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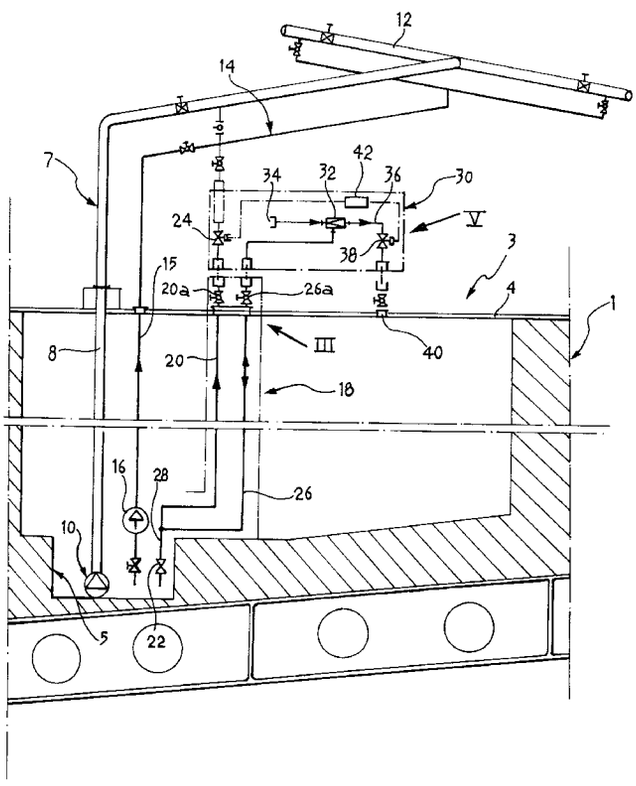
(54) Method and apparatus for draining a liquid from a tank

(57) Apparatus for draining liquid from a tank comprises a delivery duct (20) a first end of which can be disposed close to the bottom (5) of the tank (3) and the second end of which projects out from the tank (3). This duct includes a non-return valve (22) for preventing the flow of liquid back into the tank (3). First interception means (24) are disposed downstream of the non-return valve (22) and can assume a position opening or closing a delivery duct (20). A service duct (26) is connected at a first end to the delivery duct (20) and at its second end to pressure control means (32, 34) . The pressure control means (32, 34) are operable to cause conditions of depression or pressurisation alternatively in the service duct (26) in such a way as to draw in the liquid present in the tank (3) or to force it out from the tank (3) through the delivery duct (20) until the tank (3) is drained.

FIG. 2



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Description

The present invention relates in general to equipment for tankers, and in particular relates to apparatus for draining liquid from a tank.

Tankers include a plurality of tanks each of which is provided with a main emptying system having a main duct with which is associated a respective immersion pump, the so-called "deep well" pump close to the bottom of the tank. The main systems of each tank are then connected to one or more connection ducts associated with the upper deck of the boat.

The immersion pumps mentioned above are not, however, able to work in non-immersed conditions and therefore must be stopped before the tank is entirely emptied, due to the fact that the liquid contained in the tank provides the lubrication for the main bearings of the pump. In particular, such pumps are not suitable to drain the liquid column which remains within the tank in the main duct above the pump itself. The volume of liquid in this column is a function of various parameters such as the cross section of the main duct and the height of the tank, and also depends on the dimensions of the pump and the position of its main impeller. In each case, upon stopping of the "deep well" pump the liquid contained in the portion of the main duct above it flows back into the tank constituting a residue which according to recent regulations, particularly those relating to chemical installations, must necessarily be removed in such a way as to permit the almost complete draining of the liquid from each of the tanks.

Generally, each tank is further provided with a secondary emptying system for safety purposes in the case of malfunctioning of the main system, which includes a membrane of diaphragm pump. This diaphragm pump, which theoretically could be adapted to remove the above-mentioned residue from the bottom of the tank, is in practice unsuitable for this purpose because of its intrinsically poor operating reliability and due to the fact that the material constituting the diaphragm of the pump, for example PTFE, may not be entirely compatible with the liquid in the tank.

The present invention seeks to provide apparatus for draining liquid from a tank which does not have the disadvantages of the above-mentioned known systems and which will be particularly reliable in operation and simple to produce.

This object is achieved thanks to the fact that the apparatus comprises:

a delivery duct having a first end which can be disposed in proximity to the bottom of the tank and a second end extending out from the tank, and including a non-return valve for preventing a reverse flow of liquid present in it towards the tank, and first interception means disposed downstream of the non-return valve with respect to the said first end, capable of assuming respective positions opening or closing the delivery duct,

a service duct having a first end connected to the delivery duct between the non-return valve and the said first interception means, and a second end associated with pressure control means capable of determining, alternatively, in the service duct, conditions of depression or pressurisation such that when conditions of depression are caused in the service duct the liquid present in the tank is drawn into it, and when conditions of pressurisation are caused in the service duct the liquid in it is urged out from the tank through the delivery duct until the tank is drained.

The invention further includes a process for draining a liquid from a tank, characterised in that it comprises the following operations:

providing a delivery duct having a non-return valve and first interception means, and a service duct connected at its first end to the delivery duct between the non-return valve and the first interception means and its second end connected to pressure control means capable of establishing conditions of depression or pressurisation in the service duct, in which a first end of the delivery duct is disposed close to the bottom of the tank and the second end extends out from the tank, the non-return valve being positioned substantially in proximity to the said first end of the delivery duct in such a way as to prevent the flow of liquid present in it towards the tank, and the first interception means being disposed downstream of the non-return valve with respect to the first end of the delivery duct,

controlling the variation of pressure in the service duct by means of the said control means in such a way as to establish conditions of depression or pressurisation alternatively in the service duct in such a way as to perform in succession at least one phase of filling the service duct with the said liquid and at least one phase of emptying the service duct through the delivery duct until the tank is drained.

