United States Patent

[11] **3,584,844**

[72] Inventor **Agoston Papp**
Budapest, Hungary
[21] Appl. No. **792,689**
[22] Filed **Jan. 21, 1969**
[45] Patented **June 15, 1971**
[73] Assignee **Chemokomplex Vegyipari Gep-Es Berendezes Export-Import Vallalat**
Budapest, Hungary
[32] Priority **July 25, 1968**
[33] **Hungary**
[31] **PA-974**

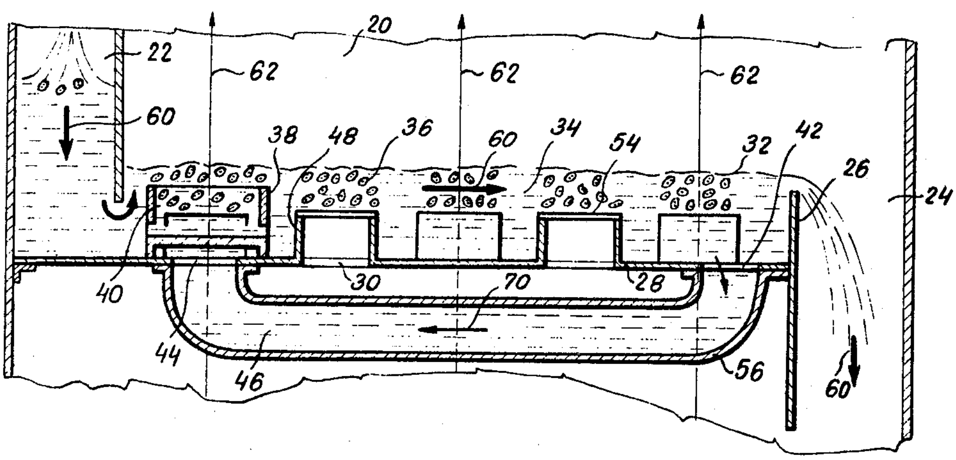
[54] **BUBBLE PLATES FOR BUBBLE TOWERS**
10 Claims, 13 Drawing Figs.

[52] **U.S. Cl.** **261/114**
[51] **Int. Cl.** **B01d 3/16**
[50] **Field of Search** .... 261/113, 114 (V.T.), 114, 114.1, 150; 202/158

[56] **References Cited**
FOREIGN PATENTS
355,437 8/1961 Switzerland 202/158

Primary Examiner—Tim R. Miles
Assistant Examiner—Steven H. Markowitz
Attorney—Young and Thompson

ABSTRACT: Thorough backmixing on a bubble plate and thereby improved plate efficiency is obtained by recirculating the liquid on a bubble plate in a vertical plane. For this purpose the air lift or mammoth pump principle is employed by means of which the liquid on the plate is enriched with gas traversing the plate at the far side thereof as regards its overflow weir which entails a local decrease of the specific weight of the liquid. Channels below the plate connect places in the neighborhood of the overflow weir with the places of locally decreased specific weight of the liquid. Consequently, the liquid of higher specific weight flows from the neighborhood of the overflow weir beneath the plate back to the far side of the plate where it ascends back into the main flow of the liquid which means a constant recirculation of the liquid around the plate in a vertical plane.



