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(54) **CRYOGENIC PLANT**

KRYOANLAGE

USINE CRYOGÉNIQUE

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## Description

**[0001]** The present invention relates to a cryogenic plant of the type as recited in the preamble of Claim 1.

**[0002]** In particular, the invention relates to a cryogenic plant, that is, a plant suitable to be used to store and, appropriately, supply a cryogenic fluid, that is, a fluid maintained in the liquid state and at a temperature below ambient temperature and, in particular, at -150°C.

**[0003]** As is known, cryogenic plants differ according to the configuration of the tanks. In detail, these may be buried so that the tanks are completely under the ground, or installed above ground so that the tanks stand on the ground and are thus visible. Furthermore, cryogenic plants differ according to the capacity of the tank. In particular, the plants known in the prior art may be of a medium to large size, with a total storage capacity of more than 20,000 $m^3$, or small, with a total storage capacity of less than 20,000 $m^3$.

**[0004]** The small cryogenic plants of the type installed above ground known in the prior art comprise: a horizontal tank with a storage capacity based on expected consumption and frequency of filling, a pump to move the fluid in the tank and a series of pipes to carry the fluid to a distribution network.

**[0005]** The tanks consist of two casings placed one inside the other and suspended above the ground by means of saddle-type supports. The outer casing is made of carbon steel, while the inner casing is made of a material capable of withstanding low temperatures. The two casings are separated from one another by a vacuum chamber filled with MLI or perlite in order to thermally insulate the tank.

**[0006]** Alternatively, medium and large sized cryogenic plants of the type installed above ground have an outer structure made of cement defining the outer body of the plant with a cylindrical inner tank having a vertical axis, a solid insulation covering the sides and the top of the inner tank and a flat bottom made of cryogenic steel resting on the ground.

**[0007]** Other cryogenic plants are disclosed in US2005115248A1, RU2437027C1, RU2437026C1 and US2016138758A1.

**[0008]** The prior art described above has a number of significant drawbacks.

**[0009]** A first important drawback lies in the fact that cryogenic plants, especially medium and large plants installed above ground, are unable to adjust to changes in consumption levels without constructing a new plant. This drawback is evident when one considers that the dimensions of cryogenic plants are defined according to an expected maximum consumption level which may change over time and not be accurate, so that a new plant has to be built.

**[0010]** Another drawback lies in the fact that, to adjust to changes in demand, the plant is unable, for example, to use the pump in conditions of maximum efficiency and is thus high in energy consumption.

**[0011]** A further drawback lies in the fact that the costs of repairing and servicing cryogenic plants are high.

**[0012]** Furthermore, an important drawback consists in the need to interrupt the supply of cryogenic fluid when carrying out repair work on the plant.

**[0013]** Another no less important drawback, specific to vertical tanks, lies in the fact that it is impossible to place thermal insulation on the bottom owing to the weight which would crush the insulation and prevent it from functioning properly.

**[0014]** Therefore, in plants with a vertical tank, a series of coils have to be installed on the bottom to control the temperature.

**[0015]** In this situation the technical purpose of the present invention is to devise a cryogenic plant able to substantially overcome the drawbacks mentioned above. Within the sphere of said technical purpose one important aim of the invention is to devise a cryogenic plant that can adapt easily and quickly to changes in the requested distribution capacity.

**[0016]** Another important aim of the invention is to provide a cryogenic plant that is easy to install and economical to run.

**[0017]** A further aim of the invention is to develop a cryogenic plant on which maintenance and repair work can be performed easily and quickly, especially without having to cut off the supply of the fluid.

**[0018]** The technical purpose and specified aims are achieved with a cryogenic plant as claimed in the appended Claim 1.

**[0019]** Preferred embodiments are described in the dependent claims.

**[0020]** The characteristics and advantages of the invention are clearly evident from the following detailed description of a preferred embodiment thereof, with reference to the accompanying drawings, in which:

**Fig. 1** shows a cryogenic plant according to the invention;

**Fig. 2** illustrates an assembly of the cryogenic plant; and

**Fig. 3** shows a detail of the plant in a view from above.

**[0021]** In this document, terms such as "first", "second", "upper", "lower", "main" and "secondary" do not necessarily indicate an order, priority or respective position, but may simply be used in order to make a clear distinction between the different components.

**[0022]** With reference to the aforesaid drawings, reference numeral 1 globally denotes the cryogenic plant according to the invention.

**[0023]** It is suitable to be used to store and supply a cryogenic fluid, that is a fluid maintained in the liquid state and at a temperature below ambient temperature and, for example, at around -150°C. In detail, the plant 1 is suitable to be used to store and supply a cryogenic fuel such as, for example, liquid hydrogen, liquid methane or other liquefied natural gas (LNG).

**[0024]** The cryogenic plant 1 is preferably of the type installed above ground.

**[0025]** It is preferably classifiable as a small cryogenic plant. It therefore has a capacity that is preferably between 9,000-27,000 $m^3$.

