



(11)

EP 3 914 850 B1

(12)

EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention of the grant of the patent:
02.08.2023 Bulletin 2023/31

(51) International Patent Classification (IPC):
F17C 7/00 ^(2006.01) **B65D 90/22** ^(2006.01)
F17C 1/02 ^(2006.01) **F17C 3/00** ^(2006.01)

(21) Application number: **20744266.6**

(52) Cooperative Patent Classification (CPC):
F17C 3/00; B65D 90/0093; F17C 2201/018;
F17C 2201/035; F17C 2201/052; F17C 2203/0619;
F17C 2203/0685; F17C 2221/035;
F17C 2223/0153; F17C 2223/033;
F17C 2250/0421; F17C 2250/0469;
F17C 2260/015; F17C 2260/048; F17C 2270/0105

(22) Date of filing: **23.01.2020**

(86) International application number:
PCT/NO2020/050011

(87) International publication number:
WO 2020/153852 (30.07.2020 Gazette 2020/31)

(54) **AN APPARATUS AND A METHOD FOR CONTROLLING A PULLING OF AN INFLATABLE BLADDER THROUGH AN APERTURE**

VORRICHTUNG UND VERFAHREN ZUM STEUERN EINES ZIEHENS EINER AUFBLASBAREN BLASE DURCH EINE ÖFFNUNG

APPAREIL ET PROCÉDÉ DE COMMANDE DE LA TRACTION D'UNE VESSIE GONFLABLE À TRAVERS UNE OUVERTURE

(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

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(43) Date of publication of application:
01.12.2021 Bulletin 2021/48

(56) References cited:
WO-A1-2006/033577 WO-A1-2014/070021
WO-A1-2014/070021 DE-A1-102004 043 380
JP-A- S58 180 897 JP-B2- S5 610 997
US-A- 2 736 356 US-A- 4 079 856
US-B2- 7 021 488 US-B2- 9 623 980

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Description

[0001] The present invention is related to removal of a flexible bellows or bladder that has been inflated inside a chamber. More particularly, the present invention is related to an apparatus and a method for controlling a pulling of an inflatable bladder through an aperture in a wall between a chamber and a structure arranged on an outside of the chamber.

[0002] The bladder may be elastic or substantially inelastic of a type suitable for use as a volume-displacing device in a chamber such as for example an LPG-tank in an LPG transport ship. A bladder or bellows intended for this purpose is disclosed in publication WO 2006/033577 A1 which discloses i.a. a method related to change of cargo of a transport vessel having at least one fluid container containing a first fluid comprising a liquid phase and a gas phase. A second fluid is introduced into a bladder which is situated inside the fluid container. The expansion or filling of the bladder reduces the internal volume of the fluid container which is available for said gas phase. The method comprises *inter alia* the following steps:

- a) ventilating the fluid container by filling the bladder with said second fluid such that the amount of gas phase which is to be vented by an inert gas, is limited to a volume defined by the internal surface of fluid container and the external surface of the bladder; and
- b) replacing the inert gas, such as for example N₂ in said volume with the gas phase of the following cargo.

[0003] Thus, WO 2006/033577 A1 discloses an efficient manner in which a gas is ventilated from an enclosure such as a tank. Once the bladder is inflated using said gas, a gas on the outside of the bellows is allowed to escape through at least one aperture and into another area for safe keeping and/or processing. Once the bladder has been completely or nearly completely inflated, all the gas on the outside of the bladder is thus displaced through said apertures.

[0004] Publication WO 2014/070021 A1 discloses an apparatus and a method for facilitating purging a vessel by means of an inflatable bellows or bladder. The bladder is connected to a conduit for communicating a fluid into or out of the bladder. The bladder is initially arranged in a fluid tight compartment outside the vessel. The compartment is provided with a closable sealing means adapted for selectively bringing the compartment in fluid communication with the internal of the vessel via an aperture in a portion of the vessel. The aperture may typically, but not exclusively, be a so-called manhole. At least a portion of the bladder is then brought into the vessel. Thereafter, the bladder is inflated by means of a fluid provided from a fluid source. When the bladder has been inflated, the vessel is cleaned by purging a space which

is defined by an internal surface of the vessel and an external surface of the inflated bladder. When the cleaning process has been completed, the bladder is deflated and thereafter brought out of the vessel and back into the compartment.

[0005] The bladder used for insertion into a first tank such as described in WO 2014/070021 A1, is typically folded inside a cartridge when it is inserted into the second adjacent tank prior to use. Upon deployment, the bellows or bladder is typically falling from its cartridge in the second, adjacent tank into the first tank such that the filling end of the bladder is retained inside the second, adjacent tank. The filling end is a narrow portion of the bladder extending from its termination point inside the second, adjacent tank into the main tank so that it forms a "neck" on the main bladder, which is intended to inflate in the first tank. The bladder is folded in so a manner so as to avoid twist, which would impede the flow of gas into the bladder once it is dropped into the first tank. Similarly, the "neck" of the bladder is typically made in a somewhat stiffer material than that of the main portion of the bladder so that it does not successively collapse and re-inflate in dynamically unstable manner during inflation and deflation.

[0006] Once the bladder has served its purpose, it is typically deflated as much as is possible through the filling of gas on the outside of the bladder inside the first tank in which it has been deployed. This deflation method, although reliable, is not guaranteed to expel all the gas from the bladder. Thus, the remaining gas inside the bladder must be allowed to escape prior to the bladder entering a collection means inside the compartment.

[0007] One of the great advantages of the apparatus and method disclosed in WO 2014/070021 A1 is that the insertion, inflation, deflation and removal of bladder may be remotely controlled without a human having to expose him-/herself to the atmosphere in the vessel once the bladder has been initially installed in the compartment. This important advantage should be present also for the apparatus according to the present invention.

[0008] The apparatus and method disclosed in WO 2014/070021 A1 works satisfactorily. However, experiences show that there may be instances in which it is difficult to completely deflate the bladder, i.e. completely remove all the gas inside the bladder, before the bladder is pulled from the vessel through the aperture separating the vessel from the compartment and further onto or into the drum as disclosed in WO 2014/070021 A1. In such instances the gas trapped inside the bladder will tend to accumulate inside the diminishing volume of the remaining bladder during the pulling process. As the bladder is being pulled through the aperture between the vessel and compartment, the remaining gas volume inside the bladder will tend to inflate the remainder of the bladder being "upstream" of the aperture, i.e. the portion of the bladder still being inside the vessel. This inflated portion being upstream of the aperture in the vessel will tend to fully block the aperture between the vessel and the com-

partment. If the pulling operation continues, the gas pressure within the inflated portion of the bladder being upstream of the aperture will increase and represent a high risk of rupture. If, or rather when, such a rupture occurs, the gas from inside the bladder will blend with that of the gas on the outside of bladder inside vessel. A person skilled in the art will appreciate that such a blend of gases is highly undesirable.

[0009] Even though it should be expected that any cutting of the bladder into elongate strips when wound onto or into a collection drum in the compartment during its extraction from the vessel through the aperture should allow for the gas to escape from the bladder, experiences show that this is not always so.

[0010] There is therefore a need for an apparatus to provide a controlled gas release from the bladder downstream of the aperture, i.e. from the portion of the bladder that has been pulled out of the vessel.

[0011] The invention has for its object to remedy or to reduce at least one of the drawbacks of the prior art, or at least provide a useful alternative to prior art.

[0012] The object is achieved through features, which are specified in the description below and in the claims that follow.

[0013] The invention is defined by the independent patent claims. The dependent claims define advantageous embodiments of the invention.

[0014] In what follows the vessel will also be denoted chamber and the compartment will also be denoted structure.

[0015] In a first aspect of the invention there is provided an apparatus for controlling a pulling of an inflatable bladder through an aperture in a wall between a chamber and a structure arranged on an outside of the chamber. The apparatus comprises:

- a pulling mechanism for pulling the bladder through the aperture;
- a cutting device for providing a slit in a portion of the bladder after said portion having passed the aperture, the cutting device being responsive to a resistance of the bladder against passing through the aperture, so that the cutting device is activated and provides the slit if the resistance exceeds a predetermined level.

[0016] Preferably, the structure may be configured for carrying the pulling mechanism and the cutting device. The structure may be a housing.

[0017] By the term "slit" is meant any passage through a wall of the bladder allowing gas to flow out of the bladder. Thus, the slit may for example be one or a plurality of circular holes, or one or more rifts in the wall of the bladder.

[0018] By providing a cutting device being responsive to a resistance of the bladder against passing through the aperture, the evacuating rate of gas out of the bladder and into the structure, such as a housing, can be controlled.

By controlling the evacuation rate of gas out of the bladder, it is possible to use the portion of bladder still being upstream of the aperture, i.e. the portion of the bladder still being on the inside of the chamber, as a sealing means against the aperture. Without controlling the evacuation rate of gas out of the bladder, two different situations may arise. If the evacuation rate of gas is too large, the gas pressure within the portion of the bladder still being upstream of the aperture, will be too small to abut the periphery of the aperture and an open space will arise between the bladder and the periphery of the aperture. On the other hand, if said evacuation rate of gas is too small, the gas pressure within the portion of the bladder still being upstream of the aperture may increase to a pressure exceeding the capacity of the bladder while the bladder is pulled out. A pressure exceeding the capacity of the bladder will result in rupture of the bladder and mixing of the gas within the bladder with the gas within the chamber.

