



(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
19.07.2006 Bulletin 2006/29

(51) Int Cl.:
B63B 25/12 (2006.01) B63B 27/24 (2006.01)

(21) Application number: 06100264.8

(22) Date of filing: 12.01.2006

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR
HU IE IS IT LI LT LU LV MC NL PL PT RO SE SI
SK TR
Designated Extension States:
AL BA HR MK YU

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(30) Priority: 14.01.2005 EP 05075104

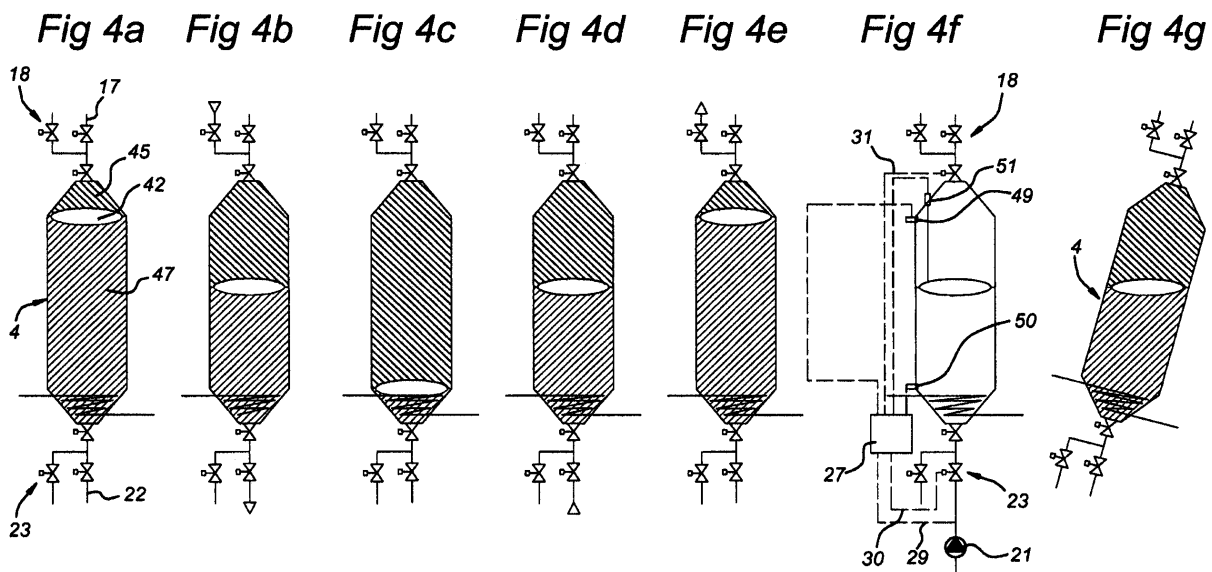
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(54) Loading and offloading system

(57) The invention relates to a vessel (1) comprising a hull (3) and within said hull a number of cylindrical tanks (4,5), each tank having a first and a second opening and respective valves (18,19,23,25) closing each opening, wherein the tanks are supported by a support structure in the hull, the first openings of the tanks being connected to a hydrocarbon inflow/outflow line (17), the second openings of the tanks being connected to a displacement fluid inflow/outflow line (22), at least one pump (21) being connected to the displacement fluid inflow/outflow and/or to the hydrocarbon inflow/outflow line, a control means

(27) being connected to the at least one pump (21) and to the valves (18,19,23,25) for controlling:

- pumping a first volume of displacement liquid or a hydrocarbon into the tanks via one of the displacement fluid inflow/outflow line and the hydrocarbon inflow/outflow line (22), while
- opening the valve (18,19,23,25) of the other of the displacement fluid inflow/outflow line and the hydrocarbon inflow/outflow line and removing a second volume of hydrocarbon or displacement fluid out of the tank via the valve.



Description

[0001] The invention relates to a loading and offloading system on a vessel comprising a hull and within said hull a number of cylindrical tanks.

[0002] A tanker comprising a number of cylindrical tanks is described in WO 00/73134.

[0003] In the known tanks, which are made of a composite material, the structural integration with the hull of the vessel may lead to fatigue problems during the service life of the vessel. Especially in high sea states, partially filled tanks may lead to sloshing of the contents and relatively high mechanical loads on the tanks.