Further characteristics and advantages of the present invention will be brought to light by the following detailed description given with reference to the attached drawings, and provided purely by way of non-limitative example, in which:

Figure 1 is a perspective view of a tanker;

Figure 2 is a schematic side view, sectioned along the line II-II of Figure 1, which illustrates a single tank of the tanker on an enlarged scale;

Figure 3 is an enlarged sectional side view of a detail indicated with the arrow III in Figure 2;

Figure 4 is a side view sectioned along the line IV-IV of Figure 3;

Figure 5 is a schematic view of a detail indicated

with the arrow V in Figure 2;

Figure 6 is a view similar to Figure 5 which illustrates a constructional variant of the invention; and

Figure 7 is a side view which illustrates an alternative embodiment of a part of the apparatus according to the invention.

With reference to the drawings, the reference numeral 1 indicates in general a tanker the hull of which is provided with a plurality of transverse and longitudinal partitions 2 which define tanks 3 for liquids delimited at the top by the upper deck 4 of the ship.

Each tank 3 includes a sump 5 in which is disposed one end of a main emptying line 7. The line 7 comprises, in a manner known per se, a duct 8 which is joined outside the tank 3 to a collection tube 12. Within the sump 5 is an immersion or "deep well" pump 10, of conventional type associated with the duct 8.

Another duct 15 also opens into the sump 5, in which is interposed a membrane pump 16 and which constitutes a secondary emptying line which has a security function in the case of malfunctioning of the main emptying line.

The tank 3 includes draining apparatus which includes a raising unit indicated generally with the reference numeral 18. The unit 18 comprises a delivery duct 20 having one end projecting from the tank 3, which can be connected to the tube 12, and an opposite end disposed in the sump 5. The duct 20 is provided with a non-return foot valve 22 preferably disposed close to the bottom of the sump 5 the function of which is to prevent the liquid present in this duct from flowing out into the tank.

A service duct 26 is connected to the duct 20 at a portion thereof, indicated 28, downstream from the valve 22 with respect to the end of the duct 20 close to the bottom of the sump 5. The duct 26 also extends out from the tank 3.

In practice the unit 18 can advantageously be made in one piece as illustrated in Figures 3 and 4, with the ducts 20 and 26 disposed one co-axially with respect to the other in such a way as to form an easily movable, portable integral tubular member having an annular attachment flange 21. The flange 21 can be provided with through holes for connection by screws to another corresponding flange 21a fixed on the upper deck 4 of the ship in correspondence with an upper opening in the tank 3. In this case the co-axial ducts 20 and 26 communicate with one another by means of radial holes 28a, typically four, formed in a common wall of the two ducts close to the non-return valve 22. Because of the particularly compact structure of apparatus in this embodiment it can be easily moved from one tank to another of the ship in such a way as to be used when needed; in particular, each ship can be provided with a single apparatus according to the invention so as to avoid the need for the introduction of expensive modifications to its tanks.

Both the ducts 20 and 26 include respective quick release ball valves 20a and 26a positioned outside the tank 3 to permit connection of the unit 18 to a control assembly of the draining apparatus indicated with the reference numeral 30 in Figure 2.

The assembly 30, illustrated in greater detail in Figure 5, includes an ejector 32 which has an input section 32a connected to a source 34 of gas under pressure and an output section 32b connected to an auxiliary duct 36 which opens into the tank 3 through a "vapour lock" opening 40. Between the sections 32a and 32b is interposed a restricted intermediate section 32c close to which is connected the end of the service duct 26 extending from the tank 3, by means of a flexible hose and a duct 26b.

The assembly 30 further includes a duct 20b intended to be connected to the delivery duct 20 via a flexible hose, provided with a pneumatically controlled interception valve 24. This valve 24, which is normally in the closed position, is controllable to open upon displacement of a pneumatic actuator 25 against the action of a resilient biasing member which urges it towards the position in which the valve 24 is closed.

A second interception valve 38, entirely similar to the valve 24, is interposed along the auxiliary duct 36. In particular, the valve 38 can be moved to its open position upon displacement of a pneumatically controlled actuator 39 against the action of a resilient biasing member which biases it towards the position in which the valve 38 is closed.

The gas source 34 delivers a gas which is inert with respect to the liquid present in the tank 3, for example at a pressure lying between 5 and 8 kg/cm^2. In particular this gas could be air or another gas such as nitrogen, if the liquid contained in the tank could react in the presence of air. The gas delivered by the source 34 is utilised to control a unit 42 for control of actuators 25 and 39 of the valves 24 and 38, and is delivered to these by means of a primary pneumatic line 44.

The primary line 44 is divided into three branches 48, 49 and 50 of which the branches 48 and 50 are, respectively, connected to the actuators 25 and 39 via respective distributor valves 52 and 54 of the two-position two-way type. These valves 52 and 54 are normally in the closed position and can be pneumatically controlled to open against the action of resilient biasing means which urge them towards the closure position.

The branch 49 includes a three-position, three-way distributor valve 46 interposed between it and a pair of secondary pneumatic lines 49a, 49b each of which permits the displacement of an associated valve 52, 54 from its rest position to be controlled. The valve 46 is normally in a neutral rest position in which it intercepts the flow of gas coming from the branch 49 and can be displaced, for example manually, between two end positions in which the branch 49 is connected to the secondary line 49a or the secondary line 49b respectively. A resilient biasing member urges the valve 46 towards its neutral rest position in the absence of any external

action.

Following a conventional tank-emptying operation, performed by means of the main emptying line, there remains in the sump 5 a residue of liquid which must be drained almost completely as prescribed by recent regulations.

For this purpose the apparatus according to the invention is put into operation in the manner described hereinafter.

By manipulating the valve 46 it is moved into the position in which the branch 49 of the line 44 is in communication with the secondary line 49b. In these conditions the valve 38 is moved to its open position by the effect of the displacement of the actuator 39 caused by the flow of gas under pressure present in the branch 50 upon displacement of the valve 54 against the action of its resilient biasing means, caused by the pressure in the line 49b. The valve 24 remains in the rest condition corresponding to the closure position, the actuator 25 not being activated.

The pressurised gas from the source 34 passing through the ejector 32 causes depression conditions in its intermediate section 32c and consequently in the ducts 26b and 26. Because of this depression the liquid present in the sump 5 is sucked into the duct 26.

