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G. ROSSI

METHOD AND MEANS TO INCREASE DURATION OF THE CONTACT AND/OR THE SURFACE OF THE SAID CONTACT BETWEEN A VAPOROUS OR GASSY FLUID AND A LIQUID PARTICULARLY FOR THE PURPOSE OF DISTILLATION, ETC

Filed May 12, 1941

Serial No. 393,122

2 Sheets-Sheet 1

FIG. 1

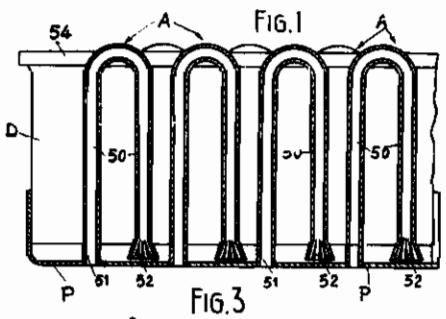


FIG. 2

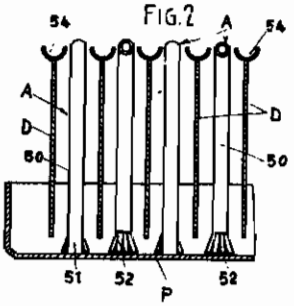


FIG. 3

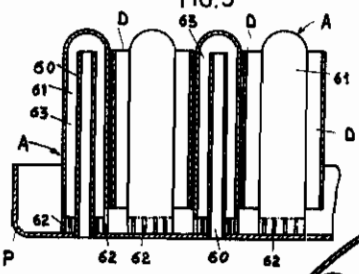


FIG. 4

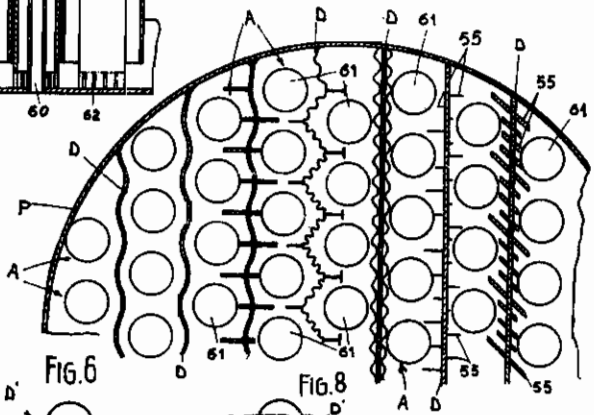


FIG. 5

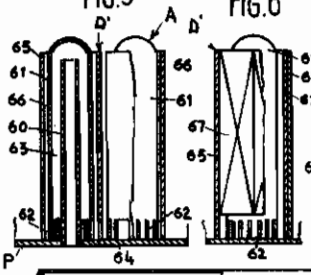


FIG. 6

FIG. 8

FIG. 7

FIG. 9

FIG. 10

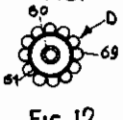


FIG. 11

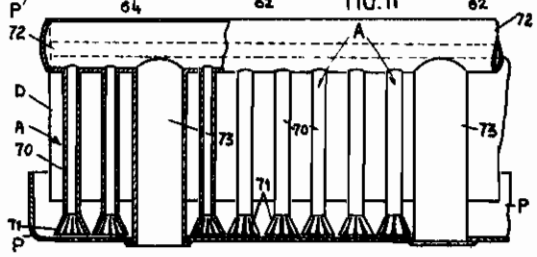
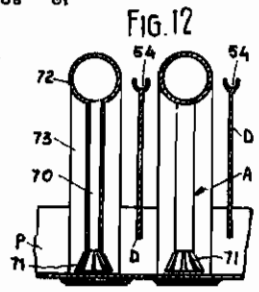