[0019] In one embodiment, the resistance is measured by measuring a load on the pulling mechanism. The load on the pulling mechanism may be measured for example by means of power consumption of the pulling mechanism, a torque, a "weight" of the device detected by means of a load cell, etc.

[0020] In another embodiment, the resistance is measured by means of a pressure sensing mechanism arranged in or at a periphery of the aperture, the pressure sensing mechanism configured for measuring a pressure exerted by the bladder. Such a pressure sensing mechanism may give signals to a control device operating the cutting device; the higher pressure sensed by the sensing mechanism, the higher number of and/or larger size of slits in the bladder is made by the cutting mechanism.

[0021] Independent of in which way the resistance is measured, the apparatus may further comprise a control device for controlling a pulling rate of the pulling mechanism, the control device being responsive to a resistance of the bladder from passing through the aperture so that the pulling rate is increased if the resistance is reduced, and vice versa; i.e. the pulling rate is reduced if the resistance is increased. This has the effect of further securing a sealing effect of the bladder against the aperture. The control device may form part of a common control device for controlling other components of the apparatus.

[0022] The cutting device may be configured for providing one or more slits along an axis being substantially in parallel with a moving direction of the bladder through the aperture. This has the effect that the bladder even after being provided with slits, is continuous in said moving direction and thus being spoolable onto a drum.

[0023] The pulling mechanism may be configured for puckering the bladder so that a volume of the bladder at the pulling mechanism is smaller than an area defined by a periphery of the aperture.

[0024] In a second aspect of the invention there is provided a method for pulling an inflatable bladder through

an aperture in a wall between a chamber and a structure arranged on an outside of the chamber, wherein the method comprises:

- bringing a portion of the bladder in engagement with a pulling device configured for pulling the bladder through the aperture between the chamber and the structure;
- activating the pulling device and measuring by means of a measuring device a resistance of the bladder against passing through the aperture; and
- if the measured resistance exceeds a predetermined level, activating a cutting device configured for providing a slit in a portion of the bladder that has been pulled through the aperture.

[0025] The method may further comprise, after activating the cutting device, controlling a pulling rate so that the resistance of the bladder against passing through the aperture is within a predetermined range.

[0026] In the following is described examples of preferred embodiments illustrated in the accompanying drawings, wherein:

- Fig. 1 shows a cut through an apparatus according to the invention prior to inserting a bladder from a structure into the chamber;
- Fig. 2 shows the bladder inserted into and fully inflated in the chamber;
- Fig. 3 shows the bladder while a gas within the bladder is urged out of the bladder by means of introducing a fluid into the chamber;
- Fig. 4 shows the apparatus after commencing the pulling operation by means of a pulling mechanism, wherein a major portion of the bladder has been pulled out;
- Fig. 5 shows the same as fig. 4 but wherein a cutting device has been activated to perforate the bladder;
- Fig. 6 shows in larger scale a cut through A-A in fig. 5;
- Fig. 7 shows an alternative cutting device of that shown in fig 5;
- Fig. 8 shows an alternative configuration of the cutting device shown in fig 5; and
- Fig. 9 shows the bladder wound onto a drum within the structure.

[0027] In the figures, same or corresponding elements are indicated by same reference numerals and letters.

[0028] Position indications such as for example, upper,

lower, upstream and downstream refers to a typical position of use of the apparatus, and as shown in the figures.

[0029] A person skilled in the art will understand that the figures are principle drawings, and that relative proportions between individual elements may be distorted. For example, in the embodiment shown in figures 1-5 and 7-8 the volume of the chamber and the volume defined by the structure are for illustrative purposes substantially the same. However, the volume of the chamber will typically be much larger, for example 100 times or more, than the volume defined by the structure.

[0030] For clarity, some of the elements shown may in some of the figures be without reference numerals.

[0031] In the figures 1 to 9, reference numeral 1 denotes an apparatus for controlling a pulling of an inflatable bladder B through an aperture 3 in a wall between a chamber 5, here in the form of a vessel, and a structure 7, here in the form of a bladder housing compartment which is desired if the gas within the bladder B is to be collected for example for future use and/or discharged distant from the structure 7. It should be noted that all required or desired piping and instrumentation of i.a. the vessel 5 and the bladder housing compartment 7 will be obvious to a person skilled in the art and are thus not shown in figures 1-9.

[0032] The bladder housing compartment 7 is connected to the vessel 5 via a conduit 9 extending from the aperture 3. The conduit 9 is similar to a so-called man-hole. Typically, a diameter of the conduit 9 is 600 mm.

[0033] The purpose of the bladder housing compartment 7 is to store the bladder B prior to insertion into the vessel 5 as shown in fig. 1, and to receive the bladder B as shown in figures 4-5 and 7-9 when it has served its purpose, i.e. when the vessel 5 has been purged, as discussed above in relation to WO 2014/070021 A1.

[0034] The bladder housing compartment 7 is provided with an internal partition 21 having a central opening therein for receiving a top portion of the bladder B. The partition 21 extends radially inwards from an internal wall of the bladder housing compartment 7. Prior to commencing the pulling operation of the bladder B, the bladder B and the partition 21 serve to divide the bladder housing compartment 7 into an upper portion 22 and a lower portion 23, as will be understood from the discussion below.

[0035] The apparatus 1 comprises a pulling mechanism 11, 11', here in the form of a pair of oblong rollers 11 abutting each other, and a rotatable drum 11'. The rotatable drum 11' is rotated by means of a driving device such as for example an electric, pneumatic or hydraulic motor (not shown).

[0036] In a first embodiment the rollers 11 are traction rollers 11 configured for rotating in opposite directions as indicated by arrows R in figures 4-5 and 7-8. The rotation is provided by means of a driving device (not shown) such as for example electric, pneumatic or hydraulic motors. In such an embodiment, the rotatable drum 11' is configured for winding the bladder B onto the

drum 11' after having passed the traction rollers 11. In this embodiment the rotatable drum 11' is configured for operating synchronous with the traction rollers 11 by means of a control device 15 operatively connected i.a. thereto. The control device 15 is typically operated from a remote location on for example a ship. For the sake of clarity, communication lines/signals to and from the control device 15 are not shown.

[0037] In a second embodiment the rotatable drum 11' is configured for pulling the bladder B out of the vessel 5. In such an embodiment the rollers 11 may be passive rollers configured for being rotated by means of the bladder B passing the rollers 11 while the bladder B is pulled by the rotatable drum 11'. In this second embodiment of the pulling mechanism, the passive rollers 11 serve as a guidance means.

[0038] In a third embodiment, the bladder B is pulled out of the vessel 5 by means of both the traction rollers 11 and the rotatable drum 11'. In this third embodiment, the rotatable drum 11' is configured for operating synchronous with the traction rollers 11 by means of the control device 15.

[0039] The rollers 11, independent of being traction rollers or rollers serving as guidance means, may in one embodiment (not shown) be provided with serrated surfaces configured for cutting the bladder B into a plurality of elongate strips when passing the rollers 11. The elongate strips are wound onto the drum 11'.

[0040] In all three embodiments of the pulling mechanism 11, 11', the rotatable drum 11' is configured for being removed from the upper portion 22 of the bladder housing compartment 7 in a manner disclosed in WO 2014/070021 A1.

[0041] The apparatus 1 further comprises a cutting device 13 for providing a slit in a portion of the bladder B after said portion having passed the aperture 3 in the wall of the vessel 5 during the pulling operation, i.e. in a "downstream" side of the aperture 3. Providing the slit in the downstream side of the aperture 3 will substantially prevent that the gas within the bladder B mixes with the gas within the vessel 5.

[0042] The cutting device 13 is movable from a passive position as shown in figures 1 - 4 wherein the cutting device 13 is not in contact with the bladder B, to an active position as shown in figures 5-8 wherein the cutting device penetrates the bladder B. It should be noted that the cutting device shown in fig. 7 is shown both in the passive position (indicated by dotted lines) and in the active position.

[0043] The movement of the cutting device 13 both ways between its passive position and its active position is controlled by the control device 15 being further configured for measuring a resistance of the bladder B from passing through the relatively small diameter of the aperture 3 in the vessel 5.

[0044] In fig. 1, the bladder B is folded and packed in a storage device 17 such as a cartridge, canister or other types of container or box having a size and a shape suitable

for efficient storage and transport and thereafter easy handling and installation within the lower portion 23 of the bladder housing compartment 7. Several storage devices 17 are typically stored for example on board a ship for easy use and installation within the bladder housing compartment 7, when needed.

[0045] Prior to commencing the pulling operation, a rim BR forming a top portion of a nozzle BN (see for example fig. 2) of the bladder B is connected to the rotatable drum 11' by means of for example a rope 18 attached to the rim BR of the bladder B and the rotatable drum 11'.

[0046] When the bladder B has been installed in the bladder housing compartment 7 and prior to commencing the pulling operation of the bladder B, the rim BR of the bladder B abuts an upper surface portion of the partition 21 at the periphery of the central opening in the partition 21. Thus, the partition 21 may support at least some of the weight of the bladder B. More importantly, when the rim BR abuts the partition 21, a sufficient seal is provided for inflating the bladder B by means of a gas, for example N₂, supplied to the upper portion 22 of the bladder housing compartment 7 via a gas supply pipe 8.