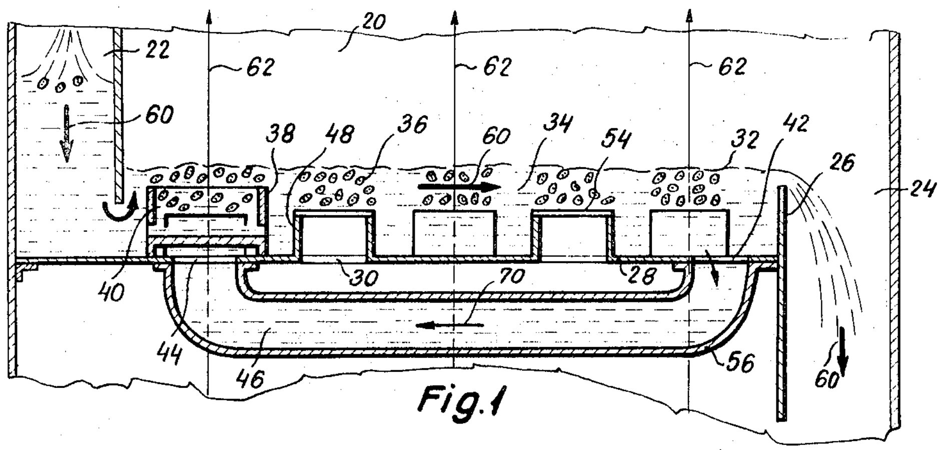


Fig. 1

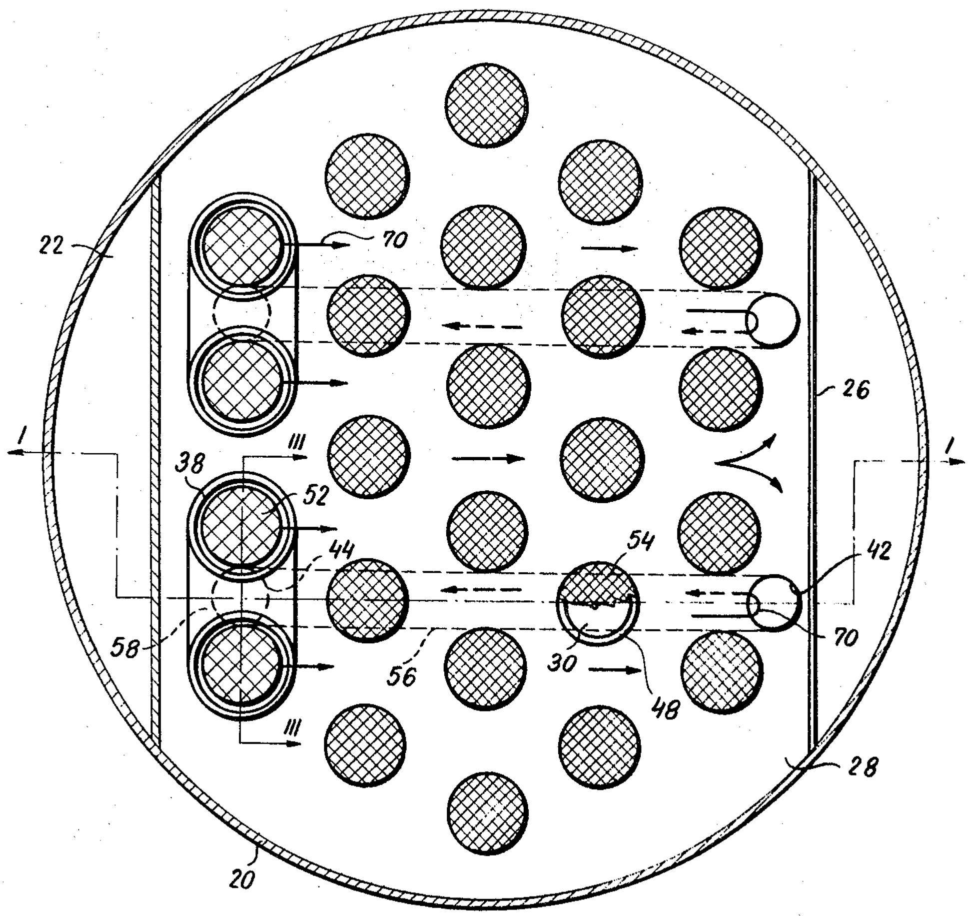


Fig. 2

INVENTOR

ÁGOSTON PAPP

BY Young + Thompson

ATTORNEYS

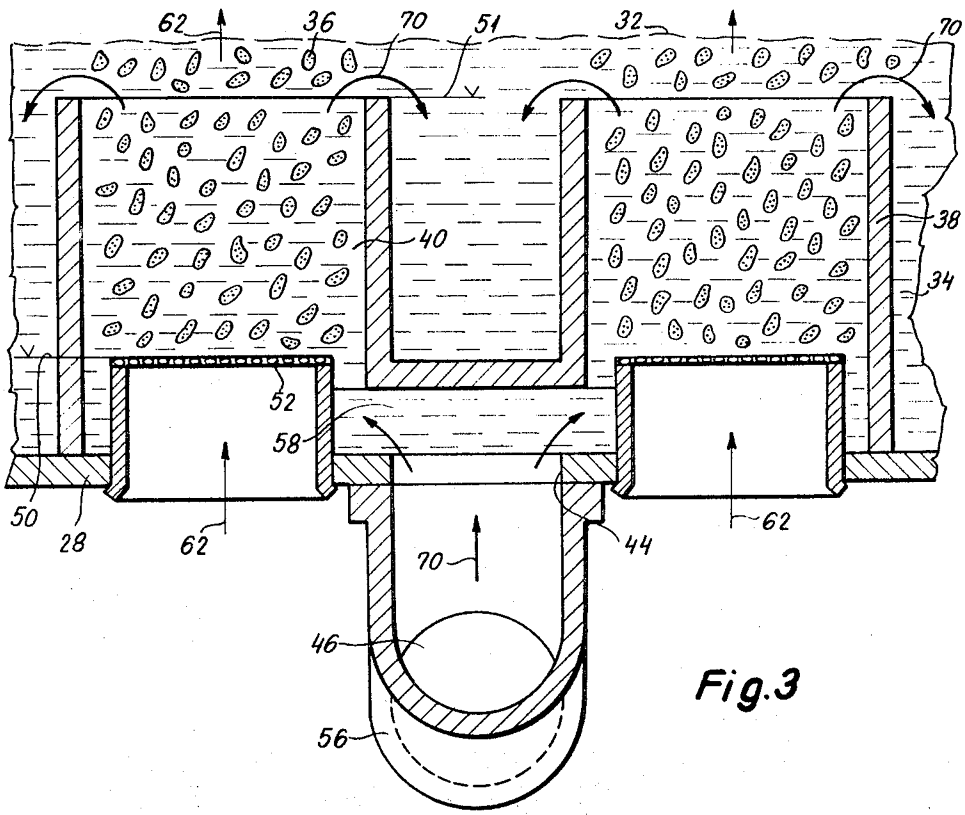


Fig.3

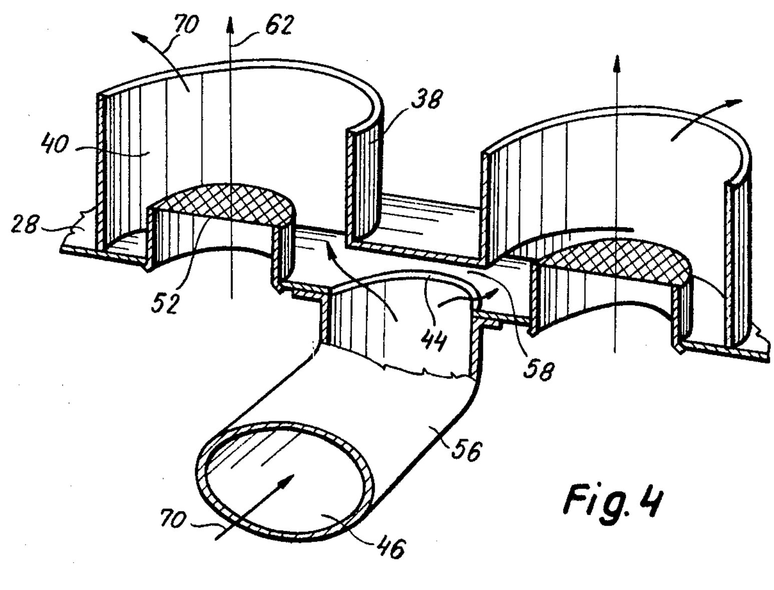


Fig.4

INVENTOR

ÁGOSTON PAPP

BY Young + Thompson

ATTORNEYS

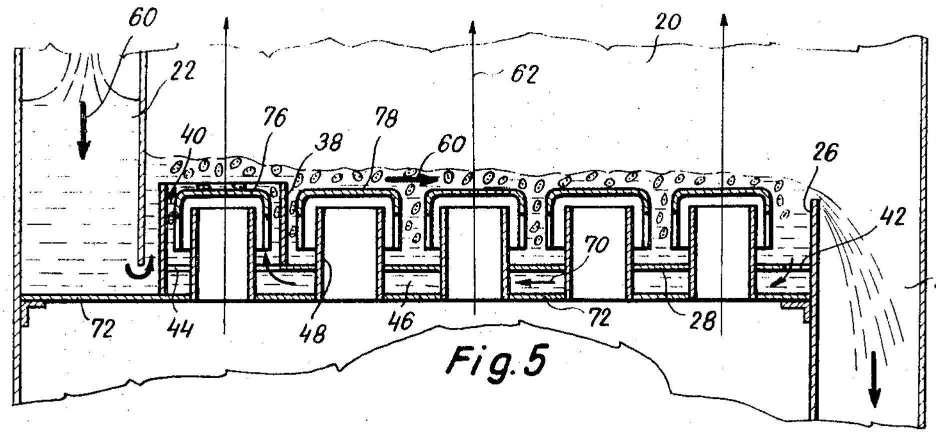


Fig. 5

