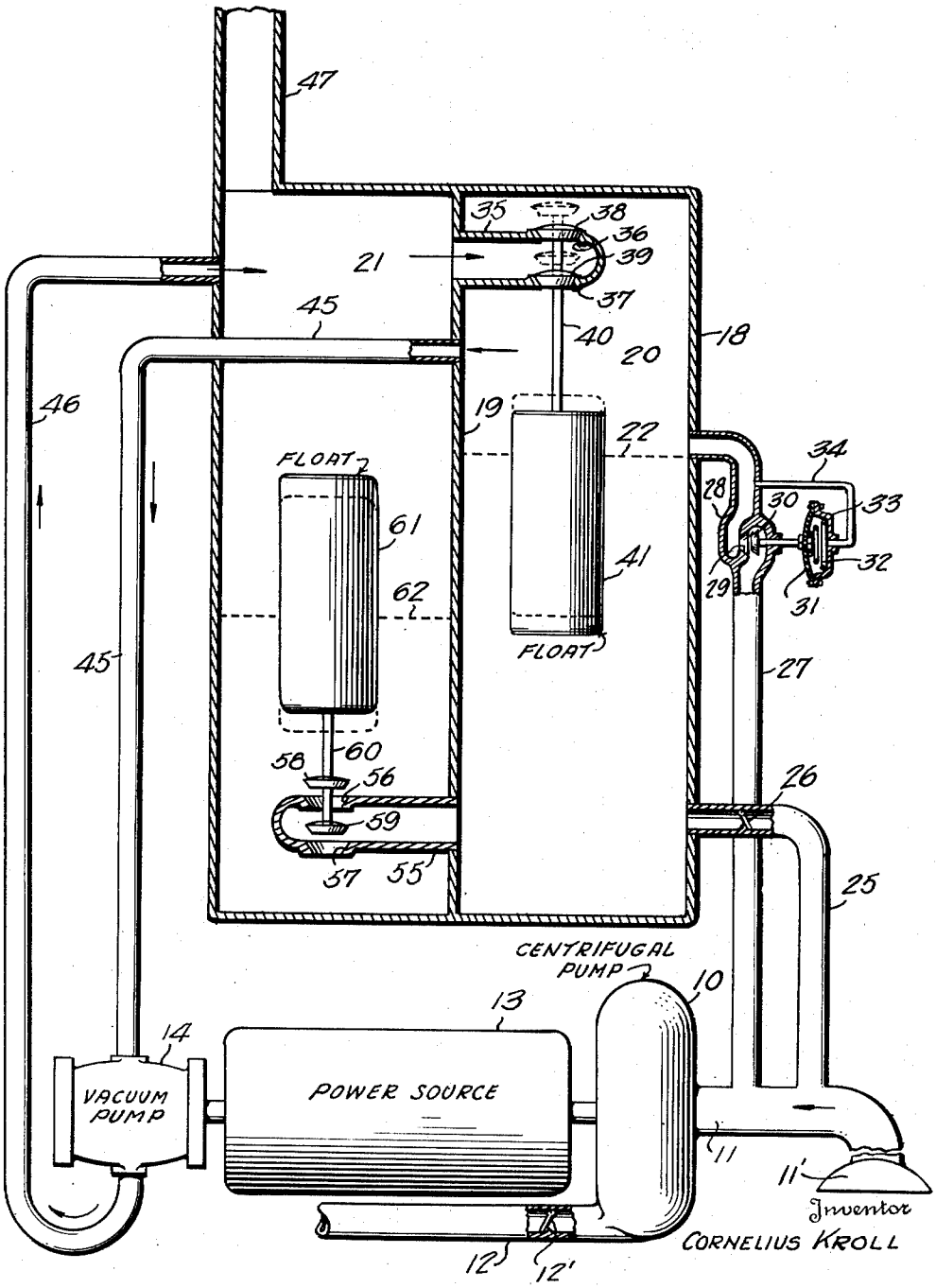
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PUMPING SYSTEM

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PUMPING SYSTEM

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This invention relates to pumping systems.