**[0026]** The cryogenic plant 1 as shown in Fig. 1, comprises one or more storage modules **1a** each of which comprising a horizontal tank **2**, that is, defining a longitudinal axis **2a** which, in use, is substantially perpendicular to the gravitational gradient. The horizontal tank 2 defines a single storage volume **2b** suitable to contain a cryogenic fluid. The cryogenic plant 1 also comprises at least one pump **3** arranged outside the tank 2 and in fluidic through connection with the tank 2 so as to control the motion of the cryogenic fluid; pipes suitable to place the pump 3 in fluidic through connection with each tank 2; and, optionally, at least one sump **4** beneath the tank 2, preferably under the ground, to collect the fluid, substantially owing to the force of gravity, when the tank 2 has to be completely emptied.

**[0027]** In some cases, the tank 2 is suitable to contain the pressurised fluid when circumstances so require.

**[0028]** Preferably, each storage module **1a** comprises two tanks 2; two pumps 3 each of which connected to both of the tanks 2 to define a redundancy of the storage module 1a; and, optionally, a sump 4 for each horizontal tank 2.

**[0029]** Each horizontal tank 2 has a cryogenic fluid storage volume 2b of at least 1,500 $m^3$. It is, preferably, arranged on the ground or on the floor and, precisely, rests on a supporting surface **1b** so that, in use, the longitudinal axis 2a is substantially parallel to said supporting surface. The horizontal tank 2 can thus be placed practically entirely above ground.

**[0030]** Each horizontal tank 2, illustrated in Fig. 2, has a three-layer structure comprising an outer casing **21**, a single inner casing **22** and a filler **23**. The outer casing 21 defines an inner chamber and the outer surface of the tank 2 and is suitable to rest on the surface 1b. The single inner casing 22 is arranged in the outer casing 21 and defines the single storage volume 2b. The filler 23 is thermally insulating and saturates the space between the casings 21 and 22.

**[0031]** The horizontal tank 2 further comprises one or more pipes **24** suitable to place the storage volume 2b in fluidic through connection with the outside of the tank 2.

**[0032]** The horizontal tank 2 comprises at least one pedestal **25**, preferably at least two, suitable to raise the inner casing 22 with respect to the outer casing 21, to guarantee their perfect spacing and, thus, the correct positioning of the filler 23. Said pedestals 25 are appropriately supporting saddles for the inner casing 22. The pedestals 25 are arranged between the inner casing 22 and the outer casing 21, to keep them apart and, thus, permit the creation of a space that is filled by the filler 23.

**[0033]** The pedestals 25 can be placed below the inner casing 22 so that the weight of the inner casing 22 is only discharged onto the outer casing 21 making it possible to have the best possible choice of the filler 23. Since the filler 23 does not have to bear the weight of the inner casing 22 it does not have a structural function and so can be chosen for its thermal insulation properties.

**[0034]** Lastly, the inner casing 22, the filler 23, the pipes 24 and the pedestals 25, if present, are advantageously the only elements arranged inside the inner chamber 21a. The outer casing 21 and the inner casing 22 have practically the same main axis of extension which is coincident with the longitudinal axis 2a.

**[0035]** The inner casing 22 is made of cryogenic steel.

**[0036]** The inner casing 22 is completely surrounded by the appropriately thermally insulating filler 23.

**[0037]** It has a cylindrical shape with its axis substantially parallel to the longitudinal axis 2a. Preferably, the tank 22 is cylindrical in shape with two hemispherical elements as the bases.

**[0038]** The thickness of the inner casing 22 is substantially uniform and practically less than 5 cm and, in particular, substantially comprised between 3 cm and 1 cm.

**[0039]** The ratio of the length, calculated along the axis 2a, to the diameter of the inner casing 22 is substantially comprised between 1.5 and 4, in particular, between 2 and 3 and, more in particular, substantially equal to 2.5.

**[0040]** The outer casing 21 is made of concrete material. Preferably, it is made of concrete and, more preferably, reinforced concrete.

**[0041]** It is made in one piece.

**[0042]** The outer casing 21 is a single-piece structure made of cementitious material, preferably concrete and more preferably reinforced concrete. The term single-piece structure refers to the fact that it is made by means of a single casting of cementitious material or other similar solution which makes it possible to obtain a continuous structure in cementitious material.

**[0043]** No other elements are thus immersed in the single-piece structure, that is, in the outer casing 21, except of course those used to produce the structure in cementitious material (in detail, in preferably reinforced concrete).

**[0044]** Inside said single-piece structure there is a single storage volume 2b defined by the single inner casing 22 and, arranged between said inner casing 22 and outer casing 21, a filler 23 saturating the space between the outer casing 21 and the inner casing 22 and appropriately thermally insulating.

**[0045]** The outer casing 21 has a right parallelepiped shape with a base that is appropriately substantially square or rectangular.

**[0046]** It has an average thickness of practically less than 100 cm, in particular, substantially of between 50 cm and 100 cm and, more in particular, of between 60 and 90 cm.