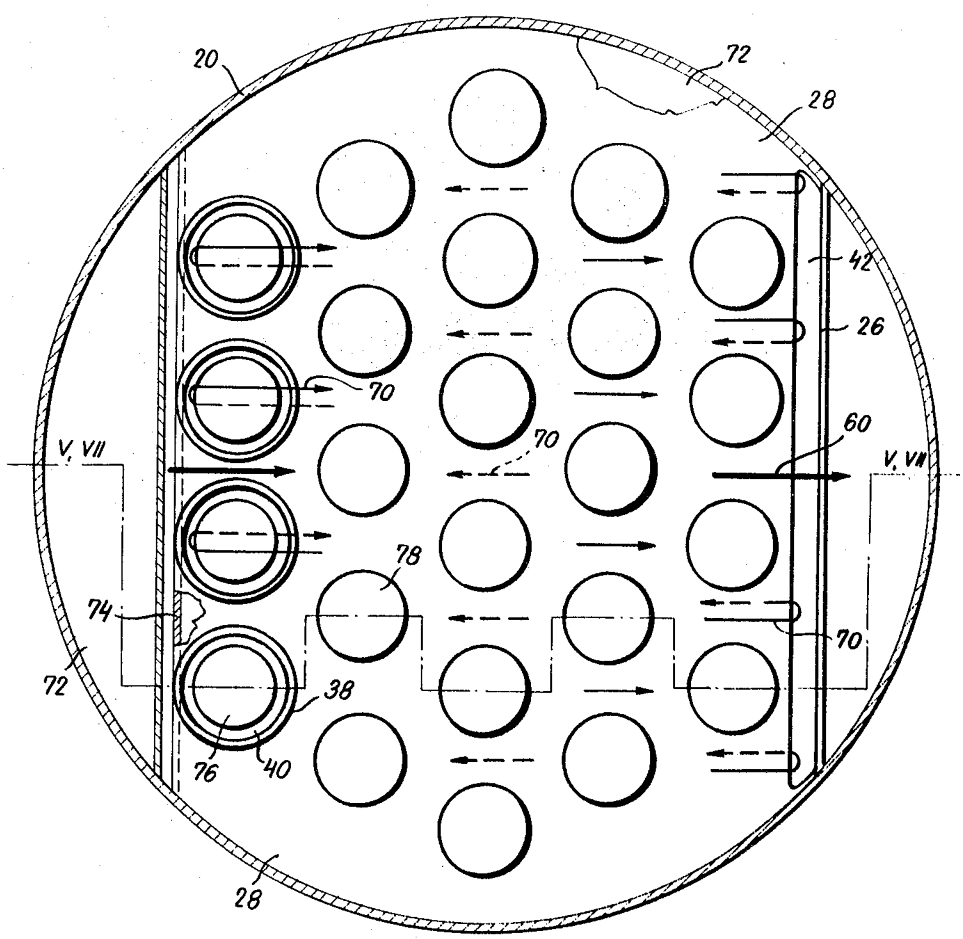


Fig. 6

INVENTOR

ÁGOSTON PAPP

BY Young & Thompson

ATTORNEYS

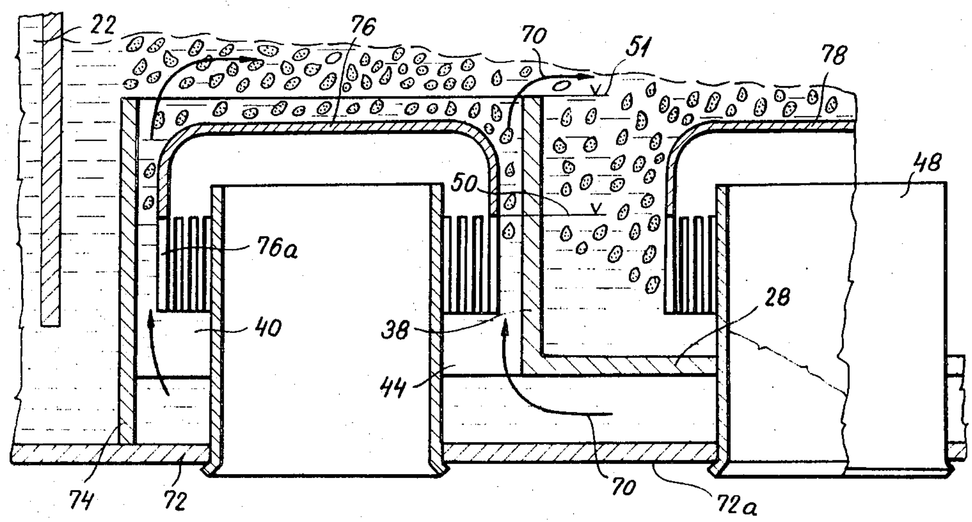


Fig. 7

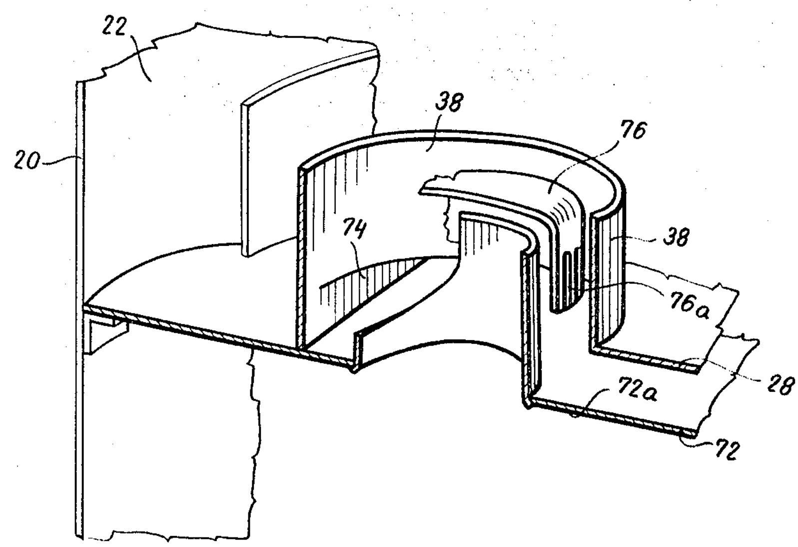


Fig. 8

INVENTOR

ÁGOSTON PAPP

BY Young + Thompson

ATTORNEYS

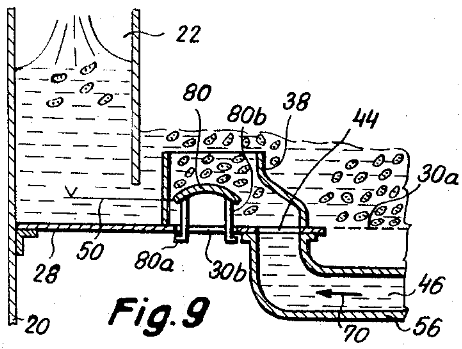


Fig. 9

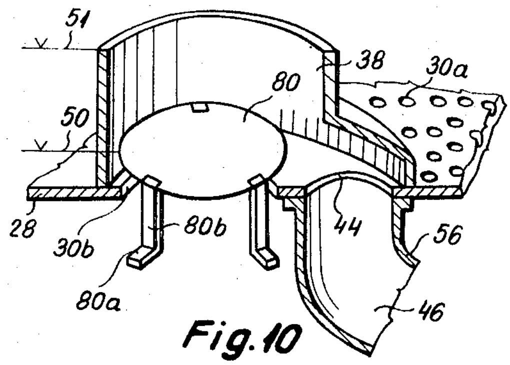


Fig. 10