In certain pumping systems, for example in systems used for pumping gasoline from tank barges, it is desirable to use a pump installed on the deck of the tank barge for safety and elimination of fire hazard and to use a centrifugal pump because of its relatively large capacity. However, such pump creates a negligible suction lift until the pump itself is completely filled with liquid. In such a system, therefore, it is necessary to prime the pump and maintain the prime so that it will properly function. In pumping volatile liquid, vapor locks sometimes occur in the system, causing the pump to lose its prime. When the level of the liquid being pumped nears the bottom of the tank, a certain amount of air is entrained with the liquid which also causes a pump to lose its prime.

An important object of the present invention is to provide a novel pumping system wherein means is employed for establishing the initial priming and maintaining such priming of the liquid pump whereby such priming is effected without the necessity for having to resort to manual priming.

A further object is to provide such a system wherein the use of a centrifugal liquid pump is rendered practicable by the use of an auxiliary priming system including a vacuum pump which effects the initial and continuing flooded suction necessary for its normal operation.

Other objects and advantages of the invention will become apparent during the course of the following description.

In the drawing I have shown one embodiment of the invention. In this showing:

The figure is a sectional-diagrammatic representation of the system, parts being shown in elevation and parts being broken away.

Referring to the drawing, the numeral 10 designates a conventional pump, preferably of the centrifugal type because of its relatively large capacity. The use of this type of pump is particularly subject to difficulty under certain conditions and this difficulty is overcome with the present system, rendering it fully practicable to employ a centrifugal pump. The pump 10 is provided with an inlet duct 11 one end of which extends downwardly into the liquid to be pumped and may be provided at its lower end with a bell mouth 11'. Liquid flows through duct 11 in the direction of the arrow into the pump to be pumped therefrom through an outlet pipe 12 provided with a check valve 12', to any suitable point. The pump 10 is driven by an engine or

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other power source 13, and this source also drives a vacuum pump 14 for a purpose to be described.

A tank 18 is divided transversely by a vertical wall 19 to form chambers 20 and 21. The chamber 20 is adapted to contain a body of a liquid which may be at the level indicated by the line 22, this level being maintained in a manner to be described.

A duct 25 has its one end tapped into the intake duct 11 and has its other end opening into the chamber 20 and is provided with a check valve 26 opening outwardly relative to the chamber 20. The check valve 26 functions to permit the flow of liquid from the chamber 20 into the inlet duct 11 under certain conditions to be described, but prevents any flow of liquid into the chamber 20, at this point.

A second pipe 27 is tapped into the duct 11 and has its other end communicating with the chamber 20 above the liquid level 22 therein. Within the length of the pipe 27 is arranged a valve casing 28 having a seat 29 engaged by a valve 30 connected to a diaphragm 31 and urged to closed position by a spring 32. This spring may be arranged within a casing 33. Casing 33 is connected by a pipe 34 to the pipe 27 above the valve 30, thereby subjecting the interior of the casing 33 to the pressure of the chamber 20 for a purpose to be described.

The wall 19 is provided near the top of the chambers 20 and 21 with a duct 35 in open communication with the chamber 21. The other end of this duct is closed, and the top and bottom of the duct are provided with valve seats 36 and 37 respectively engageable by valves 38 and 39. These valves are carried by a depending stem 40 to the lower end of which is connected a float 41. This float rises and falls with the level of the liquid in the chamber 20 and assists in determining the level of such liquid as will become apparent.

A duct 45 opens into chamber 20. This duct is connected at its other end to the intake side of the vacuum pump 14 whereby the latter exhausts gaseous fluids from the chamber 20. The outlet of the pump 14 is connected by a duct 46 to the upper part of the chamber 21. The arrows associated with the ducts 45 and 46 indicate the direction of flow of gaseous fluids through these ducts. Chamber 21 is open to the atmosphere, preferably through a vertically extending vent duct 47.

