

Nov. 27, 1934.

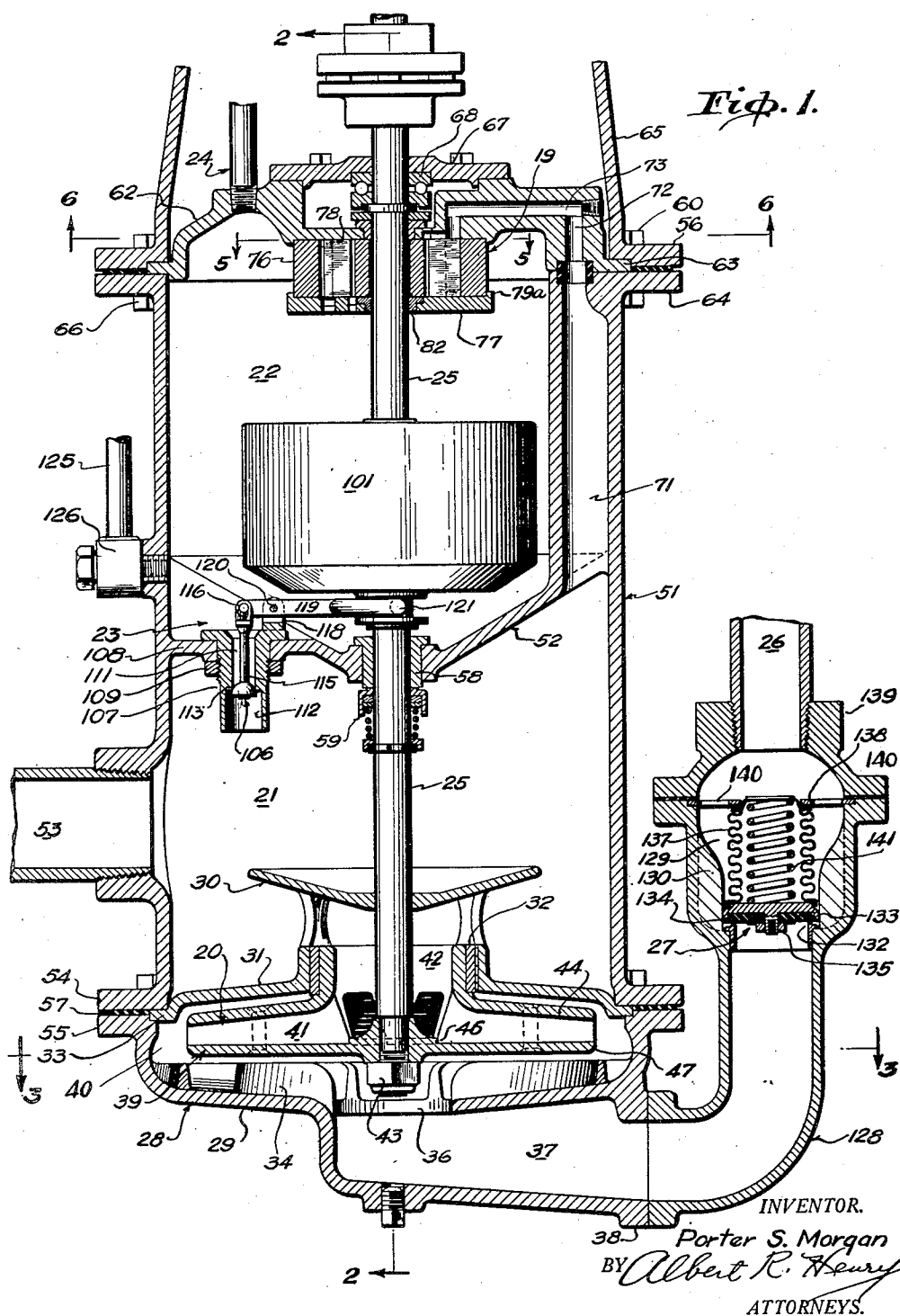
P. S. MORGAN

1,981,965

LIQUID PUMP

Filed July 16, 1932

3 Sheets-Sheet 1



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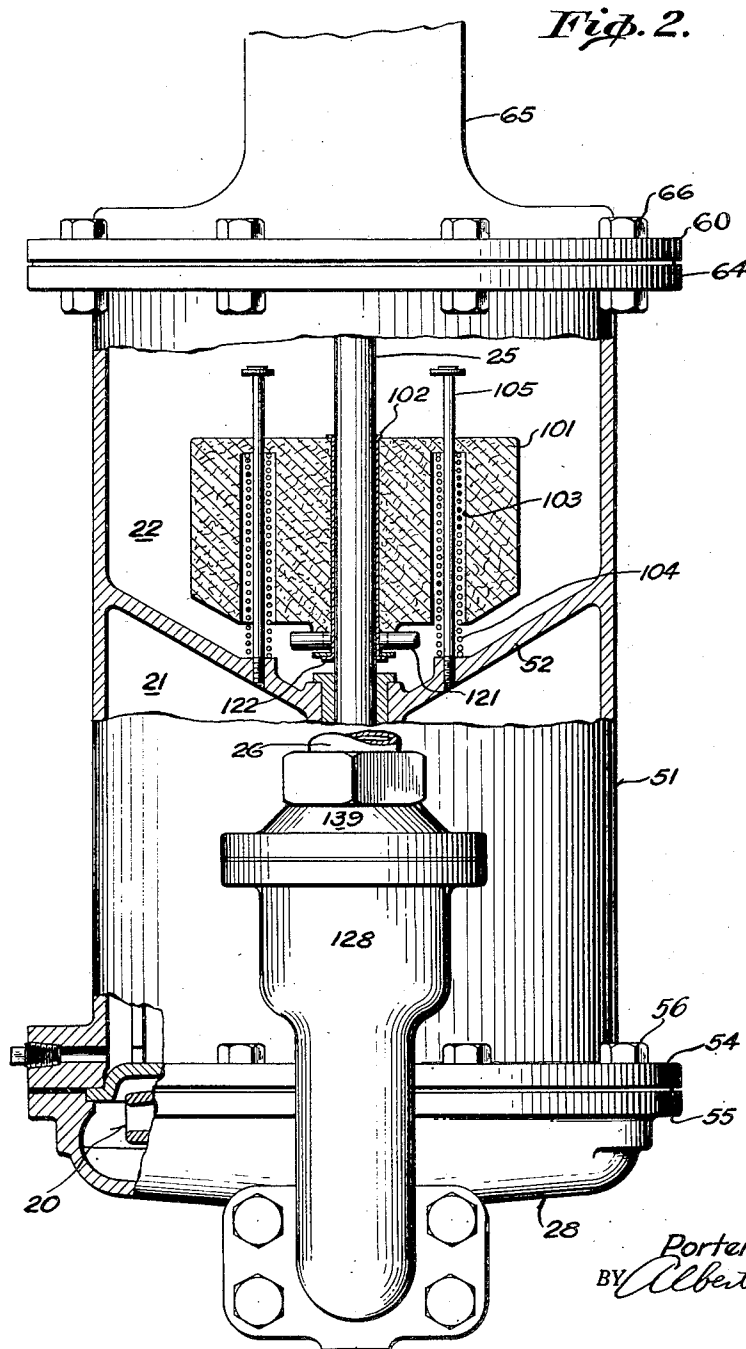
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3 Sheets-Sheet 2



