



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
29.01.2014 Bulletin 2014/05

(51) Int Cl.:
E02D 3/115^(2006.01) E02D 19/14^(2006.01)

(21) Application number: **13177293.1**

(22) Date of filing: **19.07.2013**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

(30) Priority: **24.07.2012 IT MI20121284**

(71) Applicants:
• **L'AIR LIQUIDE, SOCIETE ANONYME POUR L'ETUDE ET L'EXPLOITATION DES PROCEDES GEORGES CLAUDE**
75007 Paris (FR)
Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
• **Air Liquide Italia S.p.A.**
20148 Milano (IT)
Designated Contracting States:
IT

(72) Inventors:
• **Tagliabue, Valerio**
20148 Milano (IT)
• **Spada, Lorenzo**
20148 Milano (IT)
• **Fantoni, Roberto**
20148 Milano (IT)

(74) Representative: **Conan, Philippe Claude**
L'Air Liquide SA
Département Propriété Intellectuelle
75, quai d'Orsay
75321 Paris Cédex 07 (FR)

(54) **Method and system for freezing a portion of ground**

(57) A system for freezing a portion of ground comprises at least one probe having at least one end insertable in the ground to be frozen and having at least one lateral wall, and means for supplying a cryogenic liquefied gas connected to the probe so as to supply the cry-

ogenic liquefied gas to the same probe, said supply means comprising a device for dispensing said cryogenic liquefied gas placed on the inside of the probe, the dispensing device being spaced from said end insertable in the ground in such a manner as to spray said gas directly onto said lateral wall of said probe.

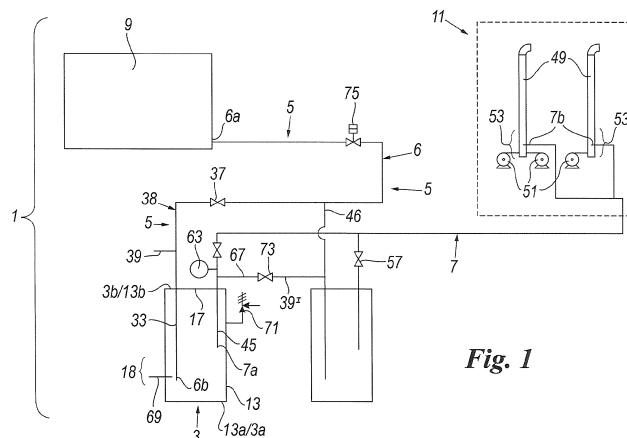


Fig. 1

Description

[0001] The present invention relates to a method and a system for freezing a portion of ground according to the accompanying claims.

[0002] Conventional systems for freezing a portion of ground are known, said systems allowing freezing of the water present in the ground so as to compact the latter, increasing its overall strength and rendering it impermeable.

[0003] Usually freezing is temporary and allows the programmed works to be carried out under safe conditions. Said works consist, for example, in the construction of wells, tunnels, underground structures and impermeable diaphragm walls.

[0004] To this end, probes have been developed such as to allow, by means of the evaporation of a cryogenic liquefied gas contained inside them, for example nitrogen, freezing of the portion of ground inside which they are buried.

[0005] The probes (also called freezing probes) usually have a sleeve inside which the cryogenic liquefied gas is introduced via first pipes. Said cryogenic liquefied gas, after evaporating and absorbing heat from the ground surrounding the probe, is then extracted from the sleeve by means of second pipes.

[0006] The first pipes introduce the cryogenic liquefied gas in a bottom zone of the sleeve (and therefore of the probe).

[0007] In this way, the cryogenic liquefied gas is propelled from the bottom of the sleeve towards an upper portion of the said bottom, filling it. In order to define the maximum filling level of the sleeve, a second pipe is provided so as to allow evacuation of the cryogenic gas which, after releasing cold, passes from the liquid state to the gaseous state.

[0008] In order to allow the introduction of the cryogenic gas inside the probe, the first pipes allow connection of a cryogenic storage tank to the sleeve. Advantageously, said pipes have at least one valve for allowing variation of the flow rate of the cryogenic liquefied gas flowing along the pipe.

[0009] The cryogenic gas extracted in the gaseous state from the probe may be conveyed by the second pipe to an apparatus for dispersion, into the atmosphere, of the cryogenic gas in the gaseous state. The second pipe, similar to the first pipe, has at least one valve intended, for example, to vary the flow rate of the nitrogen flowing along the second pipe.

