Jan. 14, 1958 J. LAMB 2,819,676

OIL TANKERS

Filed July 19, 1955 3 Sheets-Sheet 1

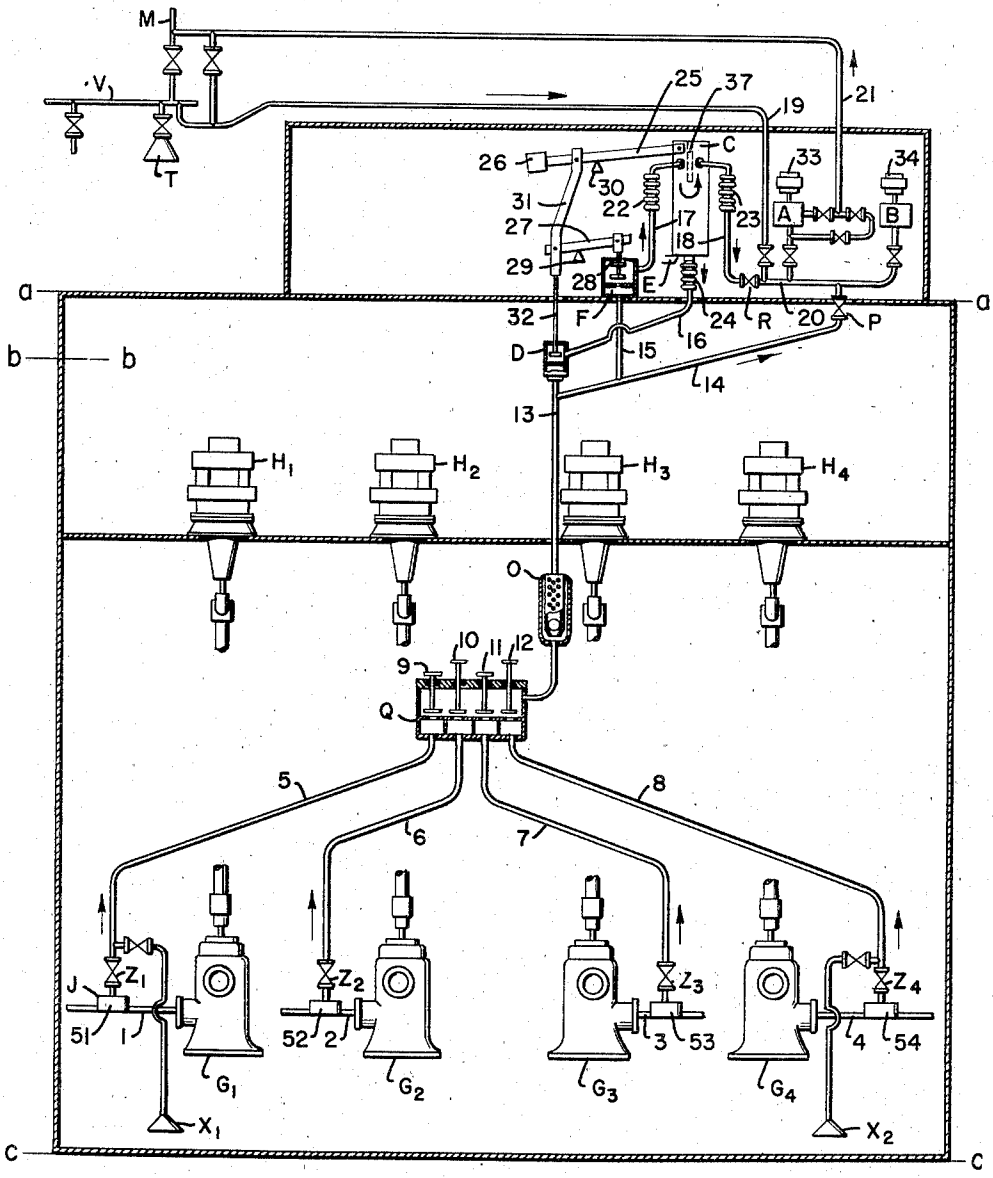