[0047] The bladder housing compartment 7 is connected to the vessel 5 by a closable sealing means 19 adapted for controllable opening and closing for communication between the bladder housing compartment 7 and the internal of the vessel 5. For illustrative purposes, the closable sealing means 19 are shown in fig. 1 only wherein it is indicated as a gate valve 19 being in its closed position.

[0048] In fig. 1 the pulling mechanism 11, 11' and the cutting device 13 are inactive.

[0049] In fig. 2, the gate valve 19 has been opened and a major portion of the bladder B has been inserted, or allowed to "drop", into the vessel 5 and subsequently fully inflated (as indicated by arrows Fi) within the vessel 5. When fully inflated, the bladder B occupies substantially the entire internal volume of the vessel 5. It should be noted that when the gate valve 19 is opened, and prior to inflating the bladder B, a fluid within the lower portion 23 of the bladder housing compartment 7 may mix with the fluid within the vessel 5. However, due to the sealing effect of the partition 21 and rim BR of the bladder B as discussed above, the fluid within the vessel 5 is substantially prevented from mixing with the fluid within the upper portion 23 of the bladder housing compartment 7.

[0050] At least after being fully inflated, the bladder B abuts the aperture 3 in the wall of the vessel 5 and thus substantially prevents fluid communication between the bladder housing compartment 7, including its lower portion 23, and the internal volume of the vessel 5 defined by an inner surface of the vessel 5 and outer surface of the bladder B.

[0051] A vessel purging operation as discussed in WO 2014/070021 A1 may now commence.

[0052] Fig. 3 shows a situation prior to commencing the pulling operation of the bladder B out of the vessel 5. The bladder B is in the process of being compressed

by means of filling a fluid, preferably a gas having a pressure being higher than the pressure within the bladder B, into the space defined by the inner surface of the vessel 5 and the outer surface of the bladder B. The fluid is supplied into the vessel 5 via vessel supply pipe 6. Thus, the bladder B is compressed and most of the gas within the bladder is urged into the upper portion 22 of the bladder housing compartment 7 and out via a conduit 8' for storage in another vessel (not shown) for later use or, depending on the type of gas, ventilated to atmosphere. The fluid flow into the vessel 5 is in fig. 3 indicated by arrow Fi and the gas flow out of the bladder B is indicated by arrow Fo.

[0053] As discussed above, experiences show that there may be instances in which it is difficult to completely deflate the bladder B, i.e. completely remove all the gas inside the bladder B, before all of the bladder B is pulled through the aperture 3 and out of the vessel 5.

[0054] Fig. 4 shows a situation wherein the bladder B has been substantially deflated by means of the pressure within the vessel 5, and the pulling process has commenced by activating the pulling mechanism 11, 11' as indicated by arrows R.

[0055] The pair of oblong rollers 11, independent of being traction rollers or guidance means as discussed above, will pucker the bladder B so that a volume of the bladder B at the rollers 11 is smaller than an area defined by the periphery of the aperture 3 in the vessel 5. Thus, during the pulling of the bladder B experiences show that the gas will accumulate in the portion of the bladder B still being within the vessel 5, i.e. upstream of the aperture 3. Due to the pulling of the bladder B, the volume available for housing the gas within the bladder B will diminish and the pressure within the bladder B will increase. This increased pressure will result in an increased resistance against the pulling of the bladder B through the aperture 3.

[0056] The apparatus 1 is provided with a measuring device (not shown) for measuring a load on the relevant pulling mechanism 11, 11'. Alternatively, or additionally, the measuring device may be a pressure sensing mechanism arranged in or at a periphery of the aperture 3 in the wall of the vessel 5. The pressure sensing mechanism is responsive to a pressure or load exerted by the bladder B while passing the aperture 3.

[0057] If the measuring device for measuring a resistance of the bladder B from passing through the aperture 3 measures a resistance exceeding a predetermined level, the control device 15 will activate a driving device of the cutting device 13 and move the cutting device 13 from an initial passive position as shown for example in fig. 4, to an active position as shown for example in fig. 5 wherein the cutting device 13 penetrates the bladder B in the portion being downstream of the aperture 3, i.e. within the lower portion 23 of the bladder housing compartment 7.

[0058] In the embodiments shown in figures 1-6 and 8-9, the cutting device 13 comprises a sharp object, such

as a knife extending from a piston movable within a cylinder (best seen in fig. 6). Thus, the driving device comprises a fluid pump, for example a hydraulic pump connected to a hydraulic source. As an alternative to said sharp object, the cutting device may for example comprise a rod configured for being heated at least in its active position so that the rod penetrates the bladder B by melting through the wall thereof. However, a cutting device in the form of a sharp object is preferred.

[0059] When being penetrated by the cutting device 13, the gas within the bladder B flows out of the bladder B and into the lower portion 23 of the bladder housing compartment 7. Due to the rollers 11 within the upper portion 22 of the bladder housing compartment 7, the bladder will be puckered, and a space will arise between the bladder B and the periphery of the opening in the partition 21. The compressed gas from within the bladder B flowing into the lower portion 23 of the bladder housing compartment 7, is then allowed to pass said space at the partition 21 and flow into the upper portion 23 of bladder housing compartment 7 and out through the conduit 8' as mentioned above. This flow is in figures 5, 7, and 8 indicated by arrows Fo.

[0060] By measuring the resistance of the bladder B from passing through the aperture 3 either continuously or at certain intervals, for example each five seconds, the cutting device 13 may be controlled both ways between its active and passive positions so that a desired resistance against the pulling is achieved.

[0061] It is desirable to substantially prevent that the gas within the vessel 5 blends with the gas in the bladder housing compartment 7. To achieve this desire, it is important that the bladder B within the vessel 5 seals around the aperture 3 during the pulling operation. Therefore, it is important that the slit(s) provided by the cutting device 13 is/are not too large. This is controlled by the control device 15 in such a manner that if the resistance against pulling of the bladder B is below a predetermined level, the cutting device 13 is retracted to its initial passive position. If the resistance thereafter increases to a level above the predetermined level, the cutting device 13 is again moved to its active position. This process continues until the bladder B is completely pulled out of the vessel 5 and the valve 19 at the aperture 3 is closed.

[0062] Fig. 6 shows an example of a configuration of the cutting device 13 comprising eight cutting elements 14 extending radially towards a centerline of the aperture 3 of the vessel and the conduit 9. It should be noted that the cutting device 13 in an alternative embodiment may comprise at least one cutting element. In the embodiment shown, each cutting element 14 is connected to a piston of a piston-cylinder arrangement 14' as discussed above. The piston-cylinder arrangements 14' are arranged at the interface between the conduit 9 and a wall of the bladder housing compartment 7.

[0063] In the embodiment shown, all eight cutting elements 14 are in their active position penetrating the bladder B. However, it is preferred that each of or at least

opposite pairs of the cutting elements 14 are configured to be controlled individually by means of the control device 15 operatively connected to the means for measuring resistance of the bladder B through the aperture 3.

[0064] Further examples of arrangements of the cutting device 13 are shown in figures 7 and 8 which will be discussed below.

[0065] In fig. 7, the cutting device 13 comprises rolling knives 14. Each rolling knife 14 is arranged at an end portion of a pivot arm 14' connected to the wall of the lower portion 23 of the bladder housing compartment 7. In the embodiment shown, the arm 14' is configured for movement between a passive position (shown by dotted lines), and an active position wherein the rolling knives penetrates the wall of the bladder B. The movement is provided by means of a hydraulic or pneumatic cylinder controlled by means of the control device 15 as discussed above.

[0066] The cutting device 13 shown in fig. 8 is similar to cutting device 13 shown in fig. 5, but inclined downwardly with respect to a pulling direction of the bladder B instead of being substantially perpendicular thereto as indicated in fig. 5.

[0067] With respect to the number of cutting elements 14, the cutting devices 13 shown in figures 7 and 8 may be arranged and operated in a similar way as discussed with regards to the embodiment shown in fig. 5 and fig. 6.

[0068] Due to the upward movement of the bladder B when pulled out of the vessel 5, it is desired to provide the slit relatively close to the aperture 3. An "effective working time" of the slit before the slit moves puckered into the upper part 22 of the bladder housing compartment 7 will then be sufficient for serving its purpose of allowing gas to flow out of the bladder B.

[0069] In fig. 9 the bladder B has been pulled out of the vessel 5 and fully wound onto the drum 11' which can then be removed from the upper portion 22 of the bladder housing compartment 7 for example via an openable top portion (not shown) thereof. The gate valve 19 has been activated to its closed position so that bladder housing compartment 7 is fluidly isolated from the internal of the vessel 5.

[0070] From the above it should be understood that it is important that the rate of gas release from the bladder attained through such controlled slit or cut is not significantly greater than that of the pulling rate of the bladder so that the bladder inside the vessel 5 is sufficiently inflated to form an effective seal against leakage from the bladder housing compartment 7 into the vessel 5 through the aperture 3. If the gas release rate is too high compared with the pulling rate of the bladder B, the bladder B may deflate more rapidly than its volumetric removal rate from vessel 5, resulting in loss of sealing of the bladder B against the aperture 3 resulting of gas leakage from the bladder housing compartment 7 into vessel 5. By the term volumetric removal rate is meant the rate at which the remaining volume of the bladder B is reduced inside the vessel 5 as a result of the bladder B being pulled

through the aperture 3 and into bladder housing compartment 7.