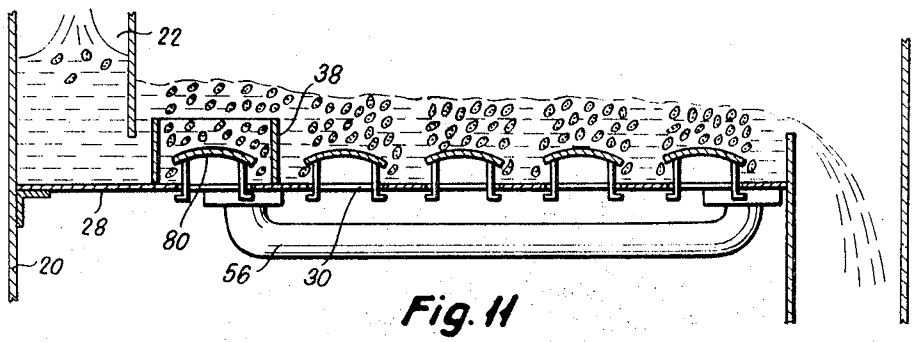


Fig. 11

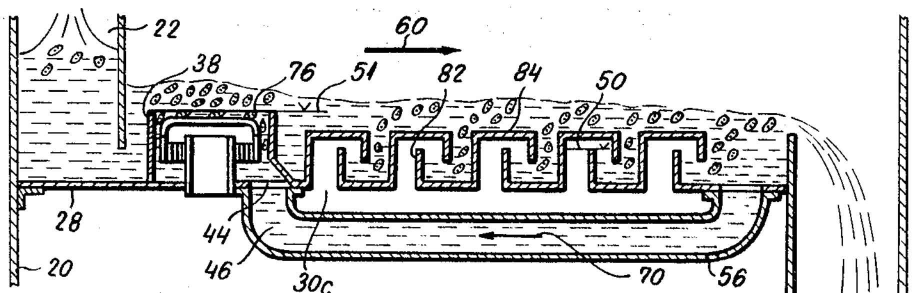


Fig. 12

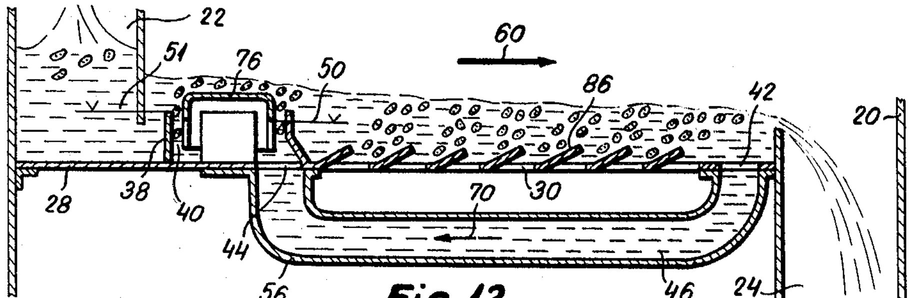


Fig. 13

INVENTOR

ÁGOSTON PAPP

BY Young + Thompson

ATTORNEYS

BUBBLE PLATES FOR BUBBLE TOWERS

This invention relates to a method of treating a liquid with a gaseous medium in a bubble tower and to a bubble plate for such method.