[0010] The solution of the type mentioned above has, however, various drawbacks associated with an inefficient configuration of the first and second pipes and therefore an inefficient heat exchange between the cryogenic liquefied gas and the ground surrounding the probe.

[0011] The object of the present invention is therefore to provide a system for freezing a portion of ground which is able to solve the said problems.

[0012] In other words, the object of the present invention is to provide a system able to improve the heat exchange between the cryogenic liquefied gas and the ground surrounding the probe.

5 **[0013]** These and other objects which will be clear to the person skilled in the art are achieved by a system for freezing a portion of ground, provided in accordance with the accompanying claims.

10 **[0014]** The present invention will be understood more clearly with reference to the accompanying figures provided purely by way of a non-limiting example. In said figures:

15 Figure 1 shows a schematic view of a system for freezing ground according to the present invention;

Figure 2 shows a cross-sectional view of a detail of the system according to Figure 1;

20 Figure 3 shows a perspective view of a further detail of the system according to Figure 1.

[0015] With reference to the said figures, the reference number 1 denotes a system for freezing a portion of ground 15.

25 **[0016]** The system 1 generally has at least one probe 3 which is buried inside the ground 15 surrounding the aforementioned probe 3 via an insertable end 3a thereof, said probe 3 being connected to supply means 5 for supplying a cryogenic liquefied gas to the probe 3. In particular said supply means 5 are able to deliver said cryogenic liquefied gas inside the probe 3.

30 **[0017]** According to the embodiment shown in Figure 1, the system 1 comprises two probes 3 and 3'. In a further embodiment, the system 1 may have a plurality of probes, the number of which is defined depending on the predefined purpose.

35 **[0018]** The aforementioned supply means 5 comprise a tank 9 of suitable dimensions for ensuring that the system 1 is kept constantly supplied. To this end, the tank 9 may have means for detecting and/or calculating and/or indicating to other devices the instantaneous and/or average delivery flow rate.

40 **[0019]** Alternatively, said supply means 5 may comprise any cryogenic liquefied gas source suitable for the purpose.

[0020] The supply means 5 also comprise a delivery pipe 6 having a first end 6a connected to the tank 9.

45 **[0021]** Said delivery pipe 6 is also connected to the probe 3 by means of a second end 6b (in order to fill it with cryogenic gas in liquid form).

50 **[0022]** Each probe (Fig. 2) usually comprises a sleeve 13 inside which the cryogenic liquefied gas, for example nitrogen, is introduced. The sleeve 13 allows the cryogenic liquefied gas to be kept separate from the ground 15 into which the probe 3 is inserted.

55 **[0023]** With the cryogenic liquefied gas it is possible to reduce the temperature of the ground down to, for exam-

ple, a temperature in the region of -10 °C (temperature detected in the ground 15 surrounding the probe 3). With this temperature it is possible to obtain substantially a wall of frozen ground which allows the works to be carried out at depth without the presence of water infiltration. Said works consist, for example, in the construction of wells, tunnels, underground structures and impermeable diaphragm walls. The freezing operation is based on the principle that the cryogenic liquefied gas introduced inside the probe 3 absorbs heat from the ground 15, evaporating and at the same time reducing the temperature of the ground 15.

[0024] The cryogenic gas in the gaseous state present inside the probe 3 is evacuated by means of a suction pipe 7.

[0025] The sleeve 13 generally has a tubular form closed at at least one first end 13a corresponding to the insertable end 3a of the probe 3, in order to contain the cryogenic liquefied gas. The sleeve 13 has preferably a round-shaped cross-section. The tubular form of the sleeve 13 is such as to define at least one lateral wall 14 of the probe.

[0026] The sleeve 13 at a second end 13b opposite to the first end 13a has a cover 17 which hermetically closes the sleeve 13 of the probe 3. In accordance with that shown, the second end 13b of the sleeve 13 is not buried in the ground 15, but is placed outside of the aforementioned ground 15.

[0027] The probe 3 extends along a longitudinal axis X defined by the tubular form of the same probe 3.

[0028] The probe 3 can be inserted into the ground 15 in such a way that, during use, the longitudinal axis X is arranged vertically.

[0029] In the region of the cover 17, preferably on the cover 17 itself, a first opening 21 is provided for housing and hermetically securing the delivery pipe 6 to the probe 3.

[0030] In the same way as for the first opening 21, in the region of the cover 17, preferably on the cover 17 itself, a second opening 23 is provided for housing and hermetically securing the suction pipe 7.