[0071] As will be apparent from the description above, the gas release rate from the bladder can be controlled by at least three different methods.

[0072] A first method of controlling the gas release rate from the bladder B in the lower portion 23 of the bladder housing compartment 7, is through monitoring the torque applied to the pulling mechanism 11, 11' and thus apply a selective degree of cut of the bladder B in the lower portion 23 of the bladder housing compartment 7 as a function of required torque above a certain threshold level. Once the required gas release rate is achieved the required torque is reduced and thus the degree of selective cut is similarly reduced.

[0073] A second method of controlling the gas release rate from the bladder B in the lower portion 23 of the bladder housing compartment 7 is through maintaining a certain degree torque applied to the pulling mechanism 11, 11'. Once a certain torque level is exceeded, the selective cut is applied in increasing degree until the torque level is reduced to within acceptable or desired limits. In this context the torque level of the pulling mechanism 11, 11' will be a proxy for the degree of sealing pressure from the bladder B against the aperture 3 on the inside of vessel 5. The degree of selective cut of the bladder B in the lower portion 23 of the bladder housing compartment 7 is successively reduced in line with reduced degree of torque requirements.

[0074] A third method of controlling the gas release rate from the bladder B in the lower portion 23 of the bladder housing compartment 7 is through maintaining a constant volumetric extraction rate of the bladder B through controlling the speed of the rollers 11 and/or the rotatable drum 11' whilst monitoring the required torque applied thereto. Once a certain torque level is exceeded, selective slit(s) is/are applied in the lower portion 23 of the bladder housing compartment 7 whilst maintaining the applied torque of the rollers 11 and/or rotatable drum 11' below a predetermined limit. The torque is maintained by varying the rotational speed thereof such that neither the extraction rate of the bladder B nor the upper torque level is exceeded. Once the torque level is below a predetermined level and the maximum predetermined rotational speed of the rollers 11 and/or rotatable drum 11' is achieved, the degree of selective cut through the wall of the bladder B is reduced or withdrawn.

[0075] It should be noted that the above-mentioned embodiments illustrate rather than limit the invention, and that those skilled in the art will be able to design many alternative embodiments without departing from the scope of the appended claims. In the claims, any reference signs placed between parentheses shall not be construed as limiting the claim. Use of the verb "comprise" and its conjugations does not exclude the presence of elements or steps other than those stated in a claim. The article "a" or "an" preceding an element does not exclude the presence of a plurality of such elements.

[0076] The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage.

Claims

1. An apparatus (1) for controlling a pulling of an inflatable bladder (B) through an aperture (3) in a wall between a chamber (5) and a structure (7) arranged on an outside of the chamber (5), wherein the apparatus (1) comprises:

- a pulling mechanism (11, 11') for pulling the bladder (B) through the aperture (3);
- a cutting device (13) for providing a slit in a portion of the bladder (B) after said portion having passed the aperture (3), the cutting device (13) being responsive to a resistance of the bladder (B) against passing through the aperture (3), so that the cutting device (13) is activated and provides the slit if the resistance exceeds a predetermined level.

2. The apparatus (1) according to claim 1, wherein the resistance is measured by measuring a load on the pulling mechanism.

3. The apparatus (1) according to claim 1, wherein the resistance is measured by means of a pressure sensing mechanism arranged in or at a periphery of the aperture (3), the pressure sensing mechanism configured for measuring a pressure exerted by the bladder (B).

4. The apparatus (1) according to any one of claims 1 to 3, comprising a control device (15) for further controlling a pulling rate of the pulling mechanism (11, 11'), the control device (15) being responsive to a resistance of the bladder (B) from passing through the aperture (3) so that the pulling rate is increased if the resistance is reduced, and vice versa.

5. The apparatus (1) according to any one of claims 1 to 4, wherein the cutting device (13) is configured for providing one or more slits along an axis being substantially in parallel with a moving direction of the bladder (B) through the aperture (3).

6. The apparatus (1) according to any one of claims 1 to 5, wherein the pulling mechanism (11, 11') is configured for puckering the bladder (B) so that a volume of the bladder (B) at the pulling mechanism (11) is smaller than an area defined by a periphery of the aperture (3).

7. A method for pulling an inflatable bladder (B) through

an aperture (3) in a wall between a chamber (5) and a structure (7), wherein the method comprises:

- bringing a portion of the bladder (B) in engagement with a pulling device (11, 11') configured for pulling the bladder (B) through the aperture (3) between the chamber (5) and the structure (7) arranged on an outside of the chamber (5);
- activating the pulling device (11, 11') and measuring by means of a measuring device (15) a resistance of the bladder (B) against passing through the aperture (3); and
- if the measured resistance exceeds a predetermined level, activating a cutting device (13) configured for providing a slit in a portion of the bladder (B) that has been pulled through the aperture (3).

8. The method according to claim 7, wherein, after activating the cutting device (13), the method further comprises controlling a pulling rate so that the resistance of the bladder (B) against passing through the aperture (3) is within a predetermined range.

Patentansprüche

1. Vorrichtung (1) zum Steuern eines Hindurchziehens einer aufblasbaren Blase (B) durch eine Öffnung (3) in einer Wand zwischen einer Kammer (5) und einer an einer Aussenseite der Kammer (5) angeordneten Struktur (7), wobei die Vorrichtung (1) aufweist:

- einen Zugmechanismus (11, 11'), um die Blase (B) durch die Öffnung (3) zu ziehen;
- eine Schneidevorrichtung (13), um einen Schlitz in einem Abschnitt der Blase (B) anzufertigen, nachdem der besagte Abschnitt die Öffnung (3) passiert hat, wobei die Schneidevorrichtung (13) reagieren kann auf einen Widerstand der Blase (B) gegen das Passieren der Öffnung (3), sodass die Schneidevorrichtung (13) aktiviert ist und den Schlitz anfertigt, wenn der Widerstand ein vorbestimmtes Niveau übersteigt.

2. Vorrichtung (1) gemäß Anspruch 1, wobei der Widerstand gemessen wird, indem eine auf den Zugmechanismus wirkende Belastung gemessen wird.

3. Vorrichtung (1) gemäß Anspruch 1, wobei der Widerstand mittels eines Druckmesssystems gemessen wird, welches in oder an einer Peripherie der Öffnung (3) angeordnet ist, wobei das Druckmesssystem ausgebildet ist, um einen von der Blase (B) ausgeübten Druck zu messen.

4. Vorrichtung (1) gemäß einem der Ansprüche 1 bis

3, aufweisend eine Steuervorrichtung (15) zur weiteren Steuerung einer Zuggeschwindigkeit des Zugmechanismus' (11, 11'), wobei die Steuervorrichtung (15) auf einen Widerstand der Blase (B) gegen das Passieren der Öffnung (3) reagieren kann, so dass die Zuggeschwindigkeit erhöht wird, wenn der Widerstand verringert wird, und umgekehrt.

5. Vorrichtung (1) gemäß einem der Ansprüche 1 bis 4, wobei die Schneidevorrichtung (13) ausgebildet ist, um einen oder mehrere Schlitze entlang einer Achse anzufertigen, welche im Wesentlichen parallel zu einer Bewegungsrichtung der Blase (B) durch die Öffnung (3) ist. 10
6. Vorrichtung (1) gemäß einem der Ansprüche 1 bis 5, wobei der Zugmechanismus (11, 11') ausgebildet ist, um die Blase (B) zu fälteln, sodass ein Volumen der Blase (B) am Zugmechanismus (11) kleiner ist als eine von einer Peripherie der Öffnung (3) definierte Fläche. 20
7. Verfahren zum Ziehen einer aufblasbaren Blase (B) durch eine Öffnung (3) in einer Wand zwischen einer Kammer (5) und einer Struktur (7), wobei das Verfahren beinhaltet: 25
 - in-Eingriff-Bringen der Blase (B) mit einer Zugvorrichtung (11, 11'), welche ausgebildet ist, um die Blase (B) durch die Öffnung (3) zwischen der Kammer (5) und der an einer Aussenseite der Kammer (5) angeordneten Struktur (7) zu ziehen; 30
 - Aktivieren der Zugvorrichtung (11, 11') und Messen eines Widerstands der Blase (B), die die Öffnung (3) zu passieren, mittels einer Messvorrichtung (15); und 35
 - wenn der gemessene Widerstand ein vorbestimmtes Niveau übersteigt, Aktivieren einer Schneidevorrichtung (13), welche ausgebildet ist, um einen Schlitz in einem durch die Öffnung hindurch gezogenen Abschnitt der Blase (B) anzufertigen. 40
8. Verfahren gemäß Anspruch 7, wobei nach dem Aktivieren der Schneidevorrichtung (13) das Verfahren femer beinhaltet, eine Zuggeschwindigkeit zu steuern, sodass der Widerstand der Blase (B), die Öffnung (3) zu passieren, innerhalb eines vorbestimmten Bereichs liegt. 45 50

Revendications

1. Un appareil (1) pour commander le passage d'une vessie gonflable (B) à travers une ouverture (3) dans une paroi entre une chambre (5) et une structure (7) agencée à l'extérieur de la chambre (5), dans lequel 55

l'appareil (1) comprend :

- un mécanisme de traction (11, 11') pour passer la vessie (B) à travers l'ouverture (3);
- un dispositif de coupe (13) pour fournir une fente dans une partie de la vessie (B) après que ladite partie a traversé l'ouverture (3), le dispositif de coupe (13) étant sensible à une résistance de la vessie (B) contre sa traversée à travers l'ouverture (3), de sorte que le dispositif de coupe (13) est activé et fournit la fente si la résistance dépasse un niveau prédéterminé.

