United States Patent

[11] 3,587,211

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[33] **France**
[31] **159,957**

[54] **DEVICE FOR DEGASSING LIQUIDS**
9 Claims, 6 Drawing Figs.

[52] **U.S. Cl.** **55/199**
[51] **Int. Cl.** **B01d 19/00**
[50] **Field of Search** 55/41, 170, 193, 199, 202, 440

[56] **References Cited**

UNITED STATES PATENTS

2,296,543	9/1942	Steen et al.	55/199
3,282,030	11/1966	Griffo et al.	55/170
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1,299,589	6/1962	France

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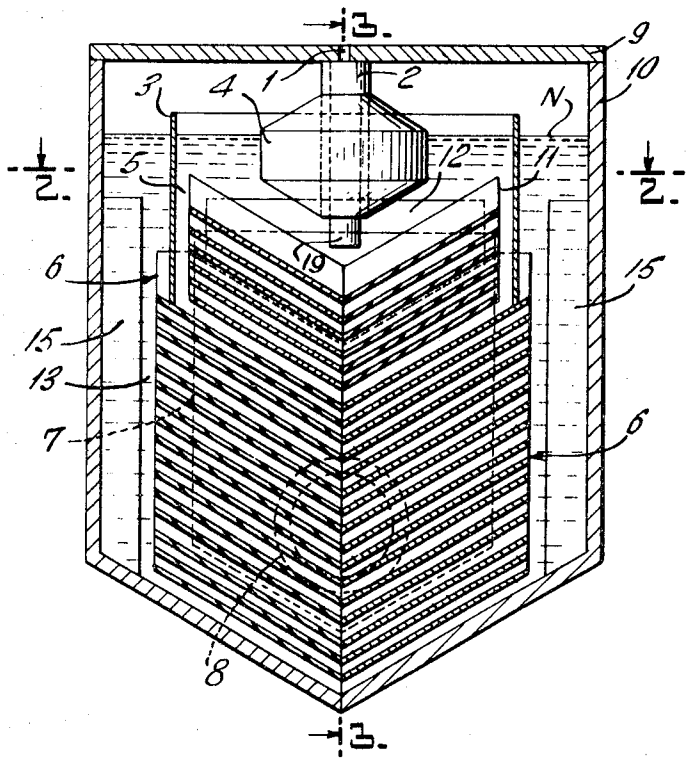
ABSTRACT: A liquid-degassing device comprises a main separator composed of a plurality of spaced and parallel dihedral sheets each having a pair of side portions rising in opposite directions from its apex line, to provide a plurality of superposed laminar liquid passages in the direction of the aligned apex lines of the sheets of shallow angular cross section. The member is mounted within a closed housing between a pair of liquid input and output equalizing chambers for dividing and passing a liquid stream to be degassed into multiple laminar partial streams traversing said passages, with the liquid rising and emerging laterally from said passages to a predetermined level above said member enclosing a gas collecting chamber with the adjoining housing walls. As a result, liquid bubbles rise laterally along the laminar passages and upwardly into said collecting chamber. Special liquid deflecting means act to bypass spurious lateral liquid currents in an upward direction upon emerging from the open lateral ends of the laminar passages for subsequent passage through an auxiliary separator disposed above the main separator.



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SHEET 1 OF 2

Fig. 1.

