LIQUID-GAS SEPARATOR

Filed May 13, 1965 4 Sheets-Sheet 1

FIG. 1

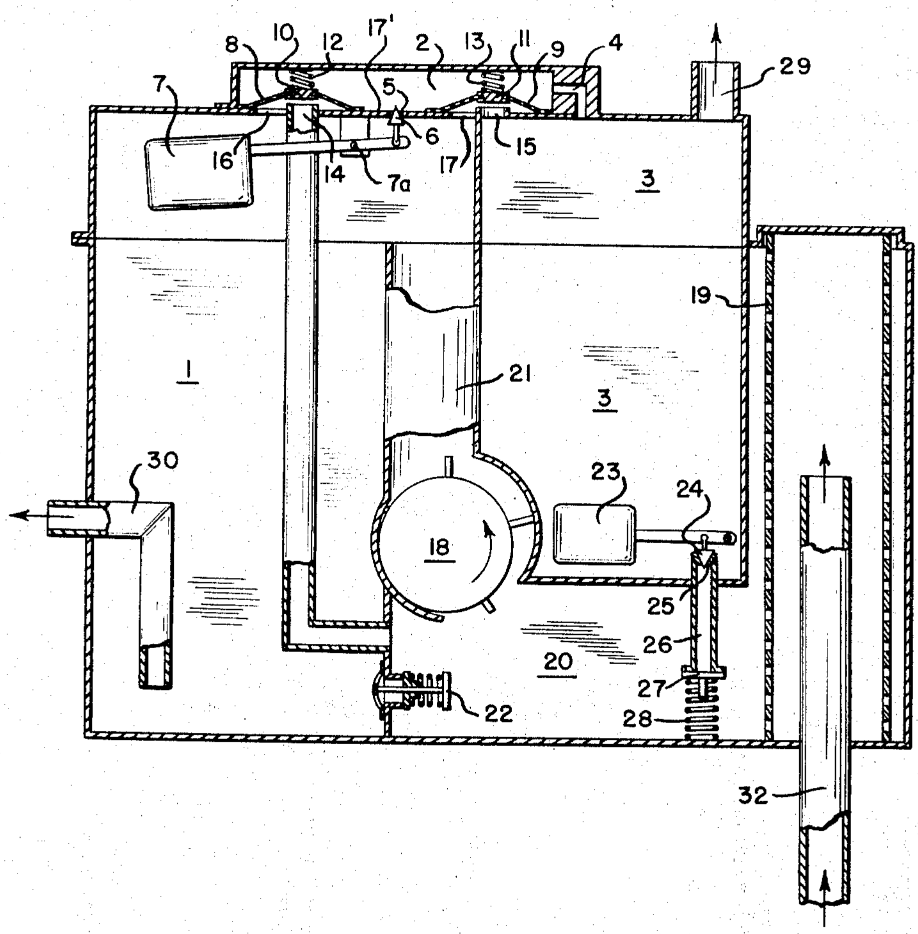

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FIG. 2

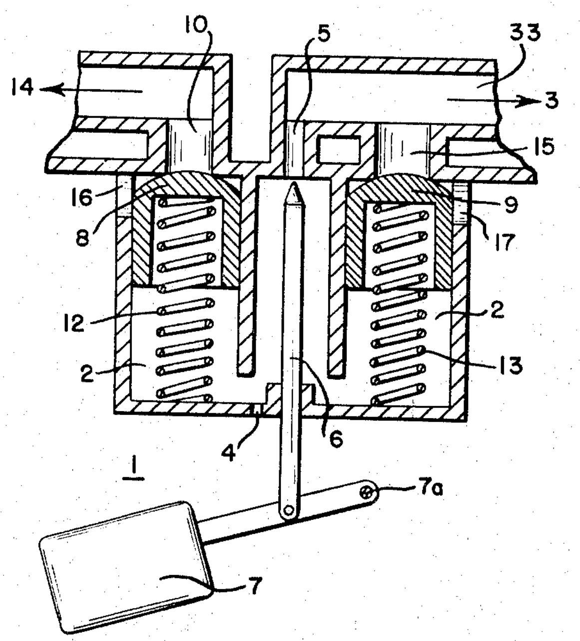

FIG. 3

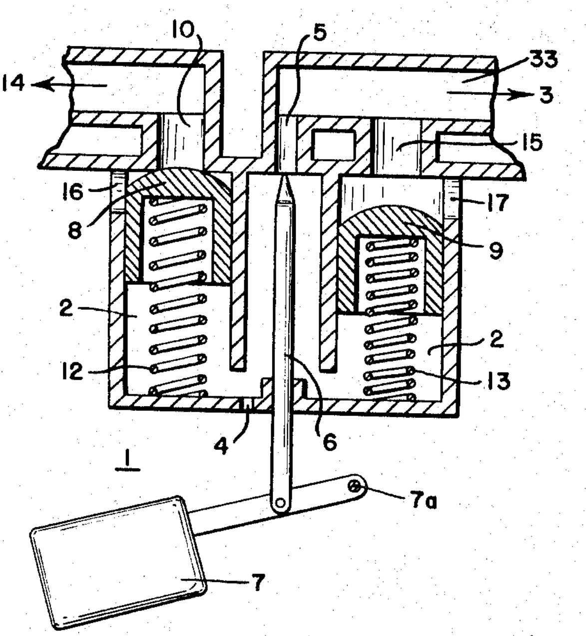

