

Dec. 5, 1933.

R. R. COLLINS

1,938,247

APPARATUS FOR PROMOTING LIQUID VAPOR OR LIQUID GAS CONTACT

Filed Aug. 2, 1930

4 Sheets-Sheet 1

Fig. 1

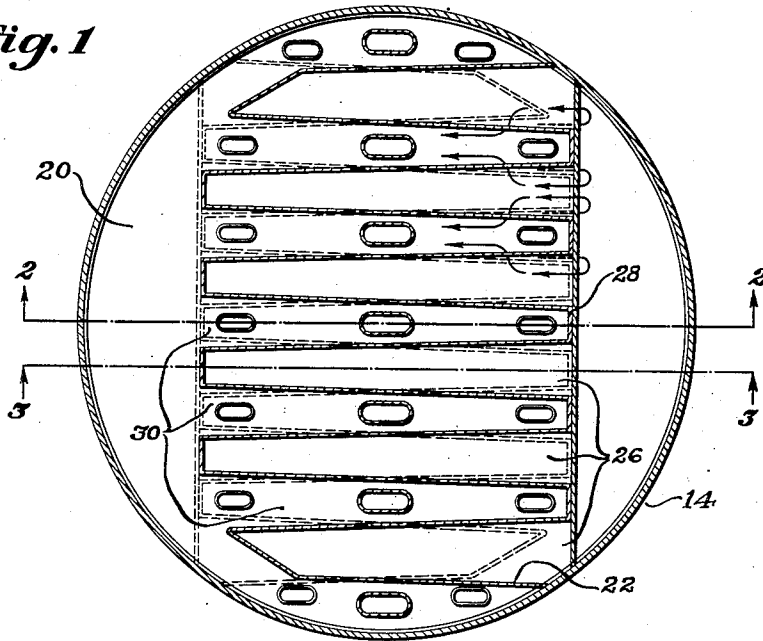


Fig. 2

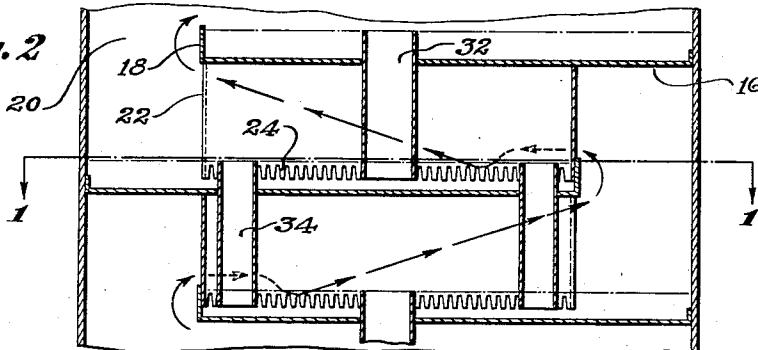
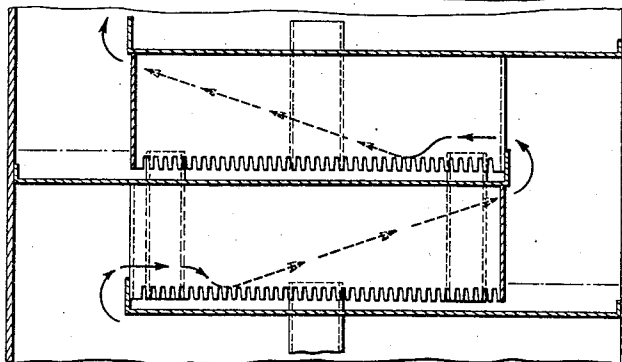