A duct 55 has one end opening into the chamber 20 and has its other end, within the chamber 21 closed, as shown. The duct 55 is provided

with upper and lower ports 56 and 57 forming valve seats respectively engageable by valves 58 and 59. These valves are carried by an upwardly extending stem or rod 60 to the upper end of which is connected a float 61 to prevent the accumulation of liquid in the chamber 21 above approximately the level indicated by the numeral 62.

The operation of the apparatus is as follows:

It will be understood that the representation of the invention in the drawing is largely diagrammatic and the pump 10 and associated elements are not necessarily below the tank 18. As a matter of fact, in most installations, the two parts of the apparatus referred to will be arranged side by side, for example on the deck of a tank barge, and the invention will be particularly described as to its operation on the assumption that the parts are so arranged. Under such conditions, for a reason which will become apparent, the liquid level 22 will be arranged from 30 to 36 inches above the inlet of pump 10.

Assuming that the apparatus has been set up on the deck of a tank barge as described and operation is about to start, the valves 38 and 39, and 58 and 59 will be in closed position, there being no liquid in either of the chambers 20 and 21. The check valve 26 will occupy its normal closed position. Inasmuch as atmospheric pressure will be present in the chamber 20, the spring 32 will hold the valve 30 on its seat. This spring is relatively light and accordingly the valve 30 closes at or slightly below atmospheric pressure.

The motor 13 is now started in operation to drive the pump 10 and the vacuum pump 14. A negligible dropping of the pressure in the inlet 11 will occur through the operation of the pump 10 since no liquid will be present therein. However, the vacuum pump 14 constantly exhausts air from the chamber 20 and exhausts it into the chamber 21 at atmospheric pressure for release through the stack 47. All of the valves shown in the drawing will be closed, as previously stated, and the operation of the vacuum pump 14 reduces the pressure in the chamber 20 to create a partial vacuum therein. This partial vacuum holds the valve 26 on its seat, but creates differential pressures on opposite sides of the diaphragm 31 to move the latter against the tension of the spring 32 to open the valve 30.

The partial vacuum in the chamber 20 will be communicated to the pipe 27, thence through the inlet duct 11 to the lower end of such duct below the level of the liquid to be pumped. Atmospheric pressure acting on the surface of such liquid will then force it upwardly into the duct 11 to pump 10, and through pipe 27 into the chamber 20. As soon as the quantity of the liquid is sufficient to flood the suction of the pump 10 it will be fully primed. The normal operation of this pump will thus be initiated and liquid will be pumped in the usual way.

The valves 38 and 39 being closed, no air will be admitted through the duct 35 into the chamber 20. The level of the liquid in this chamber accordingly will rise until the float 41 lifts the valves 38 and 39 from their respective seats 36 and 37. This operation admits air or gaseous fluid at atmospheric pressure into the chamber 20 to limit the decrease of pressure therein until a pressure balance is reached at which the liquid level will be maintained at the point 22. Any tendency for the liquid level to rise will result in opening the valves 38 and 39 to a slightly greater extent thus further limiting the decrease of pressure in the chamber 20. Any tendency of the liquid level 22 to drop will result in closing the valves 38 and 39 completely or to a greater extent, thus decreasing the pressure in chamber 20 on account of the increased rate of exhaustion of air or gaseous fluid from chamber 20 through pipe 45 relative to the admission of air through duct 35. This will result in lowering the pressure in the chamber 20 to maintain the level 22.

The partial vacuum necessary in the chamber 20 for maintaining the liquid level 22 will depend upon the difference in the level 22 and the level of the liquid in the barge tank. For example, the pressure head existing between these two liquid levels at the starting of the pumping operation will be less than will be present as pumping progresses, and such progressively increasing pressure head requires a progressive lowering of the pressure in the chamber 20. This is automatically compensated for by the operation of the valves 38 and 39 by the float 41. Obviously, as the pressure head referred to increases, there will be a tendency for the liquid level 22 to drop, and this will be accompanied by a lowering of the valves 38 and 39 to points closer to the closed positions of the valves. This reduces the rate of admission of air or gaseous fluid at atmospheric pressure to the chamber 20 in proportion to the exhaustion of air through pipe 45, thus automatically maintaining the proper sub-atmospheric pressure to hold the liquid level 22.