After a predetermined time, for example calculated as a function of the height of the tank and when presumably the duct 26 is full of liquid, the valve 46 is manipulated in such a way as to displace it into its opposite end position thus putting the branch 49 of the line 44 into communication with the secondary line 49a. As a consequence of the new position assumed by the valve 46 the valve 54 returns to its rest position and commands displacement of the actuator 39 to its inactive position in which the valve 38 is closed. Simultaneously the pressure in the line 49a commands displacement of the valve 52 against the action of its resilient biasing means thereby allowing the gas under pressure to flow into the branch 48 to operate the actuator 25 which opens the valve 24.

In these conditions the gas under pressure delivered by the source 34 through the ejector 32, which now behaves as a simple duct because of the closure of the valve 38, causes a pressure increase in the ducts 26b and 26. In this way the liquid present in the service duct 26 is urged towards the delivery duct 20 through which it flows out from the tank 3. The non-return valve 22 prevents the liquid present in the duct 20 from flowing back towards the bottom of the sump 5 by closing automatically.

By performing in succession a plurality of cycles such as that described above in succession it is possible to drain the tank 3 entirely.

Naturally, as an alternative to a control unit with manual pneumatic command, which is preferred if the liquid treated can give rise to risks in the presence of electrical energy, if the above-mentioned risks do not exist a unit comprising an electrical timer can be used in order automatically to control the displacement of the valve 46 from its rest position between its operating end positions, and likewise an electronically controlled piloting unit which cooperates directly with the actuators 25 and 39 for the purpose of cyclically controlling the opening and closure of the valves 24 and 38 may be used such that when one is in the open position the other is in the closed position, at predetermined time intervals.

In a variant illustrated in Figure 6, in which the same reference numerals have been used to identify the same or similar parts as those in Figure 5, the assembly 30 is provided with a control unit 42 of pneumatically controlled automatic type set up to control the single actuator 39 of the valve 38 in that the valve 24 is in this case simply constituted by an automatic non-return valve.

The unit 42 includes a three-way, two-position distributor valve 46' of the pneumatically piloted type whilst the distributor valves 52 and 54 are still of the two-way, two-position, normally closed type, and serve as "timers" or timing devices for regulating the duration of the vacuum or depression and pressurisation phases of the duct 26.

In particular, the gas delivered by the source 34 through the primary line 44 reaches the valve 52 along the branch 48, the valve 46' along the branch 49 and the valve 54 along the branch 50. Valves 52 and 54 control the position of the valve 46' via respective secondary lines 49a and 49b. Moreover, the valve 46' and the valve 52, this latter via a duct 53a, are both connected to the actuator 39 via a control duct 51a, whilst both the valve 46' and the valve 54, this latter by means of a duct 53b, are connected to the actuator 39 via another control duct 51b.

In the position illustrated in the drawing the valve 46' permits pressurisation of the duct 51b and connection of the duct 51a to the discharge, causing opening of the valve 38 so as to cause pressurisation conditions within the tank 3. Moreover, because of the flow of gas through the ejector 32 depression conditions in the duct 26 are established so that the liquid present in the sump 5 is drawn towards the duct 26. After a predetermined time, which is set for both the valves 52 and 54 in a manner known per se, the valve 54 is displaced by the effect of the pressure present in the duct 53b towards its position in which the branch 50 is connected to the line 49b, which causes displacement of the valve 46' towards its opposite position. Upon reaching this position of the valve 46' the ducts 51a and 53a are connected to the branch 49 and therefore to the pressurised gas source 34, controlling the actuator 39 in such a way as to carry the valve 38 into its closure position. In this way the gas coming from the source 34 is delivered to the duct 26 so as to force the liquid present in it into the duct 20 and therefore out from the tank 3.

Upon reaching the preset time for the valve 52 it displaces again into its rest position by the effect of the pressure present in the duct 53a in such a way as to displace the valve 46', for example for the purpose of

initiating a new cycle of operation.

In a particularly advantageous alternative embodiment illustrated in Figure 7 the unit 18 can be made in such a way as to guarantee emptying of the whole of the residue of the liquid present in the sump 5 with a single operating cycle of the apparatus according to the invention. In this case the unit 18 again has ducts 20 and 26 disposed one co-axially within the other in such a way as to form an integral tubular member, but the end part of the duct 26 has an enlarged form so as to delimit an internal volume substantially equal to or slightly greater than that of the sump 5. This terminal part can be constituted by a cylindrical tank 19 connected at its top by means of a flange and connection sleeve to the duct 26, and at its bottom to the non-return valve 22 disposed at the end of the duct 20 and communicating by means of a duct 23 with the bottom of the sump 5. Struts 19a support the tank 19 close to the bottom of the tank 3. If inspection of the level of residual liquid in the tank 19 is necessary it is sufficient to separate the ducts 20 and 26 from it by disconnecting the flange nearest the tank 19 and disactivating the non-return valve 22 with a suitable tool.

Notwithstanding that in the course of the present description specific reference has been made to the tanks of ships, the invention is naturally applicable also to other tanks or cisterns in general.

Claims

1. Apparatus for draining liquid from a tank, characterised in that it comprises:

   a delivery duct (20) having a first end which can be disposed in proximity to the bottom (5) of the tank (3) and a second end extending out from the tank (3), and including a non-return valve (22) for preventing a reverse flow of liquid present in it towards the tank (3), and first interception means (24) disposed downstream of the non-return valve (22) with respect to the said first end, capable of assuming respective positions opening or closing the delivery duct (20),

   a service duct (26) having a first end connected to the delivery duct (20) between the non-return valve (22) and the said first interception means (24), and a second end associated with pressure control means (32, 34) capable of determining, alternatively, in the service duct (26) conditions of depression or pressurisation such that when conditions of depression are caused in the service duct (26) the liquid present in the tank (3) is drawn into it, and when conditions of pressurisation are caused in the service duct (26) the liquid in it is urged out from the tank (3) through the delivery duct (20) until the tank (3) is drained.

2. Apparatus according to Claim 1, characterised in that the delivery duct (20) and the service duct (26) are formed in an integral unit (18) and are disposed co-axially one within the other.

