Jan. 23, 1962 H. F. KOSHOOT 3,017,950

BUBBLE-PLATE STRUCTURE FOR RECTIFICATION COLUMNS

Filed Dec. 30, 1960 2 Sheets-Sheet 1

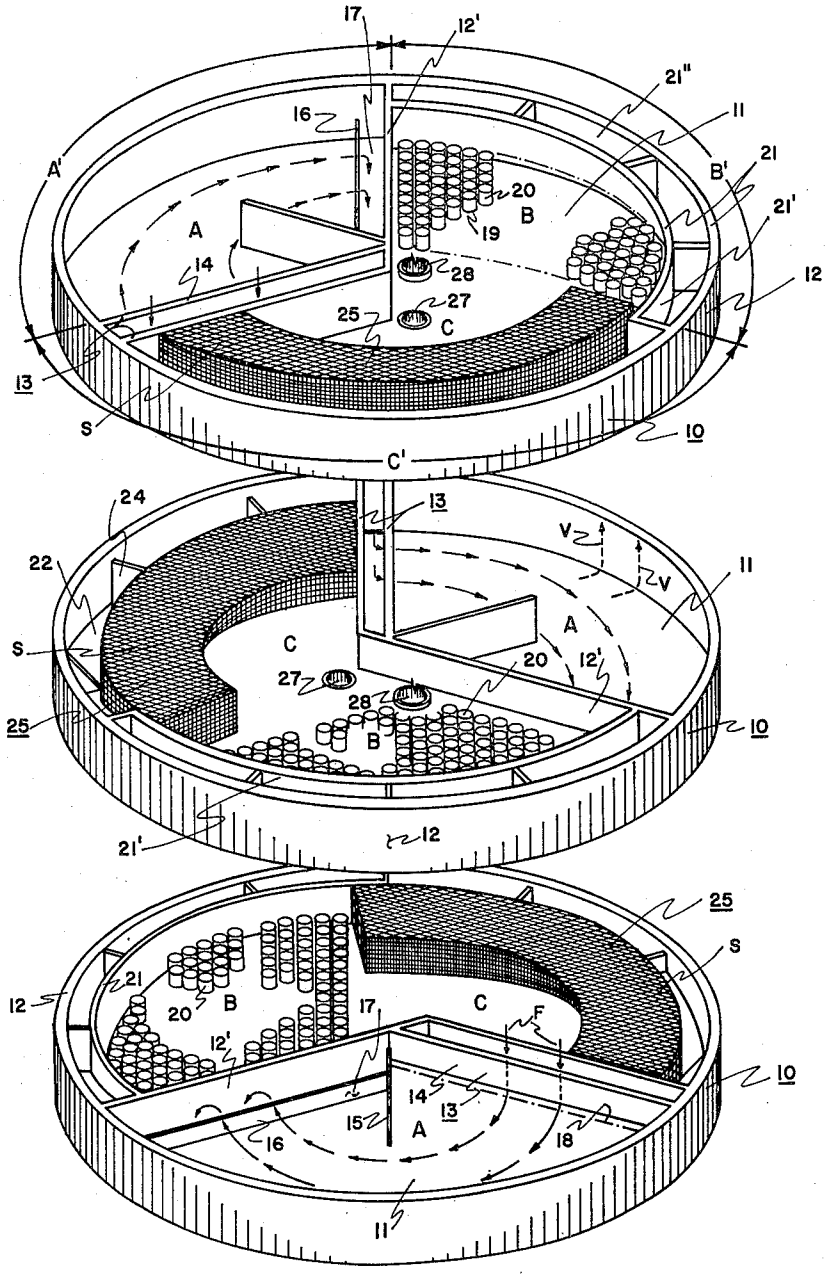

FIG. 1

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BUBBLE-PLATE STRUCTURE FOR RECTIFICATION COLUMNS

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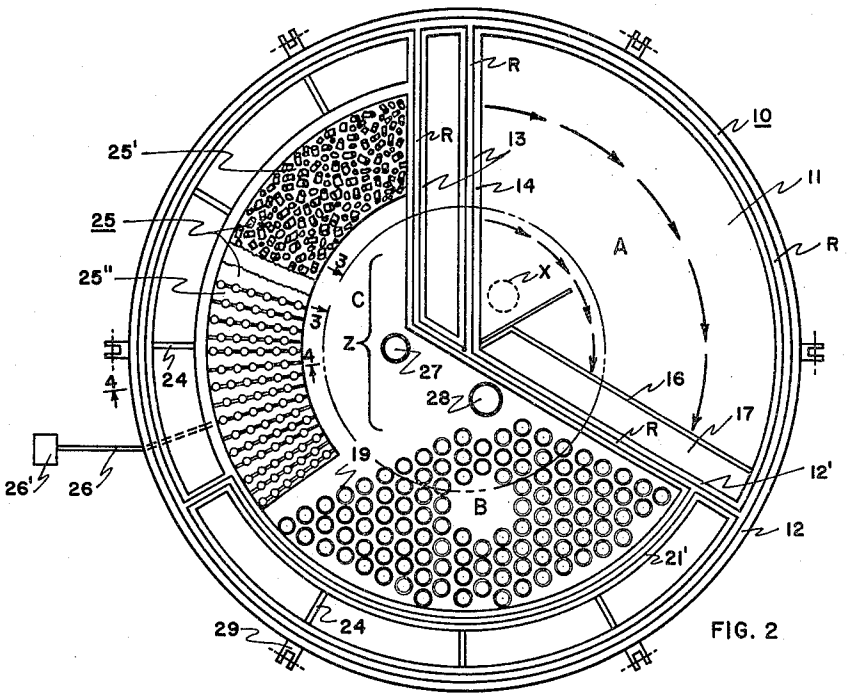

FIG. 2

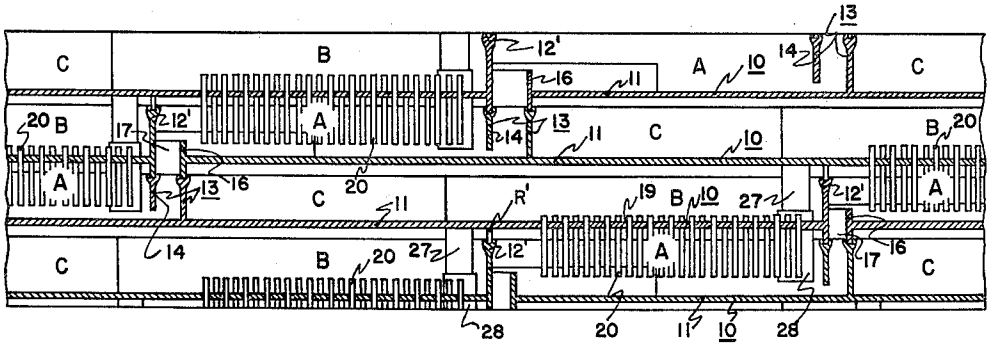

FIG. 3

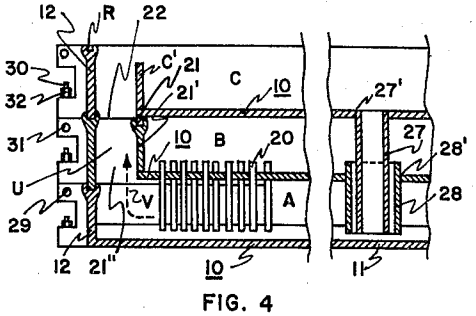

FIG. 4

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BUBBLE-PLATE STRUCTURE FOR RECTIFICATION COLUMNS

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15 Claims. (Cl. 183—2)

The present invention relates to distillation apparatus and, more particularly, to a new and improved bubble plate structure for incorporation in rectifying or fractionating columns of such apparatus.

Distillation equipment is used in a vast number of industries, of which the petroleum and alcohol industries are but two, for the purpose of separating and recovering one or more products from a selected feed material. Selection of the particular type of distillation equipment to be used in any particular process is based upon the properties of the material to be distilled, the degree of separation to be effected and the magnitude of the operation.

Distillation operations and equipment are classified as "batch" or "continuous." Continuous distillation processes are much favored in current times, owing among other factors to convenience and a high through-put rate. For difficult separations of material an additional component may be added to the feed to alter the volatility of a desired product so as to favor the desired separation. Where the added component appears in the vapor the process is termed "azeotropic distillation"; where it appears in the liquid it is termed "extractive distillation."

Different types of distillation equipment are respectively adapted by their design for the temperature ranges to be employed. Operating temperatures may range from 700–800° Fahrenheit for some separations in petroleum industry to less than —195.8° centigrade in the case of the distillation of liquid nitrogen in processes involving low temperature gas separation.

The term "rectification" refers to distillation which is carried out in such a way that the vapor rising in a still comes in intimate contact with a condensed portion of vapor, termed reflux, which is previously evolved from the same still. Resulting from this contact is an interchange of heat which secures a greater enrichment of the vapor in the more volatile components than could be secured with a single distillation operation using the same amount of heat. The condensed vapors which are returned to accomplish this objective are termed "reflux," as before stated.

"Fractionation" is synonymous with the term "rectification" and is used particularly in the petroleum industry.