Assuming that the apparatus is used for the pumping of volatile liquids, it will be obvious that some gaseous fluids and some entrained liquid will pass through the pipe 45, vacuum pump 14 and pipe 46 into the chamber 21. Such vapors will condense and entrained liquid will accumulate in the chamber 21, which is always at atmospheric pressure, and the condensation and entrainment will collect in the chamber 21. Upon the accumulation of sufficient liquid in chamber 21, the float 61 will raise the valves 58 and 59 to permit the liquid to flow through the duct 55 into the chamber 20. This flow is effected quite readily in view of the fact that pressure in the chamber 21, during normal operation of the apparatus, is always greater than pressure in the chamber 20.

From the foregoing it will be apparent that the present system is highly advantageous for initiating the operation of a centrifugal pump for pumping liquid wherein the pump is arranged above the highest level of the liquid to be pumped. However, the system is not limited to such use, as further described below.

It will be recalled that the maintenance of a partial vacuum in the chamber 20 normally maintains differential pressures on opposite sides of the diaphragm 31 to hold the valve 30 in a normal open position. Assuming that a vapor lock occurs in the inlet duct 11, the vapor will move to and thence upwardly through the duct 27 into the chamber 20. The device thus acts to remove such vapors from the line 11. The constantly operating vacuum pump 14 continuously removes such vapors to maintain such partial vacuum in charmber 20 as will maintain a constant liquid level 22, thus maintaining a continuously flooded suction of pump 10.

Thus the system operates to tend to maintain the pump continuously by removing from the intake line 11 the vapors which tend to cause the pump to lose its prime. The check valve 26 obviously opens to permit the flow of liquid from

chamber 20 tending to collect therein in an excessive amount either from discharges of chamber 21 or from the normal surges and entrainment in chamber 20 incident to the pressure balancing operation of float 41 and valves 38 and 39. In other words, upon an excessive accumulation of liquid in the chamber 20, or upon a drop in pressure therein incident to the flow of gas thereinto, the head of liquid in the chamber 20 causes the check valve 26 to open and permit the flow of liquid through pipe 25 into the inlet pipe 11. Moreover, the check valve 26 prevents the flow of liquid from the inlet duct 11 into the chamber 20, thereby forcing all liquid that enters the chamber 20 to flow through duct 27 and the control valve 29 in such duct.

The control valve 30 closes approximately at atmospheric pressure while the check valve 26 remains normally closed. This arrangement not only permits the system to be used under the conditions described above, that is, with the mechanism arranged wholly above the highest level of the liquid to be pumped, but also permits the use of the apparatus where the operation is started with the level of the liquid to be pumped above the intake of the pump 10. Such a condition exists, for example, when the pump is installed in a tanker. In such a ship, the pump is set below the deck and as close to the bottom of the ship as possible. When the pump is started, therefore, its intake is flooded and accordingly no priming is necessary.

Under the conditions referred to the priming vacuum otherwise maintained in the chamber 20 is neutralized by the maintenance of the valves 38 and 39 in open position by the float 41, the initial operation of the apparatus resulting in creating a partial vacuum in the chamber 20 to open the valve 30 for a sufficient length of time for liquid to flow through the pipe 27 into the chamber 20 until the liquid level 22 reaches the point where the float 41 will maintain the valves 38 and 39 in partially open position. When these valves reach a sufficiently open position, approximately atmospheric pressure will be present in the chamber 20 and the spring 32 will close the valve 30. No further liquid can then flow into the chamber 20, the valve 30 being closed and the valve 26 obviously preventing any flow of liquid through the pipe 25.