Fig. 3



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Fig. 4

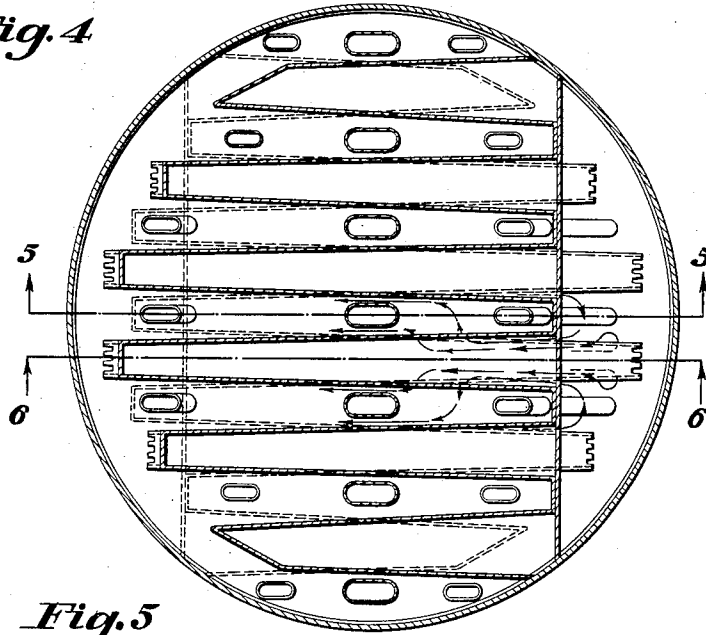


Fig. 7

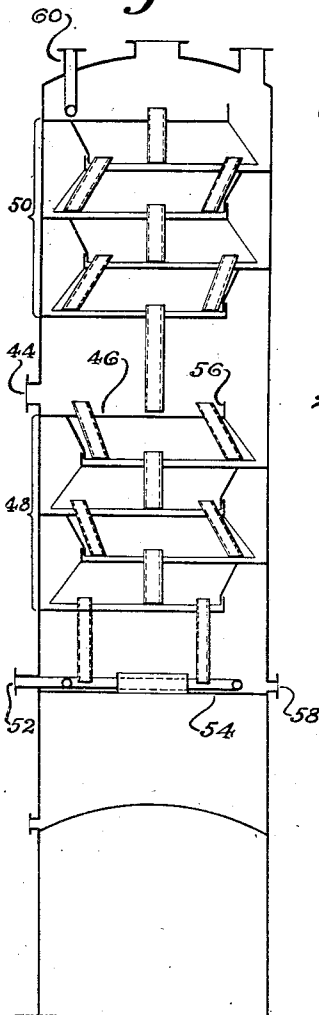


Fig. 5

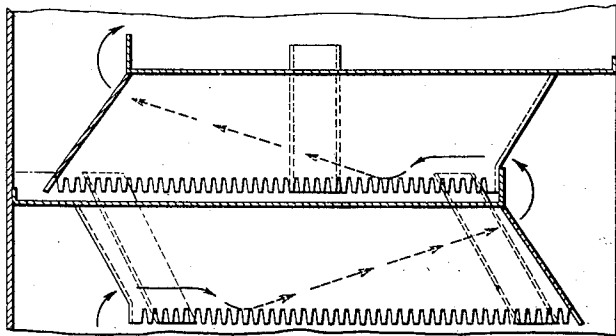
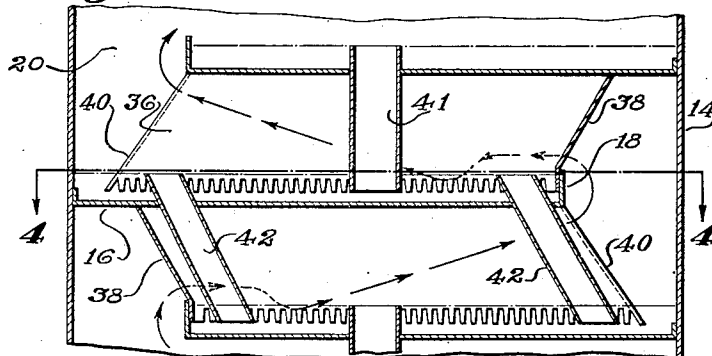


Fig. 6

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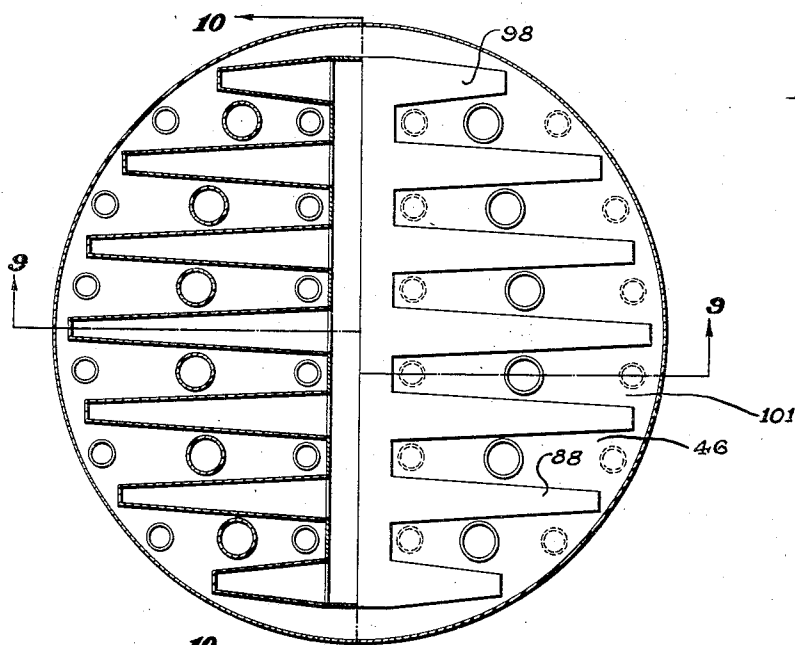


