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**(54) VESSEL FOR TRANSPORTING COMPRESSED GAS**

GEFÄSS ZUM TRANSPORTIEREN VON DRUCKGAS

NAVIRE DE TRANSPORT DE GAZ COMPRIMÉ

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## Description

**[0001]** This invention relates to the design of vessels and their equipment and systems for compressed gas transportation from production fields to the specified place.

**[0002]** There is the known vessel for transporting compressed gas, which is described in the patent of the Russian Federation No. 2299151, issued on May 20, 2007, the IPC B63B25/14, F17C1/00, F17C5/06, according to which the vessel for compressed gas transportation is equipped with a shipboard gas pipeline having means of connection with onshore or sea terminals, a pressure source, a heat exchanger and hermetic gas storage containers, each of which having gas tanks, which are designed in the form of high-pressure cylinders. Hermetic gas storage containers are designed in the form of shipboard hermetic compartments and a chamber of high pressure cylinders is divided by an elastic partition made of stretchable material, which is hermetically sealed to the walls of the cylinder over perimeter of its cross-section. In one compartment separated by the elastic partition the cylinders are equipped with the pipeline with the valve system for interconnection of cylinders' chambers of the indicated compartment separated by the elastic partition between each other and with the shipboard gas pipeline. In other compartment separated by the elastic partition the cylinders are equipped with the pipeline with the valve system for interconnection of cylinders' chambers of the other compartment separated by the elastic partition and with the pressure source, which is made in the form of a source of compressed air. The chambers of shipboard hermetic compartments for storage of high pressure cylinders with compressed gas are interconnected with the pipeline through the valve system and with the shipboard gas pipeline.

**[0003]** The vessel for transportation of compressed gas, which is equipped with the source of cold, connected to the pipeline through the valve system, and the heat exchanger with the chambers of the shipboard hermetic compartments.

**[0004]** The design drawback of the known vessel is a large size of the containers for compressed gas, which does not allow to unload containers at the ports and to deliver them to the consumer, so only a gas loading through the pipeline to the port external storage facilities is possible. Either the use of onshore main pipelines to the specified place or pumping compressed or liquid gas into the containers for transportation by other types of transport are required for further gas transfer to the customers. The fact, that containers have a large size, does not allow to transport gas under pressure more than 100 kg/sq cm, which limits the amount of gas transported by the vessel and needs constant cooling of the containers for maintaining gas parameters close to the gas critical state.

**[0005]** There is the known vessel for transporting compressed gas, which is described in the patent of the Rus-

sian Federation No. 2300480, issued on June 10, 2007, in the bulletin No. 16, the IPC B63B25/14, F17C1/00, F17C5/06, according to which the vessel for compressed gas transportation is equipped with a main shipboard gas pipeline having means of connection with onshore or sea terminals, hermetic compartments for compressed gas storage, each of which has a gas tank designed in the form of a stack of pipes, which are arranged at an angle to the horizon and connected by means of a common manifold for uploading and offloading compressed gas at the ascending end and with common manifold for condensate accumulation at the descending end, which is produced in the pipes during the compressed gas transportation. Compartments are also equipped with tanks for condensate accumulation. Chambers of shipboard hermetic compartments are connected with pipelines through a system of valves, a compressor and a heat exchanger are connected with a source of cold, which the ship is equipped with. The same manifolds of gas reservoirs and shipboard hermetic compartments are interconnected respectively with each other through a system of valves by corresponding pipelines, providing that pipelines of hermetic compartments and pipelines of compressed gas uploading and offloading manifolds are connected to the main shipboard gas pipeline through a system of valves. The pipeline of condensate accumulation manifolds is configured with the ability to be connected to the condensate accumulation tank.

**[0006]** The vessel is equipped with a pump for transmission of condensate accumulated in the manifolds into the condensate accumulation tank. Moreover, the condensate accumulation tank can be located both on board of the ship and on the onshore or sea terminals.

**[0007]** The vessel for transportation of compressed gas is equipped with the main shipboard gas pipeline comprising means of connection with onshore or sea terminals, hermetic compartments for compressed gas storage, each of which has a gas tank designed in the form of a stack of pipes with different diameter, which are arranged at an angle to the horizon and connected by means of common manifolds at both ends. Besides, uploading and offloading manifolds for compressed gas are arranged on ascending end of the pipelines and manifolds for condensate accumulation, which is produced in the pipes during the compressed gas transportation, are arranged on descending end of the pipelines. Compartments are also provided with tanks for condensate accumulation. The pipelines of smaller diameter in stacks are arranged in the spaces, which were created between pipelines of the bigger diameter, as well as between the pipelines of the bigger diameter and the walls of hermetic compartment. The cavities shipboard hermetic compartments are connected through a system of valves, a compressor and a heat exchanger are connected with a source of cold, which ship is equipped with. The same manifolds of gas reservoirs and shipboard hermetic compartments are interconnected respectively with each other through a system of valves by corresponding pipelines

and, providing that pipelines of hermetic compartments and pipelines of compressed gas uploading and offloading manifolds are connected to the main shipboard gas pipeline through a system of valves. The pipeline of condensate accumulation manifolds is configured with the ability to be connected to the condensate accumulation tank.

**[0008]** The vessel is equipped with a pump for transmission of condensate accumulated in the manifolds into the condensate accumulation tank. Moreover, the condensate accumulation tank can be located both on board of the ship and on the onshore or sea terminals.

**[0009]** The design drawback of the known vessel is a large size of the cylinders for compressed gas and the fact that they are made of steel and constructed for assembly inside the hold of the vessel, that does not allow to unload containers at the ports and to deliver them to the consumer, so only a gas loading through the pipeline to the port external storage facilities is possible. Either the use of onshore main pipelines to the specified place or pumping compressed or liquid gas into the containers for transportation by other types of transport are required for further gas transfer to the customers. The fact, that containers have a non-optimal form and a large size, does not allow to transport gas under pressure more than 100 kg/sq cm, which limits the amount of gas transported by the vessel.

**[0010]** Document US 3863460 is considered as the closest prior art and discloses the preamble of claim 1.

**[0011]** The nearest equivalent system is a shipboard system of compressed gas transportation, which is described in the patent of the Russian Federation No. 2145689, issued on February 20, 2000, the IPC B63B25/14, F17C1/00, F17C5/06, according to which a system for compressed gas transportation comprises a vessel, compartments for compressed gas storage, which design and arrangement ensure ship transportation and each of which is equipped with interconnected gas tanks, high and low pressure pipelines, both including means for connection with onshore terminals, means of circulating connection of each compartment for compressed gas storage with every pipeline of high and low pressure, and valves for selective control of compressed gas flow between every, compartment for compressed gas storage and every pipelines of high and low pressure. Moreover, each compartment for compressed gas storage is configured with the ability of selective flow connection to every pipeline of high and low pressure.

**[0012]** The vessel has cargo holds, which are equipped with vertical gas tanks. As a matter of fact the system includes a hermetic hatch cover for each cargo hold and means for inert gas supply into each cargo hold and each cargo hold is arranged so that it can be filled with the inert media from the said inert gas. Moreover, cargo holds and actually hermetic hatch covers are thermally insulated.