"Rectifying columns" or towers refer to devices in which vapor in the still, on its way to a condenser, can flow in intimate contact with and countercurrent with respect to a portion of the condensate returned as reflux. (The rectifying or fractionating column which shall be described hereinafter may or may not include reflux takeoffs at various points for deriving close fraction products.)

The art and science of distillation has reached its highest degree in the process termed "continuous fractionation" or "continuous rectification." The characteristics of continuous fractionation include the continuous feed to the column at the half height point or at the top of the fractionating column, continuous withdrawal of residue at the bottom of the column, and continuous removal of the products from the top. The operation can be conducted under various pressures. All continuous fractionating towers or columns require a source of heat at the base of the column. This may be by open steam, as in the case of alcohol distillation, by steam coil, or by reboiler. In petroleum refinery heat may be introduced into the column by means of the hot mixture of liquid and

vapors from a pipe still, by the hot vapors from a shell still, by steam, by hot oil circulated through a reboiler, or by other suitable means.

Feed may be caused to enter the top of the fractionating column as in a "stripping" operation, the object of course being the removal of a volatile component from the residue. In a straight stripping operation no reflux is returned to the top of the column. The degree of stripping will increase with the number of liquid-vapor contacts (e.g. the number of plates in a plate column) and with the ratio of vapor flow to liquid feed.

From the point of internal construction, fractionating or rectifying columns are classed as (1) bubble plate columns, (2) sieve plate columns and (3) packed columns.

The bubble plate column is by far the most universal in use. Conventional bubble plate columns include a plurality of vertically spaced, bubble-cap plates. The bubble caps of the plates are made in many diameters, designs and sizes to meet various requirements. In all cases they are designed to provide intimate liquid-vapor contact between the reflux liquid descending down a column and the vapor rising up the column. Bubble caps larger than six inches in diameter are seldom employed and, except in small laboratories, caps less than 3 inches are generally not used. With the usual cap design and plate layout the ratio of total slot area to total plate area generally falls between 0.1 to 0.2. Clearance of from one to two inches between caps is used, and a clearance of from two to three inches between the caps and the weirs, with one to two inches at the walls being adequate usually.

Perforated or sieve-plate columns have been used since about 1831 and have been employed principally in the alcohol industry. While the efficiency of sieve plates at their rated capacity is equal to bubble plates, they do have a disadvantage, namely, inflexibility. This is to say, if the volume of vapors is too small, then all of the liquid will run off the plates and there will be no bubbling effect and hence reduced rectification. If vapor volume is too large, however, then a depth of the liquid will increase and some of the result of liquid will be thrown to the plate above, and a pressure rise will occur at that point.

Packed columns have been used in many distillation industries. With a packed column the vapor-liquid contact is obtained by causing the reflux liquid to flow over the surfaces of the packing material while vapor flows up through the voids of the material. Ideally, the vapor-liquid contact in a packed tower is a true counter-current relationship which is over and above the stepwise countercurrent process of the bubble plate column even with theoretical plates. Packing in a packed column may comprise porcelain balls, Raschig-rings, particles of coke, stone, glass, earthenware, carbon and metal rings, or wood grids, jack chain Carborundum, metal and glass helices, and so forth.

When compared with equivalent bubble plate columns, packed columns possess very low pressure drops from top to bottom, are more economical from the point of time and heat consumption, and are incomparably easier to construct. The prime objection to packed columns is difficulty in obtaining an equal distribution of ascending vapor and descending liquid. If more liquid flows down one section than another, the greater portion of the vapor will follow the path of least resistance and hence ascend through another portion of the column, thereby causing a poor liquid-vapor contact. Owing to this inherent difficulty the use of packed towers is generally limited to towers of very small sizes (under 20 inches in diameter) and therefore are unacceptable in the petroleum industry.

In designing a suitable, bubble plate, rectifying or frac-

tionating column several factors must be considered, among which are: passages for the flow of the vapor and liquid streams, reduction in physical size and plate spacing in a manner consonant with elongation of the tortouous vapor path so as to reduce mechanical entrainment of droplets within the vapor, distribution of reflux and its flow over the plates, and the type and arrangement of the vapor-liquid contact devices.

The inventor has conceived of a new and useful bubble plate construction which may, optionally, be modified to obtain the advantages of packed columns or sieve plates, if desired, but avoid the disadvantages thereof and, in general, provides a bubble plate structure which is much superior to those presently used.

An object of the present invention is to provide a new and improved bubble plate structure which eliminates the necessity of employing conventional bubble caps, thus eliminating the high resistance which bubble caps offer to reflux flow and yet increasing overall, vapor-liquid contact.

An additional object of the invention is to minimize liquid gradient in the reflux pools of the column; further, to optimize liquid flow so that maximum liquid-vapor contact is achieved.