[0031] The delivery pipe 6 is housed inside the first opening 21 and extends at least partly inside the probe 3. The portion of the delivery pipe 6 placed inside the probe 3 is referred to as "dispensing pipe 33". Said dispensing pipe 33 extends at least partly parallel to the axis X.

[0032] The cryogenic liquefied gas is introduced inside the sleeve 13 by means of gravity via a dispensing device 31 placed at a second end 6b of the delivery pipe 6 of the probe 3. The second end 6b of the delivery pipe 6 corresponds to a free end facing the end 3a of the probe 3.

[0033] In particular, the dispensing device 31 has a dispensing mouth 35 via which the cryogenic liquefied gas may be sprayed onto the lateral wall 14 of the probe 3, above a liquid head generated by the cryogenic liquefied gas present inside the probe 3 at the first end 13a. Moreover, said dispensing device 31 allows spraying of

the cryogenic liquefied gas towards the end 3a of the probe 3.

[0034] Advantageously, in order to spray the cryogenic liquefied gas, the dispensing mouth 35 may be, for example, divided up into a plurality of openings (not shown in the figures) defined by means of a perforated plate or sheet (not shown in the figures). Alternatively it may have a nozzle with a form such as to allow spraying of the cryogenic liquefied gas or also other means suitable for the purpose.

[0035] By modifying the flow rate of the cryogenic liquefied gas supplied to the probe 3 it is therefore possible to limit the heat exchange at the first end 13a of the sleeve 13, favouring instead heat exchange in an intermediate portion 18 of the sleeve 13 situated between said first end 13a and said second end 13b.

[0036] The probe 3 comprises a layer of insulating material 36 placed externally to the sleeve 13 and adhering to the sleeve 13 itself.

[0037] In particular, the layer of insulating material 36 lines an upper part of the probe 3. In other words, the layer of insulating material 36 has a first end 36a placed between the dispensing mouth 35 and a suction mouth 47 positioned along a first end portion 7a of the suction pipe 7 and a second end 36b of the layer of insulating material 36 placed at the end 3b of the probe 3.

[0038] With this solution it is possible to initiate a maintenance phase (the meaning of which will be clarified below) at the first end 13a of the sleeve 13 and at the same time continue freezing of the ground 15 surrounding an intermediate portion of the sleeve 13.

[0039] Said dispensing mouth 35 is positioned at a distance H1 from the first end 13a of the sleeve 13. This distance H1 defines the height of the cold front edge which is to be obtained in the ground surrounding the probe 3. The value of the distance H1 is also determined so as to generate the front cold edge which is to be obtained in the ground surrounding the probe 3.

[0040] Moreover, the dispensing mouth 35 is positioned at a distance H2 from the suction mouth 47. This distance H2 is, for example, equal to about 1 metre and is measured in the direction defined by the longitudinal axis X.

[0041] Above the liquid head, and in particular between the dispensing mouth 35 and the suction mouth 47, a mixed liquid/gas phase consisting of the cryogenic gas in the gaseous state and a suspension of cryogenic gas droplets in the liquid state is produced. In particular, a substantially gaseous phase is present in the proximity of the suction mouth 47.

[0042] This suction mouth 47 defines an upper freezing limit of the ground 15. Said upper freezing limit of the ground 15 in turn defines a height h above which, inside the sleeve 13, there is no cryogenic gas in the liquid state. This height is determined *a priori* depending on the height at which the ground 15 is to be frozen.

[0043] The delivery pipe 6 has a first valve 37 placed at the end 13b of the probe 3, in particular upstream of

the first opening 21. The first valve 37 enables or interrupts dispensing of the cryogenic liquefied gas inside the aforementioned delivery pipe 6.

[0044] Advantageously, a first branch 39 may be present along a portion 38 of the delivery pipe 6 situated between the first opening 21 and the first valve 37. The branch 39 connects the aforementioned portion 38 to the suction pipe 7 connected to a probe 3' adjacent to the probe 3.

[0045] The delivery pipe 6 has at least one valve 75 for interrupting the flow of the cryogenic liquefied gas should the atmospheric emissions of said system 1 not comply with the oxygenation limits stipulated by the environmental safety regulations.

[0046] Said delivery pipe 6 also has at least one second branch 46. Said second branch 46 allows all the probes forming part of the system 1 to be supplied simultaneously.

[0047] The suction pipe 7 allows the sleeve 13 to be connected to at least one apparatus 11 for dispersion, into the atmosphere, of the cryogenic gas in gaseous form.