Fig. 8

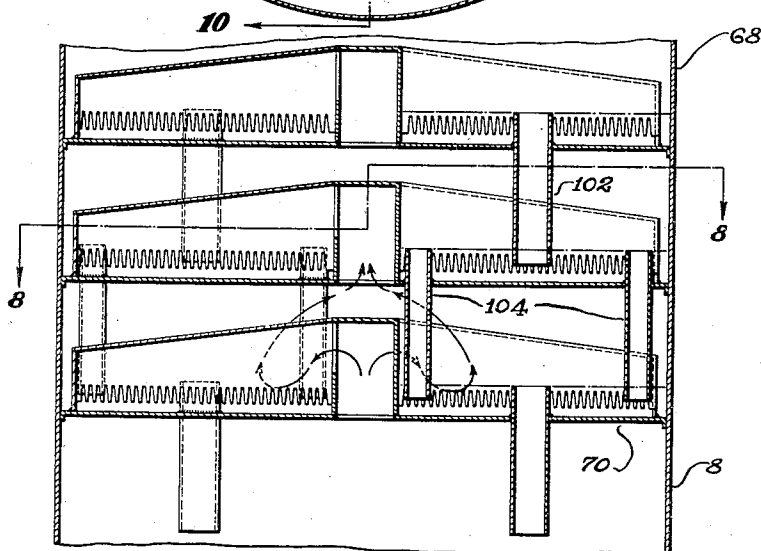


Fig. 9

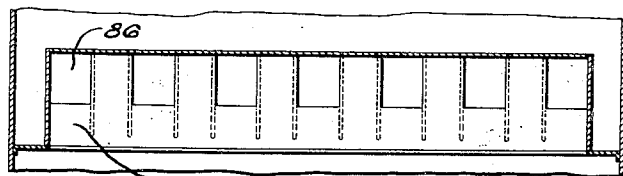


Fig. 10

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Fig. 11

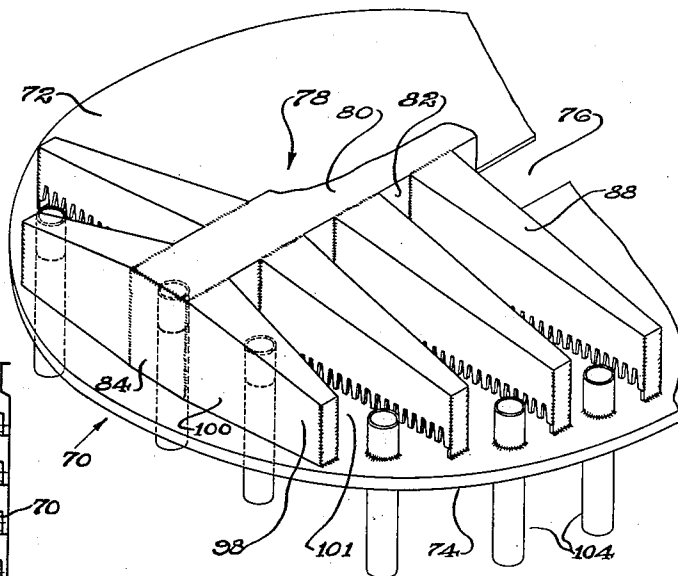


Fig. 13

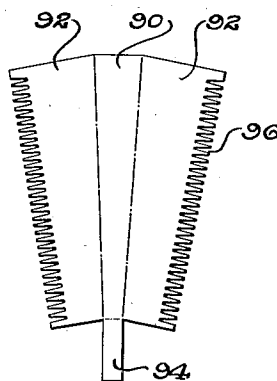
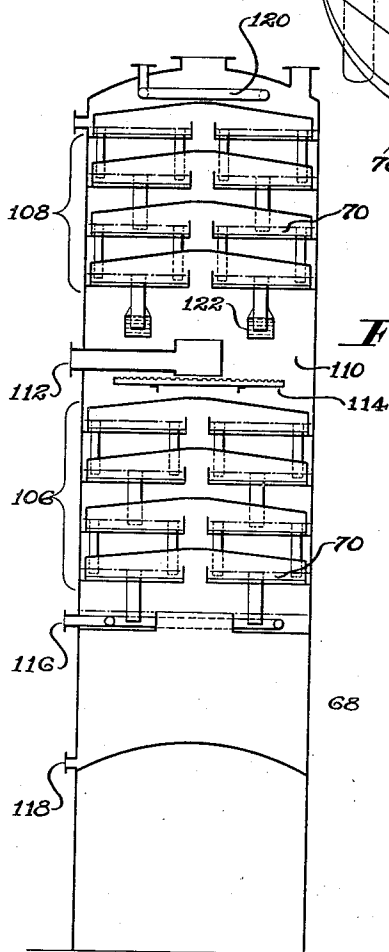


Fig. 12

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UNITED STATES PATENT OFFICE

1,938,247

APPARATUS FOR PROMOTING LIQUID-
VAPOR OR LIQUID-GAS CONTACTRaymond E. Collins, Newton, Mass., assignor to
The Lummus Company, a corporation of Dela-
ware

Application August 2, 1930. Serial No. 472,716

17 Claims. (Cl. 261-114)

The present invention relates to apparatus for promoting liquid-vapor or liquid-gas contact, useful in scrubbing and washing processes, but of particular value in fractional distillation and rectification.

The most effective existing apparatus for rectification is the well-known multiple deck boiling cap column, which provides for contact of the rising vapors with liquids of progressively varying composition on the successive decks. The construction of the boiling caps, according to modern practice, affords highly satisfactory bubbling contact of the vapor with the liquid on any deck, but nevertheless, this type of column, as a whole, is subject to definite and in some cases, serious limitations.

