July 3, 1956 D. J. BERGMAN 2,753,166

FRACTIONATING APPARATUS

Filed Dec. 1, 1953

Figure 1

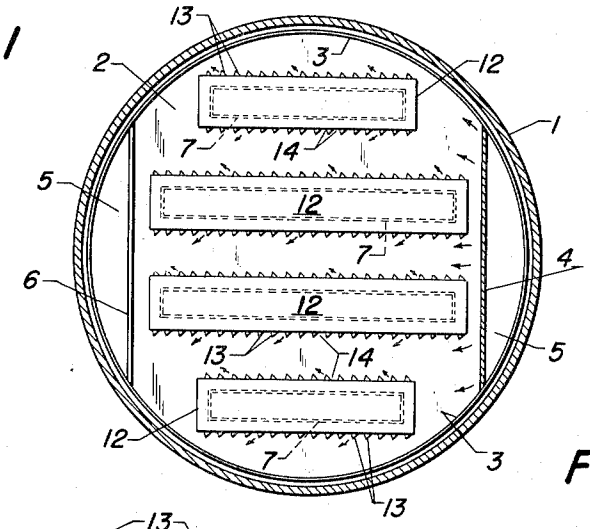


Figure 2

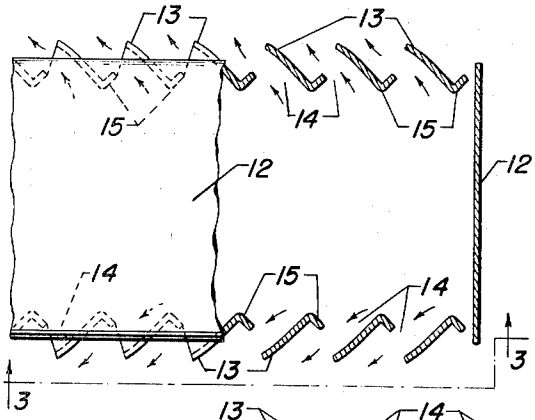


Figure 3

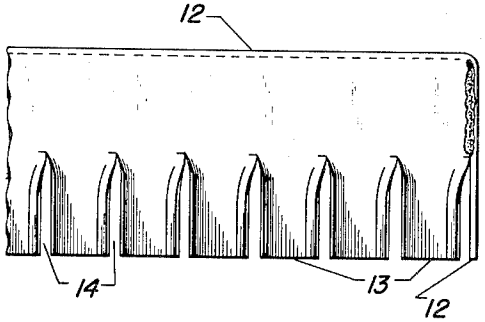
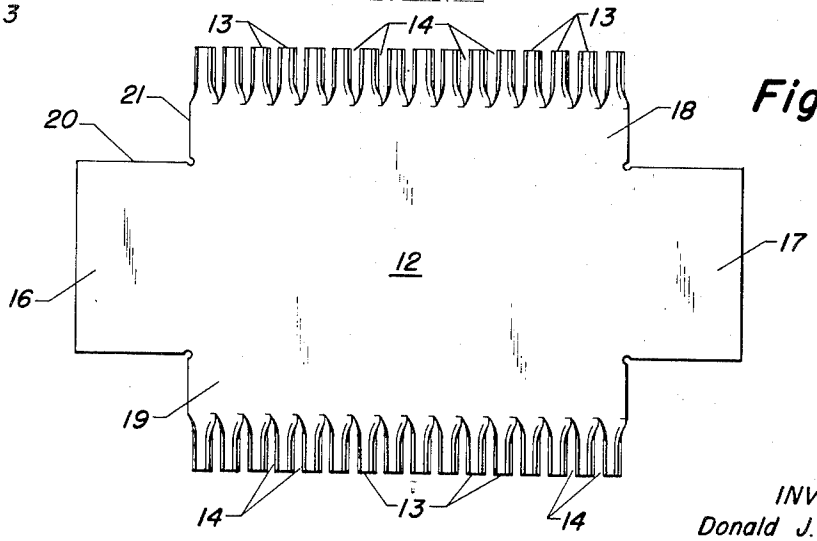


Figure 4



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FRACTIONATING APPARATUS

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Application December 1, 1953, Serial No. 395,488

3 Claims. (Cl. 261—114)

This application is a continuation-in-part of my co-pending application Serial Number 171,503, filed June 30, 1950, now abandoned.