[0048] A first end portion 7a of the suction pipe 7 is housed and hermetically secured inside the second opening 23 present at the second end 13b of the sleeve 13.

[0049] In a similar way to the dispensing pipe 33, the first end portion 7a of the suction pipe 7 extends at least partly inside the sleeve 13. This first end portion 7a situated inside the sleeve 13 is commonly referred to as "dip pipe 45". The dip pipe 45 corresponds to the first end portion 7a.

[0050] The dip pipe 45, in a similar manner to the dispensing pipe 33, extends at least partly parallel to the longitudinal axis X.

[0051] One end 45a of the dip pipe 45 inside the probe is provided with the suction mouth 47 via which the cryogenic gas is removed from the sleeve 13. This suction mouth 47 is placed at a distance h defined between the suction mouth 47 and the end 3a of the probe 3. In particular, the suction mouth 47 is placed at a height above the dispensing mouth 35 (when the axis X of the probe is arranged vertically). In this way, the evaporated cryogenic gas present inside the sleeve 13, in particular above the free surface of the cryogenic liquefied gas, may be extracted from the sleeve 13 itself in order to be dispersed into the atmosphere.

[0052] To this end, the suction pipe 7 allows transfer of the cryogenic gas in the gaseous state from the probe 3 to the apparatus 11. The transfer of the cryogenic gas in the gaseous state from the probe 3 to the apparatus 11 takes place as a result of the reduced pressure present between the tank 9 (inside which the cryogenic gas is usually kept at a pressure of at least 2 bar) and the atmospheric pressure. This apparatus 11 has at least one discharge flue 49 suitably connected to at least one fan 51. The fans 51 introduce air at a base 53 of the discharge flues 49. The fans 51 therefore allow the cryogenic gas

to be mixed with air in order to reduce the concentration and increase the temperature thereof, before said cryogenic gas is dispersed in the atmosphere. This mixing operation allows the cryogenic gas to be dispersed in the atmosphere in keeping with the parameters laid down by the environmental protection regulations.

[0053] The flues 49, along a portion passed over by an air flow generated by the fans 51, have an opening (not shown in the figures) for housing and hermetically securing a second end 7b of the suction pipe 7. Via said opening, when the fans 51 are activated, it is possible to generate inside the suction pipe 7 a vacuum such as to draw off the cryogenic gas present inside the sleeve 13.

[0054] Advantageously, a discharge flue 49 may have two fans 51 with a different air flow rate. With this solution it is possible to regulate the flow rate of the air introduced into a single flue 49 depending on the value of the flow rate of the cryogenic gas flowing along the second pipe 7.

[0055] The discharge flues 49, in the proximity of their upper portion, may have probes for detecting the temperature of the vapours emitted from the aforementioned discharge flues 49.

[0056] Advantageously, at least one environmental low-oxygenation sensor (not shown in the figures) may be provided in the proximity of said apparatus 11. In the case where the air in the proximity of the discharge flues 49 has a concentration beyond a predetermined threshold, said environmental sensor activates an alarm signal, for example an acoustic and/or visual signal. Moreover, when said predetermined threshold is exceeded, said sensor is able to send a signal for closing the valve 75, therefore interrupting the supply of cryogenic liquefied gas to the probes.

[0057] The suction pipe 7 has a first valve 57 placed at the end 3a of the probe 3, in particular downstream of the second opening 23. Said first valve 57 allows or interrupts the flow of cryogenic gas inside the aforementioned suction pipe 7, in particular the transfer of a cryogenic gas from the sleeve 13 to the apparatus 11.

[0058] A third branch 61 is generally placed along a first portion 59 of the suction pipe 7 situated between the second opening 23 and the first valve 57. Said third branch 61 is able to house at least one sensor for detecting the temperature 63 of the cryogenic gas present in the sleeve 13.

[0059] A fourth branch 67 is present along a second portion 65 of the suction pipe 7, between the first valve 57 and the temperature detection sensor 63, said branch allowing division of a cryogenic gas flow directed from the sleeve 13 to the apparatus 11. The portion of cryogenic gas which passes through the fourth branch 67 may thus be transferred to a second probe 3' adjacent to the probe 3, in order to recycle the aforementioned cryogenic gas to said second probe 3'. In particular, the gas is transferred to the second probe 3' by means of the fifth branch 39' along which there is a fifth valve 73 for enabling or interrupting the flow of the cryogenic gas. This solution is used should be cryogenic gas leaving the

sleeve 13 still be able to absorb heat from the ground 15. In this way it is possible to perform recycling of the cryogenic gas.