FIG. I

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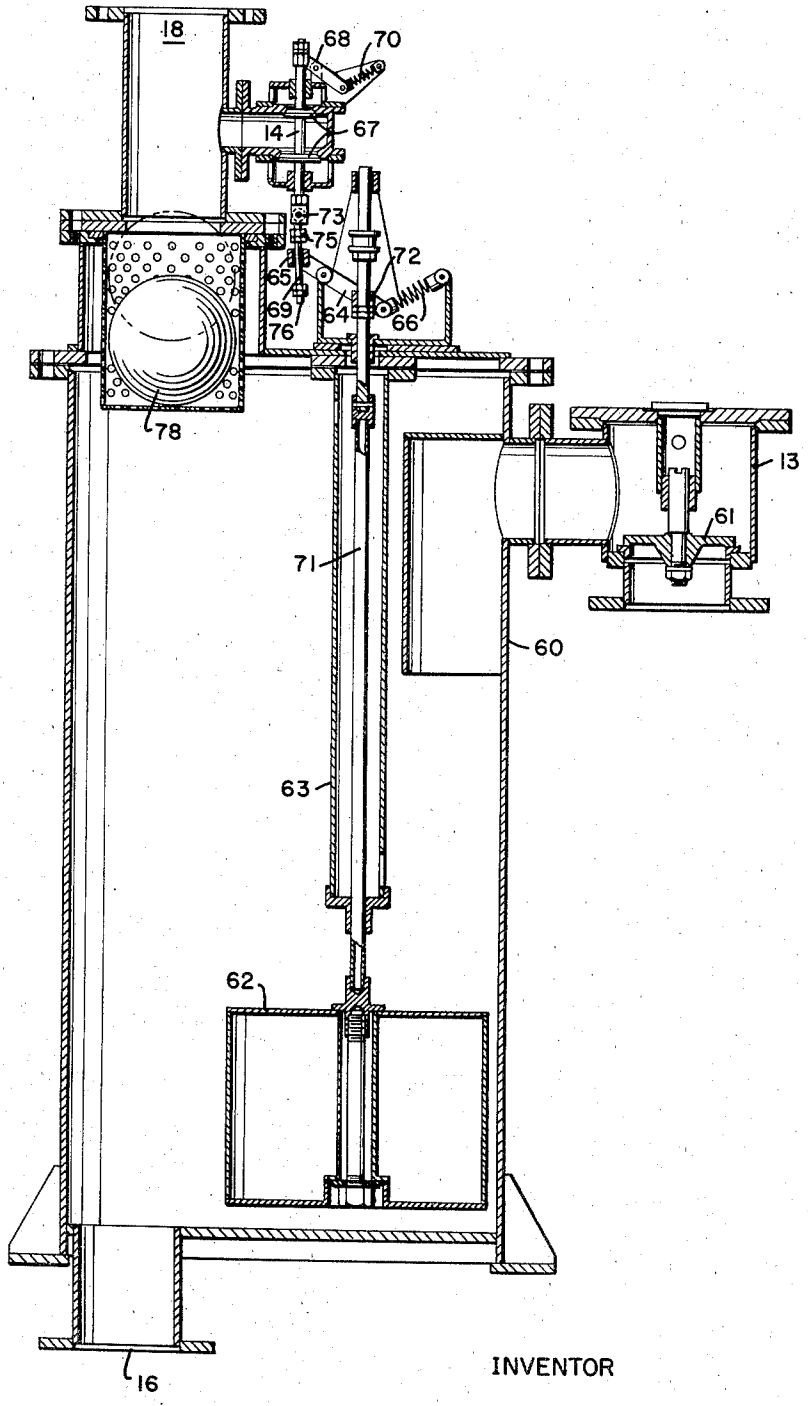