**[0047]** In some cases, the average thickness is appropriately uniform.

**[0048]** The outer casing may, optionally, have a coated inside surface, preferably painted, with a humidity insulation coating that defines a vapour barrier.

**[0049]** Preferably, said humidity insulation coating is in resin.

**[0050]** In order to facilitate the positioning of the pipes 24, the outer casing 21 is provided with a through opening **21a**, a single opening 21b, between the inner and outer chambers of the tank 2, saturated with the filler 23 and housing the pipes 24; and a closing plaque **21b** (Fig. 3) to close the through opening **21b** substantially counter-shaped with respect to said opening 21a.

**[0051]** The through opening 21a defines an extension of the inner chamber connecting said inner chamber with the outside of the tank 2.

**[0052]** The size of the through opening 21a and, thus, of the closing plaque 21b, is substantially less than 75 cm and, appropriately, its extension is substantially less than 500 $dm^2$, in particular, 300 $dm^2$ and, more in particular, substantially between 300 $dm^2$ and 200 $dm^2$.

**[0053]** The plaque **21b** is made of metallic material, preferably cryogenic steel. Additionally, the outer casing 21 may have a discharge opening 21c above the collection sump 4.

**[0054]** The filler 23 saturates the cavity between the outer casing 21 and the inner casing 22 to prevent any direct contact between the casings 21 and 22.

**[0055]** In particular, the filler 23 at least partially covers all the outside surfaces (that is, the sides and the bottom surfaces facing towards the outer casing 21) of the inner casing 22 so as to surround said inner casing 22 and, thus, prevent any direct contact between the outer casing 21 and the inner casing 22. More in particular, it surrounds all of the inner casing 22, except for the pipes 24 and any pedestals 25.

**[0056]** According to the invention, the filler 23 saturates the entire inner chamber and, preferably, the through opening 21b. It thus covers all of the outside surfaces of the inner casing 22.

**[0057]** Appropriately, the filler 23 has a thickness and, thus, defines a minimum distance between the inner casing 22 and the outer casing 21 of substantially less than 2 m and, in particular, substantially between 2 m and 1 m and, more in particular, substantially equal to 1.5 m.

**[0058]** To that end, the ratio of the length of the inner casing 22 to that of the outer casing 21, both calculated along the longitudinal axis 2a, is practically comprised between 80% and 40% and, more precisely, substantially comprised between 70% and 60%. Furthermore, the ratio of the diameter of the inner casing 22 to a side of the base of the outer casing 21, both calculated along the axis 2a, is practically between 95% and 60% and, more precisely, between 90% and 80%.

**[0059]** The filler 12 is a thermally insulating material and, preferably, appropriately expanded perlite and, appropriately, with a fine grain.

**[0060]** Lastly, the tank 2 comprises one or more couplings **26**, appropriately placed outside the outer casing 21 and, precisely, at the through opening 21b and, thus, attached to the closing plaque 21c, suitable to place the outside in fluidic through connection with the tank 22 via the pipes 24. Preferably, all the couplings 26 are placed outside the outer casing 21.

**[0061]** The couplings 26 comprise a filling coupling and a drainage coupling of the coolant. Also placed outside the outer casing 21 and, precisely, at the through opening 21b, the tank 2 comprises one or more control bodies **27** of the cryogenic fluid in the storage volume 2b each of which appropriately in fluidic through connection with the tank 22 via a specific pipe 24. Preferably, all the control bodies 27 are placed outside the outer casing 21.

**[0062]** The control bodies 27 comprise at least one flow control valve suitable to control the flow of the cryogenic fluid out of and, preferably, in to the volume 2b.

**[0063]** The control bodies 27 further comprise pressure gauges, temperature gauges and cryogenic fluid level gauges.

**[0064]** The pipes 24 are rectilinear and partially arranged in the through opening 21b.

**[0065]** Lastly, in addition to the modules 1a, the cryogenic plant 1 comprises one or more pipes **5** suitable to establish a fluidic through connection between each tank 2 and an external user system such as a distribution network; a control unit **6** suitable to control the pumps 3 according to the demand for cryogenic fluid; and, appropriately, a system of evaporators **7** to heat the steam requested by the users; a pressure control unit **8** to keep the pressure inside the tanks at a predefined level and, appropriately, substantially between 1.3-1.2 bar.

**[0066]** Appropriately, the cryogenic plant 1 comprises a plurality of storage modules 1a (that is, several horizontal tanks 2: at least one and, preferably, two pumps 3, each of which placed in fluidic through connection, via said pipes, with both of the tanks 2); and, appropriately, at least one pipe 5 suitable to connect each horizontal tank 2 to an external user system such as a distribution network.

**[0067]** In particular, the cryogenic plant 1 comprises a plurality of storage modules 1a arranged in series or, preferably, arranged parallel to one another.

**[0068]** The control unit 6 is appropriately connected to each pump 3 so as to control its operation.

**[0069]** It is also placed in connection for the exchange of data with the measurement devices 27 of each tank 2 so as to allow said unit to know the state and, in particular, the filling level of each tank 2.