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Fig. 3.

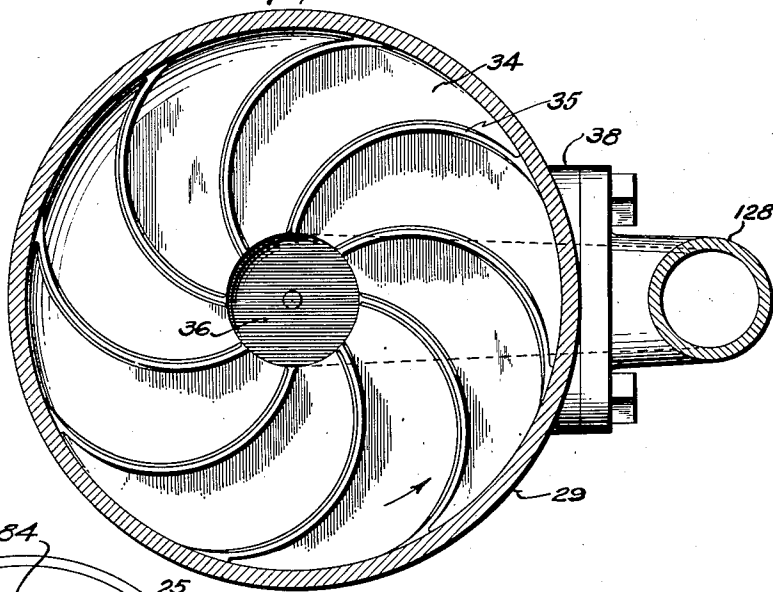


Fig. 5.

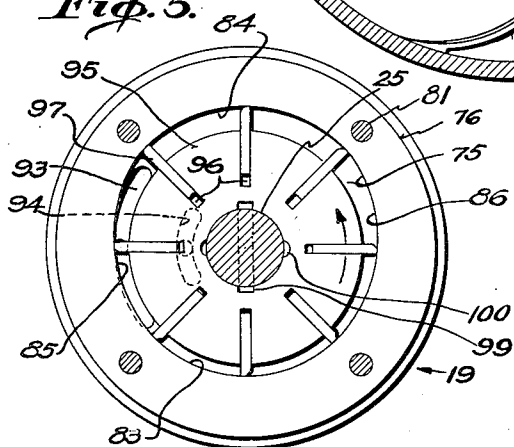


Fig. 4.

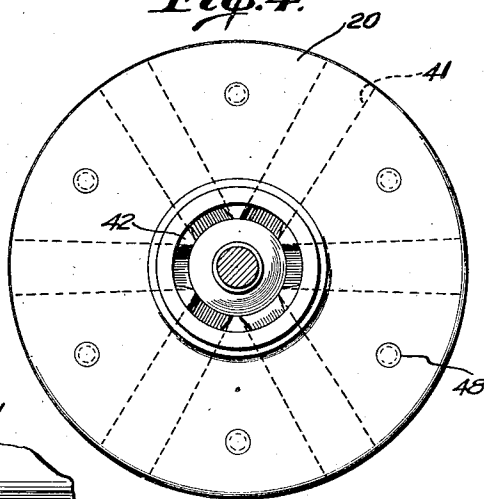
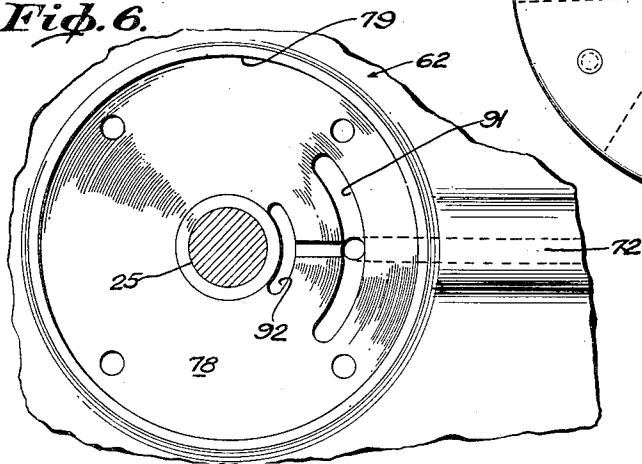


Fig. 6.