FIG. II

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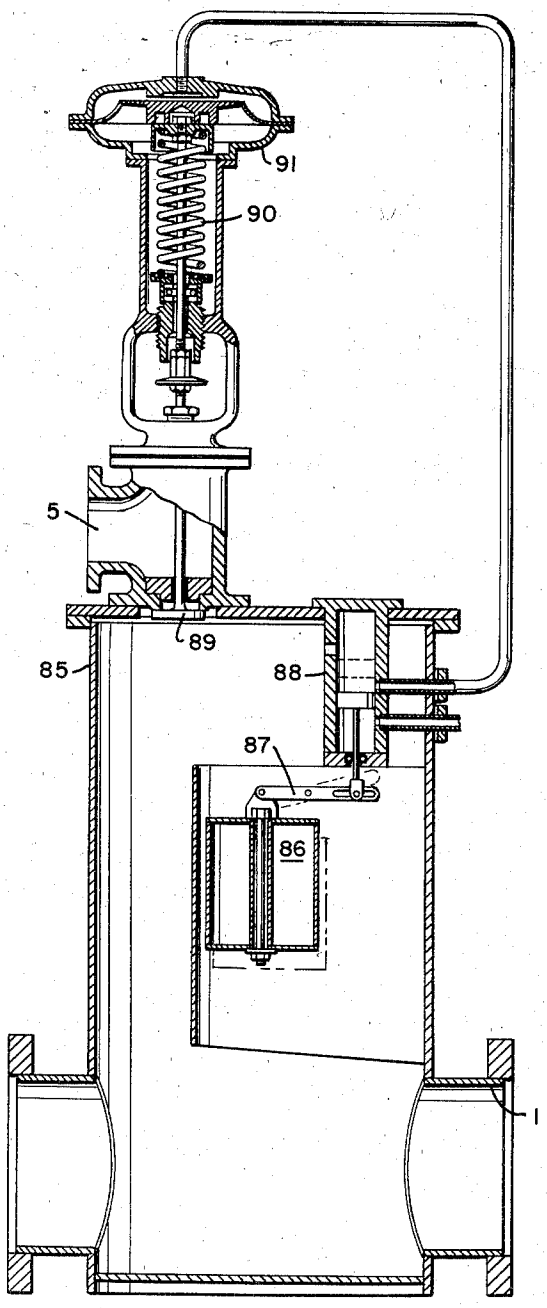


FIG. III

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2,819,676

OIL TANKERS

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Application July 19, 1955, Serial No. 522,993

Claims priority, application Great Britain July 28, 1954

4 Claims. (Cl. 103—113)

This invention relates to oil tankers having centrifugal pumps for handling oil cargo and to the operation of such oil tankers.

The trend of practice in handling oil tanker cargoes is in the direction of increase of speed, e. g. up to 1500 tons per hour, and as a result centrifugal pumps have superseded displacement-type pumps which become inconveniently large when it is a case of handling oil cargo at a rate above 500 tons per hours. Centrifugal pumps are unsatisfactory or even useless when draining oil cargo tanks; they are less effective than displacement-type pumps in dealing with the liquid and gas mixtures encountered in tank draining and become useless when the liquid level falls below the level of the pump impeller. Accordingly, it is the present practice to install displacement-type pumps as auxiliaries to the main centrifugal pumps and to use these displacement-type pumps for tank stripping. These displacement-type pumps are generally two in number and each of about 100 tons per hour capacity in a tanker having four main centrifugal pumps with a total capacity of 1500 tons per hour.

With such an arrangement it is the practice, when discharging cargo from a tank, to stop the centrifugal pump and use the stripping pump when about one foot depth of liquid remains in the cargo tank. This entails delay as, apart from the time required to make the change-over, the balance of the cargo must be discharged at a low rate. Moreover, some time before a depth of one foot is reached the output of the centrifugal pump will have been reduced, thus lowering quite substantially the average discharge rate.

For the gas-freeing of cargo tanks windsails and steam gas ejectors continue to be employed, irrespective of the type of cargo pump employed, while no provision is made to extract the gas from the cargo tanks during loading and so reduce the pressure opposing the flow of cargo into the ship's tanks.

The term "gas" is used herein to include vapor and a mixture of gas and vapor.

According to the present invention, an oil tanker having a centrifugal main-cargo-handling pump or pumps is provided with a gas collector at or near the inlet of the main pump or each of the main pumps and also with a priming pump which can withdraw gas from the gas collectors and thus maintain a sufficient liquid level in the main pump or in each main pump to enable such pump or pumps to be used for stripping.

Further features of the present invention are as follows:

(i) The priming pump is arranged to supply gas, preferably air, to the cargo tanks to assist the discharge of cargo therefrom.

(ii) The priming pump is arranged to withdraw gas from the cargo tanks and discharge it to atmosphere either for gas-freeing a tank or to create a subatmospheric pressure in a tank or tanks to assist in loading cargo.

(iii) The priming pump is arranged to withdraw gas, e. g. foul air, from the pump-room and discharge it to atmosphere.