FIG. 12



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2 Sheets-Sheet 2

FIG. 13

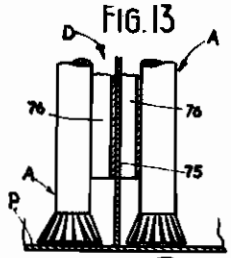


FIG. 21

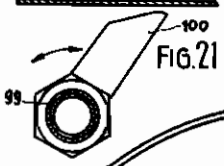


FIG. 14

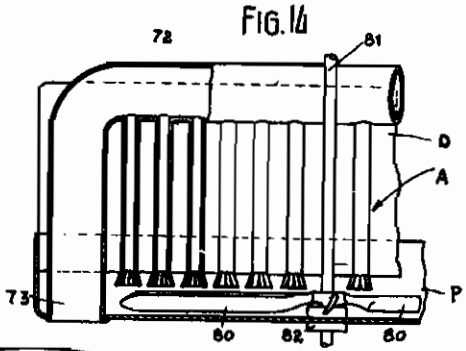


FIG. 15

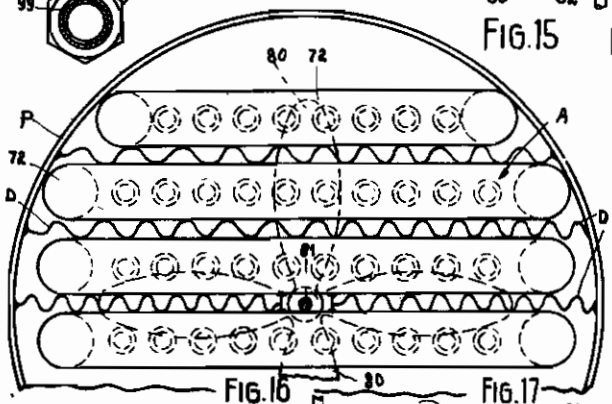


FIG. 19

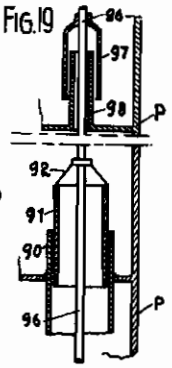


FIG. 16

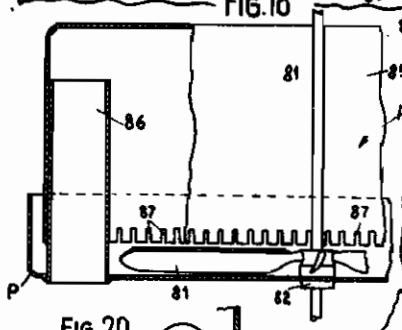


FIG. 17

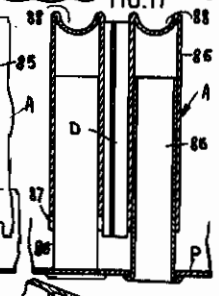


FIG. 18

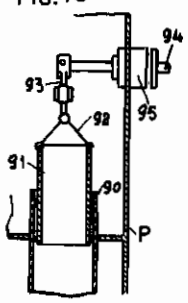


FIG. 20

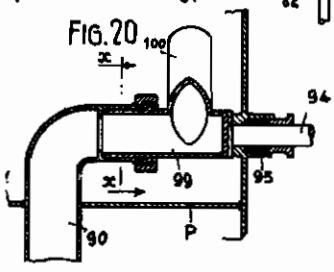
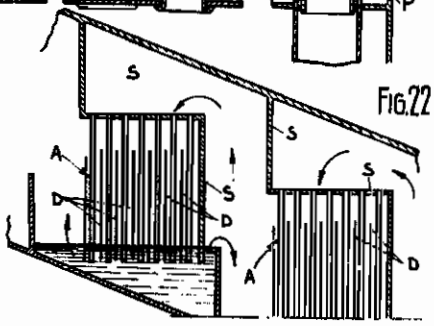


FIG. 22



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METHOD AND MEANS TO INCREASE DURATION OF THE CONTACT AND/OR THE SURFACE OF THE SAID CONTACT BETWEEN A VAPOROUS OR GASSY FLUID AND A LIQUID PARTICULARLY FOR THE PURPOSE OF DISTILLATION, ETC.