3. Apparatus according to Claim 2, characterised in that the tank (3) has a lower sump (5) and in that the service duct (26) includes a tank (19) at its first end, the capacity of which close to that of the lower sump (3) so that it is possible to empty the sump (5) with a single operating cycle of the apparatus.

4. Apparatus according to Claim 2 or Claim 3, characterised in that the said integral unit (18) is portable and has coupling means (21, 21a) to allow it to be associated with different tanks (3).

5. Apparatus according to any of Claims 1 to 4, characterised in that the means for controlling the pressure in the service duct (26) comprise an ejector (32) which has an input section (32a) connected to a source (34) of gas under pressure and an output section (32b) connected to an auxiliary duct (36) including second interception means (38) selectively controllable between respective positions opening and closing the auxiliary duct (36), there being interposed between the said input and output sections (32a, 32b) an intermediate section (32c) close to which is connected the second end of the service duct (26), the first interception means (24) being intended to assume its open position when the second interception means (38) are controlled to their closure position and vice versa.

6. Apparatus according to Claim 5, characterised in that the said gas under pressure is an inert gas with respect to the liquid present in the tank (3).

7. Apparatus according to any of Claim 1 to 6, characterised in that it includes a control unit (42) cooperating with at least the said second interception means (38) for controlling the apparatus to convert between its two alternative conditions, in the first condition the first interception means (24) being in their closure position and the second interception means (38) in their open position of the respective ducts (20, 36), in the second condition the first interception means (24) being in their open position and the second interception means (38) being in their closure position of the associated ducts (20, 36).

8. Apparatus according to Claim 7, characterised in that conversion between the said alternative operating conditions takes place cyclically in predetermined time intervals.

9. Apparatus according to Claim 7 or Claim 8, characterised in that the said predetermined time intervals are manually controlled.

10. Apparatus according to Claim 9, characterised in that the said first interception means (24) are controlled by the said control unit (42).

11. Apparatus according to Claim 10, characterised in that the first and second interception means each include an interception valve (24, 38) controllable by means of gas under pressure to open against the action of a resilient biasing member urging it towards its closure position.

12. Apparatus according to Claim 11, characterised in that the said control unit (42) includes a primary line (44, 48, 49, 50) supplied from the said source (34) of gas under pressure, having a distributor valve (46) acting as a commutator between two secondary lines (49a, 49b) each of which has an associated respective distributor valve (52, 54) controlled by the pressure present in the respective secondary line (49a, 49b) and movable between a position in which it intercepts the gas under pressure in the respective primary line (48, 50) and a position in which it allows the gas under pressure from the said gas source (34) to pass towards the respective interception valve (24, 38) to cause opening thereof.

13. Apparatus according to Claim 7 or Claim 8, characterised in that the said predetermined time intervals are automatically controlled by means of a timing device.

14. Apparatus according to Claim 13, characterised in that the said first interception means (24) include an automatic non-return valve and in that the control unit (42) directly controls the position of the second interception means (38) in such a way that the auxiliary duct (36) is opened to cause depression conditions in the service duct (26), the non-return valve (24) being in its closure position, or the auxiliary duct (36) is closed to cause pressurisation conditions in the service duct (26), the non-return valve (24) again being in its closure position.

15. Apparatus according to Claim 14,characterised in that the control unit (42) includes a primary line (44, 48, 49, 50) supplied from the pressurised gas source (34) , in which a distributor valve (46') is present connected by means of a pair of control ducts (51a, 51b) to the second interception means (38) in such a way as to control its position to cause opening or closure of the auxiliary ducts (36), and a pair of timing distributor valves (52, 54) each operable to control the position of the said distributor valve (46') by means of a respective secondary line (49a, 49b) upon establishment of pressurisation conditions in connection ducts (53a, 53b) respectively connected to the said control ducts (51a, 51b).

16. A process for draining a liquid from a tank, characterised in that it comprises the following operations:

providing a delivery duct having a non-return valve (22) and first interception means (24), and a service duct (26) connected at its first end to the delivery duct (20) between the non-return valve (22) and the first interception means (24) and its second end connected to pressure control means (32, 34) capable of establishing conditions of depression or pressurisation in the service duct (26), in which a first end of the delivery duct (20) is disposed close to the bottom (5) of the tank (3) and its second end extends out from the tank (3), the non-return valve (22) being positioned substantially in proximity to the said first end of the delivery duct (20) in such a way as to prevent the flow of liquid present in it towards the tank (3), and the first interception means (24) being disposed downstream of the non-return valve (22) with respect to the first end of the delivery duct (20),
controlling the variation of the pressure in the service duct (26) by means of the said control means (32, 34) in such a way as to establish conditions of depression or pressurisation alternatively in the service duct (26) in such a way as to perform in succession at least one phase of filling the service duct (26) with the said liquid and at least one phase of emptying the service duct (26) through the delivery duct (20) until the tank (3) is drained.

17. A process according to Claim 16, characterised in that the means for controlling the pressure in the service duct (26) comprise an ejector (32) having an inlet section (32a) connected to a pressurised gas supply (34) and an outlet section (32b) connected to an auxiliary duct (36) with which are associated second interception means (38) selectively controllable between an open position and a closure position of the auxiliary duct (36), interposed between the inlet and outlet sections (32a, 32b) there being an intermediate section (32c) to which is connected the second end of the service duct (26), and in that it includes the operation of controlling the second interception means (38) to adopt an open or closure position respectively thereby determining conditions of depression or pressurisation in the service duct (26) in a cyclic manner.