(iv) There are provided in association with the or each gas collector, automatic means, e. g. a float-controlled valve in the conduit leading from the gas collector to the priming pump, which put the gas collector in communication with the priming pump only when a predetermined amount of gas has accumulated in the gas collector.

The present invention also provides a method of operating an oil tanker wherein draining or stripping of the cargo tanks is effected by a centrifugal pump in combination with a priming pump which operates to assist the free flow of liquid to the inlet of the centrifugal pump.

The present invention further provides a method of gas-freeing cargo tanks and ventilating enclosed spaces such as the tanker pump-room by means of the priming pump as well as a method of cargo handling wherein decreased pressure is established within a cargo tank by means of the priming pump to facilitate loading of cargo and increased pressure is established within a cargo tank by means of the priming pump to facilitate discharge of cargo.

The priming pump may be any type of pump capable of creating a suction of about 10 feet water gauge. When used for certain operations indicated above, e. g. for gas-freeing up to nine cargo tanks simultaneously, it is required to handle a much greater quantity of gas than during other operations, e. g. removing gas from the suction side of one main pump. Accordingly, it is preferred, and this constitutes a further feature of the present invention, to provide a second pump, hereinafter termed a blower, to act in conjunction with the priming pump when larger quantities of gas are to be handled. This blower is preferably a pump of the same type as the priming pump. Still another feature of the present invention is the provision of a series/parallel variable connection between the priming pump and the blower so that these two components may, if desired, act in conjunction to give an increased vacuum as well as increased capacity.

The present invention also includes the novel features and combination of features disclosed in the detailed description set forth below throughout which reference is made to the accompanying drawing.

Figure I is a diagrammatic athwart ship sectional elevation of an oil tanker having centrifugal main cargo handling pumps.

Figure II is a sectional elevation of an alternate form of a liquid trapping apparatus to that included in Figure 1.

Figure III is a sectional elevation of an alternate form of gas accumulator to that included in Figure I.

Figure I shows an oil tanker pump-room having four centrifugal main pumps G_1, G_2, G_3 and G_4 each driven by motors H_1, H_2, H_3 and H_4 respectively situated above the associated pump on the driving unit deck of the engine room in accordance with known practice. The aggregate capacity of the four pumps G_1 to G_4 is, in a particular application of my invention, 1500 tons per hour. The line *a—a* represents the upper deck, which is also the top of the oil cargo tanks. The line *c—c* represents the bottom of the interior of the hull and is also the bottom level of the oil cargo tanks. The line *b—b* indicates the normal cargo level in a full oil cargo tank. It will be noted that, when stripping a cargo tank, the oil level will fall below the level of the impellers of the pumps G_1 to G_4.

Contrary to present practice, no displacement-type pumps are provided for stripping the oil cargo tanks, but a priming pump A is provided together with conduits

which connect it to the suction or inlet connections 1, 2, 3 and 4 of the pumps G_1 to G_4 respectively, to the conventional gas uptake(s) M on the mast(s) and to the conventional cargo vapor line(s) V.

The priming pump A is connected with the main pumps G_1 to G_4 by means of conduit 20, conduit 13, ball valve O, one of the valves 9, 10, 11 or 12 in a 6-inch valve manifold Q and associated conduits 5, 6, 7 or 8. When fulfilling its primary function to enable the main pumps to carry out stripping, the connection between the conduits 20 and 13 takes place through liquid trapping apparatus described in detail below and consisting primarily of a floating receiver C.

An alternative connection by way of conduit 14 controlled by valves R and P is provided between conduits 13 and 20.

Conduit 21 provides a connection between the pump A and a conventional gas uptake M on the mast.

Conduit 19 provides a connection between pump A and a cargo vapor line V.

Gas collectors 51, 52, 53 and 54 are provided in the inlets 1, 2, 3 and 4 respectively close to the pumps G_1 to G_4 and it is with the upper parts of these gas collectors that the conduits 5, 6, 7 and 8 communicate.

Screw-down lift valves Z_1, Z_2, Z_3 and Z_4 are provided near the lower ends of conduits 5, 6, 7 and 8, respectively. Conduits 5 and 8 are connected near their lower ends with bell-mouthed air intakes X_1 and X_2 respectively arranged near the bottom of the hull and each controlled by an associated valve.

A blower B is shown in association with valves which enable it to be either shut off from the system or to add its capacity to that of the priming pump A. The pumps A and B may be operated in either a series or a parallel connection arrangement.