Giovanni Rossi, Milan, Italy; vested in the Alien Property Custodian

Application filed May 12, 1941

The subject-matter of this invention is a method and means for increasing duration of the contact and/or the surface of the said contact between a vaporous or gassy fluid and a liquid particularly for the purpose of distillation, rectification, and conduction of gas and vapours, degassing, evaporation, floating and the like and apparatuses incorporating the said means.

The method according to the invention of the type in which a vaporous or gassy mass is in the presence of a liquid for the purposes mentioned hereinbefore, is characterised by the fact that the vaporous or gassy fluid is compelled to divide up in the liquid in a large number of bubbles and these by coming into contact with solid surfaces for this purpose, come up along them above the liquid thereby using the adhesion and thrust effect of the underlying bubbles.

Performance of this method can take place in widely different ways and with widely different means of which a series is illustrated in the drawings annexed.

It is known that owing to molecular adhesion, liquids have a tendency to come up along the walls.

This tendency is notably accentuated when vapours or gases are bubbled but above all when this bubbling takes place between two walls or dividers and better still if they are corrugated round or the like and very near to each other.

In this last case and with equal terms for pressure, a breaking level of the bubbles can be obtained (boiling height) which is more than the normal height of the same phenomenon produced in known conditions.

The said dividers brought near to each other, have furthermore the characteristic of keeping the liquid still and hence of being able to absorb a larger load of vapours without giving rise to spray or rippling by this.

It is furthermore possible to gather the liquids together, which in some cases may be considered as exhausted or saturated, on the top of the aforesaid walls and separate them from the remaining liquids.

With particular reference to the distillation and rectification columns, the remark must be made that the yield of a column is the function of the contact surface between the liquid and the gas and of how long this contact lasts.

Practical realisation of these conditions in the present apparatuses is very far from the limit conditions mentioned hereinbefore, and besides this, it cannot be said that the present columns with their imperfect yield, represent at least a practical apparatus easy to adjust and start, and furthermore able to support work-points.

Rational application of the aforesaid principles in a distillation column, in which in every element is used at the same time, the surface and bubbling liquid and vapour analysis, allows a yield to be obtained, with an equal amount of vapour used, which is equal to the sum of the two systems and improvements to each of them in regard to the present bubbling and surface columns.

A column according to the aforesaid inventive ideas is therefore smaller than those known and costs less.

It furthermore has the advantage of nearly doing away completely with all the troubles attributed to the other columns and of having some new and useful features, such as a larger gas passage capacity without giving rise by this to mist, spray or rippling in the liquids, as well as the possibility of constructing types suitable to work with liquids which leave sediments and hence require to be shaken continuously, the possibility of starting operation of the column in a few minutes with great broadness in the adjustment of same, the possibility of working at higher pressures or lower depressions or temperatures than the present columns with bubbling, and hence the possibility and advantage of varying the height of the liquid in the single plates, the possibility and usefulness of a forced circulation of the liquids to exploit better the features of the column itself made up either of units over each other or beside and over each other, or the like, the possibility of obtaining excellent advantages in distilling under a high vacuum (molecular distillation), the possibility of separating the exhausted liquids, or those considered as such, from the sediments in every distillation unit, and finally the possibility of totally or partly transforming even the present bubbling columns without much expense being involved.

The annexed drawings, which are only given as examples to illustrate, without confining the range of the invention in any way, show different forms of performance of the invention, namely:

Fig. 1 is a part view in a lengthwise section of a distillation plate or unit for vertical columns.

Fig. 2 is the crosswise part section.

Fig. 3 is a part lengthwise section of a second variation of performance.

Fig. 4 shows in one part plan only the different forms and arrangements of lifting means and surfaces.