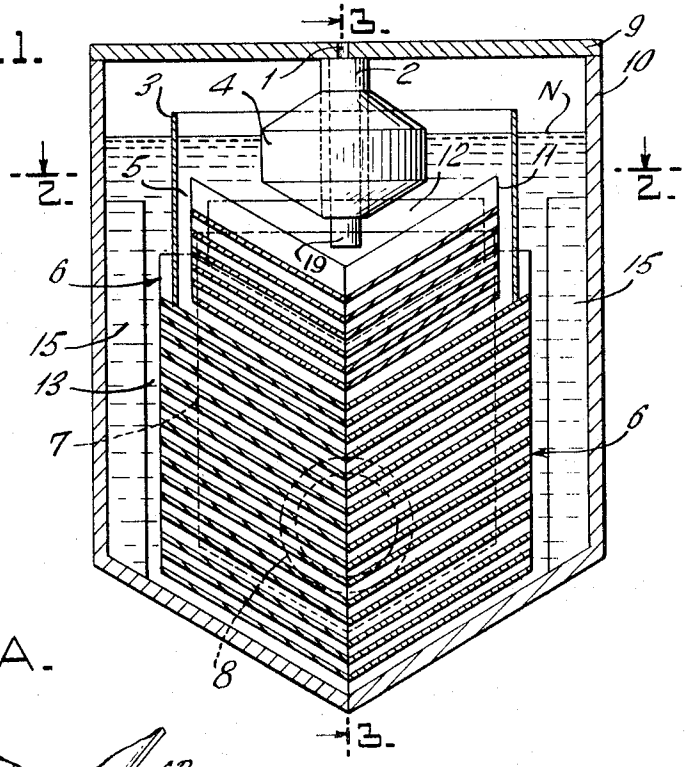

Fig. 1A.

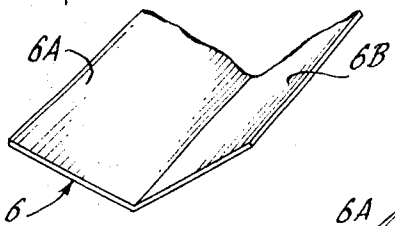

Fig. 2.

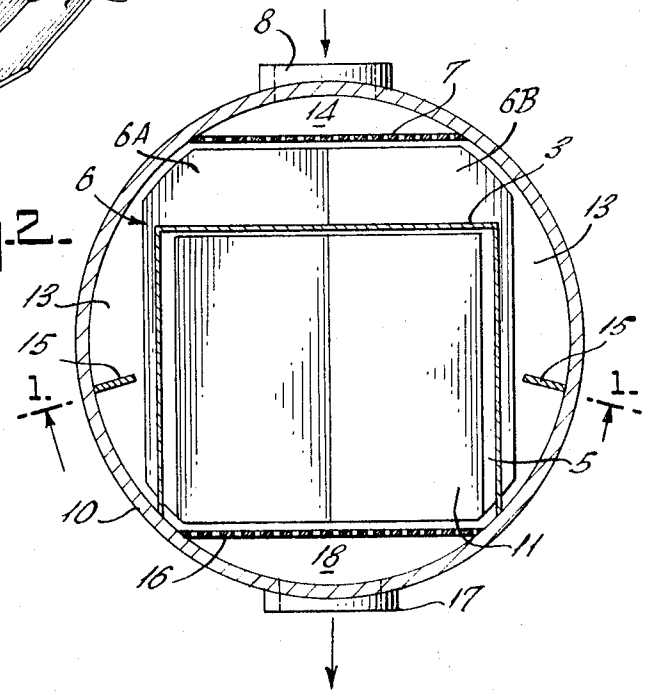

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Fig. 3.

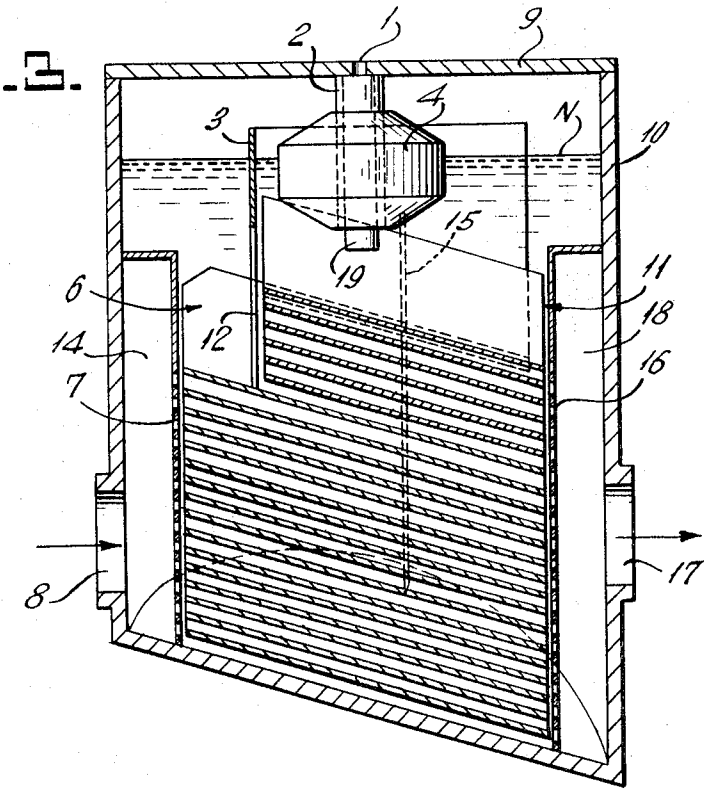

Fig. 4.