[0060] By means of the fourth branch 67 it is thus possible to connect the probe 3 to the second following probe 3' so as to define, as mentioned above, recycling the cryogenic gas. This configuration allows a plurality of probes to be connected together.

[0061] Advantageously the sleeve 13 at the end 13b, may have a further opening or branch 69. Said further opening or branch 69 allows, for example, connection of an instrument (not shown in the figures) for measuring the pressure present inside the sleeve 13 of the probe 3. By means of said measurement it is possible to define a pressure gradient and perform an estimation of the cold power exchanged between the cryogenic liquefied gas and the ground 15.

[0062] Moreover, a safety valve 71 (commonly called PSV) for protecting the mechanical integrity of the sleeve 13 and the suction pipe 7 against the risk of overpressure is present in the region of the dip pipe 45 or the end 13b of the sleeve 13.

[0063] Additional sensors (not shown in the figures) are also provided for detecting the temperature of the ground 15. Said additional sensors allow continuous detection of the temperature of the ground 15 and at the same time provide indications as to the actual condition of the ground 15 which is to be frozen. In this way it is possible to have an indication of the efficiency of operation of the freezing system 1.

[0064] Advantageously, a plurality of temperature detection sensors (not shown in the figures) which can be inserted in the ground 15 are arranged vertically aligned with one other in the aforementioned ground 15 surrounding the probe 3 and in direct contact with the probe itself. In this way it is possible to obtain an indication of the level of the cryogenic liquefied gas present inside the sleeve 13.

[0065] A method for freezing the ground 15 also forms part of the present invention.

[0066] Said method for freezing the ground 15 consists in providing the system 1 in accordance with the arrangement shown in Figure 1, burying at least one probe 3 in the aforementioned ground 15.

[0067] The cryogenic gas, by means of the supply means 5, is introduced inside the probe 3 in order to acquire heat from the ground 15 surrounding the aforementioned probe 3, evaporating.

[0068] In particular, when the cryogenic liquefied gas is emitted from the dispensing mouth 35, said cryogenic liquid gas is sprayed onto at least one lateral wall 14 of the probe 3 and/or towards a buried end 3a of the probe 3.

[0069] The cryogenic gas is then evacuated from the probe 3 by means of the suction pipe 7 which transfers the aforementioned cryogenic gas to the system for dispersion of the gases into the atmosphere 11.

[0070] This is followed by a maintenance phase during which the temperature reached during freezing is main-

tained. The aforementioned temperature is maintained by means of suitable cycles for injection of the cryogenic liquefied gas into the probe 3. These injection cycles are performed using flow rates of the cryogenic liquefied gas which are lower (than that used during freezing) or by supplying cryogenic liquefied gas discontinuously.

[0071] Finally, once the works have been completed, a thawing step is performed. This step envisages interrupting the injection of cryogenic liquefied gas to the probe 3. This step consists in merely monitoring the temperature of the ground 15 in order to check when said temperatures have returned to a level above zero degrees.

[0072] The present invention achieves the object indicated since the cryogenic liquefied gas, which is sprayed at least onto a lateral wall of the probe and/or towards the insertable end of the probe itself, allows improved heat exchange with the ground surrounding the probe to be obtained, compared to the prior art.

Claims

1. A system (1) for freezing a portion of ground (15) comprising at least one probe (3) having at least one end (3a) insertable in the ground (15) to be frozen and having at least one lateral wall (14), supply means (5) of a cryogenic liquefied gas connected to the probe (3) to supply the cryogenic liquefied gas to the same probe (3), said supply means (5) comprising a dispensing device (31) of said cryogenic liquefied gas placed on the inside of the probe (3), **characterized in that** said dispensing device (31) is spaced from said end (3a) insertable in the ground (15) in such a manner as to spray said gas directly onto said lateral wall (14) of said probe (3).
2. The system according to claim 1, **characterized in that** said probe (3) has a tubular conformation closed at said insertable end (3a) to contain the cryogenic liquefied gas, said probe (3) extending along a longitudinal axis (x), said probe (3) being insertable in the ground (15) in such a manner that the longitudinal axis (x) is arranged vertically.
3. The system according to claim 2, **characterized in that** it comprises a plurality of temperature detection sensors insertable in the ground (15) in proximity of the probe (3) and in direct contact with the same probe, said sensors being arranged aligned parallel to one another with respect to the longitudinal axis (x).
4. The system according to claim 2, **characterized in that** said supply means (5) comprise at least one delivery pipe (6), said delivery pipe (6) being at least partially on the inside of the probe (3), extending at least partially parallel to the longitudinal axis (X), the

output device (31) being placed at a second end (6b) of the delivery pipe (6).

