Nov. 25, 1952 C. J. SCHILLING 2,619,336

GAS SEPARATION APPARATUS

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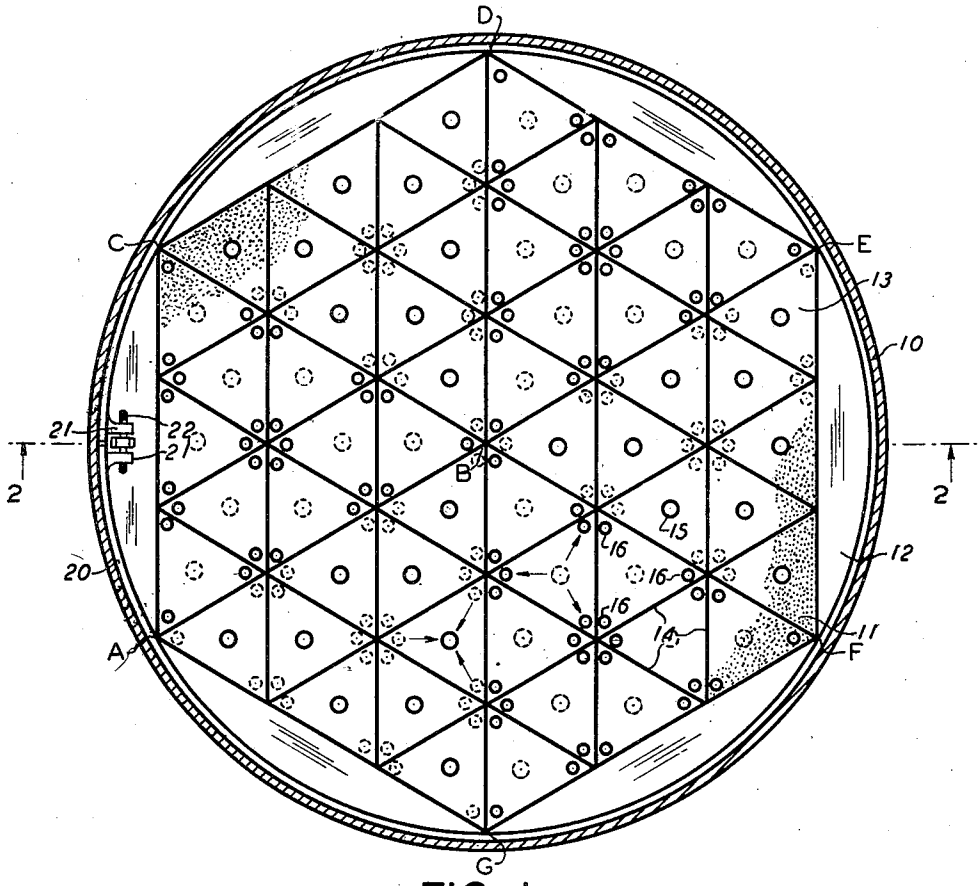


FIG. 1

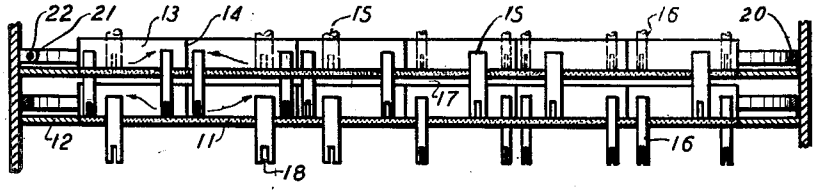


FIG. 2

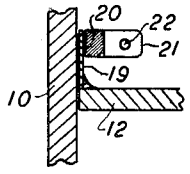


FIG. 3

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GAS SEPARATION APPARATUS

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This invention relates to apparatus adapted to bring about intimate contact between gases and liquids, and specifically to the type of gas-liquid contact column in which bubble plates are arranged one above the other to hold pools of descending liquid through which the ascending gas bubbles.

An important object of the invention is to provide plates not necessitating the use of bubble caps.

Another important object of the invention is to provide an arrangement of bubble plates in which a maximum proportion of the total area of the plate is available for gas-liquid contact; in which the liquid draining from plate to plate flows horizontally for only short distances, and in which such flows are substantially equal in extent.

A further important object of the invention is to provide a column in which the plates may be stacked loosely in the column without supporting structure between plates and in which the plates may be brought into nonleaking contact with the shell wall without the use of solder or other fused metal.

The invention will be described with reference to the attached drawings and the following description thereof, in which

Figure 1 is a view in section through the column shell of a conventional column showing a plan view of a plate embodying the present invention,

Fig. 2 is a view in section taken on the line 2—2 of Figure 1, of a fragment of the column shell of Figure 1. This column would incorporate a stack of plates embodying the present invention but, for the purpose of simplifying the showing, only two adjacent plates of such a stack are shown with parts of the next higher plate being shown in phantom, and

Fig. 3 is an enlarged view in section of part of Fig. 2 adjacent the reference numeral 22 illustrating the preferred manner of sealing the edge of the plate to the column shell wall.