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FIG. 4

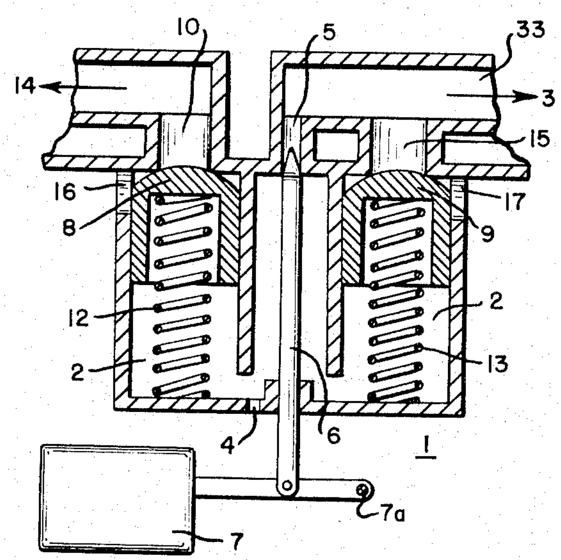
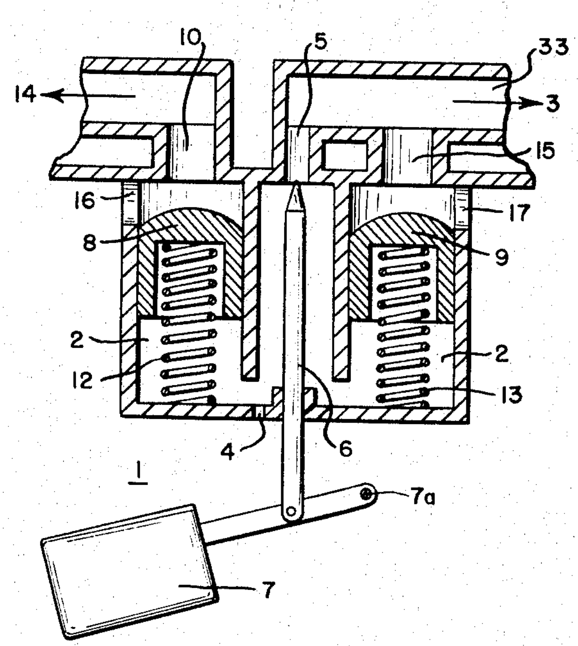


FIG. 5



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Dec. 5, 1967 A. F. BLANCHET ET AL 3,355,862