**[0013]** In each cargo hold the system may comprise additional equipment for detection of gas leaks and

means of compressed gas release into the atmosphere from the leaking gas storage compartment. The system may comprise a flare device in addition to the means of compressed gas release into the atmosphere from the leaking gas storage compartment.

**[0014]** The system comprises onshore equipment, which contains a compressor.

**[0015]** In addition the system may comprise the onshore terminal for exporting compressed gas from the ship, which contains a cryogenic unit for conversion of a compressed gas part exported from the ship into the liquefied gas.

**[0016]** In addition the system may comprise the onshore terminal for compressed gas export from ship by high and low pressure pipelines and for supply of the said compressed gas into the gas transit pipeline. The onshore terminal includes a discharging compressor for gas compressing, which is produced from the low pressure pipeline before its supply from the low pressure pipe into the gas transfer pipeline. Moreover, the high pressure pipeline, the low pressure pipeline and the discharging compressor are designed and arranged with providing a substantially complete discharge of the ship for about 8 hours.

**[0017]** The system, in which each gas tank may contain compressed gas at pressure from about 70.3 kg/sq cm (1000 pound / square inch) to about 351.6 kg/sq cm (5000 pound / square inch).

**[0018]** The system, in which each compartment for compressed gas storage comprises at least three and no more than thirty gas tanks.

**[0019]** The system, in which gas tanks are made of welded pipes of mild steel with welded dome-shaped lids at both ends.

**[0020]** The system, in which the said gas is natural gas.

**[0021]** The method of filling shipboard storage system with compressed gas from onshore equipment located at the loading point and configured to supply compressed gas to the ship from the supply pipeline under the first pressure, which actually corresponds to the pressure in the supply pipeline, and under a second pressure, which is higher than the first one, including the low pressure pipeline, configured to receive gas from onshore equipment under first pressure, high pressure pipeline, configured to receive gas from onshore equipment under second pressure, and gas storage compartments, each of them comprising interconnected gas tanks, consists of the following steps:

- (a) connecting one compartment for gas storage to the low pressure pipeline,
- (b) transferring a part of compressed gas under first pressure through the low pressure pipeline for actual partial filling of the specified compartment for gas storage under first pressure,
- (c) isolating of the said compartment for gas storage from the low pressure pipeline,
- (d) connecting the said compartment for gas storage

- to the high pressure pipeline,  
 (e) transferring a part of compressed gas under second pressure through the high pressure pipeline to the said first compartment for gas storage for its actual filling under second pressure  
 (f) connecting of another compartment for gas storage to the low pressure pipeline and  
 (q) repeating these steps until actual filling of all compartments for gas storage by compressed gas under actual second pressure.

**[0022]** Method of compressed gas export from the shipboard storage system into the onshore equipment located at the offloading point, configured to further supply of compressed gas to the gas pipeline behind it under pressure of this pipeline, and comprising decompression means for pressure reduce in compressed gas exported from the ship before its charging into the said gas pipeline and a compressor to compress the compressed gas exported from the ship before its charging into this gas pipeline, including the high pressure pipeline, which is configured to supply gas to the means of decompression, the low pressure pipeline, which is configured to supply gas to the compressor, and gas storage compartments, each one containing interconnected gas tanks with compressed gas under pressure of the shipboard system, which is in fact higher than pressure in the said gas pipeline, consists of the following steps:

- (a) connecting one compartment for gas storage to the high pressure pipeline,  
 (b) export of the part of compressed gas from the said one compartment for gas storage through the high pressure pipeline to the means of decompression,  
 (c) isolating the said compartment for gas storage from the high pressure pipeline,  
 (d) connecting the said compartment for gas storage to the low pressure pipeline,  
 (e) transferring a part of compressed gas from the said one compartment for gas storage through the low pressure pipeline to the compressor,  
 (f) connecting another compartment for gas storage to the high pressure pipeline and  
 (q) repeating these steps before actual discharging from all gas storage compartments, containing compressed gas through every pipeline of high and low pressure.

**[0023]** Moreover, this ensures the adiabatic expansion of compressed gas during ship offloading, when the adiabatic expansion of compressed gas is used to cool the gas tank and keep these tanks in a refrigerated state until they are filled with compressed gas next time.

**[0024]** An additional compressor for conversion of a compressed gas part into liquefied natural gas and means of liquefied natural gas storage are also used in the onshore equipment, as well as a part of compressed

gas from the high pressure pipeline is supplied to activate the additional compressor. Natural gas is used as compressed gas and liquefied natural gas is used as liquefied gas.

5 **[0025]** Common essential characteristic is that the vessel for transportation of compressed gas includes cargo holds with tanks for storing gas during transportation located in said cargo holds equipped with pipelines, signaling sensors, shutoff fittings and a connecting fittings,  
 10 and compressors.

**[0026]** The design drawback of the said vessel is a large size of cylinders for compressed gas, designed for vertical storage, that does not allow to unload containers at the ports and to deliver them to the consumer, so only  
 15 a gas loading through the pipeline to the port external storage facilities is possible. Either the use of onshore main pipelines to the specified place or pumping compressed or liquid gas into the containers for transportation by other types of transport are required for further gas  
 20 transfer to the customers.

**[0027]** The aim of the invention is to create a design of a vessel for transporting compressed gas, which allows not only to receive, control, charge and discharge gas through the vessel's pipeline systems, but also to  
 25 charge and discharge gas at the container terminals, ensuring gas container transportation to the specified places by shallow-draft vessels on the rivers and also by road or railway transport, without additional process steps and extra energy costs at the ambient temperature; to simplify  
 30 repair or replacement of gas tanks; to ensure quick and technologically simple conversion of cellular container vessels for transporting compressed gas.

**[0028]** Essential distinguishing characteristic are that the hull of the vessel is divided into cells with vertical  
 35 guides, at least one bulkhead is impermeable to water and gas, standard containers are stacked in cell guides one on one with compressed gas tanks horizontally placed in them and connected to the shipboard compressed gas loading system.. The hull of the vessel is  
 40 divided into cells so, that in the zone of at least one bulkhead delimiting the cell a distance from 0.8 to 2 metres is ensured and there are compressed gas distribution manifolds, pipelines with shut-off valves, a compressor, an emergency monitoring and control equipment in this  
 45 space.

**[0029]** Each double-jointed sell is locked by one jointed hatch cover which is impermeable to water and gas and separated by water- and airtight bulkheads from other  
 50 pairs of cells.

**[0030]** Besides, at least one container with empty dump tank is placed in each double-jointed compartment, with the ability to drain condensate or gas excess in the cargo containers into it, providing that dump tanks are  
 55 connected through the safety valves and pipelines are brought out to the upper deck to the excess gas burner.

**[0031]** Each tank is connected through a shut-off valve to the collector with a flexible pipeline or an expansion bellows and the manifold is arranged between the ends

of containers of the parts of double-jointed cells and connected by the pipeline through a shut-off valve and through the emergency equipment with the compressor. The pipeline is brought out into the upper deck from each double-jointed cells manifold and has the connecting fittings adjustable to external gas storage and pipeline fittings connected to other double-jointed cells.