2. L'appareil (1) selon la revendication 1, dans lequel la résistance est mesurée en mesurant une charge sur le mécanisme de traction. 15
3. L'appareil (1) selon la revendication 1, dans lequel la résistance est mesurée au moyen d'un mécanisme de détection de pression disposé dans ou au niveau d'une périphérie de l'ouverture (3), le mécanisme de détection de pression configuré pour mesurer une pression exercée par la vessie (B). 20
4. L'appareil (1) selon l'une quelconque des revendications 1 à 3, comprenant un dispositif de commande (15) pour commander en outre une vitesse de traction du mécanisme de traction (11, 11'), le dispositif de commande (15) étant sensible à une la résistance de la vessie (B) à traverser à travers l'ouverture (3) de sorte que la vitesse de traction est augmentée si la résistance est réduite, et vice versa. 25 30
5. L'appareil (1) selon l'une quelconque des revendications 1 à 4, dans lequel le dispositif de coupe (13) est configuré pour fournir une ou plusieurs fentes le long d'un axe sensiblement parallèle à une direction de déplacement de la vessie (B) à travers l'ouverture (3). 35 40
6. L'appareil (1) selon l'une quelconque des revendications 1 à 5, dans lequel le mécanisme de traction (11, 11') est configuré pour plisser la vessie (B) de sorte qu'un volume de la vessie (B) au niveau du mécanisme de traction (11) est plus petit qu'une zone définie par une périphérie de l'ouverture (3). 45
7. Un procédé pour passer une vessie gonflable (B) à travers une ouverture (3) dans une paroi entre une chambre (5) et une structure (7), dans lequel le procédé comprend : 50
 - amener une partie de la vessie (B) en prise avec un dispositif de traction (11, 11') configuré pour tirer la vessie (B) à travers l'ouverture (3) entre la chambre (5) et la structure (7) disposée sur un extérieur de la chambre (5);
 - activer le dispositif de traction (11, 11') et me-

surer au moyen d'un dispositif de mesure (15) une résistance de la vessie (B) contre le passage à travers l'ouverture (3) ; et
- si la résistance mesurée dépasse un niveau prédéterminé, activer un dispositif de coupe (13) 5
configuré pour fournir une fente dans une partie de la vessie (B) qui a été passée à travers l'ouverture (3).

8. Le procédé selon la revendication 7, dans lequel, 10
après l'activation du dispositif de coupe (13), le procédé comprend en outre la commande d'un taux de traction de sorte que la résistance de la vessie (B) contre le passage à travers l'ouverture (3) se situe 15
dans une plage prédéterminée.

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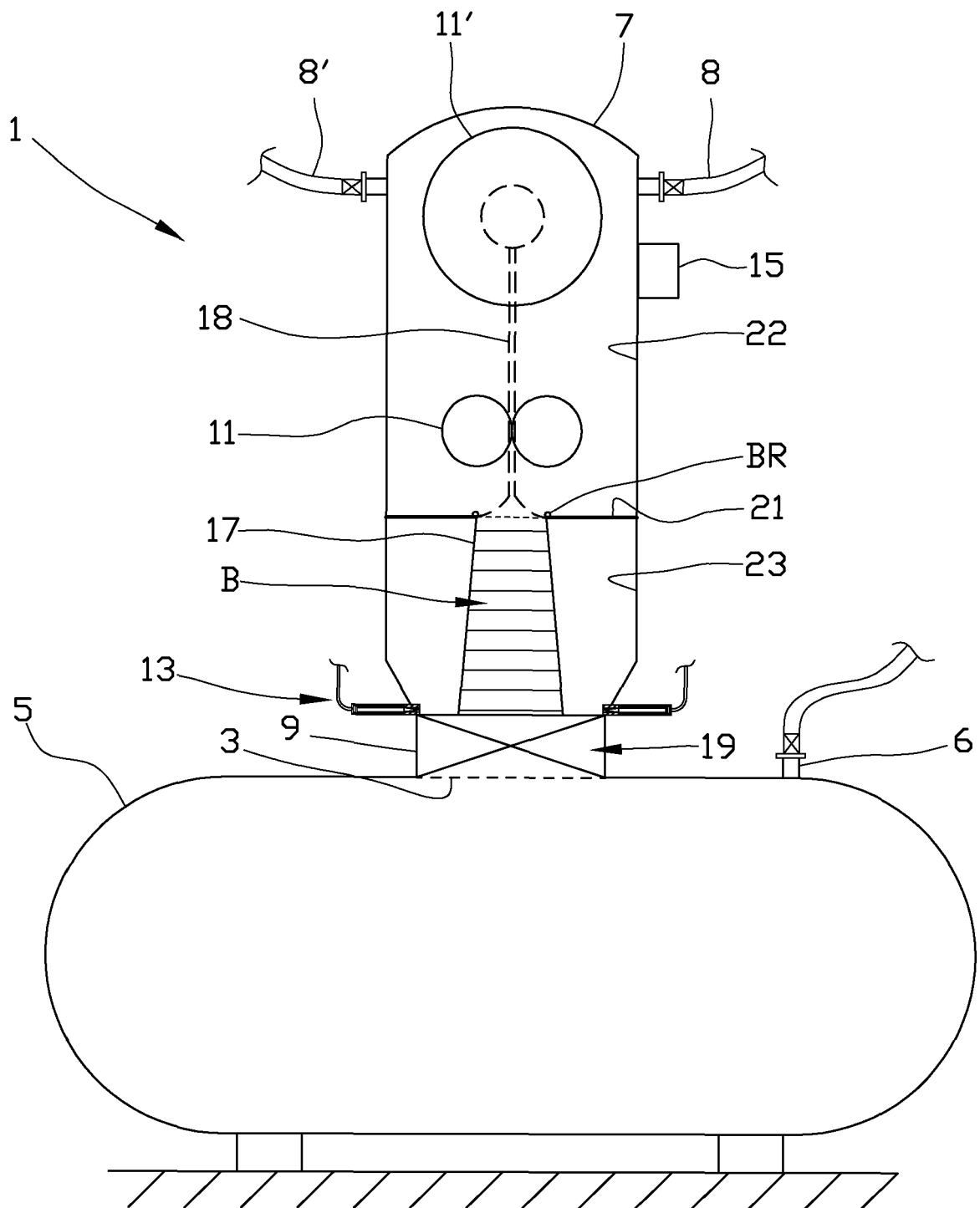