[0004] In case a hydrocarbon is stored in the tanks, the atmosphere above the hydrocarbon in the tank is formed by an inert gas, which prevents explosive mixtures to be formed in order to reduce the risk of explosions. Furthermore, the loading level of the tanks will determine the draft of the vessel, which may vary.

[0005] It is an object of the present invention to provide a loading/offloading system in which the above problems are mitigated.

[0006] Thereto the present invention is characterised by each tank having a first and a second opening and respective valves closing each opening, wherein the tanks are supported by a support structure in the hull, the first openings of the tanks being connected to a hydrocarbon inflow/outflow line, the second openings of the tanks being connected to a displacement fluid inflow/outflow line, at least one pump being connected to the displacement fluid inflow/outflow and/or to the hydrocarbon inflow/outflow line, a control means being connected to the at least one pump and to the valves for controlling:

- pumping a first volume of displacement liquid or a hydrocarbon into the tanks via one of the displacement fluid inflow/outflow line and the hydrocarbon inflow/outflow line, while
- opening the valve of the other of the displacement fluid inflow/outflow line and the hydrocarbon inflow/outflow line and removing a second volume of hydrocarbon or displacement fluid out of the tank via the valve.

[0007] Because the tanks are formed by separate units that are supported within the hull, they do not contribute to the structural integrity of the vessel in a significant manner. The hull can hence be constructed in a more lightweight manner without a reduction in safety of containment. Pressure fluctuations inside the tanks will not cause any bending stresses in the hull. In a preferred embodiment, the tanks are formed by cylindrical tanks with spherical end faces to form a pressure vessel. A single layer hull will suffice to provide a reliable containment. Upon construction or during change-out and repair, the tanks can be separately installed, replaced and/or serviced.

[0008] In a preferred embodiment, the level to which

the tanks are filled is substantially constant. When oil is removed, the displacement fluid, such as for instance sea water, takes up the volume that is freed by the oil, such that the tanks are filled to a constant level. This has an advantage that reduced sloshing of the tank contents occurs, which reduces fatigue problems. Furthermore, since the tanks are filled to a substantially constant level, no inert gases need to be utilised in order to avoid problems with volatile organics compounds. Furthermore, corrosion of the tanks, in case they are made of metal such as carbon steel, is reduced as no interface of the container contents with air is formed.

[0009] By keeping a substantially constant level of fluid in the tanks, a substantially constant draft can be achieved. This is particularly advantageous in case the vessel is moored to the sea bed, and is attached to a sub sea well via a hydrocarbon riser, such as in case of an FPSO.

[0010] In a preferred embodiment, a heat insulating material is present at the interface of the hydrocarbon and the expulsion fluid. In case the hydrocarbon is formed by oil, which is transported upward from a sub sea oil well, and the fluid is formed by sea water, the oil may have a temperature of for instance 65°C, whereas the sea water is about 10°C. In order to avoid heat loss which would negatively affect the oil viscosity and its flow properties, a movable separating member may be situated in each tank, at the interface of the hydrocarbon and the displacement fluid, of substantially equal size and shape as the cross-section of tank. Such an insulating member has a further advantage that oil-water mixing at the interface is reduced.

[0011] In a preferred embodiment the tanks are connected in groups, for instance of 10 tanks each, to a manifold for admission and removal of oil and water. The tanks may have other shapes than cylindrical, such as spherical or rectangular, and may be supported in a honeycomb structure or a rectangular matrix, such as a space frame structure.

[0012] Some embodiments of a vessel according to the present invention will be explained in detail with reference to the accompanying drawings. In the drawings:

Fig. 1 shows a schematic side view of an FPSO comprising multiple cylindrical tanks according to the present invention,

Fig. 2 and 3 show a partial perspective view of a number of tanks according to the present invention, Figs. 4a-4g show a sequence of loading and offloading using a vessel according to the present invention, and

Fig. 5 shows a lay-out of multiple interconnected tanks.

[0013] Figure 1 shows a vessel (1), such as an FPSO, comprising a hull 3 with a number of cylindrical tanks 4,5. The vessel 1 comprises a turret 7 which is anchored to the seabed 8 via anchor lines 9. The hull 3 can weath-

ervane around the turret 7 depending on the wind and current directions. A hydrocarbon riser 11 is connected to a sub sea hydrocarbon well 13, such as an oil well. Oil is for instance transferred from the well 13 to the tanks 4, 5, via a swivel 15 which connects product piping on the vessel with the geostationary riser on the turret 7. The oil can via the oil inflow/outflow line 17 and the valves 18, 19 be transported into and out of the tanks 4, 5.