**[0032]** The compressor connection system provides the bypass by the pipeline with shut-off valves enabling to transmit gas under pressure by gravity.

**[0033]** The containers are connected between each other by traversing container locks or centering cones and ties.

**[0034]** Cylindrical tanks made of composite materials are placed in the containers in horizontal position, each one having at least one connection pipe, shut-off and safety valves, pressure and temperature sensors, as well as a condensate detection sensor and a condensate drain pipe connection. Outlet connection pipe is arranged on both ends of each tank.

**[0035]** Containers are standard 40 feet shipboard containers with external dimensions: length of 12192 mm, width of 2438 mm and height of 2591 mm.

**[0036]** Each individual cell or group of cells is closed on top by a hatch cover that is impermeable to water.

**[0037]** Each individual cell or group of cells is closed on top by a removable deckhead cladding.

**[0038]** Connection pipes, shut-off valves and outlet pipelines from the manifolds to the connecting fitting are covered with coolant jackets.

**[0039]** Essential distinguishing characteristics, which are valid in all cases, are that the ship hull is divided into cells with vertical cell guides, at least one bulkhead is impermeable to water and gas, standard containers are stacked in cell guides one on one with compressed gas tanks horizontally placed in them and connected to the shipboard compressed gas loading system. The hull of the vessel is divided into cells in such a way, that in the zone of at least one bulkhead delimiting the cell a distance from 0.8 to 2 metres is ensured, and there are compressed gas distribution manifolds, pipelines with shut-off valves, a compressor, emergency monitoring and control equipment in this space.

**[0040]** Essential distinguishing characteristics, which are valid in special cases, are that each double-jointed cell is locked by one jointed hatch cover which is impermeable to water and gas and separated from other pairs of cells by bulkheads that are impermeable to water and gas.

**[0041]** Moreover, at least one container with empty dump tank is arranged at each double-jointed cell, with the ability to reset condensate in it or gas excess in the cargo tanks and the dump tank are connected through the safety valves and brought out to the upper deck piping to the gas combustion device.

**[0042]** Each tank is connected through a shut-off valve to the manifold by a flexible pipeline or by an expansion bellows and the manifold is arranged between the ends

of container double-jointed cells and connected with pipeline through a shut-off valve and pressure relief equipment to the compressor and pipeline is arranged into the upper deck from the manifold of each double-jointed cell and has the connecting fitting with to the external gas storage pipeline and connecting fittings with another double-jointed cell.

**[0043]** The compressor connection system provides the bypass of the pipeline with shut-off valves enabling to transmit gas under pressure by gravity.

**[0044]** The containers are connected between each other by traversing container locks or centering cones and ties.

**[0045]** Cylindrical tanks made of composite materials are arranged in the containers horizontally, each one having at least one connection pipe, shut-off and safety valves, pressure and temperature sensors, as well as a condensate detection sensor and a condensate drain connection. Outlet connection pipe is arranged on both ends of each tank.

**[0046]** Containers are standard 40 feet shipboard containers with external dimensions: length of 12192 mm, width of 2438 mm and height of 2591 mm.

**[0047]** Each individual cell or group of cells is closed on top by a hatch cover impermeable to water.

**[0048]** Each individual cell or group of cells is closed on top by a removable deckhead cladding.

**[0049]** Connection pipes, shut-off valves and outlet pipelines from the manifolds to the connecting fitting are covered with coolant jacket.

**[0050]** The fact that the deadweight of heavy hull of the vessel is over 10,000 tons and that the hull is divided into cells with vertical cell guides and at least with one water- and airtight bulkhead, standard containers are stacked one on one in cell guides with compressed gas tanks horizontally placed in them, which enables to create a design of the vessel for transporting compressed gas which allows not only to receive, control and discharge gas through the shipboard pipeline systems, but also to upload and offload at the container terminals, ensuring gas container transportation to the specified places by shallow-draft vessels on the rivers and also by road or railway transport, without additional process operations and extra energy costs at ambient temperature, and also to simplify repair or replacement of gas tanks, even in the port.

**[0051]** The fact, that containers are connected to the compressed gas loading shipboard system and that the hull of the vessel is divided into cells, so that there is at least one cell bulkhead between them, with ensured distance from 0.8 to 2 metres, and there are compressed gas distribution manifolds between them, pipelines with shut-off valves, a compressor, emergency monitoring and control equipment, allowed to reduce the length of the pipeline and to increase work safety.

**[0052]** Such design allows performing technologically easy conversion of cellular shipboard containers into the ships for transportation of compressed gas. With the tank

dimensions in the range suitable for 40-foot shipboard container and with taken into account available technologies, containers for gas transportation are made at the pressure of 250 kg/sq cm, while the pressure up 300 kg/sq cm is considered to be acceptable, that ensures transportation efficiency as result.

Figure 1 is a main view of the vessel;  
 Figure 2 is a plan view of the vessel;  
 Figure 3 is the cross-section of the vessel according to its middle section;  
 Figure 4 is an end view of the stacked containers with tanks and a shipboard compressed gas loading system;  
 Figure 5 is a view of the board at the stacked containers with tanks and a scheme of shipboard compressed gas loading system;  
 Figure 6 is a top view of the stacked containers with tanks and a shipboard compressed gas loading system.

**[0053]** The vessel for transporting compressed gas comprises of a hull of the vessel 1, divided into double-jointed cells 2 with vertical cell guides 3, longitudinal 4 and transverse bulkheads 5 and also containers partitions arranged between the tiers inside the cells 2, of double-jointed type, not closed, of truss type structure or closed ones which are impermeable to water and gas 6, the distance between them is 1.8 meters. Double transverse bulkheads which are impermeable to water and gas 7 with intermediate size of 0.8 meters are separating forage compartments 2 from the engine room 8 and the lower tiers of the deckhouse 9 and double-jointed transverse bulkheads which are impermeable to water and gas 10 are arranged between the compartment 11 and cells 2, which are the closest to the shipboard bow.

**[0054]** Compressed gas distribution manifolds 12 of compressed gas overload shipboard system are located between double-jointed bulkheads 6.

**[0055]** Each double-jointed cell 2 is closed by one jointed hatch cover 13 and is separated from other cells by bulkheads 4 and 5, which are impermeable to water and gas.

**[0056]** Containers 15 are installed in vertical cell guides 3 and connected between each other with quick-turning container stoppers 14, where cylindrical tanks 16 made of composite materials with spherical end parts are arranged horizontally. Containers 15 are located in three vertical cell guides 3 of their cell with the ends towards containers 15 of the other part of the double-jointed cell 2, and a common manifold 12 is placed between them at the bulkhead 6. The connection pipes 17 are arranged on each tank on the ends providing the described arrangement of the containers, a set cap 18 is located on one of them and a shut-off valve 19 is connected to another.