**[0070]** In particular, the control unit 6 is connected to the control valve of each tank 2 so as to control the flow of cryogenic fluid leaving and, preferably, entering the volume 2b and, thus, disconnect one or more horizontal tanks 2 from the rest of the cryogenic plant 1.

**[0071]** The installation and functioning of a cryogenic plant, described above in a structural sense, is as follows.

**[0072]** First, the required maximum capacity of the plant 1 is determined according to the number and type of users to be served by the plant, expected consumption levels and frequency of filling.

**[0073]** Once the maximum capacity has been determined, a plurality of horizontal tanks 2 are arranged on the supporting surface 1b and, thus, on the ground until their total capacity is practically at least equal to said maximum capacity.

**[0074]** Next, the tanks 2 are connected in pairs, via the pipes, to a pump 3 and, preferably, individually, to a distribution network and, thus to the users to be served. Optionally, a second pump 3 may be provided for each pair of tanks 2.

**[0075]** Lastly, installation is completed by using the pipes 5 to connect the system of evaporators 7, the control unit 8 and one or more external users to each horizontal tank 2.

**[0076]** At this stage, installation is complete and the cryogenic plant 1 is ready to be operated.

**[0077]** The control unit 6 operates one or more pumps 3, based on the preferably practically instantaneous consumption by the users, to draw cryogenic fluid 3 from at least some of the horizontal tanks 2 and, thus, to obtain the desired fluid flow through the distribution network.

**[0078]** When one of the horizontal tanks 2 breaks down or is empty, the control unit 6 deactivates the respective pump 3 and controls the control bodies 27 to isolate the horizontal tank 2 from the rest of the cryogenic plant 1 so that the tank 2 can be refilled and/or repaired without interrupting the supply.

**[0079]** The invention achieves some important advantages.

**[0080]** A first advantage consists in the fact that heat loss of the cryogenic plant 1 can easily be controlled and improved on the basis of user demand.

**[0081]** Owing to the limited number of items inside the tank 2 more thermally insulating material 23 can be placed between the casings 21 and 22 and, in addition, the insulating material 23 can be placed practically all around the tank.

**[0082]** Heat loss is also reduced by making the outer casing 21 as a single piece, which improves the tightness of the tank 2.

**[0083]** Another important advantage lies in the fact that the filler 23 completely surrounds the inner casing 22 so that the storage module 1a and, thus, the cryogenic plant 1 are characterised by reduced heat loss so that the cryogenic fluid (that is a fluid maintained in the liquid state and at a temperature of approximately -150°C) can be stored for longer than is currently possible.

**[0084]** Another advantage consists in the fact that the cryogenic plant 1 is substantially modular and, in particular, capable of adapting in a simple and fast manner, to changes in consumption.

**[0085]** When there is a substantial drop in demand for coolant the plant 1 can simply deactivate one or more tanks 2 and the respective pumps 3.

**[0086]** In particular, this possibility means the pumps 3 can always be used in conditions of maximum efficiency, avoiding their use in conditions that do not guarantee maximum efficiency and thus improving the plant's efficiency and consumption levels.

**[0087]** An important advantage lies in the redundancy of the cryogenic plant 1 and, precisely, of each storage module 1a, which guarantees the correct operation of the plant 1.

**[0088]** Another advantage is thus given by the fact that with the plant 1, repair and maintenance costs and times are lower that with the known plants.

**[0089]** Said modularity is also represented by the fact that, since part of the plant can be disconnected, it is possible to increase/reduce the number of horizontal tanks 2 and, thus, modify the capacity of the cryogenic plant without altering any other parts of the plant and, especially, without interrupting the supply of the cryogenic fluid. This aspect makes it possible to reduce the initial costs of implementing a cryogenic plant 1.

**[0090]** The aforesaid possibility of adjusting the delivery capacity means the cryogenic plant 1 can be small to start with and its capacity can subsequently be increased, after an increase in demand, by adding new horizontal tanks 2.

**[0091]** The possibility of isolating only the broken horizontal tank 2 from the rest of the plant means it can be repaired without interrupting the distribution.

**[0092]** The previously described reciprocal communication between the horizontal tanks 2 means that if there is a breakdown/leak in one tank 2, the broken tank 2 can be completely emptied.

**[0093]** Lastly, since the horizontal tanks 2 are self-standing modules, any breakdowns/leaks in one horizontal tank 2 will not interfere with the other tanks 2, with the pumps or any other components of the plant 1.

**[0094]** Furthermore, an important advantage is given by the particular dimensions of the inner casing 22, thanks to which the fluid 2 can be insulated in the best possible way and, in particular, appropriately expanded perlite can be used to surround the inner casing 22.

**[0095]** Modifications and variations may be made to the invention described herein without departing from the scope of the independent and dependent claims.