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UNITED STATES PATENT OFFICE

1,981,965

LIQUID PUMP

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mesne assignments, to Liberty Share Corpora-
tion, Buffalo, N. Y., a corporation of New York

Application July 16, 1932, Serial No. 622,902

16 Claims. (Cl. 103—6)

This invention relates to means for pumping liquid containing variable or adventitious quantities of non-condensable gases, such as air, and to means for effecting the separation of such air from the liquid, and it has particular reference to apparatus for handling liquids such as gasoline or light oils, which are more or less volatile in character.

In dispensing apparatus for gasoline, for example, it has heretofore been proposed to pump the gasoline from a storage reservoir through a fluid meter, and through a dispensing hose, and units of apparatus designed for this purpose have become well known for retail sales. One of the problems which has confronted those working with such installations has been the separation of air, which becomes entrained in variable quantities in the liquid stream, and, since the air actuates the fluid meter in the same manner as the liquid, it leads to serious questions under the various State and Federal regulations, as well as having an adverse effect on the purchaser. Another problem in the pumping of gasoline has been to provide a pump which will deliver the required quantity of liquid in a minimum of time and with low power consumption, and also be durable and free from service difficulties. In the present invention, as hereinafter described in one embodiment, reference will be made to an improved apparatus capable of handling gasoline and like liquids, with efficient removal of air, but it is to be understood that such reference is to but one of many of the applications of the invention, and is here proffered as illustrative of its principles and advantages.

In the pumping of gasoline, insofar as I am aware, attempts have been made to utilize centrifugal types of pumps, but such attempts have not proven satisfactory since the presence of air or gas volumes rendered the pump inoperative. However, in using a displacement pump for this purpose a greater disadvantage is experienced, that is, it indiscriminately delivers both air and gasoline to the metering elements, which, in view of the more rigid requirements in measuring standards, renders them inefficient for this purpose.

Accordingly, in the present invention the use of a centrifugal pump insures the exclusion of air from the metering elements, and in this respect it substantially functions as a gas valve. The air blocking feature which previously prohibited the use of these pumps is thus utilized to advantage, and to compensate therefor novel

means are provided to remove the abnormal air volumes causing the blocking action. Such means, additionally, remove normal volumes of air prior to entry into the pump. Thus, under normal operating conditions, the centrifugal pump is protected against air entry and is continuously operative, and, in the presence of abnormal air volumes, is cleared of the same in a brief period of time.

In the pumping of gasoline, which is a light and volatile liquid, I have observed a curious phenomenon which may be mentioned here as bearing on the invention. Under the negative pressures developed on the suction side of the pump, be it a centrifugal pump or other type, a portion of the gasoline is broken down or is volatilized, so that the mixture at the intake side of the pump, whether it contain air or not, is composed of a liquid body and a gas body. In a displacement pump, the pressure developed in passing the mixed body causes the gasoline vapors to condense, so that the discharge from the pump is practically all liquid, except for entrained air or other non-condensable gas. With a centrifugal pump, however, the volatilized gas tends to act as air would act, namely, to bind the pump, and hence, in the present invention, provision is made not only to separate air and gases from the incoming liquid stream, but to condense the volatilized liquid so that it may be delivered to and be passed by the pump.

In this aspect of the invention, there is comprehended a pump of the centrifugal type, with which is associated a chamber for effecting the separation of gas and liquid, and a separating pump, preferably of the displacement type, which serves to withdraw the gas or vapors from the separating chamber and to condense the volatilized liquid for return to the pump intake, and to discharge the non-condensable gases to a point remote from the system.

As the description proceeds, it will also become apparent that the invention comprehends certain improvements in the structure of the centrifugal pump, the displacement pump, and the parts cooperating therewith, and that there is also comprehended a novel type of valve in the pump discharge line, which is adapted to maintain a proper back pressure in the system, although the actual rate of discharge may be varied over wide limits, as by throttling the hose nozzle.

Various and other objects of the invention, and the advantages to be derived from the practical application of its principles, will be

made more apparent from a perusal of the following detailed description of a specific embodiment thereof, wherein reference is made to the accompanying drawings, in which:

Fig. 1 is a vertical section through the assembled device;

Fig. 2 is a section on the line 2—2 of Fig. 1 with a portion shown in elevation;

Fig. 3 is a section on the line 3—3 of Fig. 1, particularly showing the liquid directing scroll of the centrifugal pump;

Fig. 4 is a top view of the centrifugal pump;

Fig. 5 is a section on the line 5—5 of Fig. 1, showing the primer pump chamber and rotor;

Fig. 6 is a section on the line 6—6 of Fig. 1, showing the input port arrangement for the priming pump.