Pump A and blower B are driven by electric motors 33 and 34 respectively.

The liquid trapping apparatus comprises the floating receiver C which has a diameter of approximately 14 inches and a length of approximately 5 feet. It has an internal partition 37 which divides it into two separate chambers over the upper ⅖ of its length. This receiver C is connected to associated fixed conduits 16, 17 and 18 by lightweight flexible lengths of pipe 24, 22 and 23 respectively which are of oil-resisting material and of such a length that they will not substantially restrict free endwise movement of the receiver C over a distance of about 2 inches.

When empty, the receiver C is held in the uppermost position shown by means of a counterweight 26, lever 25 and fulcrum 30. A link 31 pivotally connected to the lever 25 and also connected to links 27, 28 and 32, is arranged to transmit, with the aid of a fulcrum 29, the movement of the lever 25 to valves D and F. The valve D is adapted to handle liquid. The valve F is adapted to handle gas and to provide communication between the conduit 17 on the one hand and, on the other hand, either conduit 15 leading to conduit 13 or to the atmosphere.

With the receiver C in the uppermost position shown, the valve D is closed and the valve F affords communication between conduits 15 and 17. If any liquid enters the receiver C, it accumulates in the bottom thereof, in part as a result of the action of the partition 37, and finally its weight becomes sufficient to overcome the counterweight 26 as well as the resistance of a spring-loading toggle or trip mechanism indicated by E. The receiver C thereupon sinks to its lower position and operates valves D and F so that the valve D is opened to provide communication for liquid between conduits 16 and 13 and the conduit 17 is put into communication with the atmosphere by means of valve F. The liquid in the receiver C then flows back to one of the inlet connections 1, 2, 3 and 4, via conduit 13. Lost-motion connections associated with the operation of the valves D and F ensure that these do not operate until the receiver C suddenly moves downwardly upon overcoming the resistance of the mechanism E. When the receiver C is empty, the counterweight 26 takes control and returns the receiver to its uppermost position. During this upward movement, the lost-motion connections prevent movement of the valves D and F until the final rapid movement of the receiver C, after it has overcome the resistance of the mechanism E, takes place. All parts of this liquid trapping arrangement may be of relatively light construction since it is not called upon to support a pressure which deviates by more than approximately 5 lbs. per square inch above or below atmospheric pressure.

Various functions of the equipment of a tanker according to the present invention will now be described.

When the liquid level in a cargo tank reaches a point at which the liquid fails to flow freely to the pump and/or gas is drawn along the inlet with the liquid, and the capacity of the associated centrifugal main cargo pump is thereby impaired, the priming pump A is started and put into communication with the affected main pump by appropriate manipulation of the associated valve 9 to 12 and the associated valve Z_1 to Z_4, the valves associated with intakes X_1 and X_2 being closed. The priming pump then creates a vacuum on the suction side of the main cargo pump and draws away along the conduit 13 the liberated gas just before such gas reaches the cargo pump. This gas passes through the floating receiver C (valve P being closed and valve R being open) and is normally discharged via conduit 21 and gas uptake M.

During this operation, a certain amount of liquid cargo may be entrained with the gas and this liquid is trapped in the receiver C. When the amount of liquid trapped reaches a certain level, e. g. about 2 feet in the case of most oils, due to the increased weight the receiver moves downwardly against the counterweight 26 and actuates the spring-urged toggle or trip mechanism E as described above. Thus, the valve D is opened and atmospheric pressure is also established in the receiver C by the actuation of the valve F. The trapped liquid accordingly flows down conduit 16 through valve D, conduit 13 and the other appropriate connections, thus returning to the appropriate main cargo pump inlet connection. As the liquid empties from the receiver C, this receiver tends to move slowly upwards. However, the lost-motion connections associated with the valves D and F previously referred to do not transmit any movement to these valves until the receiver is nearly empty, when it overcomes the spring-loaded mechanism E and suddenly returns to its uppermost position.

Conduits 5, 6, 7 and 8 are all inclined at an angle of at least 10° to the horizontal so that any oil cargo left in any conduit will flow back to the associated main pump inlet connection and thus avoid contamination of a subsequent cargo of a different nature.