## Claims

**1.** Cryogenic plant (1) comprising at least one storage module (1a); said at least one storage module (1a) comprising:

- at least one horizontal tank (2) for a cryogenic fluid;
- at least one pump (3) placed in fluidic through connection with said at least one horizontal tank (2);
- said at least one horizontal tank (2) comprising
- an outer casing (21) made in a single piece in concrete material defining an inner chamber;
- a single inner casing (22) defining a single storage volume (2a) and placed in said inner chamber;
- a filler (23) thermally insulating and saturating

said inner chamber between said outer casing (21) and said inner casing (22) and coating every outer surface of said inner casing (22) surrounding said inner casing (22) and thus avoiding direct contact between said outer casing (21) and said inner casing (22);

wherein said at least one horizontal tank (2) comprises at least one pedestal (25) arranged in said inner chamber and raising said inner casing (22) with respect to said outer casing;
wherein said horizontal tank (2) comprises pipes (24) suitable to place said storage volume (2b) in fluidic through connection with the outside of said tank (2); and said outer casing (21) comprises

- a single through opening (21a) between the inner and an outer chamber of said tank (2) saturated with said filler (23) and housing said pipes (24); and
- a closing plaque (21b) to close the through opening (21a) substantially counter-shaped with respect to said opening (21a).

**2.** Cryogenic plant (1) according to claim 1, wherein said at least one pump is placed outside said horizontal tank (2).

**3.** Cryogenic plant (1) according to one or more of the previous claims, wherein said outer casing (21) has a thickness substantially between 60 and 90 cm.

**4.** Cryogenic plant (1) according to one or more of the previous claims, wherein said horizontal tank (2) comprises at least one control body (27) of said cryogenic fluid; and wherein the totality of said at least one control body (27) are placed outside said outer casing (21).

**5.** Cryogenic plant (1) according to one or more of the previous claims, wherein said inner casing (22) is a cylindrical shape; and wherein the ratio between the length and the diameter of said inner casing (22) is substantially between 2 and 3.

**6.** Cryogenic plant (1) according to one or more of the previous claims, wherein said filler (23) defines a minimum distance between said inner casing (22) and said outer casing (21) substantially between 200 cm and 100 cm.

**7.** Cryogenic plant (1) according to one or more of the previous claims, wherein said at least one control body (27) comprises a control valve; and wherein said cryogenic plant (1) comprises a plurality of said at least one horizontal tanks (2) and a control unit (6) connected to said control valve so as to isolate at least one of said horizontal tanks (2) from the rest of said cryogenic plant (1).

**8.** Cryogenic plant (1) according to one or more of the previous claims, wherein said at least one storage module (1a) comprises two of said at least one horizontal tanks (2) for a cryogenic fluid; and two of said at least one pumps (3); and wherein each of said two pumps (3) is connected to each of said two tanks (2) defining a redundancy of said storage module (1a).

**9.** Cryogenic plant (1) according to the previous claim, comprising a plurality of said at least one storage modules (1a).

**Patentansprüche**

**1.** Kryoanlage (1), umfassend mindestens ein Speichermodul (1a); wobei das genannte mindestens eine Speichermodul (1a) Folgendes umfasst:

- mindestens einen horizontalen Tank (2) für ein Kältemedium;
- mindestens eine Pumpe (3) in Fluidverbindung mit dem genannten mindestens einem horizontalen Tank (2);
wobei der genannte mindestens eine horizontale (2) Tank Folgendes umfasst
- eine Außenhülle (21) aus einem Stück in Blockbauweise aus zementiertem Material, das eine Innenkammer definiert;
- eine einzige Innenhülle (22), die ein einziges Speichervolumen (2a) definiert und in der genannten Innenkammer positioniert ist;
- einen Füllstoff (23), der die genannte Innenkammer zwischen der genannten Außenhülle (21) und der genannten Innenhülle (22) isoliert und sättigt und jede Außenfläche der genannten Innenhülle (22) verkleidet und die genannte Innenhülle (22) umgibt und so einen direkten Kontakt zwischen der genannten Außenhülle (21) und der genannten Innenhülle (22) vermeidet;

wobei mindestens ein horizontaler Tank (2) mindestens einen Sockel (25) umfasst, der in der genannten Innenkammer platziert ist und die genannte Innenhülle (22) im Verhältnis zu der genannten Außenhülle anhebt;
wobei der genannte horizontale Tank (2) Verrohrungen (24) umfasst, die geeignet sind, das Speichervolumen (2b) mit der Außenseite des Tanks (2) in Fluidverbindung zu bringen; und wobei die genannte Außenhülle (21) Folgendes umfasst

- eine einzelne Durchgangsöffnung (21a) zwischen Innen- und Außenkammer des genannten Tanks (2), die mit dem genannten Füllstoff (23) gesättigt ist und die genannten Verrohrungen (24) unterbringt; und eine Verschlussplatte (21b) der genannten Durchgangsöffnung (21a), die im Wesentlichen ein Gegenprofil zu der genannten Durchgangsöffnung (21a) bildet.

**2.** Kryoanlage (1) nach Anspruch 1, bei der die genannte mindestens eine Pumpe an der Außenseite des genannten horizontalen Tanks (2) positioniert ist.