LIQUID-GAS SEPARATOR

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FIG. 6

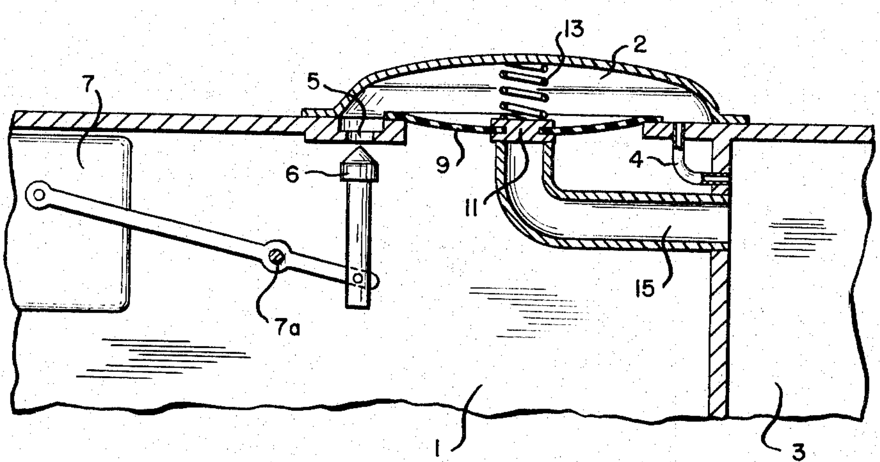
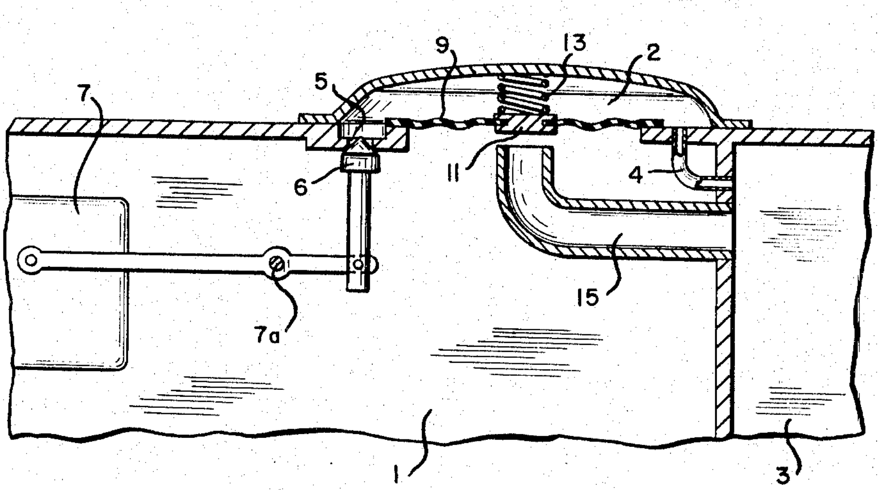


FIG. 7



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LIQUID-GAS SEPARATOR

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5 Claims. (Cl. 55—166)

The present invention pertains to devices for separating liquid and gaseous phases one from another, especially as applied to apparatus for the measured distribution of liquids, as for example in motor fuel pumping installations. In devices of this kind heretofore proposed, the outlet check valve for release of the separated gases (which may be air) is controlled by a float, either directly or through a motion amplifying device. These prior art structures are lacking in sensitivity because the larger the sensitivity achieved, the smaller must be the motion of the float required fully to open the valve. In order to open the valve effectively, the float must not only overcome the back-pressure on the face of the valve presented to the separator space but it must additionally execute a motion sufficient to open the valve. Thus sensitivity of the separator is a function of the motion of the valve and of the pressure existing in the separator.

Additionally, to obtain a dependable operation it is necessary that the gas outlet from the separator have such size that the influx of air or gas which occurs in starting and stopping the pump shall be evacuated to the exterior without producing a high pressure. It is likewise necessary for this opening to permit, in the case of accidental arrival of air or gas, passage of a certain quantity of liquid entrained with the separated gases in the form of a mist or form. The smaller the volume of the separator, the larger the quantity of foam which must so be passed. The consequence is that in the separators of the prior art, it is necessary to provide a recovery vessel or "purge" vessel having a large capacity, appropriate to the rate at which liquids and gases are to be separated.

It is an object of the present invention to surmount these advantages. More particularly the present invention has for an object the provision of a gas separator comprising an auxiliary chamber which is separated from the adjacent degassing or separating chamber per se by a partition including, in one preferred embodiment of the invention, one or more deformable components. This auxiliary chamber communicates through suitable orifices of unlike size with the separating chamber and with a closed chamber or vessel at atmospheric pressure. A float controls one of these openings to the auxiliary chamber in such fashion that the differences of pressure which are developed between the auxiliary chamber and the separating chamber cause motions of the deformable partition element or elements, these latter in turn controlling the outflow of gas and of foam or emulsions.