Fig. 1

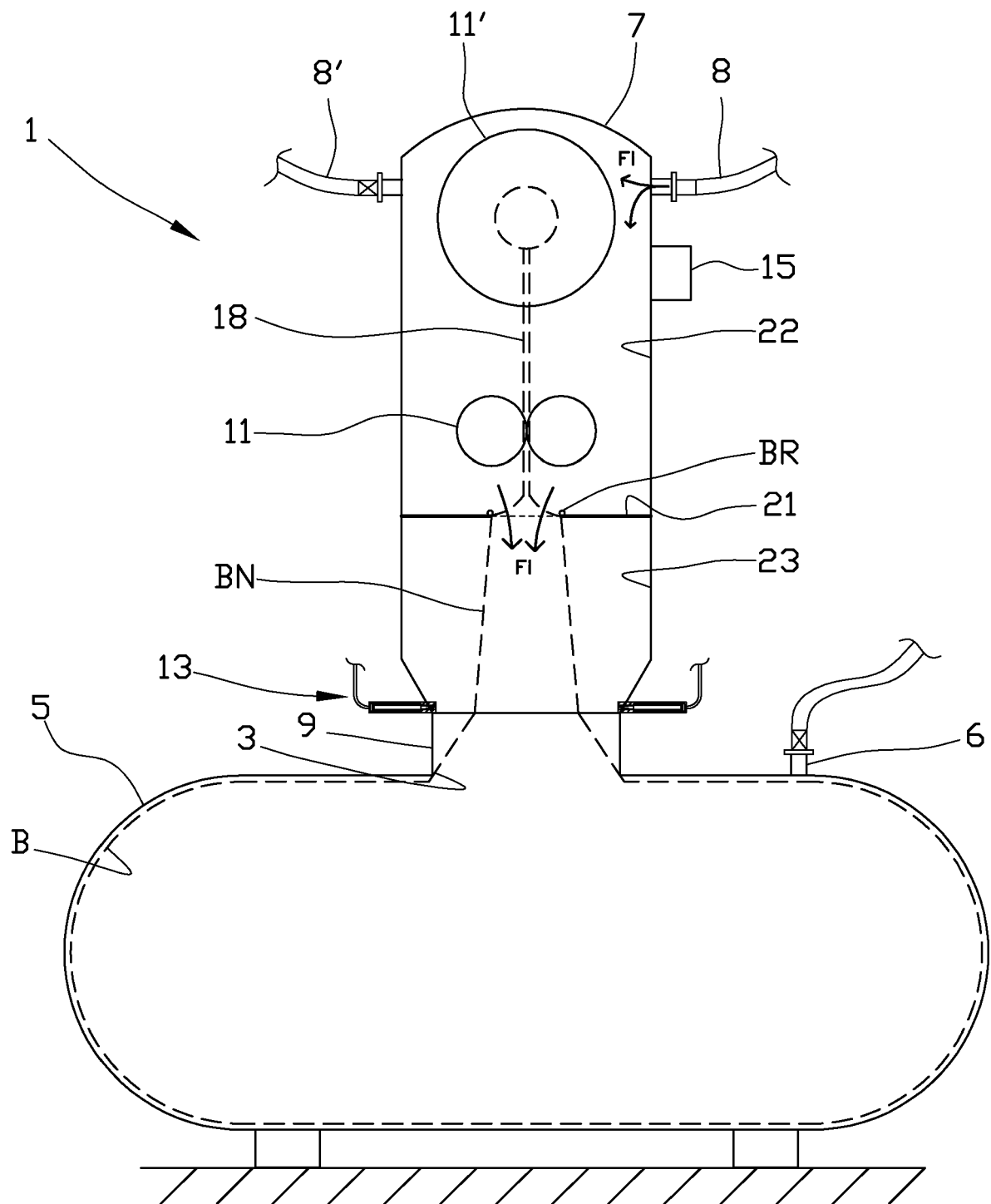


Fig. 2

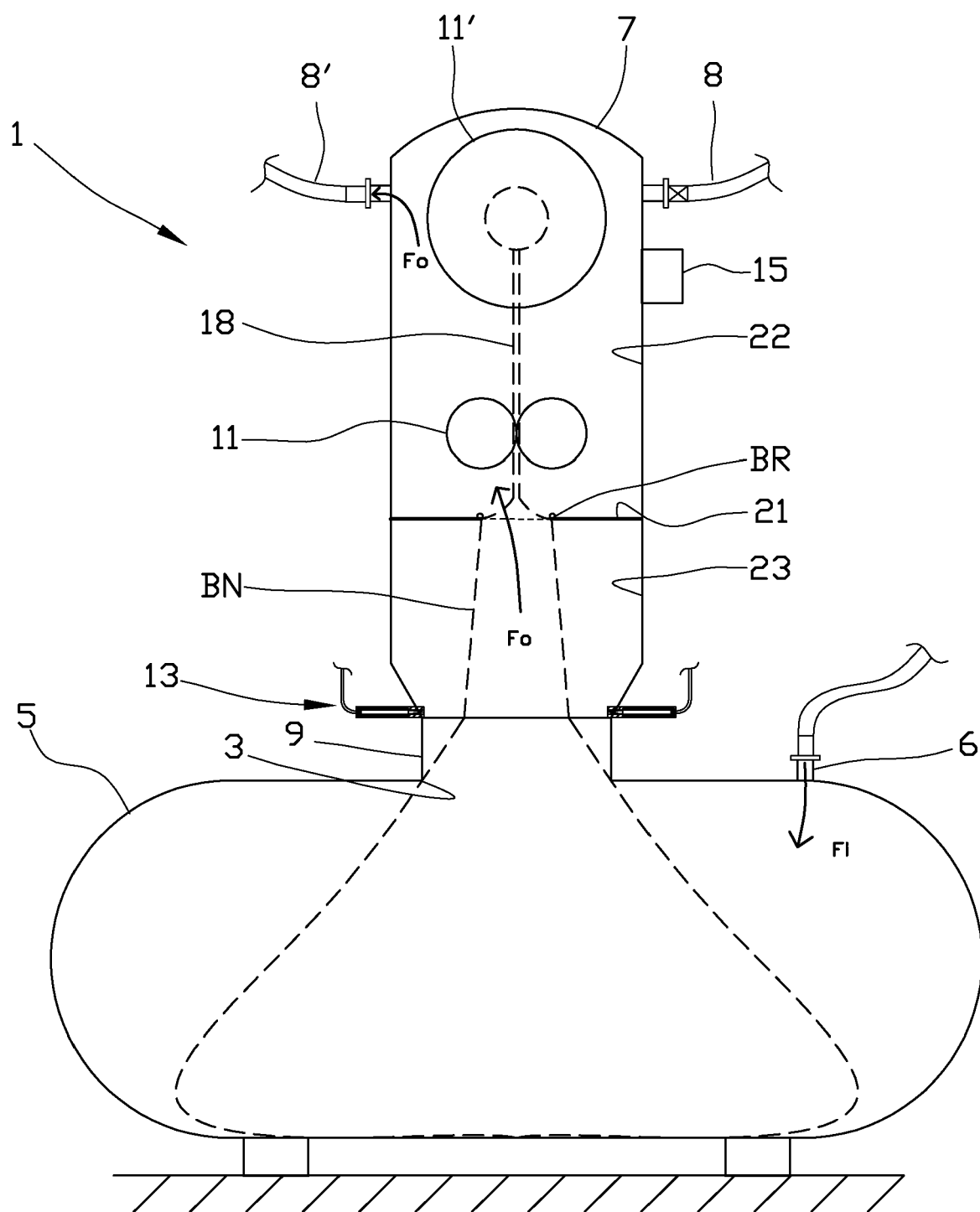


Fig. 3

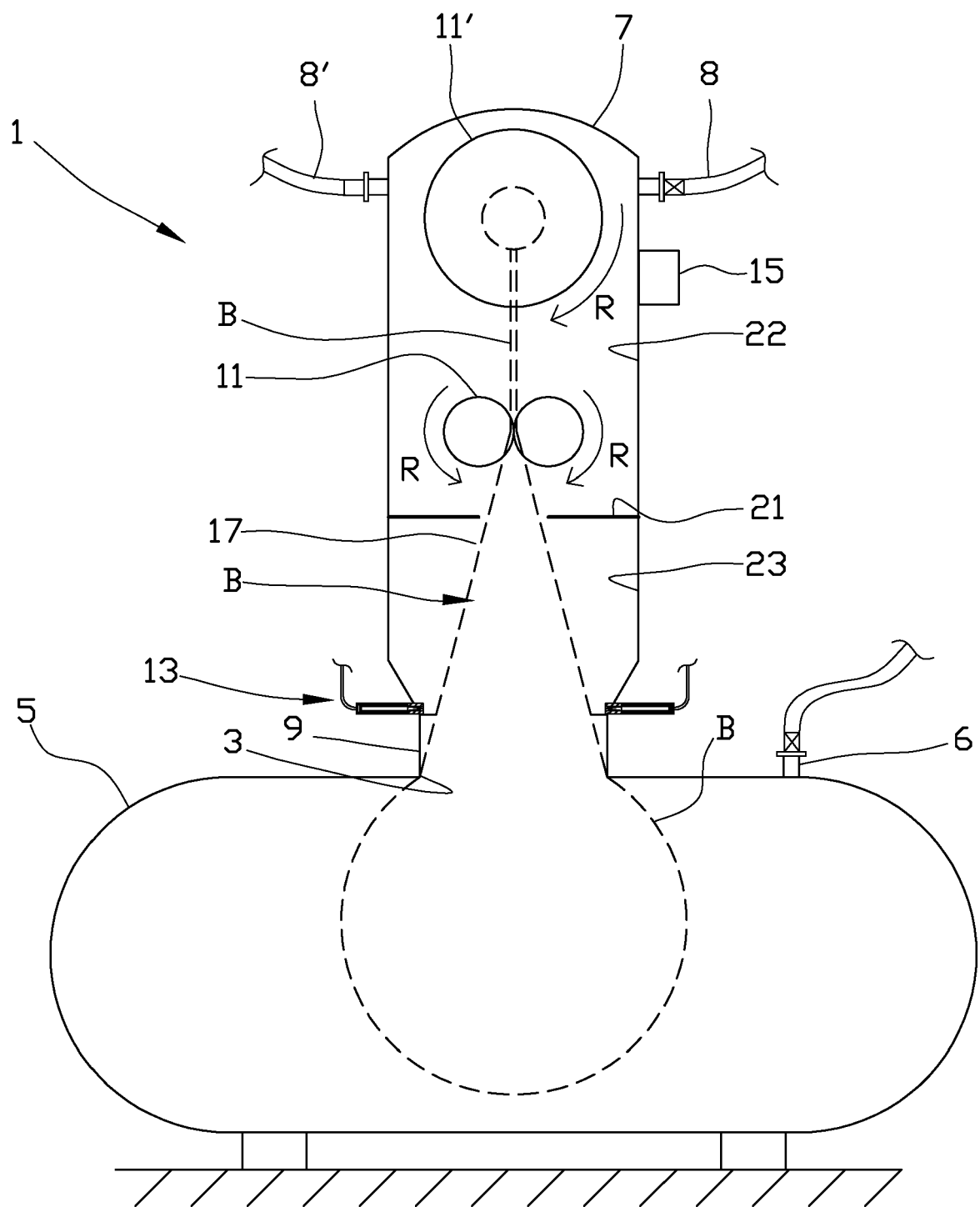


Fig. 4

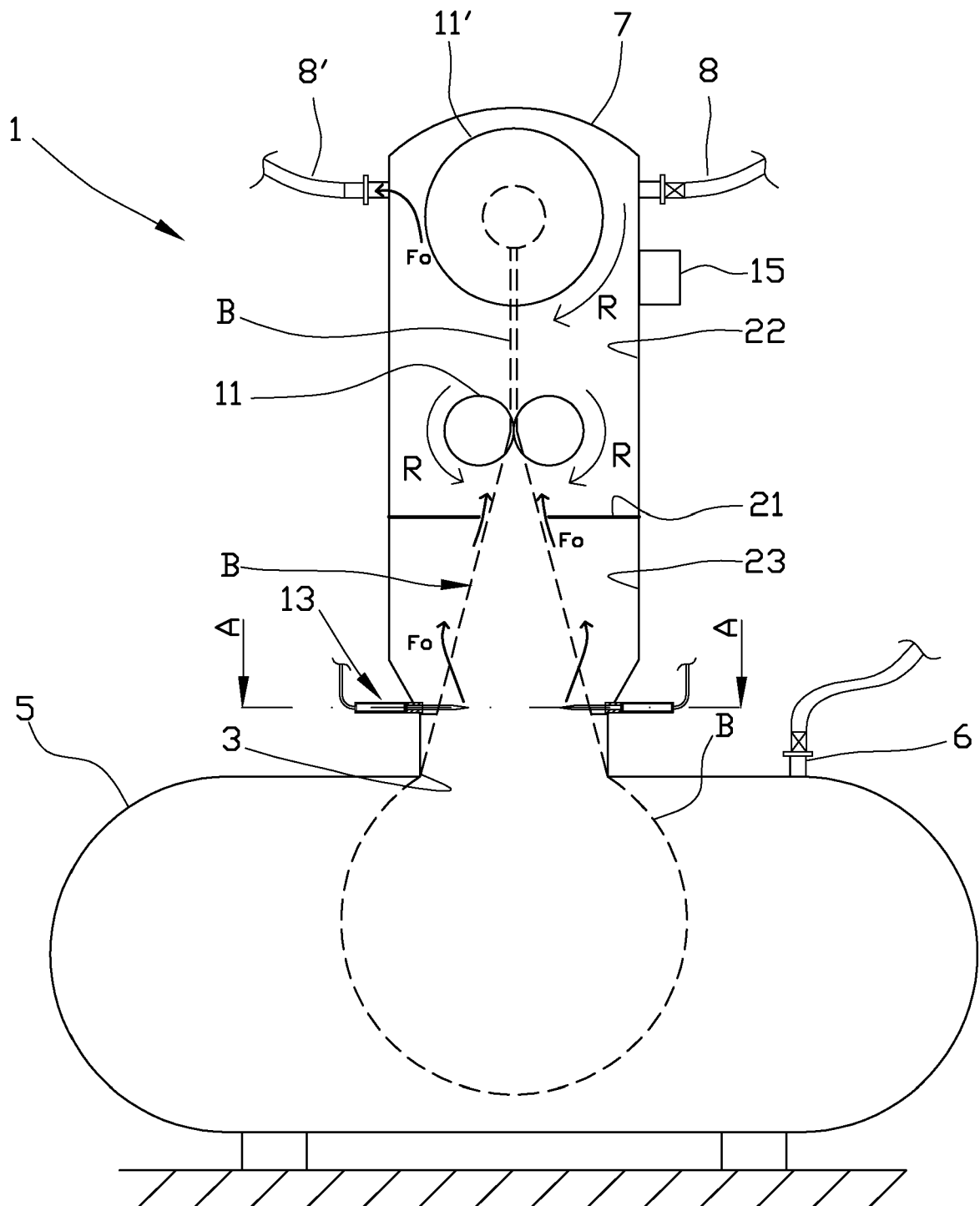