**3.** Kryoanlage (1) nach einem oder mehreren der vorangegangenen Ansprüche, bei der die genannte Außenhülle (21) eine Stärke von im Wesentlichen zwischen 60 cm und 90 cm aufweist.

**4.** Kryoanlage (1) nach einem oder mehreren der vorangegangenen Ansprüche, bei der der genannte horizontale Tank (2) mindestens ein Kontrollorgan (27) des genannten Kältemediums umfasst; und bei der die Gesamtheit des genannten mindestens einen Kontrollorgans (27) an der Außenseite der genannten Außenhülle (21) platziert sind.

**5.** Kryoanlage (1) nach einem oder mehreren der vorangegangenen Ansprüche, bei der die genannte Innenhülle (22) eine zylindrische Form aufweist; und bei der das Verhältnis zwischen der Länge und dem Durchmesser der genannten Innenhülle (22) im Wesentlichen zwischen 2 und 3 beträgt.

**6.** Kryoanlage (1) nach einem oder mehreren der vorangegangenen Ansprüche, bei der der genannte Füllstoff (23) einen Mindestabstand zwischen der genannten Innenhülle (22) und der genannten Außenhülle (21) von im Wesentlichen zwischen 200 cm und 100 cm definiert.

**7.** Kryoanlage (1) nach einem oder mehreren der vorangegangenen Ansprüche, bei der das genannte mindestens eine Kontrollorgan (27) ein Steuerventil umfasst; und bei der die genannte Kryoanlage (1) eine Vielzahl des genannten mindestens einen horizontalen Tanks (2) und ein an das genannte Steuerventil angeschlossenes Steuergerät (6) umfasst, um mindestens einen der genannten horizontalen Tanks (2) im Verhältnis zum Rest der genannten Kryoanlage (1) zu isolieren.

**8.** Kryoanlage (1) nach einem oder mehreren der vorangegangenen Ansprüche, bei der das genannte mindestens eine Speichermodul (1a) zwei des genannten mindestens einen horizontalen Tanks (2) für ein Kältemedium umfasst; und zwei der genannten mindestens einen Pumpe (3); und bei der jede der genannten beiden Pumpen (3) an jeden der genannten beiden Tanks (2) angeschlossen ist und eine Redundanz des genannten Speichermoduls (1a) definiert.

**9.** Kryoanlage (1) nach dem vorangegangenen Anspruch, umfassend eine Vielzahl des genannten mindestens einen Speichermoduls (1a).

**Revendications**

**1.** Usine cryogénique (1) comprenant au moins un module de stockage (1a) ; ledit au moins un module de stockage (1a) comprenant :

- au moins un réservoir horizontal (2) pour un fluide cryogénique ;
- au moins une pompe (3) placée en raccordement à passage de fluide avec ledit au moins un réservoir horizontal (2) ;

ledit au moins un réservoir horizontal (2) comprenant

- une gaine externe (21) venue de matière sous forme d'une pièce monobloc en ciment définissant une chambre interne ;
- une seule gaine interne (22) définissant un seul volume de stockage (2a) et placée dans ladite chambre interne ;
- une matière de remplissage (23) thermo-isolante et remplissant ladite chambre interne entre ladite gaine externe (21) et ladite gaine interne (22) et qui revête toute surface externe de ladite gaine interne (22) en entourant ladite gaine interne (21) et qui évite ainsi un contact direct entre ladite gaine externe (21) et ladite gaine interne (22) ;

dans laquelle ledit au moins un réservoir horizontal (2) comprend au moins un socle (25) placé dans ladite chambre interne et soulevant ladite gaine interne (22) par rapport à ladite gaine externe ;
dans laquelle ledit au moins un réservoir horizontal (2) comprend des conduits (24) aptes à mettre le volume de stockage (2b) en raccordement à passage de fluide avec la partie externe du réservoir (2) ; et dans laquelle ladite gaine externe (21) comprend

- une seule ouverture de passage (21a) entre la chambre interne et l'extérieur dudit réservoir (2), remplie de ladite matière de remplissage (23) et logeant lesdits conduits (24) ; et une plaque de fermeture (21b) de ladite ouverture de passage (21a) qui présente une forme sensiblement complémentaire à ladite ouverture de passage (21a).

2. Usine cryogénique (1) selon la revendication 1, dans laquelle ladite au moins une pompe est placée à l'extérieur dudit réservoir horizontal (2).

3. Usine cryogénique (1) selon l'une ou plusieurs des revendications précédentes, dans laquelle ladite gaine externe (21) a une épaisseur sensiblement comprise entre 60 et 90 cm.

4. Usine cryogénique (1) selon l'une ou plusieurs des revendications précédentes, dans laquelle ledit réservoir horizontal (2) comprend au moins un organe de contrôle (27) dudit fluide cryogénique ; et dans laquelle la totalité dudit au moins un organe de contrôle (27) est placée à l'extérieur de ladite gaine externe (21).