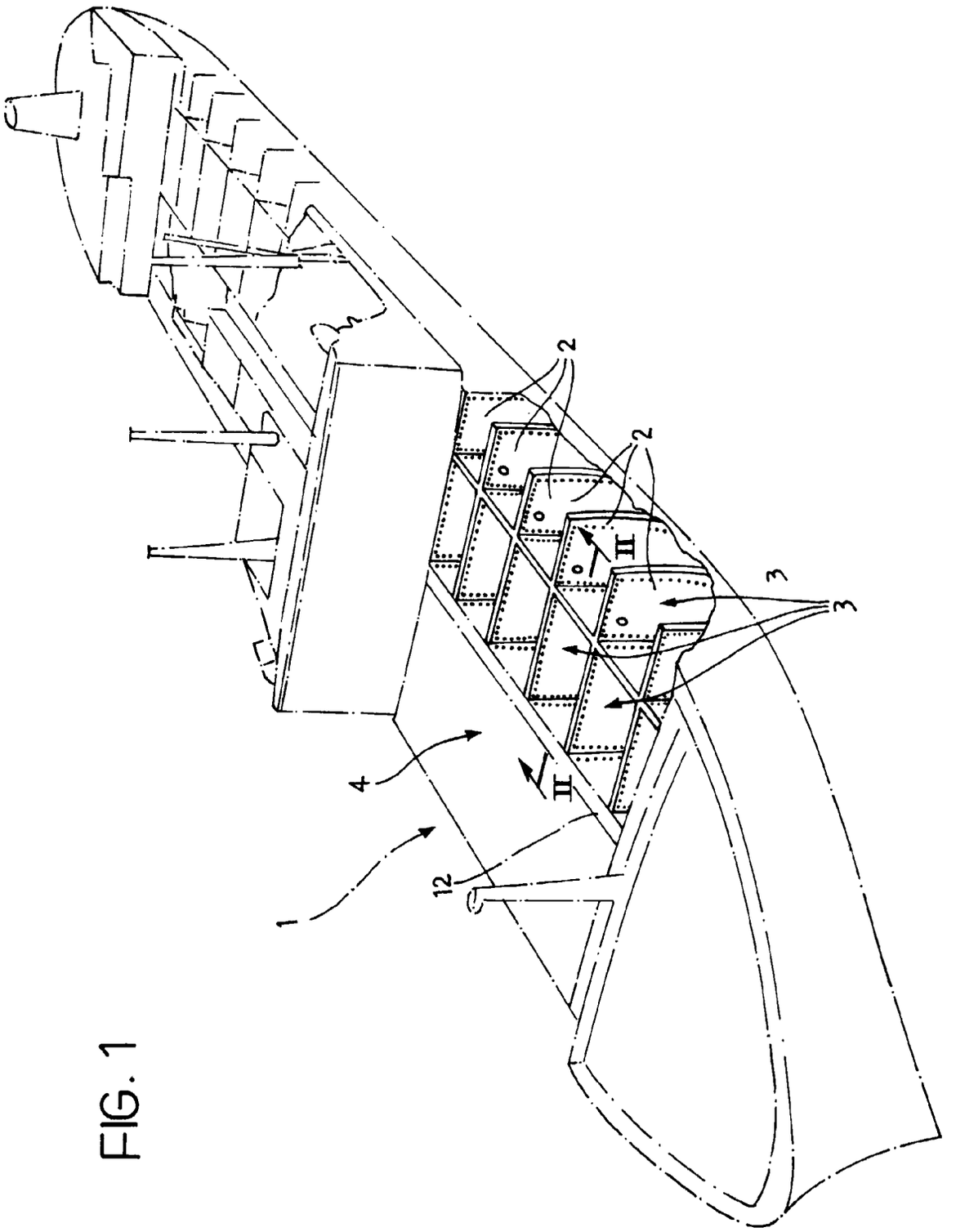

FIG. 1

FIG. 2

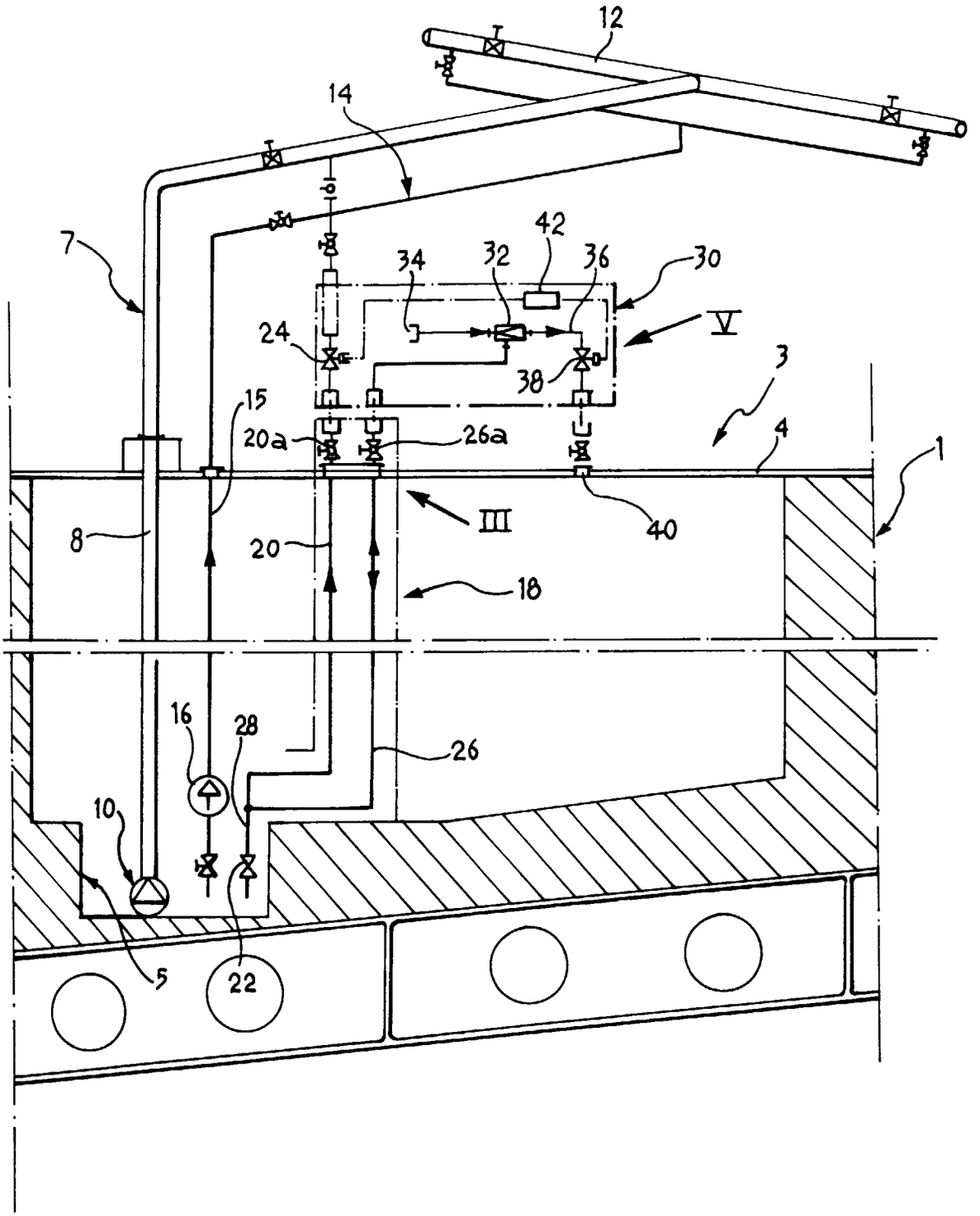
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FIG. 3