According to a particular preferred embodiment of the invention, one of the deformable partition elements controls the outgoing passage of gas towards the purging vessel and a second deformable element controls communication between the gas outlet and the source of supply. This feature makes it possible substantially to reduce the size of the purging vessel and also that of the separating chamber.

This invention will now be further described in terms of a number of non-limitative examples with reference to the accompanying drawings wherein:

FIG. 1 is a diagrammatic sectional view of a first form of separator according to the present invention;

FIG. 2 is a diagrammatic sectional view of the upper part of a separator according to the invention, with the elements shown in the position occupied by them before starting of the pump;

FIG. 3 is a view similar to that of FIG. 2, with the elements shown in the positions which they occupy when the air contained in the separator is expelled into the purging chamber by the arrival of liquid in the separating chamber;

FIG. 4 shows the elements of FIG. 2 during normal flow delivery rate;

FIG. 5 shows the position of these elements when the gases are flowing partly toward re-aspiration by the pump and partly toward the purging chamber;

FIG. 6 is a fragmentary sectional diagram of a separator according to the invention having a single outlet for the gases toward the purging chamber; and

FIG. 7 is a diagram similar to that of FIG. 6 but showing the check-valve in closed position.

In the separator shown in FIG. 1, the separating chamber proper, **1**, communicates at its upper portion with a control chamber **2** via an opening **5**. This opening is controlled by a valve **6** coupled to float **7** which is pivoted on an axis **7***a*, such that valve **6** is opened when the float is lifted by a rising level of liquid in chamber **1**.

The auxiliary chamber **2** communicates continuously with a purging chamber **3** via a conduit **4** of specified cross section which is smaller than that of the opening **5**. The auxiliary chamber **2** is closed at its lower limit (and thereby separated from chamber **1**) by a wall **17'** including two diaphragms or membrances **8** and **9** which respectively carry valves **10** and **11**. The valve **10** is subjected to the action of a spring **12**, tending thereby to close a conduit **14** which leads to the inlet chamber **20** on the low pressure side of a pump **18**, which pump is destined to effect the flow of liquid from which entrained gases are to be separated, for example prior to delivery to a volumetric meter. The valve **11** on the diaphragm **9** is subjected to the action of a spring **13** which tends to close an opening **15** through which, when open, communication may be had directly between the separating and purging chambers **1** and **3**.

Communication between the chamber **1** and the purging vessel **3** may thus occur in part via the orifice **15** and in part through the auxiliary chamber **2** via opening **5** and conduit **4**.

The pump **18** aspirates the fluid from a source of supply into the chamber **20** via a filter **19** and a conduit **32** leading to a supply reservoir, not shown. The pump **18** delivers the liquid through a conduit **21**, open at its upper end, to the upper part of the chamber **1**. A bypass **22** makes it possible to control the pressure output produced by the pump.

The purging chamber **3** contains a float **23**. This float controls a valve **24** at the orifice **25** in chamber **3** of a conduit **26**, the other end of which communicates with the low pressure side of the pump through a check valve **27**. Valve **27** is held closed by a spring **28**, but opens under effect of a negative pressure in the aspiration chamber **20**. Valve **24** is opened when float **23** is lifted by liquid in chamber **3**.

The purging chamber **3** communicates freely with the atmosphere via conduit **29** opening at the upper part of this chamber. The liquid delivered by the pump and freed from gases is directed toward the metering device through a conduit **30** which has its opening at the lower part of the separating chamber **1**.

The mode of operation of the apparatus is as follows: When the apparatus is at rest (pump **18** stationary), the check valves **10** and **11** respectively close the conduit **14** and opening **15**. When the pump is set into operation, the float **7** will be in its lower position and the valve 6 will therefore close the opening 5 which provides communication between chambers 1 and 2. Any excess of pressure in chamber 1 over that in chamber 2 is exerted on the diaphragms 8 and 9 through the openings 16 and 17 in the lower wall 17′ of chamber 2. The spring 13 of the valve 11 is dimensioned as a function of the diaphragm 9 so as to open with a low pressure exerted on that diaphragm. The spring 12 of the valve 10 is dimensioned so that with due regard for the negative pressure which can exist in line 14, the valve 10 will remain closed so long as the liquid has not filled the chamber 1.