5. Usine cryogénique (1) selon l'une ou plusieurs des revendications précédentes, dans laquelle ladite gaine interne (22) présente une forme cylindrique ; et dans laquelle le rapport entre la longueur et le diamètre de ladite gaine interne (22) est sensiblement compris entre 2 et 3.

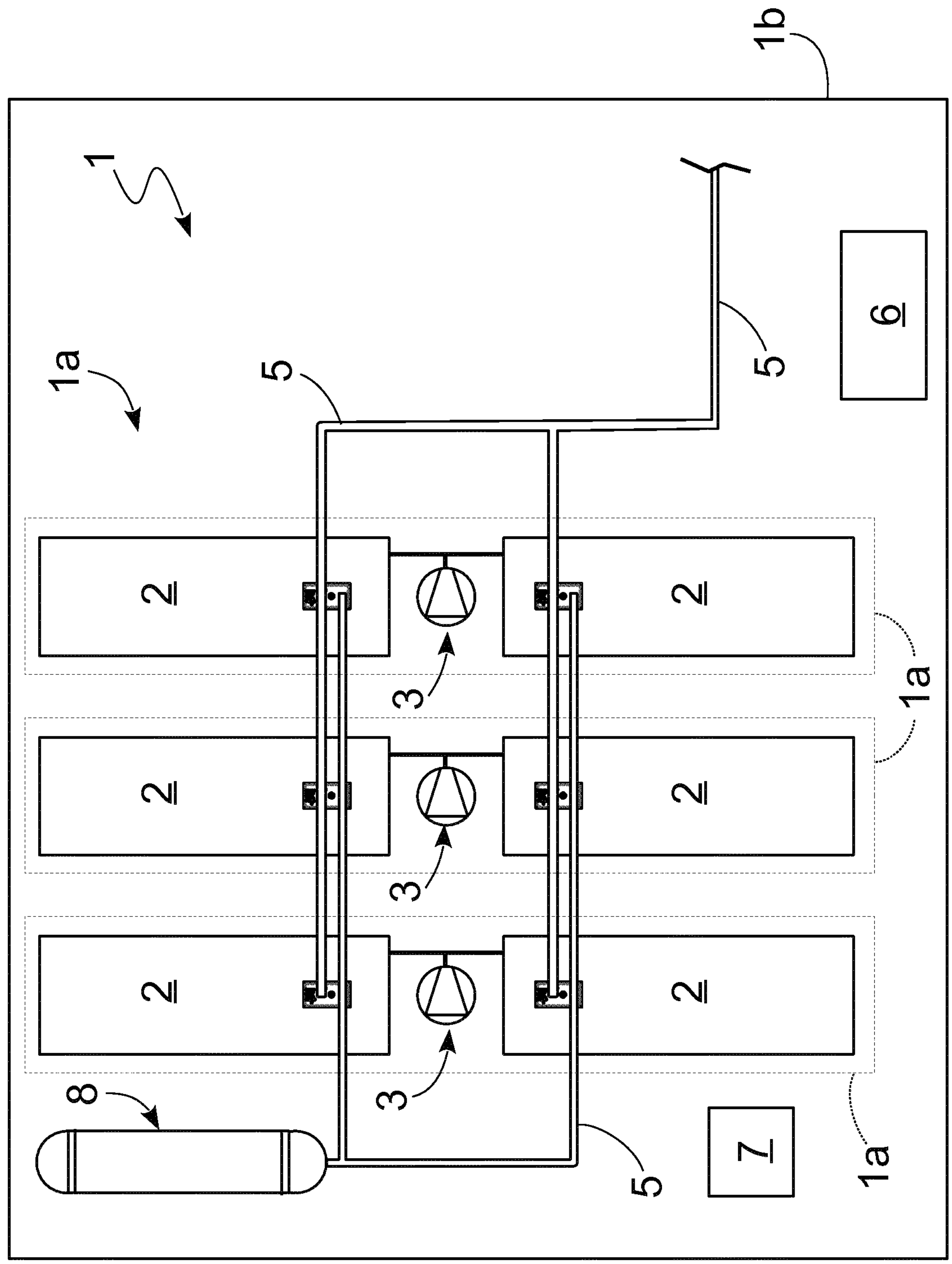
6. Usine cryogénique (1) selon l'une ou plusieurs des revendications précédentes, dans laquelle ladite matière de remplissage (23) définit une distance minimale entre ladite gaine interne (22) et ladite gaine externe (21) sensiblement comprise entre 200 cm et 100 cm.

7. Usine cryogénique (1) selon l'une ou plusieurs des revendications précédentes, dans laquelle ledit au moins un organe de contrôle (27) comprend une vanne de commande ; et dans laquelle ladite usine cryogénique (1) comprend une pluralité dudit au moins un réservoir horizontal (2) et une unité de contrôle (6) relié à ladite vanne de commande de façon à isoler au moins un desdits réservoirs horizontaux (2) par rapport au reste de ladite usine cryogénique (1).