Figures 6 and 5 show in a section other varia-

tions of performance of the bubbling means with the individual dividers.

Fig. 7 is a section on a horizontal plan of Fig. 6.

Fig. 8 is another variation partly sectioned.

Fig. 9 is a horizontal section concerning Fig. 8.

Fig. 10 is like Fig. 9 and illustrates a performance variation.

Fig. 11 is a part elevation with parts in a section of another form of performance of the distillation plate.

Fig. 12 is the respective crosswise section.

Fig. 13 shows a different arrangement of the sectors.

Fig. 14 is a part lengthwise section of a variation in which the application of mechanical shaking means is provided for.

Fig. 15 is a part plan.

Fig. 16 shows another form in a lengthwise section with parts in view.

Fig. 17 is the crosswise section relating to Fig. 16.

Figures 18, 19 and 20 show particulars of a device apt to vary the liquid beater in the distillation plates.

Fig. 21 is a section according to the line x—x of Fig. 20.

Fig. 22 schematically shows two distilling units of a slanted column which have been obtained in accordance with this inventive teaching. With reference to Figures 1 and 2, each distilling unit calls for a set of bubbling means A consisting of pipes 50 bent to a capsized U. One end 51 of the foregoing pipes is suitably fixed to plate P so as to communicate with the lower cavity, whereas the pipe end 52 has lengthwise cuts or holes or the like and remains immersed in the liquid contained in the said plate.

The ends 52 are funnel widened, as shown by the drawing, and face each other at the bottom of plate P in such a way as to bubble the vapours in the liquid of the plate. The height of pipes 50 is greater than that of the liquid of plates P and can be of about 10–20 times the diameter of the pipes. This for the purposes already mentioned as well as to guarantee that the liquid contained in the plate cannot be sucked through the said pipes, if a lack of pressure equilibrium takes place in the distilling apparatus, which may be due to any cause.

Pipes 50 are arranged in such a way as to allow diaphragms D to be inserted, which are shaped and applied in any way to obtain efficient bubbling of the vapours in the liquid and the highest lift of the said liquid in the intervening spaces formed by the walls of the said diaphragms, as well as a further sub-division of the vapour bubbles in smaller sized bubbles.

In the illustrated case, the diaphragms D have means for collecting in the upper part, any residue liquids from broken bubbles, so that the said collected liquids can be suitably conveyed into circulation or taken away. Such collecting means consist advantageously of a duct 54 on top of the diaphragms A; these ducts are joined to each other in the required way to convey the collected liquid to the desired point.

Diaphragms D can be of the most suitable type and arranged in such a way that the plate liquid follows a forced course. It is not to be excluded that the said diaphragms are put in the plates in a slanting or end-up position and so on, in order to increase the duration and the surface of contact between the liquid and the gas. Fig. 4 shows different shapes of these diaphragms more or less corrugated or eventually combined with other diaphragms so as to make different intervening spaces between one set and the other of the bubbling means 50.

Eventually the diaphragms can have holes or side wings 55 or they can be knurled (Fig. 4), brought back, or obtained in any way.

The said diaphragms can likewise be combined with or replaced by metal straw and/or mesh, Brégeat's spirals, Xanching rings and so on. Fig. 3 shows a solution equivalent to that of the foregoing case, according to which the bubbling means A consist of a middle pipe 60 fixed to plate P of a suitable length and covered by hood 61 with ports 62 or holes on its mouth at a limited height.

In this way the vapours coming from the lower chamber go up in pipes 60 and come down in the intervening spaces 63 formed between them and the inside of the hoods 61 and by going through the ports 62, they bubble in the liquid and pass into the upper chamber. This arrangement allows a large number of the said bubbling units to be installed for each unit of surface of the plate, thereby the condition is accomplished of having nearly all the liquid undergo the action of the vapours or gases.