This invention relates to an improved type of fractionating apparatus and more particularly to an improved type of easily fabricated bubble cap for a bubble deck or tray.

As known to those familiar with the chemical and petroleum industries, there are various forms of bubble caps and vapor-liquid contacting devices which are used in the various types of columns such as for fractionation, absorption, stripping, treating and the like. The present improvement relates to a modification of the bubble cap disclosed in my Patent No. 2,091,349, issued August 31, 1937, where the cap has slots or vapor passageways therethrough that are positioned angularly to direct vapors from under the cap outwardly in the same general direction as the liquid flow across the bubble tray.

Flow of liquid across a bubble deck requires head which shows up as the hydraulic gradient across the tray. This gradient may, in some cases, amount to 6 or 8 inches of liquid for a total from 24 to 30 inches between decks, thus it may be an appreciable portion of the total resistance. Angularly positioned slots in the caps of a bubble deck or tray pump the liquid across the tray by giving up energy from the gas or vapor to the liquid in a component direction of the flow of the liquid. As a result the hydraulic gradient backing up against the flow down the downpipe or pipes is minimized so that distribution of flow of vapor through the various caps on a deck is greatly improved and the capacity of a fractionating tower can be increased.

The improved bubble cap of this invention provides a cap which not only directs vapor flow to aid liquid flow across the deck, but has projecting means which form orifice-like restrictions and liquid pockets or recesses at each vapor slot in a manner which aids the mixing of liquid and vapor, as the latter passes through the slots of the bubble cap.

It is also an object of the invention to provide a construction where bent or angular-shaped tooth-like members are formed directly from the side walls of a cap-shaped member, to in turn form a bubble cap which will provide the desired improved vapor-liquid mixing.

In one embodiment, the improved fractionating tray or bubble deck comprises in combination, a deck member with a plurality of vapor riser openings therethrough, means for causing a liquid flow across the deck member and around the vapor riser openings, and a bubble cap member disposed over each of the riser openings, with each of the bubble cap members having a plurality of spaced and vertically positioned tooth-like members of bent or angular cross-section in the side walls thereof, with all of said toothed members being positioned angularly and symmetrically with respect to the axis of the cap member which is parallel to the direction of liquid flow across the plate, in a manner forming a plurality of spaced vertical slots or vapor passageways which are

arranged to direct the vapor outwardly in the same general direction as the liquid flow across the deck, and each bent or angle-shaped tooth member has a leg section or projection extending at substantially right angles to an adjacent vapor passageway, whereby to form a liquid pocket or recess out of direct alignment with the vapor flow and an orifice or venturi-like restriction which causes differential pressures and velocities in the stream passing through the slot.

The tooth-like members have an L-shaped cross-section with a projecting leg portion which extends substantially the full height of the tooth at the inner edge thereof, with respect to the inside of said cap, and is positioned to form an orifice-like restriction with the next adjacent tooth such that the vapors passing through the angularly positioned slot or passageway must pass through a restricted cross-section thereby being accelerated and decelerated as well as compressed and expanded to cause an aspirator effect which forms swirls or eddies around the edge of the projection and which causes the liquid in the bend of the L-shaped tooth to be drawn into the vapor stream in a manner to permit more turbulence and mixing with the liquid on the contacting deck. The bubble caps may of course be formed from a cast metal or alloy, but preferably are formed from rolled sheet steel or alloy. Thus, the bent or angle-shaped tooth-like members, with a portion thereof projecting into the vapor passageway to form a restriction, may be pressed and formed from a flat sheet into the desired angular shape by a die which also notches the corners so that the final flat sheet may be simply bent, and if necessary welded along the edges to form the desired cap. The cap thus formed contains a plurality of slots adapted to discharge the vapor in the same direction as the liquid. The flow through a venturi or orifice-like restriction creates a turbulent stream by the baffling effect of the lip member as well as by the aspirator effect caused by the vena contracta which in turn causes differential pressures and velocities due to the passage of a gas stream through a restricted cross-section. In other words, the apparatus of this invention does not permit the vapor stream to pass outwardly through each of the passageways in straight streamline flow.