The first limitation of the usual boiling cap rectification column is a limitation of vapor velocity because of entrainment. The vapors, bubbling through the surface of the liquid on the deck, agitate the surface of the liquid, and this surface agitation causes particles or droplets of the liquid to be thrown upwardly into the inter-deck space as a fine mist. These particles of liquid, after being liberated from the surface, are then carried upwardly in the vapor stream to a height depending on the vapor velocity. Above a certain critical velocity, depending on the spacing between decks, the entrained liquid is actually carried through the vertical vapor risers into the deck next above. It is, of course, a necessary condition for effective rectification that the liquids on the several decks shall be definitely classified, that is, it is essential to maintain a definite progressive variation in liquid composition from deck to deck. It is therefore apparent that the capacity of any conventional boiling cap column is definitely limited by the maximum vapor velocity at which fractionation can take place without carrying of entrained particles of liquid from deck to deck.

This limitation of vapor velocity becomes increasingly important as the pressure on the system is reduced. In vacuum distillation, for example, it is necessary to handle a large volume of vapors in attenuated form, and since the allowable velocity of the vapors is still limited by the entrainment factor, the use of a column of inordinately large diameter may be required; or if a high velocity is used, the deck spacing must be greatly increased.

There is another limiting factor, which although not of primary importance at pressures near atmospheric, becomes of increasing importance as the pressure is reduced. This is

the back pressure of the column, which is made of two components, first, the static head due to the liquid level on the decks, and second, the velocity head due to passage of the vapor through the frictional resistances of the column. Although it is usually considered that the static head is the preponderant component of back pressure, I have discovered that this does not hold for moderately high vacua, where the velocity is usually somewhat greater than at atmospheric pressure, and that in a well designed boiling cap column, if the velocity is raised to the maximum value permissible without loss of efficiency by entrainment, the velocity head is of utmost importance. In the ordinary boiling cap column, the vapor must divide into relatively small streams in passing upwardly through the vapor risers from deck to deck. The friction drop, which is proportional to the square of the velocity, is aggravated, not only by the fact that the aggregate area of the risers is much less than the cross-sectional area of the column, but also by the fact that the resistance of a number of small pipes is much greater than that of a single large one. A back pressure of, say, 100 mm. which may be of no importance whatever in an atmospheric column, is a vital limitation on operation under even a moderate vacuum, for even if a perfect vacuum could be maintained at the top of the column, the pressure at the point of vaporization where the vacuum is most needed would be 100 mm.

The principal object of the present invention is to provide an improved contact apparatus whereby the limitations due to the factors of entrainment and back pressure are substantially avoided, to increase the capacity of the apparatus and to permit operation at high vapor velocities and with maximum efficiency of contact.

Another object of the invention is to provide a contact apparatus of simple, inexpensive, and easily assembled construction.

With these objects in view, the present invention comprises an apparatus whereby there is obtained not only a high degree of bubbling contact to at least as great an extent as in a conventional boiling cap column of comparable size, but also a valuable additional or secondary contact between the vapor and suspended mist of the liquid without, however, introducing any possibility of carrying entrainment over from deck to deck. In its simplest and best form yet devised, the apparatus comprises a column having a plurality of decks at different levels across

which the vapors pass with a horizontal component of velocity. Each deck is provided with plates or skirts having a submerged lip of extended length which may readily be made at least as great as, if not greater than, the aggregate lip length of an ordinary boiling cap deck to afford a comparable degree of bubbling contact. The vapor is passed from deck to deck through a single riser passage of sufficient area to limit the frictional resistance drop to a practically negligible quantity. In view of the low frictional resistance, the vapor velocity may be greatly increased without introducing an appreciable back pressure and in fact, a feature of the invention comprehends the use of a velocity high enough to cause extension agitation of the liquid with consequent dispersion of a considerable liquid mist in the inter-deck space. Thus on each deck, a secondary contact between the vapor and the mist is provided, which augments the bubbling contact and greatly improves the efficiency of rectification. Since the vapor travels in a general horizontal direction through the vertically projected mist rather than in the same direction, and since the vapor is caused to change its course in passing from deck to deck, there is no possibility of carrying over entrained liquid even at velocities several times as high as those considered practicable in the ordinary boiling cap column. The suspended mist of liquid, therefore, instead of imposing a limitation on capacity by the entrainment factor, is actually converted into a distinct advantage. Whether used under pressure or under vacuum, the present invention provides for greatly increased capacity because of the higher allowable velocities and also makes for maximum efficiency of rectification because of the high efficiency of contact.

Other features of the invention consist of certain novel features of construction and modes of operation hereinafter described and particularly defined in the claims.

In the accompanying drawings, Fig. 1 is a horizontal sectional view of a simple type of column embodying the features of the present invention, being a section on line 1—1 of Fig. 2; Fig. 2 is a sectional elevation of a portion of the column on line 2—2 of Fig. 1; Fig. 3 is a section on line 3—3 of Fig. 1; Fig. 4 is a horizontal section of a modified and in some respects preferable form of the invention; Fig. 5 is a section on line 5—5 of Fig. 4; Fig. 6 is a section on line 6—6 of Fig. 4; Fig. 7 is a diagrammatic sectional elevation of the column showing the preferred deck arrangement in a column for distillation of petroleum oils; Fig. 8 is a horizontal sectional view of another modified form of the invention on line 8—8 of Fig. 9; Fig. 9 is a sectional elevation on line 9—9 of Fig. 8; Fig. 10 is a section on line 10—10 of Fig. 8; Fig. 11 is a perspective view of one of the decks; Fig. 12 is a detail showing the manner of constructing a hood; and Fig. 13 is a diagrammatic sectional elevation showing the arrangement of decks in a typical vaporizing and rectifying column.