A further object of the invention is to provide a new and improved bubble plate structure wherein vapor distribution is optimized, thereby increasing the efficiency of the bubble plates used.

An additional object of the invention is to provide for uniform vapor distribution throughout the several bubble plates so that the bubble tubes employed will handle the same amount of vapor for a given time.

A further object of the invention is to provide novel entrainment separators which themselves serve as rectifiers, optionally used, and horizontal, elongate quieting zones in such a manner and by such a construction that the vapor path is elongated from reflux pool to bubble tube area without necessitating an increase in plate spacing and the consequential increase in column size and/or height which would result.

An additional object is to supply a circular bubble plate structure wherein the height of the column employing such a structure is minimized without decreasing, and in fact elongating the length of the tortuous vapor path needed to accomplish satisfactory disentrainment of the vapor.

According to the present invention the bubble plate structure comprises three or more bubble plates of like construction and are secured together in a vertical column in a usual manner. The plates employ bubble tubes as vapor-liquid contact devices and are divided into three or more sectors, preferably three 120° sectors, and each sector being of one of three unique physical constructions. The plates are rotationally displaced in respect to each other so that different sectors of adjacent plates are in registry in a unique pattern. The sector of the lowermost of three plates, for example, will contain a reflux pool, the sector registered thereover of the intermediate plate a combination quieting zone and bubble tube admittance area, with bubble tubes extending therefrom into said reflux pool, and the registered sector of the uppermost plate an initial quieting zone with an optionally included packing member or sieve. Vapor bubbled through the bubble tubes of the device is directed outwardly and upwardly past the intermediate plate to enter the top plate and there enter an elongate quieting zone, serving to slow down the velocity of the vapor and allow the entrained droplets thereof to drop out onto the uppermost plate. The disentrained droplets are directed back into the reflux pool of the lowermost plate, whereas the reformed vapor is evenly distributed throughout the bubble tube area of the uppermost plate for further downward routing through other bubble tubes and further ascension. It is desirous that a type of "baffle," in the form of a suitable packing member or molecular sieve, be disposed in the initial part quieting zone of the upper plate so as to accomplish additional rectification, if a packing member is used, or a separation of a bi- or multiple, component vapor mixture, the molecular sieve with its associated vacuum pump is used.

The bubble tubes employed reduce the reflux resistance and hence greatly reduce fluid gradient of the reflux pools so that uniform bubbling through the reflux liquid may be effected.

A liquid flow device may be utilized advantageously so as to ensure uniform, low gradient reflux pools.

Of importance is the fact that the reformed vapors rising from the reflux pools of the column are directed radially outwardly through the vapor upcomer areas of the column so as to lengthen the vapor path, thereby maximizing the possibility of the removal of entrained fluid droplets in the vapor. It is well known that vapor, in carrying mechanically entrained liquid droplets from plate to plate, reduces plate efficiency by tending to destroy the countercurrent action of the column. Entrainment increases rapidly with vapor throughput and, more importantly, with decrease in plate spacing (where vapor path length equals plate spacing). Heretofore, the only way to control entrainment other than by bubble-cap design was to increase the spacing between the bubble plates. It will be seen that the present invention elongates the tortuous pass of the vapor in a manner so that inter-plate spacing may be held to a minimum, and this in a unique circular column design having a high degree of compactness and a low manufacturing cost.

A condenser can be placed directly on the tower or column, with hot reflux going back into the column from the condenser. Better separation and control may therefore be achieved and greater efficiency in a column operation ensured.

It will be noted further in the invention that rectification occurs in the quieting zones of the column per se.

The features of the present invention which are believed to be novel are set forth with particularity in the appended claims. The present invention, both as to its organization and manner of operation, together with further objects and advantages thereof, may best be understood by reference to the following description, taken in connection with the accompanying drawings in which:

FIGURE 1 is an exploded perspective view of a representative bubble plate structure as contemplated by the present invention and, for convenience of illustration, omits the details of the tongue and groove construction (shown in the other figures) enabling the sealing of the plate sectors and the coaxial stacking of the plates.

FIGURE 2 is a plan view of the structure shown in FIGURE 1, with portions of inter-plate securement means also being illustrated.

FIGURE 3 is a developed section taken along the arcuate line 3—3 in FIGURE 2 and illustrates in detail the composite structure of the invention and the manner of operation thereof.

FIGURE 4 is an enlarged, fragmentary section taken along the line 4—4 in FIGURE 2.

In the drawings the bubble tubes in bubble tube sectors B have been reduced in the number shown, for convenience of illustration.