8. Usine cryogénique (1) selon l'une ou plusieurs des revendications précédentes, dans laquelle ledit au moins un module de stockage (1a) comprend deux dudit au moins un réservoir horizontal (2) pour un fluide cryogénique ; et deux de ladite au moins une pompe (3) ; et dans laquelle chacune desdites deux pompes (3) est reliée à chacun desdits deux réservoirs (2) définissant une redondance dudit module de stockage (1a).

9. Usine cryogénique (1) selon la revendication précédente, comprenant une pluralité dudit au moins un module de stockage (1a).

*Fig. 1*



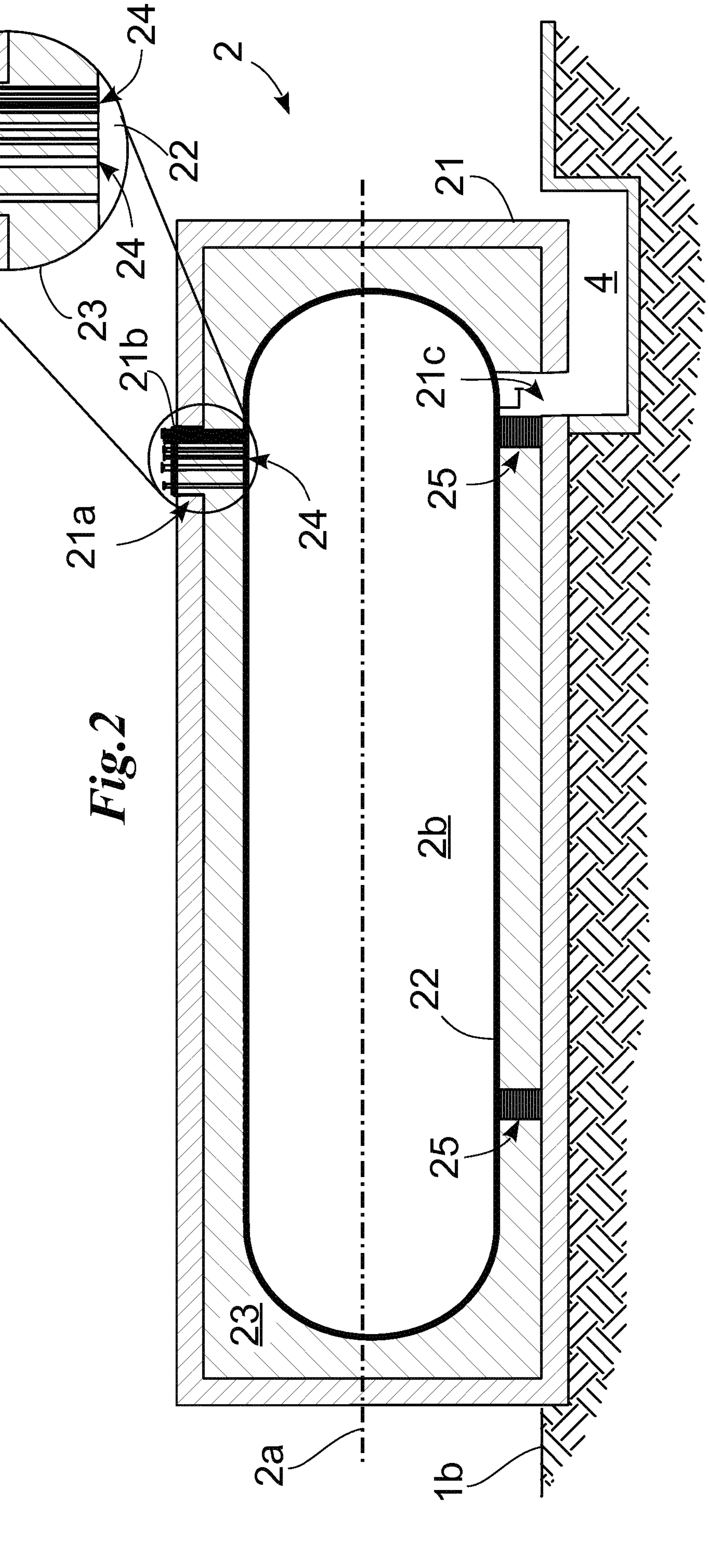

2
27
26
24
22
24
21c
21
23
21b
21a
24
21
4
21c
25
2b
22
25
23
2a
1b

*Fig.2*

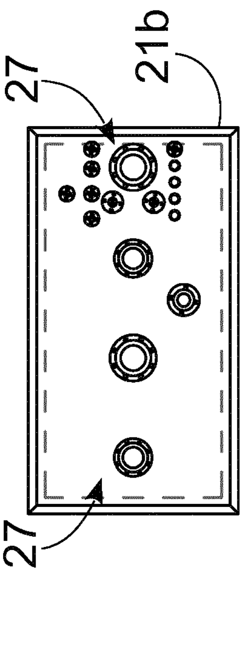

27
21b
27

*Fig. 3*

## REFERENCES CITED IN THE DESCRIPTION

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### Patent documents cited in the description

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