In the case of highly volatile cargoes, the discharging of cargo is facilitated and the rate of discharge increased for a given capacity of cargo pump if a pressure is produced in the cargo tank. The pressure in such a case is about 2 lbs. per square inch or an equivalent of from 5 to 7 foot head depending upon the specific gravity of the liquid.

The priming pump A will provide this pressure; all that is necessary is to start the priming pump and draw from the pump-room through air intakes X_1 and X_2 and their associated valves, valves Z_1 and Z_4 being closed. By appropriate setting of the valves on the delivery side of the priming pump the air will be directed into the desired cargo tank(s) through the ship's normal vapor line(s) V.

When the level of oil in the cargo tank reaches a point at which gas must be extracted from the main cargo pump inlet connection to prevent a reduction of output, the valves associated with intakes X_1 and X_2 are closed

and one or more of the valves Z_1 to Z_4 opened. Gas instead of air will then be delivered by the priming pump. This gas may be delivered either to the cargo tank or the atmosphere as required.

In addition to expediting discharge of cargo, the pump-room will be maintained free of gas and in a safe condition when supplying air to the cargo tanks.

When it is desired to extract from as many as nine compartments simultaneously, it will be necessary to operate the blower B, the capacity of which is such that it is capable of changing the gaseous contents of nine compartments once every hour, or nine times every hour in the case of one compartment, the assumed average cubic content of each compartment being 20,000 cubic feet.

The gas will be drawn through the cargo tank suction pipeline and discharged to the atmosphere through the uptake M. During this operation, it will be necessary to manually open the vacuum relief valve of the usual pressure/vacuum relief valve combination provided in each cargo tank to remove any pressure opposing the flow of gas to the atmosphere.

As the gas drawn from the cargo tanks during this operation will probably be free from liquid particles it may not be necessary for it to pass through the floating receiver C. Arrangements to by-pass this part of the plant are, therefore, provided. This is effected by simply opening valve P and closing valve R, so that the gas passes along conduit **14**.

The volume of gas to be dealt with in a given time is much greater during this operation and whilst 6-inch lines will suffice for all other operations, the gas-freeing of nine compartments simultaneously calls for a 10-inch line. This increased size and weight of pipes and fittings can be avoided by leading the pipe S into one—not shown—of the main cargo pump uprisers.

To effect the removal of gas from the pump-room all that is necessary is to start the blower and draw gas through the air intakes X_1 and X_2 and discharge to atmosphere through uptake M.

During the loading of cargo the blower B can be made to draw gas through the ship's normal vapor line(s) V and discharge it into the atmosphere through uptake M. At the same time the pressure valve of the pressure/vacuum relief valve combination requires to be held open and the vacuum relief valve must be held closed.

When drawing from three compartments a vacuum of 7 inches water gauge will be produced, so that whenever openings into compartments are uncovered for the taking of samples or ullages, air will flow into the compartment instead of gas being forced out by the incoming cargo. Furthermore, the flow of cargo into the tanks will be assisted by reducing the back pressure a small amount.

In the above-described operations, it will be noted that all gas extraction operations can be carried out without uncovering any opening in the tops of cargo tanks. Moreover, all gas is discharged at mast top level through uptake M.

When air is required to flow into the tanks to replace gas drawn out during the gas-freeing operation, this air may flow through the ship's normal vapor line(s) and air inlet valve(s) T provided for the purpose in addition to, or in place of, flowing through existing fittings such as the pressure/vacuum relief valve combination referred to above. Three such valves T, equally spaced, would be required in an 18,000 ton D. W. tanker to reduce pipe friction to within acceptable proportions.

A double safeguard is provided against the discharge of liquid from the uptake M due to mishandling. The first is the ball float valve O. When gas is passing upwards or liquid downwards through this valve the ball remains at its lowest position, but when liquid rises, the ball floats and closes the conduit **13**.

Communication between the inlet connections **1**, **2**, **3** and **4** and the priming pump A will not be restored until the level of liquid in the cargo tanks falls below the level of the ball float valve. Should the ball fail to follow the level of liquid owing to the suction effect of the priming pump, all that is required to start the plant working is to raise by hand the counterweight **26** when the vacuum in conduit **13** will be "broken." Means are also provided to manually force the ball from its highest to lowest position.

If for some unlikely reason this ball float valve O should fail to act and in the event of the priming pump A being inadvertently started when a cargo tank is full, the pump A will begin drawing liquid into the receiver C which will result in the operation of the valve F and the admission of atmospheric air to the inlet of the pump A. This forms the second safeguard.