**[0057]** The safety valve 20, the pressure sensor 21, the temperature sensor 22 and the condensate detection

sensor 23 are also placed on tanks 16 and condensate pipe connections 24 are mounted in the bottom of tanks 16, where shut-off valves 25 are located.

**[0058]** In this particular example, according to the external dimensions and mounting elements, containers 15 are standard shipboard 40 feet containers having external dimensions as follows: length of 12 192 mm, width of 2438 mm and height of 2591 mm. Such containers are suitable for further transportation by shallow-draft vessels on the rivers as well as by road and railway transport, but one may use other standard containers of new sizes.

**[0059]** Tanks 16 of containers 15 are connected through their shut-off valve 19 by the flexible pipeline 26 with the manifold 12, which consists of vertically oriented pipes 27 with shut-off valves 28. Pipes 27 are interconnected by a locking pipeline 29 with shut-off valves 30. The manifold, which is placed between the tiers in the cells, allows reducing the length of pipes and simplifying maintenance and management of gas loading system. The manifold system 12 also includes the pipeline 31, which is connected through the shut-off valve 32 to manifold pipes 12 and through the shut-off valve 33 to the compressor and, as a result, through the connecting device 44 to external storage facilities.

**[0060]** Manifold pipes 12 are connected through shut-off valves 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, to the connection unit 44 and to the pipeline of external gas storage. The shut-off valve 45 and the gas meter 46 are also installed. And the manifold pipe system of each cells pair 2 is connected to the connecting pipeline 47 laid on the upper deck with shut-off valves 48.

**[0061]** Each double-jointed cell 2, mentioned in the described manifold system 12, has the compressor 49, which is connected to the pipe 31 through the shut-off valve 36 and the pipe 27 through the shut-off valve 35 and the safety valve 50.

**[0062]** The compressor 49 is bypassed by the pipeline with shut-off valves 38, 37, 34, 39, 40, 49, and by shut-off valves 36 and 35 at its inlet and outlet.

**[0063]** The connection unit 44 and the compressor 49 are installed in the hermetic stowed position and in the intensively ventilated area 51, which is established at the level of the upper deck in the area of the manifolds 12 location, in each double-jointed cell 2 along the length of the ship.

**[0064]** Cells 11 are not connected to the general compressed gas loading system and are used for other gases that are by-products, such as helium, while the main gas for transportation is methane.

**[0065]** Although, with the existing scheme, it is possible to close and block the access to specified manifolds of the selected double-jointed cells 2 and to transport several different gases by one ship.

**[0066]** Each double-jointed cell 2 has two containers 52 with the empty dump tank 53, with the ability to drain condensate or gas excess in the cargo tanks 16 into it, providing that dump tanks 53 are connected through their safety valves 54 and pipelines are brought out to the up-

per deck to the gas combustion device 55.

**[0067]** The condensate collector and drain system includes shut-off valves 25, mounted in the lower part of containers 16, which are connected through flexible pipelines 56 and shut-off valves 57 with vertical pipes 58, interconnected by switchers 59 with each other and connected to the separate pump 60.

**[0068]** The hatch cover availability makes possible to use the vessel according to the invention, both in gas uploading and offloading mode through the gas loading shipboard system or to load it with containers filled with gas tanks or offload filled containers at the container terminal and deliver gas by other means of transport.

**[0069]** If it is intended to offload containers only during vessel repair, then instead of hatch covers, deckhead cladding panels can be provided at the deckhouse 61 that are installed at the coaming, welded and contain constructive elements that can be cut in case of repair and access to some cell.

**[0070]** Considering the fact that the gas temperature is changing during gas uploading and offloading, some shut-off valves and manifold outlet pipelines 12 are covered with heat-carrying medium. The system is not shown herein, as it is known to the experts and is not the subject of the invention.

**[0071]** Rotatable container locks allow loading spreader at the container terminal to install automatically or unload containers from the ship. Fixing container 15 by centering cones and ties are more suitable for gas uploading and offloading through the shipboard system.

**[0072]** Gas uploading and offloading is produced both by gravity and by compressor gas supply according to the differential pressure.

### Gas uploading process

**[0073]** Receiving devices 44 are connected to the gas storage outer pipeline at the production field, and as empty tanks 16 are under residual pressure of 1 kg/cm<sup>2</sup> gas is taken from the external gas storage under pressure above 100 kg/cm<sup>2</sup> through the open shut-off valves 41, 38, 37, 34 and manifolds 12 of each cell 2, and gas enters from manifolds 12 through the open shut-off valves 28 and 19 to tanks 16 of containers 15. In this case shut-off valves 48, 42, 43, 40, 36, 35, 33, 32 are closed. In the absence of sufficient number of external gas storage pipelines, shut-off valves 42 and 48 are opened additionally and gas is supplied into other double-jointed cell 2, in which the shut-off valve 38 is closed and gas enters the tank 16 through the shut-off valve 42 and other ones above mentioned for the first cell (see Fig. 5, which shows a part of the loading system of another double-jointed cell 2).

**[0074]** When gas drop is reducing, shut-off valves 42, 38 and 37 are closing in the cells loading system, which is connected to the external pipeline by the unit 44, and shut-off valves 39, 40, 36, 35 are opening and gas is supplied by the compressor 49 and continues to flow until

reaching the specified pressure in tanks 16. When tanks of this double-jointed cell are filled, the compressor 49 is off, shut-off valves 40, 36 are closing and shut-off valves 39, 43 are opening and gas is supplied to tanks of the double-jointed cell on the left, and if it is required to supply gas to the right (see Figure 5), then the shut-off valve 48 is opening. Into the next double-jointed cell, which is not connected directly through the unit 44 to the external gas storage, gas is received with open shut-off valves 43, 40, 36, compressor 49 of this cell and shut-off valves 35 and 34, which are described above, manifold valves 12 are similar to the Figure .5.

**[0075]** The junction points with the pipes of the manifold 12 are denoted with letters A and B.

**[0076]** During gas pumping, if it is necessary, the shut-off valve 45 is opening and gas counter 46 starts to work, but pressure control enables to estimate gas quantity without the counter.

**[0077]** In case of overpressure above in the compressor 49 the safety valve 50 is activated.

**[0078]** During transportation, in case of exceeding the maximum of allowable pressure in any of the tanks 16, gas is discharged into dump tanks 53. In this case the shut-off valve 19 of emergency tank is opening, the shut-off valve 28 at the manifold 12 of corresponding tanks is opening and a part of gas flows into the drain tank 53 by gravity. The safety valve of the dump tanks is set to the pressure which is 50 kg/cm<sup>2</sup> less than the set pressure of cargo tanks 16. When pressure exceeds the values at the dump tank, gas is discharged from the dump tanks 53 into the gas combustion device and they are always ready, with pressure drop of 50 kg/cm<sup>2</sup>, to take gas from the cargo tanks 16 with high pressure above normal.

**[0079]** Also, the system allows redistributing gas between tanks in case of incomplete vessel loading and tanks being in emergency state in any of the cells.

**[0080]** Condensate can be removed from the tanks by using the gas pressure in tanks both before gas uploading and on the beginning of uploading or by the additional pump 60.