The column shown in Figs. 1, 2 and 3 comprises a vertical shell 14 enclosing a plurality of superposed decks or trays 16. Each deck is of circular segmental shape riveted at its edge to the shell and having a straight dam 18 formed at one edge and extending across a portion of the column. The space between the dam 18 and the shell defines a vertical vapor riser of segmental shape. Alternate decks are oppositely arranged in the shell to cause the vapor to travel in a

general horizontal direction in the inter-deck space in passing from one vapor riser to the next vapor riser passage. In order to afford a bubbling contact between the vapor and the liquid, each tray cooperates with an extended skirt 22. The skirt is provided with a lip submerged below the liquid level on the deck. The lip may be slotted or serrated, as indicated at 24, in a fashion similar to the formation of a boiling cap lip. The skirt comprises a plate or series of plates disposed in zigzag arrangement directly above the deck and secured, as by welding, to the under side of the deck next above. As shown in Fig. 1, the skirt is formed to provide a plurality of elongated converging vapor entrance channels 26 into which the vapor is directed after passing over the dam 18. The front portions 28 of the skirt are welded to the dam 18 for additional support. On the opposite side of the skirt from the entrance channels 26 are formed a plurality of conjugate vapor exit channels 30. The vapor entrance channels 26 communicate with the vapor riser passage 20 leading from the deck below and the vapor exit channels 30 communicate with the vapor riser passage 20 leading to the deck next above. In order to pass from deck to deck, the vapor is constrained to flow into the entrance channels 26, under the extended lip of the skirt, and thence through the elongated exit passages 30 with a horizontal component of velocity to the vapor riser of the deck next above.

The walls of each channel preferably converge or taper from end to end in order to present the greatest cross-sectional area where the volume of vapor is greatest, but inasmuch as the channels may usually be made sufficiently large so that there is no throttling of the vapors in any event, the convergent construction is not essential, and if desired, the skirt may zigzag across the deck with parallel walls to form channels of uniform cross-section. The decks are mounted in superposed relation, with the vapor exit channels 30 of one deck directly above and below the channels 30 of the adjacent decks.

Liquid is maintained on each deck at a level determined by the down pipes 32 and 34. The down pipes connect the exit channels 30 of adjacent decks, the bottom ends of each down pipe being sealed in the liquid. As shown in Fig. 2, a staggered arrangement of down pipes is employed, a single down pipe 32 being placed in the center of each exit passage of one deck and two smaller down pipes 34 being placed at the ends of the exit channels of the next adjacent deck. By this staggered down pipe arrangement, a practically uniform distribution of liquid is assured. The liquid entering the deck from a central down pipe divides and flows in both directions toward the end down pipes on the next deck below, and there the liquid flows from the ends to the center. By thus dividing the flow of liquid, contact of the vapors with practically fresh liquid in each deck is obtained.

In operation, the vapors rise through the column in the manner indicated generally by the arrows of Figs. 1 and 2. In passing from a vapor riser passage 20, the vapor divides into the various entrance channels 26 and by its pressure depresses the liquid level on the entrance side sufficiently to permit the vapor to pass through the slots in the lip and to bubble through the liquid into the exit channels 30. This bubbling contact is comparable to that obtainable in a conventional boiling cap column, and in a

column of given size is at least as extensive because the total lip length on any deck can be made at least as large as the aggregate lip length of a number of circular boiling caps.

5 The vapor is passed through the column at a considerable velocity, high enough to agitate the surface of the liquid and to cause particles of the liquid to be projected upwardly into the inter-deck space as a mist. The vapor in passing through the elongated channels 30, has excellent opportunity for contact with the mist. This contact is particularly effective because of the small dimensions of the particles of suspended liquid. It will be noted that this contact is secondary and additional to the bubbling contact afforded by the lip. The vapors in leaving the exit channels 30 then rise vertically through the vapor riser passages 18 and into the entrance channels 26 of the deck next above. In passing from deck to deck, the vapors make two changes of direction, first, a nearly right angle turn into the riser passage, and second, another right angle turn from the riser to the next deck. These changes of direction at the high velocities at which the vapors are traveling, cause any entrained particles to be thrown off toward the wall of the shell by centrifugal force. The entrainment thus thrown off falls back onto the deck immediately below and hence cannot be carried over into the deck above. Accordingly, the desirable classification of liquid is at all times maintained. As employed for rectification of distillate vapors, the reflux is continuously passed through the down pipes in general counter-current direction to the flow of vapors.