Referring to FIGURES 1 and 2 it will be seen that all of the bubble plates **10** are of like construction, and each may be considered as divided into equal sectors A, B and C the extent of which may be determined by the arcuate arrows designated as A′, B′ and C′, respectively. See FIGURE 1, the top plate thereof. The various sectors A, B and C will be substantially identical to corresponding sectors of others of the bubble plates. However, it will be noted with reference to FIGURE 1 that the several bubble plates, while coaxially disposed in stacked relationship, are displaced 120° relative to each other so that the sectors A, B and C (proceeding upwardly) will be in registration. It is conceivable that the several bubble plates may have an increased num-

ber of (duplicate) sectors, with inter-plate displacement being correspondingly reduced; however, maximum efficiency of the structure is believed obtainable when but three 120° sectors per plate are employed.

Each of the plates **10** includes a horizontal floor **11** and a peripheral side **12** circumscribing and affixed to or integral with floor **11**. Sector A of each of the plates **10** is delineated by partition **12'** (separating sectors A and B) affixed to or integral with floor **11** and by fluid downcomer conduit **13** which partitions sectors A and C. As shown in FIGURE 1, the partition **12'** and downcomer conduit **13** may be of integral structure, and either integral with or, when separate, affixed to the floor **11** of plate **10**. The forward side **14** of fluid downcomer conduit **13** is shown to be upstanding from floor **11** (see the lower bubble plate of FIGURE 1) so that fluid flowing down conduit **13** as indicated by arrows F (see FIGURE 1, lower plate) will flow under side **14** and into sector A of plate **10** and directly over the floor **11** thereof. Preferably included in the bubble plate structure is a liquid flow guide **15** which is affixed to floor **11** and takes the form of a semi-partition radially oriented at a medial position within sector A. Flow guide **15**, in being preferable of rectangular construction, avoids "short circuit" fluid flow and gradient build-up in sector A, thus insuring a uniform distribution flow of fluid proceeding down conduit **13** and over weir **16** to the outlet aperture **17**. See the top bubble plate of FIGURE 1. Weir **16** is a strip-like rectangular device which regulates the depth of the pool of reflux liquid gradually flowing across sector A of the plate. The downcomer fluid aperture **17**, as seen in FIGURE 1, is disposed immediately between partition **12'** and weir **16**.

In turning attention to the top two plates of FIGURE 1 it will be seen that, when the plate structure is put in operation, the reflux fluid thereof coming across sector A will flow over weir **16** and through fluid downcomer aperture **17**, with aperture **17** being in direct fluid communication with fluid downcomer conduit **13** which opens into sector A of the bubble plate therebelow. Conduit **13** partitions sectors A and C of the bubble plate therebelow (in fact, all bubble plates), in addition to receiving reflux liquid flowing from the plate above through aperture **17**. Thus, the travel path of reflux liquid (see FIGURE 1) will be through sector A of the top bubble plate **10** in FIGURE 1, over the respective weir **16** and through aperture **17**, subsequently through downcomer conduit **13** and underneath side **14** thereof, through sector A of the second bubble plate **10**, over weir **16** (not shown) and down aperture **17** (also not shown) to flow out conduit **13** between the broken line **18** and conduit side **14** to enter sector A of the third and lowermost bubble plate. Hence, the reflux fluid takes a path of 120° in its flow in a clockwise direction before dropping down to sector A of the plate next below to continue its course. When the reflux liquid has traveled down aperture **17** and conduit **13** and across sectors A of three plates, the reflux liquid will have traveled 360° relative to its starting point.

For an understanding of the structural provision for ascending vapor flow in the composite plate structure it is best to refer to FIGURE 3. It will be noted with reference to FIGURE 3 that the floors **11** of the various plates **10** are supplied with bubble tube mounting apertures **19** which mount a multiplicity of bubble tubes **20**. The several multiplicities of bubble tubes **20** are mounted through the respective bubble plate floors **11**, through the aforementioned apertures, so that they depend downwardly below the weir level (see weirs **16**) and hence below the surface of the reflux level of the plate sector A immediately therebelow. Thus, and see FIGURE 4, vapor in sector B of each plate is conducted downwardly through bubble tubes **20** and subsequently travels upwardly (see dotted arrows V in FIGURES 1 and 4) to pass through vapor upcomer conduit aperture **21''** and conduit **21** (i.e. conduit partition **21'** operating with side **12**) of the bubble plate thereabove, to pass subsequently through vapor admittance aperture **22** of floor **11** of the next above bubble plate. This is made possible by the provision of aperture **21''** in floor **11** in sector B of the bubble plate. This aperture may, as shown, merely comprise an indentation. In construction in FIGURE 4, extension C' may be omitted if packing or other materials (such as a molecular sieve) are included in sectors C. Partitions and seals in FIGURES 3 and 4 may be of tongue-in-groove, integral or other construction.