As is known, treating a liquid with a gaseous medium may be carried out in bubble towers which are described e.g. in W. S. Norman's "Absorption, Distillation and Cooling Towers" (Longmans, 1961). Bubble towers comprise bubble plates or trays which are likewise known in the art. Efficiency of a bubble tower largely depends on what is called the mass transfer driving force on its plates. The mass transfer driving force is the difference between the mole fraction of a gaseous medium at a point and the mole fraction of the gaseous medium in equilibrium with the liquid at the same point. The greater the mass transfer driving forces along the plate, the greater will be the mass transfer and, thus, the efficiency of the plate. The liquid, however, is in motion across the plate which means a concentration gradient on the plate and this, in turn, means a diminishing of the mass transfer driving forces in the direction of flow. The undesired result is a diminishing of the plate efficiency. Therefore, the actual number of plates has hitherto been substantially greater than theoretical plate numbers.

The main object of the present invention is to eliminate this inconvenience and to provide means whereby concentration gradients can be dispelled from or at least substantially reduced on bubble plates. The invention recognizes that thorough backmixing of the liquid on the plate entails compensation of composition differences which, in turn, results in diminishing of the concentration gradient and, thereby, in practically uniform mass transfer conditions on the plate. These again are, within practical limits, responsible for a possible optimum of overall plate efficiency. Thus, contrary to the general belief accepted in the art (e.g. op.cit. page 360) backmixing improves the plate efficiency and permits to employ a substantially lesser number of plates for a desired performance of separation.

In my copending application Ser. No. 714,360, filed March 19, 1968 and now abandoned it has been suggested to obtain such backmixing by recirculating the liquid on bubble plates by means of movable bubble caps which rotate in opposite directions in adjacent rows disposed in the main flow direction of the liquid. Thus, every other branch of flow between a pair of bubble cap rows is directed upstream and is handicapped by the hydraulic gradient across the plate.

The invention eliminates this inconvenience by employing a basically new concept of recirculation which consists in circulating the liquid in a vertical rather than in a horizontal plane or, in other words, around rather than on the tray of a bubble plate. This means that backflow of the liquid takes place beneath the tray of the bubble plate where it is relieved from counteracting the effect of the hydraulic gradient which appears only in the main flow of liquid on the tray. In order to ensure the motive force for such recirculation, the invention suggests to apply the airlift or mammoth pump principle of operation to bubble plates by which a backmixing of the liquid and, thereby, an intimate mixing of various portions thereof may be obtained through purely hydraulic conditions. The airlift or mammoth pump principle proper means that the specific weight of a liquid is locally decreased by air being admixed to it so that a local upward flow of the liquid will set in and exert a suction on liquid portions of heavier specific weight which, in turn, will flow to places where air is introduced. Thereby, a continuous upward flow of the liquid is obtained.

Applying the aforesaid principle to bubble towers with a plurality of bubble plates an improved method of treating a liquid with a gaseous medium in countercurrent flow with the gaseous medium flowing upwards and traversing a layer of the liquid on each bubble plate is obtained in which the improvement consists in the step of circulating such layer in a vertical plane by locally enriching the liquid in gaseous medium so as to decrease the specific weight of a portion of the layer with respect to the specific weight of other portions thereof, and to cause such other portions to flow beneath the layer to where the specific weight of it is relatively lower, such recirculation of the layer in a vertical plane resulting in substantially uniform composition of the liquid along the whole extension of recirculation. Theoretical considerations show that uniformity of composition and, thereby, zero value of the concentration gradient is the more approached the greater the bubbling depths on the plate. On the other hand, experiments prove that by the expedient of such recirculation the plate efficiency is rendered so high that, practically, optimum values can be reckoned with which means a considerable decrease of the number of plates required for a desired separation of substances.

The above-described method will preferably be carried out by means of a bubble plate for bubble towers comprising, in a manner known per se, a tray on which a constant level of liquid is maintained by an overflow weir, sealed perforations such as the meshes of a sieve in the tray being provided for a gaseous medium flowing upwardly therethrough. The bubble plate for carrying out the method according to the invention is distinguished over the prior art by the provision of a partition remote from the overflow weir and confining an axial passage above sequestered and perforated portion of the tray with a seal on the perforation, the level of the seal being lower than the level of the top brim of the partition, and the flow resistance of the axial passage against the flow of the gaseous medium being smaller than such flow resistance outside the partition, a passage of intercommunication in the tray upstream in the proximity of the overflow weir, another passage of intercommunication in the tray inside the partition, and a channel connecting both passages of intercommunication with one another beneath the tray.

Obviously, the level of the seal inside the partition must be lower than the level of the top brim of the partition since, otherwise, there would be no room for the liquid being enriched with gaseous medium.

A desired difference between the flow resistances inside and outside the partition is obtainable in various manners. Where the perforations inside and outside the partition are sealed with sieves at the level of the tray, the meshes of the sieve inside the partition may be of greater size than outside thereof. The same applies to seals consisting of foraminated plates. If the perforations are provided with risers or chimneys the height thereof may be relatively greater inside the partition. With seals consisting of axially movable bubble caps, the bubble cap employed inside the partition may be lighter. The aforesaid means of sealing may also be employed in combination. Then, their individual effects will be added. E.G. when a riser inside the partition is sealed by a sieve, the size of the meshes of the sieve may be equal to or, depending on the height of the riser, even smaller than that of the sieves employed for sealing the perforations outside the partition at the level of the tray, etc.