**[0081]** Manifold pipes purging by inert gases is performed when shut-off valves 32 are opened.

**[0082]** The schemes show shut-off valves in order to explain the vessel's design and schemes of the loading, control and storage system for transportation of compressed gas, without specifying the type and the drive, but the latter is a well known electrical, hydraulic and pneumatic remote control of all types of valves in engineering, which is not described in the claim, as it is not the subject of invention. Specialists and engineers of automation control are able to develop remote control systems of shut-off valves and compressors using programmable controllers connected to sensors of pressure, temperature and by switching on the operation modes for specified programs.

## Claims

1. A vessel for transporting compressed gas, comprising cargo holds with tanks for storing gas during transportation arranged in said cargo holds equipped with pipelines, signaling sensors, a shutoff fitting and a connecting fitting, and compressors, **characterized in that** the hull of the vessel is divided into cells (2) with vertical guides (3), at least one bulkhead (4, 5) in said cells is impermeable to water and gas, and unified containers (15) with the tanks (16) for compressed gas arranged horizontally therein are mounted one on top of the other in the guides (3), said containers (15) being connected to a vessel system for compressed gas transfer, wherein the hull of the vessel is divided into the cells (2) in such a way that, in the zone of at least one bulkhead delimiting the cell, a distance of from 0.8 to 2 metres is ensured, and collectors (12) for distributing the compressed gas, the pipelines (17) with the shutoff valves (19), the compressor (49) and accident monitoring and control equipment are arranged in this space.
2. The vessel according to claim 1, wherein each double-jointed cells (2) its closed by one jointed hatch cover (13) which is impermeable to water and gas and is separated from other double cells by bulkheads (4, 5) which are impermeable to water and gas.
3. The vessel according to claim 2, wherein at least one container (52) with empty dump tank (53) is placed in each double-jointed cell (2), with the ability to drain condensate or gas excess in the cargo containers (15) into it, providing that dump tanks (53) are connected through the safety valves and pipelines are brought out to the upper deck to the excess gas burner.
4. A vessel according to claim 2, wherein said each tank (16) is connected through a shut-off valve (19) with manifold (12) with a flexible pipeline (26) or a expansion bellows, and the manifold (12) is arranged between the ends of containers of the parts of double-jointed cells (2) and connected by the pipeline (31) through a shut-off valve (32) and safety equipment with the compressor (49) providing that the pipeline is brought out into the upper deck from each double-jointed cells manifold and has the connecting fittings adjustable to external gas storage and pipeline fittings connected to another double-jointed cell (2).
5. A vessel according to claim 2, wherein the said compressor connection system provides the bypass by the pipeline with shut-off valves (38, 37, 34, 39, 40, 49) enabling to transmit gas under pressure by grav-

ity.

6. A vessel according to claim 1, wherein the said containers (15) are connected between each other by traversing container locks or centering cones and ties.
7. A vessel according to claim 1, wherein said cylindrical tanks (16) made of composite materials are placed in the containers (15) in horizontal position, each one having at least one connection pipe (17), shut-off (25) and safety valves (20), pressure and temperature sensors (21, 22), as well as a condensate detection sensory (23) and a condensate drain pipe connections (24).
8. A vessel according to claim 7, wherein said outlet connection pipe is arranged on both ends of each tank (16).
9. A vessel according to claim 1, wherein said containers (15) are standard 40 feet shipboard containers with external dimensions: length of 12 192 mm, width of 2438 mm and height of 2591 mm.
10. A vessel according to claim 1, wherein said that in each individual cell (2) or group of cells (2) is closed on top by hatch cover which is impermeable to water.
11. A vessel according to claim 1, wherein said that in each individual cell (2) or group of cells (2) is closed on top by a removable deckhead cladding.
12. A vessel according to claim 1, wherein said that the connection pipes, shut-off valves and outlet pipelines from the manifolds (12) to the connecting fitting are covered with coolant jackets.

## 40 Patentansprüche

1. Ein Schiff für den Transport von Druckgas, bestehend aus Frachträume mit Behältern zum Speichern von Gas während des Transports, angeordnet in den genannten Frachträumen, ausgestattet mit Rohrleitungen, Signalsensoren, eine Absperrarmatur und ein Anschlussarmatur und Kompressoren, **dadurch gekennzeichnet, dass** der Rumpf des Schiffes in Zellen (2) mit Vertikalführungen (3) unterteilt ist, mindestens eine Schottwand (4, 5) in diesen Zellen für Wasser und Gas undurchlässig ist, und in den Führungen (3) einheitliche Containers (15) mit horizontal angeordneten Behältern (16) für komprimiertes Gas einer auf den anderen angebracht sind, wobei die Containers (15) zum Schiffsystem für Druckgasübertragung verbunden sind, wobei der Rumpf des Schiffes in die Zellen (2) derart geteilt ist, dass im Bereich der mindestens einen Schottwand, die die

- Zelle begrenzt, ein Abstand von 0,8 bis 2 m gesichert ist, und in diesem Raum Verteilerröhre (12) für die Druckgasverteilung, die Rohrleitungen (17) mit den Absperrventilen (19), der Kompressor (49) und die Unfallüberwachungs- und Kontrolleinrichtungen unterbracht sind.
2. Ein Schiff nach Anspruch 1, wobei jede doppelte Zelle (2) durch einen Lukendeckel (13) abgeschlossen ist, der für Wasser und Gas undurchlässig ist, und von den anderen doppelten Zellen durch eine Schottwand (4, 5) getrennt ist, die für Wasser und Gas undurchlässig ist.
  3. Ein Schiff nach Anspruch 2, wobei in jeder doppelten Zelle (2) mindestens ein Container (52) mit leeren Zwischenbehälter (53) angeordnet ist, mit der Fähigkeit, Kondensat oder Gasüberschuss von den Frachtcontainers (15) zu entwässern, wobei die Zwischenbehältern (53) durch die Sicherheitsventile und Rohrleitungen verbunden sind und zum überschüssigen Gasbrenner auf dem Oberdeck hinausgeführt sind.
  4. Ein Schiff nach Anspruch 2, bei dem jeder Behälter (16) über ein Absperrventil (19) und einer flexiblen Rohrleitung (26) oder über einen Faltenbalg mit dem Verteilerrohr (12) verbunden ist und der Verteiler (12) zwischen den Stirnseiten der Containersteilen der doppelten Zellen (2) angeordnet ist und durch die Rohrleitung (31) über ein Absperrventil (32) und Sicherheitseinrichtung mit dem Kompressor (49) verbunden ist, wobei die Rohrleitung von dem Verteiler jeder doppelten Zelle auf dem Oberdeck hinaufgeführt ist, und die Anschlussarmaturen zum externen Gasspeicher einstellbar sind und Rohrleitungsarmatur mit einem anderen doppelten Zelle (2) verbunden sind.
  5. Ein Schiff nach Anspruch 2, wobei mit dem genannten Schaltsystem des Kompressors der Bypass durch die Rohrleitung mit Absperrventilen (34, 37, 38, 39, 40, 49) vorgesehen ist und die Übertragung des unter Druck stehenden Gases durch die Schwerkraft ermöglicht ist.
  6. Ein Schiff nach Anspruch 1, wobei die genannten Containers (15) untereinander durch durchquerenden Containerverriegelungen oder zentrierende Kegel und Bindungen verbunden sind.
  7. Ein Schiff nach Anspruch 1, wobei die genannten zylindrische Behälter (16), die aus Verbundwerkstoffen bestehen, in den Containers (15) in horizontaler Lage angeordnet sind, die jeweils mindestens ein Verbindungsrohr (17), Absperr- (25) und Sicherheitsventile (20), Druck- und Temperatursensoren (21, 22), sowie eine Kondensaterfassungssensor (23) und eine Kondensatablaufrohrverbindung (24) aufweisen.
  8. Ein Schiff nach Anspruch 7, wobei der Auslaßstutzen an beiden Enden jedes Behälters (16) angeordnet ist.
  9. Ein Schiff nach Anspruch 1, wobei die genannten Containers (15) genormte 40-Feet Schiffbordcontainers sind, mit äußeren Abmessungen: Länge von 12 192 mm, einer Breite von 2438 mm und einer Höhe von 2591 mm.
  10. Ein Schiff nach Anspruch 1, wobei jede einzelne Zelle (2) oder Gruppe von Zellen (2) auf der Oberseite durch Lukendeckel geschlossen ist, die für Wasser undurchlässig ist.
  11. Ein Schiff nach Anspruch 1, wobei jede einzelne Zelle (2) oder Gruppe von Zellen (2) auf der Oberseite von einer entfernbaren Decke geschlossen ist.
  12. Ein Schiff nach Anspruch 1, wobei die Verbindungsrohre, Absperrventile und Ausgangsleitungen von den Verteilerröhren (12) zu den Verbindungsanschlüsse mit Kühlmänteln bedeckt sind.