5. The system according to claim 4, **characterized in that** the probe (3) is provided with a suction pipe (7), said suction pipe (7) being at least partially placed on the inside of the probe (3), extending at least partially parallel to the longitudinal axis (X) and having at a first end (7a) of said suction pipe (7) on the inside of the probe (3) a suction mouth (47).

5
10

6. The system according to claim 5, **characterized in that** said probe (3) has a distance (h) defined between the suction mouth (47) of said suction pipe (45) and said insertable end (3a) of the probe (3) greater with respect to a distance (H) defined between said dispensing device (31) and said insertable end (3a) of the probe (3).

15

7. The system according to claim 2, **characterized in that** the probe (3) comprises a sleeve (13), said sleeve (13) having a layer of insulating material (36) placed externally to the sleeve (13) and adhering to the same sleeve (13), preferably said insulating material (36) has a first end (36a) comprised between the dispensing device (31) and the suction mouth (47).

20
25

8. The system according to at least one of the preceding claims, **characterized in that** the probe (3) has on the inside thereof a mixed liquid/gas phase of said cryogenic gas, said mixed liquid/gas phase being placed at least between the dispensing mouth (35) and the suction mouth (47).

30
35

9. A method for freezing a piece of ground (15) comprising the steps of:

- inserting at least one probe (3) having at least one lateral wall (14) into the ground (15) to be frozen;
 - introducing a cryogenic liquefied gas into the probe (3);
 - evaporating the cryogenic liquefied gas;
 - evacuating the cryogenic gas from said probe (3) ; **characterized in that** the step of introducing a cryogenic liquefied gas into the probe (3) is obtained by spraying the cryogenic liquefied gas directly onto at least one lateral wall (14) of said probe (3).

40
45
50

10. The method according to claim 9, **characterized in that** the step of introducing the cryogenic liquefied gas into the probe (3) comprises the step of spraying said cryogenic liquefied gas towards a buried insertable end (3a) of the probe (3).