The apparatus as shown in Fig. 1 comprises, in general, a plurality of interconnected housings forming a rigid assembly containing a centrifugal supply pump 20, at the suction side of which an air separating chamber 21 is provided. A priming or gas-removing pump 19 removes both gas and air from this chamber, and during the process condenses the gas for delivery into a return chamber 22. The condensed gas bodies are returned to the separating chamber 21 by a float controlled valve generally indicated at 23, and the air bodies are vented through a stand-pipe 24. Both pump devices are driven by a suitable motor (not shown) through a shaft 25, and the liquid delivered by the centrifugal pump 20 is directed, in the present instance, to a gasoline meter through a conduit 26, wherein is interposed a novel form of pressure valve 27.

The centrifugal pump 20 (Figs. 1 and 4) comprises an impeller housing 28 formed of a lower casting 29 and an upper casting 31, the latter casting being formed with a central opening into which is pressed a radial bearing 32 for the centrifugal pump. Immediately above the central opening this casting is formed with a raised dish-shaped portion 30 entering the chamber 21. This casting contains a peripheral flange 33 which seats in a suitable groove in the casting 29, which is formed with a concentric vortex chamber 34 entering a chamber 40 formed with a plurality of vertical ribs 35 arranged in spiral form (Fig. 3) and converging to a central discharge opening 36 which enters a radial cored conduit 37. This conduit terminates in a flange 38 to which a fitting leading to the conduit 26 is secured, as hereinafter more fully set forth.

The impeller 39 of the centrifugal pump is enclosed by the castings 29 and 31 and it is advantageously of the closed type, having a plurality of hollow arms 41 radiating from a central inlet throat 42, rotatably mounted in the bushing 32 disposed in the upper casting. The impeller is keyed to the shaft 25 and is retained against axial movement thereon by a nut 43. It will be noted that the arms 41 are substantially uniform in cross sectional area for their entire length and that liquid delivered by the same is directed to the peripheral wall of the vortex chamber 34 and thence into the spiral ribs 35 which direct the liquid to the opening 36 for disposal through the conduit 37.

More specifically, the impeller is constructed of an upper plate 44 having passages therein forming the hollow arms 41 and having a central depression adapted to receive a hub or centering portion 46 of a lower plate 47. The upper and lower plates are rigidly secured by means of a plurality of rivets 48.

The air separator body 51 is a cylindrical cored casting having a central partition 52 dividing the air separating chamber 21 from the recovery chamber 22. The centrifugal pump is supplied with liquid entering the separating chamber 21 through an input pipe 53 connecting this chamber to a source of liquid supply such as a gasoline tank or other container. The lower portion of the body 51 is formed with a peripheral flange 54 and it is secured by means of bolts 56 to a corresponding flange 55 formed in the lower casting 29. These flanges and a gasket 57 securely encompass the flange 33 of the upper casting 31 and provide a mutual centering and liquid sealing means.

The drive shaft 25 extends axially through the body 51 and through the portion 30 of the casting 31, and it is provided with a bearing 58 pressed into the partition 52. Leakage of fluid between the chambers 21 and 22 is prevented by means of a suitable spring-pressed gasket device 59. The upper end of the body 51 is formed with a head 62 provided with an annular flange 63 similar to the flange 33 of the casting 31 which is clamped between an upper flange 64 on the body 51 and a flange 60 of a motor supporting casting 65 by the bolts 66. The head 62 is provided with a cap member 67 which serves as a mounting for a thrust bearing 68 for the shaft 25.

The air and gases, gravitationally and otherwise separated from the liquid bodies in the chamber 21, are withdrawn through a vertical passage 71 formed in the body 51, and thence through drilled passages 72 and 73 in the head 62 by means of the priming pump 19. This pump, as shown in Figs. 1 and 5, is provided with a rotor chamber 75 formed of a rotor casing 76, a lower head 77, and an upper mounting face 78 machined in the central portion of the body head 62 (Fig. 6). This face is defined by an annular shoulder 79 for receiving the casing 76, and the lower head 77 is formed with a similar shoulder 79a for receiving the opposite face of the casing. Screws 81 secure the head 77 and casing 76 to the body head 62.

The drive shaft 25 extends through the chamber 75 and a bushing 82 is pressed into both the lower head 77 and the head 62 to provide bearings therefor. The finish face 78 is provided with an arcuate input port 91 and a communicating minor or compensating input port 92 (Fig. 6) both of which are in communication with the passages 72 and 73. Similarly, the lower head 77 is provided with an output port 93 and a supplementary output port 94 of similar proportions and arranged diametrically opposite the input ports 91 and 92.

The inner wall of the rotor casing 76 is formed in a manner roughly eccentric to the shaft center by a plurality of curves providing a constant diameter for this wall at all angles of rotation. The curves consist of a circular or dwell surface 83 arranged intermediate the inlet and outlet ports, and an opposed arcuate surface 84 of a greater radius. These curves are each approximately 90 degrees of arc, and their extremities are connected by connecting curved surfaces 85 and 86, which are complementary harmonic curves of a type suitable both to provide for a minimum rate of change of curvature and to retain the diametrical characteristics above referred to.

The chamber 75 is adapted to receive and cooperate with a rotor 95 which is a cylindrical

member formed with a plurality of radiating slots 96, each of which is adapted to receive a rectangular vane 97 (Fig. 5). These vanes are adapted for sliding movement in the slots 96 and are centrifugally retained against the curved surface 83 during operation. The rotor 95 is secured to the drive shaft 25 by a pin which enters slots 99 formed in the rotor, and vertical drainage slots 100 are also formed in the rotor adjacent the shaft 25, the function of which is hereinafter more specifically described. It will be noted that the open portions of the slots adjacent the inner ends of the vanes 97 are adapted to pass over and communicate with the supplementary ports 92 and 94, thus preventing undesirable suction or pressure conditions from being set up therein.