#### Revendications

1. Navire pour le transport de gaz comprimé, comprenant des soutes avec des réservoirs pour le stockage du gaz pendant le transport disposés dans lesdites soutes équipées de canalisations, de capteurs de signalisation, d'un équipement de coupure, d'un équipement de raccordement et de compresseurs, **caractérisé en ce que** la coque du vaisseau est divisée en cellules (2) par des guides verticaux (3), au moins une cloison (4, 5) dans lesdites cellules (2) étant imperméable à l'eau et au gaz, des conteneurs (15) unis avec des réservoirs (16) pour le gaz comprimé étant disposés horizontalement et en cela montés superposés l'un sur l'autre dans les guides (3), lesdits conteneurs (15) étant raccordés à un système du vaisseau pour le transfert du gaz comprimé, dans lequel la coque du vaisseau est divisée par les cellules (2) de sorte qu'une distance de 0,8 mètres à 2 mètres est ménagée dans la zone d'au moins une cloison (4, 5) délimitant une cellule (2), des collecteurs (12) de distribution du gaz comprimé, des canalisations (17) avec des valves d'arrêt (19), un compresseur (49) ainsi qu'un équipement de surveillance et de contrôle étant disposés dans cet espace.
2. Navire selon la revendication 1, dans lequel chaque couple de cellules (2) est fermé par une trappe commune de couverture (13) qui est imperméable à l'eau

et au gaz et qui est séparée d'un autre couple de cellules (2) par les cloisons (4, 5) qui sont imperméables à l'eau et au gaz.

3. Navire selon la revendication 2, dans lequel au moins un conteneur (52) avec un réservoir de vidange (53) est placé dans chaque couple de cellules (2), avec la capacité de drainer des condensats ou des excès de gaz dans les containers (15), de sorte que les réservoirs de vidange (53) sont connectés via les valves de sécurité et des canalisations ressortant au pont supérieur vers un brûleur d'excès de gaz. 5
4. Navire selon la revendication 2, dans lequel chaque réservoir (16) est raccordé via une valve d'arrêt (19) avec le collecteur (12) au moyen d'une canalisation flexible (26) ou de soufflets d'expansion, et dans lequel le collecteur (12) est ménagé entre les extrémités des conteneurs des parties des couples de cellules (2) et est raccordé par une canalisation (31) à travers une valve d'arrêt (32) et l'équipement de sécurité avec le compresseur (49), de sorte que la canalisation ressort vers le pont supérieur depuis chaque couple de cellules et comporte des équipements de raccordement réglables au site de stockage extérieur et des équipements de canalisation connectés à un autre couple de cellules (2). 10 15 20 25
5. Navire selon la revendication 2, dans lequel ledit système de raccordement du compresseur procure la dérivation par la canalisation avec les valves d'arrêt (34, 37, 38, 39, 40, 49) permettant de transfert du gaz sous pression par gravité. 30 35
6. Navire selon la revendication 1, dans lequel lesdits containers (15) sont connectés entre eux par des sas traversant ou des cônes de centrage et des attaches. 40
7. Navire selon la revendication 1, dans lequel lesdits réservoirs cylindriques (16) issus de matériaux composites sont placés dans les containers (15) en position horizontale, chacun ayant au moins un conduit de raccordement (17), des valves d'arrêt (25) et des valves de sécurité (20), des capteurs de pression et de température (21, 22), ainsi qu'un capteur de détection de condensat (23) et un connecteur d'un conduit de drainage (24) du condensat. 45 50
8. Navire selon la revendication 7, dans lequel ledit connecteur du conduit de drainage est ménagé à chacune des extrémités de chacun des réservoirs (16). 55
9. Navire selon la revendication 1, dans lequel lesdits conteneurs (15) sont des conteneurs standards d'embarquement de 40 pieds avec des dimensions

extérieures de 12.192 mm. de longueur, de 2.438 mm de largeur et de 2.591 mm. de hauteur.

10. Navire selon la revendication 1, dans lequel chacune des cellules (2) individuelles d'un groupe de cellules (2) est fermée à son sommet par une trappe de couverture qui est imperméable à l'eau.
11. Navire selon la revendication 1, dans lequel chacune des cellules (2) individuelles d'un groupe de cellules (2) est fermée à son sommet par un revêtement amovible d'un étage supérieur.
12. Navire selon la revendication 1, dans lequel les conduits de raccordement, les valves d'arrêt et les conduits de drainage depuis les conteneurs (12) vers les équipements de raccordement sont couverts avec des gaines de refroidissement.