[0014] Via a pump 21 and a water inlet/outlet line 22, sea water can be pumped into and out of the tanks 4,5 via valves 23,25. The pump 21 and the valves 18,19,23,25 are controlled by a control unit 27, such as a computer, which is attached via electrical or electro-optical cables 29, 30, 31 to the pump 21 and to valves 18-25.

[0015] Figure 2 shows a number of tanks 4, 5 placed on a grid of stiffener beams 33 which provide a hull reinforcement in the longitudinal and in the transverse directions. The tanks are connected via a top manifold 35 to main transport ducts 37, and at the bottom to main transport ducts 39. As shown in figure 3, a top grid structure 40 is situated over the tanks 4, 5 and carries the deck 41, below which the manifolding 35 and the main transport ducts 37 are situated.

[0016] Figure 4a shows at the tank 4 after offloading, wherein the majority of the tank is filled with seawater 47. A separator, such as a circular floater 42, separates the oil 45 from the seawater 47. During loading of the tank 4, such as shown in figures 4b and 4c, the water 47 is removed via valves 23, and the oil is admitted via valves 18. For offloading, as shown in figures 4d and 4e, oil is removed via valves 18, and water is admitted via valves 23.

[0017] In figure 4f, the control unit 27 is seen, controlling the pump 21 and the valves 18 and 23. Two level sensors 49,50 are connected to the control unit 27 for providing input to the control unit about the level of oil and water in the tank 4. A tank radar transducer 51 is coupled to the control unit 27 for providing a position control signal of the floater 42 in the tank.

[0018] As is schematically indicated in figure 4g, tilting of the vessel does not result in any sloshing of liquids in the tank 4.

[0019] Finally, figure 5 shows a group 60 of ten tanks, which have a common loading/offloading duct 61 for hydrocarbons 61 and a common supply and discharge line 62 for seawater, which is taken in from the sea via seawater inlet chests 64,65 in the hull of the vessel 1.

to a hydrocarbon inflow/outflow line (17), the second openings of the tanks being connected to a displacement fluid inflow/outflow line (22), at least one pump (21) being connected to the displacement fluid inflow/outflow and/or to the hydrocarbon inflow/outflow line, a control means (27) being connected to the at least one pump (21) and to the valves (18, 19, 23, 25) for controlling:

- 5 - pumping a first volume of displacement liquid or a hydrocarbon into the tanks via one of the displacement fluid inflow/outflow line and the hydrocarbon inflow/outflow line (22), while
- 10 - opening the valve (18, 19; 23, 25) of the other of the displacement fluid inflow/outflow line and the hydrocarbon inflow/outflow line and removing a second volume of hydrocarbon or displacement fluid out of the tank via the valve.

20 **2.** Vessel (1) according to claim 1, wherein the first and second volumes are substantially equal.

25 **3.** Vessel (1) according to claim 1 or 2, the combined volume of hydrocarbon and displacement fluid in each tank being substantially constant.

30 **4.** Vessel (1) according to any of the preceding claims, a movable separating member (42) being situated in each tank, at the interface of the hydrocarbon and the displacement fluid, of substantially equal size and shape as the cross-section of tank.

35 **5.** Vessel (1) according to any of the preceding claims, wherein the vessel is anchored to the sea bed (8), a sub sea riser (11) extending from a sub sea hydrocarbon well (13) to the vessel (1) for supplying the hydrocarbon to the tanks (4, 5).

Claims

1. Vessel (1) comprising a hull (3) and within said hull a number of cylindrical tanks (4, 5), each tank having a first and a second opening and respective valves (18, 19; 23, 25) closing each opening, wherein the tanks are supported by a support structure in the hull, the first openings of the tanks being connected