Upon proceeding through vapor admittance aperture **22** and being able to go no higher by virtue of the floor of the bubble plate thereabove, vapor travels through sector C to sector B, to be bubbled through the bubble tubes **20** of the plate thereabove in a manner as before mentioned. Thus, it will be seen, particularly with reference to FIGURES 3 and 4, that vapor is conducted from sector B through bubble tubes **20** to sector A and up the upcomer U to sector C. Hence, vapor travels downwardly one plate and up two plates and proceeds upwardly in such a manner in a counter-clockwise direction. (The upcomer U of FIGURE 4 is formed by the sides **12** of the several plates **10**, by apertures **22** and **21'**, and by the conduit **21**. Structural rib spacers **24** may also be supplied as shown in FIGURE 2, if desired.)

In FIGURES 1 and 2 there will be noted an optionally used member **25** disposed in sector C of each of the plates. Further, it will be seen that all of the vapor coming up through the upcomer U in chamber C will pass through member **25** before reaching a bubble tube area B. Member **25** may comprise essentially one of two members, i.e. either a packing member **25'** or a molecular sieve member **25''** as shown in FIGURE 2. If a packing member **25'**, then the same will include a fine mesh metal screen enclosure member S which generally takes the form of an arc shaped lattice container made of stainless steel wire. This container S is suitably installed upon floor **11** and is disposed adjacent aperture **22**. In the container S is a quantity of suitable packing material such as coke, stone, glass, or earthenware particles, carbon and metal rings, wood grids, jack chain Carborundum, and metal and glass helices, or any other one of the large number of other packings extant including many which are manufactured packings of special shapes. Likewise, Raschig-rings may be disposed in the container S and are advantageous in that they provide large surface, large free space per unit volume. Thus, by such incorporation of the optionally included packing member **25'**, removal of a high percentage of such entrainer droplets as are present in the vapor upstream and horizontal occurs, plus a high degree of rectification owing to the intimate contact of the upcomer vapors going through member **25'** with the disentrained and condensed vapor fluids which are present throughout the packing member. This achieves a substantial drying of the vapors which are subsequently passed downwardly through the tube multiplicity in sector B so as to increase the efficiency of the rectifying process of the bubble plates and tubes themselves.

In lieu of a packing member, the member **25** may comprise a currently popular molecular sieve **25''** which comprises hollow fingers or grids of ceramic or other suitable porous material to which a vacuum pump (such as **26'**) and line (such as **26** in FIGURE 2) are connected. The molecular sieve material in being porous operates in admitting the small molecule vapors to be drawn away by vacuum pump **26'** while passing the large molecule vapors through sectors C and B for bubbling through the pools of reflux liquid disposed in sectors A of each of the plates. Thus, the separative quality of the molecular sieve may be advantageously utilized in removing desired volatile vapors at selective points along the column while retaining other vapors to be rectified in the usual manner.

In utilizing a packing member 25' in conjunction with the novel plates of the column, the prime objection of packed columns, namely, that of difficulty in obtaining a uniform distribution of ascending vapor through descending liquid is avoided, since it will be noted that the upcoming vapor travels horizontally through the packed column. However, the packing member 25' does enable a drying of vapors prior to their entrance into bubble tubes 20 so as to increase the efficiency of the column.

Likewise, the use of a molecular sieve 25'' is advantageous in the present horizontal quieting zone (sectors C and B), and in this construction the sieve efficiency is enhanced (over conventional, vertically spaced sieves).

Once vapor has traveled upwardly so as to enter sector C, it will enter a certain quieting zone Z (chambers C and B and in part formed by member 25) so as to drop a large percentage of such fluid as might be entrained within the vapor. This fluid drops to the floor 11 of chambers B and C and flows out the disentrained fluid downcomer conduits 27 and 28, disposed in apertures 27' and 28'. Conduits 27 and 28 may be spaced apart as shown in FIGURE 4, if desired, provided conduit 28 is elevated above floor level to provide a liquid barrier in sector B. Thus, disentrained fluid droplets from chamber C are returned through conduits 27 and 28 to chamber A reflux (where the vapor originated), and vapor is bubbled therethrough. All of the reflux is transported down the still, from sector A to sector A of each succeeding bubble plate. The dotted circle X in sector A of FIGURE 2 merely illustrates that area upon the floor 11 of each plate which will be in registry with the tubular conduits 27 and 28 to return the disentrained droplets.

Preferably the sides 12 of each of the bubble plates 10 include grooves R (see FIGURES 2 and 4). Where such grooves are included, then the lower edges of sides 12 may fit in the grooves of the sides of the next lowermost plate so as to form an aligned structure. The structure may be locked together with clevis locking means 29 which may be welded integral or otherwise secured to peripheral sides 12. Locking may be accomplished by bolts 30 being pivoted by pins 31 and being secured by nuts 32 as illustrated in FIGURE 4. The clevis attachments 29 only are illustrated in FIGURE 2, whereas FIGURE 4 illustrates the entire locking construction.