55

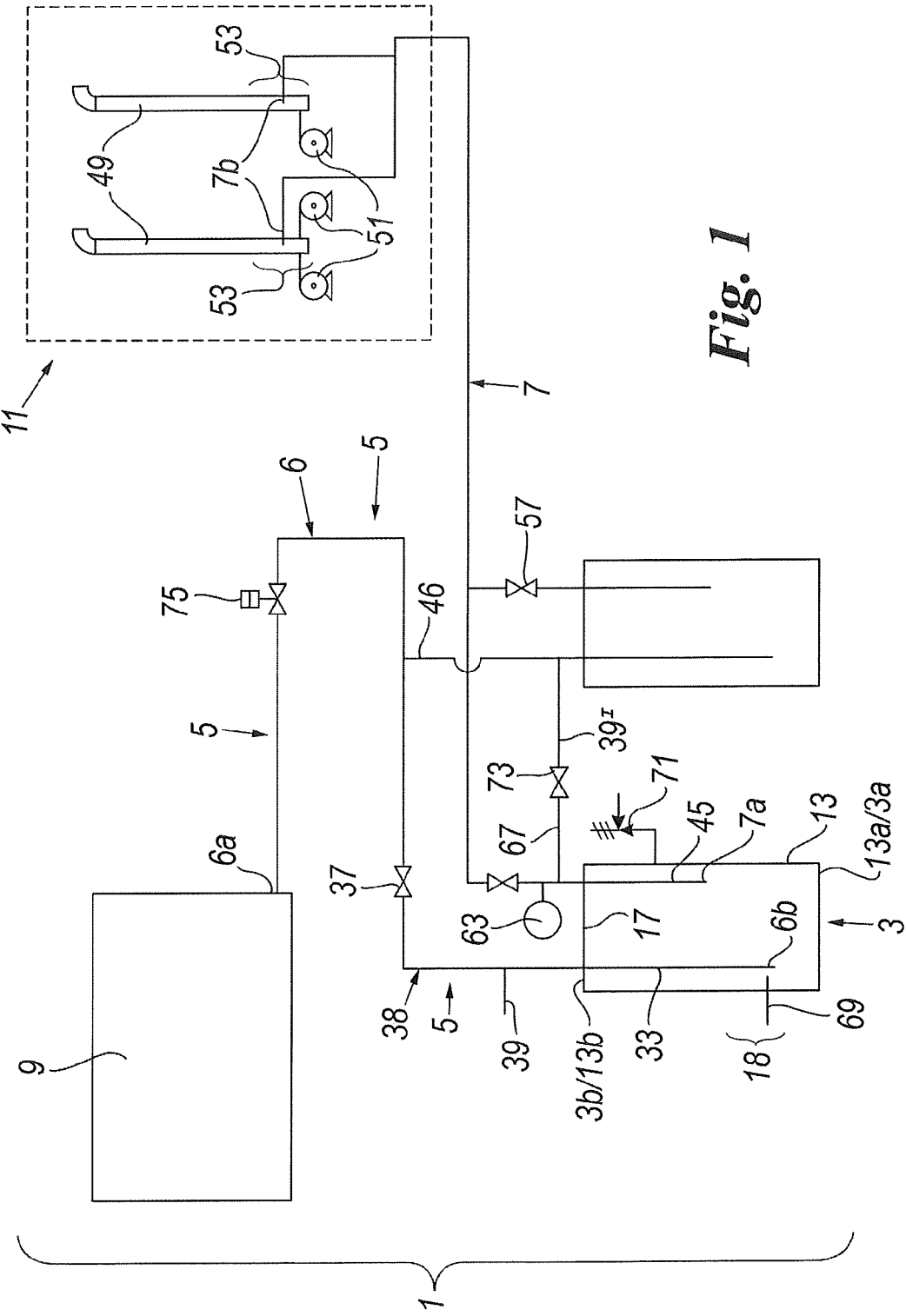


Fig. 1

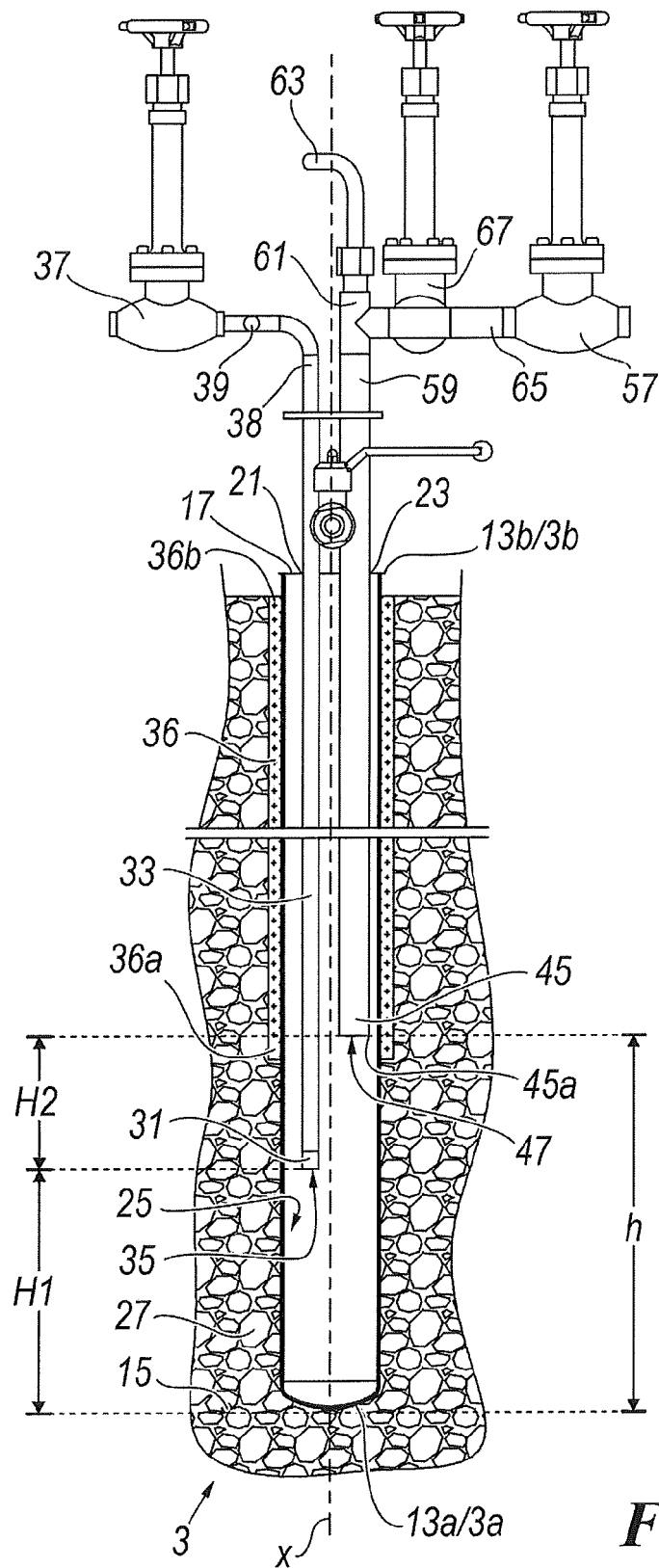


Fig. 2

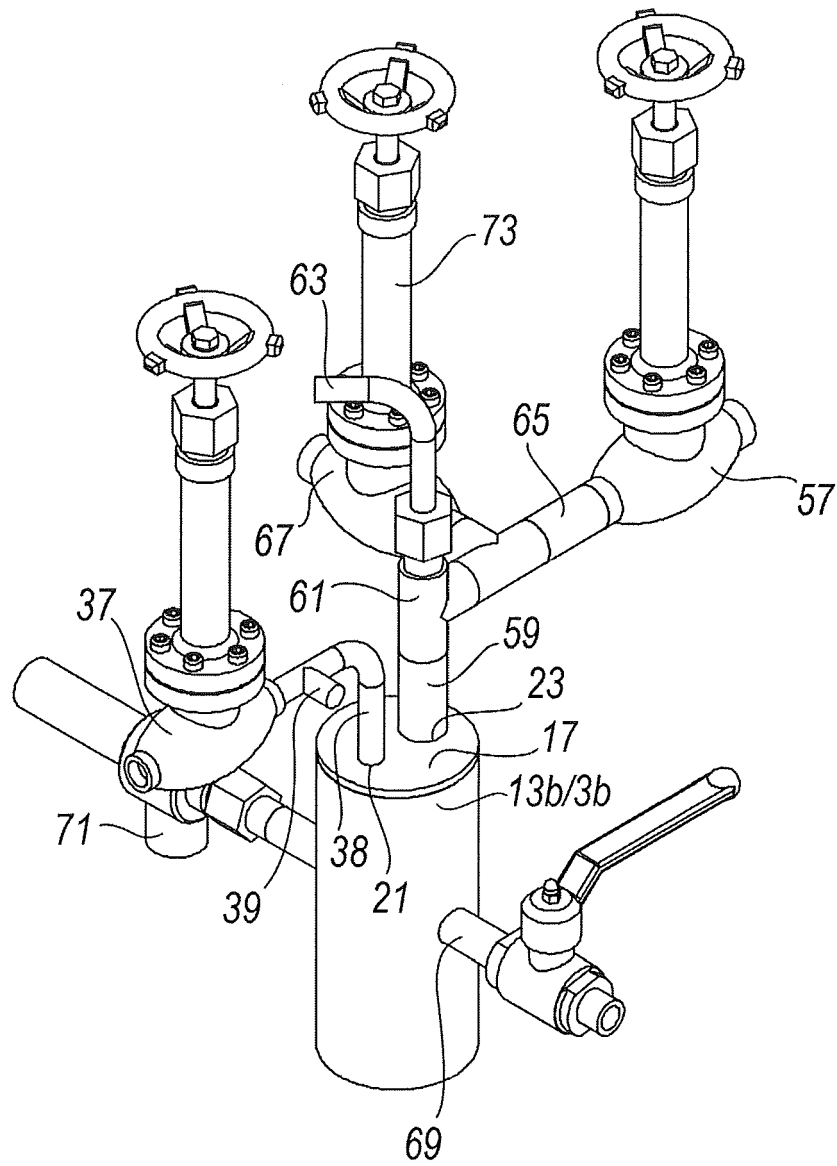


Fig. 3



EUROPEAN SEARCH REPORT

Application Number
EP 13 17 7293

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 3 943 722 A (ROSS JOHN WILLIAM) 16 March 1976 (1976-03-16) * column 7, line 26 - line 48; figure 1 * -----	1-4,8-10	INV. E02D3/115 E02D19/14
A	JP S61 134417 A (SHOWA ALUMINUM CORP) 21 June 1986 (1986-06-21) * abstract * -----	1-10	
			TECHNICAL FIELDS SEARCHED (IPC)
			E02D
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 28 October 2013	Examiner Geiger, Harald
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

1
EPO FORM 1503 03/82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 13 17 7293

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

28-10-2013

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 3943722	A	16-03-1976	NONE	

JP S61134417	A	21-06-1986	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82