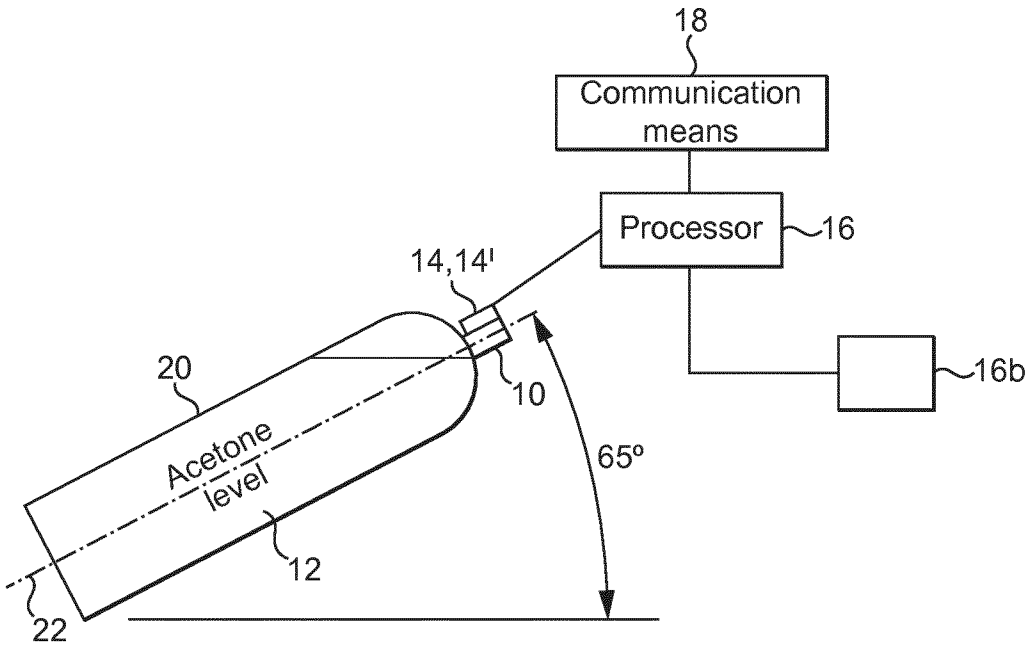

18
Communication means
Processor
16
14,14'
16b
20
10
Acetone level
65°
12
22

FIG. 1C

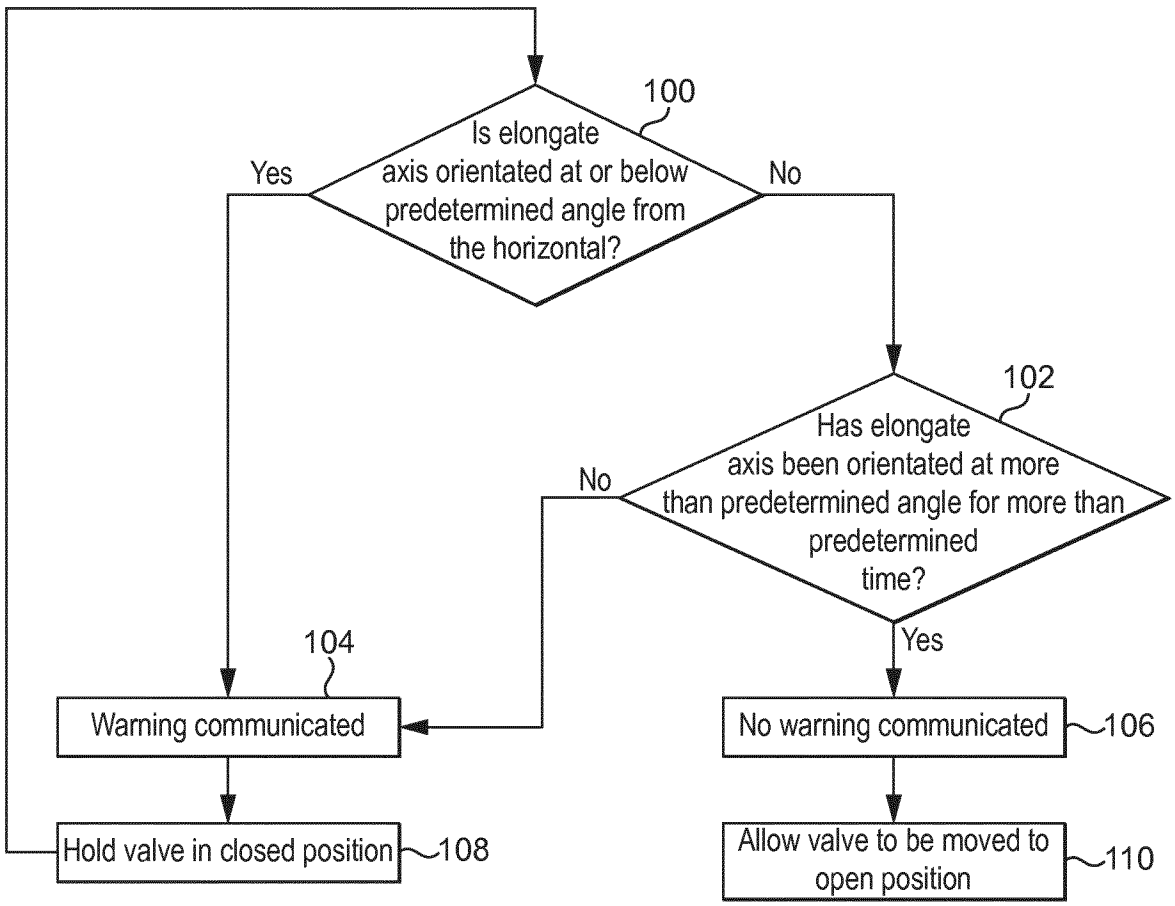

100
Is elongate axis orientated at or below predetermined angle from the horizontal?
Yes
No
102
Has elongate axis been orientated at more than predetermined angle for more than predetermined time?
No
Yes
104
Warning communicated
No warning communicated
106
Hold valve in closed position
108
Allow valve to be moved to open position
110

FIG. 2

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2016/055799

A. CLASSIFICATION OF SUBJECT MATTER
INV. F17C13/04
ADD.

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)
F17C F16K

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)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 7 334 596 B1 (CHESTERS THOMAS PETER [US]) 26 February 2008 (2008-02-26) fig.1-fig.3; (100), (106), (101), (104); col.1, l. 18-25; col.5, l.34-40, l.47-53, l.63-67; col.6, l.51-64; col.8, l.5-8, l.27-33	1-17
A	EP 2 006 600 A1 (LUXEMBOURG PATENT CO [LU]) 24 December 2008 (2008-12-24) fig.1, (3), (6), (10); [0021], [0024]	1-17
A	JP 2006 160287 A (NIPPON SHARYO SEIZO KK; MIYAIRI VALVE MFG) 22 June 2006 (2006-06-22) fig.3, (12), (44); [0010], [0022], [0025], [0033]	1-17

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[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

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
10 May 2016	20/05/2016

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Todor, H

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Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2016/055799

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2015/001555 A1 (ELTAV WIRELESS MONITORING LTD [IL]) 8 January 2015 (2015-01-08) fig.6, 7, (220a), (220b), (271), (272); p.14, last paragraph-p.15; p.16, last paragraph-p.17, first paragraph -----	1-17

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2016/055799

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