Referring first to Figs. 1 and 2, 10 is the shell of the column, of which only a small fragment is shown in Fig. 2. The bubbling plate, which should be a loose fit within the column, consists of two portions made from different materials, the portion 11 within the hexagonal outline and dotted in parts being a substantially continuous sheet of gas permeable thin sintered metal and the segments 12 outside the hexagonal outline being of gas impermeable sheet metal. The sheet of sintered porous metal 11 may be formed by welding at their edges the largest pieces of such metal

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available, and the filling segments 12—12 are welded to the porous hexagon along its straight sides, thus forming a continuous disc or diaphragm extending across the column from wall to wall on all sides.

The gas-permeable portion of the plate is divided into a plurality of shallow wells 13 by partitions 14 of thin sheet metal, welded or soldered to each other at their intersections and to the porous plate along their lower edges. These wells may be formed separately with integral side walls, the side walls being then attached to the side walls of adjacent wells to form the plate and partitions. These wells are preferably in the form of equilateral triangles as illustrated in Fig. 1, are equal in size and are of such dimensions that a desired number of wells forms a hexagon of which the maximum dimension is slightly less than the inside diameter of the shell in which the plates are to be used. In the layout shown, which is suggested for a column six feet in diameter, the side dimension of each well is approximately one foot and the hexagon contains fifty-four wells, but the overall dimensions of such a pattern may be modified indefinitely by varying either the size or the number of wells.

Half of the wells on each plate are provided each with a single, centrally disposed drain pipe 15 extending to such height above the plate as to maintain a liquid pool of the desired depth. The other half of the wells are provided each with three drain tubes 16, 16 located close to the corners of the well. These two types of well are so grouped as to form six major triangles bounded by lines extending from the center of the hexagon to its angles and by the straight sides of the hexagon, the apices of the triangles in the upper plate shown in plan in Fig. 1 being indicated at A, B, C, D, E, F and G. All of the wells in each major triangle have their drain tubes similarly disposed and this disposition is alternated: e. g., all the wells in major triangles ABC, DBE and FBG, herein termed "corner draining triangles," have a drain tube in each corner, and all the wells in triangles CBD, EBF and GBA, herein termed "centrally draining triangles," have each a centrally located drain tube.

In stacking the plates in the column, each plate is oriented at an angle of 60° to the plate next below, as best illustrated in Fig. 1 by the dotted lines: i. e., in such manner that each corner draining triangle is arranged above or below and coinciding with a centrally draining triangle. This arrangement permits all the plates to be identical in pattern while bringing all the

central drain tubes over wells having corner drains, and vice versa. Thus the flow in each well having a central drain tube is from the corners to the center, and in each well having corner drain tubes from the center to the corners, as indicated by the directional arrows in Figs. 1 and 2.

The drain tubes extend to such distance below the plate as to rest on the plate next below while spacing the plates the desired distance. This distance should be such as to provide a free space 17 between the upper edge of the partitions 14 and the lower face of the plate next above for the free circulation of vapor over the tops of the wells. This space 17 need not be over about an inch in wide columns and may be less in columns of small diameter. The lower end of each drain tube is serrated or slotted as at 18 to permit outflow of refluxing liquid, the height of these slots being somewhat less than the height to which the drain tubes project above the plate.

The lowermost plate in each stack may be supported in any convenient manner not shown, for example by a grid resting on projections from the shell and having bars so arranged as not to interfere with the drain pipes from the lower plate. The remainder of the plates making up each group rest on the lowermost plate and on each other and the stack may thus be built up to any desired height.

As each plate is inserted in the column, its outer edge may be welded or soldered to the column shell to avoid leakage over the edge, but I prefer to make a leak-proof joint while keeping the plates removable by the use of an expansible skirt backed up by a ring expander, as shown in Fig. 3.

In this construction, a ring 19 of thin sheet metal, such as soft copper, is soldered or brazed around the edge of the plate prior to insertion, the depth of this skirt being somewhat less than the face to face distance between adjacent plates. After the plate is positioned an expander ring 20 is inserted within the skirt ring to press its edge against the inner wall of the column. In relatively small columns the ring 20 may be self expanding, in the form of a piston ring. In larger columns the outward pressure thus obtainable may not be sufficient to produce a tight seal, and in such case the ends of the expander ring may be provided with threaded lugs 21 spaced by a right-and-left threaded screw 22 by which the ring may be expanded to exert any desired pressure.