The bodies of air and the condensed liquid discharged from the output port 93 of the priming pump enter the recovery chamber 22 where the air rises and is forced out through the vent pipe 24, while the condensed liquid drops to the bottom of this chamber and gradually collects therein, eventually to operate the float controlled liquid release valve 23.

The valve device 23 comprises a solid cylinder 101 of a material suited for immersion in gasoline, such as an artificial resin, and it contains a central orifice wherein is pressed a bushing 102 which is rotatably mounted on the drive shaft 25. The cylinder 101 contains a plurality of vertical recesses 103 which are adapted to receive coil springs 104. The top walls of the recesses are drilled to provide bearings for guide pins 105 which extend therethrough and through the springs and are secured to suitable pads on the partition 52. The springs 104 function to compensate for differences in specific gravity between the float assembly and the gasoline, so when the lower portion of the recovery chamber 22 is flooded, the cylinder will rise on the shaft 25 due to the urge of the springs 104 plus the urge of the liquid displaced by the cylinder.

The cylinder 101 is adapted to operate a fluid release valve 106, which comprises a seat body 107 engaging through a suitable orifice formed in a relieved portion 108 of the partition 52, and secured against displacement by means of a nut 109. The valve body 107 is formed with a central passage 111 and an enlarged counterbore 112 defining a sharp seat portion 113. The valve 106 is adapted to engage on the seat portion 113 and it is generally spherical in shape and is secured to a valve stem 115 which terminates in a bearing portion 116. The valve seat body 107 is formed with lugs 118 adapted to receive therebetween a yoke member 119. A pin 120 engages through the yoke and the lugs 118 and serves as a pivot for this member. The left hand end of the yoke 119 is pivotally connected to the bearing portion 116 of the valve stem, while the opposite extremity of the yoke is bifurcated as indicated by the numeral 121, and the extremity of each arm thereof extends inwardly to slidably engage the protruding portion of the bushing 102. A thrust washer 122 engages the lower portion of the bifurcated extremity of the yoke and is retained in assembly with the bushing 102 by means of a flange formed on the bushing 102.

The above described device may be advantageously used in conjunction with a meter of the type disclosed in my copending application Serial No. 591,321, filed February 6, 1932, wherein a corrective portion of liquid is returned to the

supply pump. This portion may be advantageously directed to the recovery chamber through a return conduit 125 in communication with the chamber 22 by means of a fitting 126.

It has been found desirable to insure predetermined pressures of liquid in the output pipe 26 of the apparatus by means of a suitable back pressure device. In the present instance this consists of an angle fitting 128 interposed between the pipe 26 and the conduit 37, and it is formed with an open chamber 129 provided with a number of valve guide ribs 130. The lower portion of the chamber is provided with a pressed-in valve seat 132 which is adapted to receive an upwardly opening valve 133. This valve is counterbored to receive a disc 134 of a soft material adapted to intimately engage the seat 132 and is secured against displacement by a nut and washer secured to a depending stem 135 formed thereon.

Means are provided to retain the valve 133 in open position in response to predetermined pressure conditions in the chamber 129 and it comprises an expanded bellows 137 which is soldered at one extremity to the body of this valve and is retained in position at its opposite extremity by a spider 138. The spider is formed with holes 140 for permitting the flow of liquid therethrough. This assembly is capped by a head 139 which is bolted to the fitting 128 and the pipe 26 is secured therein. The peripheral portion of the valve body 133 is adapted to be guided by the extremities of the ribs 130 to proper seating position and the valve is retained on its seat by spring 141 enclosed in the bellows 137, such spring being properly designed so that the valve will not open until a predetermined pressure in the conduit 37 is obtained.

Operation

The liquid drawn into the separating chamber 21 by the centrifugal pump 20 is gravitationally separated into two bodies, as heretofore mentioned, an air body, which rises in the chamber, and a liquid body which is directed into the conduit 37 by the action of the centrifugal pump 20. During this operation, where the liquid pumped is gasoline or other volatile liquid, a certain amount of gasification is experienced, and such gasified portion, together with the air separated from the liquid, is withdrawn from the separating chamber by the action of the displacement pump 19.

The liquid, thus devoid of its objectionable air volumes, enters the centrifugal pump for direction to the metering and dispensing elements of the gasoline system. During entry into the throat of the centrifugal pump 20, the liquid is directed under the dish portion 30 which prevents the formation of a liquid vortex in the chamber 21. Under certain normal conditions, certain portions of air will be directed into the throat of the centrifugal pump 20. In the present device, the hollow arms 41 are proportioned so that the cross-sectional areas are substantially uniform throughout their length, and as a result prevent the usual air jamming or blocking action experienced in the tapered type of hollow arm construction. In the event an air bubble enters the throat 42 of the centrifugal pump, it reaches a certain position in one or more of the hollow arms 41, thus temporarily blocking the same. The remainder of the arms, however, continue to function and as additional volumes of liquid are drawn into the throat 42 the air

bubble is gradually forced inwardly, since it will not react to centrifugal force. The air bubble is thus gradually dispersed and is finally forced out of the throat 42 for eventual direction into the recovery chamber 22.