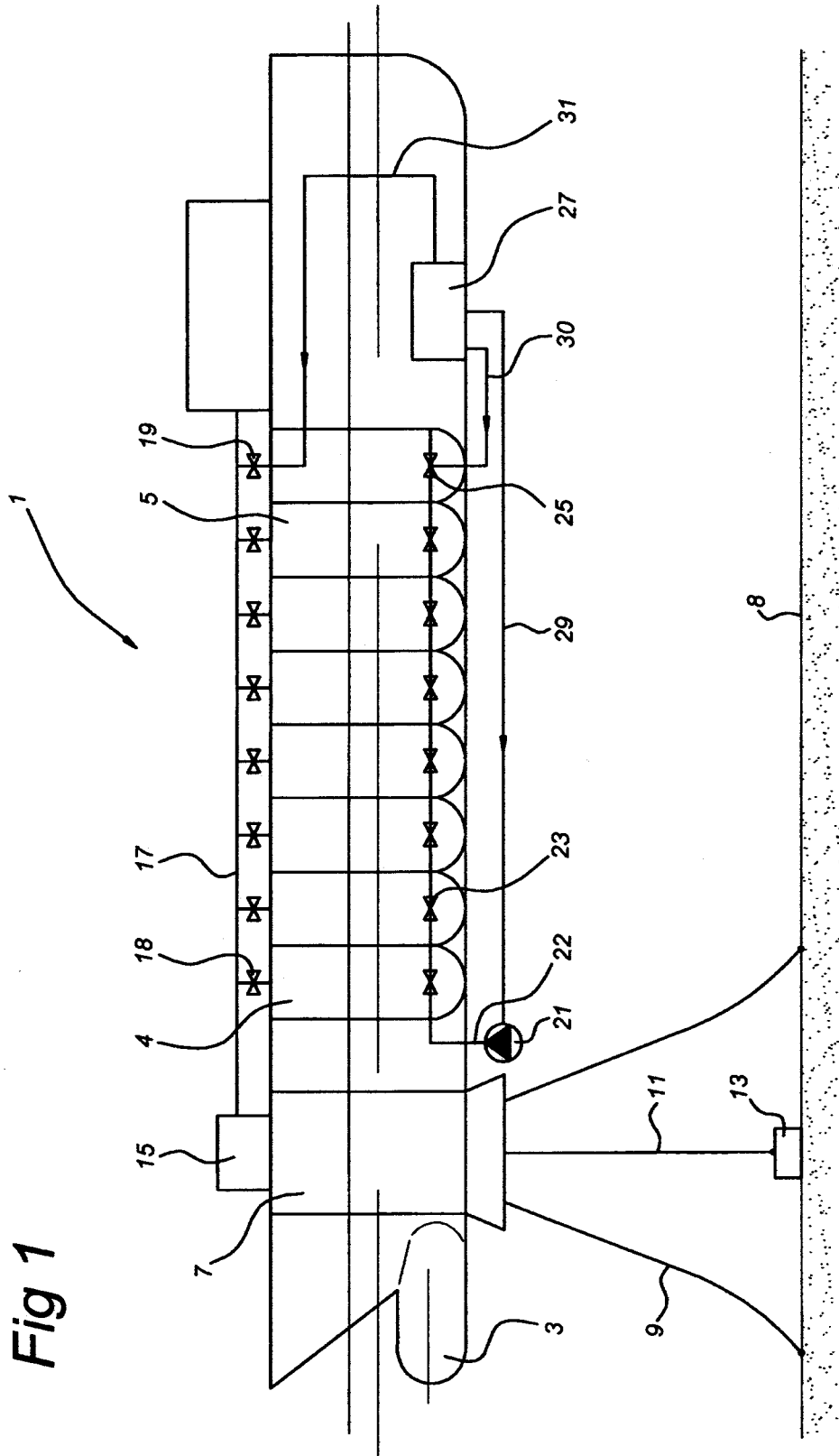


Fig 1

Fig 2

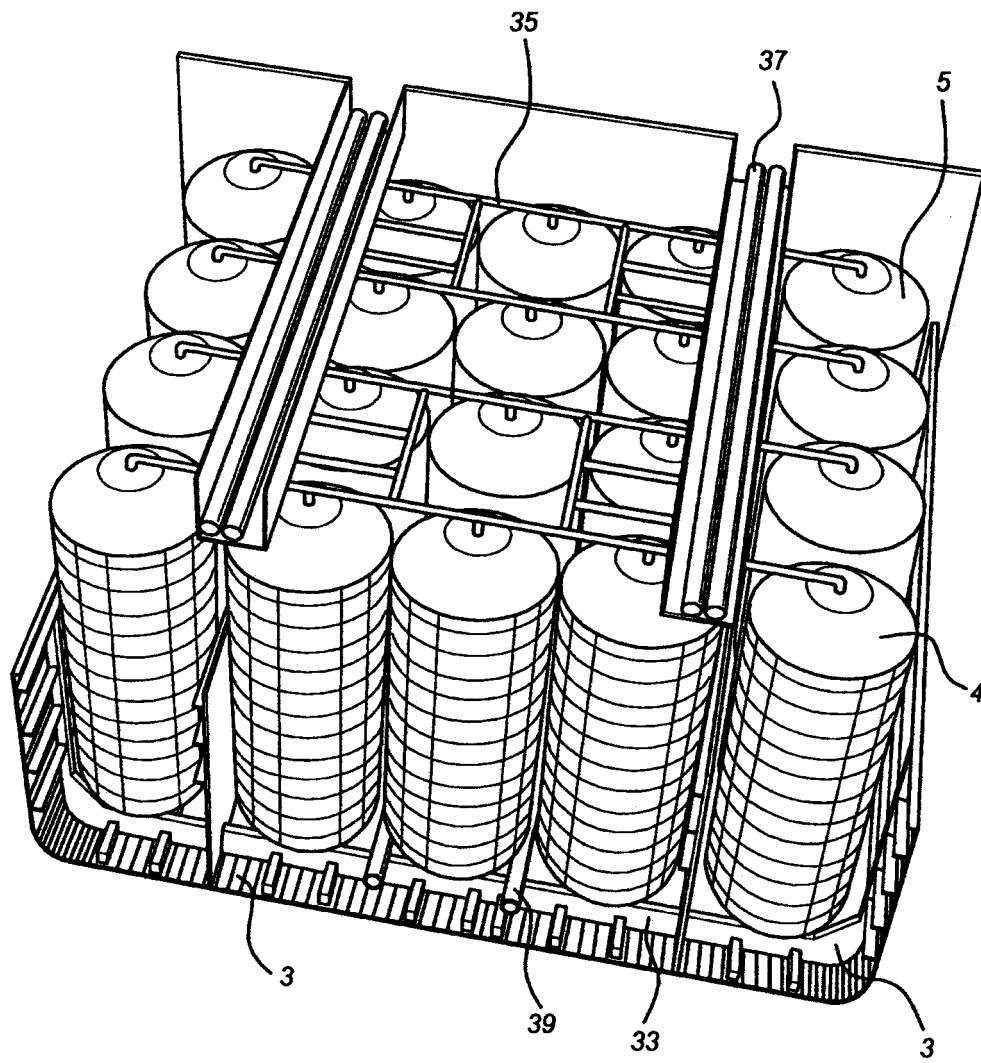


Fig 3

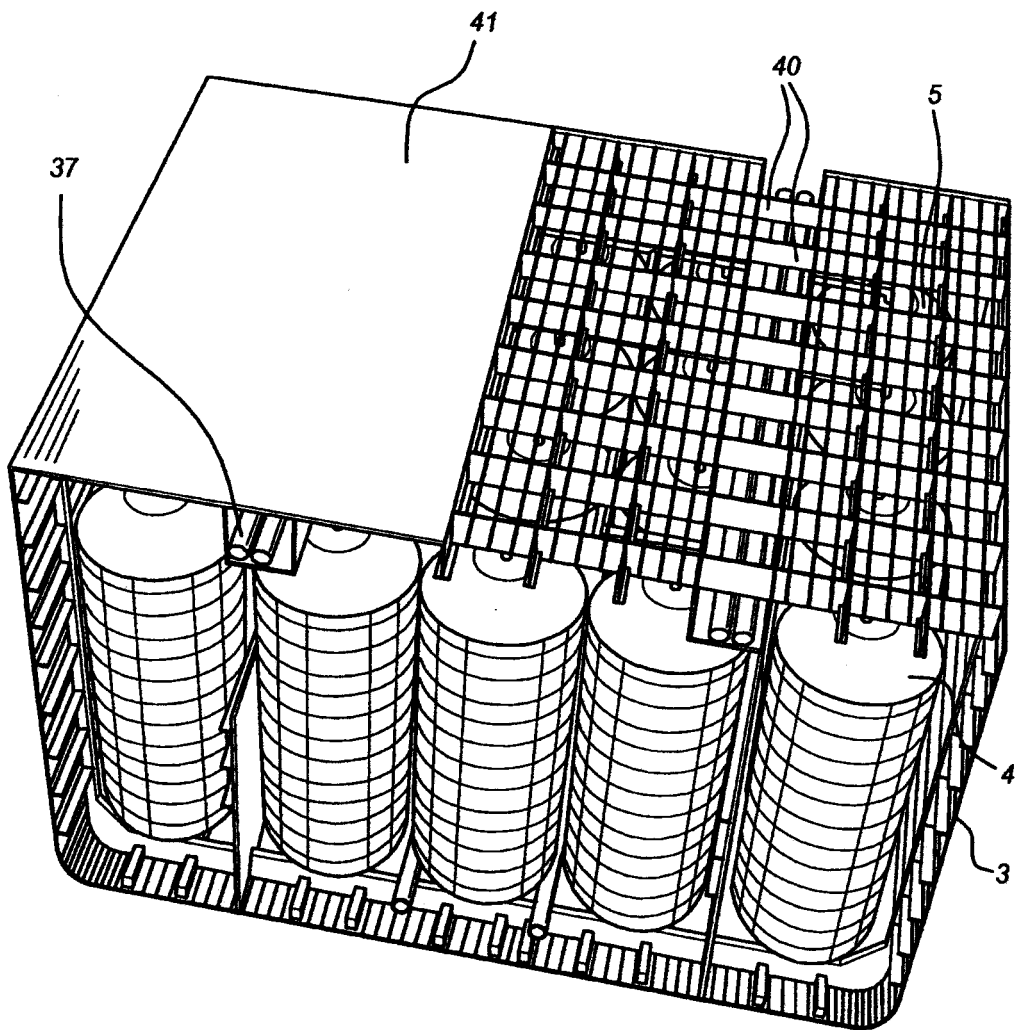


Fig 4g

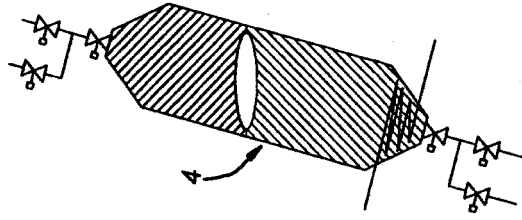


Fig 4f

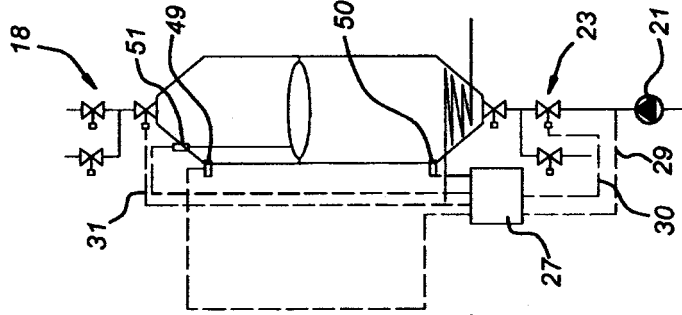


Fig 4e

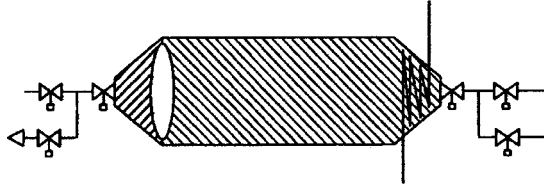


Fig 4d

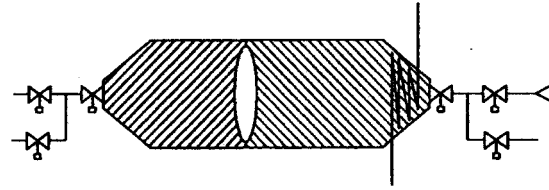