It will be seen that such features permit to easily recognize a difference between the gaseous medium flow resistances inside and outside the partition. Moreover, they are responsible for a suitable recirculation in a vertical plane on any type of bubble plates merely by defining hydraulic conditions which, by their very nature, generate pressure differences and, thereby, induce a flow of liquid in the direction of pressure drop as is in compliance with the above described airlift or mammoth pump principle.

The invention will now be described in closer details by taking reference to the accompanying drawings which show exemplified embodiments thereof and in which:

FIG. 1 is a longitudinal sectional view of an exemplified bubble plate taken along III–I of FIG. 2.

FIG. 2 shows a top view of the bubble plate according to FIG. 1.

FIG. 3 illustrates an enlarged sectional view of a detail taken along line III–III of FIG. 2.

FIG. 4 represents a perspective view of the detail illustrated in FIG. 3.

FIG. 5 is a longitudinal sectional view of another exemplified embodiment taken along line V–V of FIG. 6.

FIG. 6 shows a top view to FIG. 5.

FIG. 7 illustrates an enlarged sectional view of a bubble plate according to the present invention.

FIG. 8 represents a perspective view of the detail shown in FIG. 7.

FIG. 9 shows a longitudinal sectional view of still another exemplified embodiment.

FIG. 10 is a perspective view of a detail designated by a circle in FIG. 9.

FIGS. 11 to 13 illustrate longitudinal sectional views of further exemplified embodiments.

Same reference characters in the various views designate similar details thereof.

In the drawings, reference character **20** refers to an intermediate portion of a bubble tower known per se with a bubble plate according to the invention in it, the bubble plate being distinguished from the tower in the drawing by an increased thickness of lines. The bubble plate is arranged between downcomers **22** and **24** the inner walls of which form, above the levels of the bubble plates, overflow weirs as is known in the art. Thus, the inner wall of the downcomer **24** forms the overflow weir **26** of the represented bubble plate whereas the inner wall of the downcomer **22** forms the overflow weir of an uppernext bubble plate not shown. The overflow weir **26** is supported by a tray **28** with perforations in it one of which is designated by reference character **30**. As is known in the art, the overflow weir **26** serves for maintaining a constant level **32** of liquid **34** on the tray **28** while the perforations **30** are destined to permit a gaseous medium such as a vapor to flow upwards therethrough and traverse the layer of liquid **34** in the form of bubbles **36**.

A basic feature of the invention is the provision of one or more partitions such as partition **38** sequestering a portion of the surface of the tray **28** with at least one of the perforations **30** remote from the overflow weir **26** from other tray surface portions and confining an axial passage **40** on such sequestered area. The perforation **30** inside the partition **38** is sealed in a conventional manner. However, as has been pointed out, sealing means, design and/or dimensions are selected so that, on the one hand, the level of the seal on the perforation inside the partition be lower than the level of the top brim of the partition and, on the other hand, the flow resistance in the axial passage against the flow of the gaseous medium be smaller than such flow resistance outside the partition.

Another basic feature consists in that a backflow of the liquid **34** on tray **28** from the overflow weir **26** directly into the axial passage **40** is rendered possible by employing passages such as passages **42** and **44** of intercommunication in the tray **28** upstream in the proximity of the overflow weir **26** and in the sequestered portion, respectively, and a channel **46** which connects both passages **42** and **44** with one another beneath the tray **28**.

With the represented embodiment shown in FIGS. **1** to **4** the tray **28** is, in a manner known per se, studded with chimneys or risers **48** of similar heights which surround each a perforation **30** in the tray **28** and are sealed by sieves or foraminated plates in the usual manner.

However, members of the row of chimneys **48** remotest from the overflow weir **26** and in the immediate proximity of the downcomer **22** are distinguished from their fellow chimneys downstream in the tray **28** by that they are surrounded, pairwise and in spaced apart relationship, by a corresponding number of the partitions **38** which extend from the tray **28** upwardly beyond the chimneys **48** forming, in the instant case, four axial passages **40** each around and above a chimney **48** on the far side of the tray **28** as regards the overflow weir **28**.

Furthermore, the chimneys **48** inside and outside the partitions **38** are sealed by sieves of different mesh sizes and, therefore, designated by different reference numerals **52** and **54**, respectively (see e.g. FIG. **2**). Meshes of the sieves **52** inside the partitions **38** are bigger than the meshes of the sieves **54** outside the partitions **38**. Consequently, a gaseous medium flowing upwards through chimneys **48** inside the partitions **38** will meet smaller flow resistance than in chimneys **48** outside the partitions **38** which is a basic requirement of the invention. It is seen (FIG. 3) that the level of the seals arranged on the chimneys **48** inside the partitions **38**, such as level **50** of the sieves **52**, is lower than level **51** of the top brims of the partitions **38** so that there is plenty of room for the liquid **40** being enriched with gaseous medium as required by the invention.

In the instant case, the channels **46** connecting the pairs of passages **42** and **44** of intercommunication are formed each by a pipe conduit **56** which opens via a distribution chamber **58** into the axial passages **40**.

In operation, the liquid **34** comes pouring down through downcomer **22** from the not represented uppernext bubble plate onto the tray **28** where it is impounded by the overflow weir **26** so that, at a constant rate of flow, the level **32** of liquid **34** on the tray **28** will be maintained constant, the surplus amount of liquid **34** constantly spilling over the weir **26** into downcomer **24** and from there onto a lowernext bubble plate likewise not shown. Such liquid flow is indicated in FIG. **1** by thick arrows referred to by reference character **60**. Mass transfer is effected by a gaseous medium such as vapor which rises from above the lowernext bubble plate into the chimneys **48** from where it bubbles through the liquid **34** in the form of bubbles **36** and flows towards the uppernext bubble plate as indicated in FIG. **1** by thin arrows designated by reference character **62**.