The porous, sintered metal sheets above referred to are obtainable in various metals, of which bronze, copper and stainless steel are the best adapted to this use. They are also available in a wide range of degree of porosity, depending on the size of the metallic granules from which they are fabricated and the pressure applied in forming them. For the use here described, the pressure drop through the plate, at the calculated vapor velocity through the column, should be at least slightly greater than the hydraulic head of refluxing liquid carried on the plate.

While the porous metal of which the greater part of the area of the plate is composed is somewhat costly, this excess cost is more than offset by the elimination of the great number of bubble caps required in the fabrication of the conventional type of plate and of the labor required in positioning them. The great advantage, however, of the porous plate is that the upflowing vapor is divided into myriads of bubbles and streams many times smaller and more numerous than may be produced with even the smallest bubble caps, resulting in an extremely effective washing of the upflowing vapor by the refluxing liquid.

The structural elements and arrangements above described are subject to several modifications, each of which preserves some, though not all, of the advantages of the described structure.

The use of porous metal to form bubbling plates which require no bubble caps is not restricted to the triangular form of bubble well herein shown. The partitions may be so arranged as to produce rectangular or hexagonal wells, in brief, any form which may be grouped to form a pattern free or substantially free from inoperative areas. The described pattern made up of triangles is preferred as utilizing the maximum proportion of the total plate surface for washing the upflowing vapor.

The described arrangement of triangular wells in six triangular groups, three of these groups having a central drain tube in each well and the remainder a drain tube in each angle of the well, the groups being alternated in the pattern of the hexagonal figure, is useful in the fabrication of plates which are identical in pattern and are alternated in the column by placing the groups having central drains over the groups having angle drains. This advantage of being able to make any required number of plates in a single pattern is gained whether the bubbling means consists of a sheet of porous, gas-permeable metal or is the conventional arrangement of bubble caps mounted on an otherwise impermeable plate.

The use of porous, gas-permeable metal sheets in lieu of bubble caps to produce fine subdivision of the upflowing vapor is not restricted to plates divided into wells. It is possible, and in some instances may be desirable, to omit the partitions entirely and to maintain a single liquid pool covering the entire area of the plate. In this practice, a plurality of drain tubes should be spaced evenly over the plate area, and these tubes should be so arranged that the drain tubes from one plate are centrally disposed as regards the adjacent drain tubes on the plate next below. This modification of the structure is advantageous in doing away with the requirement for a liquid distributor supplying a substantially equal quantity of liquid to each of the wells on the uppermost plate of any stack, which is essential when the plates are divided into wells. It is disadvantageous in requiring careful levelling of the plates and is therefore better adapted to relatively small than to very large diameter columns.

The use of a plurality of spacing members symmetrically distributed over the area of the plate and projected downwardly for such distance as to provide the desired spacing of the plates is advantageous in making it possible to rest each plate except the lowermost on the plate next below, it then being necessary to support only the lowermost plate from the column wall. If these spacing elements, above described as the drain tubes but which may be mere studs suitably distributed, are of exactly the same length, the plates will be maintained in exact parallelism by their own weight and all of the plates in the stack will be level if the support for the lowermost plate of the stack is accurately levelled. The cost of assembling the stack in the column is thus much reduced and it is possible to form the plates of much thinner and more flexible metal than would be

possible where the plate is supported around its periphery. This feature of the invention is applicable to plates of any type and material but is particularly advantageous in the use of porous, gas-permeable sheets because of the relatively high cost of this material. Where studs instead of the drain pipes are used for spacing they may of course be projected upwardly instead of downwardly from the plate.

The described sealing means consisting of an expansible skirt and an expander ring is likewise adapted to use with any type of plate, especially that which is supported by resting on the plate next below. This structure is advantageous as compared with other edge-sealing means in facilitating the assembling of the plate stack, in allowing slight movement to permit temperature expansion and contraction, and in rendering the plates readily removable.

No form of column is illustrated as plates of either type described may be used in any gas-liquid contact column, single stage or two stage.

The term "diaphragm" as used herein means a thin partition and does not include the connotation of porosity, except where expressly indicated by the use of qualifying language.

I claim:

1. A bubble plate for use in gas-liquid contact columns comprising a diaphragm member adapted to extend from wall to wall of the column, said diaphragm member being provided with a plurality of drain tubes projecting above said member to maintain at least one liquid pool thereon, a skirt of flexible material connected in non-leaking relation around the periphery of the diaphragm and extending upwardly from the surface of the diaphragm, the skirt periphery having a free edge portion at an angle to the surface of the diaphragm member, means associated with the skirt for expanding the skirt radially outwardly for sealing engagement with the walls of the column completely around the inner surface thereof.

2. A bubble plate of the character described in claim 1 in which the means comprises an expander ring is arranged within the skirt and above the plate for urging the skirt outwardly into sealing engagement with the column.

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