In one aspect, therefore, it will be seen that the centrifugal pump serves a purpose of separating air and liquid, since air cannot pass through the pump, while liquid does. When an exceptionally large or abnormal volume of air enters the chamber 21, a total blockade of the centrifugal pump is effected, whereupon the centrifugal pump continues to act as air valve, since it will not permit the entry of air into the conduit 37, and as a result the pump, although continuously rotating, does not deliver liquid to the pipe 26 until the removal of this excess volume of air by the priming pump 19.

The pump 19 has a capacity sufficient to clear the pipe 53 and chamber 21 of a large air volume in a short interval of time, and since it is of the positive displacement type, it is not affected by the medium which it pumps. The gases, consisting of air and gasoline, enter the pump 19 through the input port 91 and are delivered to the recovery chamber 22 through the output port 93. It will be noted that the displacement pump, in effect, has a duplex action, that is, the pockets between the vanes 97 carry the major portion of the gas, and that because of the novel arrangement of the minor input port 92, gas is also directed to the space in the slots 96 immediately behind the vanes 97. Thus the pressure on all sides of each vane is equal, permitting the free centrifugal action of the same. Upon entering the output curve area 85 the vanes are pressed inwardly to discharge the loads of fluid in the pockets therebetween, and simultaneously the gas present in the blocked pockets at the rear of the vanes is discharged through the minor output port 94, thus preventing a pressure condition from being set up therein.

During the above described operation, it has been found expedient to prevent the leakage of gases into the chamber formed by the cap member 67, both to prevent possible leakage through the cap joints and to retain lubricant packed therein from association with gasoline or other vapors. This is prevented by the vertical slots 100 formed in the rotor 95 which collect any leakage occurring across the top of the vanes for drainage into the recovery chamber 22.

The displacement pump 19 in effect reverses the breakdown action, caused by suction on the intake line 53, on the more volatile forms of the liquid received from the chamber 21, since it exerts a definite pressure on the same, resulting in the immediate condensation of such bodies. Thus gasified liquid entering the pump 19 is discharged through the port 93 in the form of liquid for collection at the bottom of the recovery chamber 22, where its buoying effect on the float cylinder 101 results in the raising of the yoke member 119 and the unseating of the release valve 106, thus establishing communication between the recovery chamber 22 and the separating chamber 21, to drain the recovery chamber of excess fluid. During this operation the air entering the recovery chamber is forced into the atmosphere through the vent pipe 24.

Since the above described action of the displacement pump 19 is continuous, any excessive and blocking volume of air directed into the chamber 21 is eventually dispersed and in ad-

dition, any air present in the centrifugal pump 20 is withdrawn therefrom to condition the supply pump for operation. During this interval, the suction produced by the pump 19 lifts a quantity of liquid from the supply tank to the chamber 21, whereupon the centrifugal pump resumes its normal operation.

The above described abnormal condition in practical application is only experienced after a long shut-down of the apparatus, when, due to a faulty foot valve in the supply tank or to an air leak in one of the conduits of the system, a large volume of air is admitted to the system. During normal operation of the device, however, only occasional volumes of air are to be contended with, and these are readily removed by the pump 19 without affecting the centrifugal pump 20. In this event the pump 19 acts as a booster to the centrifugal pump as its capacity is in excess of the gas removing demands and thus no inefficiency is experienced, since both pumps cooperate to lift fluid from the supply tank.

The liquid flow from the output of the centrifugal pump 20 is resisted so that discharge will not obtain until a predetermined pressure is built up in the conduit 37. This back pressure condition reacts in the hollow arms 41 to prevent the escape of casual air volumes through the same, prior to the building up of maximum speed of the impeller 39, and it is caused by the spring loaded valve 133 which is adapted to lift from its seat 132 in the presence of the desired pressure in the conduit 37. Upon the opening of this valve, the pressure in the conduit 37 and the pipe 26 are immediately equalized and the bellows 137 is directly subjected upon all sides of its convolutions to the increased pressure resulting in the collapse of the same and its maintenance in such position until a disturbing factor reduces the pressure in the conduit 37, whereupon the spring 141 restores the valve to its seat.

From the foregoing description, it will be understood that there is provided a pumping apparatus, particularly applicable in the pumping of liquids such as gasoline or other volatile substances, in which a centrifugal pump may be utilized as the pumping element. It will also be understood that the invention is applicable to cases wherein air may not be included with the liquid body, and that the invention is not limited to the pumping of volatile liquids alone, but may be used for other materials. It will also be appreciated that the invention resides in certain combinations of elements, and in certain novel and useful improvements in the elements themselves, and hence it is desired to point out that the invention should not be limited to the precise embodiment shown, as it is susceptible of numerous variations from the illustrated form within the principles thereof, as set forth in the following claims.

I claim:

1. Apparatus for separating gas from liquid, comprising centrifugal pump means having an input conduit, a separating chamber interposed in the input conduit in concentricity with said centrifugal pump, said pump being adapted to remove liquid volumes from said chamber to the exclusion of air bodies therein, and displacement pump means for removing gas separated from the liquid in said chamber.

2. Apparatus for separating gas from liquid, comprising centrifugal pump means having an input conduit and an output conduit, a separat-

ing chamber interposed in the input conduit, means for removing gas separated from the liquid in said chamber, an outwardly opening valve in the output chamber, and a bellows containing a compressible medium and secured to said valve, said bellows being adapted to contract and open said valve in the presence of predetermined pressures in said output conduit.