When the liquid delivered by the conduit 21 fills the chamber 1, the float 7 will be lifted, thereby opening the valve 6, and the same pressure will be established in the auxiliary chamber 2 as in the separating chamber 1. The valve 10 remains closed and the valve 11 will close, it having been previously opened during filling of chamber 1.

As liquid rises into chamber 2 through the now-opened valve 6, it will flow out into chamber 3 at a low rate through the small-bore conduit 4. The liquid accumulates in the purging vessel 3 until the floater 23 is lifted, opening the valve 24. This permits the pump to withdraw from chamber 3 the liquid collected therein.

When however the pump aspirates a mixture of liquid and air or gas, due to entry of air or gas into the supply line upstream of the chamber 20, the air or gas and any emulsion (e.g. produced by the pumping action) collect at the upper portion of the separator chamber 1. Float 7 will therefore fall, closing opening 5 (and thus the inlet to chamber 2) with the aid of valve 6. The conduit 4 permits the liquid in chamber 2 to flow off into the purging chamber 3. The diaphragms 8 and 9, subjected to the rising gas pressure existing in the chamber 1, will rise with their associated valves 10 and 11. The air, gases or emulsion accumulated in the chamber 1 then have a free flow towards the conduit 14 and also to the purging chamber via the opening at 15 produced by opening of valve 11.

The air, gases and emulsion which pass through the conduit 14 thus by-pass the purging chamber, which receives only a part of such air, gases and emulsion. The fraction flowing through the conduit 14 is redelivered by the pump to the chamber 1. Thus the elimination of the air, gas or emulsion effected in the purging chamber 3 is distributed over a longer period of time than would be the case if the conduit 14 were not provided. It is thus possible to reduce the size of the purging chamber 3. In addition the degree of gas or air separation is improved.

In the embodiment of the invention illustrated in FIG. 2, the chamber 1 of the separator, not shown, has disposed above it an auxiliary chamber 2 which communicates with the purging vessel 3, again not shown, through a tube 5 of appropriate cross section and also with the separating chamber 1 through a calibrated opening 4, the opening 4 being of smaller section than the conduit 5. Conduit 5 is controlled by a valve 6 operated by the float 7, so pivoted that conduit 5 is closed by valve 6 when the liquid in chamber 1 lifts the float.

The chamber 2 is closed at its upper end by means of two pistons 8 and 9 which function as valves; the valve 8 controls an opening 10 between the chamber 1 (at 16) and a conduit 14 which connects directly to the low pressure side of the pump as in FIG. 1. The valve 9 controls an opening 15 between the chamber 1 (at 17) and the purging vessel via a conduit 33 of large size. The conduit 5 controlled by the valve 6 opens into the conduit 33. The valves 8 and 9 are subjected to the action of separate springs 12 and 13 which tend to hold them in closed position.

The valves 8 and 9 are also subjected on their underside and over the complete cross section thereof to the pressure which exists in the chamber 2, and they are subjected on the upper side thereof over an annular portion of their surface, excluding the openings 10 and 15, to the pressure in chamber 1. The pressure in chamber 1 reaches the outer annular upper surface of the valves 8 and 9 through the openings 16 and 17.

The embodiment of FIGS. 2 to 5 operates as follows: when the apparatus is at rest, i.e., before the pump is started, the valves 8 and 9 are held in closed position by their respective springs 12 and 13, closing off chamber 1 from conduits 14 and 33. The float 7 is in lowered position so that the valve 6 is open, leaving the orifice 5 likewise open.

When the pump is started, air is expelled from chamber 1 by the delivery of liquid to that chamber. This air passes through the opening 4 into the chamber 2 which communicates with the purging vessel via the orifice 5. Since the orifice 5 is substantially larger than the opening 4, the pressure in the chamber 2 is and remains the same as that in the purging vessel, i.e., it is substantially that of the open atmosphere.