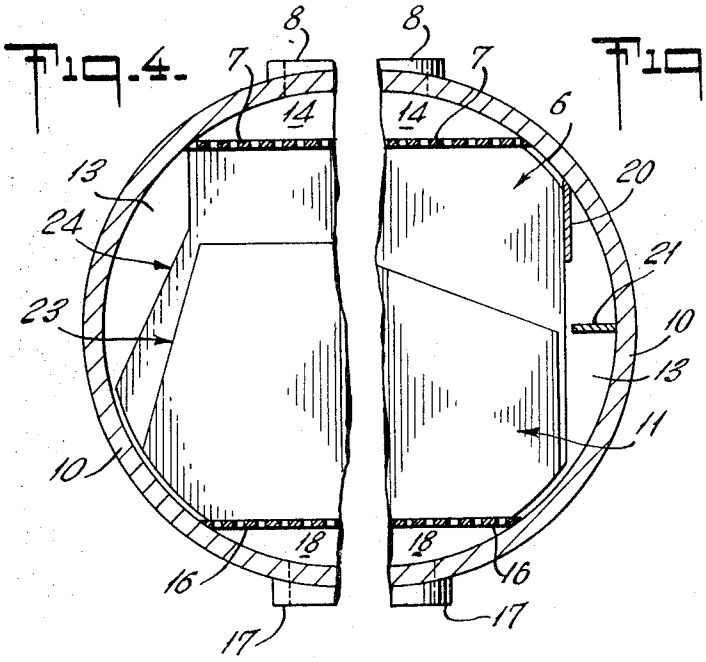

Fig. 4A.

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DEVICE FOR DEGASSING LIQUIDS

The present invention relates to liquid-degassing or separating devices of the general type shown and described by French Pat. No. 1,299,589 and comprising essentially a separator member composed of a plurality of spaced and parallel dihedral sheets of metal or the like, each sheet having a pair of side portions rising in opposite directions from its apex line and the sheets being arranged in spaced and aligned relation, to provide a plurality of superposed laminar liquid passages of relatively shallow angular cross section. By passing a liquid stream to be degassed through said passages in the form of a plurality of partial laminar streams recombined at the output end of the device, gas bubbles contained in the liquid are enabled to readily rise laterally along and outwardly from the laminar passages for collection and removal by any suitable evacuation means.

The present invention has for its main object the provision of an improved separator or liquid-degassing device of the type shown by the above patent and designed to substantially improve the efficiency of the gas separation, whereby to increase the output and reduce the cost of a device of given size or dimensions.

The invention, both as to the foregoing and ancillary objects as well as novel aspects thereof, will be better understood from the following detailed description, taken in conjunction with the accompanying drawings forming part of this disclosure and in which:

FIG. 1 is a vertical cross-sectional view, taken on line 1–1 of FIG. 2, of a separator or liquid-degassing device embodying the improvements according to the invention;

FIG. 1A is a detail view shown in perspective;

FIG. 2 is a horizontal cross-sectional view taken on line 2–2 of FIG. 1; and

FIG. 3 is a vertical cross-sectional view taken on line 3–3 of FIG. 1;

FIGS. 4 and 4A are fragmentary horizontal cross sections similar to FIG. 2 and showing modifications of the invention.

Like reference numerals denote like parts throughout the different views of the drawings.

In the following there will be described a basic separator device and its function according to the prior art as represented by the aforementioned French patent.

Referring more particularly to FIGS. 1–3, the separator or degassing device shown comprises essentially a closed cylindrical housing **10** having an angular-shaped bottom wall and a cover **9** and being fitted with a pair of opposite horizontal ingress and egress ports or openings **8** and **17**, respectively, for the forceful passing of a liquid to be degassed through the device, as indicated by the arrows in FIGS. **2** and **3**. Cover **9** has a vent hole **1** for cooperation with a float **4** fitted with a tubular shutter which in turn cooperates with a hollow cylinder serving as a guide for the float **4** and having suitable vent openings, to maintain a constant liquid level N, in the manner more clearly described hereinafter.