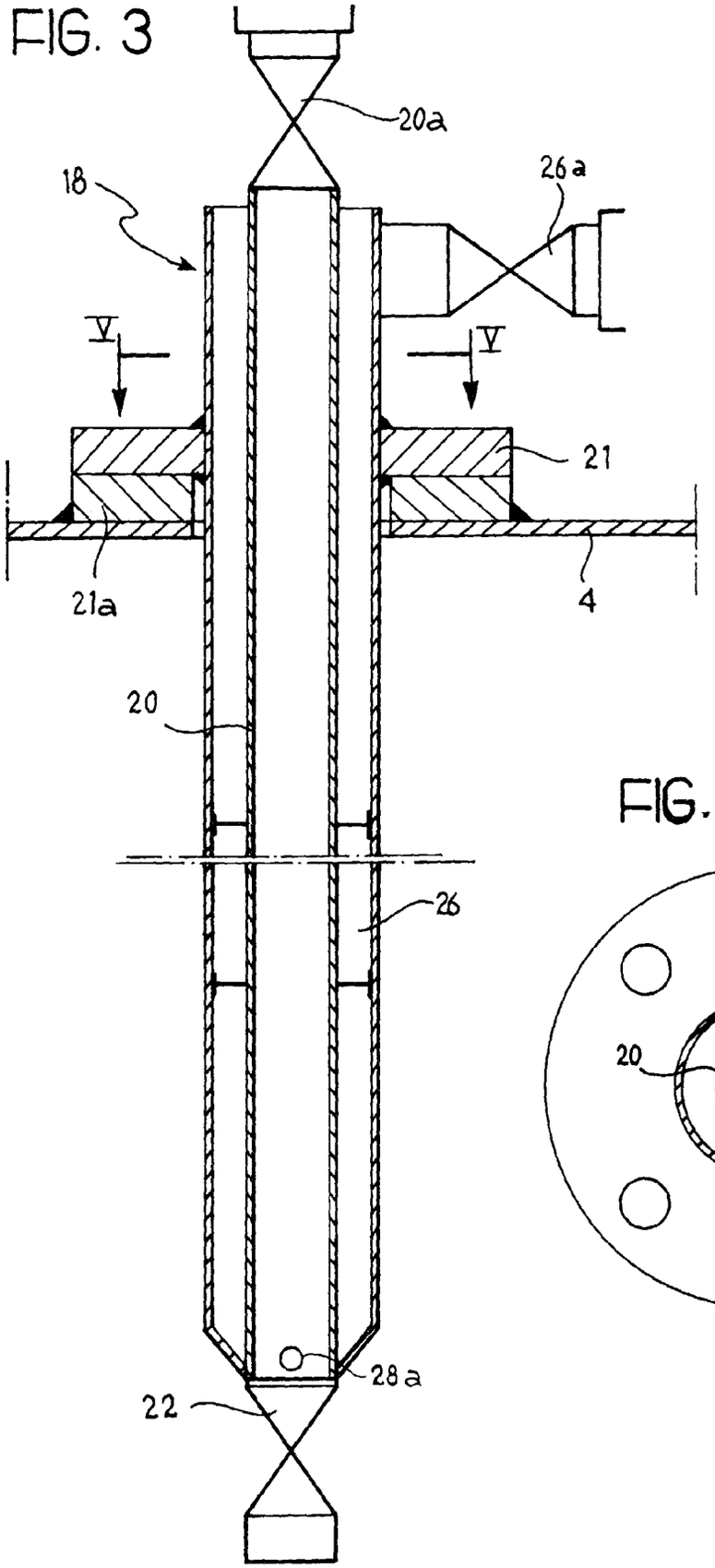
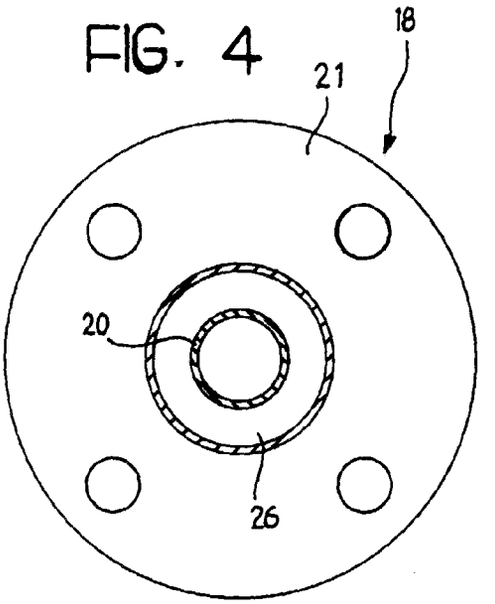