However, when the level of the liquid in the tank is pumped down to the point where it drops below the intake of the pump 10, the present system comes into operation to maintain a flooded pump intake. When the liquid level in the tank is pumped down to a point below the level of the intake of pump 10 reducing the pressure at the intake of pump 10 to below atmospheric pressure, some of the liquid in the tank 20 will flow downwardly through pipe 25 into the duct 11 until the valves 38 and 39 partially or completely close. Air or gaseous fluid being continuously evacuated from chamber 20 by vacuum pump 14 will then cause the pressure in chamber 20 to decrease below atmospheric pressure opening the valve 30 and creating the necessary vacuum in the pipe 11 to lift the liquid to the pump 10 and maintain the priming thereof, all as hereinbefore described.

The use of double valves 38 and 39 and 58 and 59 is essential for the purpose of balancing the forces to which the valve stems are subjected to render the valves readily operable by their associated floats. For example, the sub-atmospheric pressure normally present in the chamber 20 will cause a thrust on the face of valve 38 in the opposite direction to that on the face of the valve 39, and accordingly the sub-atmospheric pressure will be balanced as to these valves, since they are attached to the same stem. The same situation exists as to the valves 58 and 59, and the two sets of double valves accordingly are completely sensitive to operation of the associated floats.

The system is particularly highly effective for the pumping of volatile and non-volatile liquids from barges and tankers, and it has been found that its operation greatly reduces the time required for such a pumping operation. This system is also effective in what is known as "stripping" the tanks by which is meant the practically complete pumping out thereof. By placing the bottom intake of pipe 11 with a suitable bell-mouth very close to the bottom of the tank, the tanks can be completely stripped, since the air or gaseous fluid entrained with the liquid when the last part of the liquid is being sucked up into the pipe 11 does not cause the pump 10 to lose its prime. Such entrained air or gaseous fluids are continuously removed from the suction intake of pump 10 by this system as rapidly as such air or gaseous fluids are entrained or accumulated.

I claim:

1. In a liquid pumping system comprising a pump having an outlet duct and an inlet duct adapted for connection with a source of liquid to be pumped, a chamber, a branch duct connecting said chamber to the inlet duct of the pump, means operative wholly independently of the pumping effect of said pump for maintaining a level of liquid from said source in said chamber above the inlet duct of the pump, and means operative upon a predetermined increase in the pressure in said chamber for closing said branch duct.

2. In a liquid pumping system comprising a pump having an outlet duct and an inlet duct adapted for connection with a source of liquid to be pumped, a chamber, a branch duct connecting said chamber to the inlet duct of the pump, a vacuum pump connected to said chamber for causing a reduction in pressure in the inlet duct of the pump and for causing a flow of liquid into said chamber, means for controlling the quantity of liquid in said chamber to maintain the level thereof at a point above the inlet duct of said first named pump, and means operative upon a predetermined increase in the pressure in said chamber for closing said branch duct.

3. In a liquid pumping system comprising a pump having an outlet duct and an inlet duct adapted for connection with a source of liquid to be pumped, a chamber, a branch duct connecting said chamber to the inlet duct of the pump, a vacuum pump connected to said chamber for causing a reduction in pressure in the inlet duct of the pump and for causing a flow of liquid into said chamber, float controlled means in said chamber for governing the admission of air thereinto to maintain in said chamber the necessary sub-atmospheric pressure to maintain said level of the liquid therein, and means operative upon a predetermined increase in the pressure in said chamber for closing said branch duct.

4. In a liquid pumping system comprising a pump having an outlet duct and an inlet duct adapted for connection with a source of liquid to be pumped, a chamber, a branch duct connecting said chamber to the inlet duct of the pump, means operative wholly independently of the pumping effect of said pump for maintaining a

level of liquid from said source in said chamber above the inlet duct of the pump, a valve for controlling communication through said branch duct, means biasing said valve to closed position, and differential fluid pressure operated means comprising a pressure responsive element connected to said valve and having one face subject to sub-atmospheric pressure in said chamber to maintain said valve open when the pressure in said chamber decreases to a predetermined point.