The orifice-like restriction also causes the liquid flowing across the tray to move vertically. The aspirator effect caused by the restriction between teeth causes the liquid in the bend of the L-shaped teeth to be drawn into the gas stream. As a result, the liquid both above and below the teeth flows vertically downwardly and upwardly respectively, to fill the space left by the liquid that was moved horizontally into the vena contracta caused by the flow of vapor through the restricted cross-section.

The construction of the improved bubble cap, as well as its advantageous use in a bubble tray assembly, may be better described and shown in connection with the accompanying drawing and the following description thereof.

Figure 1 of the drawing is a sectional plan view, indicating a bubble tray in a fractionating column or other type of vapor-liquid contacting column, with the tray utilizing elongated vapor riser openings and the improved type of bubble cap members.

Fig. 2 of the drawing is an enlarged sectional plan view of the bubble cap, where the latter is fabricated and formed from sheet steel or plate as hereinbefore described. Figure 3 of the drawing shows an elevational view of the cap having the pressed and formed tooth-members, as indicated by the elevational view along line 3—3 in Figure 2 of the drawing.

Figure 4 is an elevational view of a stamped sheet which is ready to be bent into a cap as illustrated in Figures 2 and 3.

Referring now to Figure 1 of the drawing, there is shown a cylindrical shell 1 of a fractionating column or

the like, which supports a plurality of contact decks or trays 2. Each deck 2 has a suitable flanged or upturned edge 3 in order that a liquid level may be maintained on each deck, with liquid being supplied thereto by means of a suitable downspout such as indicated at 4. This downspout 4 passes liquid from the deck next above in the fractionating column to the upper surface of the deck 2 and thereacross in a manner permitting it to pass laterally and substantially uniformly to a downspout opening 5 for subsequent passage to the contacting deck next below. A suitable liquid weir extends around the periphery of the downspout opening 5 to maintain a given liquid level or liquid head across the deck 2.

The vaporous and/or gaseous material to be fractionated passes in a general upward direction through the column and through each of the decks 2 by means of a plurality of vapor riser openings indicated by the walls 7, each of which is in turn covered by a spaced bubble cap 12. In each case the rising vapor streams are directed downwardly by the bubble caps, with vapor bubbling and passing outwardly and angularly from under each cap through a plurality of vapor slots in the side walls thereof, into the main portion of the body of liquid maintained in the tray or bubble deck. The vapors which remain uncondensed by this contacting and scrubbing action with the liquid as it bubbles therethrough, pass from the surface of the liquid to the next higher tray or bubble deck.

In accordance with the present invention, each of the tooth-like members 13 has a projecting section or leg 15 at the inner edge thereof, with the projection 15 in each case extending outwardly into the vapor passageways 14 at substantially right angles to the vapor flow through the latter and in space relationship to the next adjacent tooth to form an orifice-like restriction. This construction provides a small recess or pocket for liquid within the included angle formed by the leg 13, and the baffling member 15 as well as the above mentioned restriction. The projections 15 thus preclude a streamlined vapor flow through the passageways and results in vapor-liquid turbulence within each passageway at a point outside of or beyond each of the projecting portions 15. This turbulence in turn provides a desired increased mixing between the liquid and the vapor stream bubbling therethrough.

The tooth-like members need not be limited to the exact form or shape indicated in Figure 2 of the drawing, but in general preferable embodiments provide a substantially right angle leg or projecting section 15, on each tooth-like member, that extends vertically for substantially the entire height of the tooth-member, in order that increased turbulence may be obtained while effecting the vapor-liquid contacting.

Figures 2 and 3 of the drawing indicate diagrammatically the preferred form or embodiment of the improved bubble cap, the latter being entirely fabricated and formed from rolled steel plate or alloy sheets. The cap 12 has a plurality of bent or angle-shaped tooth-like members 13 which are positioned angularly and spaced to provide a plurality of spaced vertical slots or vapor openings 14, which in turn are positioned at an angle as well as symmetrically with respect to a center line or longitudinal axis of the cap 12 which axis is parallel to the flow of liquid across said plate. Each of the vertically positioned tooth-like members 13 is bent and formed by suitable stamping or pressing dies to provide both the angular positioning and the bent toe or leg sections 15, which in turn project at substantially right angles into the vapor passageways 14 and thus provide a desired restriction and turbulence for the liquid and vapor contacting operation. The bent projecting sections 15 are in each case on the inside portion of each tooth-like member, with respect to the bubble cap, so that there is a pocketing or baffling provided for the liquid maintained on the bubble deck around each of the bubble caps and an orifice or venturi-like restriction to cause differential velocities and pressures thereby further creating turbulence.