Fig 4c

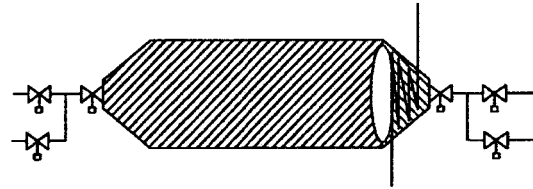


Fig 4b

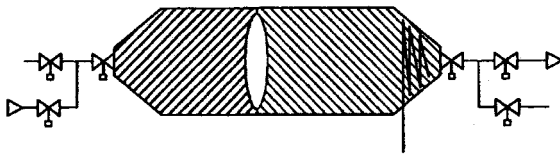


Fig 4a

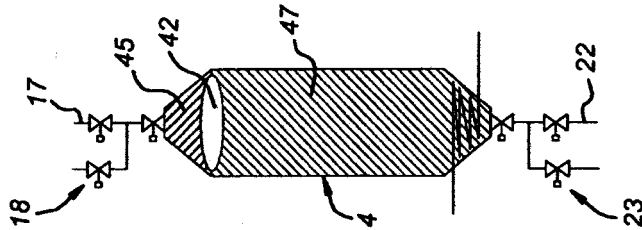
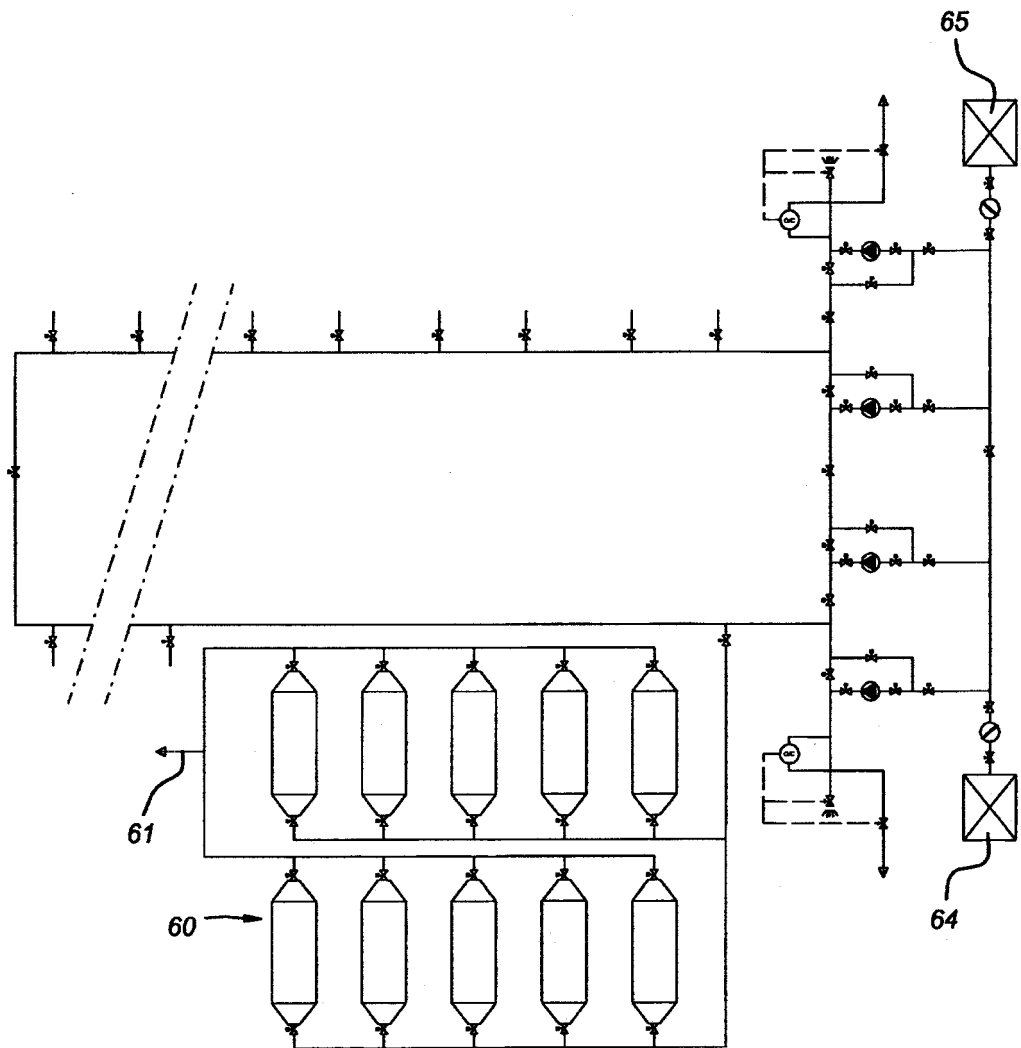


Fig 5





DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 4 446 804 A (KRISTIANSEN ET AL) 8 May 1984 (1984-05-08)	1,3,5	INV. B63B25/12 B63B27/24
Y	* column 2, line 63 - column 6, line 9; figures *	2	
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			TECHNICAL FIELDS SEARCHED (IPC)
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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 25 April 2006	Examiner Moya, E
CATEGORY OF CITED DOCUMENTS		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons ----- & : member of the same patent family, corresponding document	
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document			

EPO FORM 1503 03/02 (P04/C01)

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

EP 06 10 0264

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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