The separator member proper disposed within the housing **10** comprises a plurality of spaced and superposed dihedral sheets **6** of metal or a like material having side portions **6A** and **6B**, FIG. **1A**, extending upwardly from an apex line, whereby to provide a plurality of substantially horizontal laminar liquid passages of shallow angular cross section extending between the ingress and egress ports **8** and **13**. Interposed between the latter and the separator member proper are closed input and output equalizing chambers **14** and **18** formed, in the example shown, by parts of the cylindrical housing wall and including a pair of parallel perforate walls **7** and **14**, respectively, between which are disposed the set of spaced angular sheets **6**.

Preferably the superposed and aligned apex lines of the sheets **6** coinciding substantially with the direction of the liquid flow through the device descend from the input chamber **14** to the output chamber **18** at a predetermined incline angle, as more clearly seen in FIG. **3**.

Disposed adjacent to each of the opposite lateral ends of the angular laminar passages provided by the sheets **6** are a pair of vertical liquid passages **13** defined, in the example shown, by the lateral edges of the sheets **6** and the adjoining cylindrical wall portions of the housing **10**. As can be seen, the perforations of the wall **7** of the input chamber extend only to the uppermost sheet **6** of the separator member, while the perforations of the wall **16** of the output chamber extend to a higher level, for the purpose as more clearly described hereinafter.

In brief, the function of the conventional separator or degassing device described in the foregoing is as follows. The liquid to be degassed arriving at the ingress opening **8** spreads through the chamber **14** to be applied against the perforate wall **8** and, upon traversing said wall, passes, at a reduced speed and in the form of a plurality of laminar partial streams of angular cross section, through the separator member composed of the sheets **6**, to be recombined in the output chamber **18** for delivery to and discharge from the egress port **17**. Due to the substantial speed reduction during passage of the liquid through the separator member and the increase in liquid pressure resulting therefrom, the liquid emerging from the opposite lateral ends of the laminar passages rises to form a predetermined liquid level N within the housing **10**, said level being maintained constant by the float **4**. At the same time, the air or other gas bubbles contained in the liquid rise in passing transversely through the individual laminar passages and upwardly through the lateral passages **13**, to be collected in the evacuation chamber formed above and by the liquid level N and the adjoining housing walls. The gas thus collected may be removed or evacuated in any suitable manner. Due to the subdivision of the main liquid stream into a large number of relatively flat or laminar partial streams in the manner shown and described, an expeditious and effective gas separation may be achieved in a relatively simple and efficient manner.

In using a separator of the foregoing type, applicant has discovered the existence of undesired spurious or transverse currents due to the angular shape of the sheets **6**, on the one hand, and to the suddenly imposed deflection and change of direction of the liquid stream upon emerging from the perforations of the wall or plate **7** of the input chamber **14**, on the other hand. As a consequence, a substantial portion of the main liquid stream will be forced laterally and outwardly into the vertical passages **13**, creating thereby rising spurious currents of an intensity depending mainly upon the angle of the sheets **6** and the square of the initial liquid speed. In other words, the speed to be considered is that of the laminar streams immediately upon emerging from the perforations of the wall **7**, rather than the speed of the recombined streams, the former speed being many times greater than the latter speed. This phenomenon, which may arise with relatively shallow angles of the sheets **6** and at relatively low liquid speeds, is highly undesirable for the following reasons, among others.

In the first place, the liquid being deviated laterally through higher laminar compartments or passages of the separator acts to accelerate and disturb, due to its following an oblique course upon leaving the separator, the conditions in the upper part or expulsion chamber of the device. In the second place, the spurious or lateral liquid currents emerging from the lower laminar compartments of the separator, in rising obliquely within the vertical passages **13**, may at least in part reenter said compartments at an upper level, carrying along thereby the gas bubbles contained therein which are thus prevented from being collected and evacuated. As a result, the efficiency of the gas separation is greatly reduced thereby, aside from other disadvantages and defects resulting from the lateral liquid flow or currents.