In such circumstances, the liquid will not be able to drain from the receiver because the drain pipe will be full of liquid. This being so the valve F will remain closed until the level in the cargo tank has been reduced to the point when the liquid can flow freely from the receiver.

The same double safeguards operate as described above when the pump A is brought into use in the case where a fully laden cargo tank is under gas pressure owing to the normal gas vent valves being inadvertently closed.

In addition to the cargo spaces, all cargo pipelines as well as all gas lines can be cleared of dangerous gases after carriage of volatile cargoes in a safe and efficient manner by this system.

All parts of the equipment described above necessary for proper operation can be tested instantly at any time by simply exerting slight downward hand pressure on the floating receiver C. This will prove on sight that the only three parts likely to be adversely affected by neglect, namely, the floating receiver C, the valve D and the valve F, are in working order.

As mentioned earlier herein, instead of the floating receiver C shown in Figure I, I may substitute a fixed receiver **60** with a moveable float **62** as shown in Figure II. This receiver **60** is connected to the priming pump A by a conduit **18** and to the inlets of the main pumps Z_1, Z_2, Z_3 and Z_4 by conduit **13**. A non-return valve **61** is positioned between the inlet to the receiver and conduit **13**. The bottom of the receiver is connected to a conduit **16** for the return of liquid trapped in the receiver as shown in Figure I. A double or balanced valve **67** is arranged to provide communication with the atmosphere when open. Further details of the fixed receiver **60** are as follows. The float **62** previously mentioned is secured to a rod **71** and is disposed in the receiver **60** near the bottom thereof. A guide **63** for the rod **71** permits a limited up and down movement of the float. A collar **72** on the upper end of the rod **71** is provided with a pin and slot connection to a link **64** which together with spring **66** acts as a spring loaded toggle linkage. One end of the link **64** is pivotally connected to a collar **65** slidably mounted on a rod **69** having an articulated connection **73** with the stem of double valve **67**. The collar **45** is free to move in relation to the rod **69** over a distance set by stops **75** and **76**. This provides a lost-motion connection between the lever **64** and the valve **67** so that the valve **67** can only be moved when the float reaches one of its extreme positions. The valve **67** is maintained either in the open or closed position by means of a toggle linkage formed by a spring **70** and a link **68** having a pin and slot connection with the upper end of the valve stem **74**.

The operation of the fixed receiver **60** is as follows: as liquid accumulates in the receiver **60** the float **62** rises towards its uppermost position and then when the upward force on the rod **71** is sufficient to overcome the downward force exerted by the spring **66**, the rod **71** and the float **62** move rapidly into its uppermost posi-

tion under the combined influence of the buoyancy of the float 62 and the action of the spring 66. This causes the collar 64 to strike the stop 76 and thus suddenly to open the valve 67 against the action of the spring 70. The receiver 60 and the conduit 18 are thus placed in communication with the atmosphere and the vacuum built up by the priming pump A and/or the blower B is destroyed. The liquid accumulated in the receiver 60 accordingly flows down the conduit 16 and back to the inlet of the centrifugal pump.

As the liquid leaves the receiver 60 the float 62 moves downward until the weight of the float 62 and rod 71 overcomes the upward force exerted by the spring 66 and then the toggle linkage formed by link 64 and spring 66 suddenly reverts to the position shown in Figure II and the float 62 drops to its lower position. As a result of this the collar 65 strikes the stop 75 and closes the valve 67. The priming pump A and/or the blower B can now re-establish a vacuum in the receiver 60 and withdraw further gas through conduit 13. A ball float valve 78 is provided as a safety device in the inlet to conduit 118. If for any reason the float 62, the valve 67 and the associated linkages become inoperative and the reeciver 60 fills with liquid, the ball float valve will close the end of the conduit 18 thus preventing any liquid from reaching the priming pump A or the blower B or the vents connected with the.

Instead of the gas collectors 51, 52, 53 and 54 as shown in Figure I, I may substitute the form of gas collector shown in elevation in Figure III. Each gas collector comprises a cylindrical casing 85 in open communication at its lower end with the suction or inlet connection of one of the centrifugal pumps.