Fig. 5

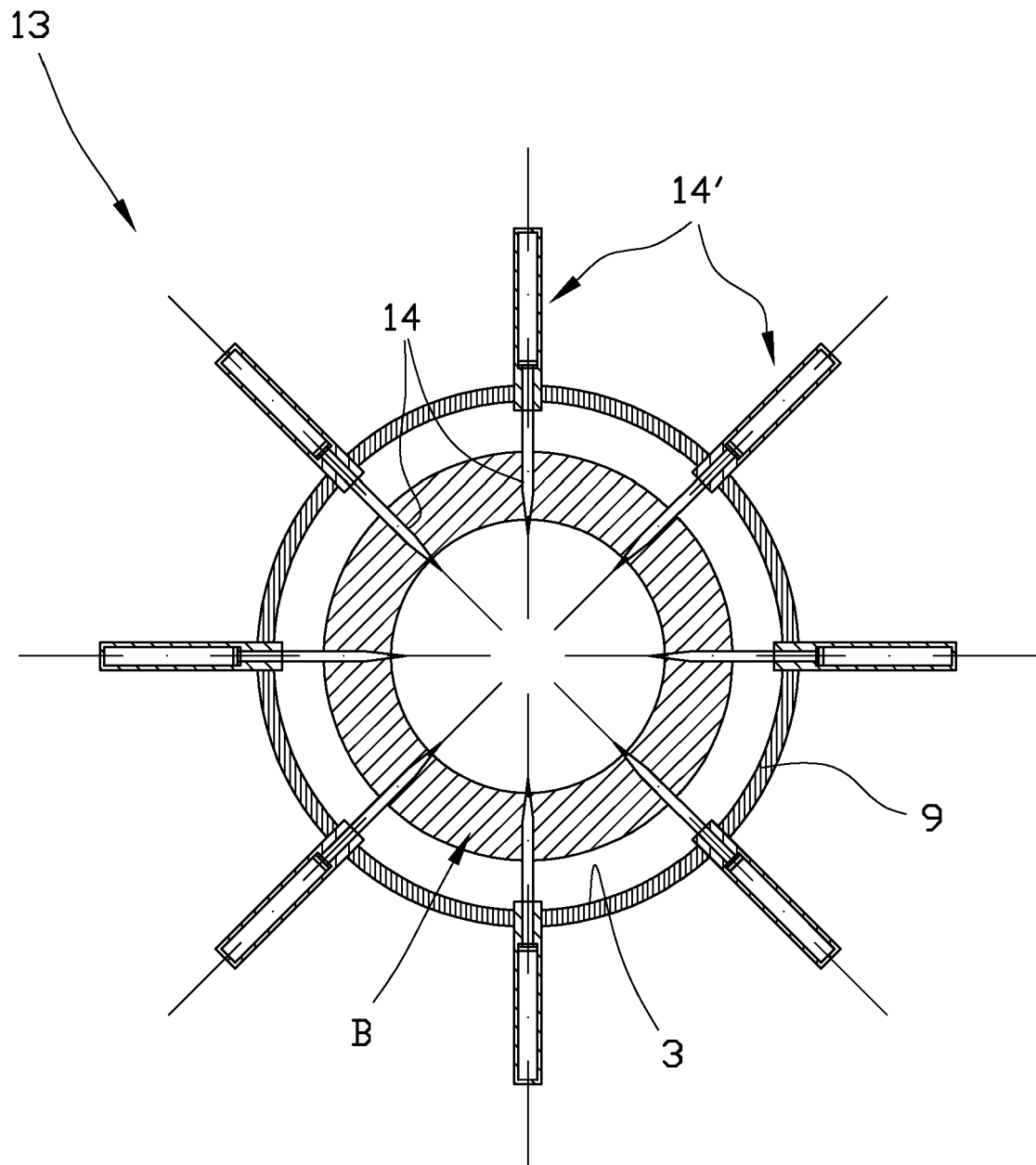


Fig. 6

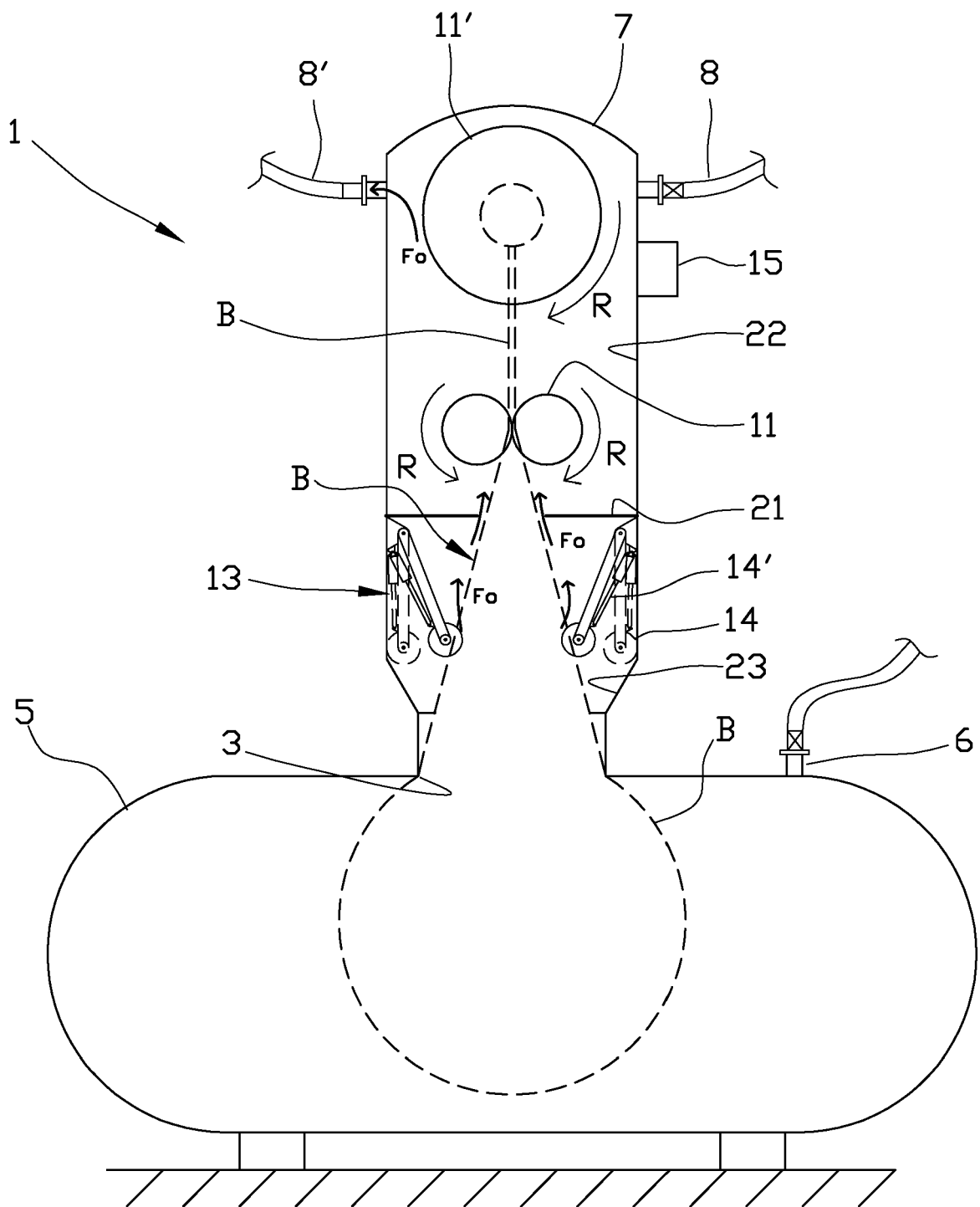


Fig. 7

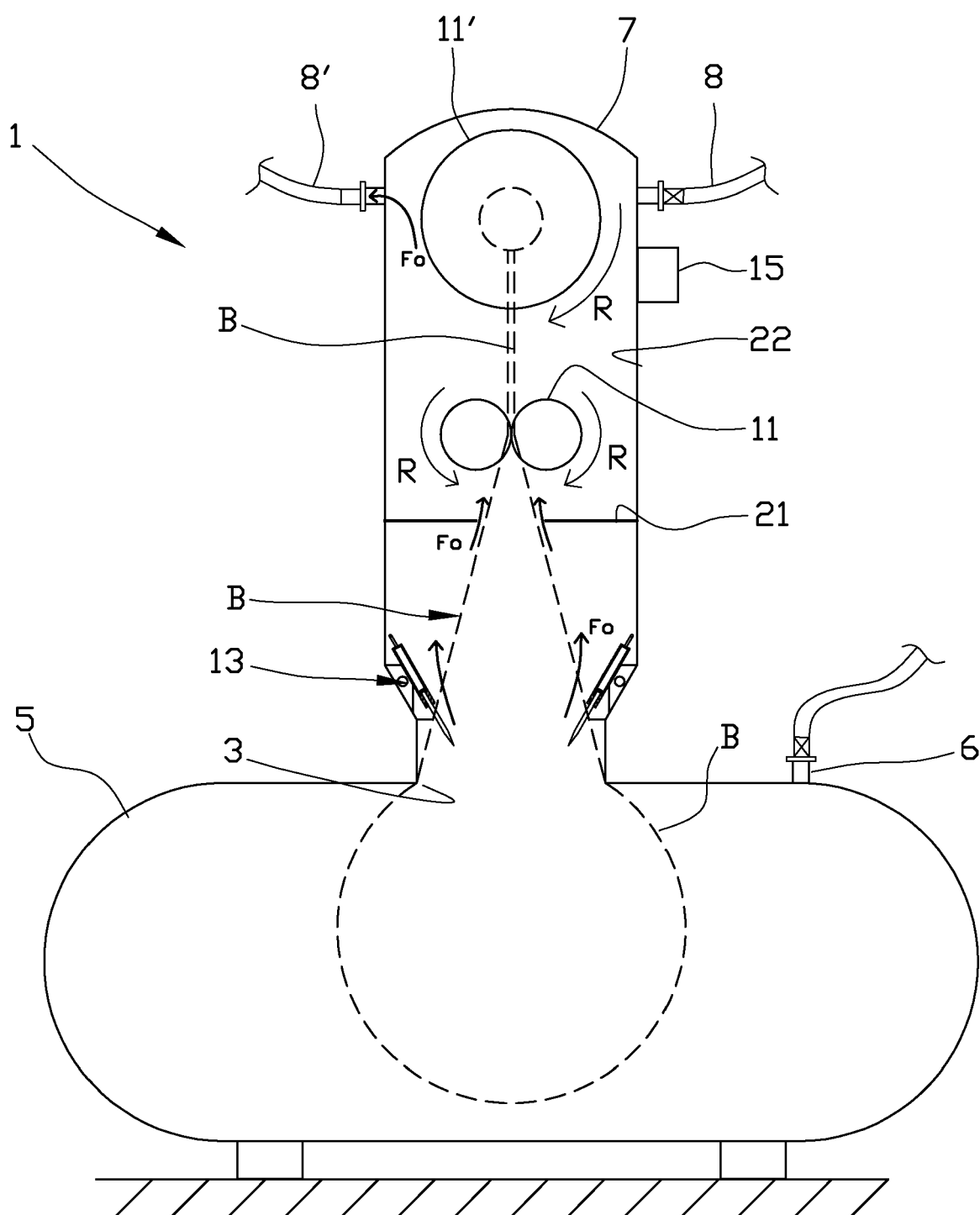


Fig. 8