Thus no supra-atmospheric pressure is exerted on the underside of valves 8 and 9. Instead, the air pressure existing in the chamber 1, above atmospheric, operates on the annular portion of the upper side of valves 8 and 9 through the openings 16 and 17. The spring 13 is dimensioned to permit the valve 9 to open for a low net air pressure exerted thereon. The spring 12 is so dimensioned that having due regard for the negative pressure existing in the conduit 14 when the pump is operating, the valve 8 remains closed so long as the liquid has not filled the chamber 1. Hence, the pressure of the air delivered into the chamber 1 effects opening of the valve 9, and the air escapes freely from chamber 1 through openings 17, 15 and conduit 33 toward the purging vessel, as indicated in FIG. 3.

When the liquid fills the separator chamber 1, it lifts the float 7, thereby effecting closure of the conduit 5 by means of the valve 6. The pressure in chambers 1 and 2 thereupon equalizes. The valves 8 and 9 then experience, on the whole surface of their lower side (in chamber 2), the same pressure as they do via the openings 16 and 17 on a smaller annular portion of the upper surface thereof. Valves 8 and 9 therefore close, and all outlet conduits to the purging chamber and also to conduit 14 are closed, so long as the liquid delivered by the pump does not include air or gases (FIG. 4).

When the pump delivers a quantity of air or gas to chamber 1, such gas will rise to the upper end of the chamber, either as such or in the form of a foam or emulsion, and the float 7 will fall, effecting opening of the orifice 5. Since this orifice is substantially larger than the orifice 4, the pressure in chamber 2 will fall and the pressure existing in chamber 1, higher than that in chamber 2, will be exerted on the upper annular portion of the valves 8 and 9. These valves will thereupon open, freeing the orifices 10 and 15. The air or emulsified gas will then be delivered from chamber 1 simultaneously in part toward the purging vessel (through conduit 33) and in part toward the low pressure side of the pump (through conduit 14). This condition of affairs is illustrated in FIG. 5. The quantity so delivered to the pump is recycled as previously stated (FIG. 5).

Upon comparison of the two separators hereinabove described, namely that of FIG. 1 and that of FIGS. 2 to 5, it will be observed that the communication between the chamber 1 and the purging vessel 3 includes in each an auxiliary chamber 2 open at one end to the main chamber 1 and at the other end to the purging chamber 3, with communication between the auxiliary chamber and one of chambers 1 and 3 via a small orifice 4, and between the auxiliary chamber and the other of the chambers 1 and 3 via a larger orifice 5 controlled by a float-operated valve 6. There is also provided in each case in addition a "direct access" valve, 11 in FIGS. 1 and 9 in FIGS. 2 to 5, which when open provides direct access between the chambers **1** and **3**, bypassing the auxiliary chamber. The conduit **33** of FIGS. 2 to 5 being of large cross section, that conduit is equivalent to the interior of the chamber **3** of that embodiment, not shown. In each case this direct access valve is subjected on one side to the pressure in chamber **2**, and on the other side to the pressure in chamber **1**. In the case of FIG. 1, the small opening **4** is at the downstream end of the auxiliary chamber, in the sense of flow from the separating chamber through the auxiliary chamber to the purging chamber, and the float is arranged to close the large opening **5** at the upstream end when the float is in the lower position, i.e., for a low level of liquid in chamber **1**. In the case of FIGS. 2 to 5, the small opening **4** is at the upstream end of chamber **2**, and the float is arranged to close the large opening **5** at the downstream end of that chamber when the float is raised, i.e., for a high level of liquid in the separating chamber **1**.