The construction and operation of the gas collector of Figure III will be described in relation to centrfiugal pump G_1 of Figure I. The upper end of the casing is closed and is provided with a valve 89 which is held closed by a spring 90. The valve 89 controls communication with the conduit 5. Within the casing 85 there is located a float 86 which is articulately connected with a lever 87. The lever 87 is in turn connected with a control valve 88 whereby compressed air is employed to exert a pressure upon the valve controller 91 which in turn opens the valve 39 against spring pressure.

As will be seen, movement of the float to the uppermost position shown in full lines in Figure III causes the air pressure to be released and permits the spring 90 to close the valve 89. Movement of the float to the lower position indicated in broken lines in Figure III causes valve 89 to be opened against the action of the spring 90.

Under the conditions most frequently existing, the casing 85 will be full of oil, the float 86 in the uppermost position and the valve 89 closed. When, however, gas is entrained with the oil passing through the suction or inlet connection 1 this gas will accumulate within the casing 85 reducing the liquid level therein until it is such to cause the float 86 to assume its lower position. Thereupon the valve 89 is opened by means of the valve controller 91 and the priming pump A and/or blower B will withdraw the accumulated gas through the conduit 5. The resulting rise of the liquid level in the casing 85 will return the float 86 to its uppermost position and thus result in the closing of the valve 89. By this means the load on the priming pump A and/or blower B is reduced and the possibility of liquid reaching the liquid receiver C or 60 minimized.

It will thus be seen that I may use either a floating type of liquid receiver C or a fixed type 60 as shown in Figure II and that I may use a gas accumulator as shown at 51 in Figure I or a float containing type as in Figure III. In the design of this system it will be seen that every precaution is taken to prevent the discharge of liquid from the vents such as M.

I claim as my invention:

1. In a liquid pumping system for tankers having a main centrifugal pump and a vacuum pump connected in parallel section relationship the combination of: a suction strum, an inlet to said centrifugal pump, a duct connecting said suction strum to said inlet, an inlet to said vacuum pump, a duct connecting said suction strum to said vacuum pump inlet, an elevated receiver having an elevated inlet in said duct connecting said suction strum to said vacuum pump inlet, a float in said receiver, a non-return valve positioned between the inlet to said receiver and said suction strum, an outlet in the bottom of said receiver said outlet being connected to the inlet of said centrifugal pump, an air valve in the top of said receiver and a toggle switch connected to said float and to said air valve so constituted and arranged that a movement of said float to the limit of its travel results in a snap closing or opening of said air valve.

2. In a liquid pumping system for tankers having a main centrifugal pump and a vacuum pump connected in parallel the combination of: a suction strum, a chamber having an inlet connected to said suction strum, a main line from said chamber connected to said centrifugal pump, an elevated second line from said chamber connected to said vacuum pump, a float valve in said chamber controlling the opening to said second outlet, a receiver connected between said second outlet and said vacuum pump and valve means including a trip mechanism connected to said receiver whereby gas under atmospheric pressure may be admitted to said receiver upon a predetermined amount of liquid accumulating therein.

3. A liquid pumping system for tankers comprising: a main centrifugal cargo pump, an inlet to said cargo pump, a vacuum pump connected to said inlet for the removal of gas from said inlet, an elevated receiver vessel connected to said inlet for the accumulation of entrained liquid, valve means including a float operated trip mechanism in said receiver to admit gas under pressure to said receiver and allow all the accumulated entrained liquid to return to said inlet upon the amount of said liquid in said receiver reaching a pre-set quantity.

4. In a liquid pumping system for tankers having tanks for liquid cargo comprising: centrifugal cargo pumps situated near the bottom of said tanks, inlets to said pumps, a vacuum pump situated above the top liquid level of said tanks for liquid cargo, gas accumulators connected to each of said cargo pump inlets, gas outlets from said accumulators, float valves connected to and controlling each of said gas outlets, a liquid receiver situated above the top liquid level of said cargo tanks, an elevated gas inlet to said receiver, a duct joining said gas outlets to the gas inlet of said liquid receiver, a float in said receiver, lost-motion link mechanism connected to and operated by said float, a valved air inlet to said receiver connected to and responsive to said lost-motion link mechanism, a bottom outlet in said receiver for returning liquid to said cargo pump inlets, a top outlet in said receiver, a duct leading from said top outlet to said vacuum pump and a float-operated valve in said top outlet to prevent liquid from reaching said vacuum pump.

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