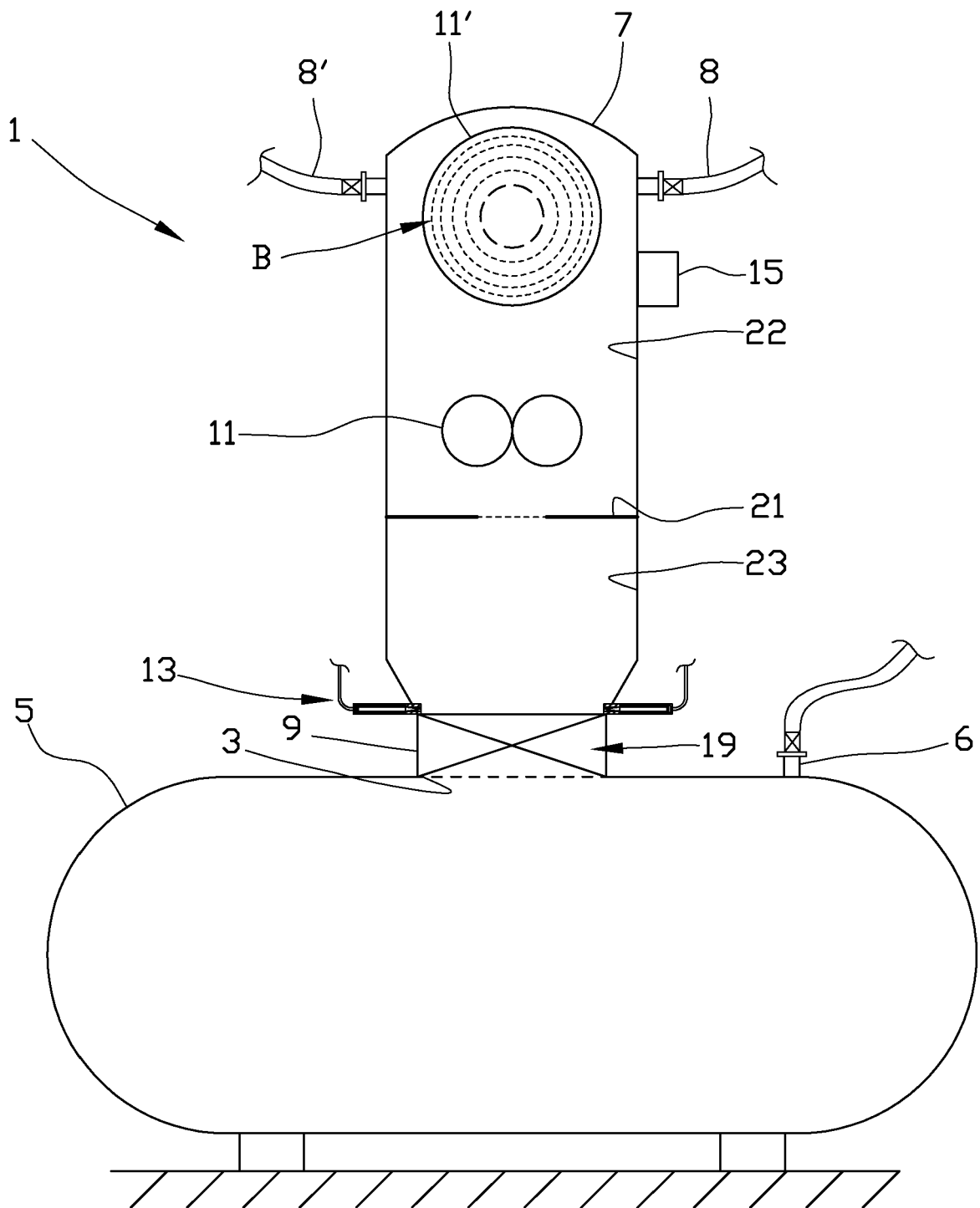


Fig. 9

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- WO 2006033577 A1 [0002] [0003]
- WO 2014070021 A1 [0004] [0005] [0007] [0008]
[0033] [0040] [0051]