3. A back pressure device for a liquid supply system, comprising pump means having an output conduit, a valve seat in said conduit, an outwardly opening valve on said seat, bellows means mounted in said conduit containing a compressible gas and secured to said valve, resilient means for retaining the valve on its seat, said bellows being adapted to contract in the presence of predetermined pressures to overcome said resilient means and open said valve.

4. A back pressure device for a liquid pumping system, comprising pump means having an output conduit, a valve seat in said conduit, an outwardly opening valve on said seat, bellows means containing a compressible gas and secured to said valve, resilient means for retaining the valve on its seat, said bellows being adapted to contract in the presence of predetermined pressures to overcome said resilient means and open said valve, and means in said conduit for guiding said valve during movement.

5. A liquid pump and separator comprising a tank having a partition wall formed transversely thereof dividing said tank into upper and lower compartments, a centrifugal pump impeller mounted in the lower portion of said lower compartment and having an inlet port directly communicating with said lower compartment, a liquid inlet port formed in said lower compartment above said centrifugal pump impeller, a pump casing secured to the lower portion of said tank, said pump casing being formed with a discharge port, a fluid conduit extending upwardly from said lower tank to said upper compartment, means interposed in said conduit and disposed in said upper compartment for removing gases from said lower compartment, an air vent in said upper compartment, a discharge port formed in said gas removing means communicating with said upper compartment to direct condensed liquid toward said partition, said partition being formed with a port communicating with said lower compartment, a float controlled valve in said last named port, and a shaft for said centrifugal pump impeller extending upwardly therefrom through said partition and said upper compartment.

6. A liquid pump and separator comprising a centrifugal pump, an inlet line therefor, a separator interposed between said pump and inlet line and above the inlet throat of said pump, a vapor exhaust line connected to the upper portion of the separator and said inlet line, a displacement pump disposed above said separator, said displacement pump being connected on its intake side to said vapor exhaust line, a return chamber in communication with the discharge side of said displacement pump positioned below said pump, said return chamber being formed with an air vent whereby incondensable gases passing through said displacement pump may be removed from the system, said return chamber being formed at a low point therein with a single draw off opening for discharging liquid and condensed vapor discharged by the displacement pump, said draw off leading to the separator, and a float controlled valve in the return cham-

ber for controlling the passage of liquid through said draw off.

7. Apparatus for pumping mixed bodies of liquid and gas and simultaneously separating the gas from such liquid, comprising a casing, a centrifugal pump impeller disposed in the lower portion of such casing, a separating chamber formed in said casing and in communication with the inlet of said impeller, an inlet formed in said separating chamber for admission of a mixed body of liquid and gas, means disposed in the upper portion of said separating chamber for exhausting gas separating from said liquid body in said separating chamber, means associated with said exhausting means for returning to said separating chamber adventitious quantities of liquid withdrawn from said separating chamber, whereby separation of said liquid and gas is effected prior to passage of liquid through said impeller, a casing for the impeller, a liquid discharge line connected to said casing, and a pressure operated valve in said discharge line, said pressure operated valve being adapted to open only after development of a predetermined pressure in said discharge line, whereby gases are resisted by liquid pressure from entering said discharge line through said impeller.

8. Apparatus for pumping mixed bodies of liquid and gas and simultaneously separating the gas from such liquid, comprising a casing, a centrifugal pump impeller mounted in the lower portion of such casing, a pump casing secured to the lower portion of said first named casing, said pump casing being formed with an inlet port in communication with said first named casing and with a discharge port, a discharge line connected to said discharge port, a pressure controlled valve adapted to open only upon the development of a predetermined pressure disposed in said discharge line, whereby a predetermined liquid pressure is established on the discharge side of said impeller, a liquid and gas inlet line communicating with said first named casing, a gas and vapor exhaust line communicating with the upper portion of said first named casing, vapor condensing means interposed in said exhaust line, means for returning to said first named casing and to the inlet of said impeller condensate from said vapor condensing means, whereby separation of gas from liquid is effected in said first named casing and flow of gas through said impeller is resisted by liquid pressure in said discharge line.

9. Apparatus for pumping mixed bodies of liquid and gas and simultaneously separating the gas from the liquid, comprising a casing formed with a liquid inlet passage and a partition wall above said inlet dividing the casing into upper and lower compartments, a pump housing secured to the lower portion of said casing and formed with an inlet communicating with said lower compartment, a centrifugal pump impeller mounted in said pump casing, a discharge line from said pump casing, a pressure operated valve adapted to open only upon development of a predetermined positive pressure disposed in said discharge line, a fluid conduit leading from the upper portion of said lower compartment to said upper compartment, a displacement pump mounted in said upper compartment and having its inlet port in communication with said fluid conduit, the discharge port of said displacement pump communicating with said upper compartment, venting means for incondensable gases in

said upper compartment, a return line for liquid extending from said upper compartment to said lower compartment, and a float controlled valve in said upper compartment for said liquid return line.

10. Apparatus for pumping mixed bodies of liquid and gas and simultaneously separating the gas from the liquid, comprising an upright casing formed with a partition wall in the mid-portion thereof dividing said casing into upper and lower compartments, an inlet formed in said lower compartment, a fluid conduit extending from the upper portion of said lower compartment to said upper compartment, means in said upper compartment for exhausting gases introduced into said lower compartment, liquid return means extending from said upper compartment to said lower compartment, a cover plate secured to the bottom of said casing, a second plate extending across the bottom of said casing and spaced from said cover plate, a centrifugal pump impeller mounted intermediate said plates, said second plate being formed with an inlet port communicating with the inlet of said impeller, said cover plate being formed with a discharge opening for discharging liquid delivered by said impeller.