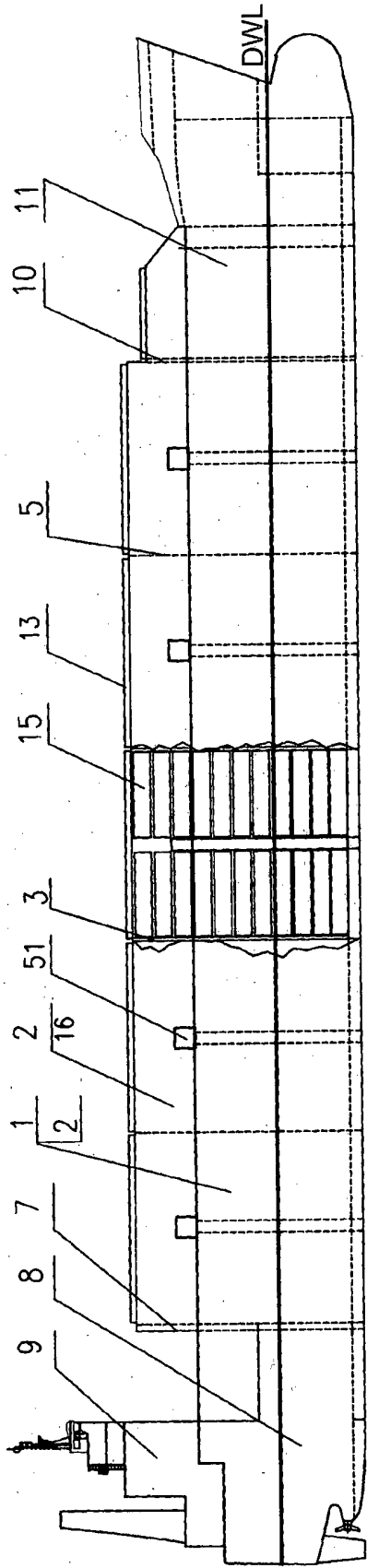


Fig. 1

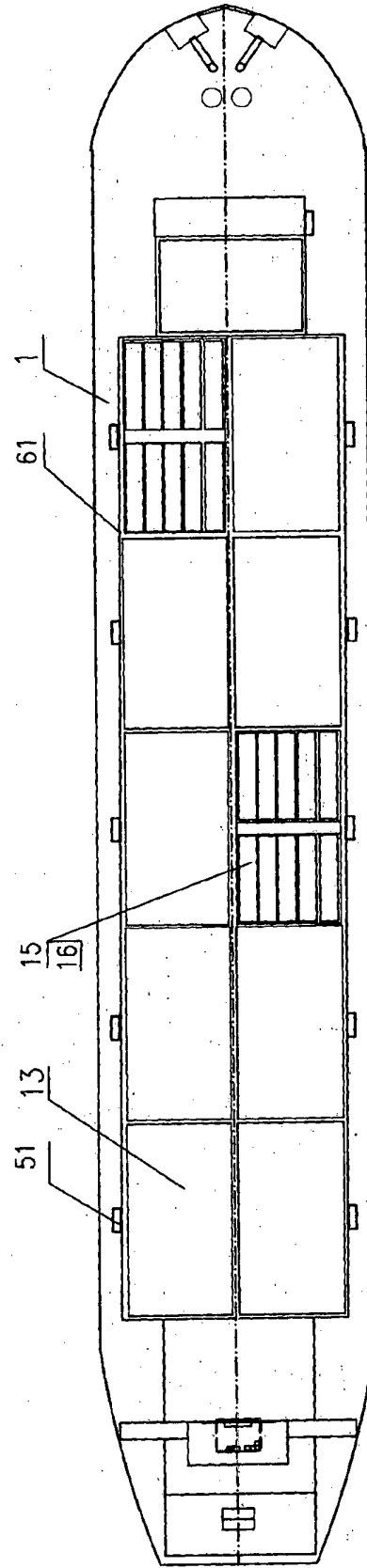


Fig. 2

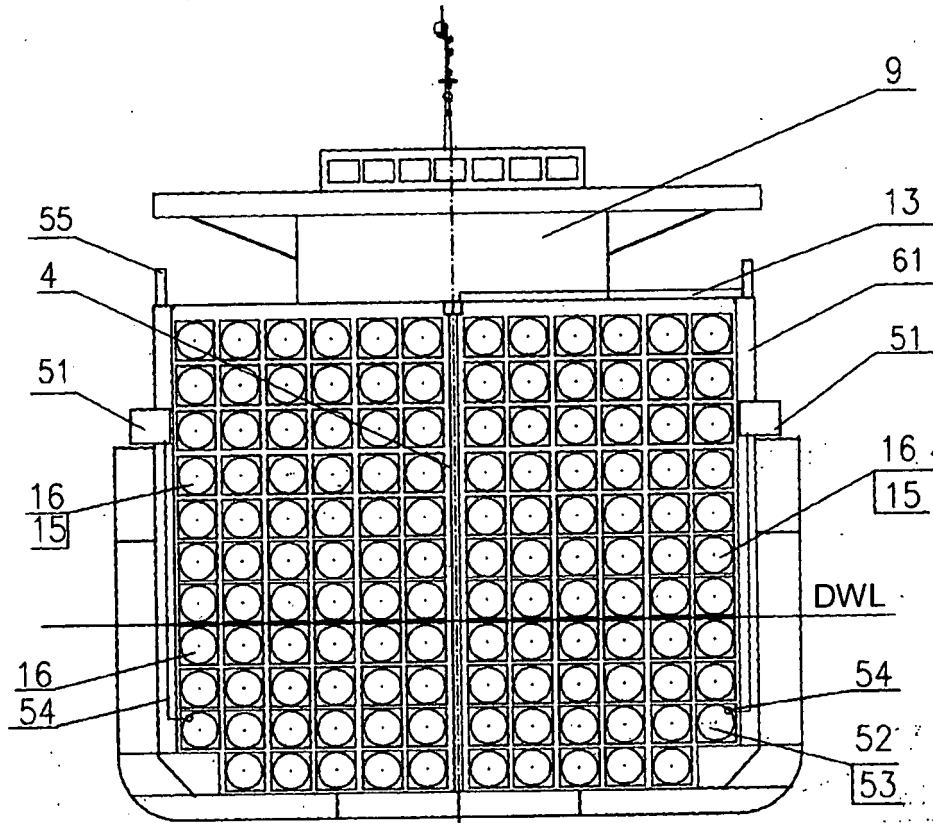


Fig. 3

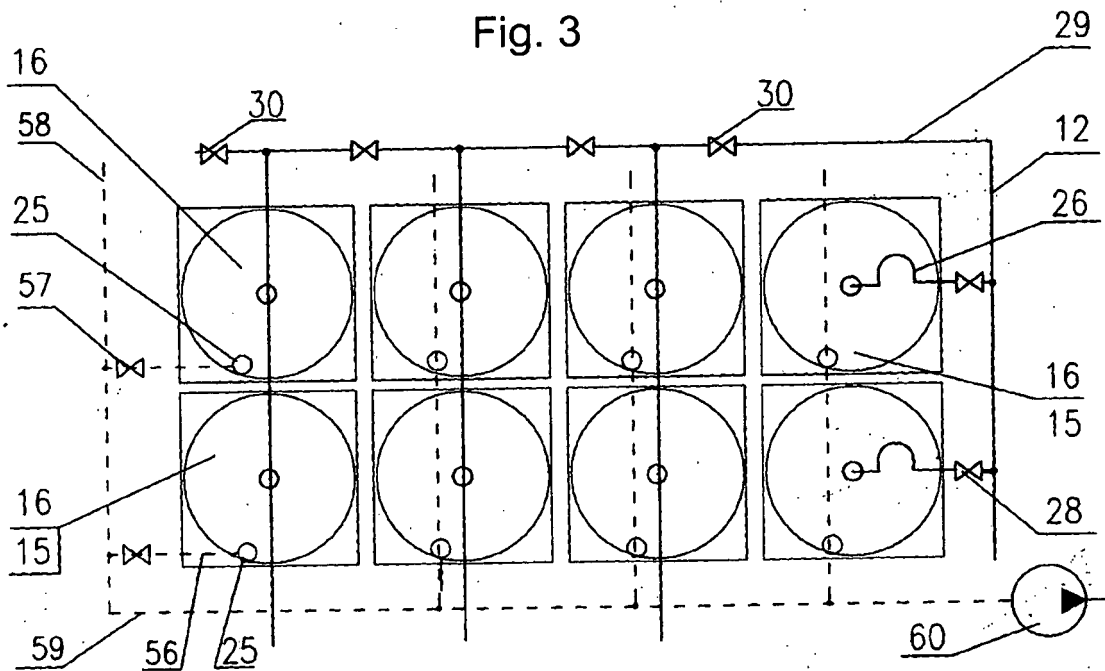