FIGS. 6 and 7 show a simplified form of separator in accordance with invention having a single outlet **15** for the gases leading to the purging vessel **3**, and it shows in further detail the arrangement of the deformable elements, provided in this case by the diaphragm **9**, valve **11** and spring **13** of the auxiliary chamber **2**. The chamber **1** of the separator is connected to the purging chamber **3** via a conduit **15** which may be closed by means of a valve **11**. Valve **11** is supported on the diaphragm **9**, one of whose faces is in permanent, direct communication with the chamber **1**. The other face is subjected to the pressure existing in the auxiliary chamber **2**. Chamber **2** communicates with the chamber **1** via an opening **5** and with the purging vessel **3** via a conduit **4**. The cross section of the conduit **4** is smaller than that of the opening **5**. The latter may be closed by means of a valve **6** controlled by a lever which is pivoted at **7*a*** and coupled to a float **7**. The size of the opening **5** being larger than the cross section of the conduit **4**, the passage of the foam formed by the air and liquid is retarded due to the small size of the conduit **4** compared to the passage **5**. For the same reason, the pressure in the chamber **2** is the same as that existing in the separating chamber **1** while valve **6** is open. The spring **13** will therefore hold the valve **11** in position to close the conduit **15** so long as the valve **6** leaves the opening **5** open.

Let it be supposed that the chamber **1** is entirely empty and that the same is true of the purging vessel **3**. During filling of the apparatus, the liquid level will rise in the chamber **1**. During such rise the float **7** will be in its lowermost position so that the valve **6** will close the opening **5**. The pressure existing in the chamber **2** is therefore that of the purging vessel **3** (i.e., atmospheric), and the pressure which gradually rises in the separating chamber **1** will finally open the valve **11**. Any gases which have been delivered by the liquids, as well as the air initially present in chamber **1** which has now been displaced by liquid, can then freely escape through the conduit **15** into the purging vessel **3**.

When the liquid rises high enough in chamber **1**, the float **7** will lift, withdrawing the valve **6** from the opening **5**. The pressure in the chamber **2** will rise substantially to that of chamber **1**, due to retarding by the conduit **4** of the flow of liquid through it. The pressure in the chamber **2** thus tends to rise to that existing in the separator **1**, and the spring **13** pushes the valve **11** to the position which closes the conduit **15**.

If there then occurs an arrival of gas, forced into the separator **1** with newly-arriving liquid, the float **7** will fall, which will close the opening **5** by means of valve **6**. The chamber **2** will then no longer be supplied with liquid and its contents will flow out through the conduit **4**. Under these conditions the pressure in the chamber **2** will decline and that existing in the chamber **1** will lift the diaphragm **9** and the valve **11** from the conduit **15**, which communicates directly and freely between the chamber **1** and the purging vessel **3**. As may be observed under all conditions:

(a) The opening of the direct access-controlling valv (**11** in FIG. 1, **9** in FIGS. 2 to 5 and **11** in FIGS. 6 an 7), and of the similar valve **10** in FIG. 1 and valve **8** i FIGS. 2 to 5 of the recycling line **14**, does not depen upon the travel of the float **7**. This travel may be ver small in order to operate effectively on the valve **6** whic controls an opening **5** (small compared with the direct access opening **15**) and thereby to operate effectively o the presssure in auxiliary chamber **2**.

(b) The opening of the direct access-controlling valve is produced as a result of the difference in pressure exist ing between the separating chamber **1** and auxiliary cham ber **2** when the latter is placed at atmospheric pressur by operation of the float-operated control valve **6**, in con junction with the valve-loading spring **13**. Similarly, i the embodiments of FIGS. 1 and 2 to 5, the opening o the recycle line controlling valve (valve **10** in FIG. 1 an valve **8** in FIG. 4), is produced as a result of the sam difference in pressure, in conjunction with the valve-load ing spring **12** and the effect of reduced pressure in th line **14**. To establish this difference in pressure betwee chambers **1** and **2**, the auxiliary chamber is subjected t atmospheric pressure by closure of valve **6** in the case o FIGS. 1, 6 and 7 and by opening thereof in the case o FIGS. 2 to 5.

(c) The functional sensitivity is very great due to th fact that the control valve **6** operates on a passage o small cross section compared to that required by the direc access valves **10**, **11**, **8**, **9**.