FIG. 4



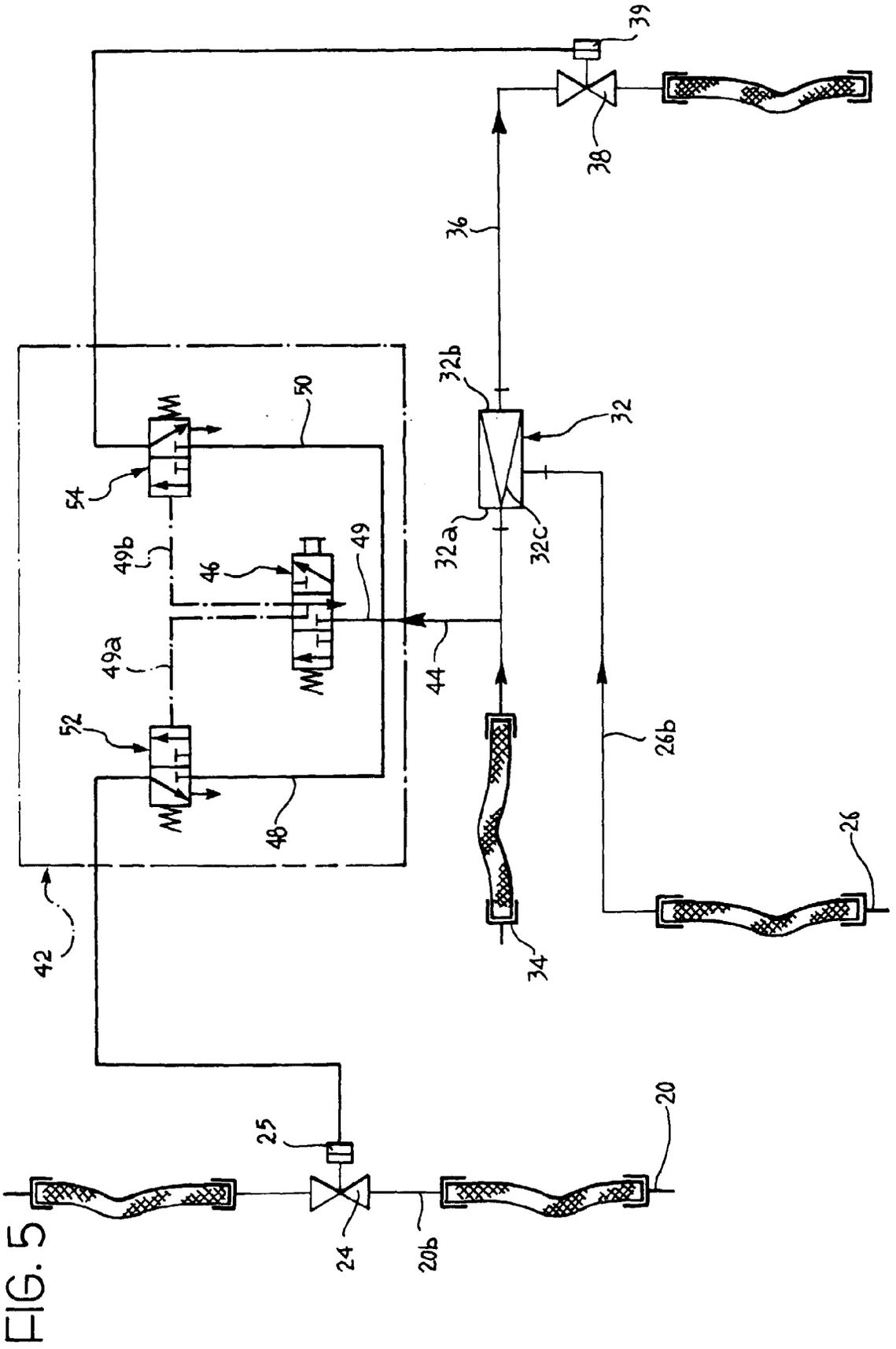

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FIG. 5

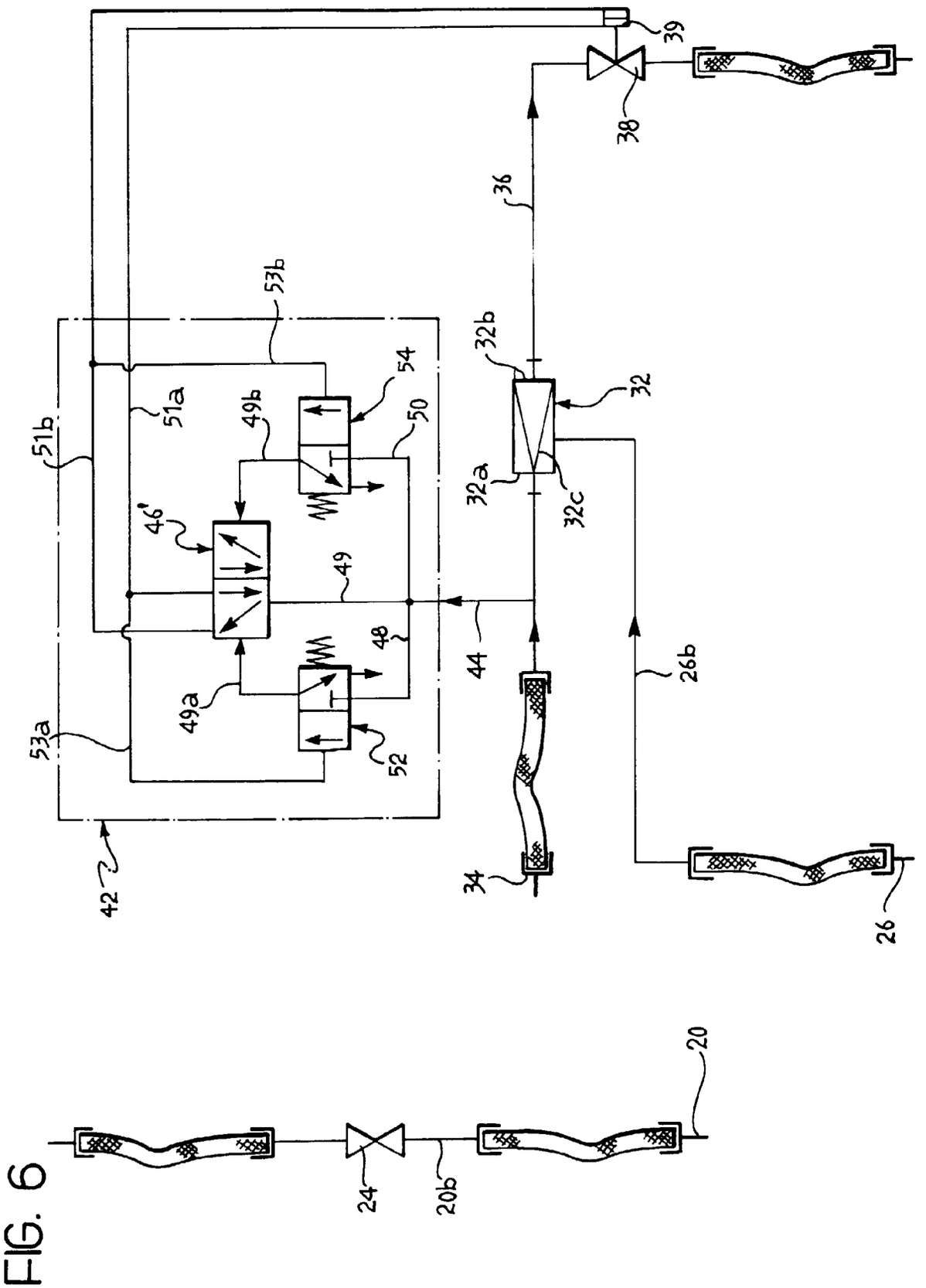
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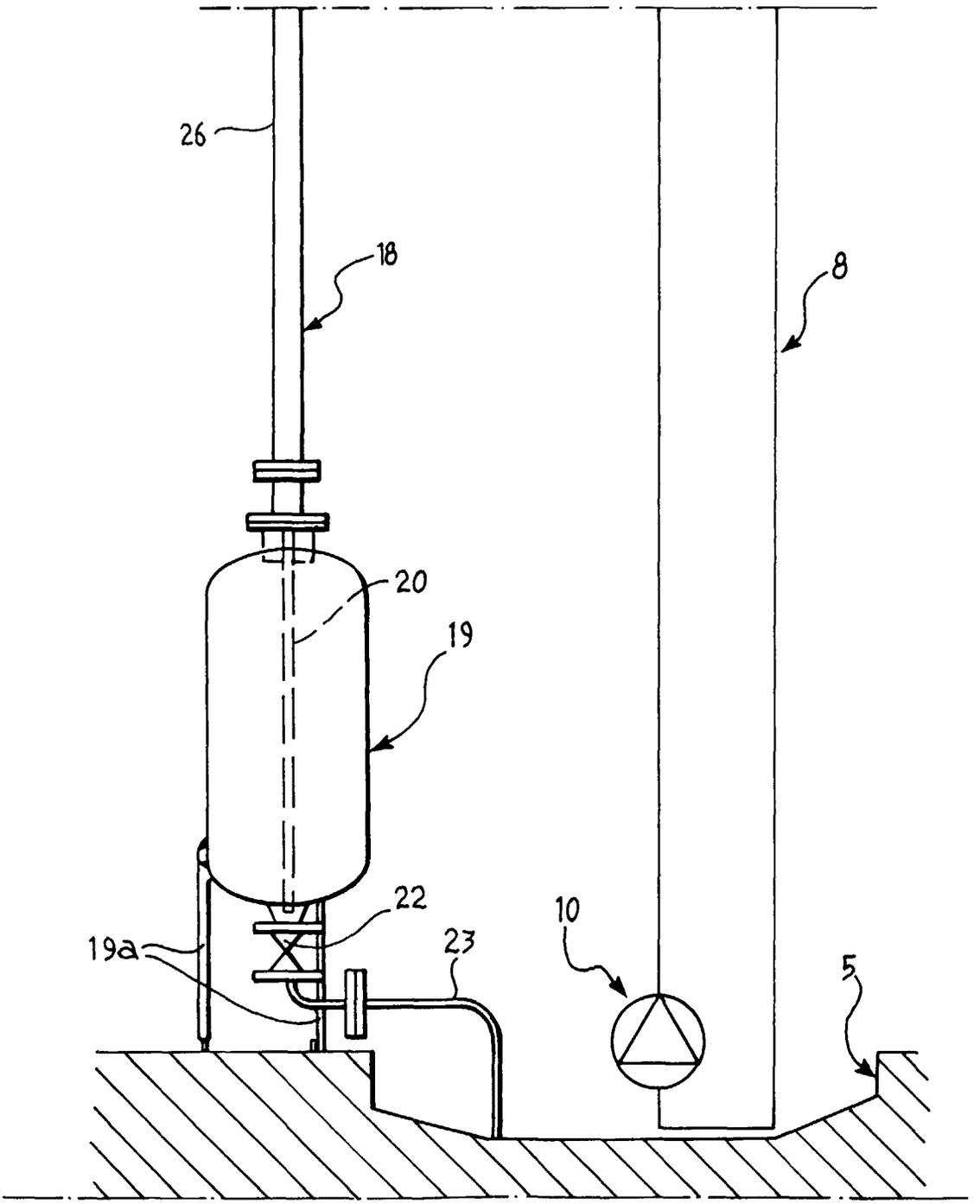
FIG. 6

FIG. 7



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EUROPEAN SEARCH REPORT

Application Number
EP 96 10 0589

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	WO-A-84 01138 (THUNE-EUREKA A/S)	1,7-10, 13,14, 16,17	B63B27/24
A	* abstract; figure 1 *	3,4,11, 15	
A	GB-A-2 022 707 (F.A.HUGHES & CO,LTD) * figures 1-5 *	2,3,5	
A	GB-A-2 044 202 (YAMASHITA-SHINNIHON STEAMSHIP CO,LTD) * page 1, line 99 - line 121; figure 4 *	2,3	
A	GB-A-1 179 469 (KRACHT ET AL) * the whole document *	5,12	
A	GB-A-945 179 (WEIR LTD) * figure 1 *	7	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)

B63B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	15 April 1996	DE SENA, A

CATEGORY OF CITED DOCUMENTS

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D : document cited in the application
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