5. In a liquid pumping system comprising a pump having an outlet duct and an inlet duct adapted for connection with a source of liquid to be pumped, a chamber, a branch duct connecting said chamber to the inlet duct of the pump, a vacuum pump connected to said chamber for causing a reduction in pressure in the inlet duct of the pump and for causing a flow of liquid into said chamber, means for controlling the quantity of liquid in said chamber to maintain the level thereof at a point above the inlet duct of said first named pump, a valve for controlling communication through said branch duct, means biasing said valve to closed position, and differential fluid pressure operated means comprising a pressure responsive element connected to said valve and having one face subject to sub-atmospheric pressure in said chamber to maintain said valve open when the pressure in said chamber decreases to a predetermined point.

6. In a liquid pumping system comprising a pump having an outlet duct and an inlet duct adapted for connection with a source of liquid to be pumped, a chamber, a branch duct connecting said chamber to the inlet duct of the pump, a vacuum pump connected to said chamber for causing a reduction in pressure in the inlet duct of the pump and for causing a flow of liquid into said chamber, float controlled means in said chamber for governing the admission of air thereinto to maintain in said chamber the necessary sub-atmospheric pressure to maintain said level of the liquid therein, a valve for controlling communication through said branch duct, means biasing said valve to closed position, and differential fluid pressure operated means comprising a pressure responsive element connected to said valve and having one face subject to sub-atmospheric pressure in said chamber to maintain said valve open when the pressure in said chamber decreases to a predetermined point.

7. In a liquid pumping system comprising a centrifugal pump having an outlet duct and an inlet duct adapted to be connected to a source of liquid to be pumped, and a check valve for preventing reverse flow of liquid through said pump, a chamber having a branch duct connected to said inlet duct, a constantly-operating vacuum pump connected to said chamber to tend to maintain sub-atmospheric pressure therein to reduce pressure in said inlet duct and to effect a flow of liquid into said chamber, a float in said chamber, an atmospheric valve connected to said float to be opened upon upward movement of the float and closed upon downward movement thereof to maintain in said chamber the proper sub-atmospheric pressure necessary to maintain liquid in said chamber at a predetermined level above said inlet duct, and valve means for closing said branch duct upon an increase in pressure in said chamber approximately to atmospheric pressure.

8. In a liquid pumping system comprising a centrifugal pump having an outlet duct and an inlet duct adapted to be connected to a source of liquid to be pumped, and a check valve for preventing reverse flow of liquid through said pump, a chamber having a branch duct connected to said inlet duct, a constantly-operating vacuum pump connected to said chamber to tend to maintain sub-atmospheric pressure therein to reduce pressure in said inlet duct and to effect a flow of liquid into said chamber, a float in said chamber, an atmospheric valve connected to said float to be opened upon upward movement of the float and closed upon downward movement thereof to maintain in said chamber the proper sub-atmospheric pressure necessary to maintain liquid in said chamber at a predetermined level above said inlet duct, a valve in said branch duct biased to closed position, a fluid pressure responsive element connected to said valve, a casing forming with said pressure responsive element a chamber communicating with said first named chamber, the other side of said pressure responsive element being subject to atmospheric pressure to tend to maintain said valve in open position.

9. In a liquid pumping system comprising a centrifugal pump having an outlet duct and an inlet duct adapted to be connected to a source of liquid to be pumped, and a check valve for preventing reverse flow of liquid through said pump, a chamber having a branch duct connected to said inlet duct, a constantly-operating vacuum pump connected to said chamber to tend to maintain sub-atmospheric pressure therein to reduce pressure in said inlet duct and to effect a flow of liquid into said chamber, a float in said chamber, an atmospheric valve connected to said float to be opened upon upward movement of the float and closed upon downward movement thereof to maintain in said chamber the proper sub-atmospheric pressure necessary to maintain liquid in said chamber at a predetermined level above said inlet duct, valve means for closing said branch duct upon an increase in pressure in said chamber approximately to atmospheric pressure, a condensation chamber, said vacuum pump having an outlet connected to said condensation chamber, and float controlled means for connecting said condensation chamber to said first named chamber upon the accumulation of condensate in said condensation chamber above a predetermined level.

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