It will thus be seen that the invention provides separat ing apparatus in which gases (including of course air) o foams or emulsions are separated from liquid in a sep arating chamber. The gases, foams or emulsions pass ou of the separating chamber (preferably into a settling o purging chamber in which the liquid constituent of the foam or emulsion may be recovered) through a valve o large flow capacity which is operated by the difference in pressure between the separating chamber and an auxiliary chamber. The large flow capacity valve, hereinabove sometimes called a direct access valve, is spring-loaded to closed position and is opened by an excess of pressure in the separating chamber over that in the auxiliary chamber. The auxiliary chamber connects through separate conduits, preferably of unlike flow section, with the separating chamber and with the exterior of the separating chamber (preferably the purging chamber, if one is provided). One of these conduits is opened and closed by the movement of a control valve responsive, as by action of a float, to changes in liquid level in the separating chamber so that as long as the float is not lifted by liquid in the separating chamber, a higher pressure can be built up by the pump in the separating chamber than in the auxiliary chamber. This higher pressure opens the large flow capacity valve as necessary to permit gases, foams or emulsions accumulated at the upper part of the separating chamber to flow out into the purging chamber. Lifting of the float by liquid on the other hand prevents maintenance of this pressure difference, and so prevents direct pumping of liquid as such through the large flow capacity valve. In certain embodiments of the invention illustrated in FIG. 1 and in FIGS. 6 and 7, the large flow capacity valve is built into a diaphragm or flexible portion of the wall separating the separating and auxiliary chambers, whereas in another embodiment (that of FIGS. 2 to 5) the large flow capacity valve (**9**) slides in suitable guides.

While the invention has been described herein in terms of a number of preferred embodiments, the invention itself is not limited thereto; rather the invention comprehends all modifications and variations thereof falling within the spirit and scope of the appended claims.

We claim:

1. Apparatus for degasifying liquids comprising a separating chamber having an inlet and a liquid outlet, an auxiliary chamber, a purging chamber, a pump having an intake and having a discharge connected to said inlet, a first conduit between the separating and auxiliary chambers, a first valve in said first conduit, a second conduit of greater flow resistance than said first conduit between said auxiliary and purging chambers, a second valve between the separating and purging chambers, a third valve between the separating chamber and pump intake, means responsive to a rise in liquid level in the separating chamber to open said first valve, means responsive to a pressure in said separating chamber higher by a first amount than the pressure in said auxiliary chamber to open said second valve, and means responsive to a pressure in said separating chamber higher by a greater amount than the pressure in said auxiliary chamber to open said third valve.

2. Apparatus for degasifying liquids comprising a separating chamber having an inlet and a liquid outlet, an auxiliary chamber, a purging chamber, a pump having an intake and having a discharge connected to said inlet, a first conduit between the separating and auxiliary chambers, a second conduit of lesser flow resistance than said first conduit between the auxiliary and purging chambers, a first valve in said second conduit, a second valve between the separating and purging chambers, a third valve between the separating chamber and pump intake, means responsive to a rise in liquid level in said separating chamber to close said first valve, means responsive to a pressure in said separating chamber higher by a first amount than the pressure in said auxiliary chamber to open said second valve, and means responsive to a pressure in said separating chamber higher by a larger amount than the pressure in said auxiliary chamber to open said third valve.

3. In an apparatus for degasifying liquids having a pump, a separating chamber provided with an inlet for liquid to be degasified, an outlet for degasified liquid, a gas and foam outlet to a purging chamber, and a gas and foam outlet to the suction side of the pump, the improvement which comprises an auxiliary chamber, a conduit between the separating and auxiliary chambers, a conduit between the auxiliary and purging chambers, said conduits having unlike resistance to flow, a first valve in the one of said conduits of lesser resistance to flow, a second valve controlling the gas and foam outlet to the purging chamber, a third valve controlling the gas and foam outlet to the suction side of the pump, means responsive to liquid level in the separating chamber to control said first valve, first resilient means biasing said second valve to closed position and permitting said second valve to open for a first excess of presusre in said separating chamber over said auxiliary chamber, and second resilient means biasing said third valve to closed position, said second resilient means permitting said third valve to open for a second excess of pressure in said separating chamber over said auxiliary chamber greater than said first excess.

4. Apparatus according to claim **3** wherein the one of said conduits of lesser resistance to flow is between the separating and auxiliary chambers and wherein said means responsive to liquid level open said first valve upon rise in said liquid level above a predetermined limit.

5. Apparatus according to claim **3** wherein the one of said conduits of lesser resistance to flow is between the auxiliary and purging chambers and wherein said means repsonsive to liquid level close said first valve upon rise in said liquid level above a predetermined limit.

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