Fig. 4

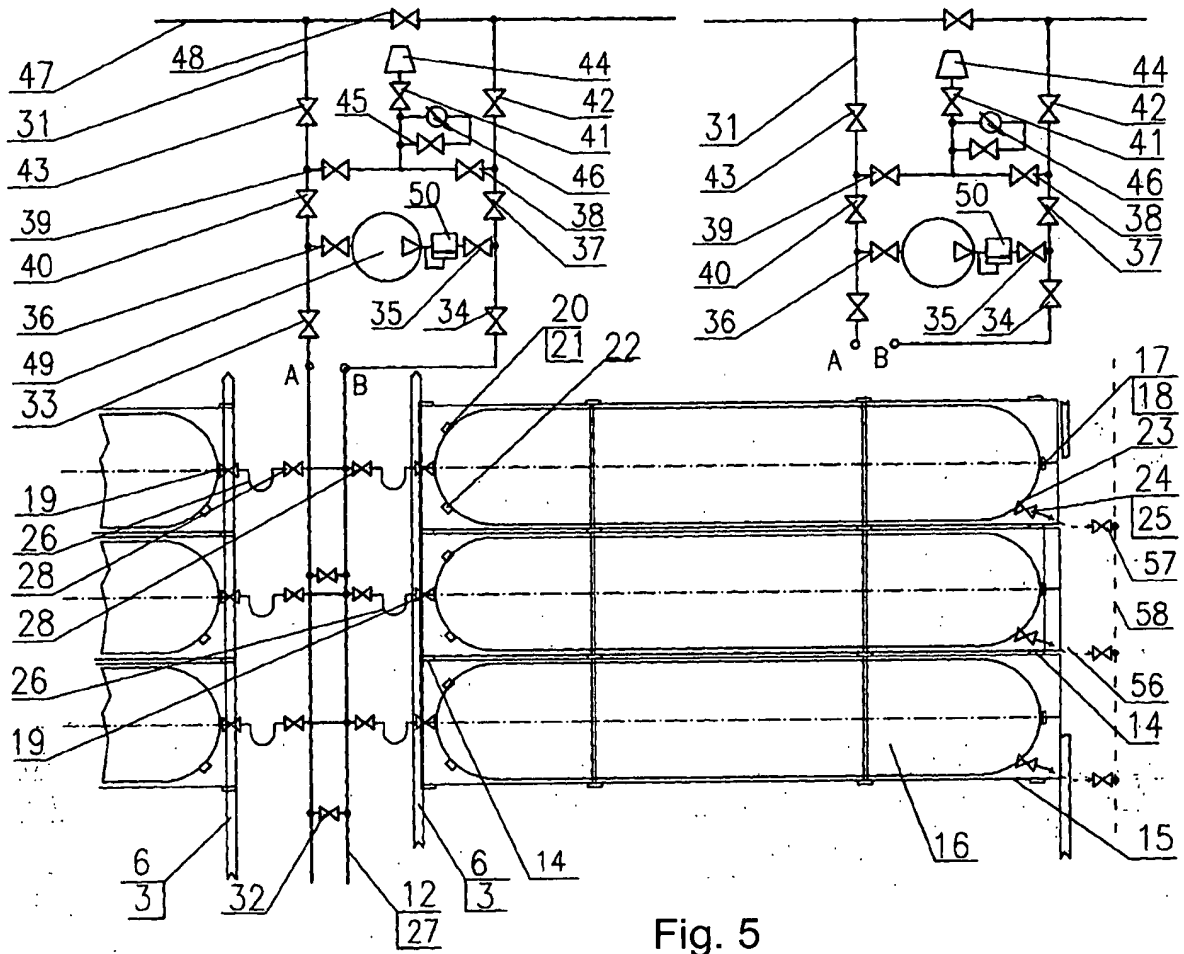


Fig. 5

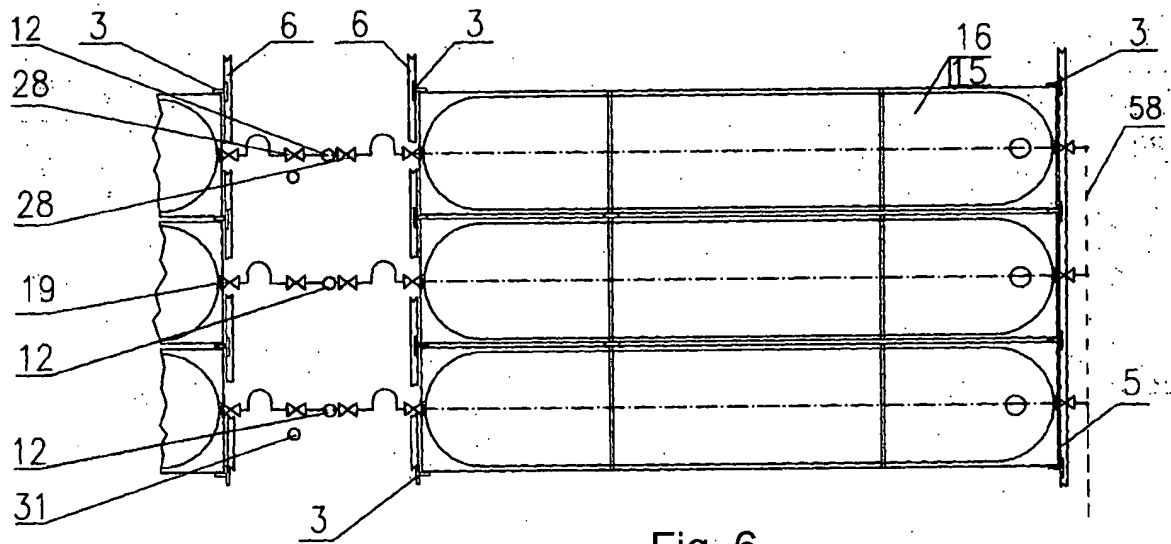


Fig. 6

**REFERENCES CITED IN THE DESCRIPTION**

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