35 The apparatus shown in Figs. 4 to 7 inclusive is similar to that described above but is constructed to make use of a greater proportion of the area of the deck for bubbling contact. The column 14 and the trays 16 with the dams 18 are similar to those employed in the first embodiment of the invention and similar vapor riser passages 20 are thus formed. The skirt 36 for each deck is constructed in zigzag form to provide elongated vapor entrance and exit channels. But the end walls of the portions of the skirt at the central part of the column, instead of being vertically disposed, are inclined, as indicated at 38 and 40, the former representing a front wall which is secured to the dam 18, and the latter a rear wall which extends into the segmental vapor riser space. The lip of each section of the skirt extends more closely toward the shell and can therefore be made of greater aggregate length in a shell of given size, without, however, diminishing the vapor passage area of any of the channels or of the vapor riser passage. Down pipes 41 and 42 are provided, the former comprising single vapor pipes disposed near the center of the vapor exit channels, and the latter comprising inclined pipes disposed at the ends of the channels of alternate decks. The increased lip length is brought about by the provision of the inclined rear walls 40; the inclined front walls do not increase the lip length but are employed only to accommodate the inclined down pipes. The flows of vapor and of liquid are substantially identical with those of the first embodiment of the invention, the only difference residing in the increased provision for bubbling contact. It will be noted that a small part of the vapors, bubbling through the liquid at the rear edge of the skirt, pass nearly vertically into the vapor riser passage, but inasmuch as they are compelled to turn

through practically a right angle into the deck next above, any entrainment is effectively thrown off. In addition to the increased bubbling contact afforded by the extended lip of this form of the invention, the desirable secondary contact between the vapors and the liquid mist is also obtained.

The column shown in Fig. 7 shows diagrammatically an arrangement of decks for a vaporizing and rectifying column suitable for steam distillation of petroleum oils. The vapors, preheated to a suitable temperature, are introduced into a mediate point of the column through an inlet pipe 44. Below the inlet 44 is a flash deck 46 on which the heated liquid falls, and below this deck is a stripping section 48 composed of four of the decks of the type shown in Figs. 5 and 6. Above the inlet pipe 44 is a rectifying section 50 also composed of four decks of similar construction. Steam is admitted at 52 into direct contact with the residual oils collected on a bottom deck 54. The oil on the deck 46 flows over the dam 56 and thence passes downwardly through the down pipes of the section 48 in counter-current to a rising vapor mixture of steam and oil. Residual oils are drawn off through the pipe 58. The vapors rising above the inlet 44, which include the vapors flashed upon entrance of the heated oil into the column and the vapors rising from the stripping section 48, pass through the decks of the rectifying section 50 in counter-current to reflux liquid admitted through the pipe 60 in the top of the column. Fig. 7 illustrates a typical arrangement of decks for steam distillation. The number and arrangement of decks may be varied to suit any desired condition. In any case, the invention provides for maximum efficiency of contact with minimum back pressure and practical elimination of entrainment losses.

The construction shown in Figs. 8 to 13 is a modified form of the invention in which the same desirable results are obtained. This type of column commends itself particularly because of its simplicity of construction and ease of assembly.

This column comprises a vertical shell 68 enclosing a plurality of decks 70 of the type shown in Fig. 11. Each deck 70 comprises a flat plate or tray 72 having a depending riveting flange 74 which is secured to the shell. Each tray has a diametrical opening 76 extending nearly across the deck. The decks are mounted in the column with the openings 76 arranged one directly above another. Secured to each plate is a vapor riser 78 which is constructed from a single piece of sheet metal to form an imperforate top 80, side walls 82, and end walls 84. Each side wall has in the upper part thereof a plurality of spaced vapor openings 86, the portion of the wall below each opening forming a dam 87. The riser is mounted directly over the vapor opening 76 and is secured to the tray by welding the side walls thereto. Communicating with the riser 78 and arranged on opposite sides thereof is a plurality of hoods 88 enclosing horizontal vapor entrance channels through which the vapors pass into bubbling contact with the liquid maintained on the trays. Each hood, as shown in Fig. 12, is made of a single piece of sheet metal, folded to form a sloping top 90, two side walls 92, and a closed end wall 94. The side walls which are submerged in the liquid of each deck, form bubbling lips which may be provided with slots or serrations 96, as is customary in ordinary

boiling cap construction. Each hood is formed by folding on the dot-and-dash lines of Fig. 12, and the end wall 94 is welded along both edges to the side walls 92. The end wall 94 is of greater depth than the side walls so that the lip 96 is suspended above the deck when the lower edge of the end wall is welded to the deck. The separate hoods are secured to the riser by welding to the side walls of the riser about the vapor openings 86. As shown in Fig. 8, each side of the deck has five of the hoods 88 and two end hoods 98 of slightly different construction. The hoods 88 are identical except for necessary variations in size to permit accommodation on the circular plate. The end hoods 98 are similar to the hoods 88 except that their outer side walls 100 are not formed as bubble lips but extend into engagement with the plate.

The side walls of the hoods form a skirt which is arranged in general zigzag fashion on each deck. The external spaces 101 between adjacent hoods constitute horizontal vapor exit channels through which the vapors pass for extended secondary contact with the liquid mist, after the initial or bubbling contact.