It will be noted in connection with FIGURE 3 that sealing rib R' is disposed beneath floor 11 and between sectors B and C and serves additionally as a stiffener for floor 11.

It has been indicated previously, and in a brief manner, that a condenser can be placed directly upon the tower or column employing the inventor's plate structure. This is due to the fact that the nature of the inventor's plate structure reduces inter-plate spacing so that the over-all column will be of greatly reduced height (with a consequential increase in plate area so that capacity remains the same). With column designs heretofore devised, the condenser equipment, of necessity quite bulky, has had to be placed side by side with the column or below column level. This in turn necessitates extensive plumbing, expensive pumps, and so forth in order to transmit reflux from the condenser to the top of the column. For some processes it is advantageous that the reflux be returned to the top plate of the column at a relatively high sensible heat, ordinarily necessitating further increase in installation cost and maintenance cost (due to the usual corrosiveness of hot reflux liquids and the materials which they require). Return of hot reflux prevents certain partial condensation which would otherwise occur at the top two or three trays of the column by the return of cooler reflux, which, in turn, would result in the impairment of the true fractionating action of these trays. This phenomenon is discussed fully at page 602 of the Chemical Engineer's Handbook by John H. Perry, 1950 edition.

By the inventor's invention, on the other hand, the physical reduction in size (i.e. height) of the column enables the condenser to be placed directly at the top of the column or tower so as to enable direct feed of warm reflux back to the top plate of the column. This preserves the efficiency of the upper plates of the column. Furthermore, the increased area of the plates of the invention in fact adapts the column for the mounting thereto of condenser equipment.

Some explanation should be added concerning the advantages of the use of bubble tubes, as disclosed in the invention, wherein vapor is directed upwardly to enter the top of the tubes and descend downwardly therethrough into reflux liquid. In the first place, the downward direction of the vapor into the liquid reduces mechanical entrainment of fluid droplets within the vapor which is in counter-distinction with the action of conventional, slotted bubble caps, for in the case of the latter, vapor is directed from the caps upwardly through the reflux so as to tend to carry entrained droplets therewithin.

An additional advantage of the use of bubble tubes is to increase the effective vaporization area of the plates. In conventional bubble cap plates effective vaporization is reduced by virtue of the inclusion of double weirs, risers, and the enlarged bubble cap areas which must necessarily be so in order to circumscribe the risers. All of this structure is avoided in the inventor's invention and all space is useable and effective in the vaporization process (with the exception of, those areas immediately underneath the tube themselves). Thus, reduction in effective area of the bubble plates by use of the applicant's bubble tubes is held to a bear minimum. Furthermore, the vapors rising from the reflux pools pursue their tortuous paths directly adjacent the bubble tubes themselves, and the hot vapor within the bubble tubes enters a heat exchange relationship with rising vapors exterior thereto so as to dry the vapors ascending from the reflux pool and hence achieve a partial dephlegmation at this area per se.

Further, it should be mentioned that when the inventor's bubble tubes are employed, there will be no "dumping" of reflux fluid through bubble caps and risers to lower plates. Rather, since the vapor is directed downwardly into the reflux pool, then even in the presence of large liquid gradients (which are highly improbable in the inventor's system) and resultant "deep spots" in reflux pools, reflux will not go upwardly into the tubes so as to be spilled down to lower plates. In the petroleum industry it is well known that froth is always present in the bubble plates and, by virtue of its own nature, will be dumped to a small degree from time to time to lower plates. Occurrence of this so-called "dumping" of froth to lower bubble plates will generally be due to intentioned or unintentioned reduction in through-put and/or reduced, plate-to-plate pressure drop.

The above is avoided in the inventor's system since the vapor proceeds downward through the bubble tubes into the reflux pools, thereby blocking off froth from access into the tubes.

Finally, it will be observed with reference to the apparatus of FIGURE 1 that the ratio of weir length over useable area is quite large in comparison with conventional bubble plates. This insures a more even distribution of incoming liquid into the reflux pools of the system.

While particular embodiments of the present invention have been shown and described, it will be obvious to those skilled in the art that changes and modifications may be made without departing from this invention in its broader aspects, and, therefore, the aim in the appended claims is to cover all such changes and modifications as fall within the true spirit and scope of this invention.