Bubbling means A are shown in the figures from 5 to 10, of the hood type having auxiliary or individual diaphragms D'. In the simplest case these consist of a pipe 65 (Fig. 5) provided with an opening 64 coaxial to hood 61 so as to form with this a limited size ring shaped intervening space 66. The vapours or gases throttled by the bubbling unit A, subdivide into very small bubbles which rise in the intervening space above the liquid. When they become larger they can be further subdivided by re-dividing units 67, 68 and 69.

Owing to their limited diameter and the moiccular adhesion the gas bubbles do not break, and little by little as they go up, their speed is slackened owing to the guide and contact surfaces thereby increasing the duration of contact and the surface of this contact between the liquid and the vapour. The action of the individual diaphragms D' can be magnified by having in the intervening space 66, which in this case is larger than in the previous case, bodies or pipes with a star or polygonal section 67 (Figures 6 and 7) or with ripples 68 (Figures 8 and 9). In the last case diaphragm D' can be reduced to a corrugated sleeve 69 inserted on pipe 61, it can be eventually adapted to pipes 50 of the example illustrated in Figs. 1 and 2.

Figures 11 and 12 show another very advantageous form of realisation of a distillation plate P, where the fixing holes of the bubbling means A are done away with. These consist of tubes 70 ending with a funnelshaped part 71 or joined to an upper collector 72 fed in its turn by a conduit 73. In this case too, the diaphragms have collecting ducts 54 on the upper part. The diaphragms can possibly be of another type as illustrated in Figures 4 to 10 mentioned before. Application of the diaphragms illustrated in Fig. 13 is of particular importance, which calls for a set of elementary diaphragms beside each other with a middle sector 75 and another two side sectors 76 having the task of further sub-dividing the larger bubbles.

The corrugated sectors 76 are placed in such a way that they are raised from the bottom of plate P to a certain height. This is to bring about that when the gas or vapour bubbles increase in their volume in their movement upwards, they

are fractured by the corrugated sectors 76, so as to produce other bubbles with a smaller diameter for the purposes given. The case cannot be excluded that the intervening space made between the bubbling units A, can receive more sets of diaphragms D as described hereinbefore. When thick liquids are being dealt with or those having materials in suspension it is generally expedient to keep on shaking the liquid. If it is to be shaken mechanically, this can easily be done with the arrangement illustrated in Figures 14, 15 and 16.

The bubbling means A are fixed to collector 72 so that they are raised from the bottom of plates P to the required height to leave a place for the agitating vanes 80 operated by a shaft 81 provided with a gland or water-tight means 82.

Collector 72 is supported by stand pipes 73 fixed towards the periphery of plates P.

Fig. 16 shows a variation of the shape according to Figures 14 and 15 and Figures 11 and 12 too, where the bubbling means A consist of a canted cavity 85 fixed at a suitable height to pipes 86, these being fixed to plate P. The edge of the said hood which is dipped in the liquid, has cuts 87 or holes, or the like capable of finely fractionating the gaseous fluid.

In the form of Fig. 16, the ducts 88 can be advantageously made at the top of the hoods 85.

According to the materials dealt with it is better to vary the level of the liquid on each plate P without interrupting the run of the column. This can be done with one of the devices shown by Figures 18 to 21. In the case of Figure 18, the discharge or overflow pipe 90 fixed to plate P and fishing in the liquid of the following plate, is combined with a telescope pipe 91 entrusted by the auxiliary of rods or chains 92, to an arm 93.

An operating shaft 94 is in one with the arm 93 and by going through a gland or the like 85, it juts out at the outside of the distillation column. By operating the said shaft, pipe 91 is put more or less in pipe 90, so that the liquid beater is varied during the operation. Shafts 94 of the different plates making up the column are kinematically coupled between each other so as to obtain at the same time with one manoeuvre only the same level variation in all the plates.