As many of the decks 70 as are necessary for effective rectification are mounted in the column in superposed relationship. A liquid level is maintained outside of the hoods on each deck, as indicated by the dot-and-dash lines of Fig. 9, the level on the inside being depressed by the vapors sufficiently to permit the vapors to pass under the lips. The liquid level is determined by a plurality of down pipes indicated at 102 and 104. The down pipes are disposed in the longitudinal liquid spaces 101. As shown in Fig. 9, the uppermost deck is provided with a single down pipe 102 for each channel and the deck next below is provided with double down pipes 104 arranged at the ends of each channel. Single and double down pipes alternate for successive decks throughout the column. By this means, a practically uniform fluid distribution is attained. The liquid overflow from the uppermost deck flows through the central down pipe 102 into the deck below and divides in both directions to flow into the end down pipes 104, and so on through the column. The vapors at whatever point they may bubble through the liquid are assured of contact with liquid of substantially uniform composition.

The column shown in Fig. 13 illustrates the preferred arrangement of decks for fractional distillation of petroleum oils. The column comprises the shell 68 having near the bottom a stripping section 106 of four of the decks 70 and near the top a rectifying section 108 of four of the decks 70, the two sections being separated by an oil inlet space 110. The oil to be fractionated is heated in a pipe still of any usual or preferred form and introduced into the inlet space through an inlet pipe 112. The oil is discharged on a perforated tray 114 and some of it vaporizes to pass upwardly through the upper set of decks. The unvaporized oil drops through the perforated plate 114 and passes downwardly through the lower set of decks in counter-current to steam introduced at 116. In the passage of the oil downwardly through the lower set of decks, the liquid is stripped of its lighter components to leave a residue which is withdrawn through the draw-off pipe 118. The vapor passing upwardly through the upper decks is rectified by reflux introduced through the top of the column into a perforated spray pipe 120. The

down pipes of the lowermost deck of the rectifying section are sealed in cups 122.

In either the upper or the lower section of decks, an intimate bubbling contact is afforded between the rising vapors and the liquid on the successive decks. As shown in Fig. 9, the vapor rises through the riser 78, then turns through the vapor openings 86 into the horizontal vapor inlet passages enclosed by the hoods 88. The vapor pressure depresses the liquid internally of the hoods and permits the vapor to break through the serrations 96 and to bubble upwardly through the liquid into the vapor exit channels 101. The vapors then move toward the center of the deck to pass upwardly into the riser of the deck next above. The reflux liquid flows downwardly in counter-current fashion through the overflow pipes 42 and 44.

As in the embodiments of the invention previously described, the column shown in Figs. 8 to 13 possesses the advantages of low back pressure due to passage of the vapors through a single large riser, a high degree of primary or bubbling contact because of maximum utilization of the column area for accommodation of bubbling lips, a valuable secondary contact between the vapors and a liquid mist, and practically complete freedom from entrainment losses even at very high velocities, because of the changes of direction of the vapors in passing from deck to deck.

Any of the columns described herein may be constructed with less expense than ordinary boiling cap column having the same number of decks; moreover, a further saving may usually be effected because the number of decks may be reduced on account of the superior efficiency of rectification.

Having thus described the invention, what is claimed is:

1. A contact apparatus comprising a shell, a plurality of decks in the shell, a skirt submerged in the liquid on each deck and having an elongated lip close to the deck and extended back and forth across the deck, liquid downflow pipes in the spaces between adjacent portions of the skirt of each deck and connecting corresponding portions of an adjacent lower deck, and a vapor riser passage for each deck.

2. In a contact apparatus, a deck having provision for maintaining a definite level of liquid thereon, a continuous skirt of zig-zag form having a submerged lip, the skirt forming a plurality of conjugate elongated vapor entrance and exit passages, means for directing vapor horizontally into the entrance passages to cause the vapors to pass under the lip and to continue in the exit passages in the same general horizontal direction to afford a secondary contact of horizontally moving vapor with liquid particles projected upwardly into the exit passages by agitation, and liquid downflow pipes in the spaces between adjacent portions of the skirt of each deck and connecting corresponding portions of an adjacent lower deck.

3. A contact apparatus comprising a shell, a plurality of decks in the shell, alternate decks being formed at opposite sides with vapor riser passages, means for maintaining a level of liquid on each deck, a skirt having a lip close to the deck and disposed below the liquid level of each deck and depending from the deck next above, the skirt being of zig-zag form to provide an elongated lip.

4. A contact apparatus comprising a shell,

a plurality of decks in the shell, successive decks being formed on opposite sides to provide vapor riser passages, a skirt having a lip close to the deck submerged in the liquid of each

deck and having walls forming elongated vapor entrance and exit channels, and liquid downflow pipes connecting the vapor exit channels of each deck to a corresponding channel of an adjacent lower deck.

5. A contact apparatus comprising a shell, a plurality of decks in the shell, successive decks being formed on opposite sides to provide vapor riser passages, a skirt having a lip close to the deck submerged in the liquid of each deck and having walls forming elongated vapor entrance and exit channels, and means for passing liquid from each deck to the deck next below including staggered down pipes connecting the vapor exit channels of each deck to a corresponding channel of an adjacent lower deck to give a substantially uniform liquid distribution on each deck.