In this latter embodiment, the bent tooth-like members 13 are formed entirely from the metal of the side wall of the bubble cap 12, with the forming and stamping dies cutting and bending the lower portion of each tooth-like member into the desired bent shape, having the projections 15 extending outwardly in each case into an adjacent vapor passageway 14. In the preferred mode of stamping no metal is removed from the sheet, the entire shape resulting from deforming the existing metal of the sidewalls. The size of the tooth-like members 13 and the spacing therebetween, forming the vapor slots 14, may of course be varied to suit a particular design in accordance with a desired vapor-liquid contact.

The fabricated bubble cap need not be of an elongated shape only, but may be round, square, of a polygonal shape, or of any other desired shape that may be used for any of the various types of fractionating decks. For each shape, however, the angular tooth-like projections shall be symmetrical to the axis of the cap that is parallel to the direction of liquid flow across the plate and shall discharge in the general direction of flow.

Regardless of the shape of the cap, the preferred method of fabrication is to stamp the tooth-like members, 13, out of a flat sheet and at the same time notch the corners to adapt the sheet to be bent into a box-like shape. Figure 4 shows a stamped piece ready for bending. Tooth-like members 13 are formed to be vertical and symmetrical about the long axis of the cap when it is in its final form. The notched corners form end closure members 16 and 17 which are adapted to be bent down to form the end closures of the cap and to intersect members 18 and 19 along line 20 and 21 and the lines corresponding to lines 20 and 21 on the other corners. The meeting edges may be welded or merely pressed together to form a sufficiently close seal to prevent the escape of vapors.

The formed flat sheet may of course not have end members 16 and 17 attached thereto but separately made and subsequently attached. This embodiment is especially desirable when large quantities of caps of undetermined length are prepared since lengths of stamped sheeting could be prepared and stored and the proper length of cap could be cut off when desired and the end closures welded in.

The bubble caps of this invention will be provided with whatever brackets, etc. that are required to bolt, rivet or weld them into place on the deck or tray. The caps of the present invention may be adapted to be asymmetrically mounted to insure that the final tray assembly pumps the liquid rather than having the vapor flow oppose the liquid flow. By having the caps mounted in one way only the possibility of accidental mis-mounting may be substantially eliminated.

I claim as my invention:

1. A bubble cap having a plurality of vertically extending toothed members of L-shaped cross-section arranged to define vertically elongated passageways between adjacent members, each of said members having a leg bent at right angles to said member and extending toward the adjacent member, said legs restricting said passageways at the entrance thereto.

2. A rectangular bubble cap having in each of its long side walls a plurality of vertically extending toothed members of L-shaped cross-section arranged to define vertically elongated passageways between adjacent members, each of said members having a leg bent at right angles to said member and extending toward the adjacent member, said legs restricting said passageways at the entrance thereto.

3. A bubble tray assembly comprising in combination a deck plate adapted to have liquid flow thereacross, liquid distributing means at one end thereof and liquid downspout means on the other end thereof, a plurality of spaced

vapor risers in said deck, and a bubble cap disposed on the upper end of each of said risers, each of said bubble caps having a plurality of vertically extending toothed members of L-shaped cross-section arranged to define vertically elongated passageways between adjacent members, each of said members having a leg bent at right angles to said member and extending toward the adjacent member, said legs restricting said passageways at the entrance thereto.

References Cited in the file of this patent

UNITED STATES PATENTS

1,673,895	Alexander	June 19, 1928
1,878,467	Clarke	Sept. 20, 1932
2,060,601	Wentworth	Nov. 10, 1936
2,091,349	Bergman	Aug. 31, 1937

FOREIGN PATENTS

164,250	Austria	Oct. 25, 1949
629,086	Germany	Apr. 22, 1936