Thus, liquid and gaseous medium meet in countercurrent flow (represented by the arrows **60** and **62**) which is a known operational feature of bubble towers.

Now, due to the gas flow resistance being smaller inside the partitions **38** than outside thereof, the amount of liquid inside the partitions **38** will be met by relatively more gaseous medium and, therefore, enriched in it with a corresponding decrease of the specific weight of the liquid. Consequently, the liquid inside the partitions **38** will likewise flow upwards until it reaches the partition brims and spills over into the bulk of the liquid **34** whether the liquid level **32** is higher or lower than the brim level **51** (FIG. **3**). At the same time, it creates an upwardly directed suction in compliance with the air lift principle which induces, in turn, a backflow of liquid through the passages **42** of intercommunication, the pipe conduits **56**, the other passages **44** of intercommunication and the distribution chambers **58** into the axial passages **40** as indicated by arrows of medium thickness designated by reference character **70** and drawn by broken lines (in FIG. **2**) where the flow takes place below the plane of the drawing (in the pipe conduits **56**).

Thus, while the main or primary flow of the liquid **34** takes place in a manner known per se on a horizontal plane as indicated by the thick arrows **60**, there is also an additional or secondary flow of liquid in the direction of the arrows **70** in the clockwise sense as regards FIG. **1**, and in a vertical plane such as plane I–I in FIG. **2**. This secondary flow is closed in itself and is, actually, a recirculation of liquid around the bubble tray **28**. Obviously, such recirculation results in a possible homogeneous composition of the liquid **34** on the tray **28** and, thereby, in a possibly low concentration gradient between the downcomers **22** and **24** and, thus, in a possible maximum mass transfer force on the bubble plate which is the main object of the present invention as has hereinbefore been pointed out.

The exemplified embodiment shown in FIGS. **5** to **8** differs from the previous one in three respects.

First, the channel **46** which connects the passages **42** and **44** of intercommunication is confined by the tray **28** and a bottom wall **72** therebeneath rather than by pipe conduits **56**. In order to separate the perforations **30** in the tray **28** from the channel **46** between the tray **28** and the bottom wall **72** the chimneys **48** extend downwardly from the tray **28** through the bottom wall 72 and connect the perforations 30 in the tray 28 with the bottom side 72*a* of the bottom wall 72 or, in other words, with the space therebelow.

In the second place, the passage 42 of intercommunication (see FIG. 6) upstream in the proximity of the overflow weir 26 is a single oblong aperture which extends across the whole width of the tray 28 rather than a number of individual orifices opening into individual pipe conduits 56. Obviously, this is a very preferable feature of the illustrated exemplified embodiment since, on the one hand, it means a possible low flow resistance against recirculation where the liquid enters the channel 46 and, on the other hand, it offers an unlimited access across the whole width of the tray 28 so that a bottom layer of the liquid 34 cannot fail to enter the channel 46 and, thereby, to ensure a uniform and complete recirculation of the whole amount of liquid which happens to be retained on the tray 28 by the overflow weir 26.

In the instant case, the completeness of recirculation is enhanced by a wall 74 by which the channel 46 is closed at the upstream apeces of the partitions 38 as goes forth particularly from FIG. 6. This means that the channel 46 does not extend below the downcomer 22 and, thus, no liquid due for recirculation will be present in an area which is already beyond the passage 44 of intercommunication and, therefore, aside the main line of circulation. Obviously, such liquid would, practically, be doomed for stagnation. Certainly, it would handicap the liquid flow 70 through the axial passages 40.

In the third place, the chimneys 48 inside and outside the partitions 38 are sealed by axially movable slotted bubble caps 76 and 78, respectively, rather than by sieves. Obviously, the seal level 50 is then determined by the uppermost level of the slots 76*a* (see FIG. 7).

The requirement of local decrease of the specific weight of the liquid in the axial passages 40 may also here be fulfilled in various manners. As has already been mentioned, the axially movable bubble caps 76 on chimneys 48 inside the partitions may be lighter than the others. Then, the designs of both types of bubble caps 76 and 78 may be quite identical as in the instant case. However, the slots of the bubble caps 76 inside the partitions 38 may upwardly exceed the slots of the exterior bubble caps 78 thereby representing a decreased gas flow resistance with respect to the latter. The diameters of the chimneys 48 inside the partitions 38 and of the bubble caps 76 on such chimneys may be greater than the corresponding dimensions of exterior chimneys and bubble caps. Various combinations of the aforesaid expedients may likewise be employed as well as combinations with other features such as described hereinafter in connection with further exemplified embodiments.

If bubble caps with no axial slots in their skirts are employed, the seal level 50 is obviously defined by the skirt brim of the bubble cap.

In any case, for reasons already stated, the level 50 of the seal must in all operational positions be lower than the level 51 of the top brim of the partition 38.

In operation, the exemplified embodiment of the invention shown in FIGS. 5 to 8 is distinguished over the previously described one by a more vigorous recirculation. This can easily be judged by the pattern of arrows 70 of medium thickness (FIG. 6) which shows that—apart from the liquid which is spilling over the weir 26—the bulk of it across and along the whole plate 28 participates in the same uniform and even motion. This is due to the cross-sectional flow areas between the passages 42 and 44 of intercommunication above and beneath the tray 28 being substantially equal to one another which is the main advantage of the represented embodiment. Obviously, the passages 42 and 44 of intercommunication may easily be sized so as to have equal flow areas.

FIGS. 9 and 10 show an exemplified embodiment of the sieve or perforated plate type where the perforations of the tray 28 are formed by a great number of meshes or holes 30*a* in a sieve or foraminated plate, respectively, except inside the partition 38 where a perforation 30*b* of the hitherto described type is employed and sealed by what is called a floating cap or valve 80. The seal level 50 coincides with the bottom brim of the valve 80. Upward displacements are limited by prongs 80*a* on legs 80*b* of the valve 80.