6. A contact apparatus comprising a shell, a plurality of horizontal decks in the shell, each deck having a dam extending across an edge of the deck, the space between the dam and the shell forming a vertical riser passage, and bubbling means including a skirt close to the deck and having walls extending away from the dam to form conjugate vapor entrance and exit channels, the riser passages for successive decks being disposed at opposite sides of the shell to cause the vapor to pass in a general horizontal direction across a deck, and in opposite directions on alternate decks, and liquid downflow pipes connecting the vapor exit channels of each deck to a corresponding channel of an adjacent lower deck.

7. A contact apparatus comprising a shell, a plurality of decks in the shell, each deck being formed to provide a vapor riser passage between the edge of the deck and the shell, alternate riser passages being arranged on opposite sides of the shell, a skirt for each deck having walls forming elongated vapor entrance and exit channels, the walls being extended outwardly beyond the edge of the deck next above.

8. A contact apparatus comprising a shell, a plurality of decks in the shell, each deck being formed to provide a vapor riser passage between the edge of the deck and the shell, alternate riser passages being arranged on opposite sides of the shell, a skirt for each deck having walls forming elongated vapor entrance and exit channels, the walls being extended into the vapor riser passage leading to the deck next above, and inclined down pipes leading from the portion of the deck under the extended walls to the deck next below.

9. A contact apparatus comprising a shell, a plurality of decks in the shell, the decks being of segmental shape to provide riser passages from deck to deck, the riser passages being disposed on opposite sides of the shell for successive decks, a dam across the edge of each deck, a skirt for each deck having a lip submerged in the liquid of each deck, the skirt being secured to the bottom of the deck next above, the skirt having front and rear walls and connecting side walls to form conjugate vapor entrance and exit channels through which the vapors pass in a general horizontal direction, and down pipes connecting the successive decks.

10. A contact apparatus comprising a shell, a plurality of decks in the shell, each being of

segmental shape, a dam at the edge of each deck, the dams of successive decks being arranged at opposite sides of the shell, a skirt for each deck comprising a front wall connected to the dam, side walls extending rearwardly from the dam, and an inclined rear wall projecting beyond the edge of the deck next above, means for supporting the skirt, and down pipes connecting successive decks.

11. A contact apparatus comprising a shell, a plurality of decks in the shell, a skirt submerged in the liquid on each deck and having a plurality of sections disposed in zig-zag relationship above the deck, each deck being formed to provide a single vapor riser passage between the deck and the shell, and liquid overflow pipes placed in each space between adjacent zig-zag sections of the skirt and connecting with a corresponding space of an adjacent lower deck.

12. A deck for a contact column comprising a tray having a dam at the front edge, a skirt having a lip supported above the tray, the skirt comprising side walls extending back and forth above the deck to form conjugate vapor entrance and exit channels through which the vapors are adapted to pass in a general horizontal direction, and liquid downflow pipes in each vapor exit channel and adapted to connect with a corresponding channel of an adjacent lower deck.

13. A contact apparatus comprising a shell, a plurality of decks in the shell, each deck comprising a tray having a vapor opening, a plurality of hoods connected with the vapor opening and having lips adapted to be submerged in the liquid maintained on the deck, the hoods forming elongated vapor channels, and a liquid downflow pipe in each vapor channel between adjacent hoods of each deck and connecting a corresponding channel of an adjacent lower deck.

14. A contact apparatus comprising a shell, a plurality of decks in the shell, each deck having a diametrical opening, a vapor riser surmounting the opening and having openings in its walls, a plurality of elongated hoods extending from the riser and having open ends communicating with the openings of the riser, whereby vapors pass upwardly into the riser and thence in a general horizontal direction through the hoods, and a liquid downflow pipe connecting each space between adjacent hoods of each deck with the corresponding space of an adjacent lower deck.

15. A contact apparatus comprising a shell, a plurality of decks in the shell each having a central diametrical riser provided in its side walls with vapor openings, a plurality of hoods connected on opposite sides of each riser and having open ends communicating with the openings of the riser, each hood being constructed to permit passage of vapors in a general horizontal direction therethrough, and a liquid downflow pipe connecting each space between adjacent hoods of each deck with the corresponding space of an adjacent lower deck.

16. A contact apparatus comprising a shell, a plurality of superposed decks in the shell, each deck having a diametrical vapor riser opening, a riser surmounting the opening and having side walls provided with openings, a plurality of hoods extending from the riser toward the shell, each having a lip adapted to be submerged in liquid on the deck, each hood having a closed top whereby vapor passes upwardly into the

risers, outwardly through the hoods, and thence after bubbling through the liquid, in a general horizontal direction to the vapor riser of the deck next above, and a liquid downflow pipe
5 connecting each space between adjacent hoods of each deck with the corresponding space of an adjacent lower deck.

17. A deck for a contact apparatus comprising a tray having an elongated diametrical
10 opening, a riser surmounting the opening and

having side walls provided with spaced vapor openings, a plurality of hoods extending from the riser toward the walls of the shell and having open ends communicating with the openings of the riser, each hood having a lip adapted
80 to be submerged in liquid on the tray, and a liquid downflow pipe connecting each space between adjacent hoods of each deck with the corresponding space of an adjacent lower deck.

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