11. Apparatus for pumping mixed bodies of gas and liquid and simultaneously separating the gas from the liquid, comprising an upright casing formed with an inlet above the bottom thereof, a plate formed with a centrally disposed aperture secured to the bottom of said casing, a second plate spaced from said first named plate secured to the bottom of said casing, said second plate being formed with a centrally disposed aperture, a discharge conduit connected to said last named aperture, said second plate being formed with a plurality of spiral ribs extending from said aperture toward the outer edges of said plate, a centrifugal pump impeller mounted intermediate said plates and above said ribs, the inlet of said impeller being in communication through the aperture in said first named plate with said casing, a partition wall in said casing above the inlet formed therein, and means in said casing above said partition for withdrawing wet gas from below said partition and for returning the liquid portion of said wet gas.

12. Apparatus for pumping liquids and separating gases therefrom, comprising an upright casing provided with an interior partition wall adjacent its midportion dividing the casing into upper and lower compartments, a pair of plates secured in spaced relation to each other and to the lower end of said casing, the upper of said plates being formed with a centrally disposed aperture, the lower of said plates being formed with a discharge port, a centrifugal pump impeller mounted between said plates and in said centrally disposed aperture, a shaft extending upward from said impeller through said partition and the upper end of said casing, a cover for the upper end of the casing, said cover being formed with a centrally disposed aperture through which said shaft extends, means interposed between said shaft and said partition preventing fluid leakage therethrough, a fluid conduit extending from the upper portion of said lower compartment to the upper part of said upper compartment, a displacement pump mounted on said shaft adjacent the upper part of said upper casing, the intake of said displacement pump being in communication with said fluid conduit, the discharge of said displacement pump communi-

cating with said upper compartment, means in said upper compartment for venting incondensable gases, a valve seat formed in said partition, a valve in said seat, and float means in said upper compartment for operating said valve.

13. In apparatus for pumping liquids and separating incondensable gases therefrom, the combination of a casing formed into upper and lower compartments by a partition wall disposed therein, a shaft extending through said casing, a centrifugal pump impeller mounted on said shaft adjacent the lower portion of said casing, said impeller being provided with an inlet port in fluid communication with said lower compartment, a liquid inlet formed in said lower compartment, an aperture formed in said partition through which said shaft extends, a packing around said shaft to prevent leakage between said compartments through said aperture, a fluid conduit extending upwardly from said lower compartment to a point adjacent the top of said upper compartment, a gas pump mounted on said shaft in said upper compartment, said gas pump having an inlet port communicating with the upper end of said fluid conduit, a discharge line extending from said gas pump into said upper compartment, a gas vent formed in said upper compartment for removing incondensable gases therefrom, a fluid port formed in said partition, and a float controlled valve mounted in the lower portion of said upper compartment and controlling the flow of fluid through said fluid port from said upper compartment to said lower compartment.

14. Apparatus for pumping mixed bodies of liquid and gas and separating the gas from the liquid, comprising an upright casing, a partition wall disposed transversely of said casing at the mid-portion thereof and dividing said casing into upper and lower compartments, said casing being formed in said lower compartment with a liquid and gas inlet port, a pump mounted in said lower compartment for pumping liquid through said apparatus, a fluid conduit extending from said lower compartment to said upper compartment, a cover for the upper end of said casing, said cover being formed with a conduit in fluid communication with said first named fluid conduit, a displacement pump mounted on said cover and having an inlet port in communication with said fluid conduits, a discharge port for said displacement pump communicating with said upper compartment, valve means in said partition for returning liquid in said upper compartment to said lower compartment, and an air vent formed in said upper compartment for removing incondensable gases therefrom.

15. Apparatus for pumping mixed bodies of liquid and gas and separating the gas from the liquid, comprising an upright casing, a partition wall disposed transversely of the casing adjacent the mid-portion thereof dividing said casing into upper and lower compartments, a centrifugal pump impeller mounted in the lower portion of the casing, a shaft for said impeller extending upward through the casing, a gas pump mounted on said shaft adjacent the top of the upper compartment, a fluid conduit for mixed vapors extending from said lower compartment to said gas pump, a condensed liquid return line extending from said upper compartment to said lower compartment, a valve for said return line, and float means in the upper compartment controlling said valve, said float means including an an-

nular float mounted on said shaft and being guided thereby in its up and down movements.

16. Apparatus for pumping and separating gas and liquid comprising an upright casing, a partition in said casing dividing it into upper and lower compartments, a liquid inlet line formed in said casing in communication with said lower compartment, a pump disposed in said lower compartment for transmitting liquid, a vapor line extending from said lower compartment upward to said upper compartment, a cover for said upper compartment, said cover being formed with a radial conduit, the outer end of said conduit being in communication with said vapor line, a displacement pump casing mounted

on said cover, a rotary displacement pump within said pump casing, the inlet port of said pump being in communication with said radial conduit, the discharge port of said displacement pump being in communication with said upper compartment, a shaft for said displacement pump extending through said cover, means sealing said cover and shaft to prevent air leakage, venting means formed in said upper compartment, and means disposed at the lower portion of said upper compartment for returning to said lower compartment liquid draining from said displacement pump.

PORTER S. MORGAN.

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10	85
15	90
20	95
25	100
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35	110
40	115
45	120
50	125
55	130
60	135
65	140
70	145
75	150