The exemplified embodiment shown in FIG. 11 is distinguished from the previous one by uniform perforations 30 inside and outside the partition 38 all sealed by valves 80 and by pairwise arrangement of the partitions 38, as in case of the exemplified embodiment shown in FIGS. 1 to 4, the sectional view being taken through the nearside member of such pair.

The exemplified bubble plate illustrated in FIG. 12 is of the uniflux or turbogrid tray type where the perforations in the tray 28 are longitudinal slots 30*c* disposed transversely of the direction 60 of the main liquid flow. The slots 30*c* are confined by a gridlike structure consisting of parts referred to by reference characters 82 and 84 which eclipses the slots 30 in the direction 60 of the main flow of liquid in a manner well known in the art. If such structure 82, 84 is used for sealing the perforation inside the partition 38, the sealing level 50 would be determined by the bottom edge of grid part 84.

Finally, FIG. 13 represents an exemplified embodiment of the jet tray type. Here, the perforations 30 outside the partition 38 are formed by punching up semicircular tabs 86 from the body of the tray 28, the tabs 86 being inclined to the plate so as to give the gaseous medium a horizontal component of velocity in the direction 60 of the main liquid flow.

Inside the partition 38 an arrangement similar to that shown in FIGS. 5 to 8 is employed. In the instant case, however, the bubble cap 76 protrudes upwardly from the axial passage 40 beyond the brim level 51 of the partition 38. Nevertheless, the requirement that the seal level 50 be lower than the partition top brim level 51 is fulfilled since the former is determined by the uppermost level of the slots in the skirt of the bubble cap 76 and this is well below the level 51.

Chimney and bubble cap inside the partition might be replaced e.g. by tabs similar to the tabs 86 outside the partition 38. Then, the seal level 50 would obviously be determined by the tops or apeces of the tabs 86.

The above-described exemplified embodiments show that the invention permits a great variety as to the nature of perforations of the tray and of the seals on the perforations inside the partitions. Sieves, bubble caps and valves have been shown and others have been mentioned. It will be clear that any conventional sort of perforation and seal usual in the art may be employed.

However, all represented embodiments are of the crossflow of liquid type where the downcomers are at opposite sides of the tray so that the main liquid flow extends unidirectionally across the whole of a plate. Obviously, the invention is feasible with so-called split-flow of liquid-type bubble plates as well with which the downcomers of alternate bubble plates are disposed centrally rather than peripherally whereas other bubble plates are provided with circumferential downcomers and central inflow.

Moreover, all sorts of bubble plates will obviously be suitable for being provided with recirculation means according to the invention since all bubble plates work on the principle of passing a liquid medium across a tray between an inlet and an outlet separated from one another by a suitable distance which already permits to employ the invention.

Hereinbefore, the gaseous medium was exemplified by references to vapors Obviously, other gaseous media such as gases or steam might be employed as well.

The term "treating" has been employed in the specification and claims to cover all sorts of contacting a liquid with a gaseous medium such as fractionating, distilling, absorbing, stripping and the like.

What I claim is:

1. In a bubble tower with a plurality of bubble plates a method of treating a liquid with a gaseous medium in countercurrent flow with the gaseous medium flowing upwards and traversing a layer of the liquid on each bubble plate wherein the improvement consists in the step of recirculating a portion

of such layer in a vertical plane by locally enriching the liquid in gaseous medium so as to decrease the specific weight of a portion of the layer with respect to the specific weight of other portions thereof, and to cause such other portions to flow beneath the layer to where the specific weight of it is relatively lower, such recirculation of the layer in a vertical plane resulting in substantially uniform composition of the liquid along the whole extension of recirculation.

2. In a bubble plate for bubble towers comprising a tray, an overflow weir on the tray for retaining a certain amount of liquid thereon and sealed perforations in the tray for a gaseous medium flowing upwardly therethrough, the improvement of a partition remote from the overflow weir defining an axial passage on a sequestered and perforated portion of the tray with a seal on the perforation, and the level of the seal being lower than the level of the top brim of the partition, the flow resistance inside the partition against the flow of the gaseous medium being smaller than such flow resistance outside the partition, a passage of intercommunication in the tray upstream in the proximity of the overflow weir, another passage of intercommunication in the tray opening into the axial passage, and a channel connecting both passages of intercommunication with one another beneath the tray.

3. In a bubble plate as claimed in claim **2** the improvement of a chimney on the perforation inside the partition with the seal arranged on the chimney.

4. In a bubble plate as claimed in claim **2** wherein the seal is movably arranged, the level of the seal in all operational positions thereof being lower than the level of the top brim of the partition.

5. In a bubble plate as claimed in claim **4** the seal on the chimney being an axially movable bubble cap arranged for permitting a bubbling of the gaseous medium from the chimney beneath the bubble cap into the axial passage inside the partition, the level of the skirt brim of the bubble cap being lower than the level of the top brim of the partition.

6. In a bubble plate as claimed in claim **5** the skirt of the bubble cap on the chimney inside the partition having slots the uppermost level of which is lower than the level of the top brim of the partition.

7. In a bubble plate as claimed in claim **2** the improvement of a bottom wall beneath the tray, chimneys extending downwardly from the tray through the bottom wall and connecting the perforations in the tray with the bottom side of the bottom wall, the channel connecting both passages of intercommunication being confined by the tray and the bottom wall.

8. In a bubble plate as claimed in claim **7**, the channel connecting both passages of intercommunication being closed by a wall at the upstream apex of the partition.

9. In a bubble plate as claimed in claim **7**, the passage of intercommunication in the tray upstream in the proximity of the overflow weir being a single oblong aperture which extends across the whole width of the tray.

10. In a bubble plate as claimed in claim **2** wherein the channel connecting both passages of intercommunication is formed by a pipe conduit disposed beneath the tray.