I claim:

1. In a rectifying column, in combination, a plurality

of coaxially aligned, stacked bubble plates of like construction, each of said bubble plates being divided into at least three equal sectors, arbitrarily designated respectively as A, B, and C, proceeding in a clockwise direction, with the plates being displaced with respect to each other so that registered sectors of adjacent plates will follow the sequential order, proceeding upwardly of A, B, C, A, B, C, etc., each of said plates comprising a floor extending in all three of said sectors, a peripheral side circumscribing said floor, the sides of said plates being in engagement with each other, said floor being provided with an upcomer, vapor admittance aperture disposed adjacent said side in sector C and an upcomer vapor conduit aperture adjacent said side in sector B; a plurality of conduit means extending from said conduit apertures of sectors B of respective ones of said plates to said upcomer, vapor admittance apertures of sectors C of adjacent ones of said plates directly thereabove, sectors A of others of said plates immediately below said respective ones of said plates being in vapor communication with said conduit means and, thereby, with sectors C superimposed thereabove; a plurality of partitions each being disposed in proximity with the respective boundaries of sectors A and B of respective plates and extending upwardly therefrom, from the respective floors thereof, to the respective floors of adjacent plates thereabove; each of said plates having a weir disposed upon its respective floor in sector A and spaced from said partition, said respective floor being provided with a fluid downcomer aperture disposed between said weir and said partition; a plurality of fluid downcomer conduit means respectively disposed between and separatingly partitioning sectors C from A of the several plates, each conduit means circumscribing a respective one of said downcomer apertures and opening into sector A of the next, lowermost respective plate; said floor of each of said plates being provided with at least one, disentrained fluid downcomer aperture in one of sectors B and C; a plurality of conduit means respectively communicating with and extending from respective disentrained fluid downcomer apertures and opening into sectors A of lower plates in registry therewith; said floor of each plate being provided with a multiplicity of bubble tube mounting apertures in sector B, each of said plates being provided with a multiplicity of bubble tubes disposed in said apertures and extending downwardly into sector A of the plate therebelow and beneath the level of said weir thereof; and means for securing said bubble plates together.

2. Structure according to claim 1 wherein said bubble plates are circular, said sectors A, B, and C are 120° sectors, and wherein said bubble plates are disposed 120° with respect to each other.

3. Structure according to claim 1 wherein each of said bubble plates is provided with a liquid flow guide disposed in sector A and extending outwardly between said fluid downcomer conduit means and said weir and upwardly from said floor.

4. Structure according to claim 1 wherein each of said bubble plates is circular and is provided with a liquid flow guide disposed in sector A and extending radially outwardly between said fluid downcomer conduit means and said weir and upwardly from said floor.

5. Structure according to claim 1 wherein each of said bubble plates includes a packing member disposed upon said floor, extending upwardly therefrom to the floor of the bubble plate thereabove, and extending as a baffle between said upcomer, vapor admittance aperture of sector C and sector B of the same bubble plate.

6. Structure according to claim 1 wherein the respective floors of each bubble plate are each provided with disentrained fluid downcomer apertures in sectors B and C, the last mentioned conduit means plurality extending from said disentrained fluid downcomer apertures and opening into sectors A of lower plates in registry therewith, the conduit means of sector B disentrained fluid downcomer apertures being coaxially aligned with, larger than, and circumscribing the conduit means of sector C disentrained fluid downcomer apertures.

7. Structure according to claim 1 wherein each of said conduit means circumscribing said downcomer apertures opens into sectors A at floor level in the form of a transverse slot.

8. Structure according to claim 1 wherein each of said bubble plates includes a molecular sieve disposed upon said floor, extending upwardly therefrom to the floor of the bubble plate thereabove, and extending as a baffle between said upcomer, vapor admittance aperture of sector C and sector B of the same bubble plate, said molecular sieve being supplied with means for extracting such contents as become entrapped therewithin.

9. Structure according to claim 2 wherein said upcomer, vapor admittance aperture of each of said bubble plates extends 120° along said side in sector C.

10. Structure according to claim 2 wherein said weir is of strip-like configuration bounding one side of said fluid downcomer aperture, said fluid downcomer aperture comprising a radial slot.

11. Structure according to claim 2 wherein each of said conduit means circumscribing said fluid downcomer apertures opens into sectors A at floor level in the form of a transverse slot.

12. Structure according to claim 5 wherein said packing member terminates short of said bubble tubes to supply a quieting zone therebetween.

13. Structure according to claim 6 wherein said coaxially aligned conduit means are spaced apart, the conduit means of sector B being elevated with respect to floor level to provide a liquid barrier.

14. Structure according to claim 8 wherein said molecular sieve terminates short of said bubble tubes to supply a quieting zone therebetween.

15. Structure according to claim 9 wherein said upcomer, vapor conduit aperture of each of said bubble plates extends 120° along said side in sector B.

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