Accordingly, a more specific object of the invention is the provision of means in conjunction with a liquid-degassing device of the referred to type by which the disadvantages and defects resulting from a lateral liquid flow are substantially reduced or minimized and the efficiency of the gas separation increased accordingly.

Another object of the invention is the prevention of spurious cross currents in a device of the referred to type from

reentering the separator prior to collection and expulsion of the gases to be removed.

Yet another object of the invention is the provision of means in conjunction with a liquid-degassing device of the referred type to direct or deviate the undesirable cross currents in an substantially upward direction for collection of the gases contained therein in the evacuation chamber chamber of the device.

Another object of the invention is the provision of means in conjunction with a liquid degassing device of the referred to type to guide or direct the cross currents for impingement upon an auxiliary separator member disposed above the main separator member and effectively shunting the main separator for removal of the residual gases contained in said currents.

According to a first feature and aspect of the invention, as shown by FIGS. 1 and 3, there is provided means in the form of a pair of guide or deflector plates 15 disposed within the lateral vertical liquid passages 13, said plates extending, in the example shown, substantially radially to the cylinder axis and upwardly to points close and below the liquid level N. As a consequence, the spurious transverse currents emerging from the main separator member are deviated in the upward direction, whereby to promote or accelerate the rising of the gas bubbles carried thereby, while substantially preventing a return of the currents or part thereof to the separator member. In other words, the effect of the guide or deflector plates 15 per se results in a substantial improvement of the efficiency of the device in separating or expelling the gas or gasses contained in the liquid stream being treated.

According to a further feature and aspect of the invention, the deflected transverse liquid currents are in turn passed through an auxiliary separator similar to the main separator member composed of the sheets 6 and disposed above said main member, said auxiliary separator being in effective parallel relation in respect to the main liquid flow through the main member and being comprised, in the example shown, of a plurality of auxiliary dihedral sheets 11 similar to but of shorter length and lesser number than the sheets 6, the arrangement of the parts being furthermore such as to cause the vertical liquid currents in the passages 13, or a substantial part thereof, to be impinged upon the auxiliary separator and discharged into the output chamber 18 via the perforate plate or wall 16, the latter being extended for this purpose in the upward direction, to encompass the output ends of both the main and auxiliary separator members.

In brief, the guide plates 15, by vertically deflecting the lateral or spurious liquid currents emerging at oblique angles from the output ends of the laminar flow passages of the main separator member, substantially prevent said currents from reentering the member, on the one hand, while carrying along the gas bubbles contained in the liquid for collection in the evacuation chamber above the liquid level N and/or renewed passage through the auxiliary separator constituted by the sheets 11, on the other hand.

Furthermore, according to the invention as shown by the drawing, a U-shaped cage 3 having three sides is placed upon the uppermost sheet 6 of the main separator member, to enclose the auxiliary separator member 11 and to provide auxiliary vertical liquid passages 5 adjoining the lateral open ends of the sheets 11. The outer parts of the cage 3 which may conform with the shape of the housing 10 may be secured to the later while the central part of the U is provided with a suitable recess or aperture, to provide ready access of the vertical liquid stream or currents to the input ends of the auxiliary separator member. The cage 3 terminates at a point below the liquid level N and its inner space is such as to leave a triangular opening 12 between the cage and the auxiliary separator, affording thereby adequate communication between the inside and the outside of the cage.

In operation, the two vertical currents rising within the passages 13 pass around the sides of the cage 3 to combine in front of the central portion of the cage. As a consequence, the major portion of the gas bubbles carried by the currents rise and are collected in the evacuation chamber above the liquid level N, while the bubbles having too low a speed remain immersed to be separated by passage of the currents through the auxiliary separator member composed of the sheets 11. Again, the gas bubbles pass transversely between the auxiliary sheets 11 and into the vertical passages 5, to be collected in the evacuation chamber, in substantially the same manner as in the main or primary separator composed of the sheets 6.

The float 4 in following the variations of the liquid level N causes its tubular shutter 2 being guided by the cylinder 19 to cover or uncover, respectively, the vent holes in the latter communicating with the escape opening 1, whereby to maintain the liquid level N at a predetermined constant value.