The variation according to Fig. 19 provides that the telescope pipes 91 are supported by a vertical rod 96 going through all the plates P and hence inside the column. The passage for rod 96 in correspondence with plates P having an overflow pipe 90 in a position opposite to that illustrated, is obtained by means of a hydraulic joint consisting of a bell 97 in one with the said rod, which dips in the liquid and fits in a pipe 98 higher than the highest level taken by the liquid in plates P to thereby obtain the required tightness. Coupling takes place in the same way for the other telescope pipes opposite to those now taken into consideration; the rods 96 after passing through the two glands, jut out at the outside for the drive.

The level of the liquid can also be varied with the device illustrated by Figures 20 and 21 where the overflow pipe 90 is right angle bent and receives a hollow turning body 99 ending with a vertical mouth 100. The manoeuvre of shaft 84 in one with the hollow body 99 angularly moves mouth 100 and dips it more or less in the liquid varying consequently the level of this liquid. The telescope pipe can possibly have a thread to adjust the level. Although the technical and inventive ideas described hereinbefore refer to columns of distillation and/or rectification of the vertical type, they can likewise be made an accomplished fact in horizontal or slanting columns. A scheme of this last type is illustrated by Fig. 22, where the bubbling units A consist of tubes turned over to the division sectors S. The bubbling units are combined with diaphragms D of the previously described and illustrated type. In the case of horizontal columns the circulation of the liquid will be forced by suitable means (pumps, injectors and the like) with an individual drive for each plate, so as to have the column operate in pressure or depression.

The fundamental technical rule can of course be applied advantageously to the case of production of vapour in each single plate with the help of heating power. In this case the bubbling units are done away with as the presence of units for raising contact and surface are sufficient in the form of dividers, rods, pipes and the like. The boiling height and therefore duration of the bubbles can be favoured by the presence of suitable chemical agents. For instance, in the case of a neutral liquid (an alcoholic solution), this chemical agent can be sodium hydrate in a very small quantity.

Fractioning of the vapours in accordance with the foregoing, takes place in the beginning as in the ordinary bubbling columns, with the advantage over the latter however of such a subdivision of the vapours as to obtain extremely small and regular bubbles spread nearly all over the surface of the plate. They are sent out preferably horizontally into the liquid, through thin cuts or little holes, and on the bottom of the plate if possible.

While this throttling of the vapours increases the outlet speed of same, it makes it impossible for continual vapour jets to form, as they are immediately fractioned in the liquid in very small bubbles which go away from the source with a horizontal run before arriving at the surface of the liquid.

During this run the bubbles increase in size at the surface of the liquid when going up and when they come into contact with the units of sustenance and of raising (which have the further aim of limiting their association and eventually of fractioning those which are too large), and in virtue of the molecular adhesion, the said bubbles do not break but slacken ascensional speed thereby increasing the duration and the exchange surface between the liquid and the vapours.

In suitable running conditions the said bubbles reach the top of the raising unit, and without supports their breakage takes place there, which is helped by the increase in size of the bubbles and the impoverishment of the liquid given to the support walls, having made their thickness extremely fine, and such as to not cause spray or atomisation of the liquid when they break, because the vapours that formed them were nearly at the same tension as those of the upper part of the distilling unit.

As mentioned before, it might be interesting to collect the liquids left over from the breaking of the bubbles on the top of the aforesaid units to convey them outside of the distilling unit, since in some cases, the said liquids, if they have rationally undergone the aforesaid treatment, can be considered as exhausted; hence considerably increasing the working capacity of the following

distilling units in this way and consequently reducing the consumption of steam.

If they are not collected as above, these liquids can go down again along the sustenance units, or fall outside of the said units thereby giving rise to a real vertical circulation and a new factor of surface analysis.

The liquid-vapour analysis can therefore be pushed to extreme possibilities thereby justifying the exceptional yield of a column realised in accordance with the aforesaid system.

The particulars of performance and execution in practice, as well as the uses, can vary in any way without leaving the range of the invention by this, or the protection of the industrial patent.

GIOVANNI ROSSI.