The accelerating effect on the lateral or bypass currents utilized in accordance with the invention, the impact exerted by said currents at the input ends of the laminar flow passages formed by the sheets 6, that is, exactly at the point where the liquid contains a maximum of gas to be evacuated, as well as the utilization of the auxiliary separator composed of the sheets 11, all combine in enabling the use of primary separator sheets 6 spaced by relatively small vertical distances, to afford an optimum liquid output or efficiency of the device for a desired degree of gas separation, the output being advantageously controlled by the three-fold variation of the spacing of the sheets 11, the position or orientation of the plates 15 and the incline angle of the sheets 6, respectively.

Various modifications of the liquid-degassing device described will suggest themselves to those skilled in the art.

Thus, a practically complete degassing effect, though at the expense of reduced speed, may be achieved by the use of an entrance plate or wall 7 the perforations of which, which may have any shape, are inclined at an angle so as to be in line with the incline angle of the apex lines of the sheets 6, whereby to minimize the generation of spurious or lateral currents transverse to the main liquid flow through the separator.

According to another modification, the same effect is obtained by the sheets 6 of the separator being arranged with their apex lines extending horizontally, in which case the openings in the plate may also be horizontal, to again reduce or minimize the lateral or bypass current, though at the expense of reduced efficiency or output of the device.

According to another modification as shown by FIG. 4, two vertical baffle plates 20 adjoin the lateral edges of the sheets along a portion of their length and on the side of the input port 8. The function of the plates 20 is to contain the liquid laterally where it changes its direction, to prevent the creation of a lateral or bypass current. This makes it possible to vary the incline angle of the sheets 6, to suit a particular case or condition.

According to still another modification also shown by FIG. 4, the cage 3 is omitted and the vertical plates disposed centrally within the passages 13, as shown at 21 in the figure. The resulting function is the same as in the preceding modification with this difference that the auxiliary sheets 11 act to evacuate the gas bubbles within the downstream portion of the passages 13.

Finally, yet another modification as shown by FIG. 4A involves the omission of both the cage 3 and the separator plates 15 or 21, respectively. In this case, the sheets of the primary separator may have a shape as shown at 24 and the sheets of the auxiliary separator may have a shape as shown at 23 in the figure, resulting in a function of the device as described in the following.

On the one hand, the bypass current emerging from between the lower primary sheets 24 traverses the passages 13 in an oblique direction and reenters, at a relatively higher level, the spaces between the remaining (upper) sheets 24 of the separator. The current then passes between the sheets to be subjected to a second but less short gas evacuation before reaching the output plate 16. On the other hand, the bypass currents emerging from between the upper primary sheets 24, arrive at the evacuation chamber by following an oblique course laterally of the auxiliary separator or sheets 23, due to

the retraced position of the latter, as shown in the figure. The currents then make a half turn and combine with the first bypass current, whereupon the combined current passes between the auxiliary sheets 23 to be finally discharged through the plate 16. The gas bubbles emerging from between the sheets 23 escape through the open lateral ends of the separator and combine with the bypass current passing above the auxiliary separator.

Other variations are possible, in particular the use of auxiliary sheets having single inclined portions arranged either lengthwise or crosswise, in which case the output of the device is reduced. According to another variation, the primary sheets, to preserve the effect of angular sheets without producing any transverse current, may have a complex shape by combining the transverse inclination of the sheets with a longitudinal profile having a contour descending towards the output of the device. Alternatively, the transverse inclination of the angular separating sheets may be inverted, in which case the gas bubbles to be removed are directed towards a common central evacuation passage.

In all the aforedescribed embodiments, the bypass currents are either suppressed, reduced, or utilized to effect additional gas separation, the result being an increase of as much as 50 percent of the output of the device. The auxiliary separator may be substantially ineffective under certain operating conditions by the transverse current rising freely through the vertical flow passages. For greater outputs part of the bypass current is then deviated through the auxiliary separator, to maintain high output efficiency within a wide range of operating conditions.

In the foregoing, the invention has been described in reference to a preferred exemplary device or embodiment. It will be evident, however, that variations and modifications as well as the substitution of equivalent parts and devices shown for illustration, may be made without departing from the broader purview and spirit of the invention.

I claim:

1. A device for degassing liquids comprising in combination:
1. a closed housing
2. oppositely disposed horizontal ingress and egress ports in said housing for passing therethrough a liquid to be degassed,
3. closed input and output chambers communicating respectively with said ingress and egress ports,
4. each of said chambers having a perforate wall with the walls of both chambers being parallel and spaced from one another,
5. a separator member composed of a plurality of spaced and parallel dihedral sheets, each of said sheets having a pair of side portions rising in opposite directions from an apex line, to provide a plurality of aligned and superposed laminar liquid passages of relatively shallow angular cross section,
6. said member being disposed between and adjoining said walls, to cause a liquid stream supplied to said input chamber via said ingress port to be divided into a plurality of parallel laminar partial streams passing through said passages substantially in the direction of the apex lines of said sheets and being recombined in said output chamber for discharge from said egress port,
7. means to provide a pair of lateral vertical liquid passages each communicating with one of the open lateral ends of said laminar passages, to cause liquid to rise above said member and to a predetermined level enclosing a gas evacuation chamber with the adjoining wall portions of said housing,
8. whereby to cause gas bubbles contained in said liquid to rise through said laminar and vertical passages to said chamber, and
9. deflector means within said lateral passages to divert spurious transverse liquid currents emerging from the open lateral ends of said laminar passages into substantially vertical currents within said lateral passages.

2. A liquid-degassing device as claimed in claim 1, wherein said member is designed and arranged with the apex lines of said sheets descending from the wall of said input chamber to the wall of said output chamber at a predetermined incline angle.

3. A liquid-degassing device as claimed in claim 2, wherein the perforations in the wall of said input chamber extend at an angle equal to said predetermined incline angle.

4. A liquid-degassing device as claimed in claim 1, wherein said housing is in the form of a hollow cylinder and said deflector means is comprised of at least one vertical guide plate in each of said vertical liquid passages disposed radially to the cylinder axis and extending to points said liquid level.

5. A liquid-degassing device as claimed in claim 1, including an auxiliary separator member composed of dihedral sheets similar to but of reduced size compared with said first member, said second member being disposed above said first member and below said liquid level with the input ends of its laminar passages arranged to receive at least part of said vertical currents and with the output ends of its laminar passages adjoining the perforate wall of said output chamber, whereby to bypass the transverse liquid currents through said second separator member.

6. A liquid-degassing device as claimed in claim 1, including an auxiliary separator member composed of dihedral sheets similar to but of reduced size compared with said first member, said second member being disposed above said first member and below said liquid level with the input ends of its laminar passages arranged to receive at least part of said vertical currents and with the output ends of its laminar passages adjoining the perforate wall of said output chamber, whereby to by pass the transverse liquid currents through said second separator member, and further means spaced from each of the lateral ends of the laminar passages of said auxiliary separator member, to provide auxiliary vertical liquid passages adjoining said auxiliary separator member.

7. A liquid-degassing device as claimed in claim 6, said further means being in the form of a U-shaped member having lateral portions acting as separator plates and affixed to said housing and having a cross-portion formed with a recess adjoining the input ends of the laminar passages of said auxiliary member.

8. A liquid-degassing device as claimed in claim 1, including float means to maintain said liquid level at a substantially constant height above said member.

9. A device for degassing liquids comprising in combination:
1. a closed housing
2. ingress and egress ports in said housing for passing therethrough a liquid to be degassed,
3. a separator comprised of a plurality of spaced and parallel dihedral sheets, each of said sheets having a pair of side portions rising in opposite directions from an apex line, to provide a plurality of aligned superposed laminar liquid passages of angular cross section,
4. said separator being disposed between said ports, to cause an input liquid stream to be divided into a plurality of parallel laminar partial streams passing through said separator substantially in the direction of the apex lines of said sheets from the ingress to the egress port,
5. means to provide a pair of lateral vertical liquid passages each communicating with the open lateral ends on one side of said laminar passages, to cause liquid to rise above said separator to a predetermined level enclosing a gas evacuation chamber with the adjoining wall portion of said housing,
6. whereby to cause gas bubbles contained in said liquid to rise through said laminar and vertical passages and into said chamber, and
7. means within said lateral passages to divert spurious transverse liquid currents emerging from the open lateral ends of said laminar passages into substantially vertical currents through said lateral passages.