Sept. 28, 1954 S. M. JORGENSEN 2,690,332

BUBBLE TOWER

Filed May 25, 1950 3 Sheets-Sheet 1

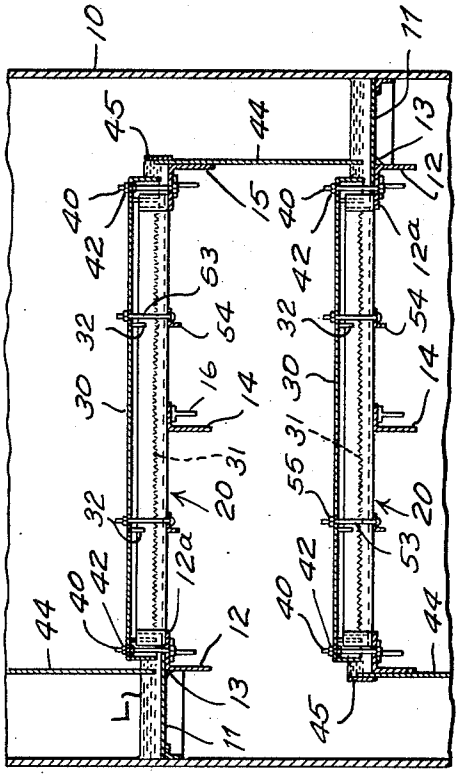


Fig. 1.

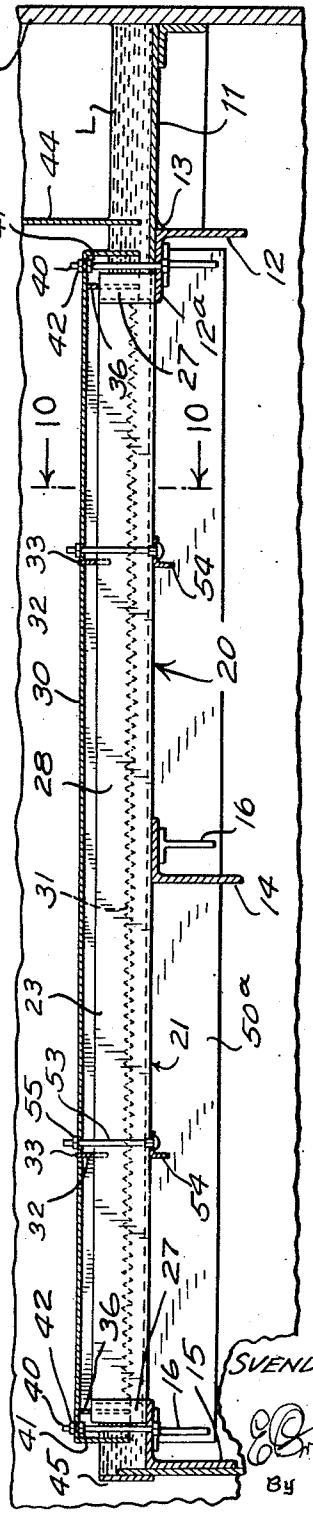


Fig. 2.

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BUBBLE TOWER

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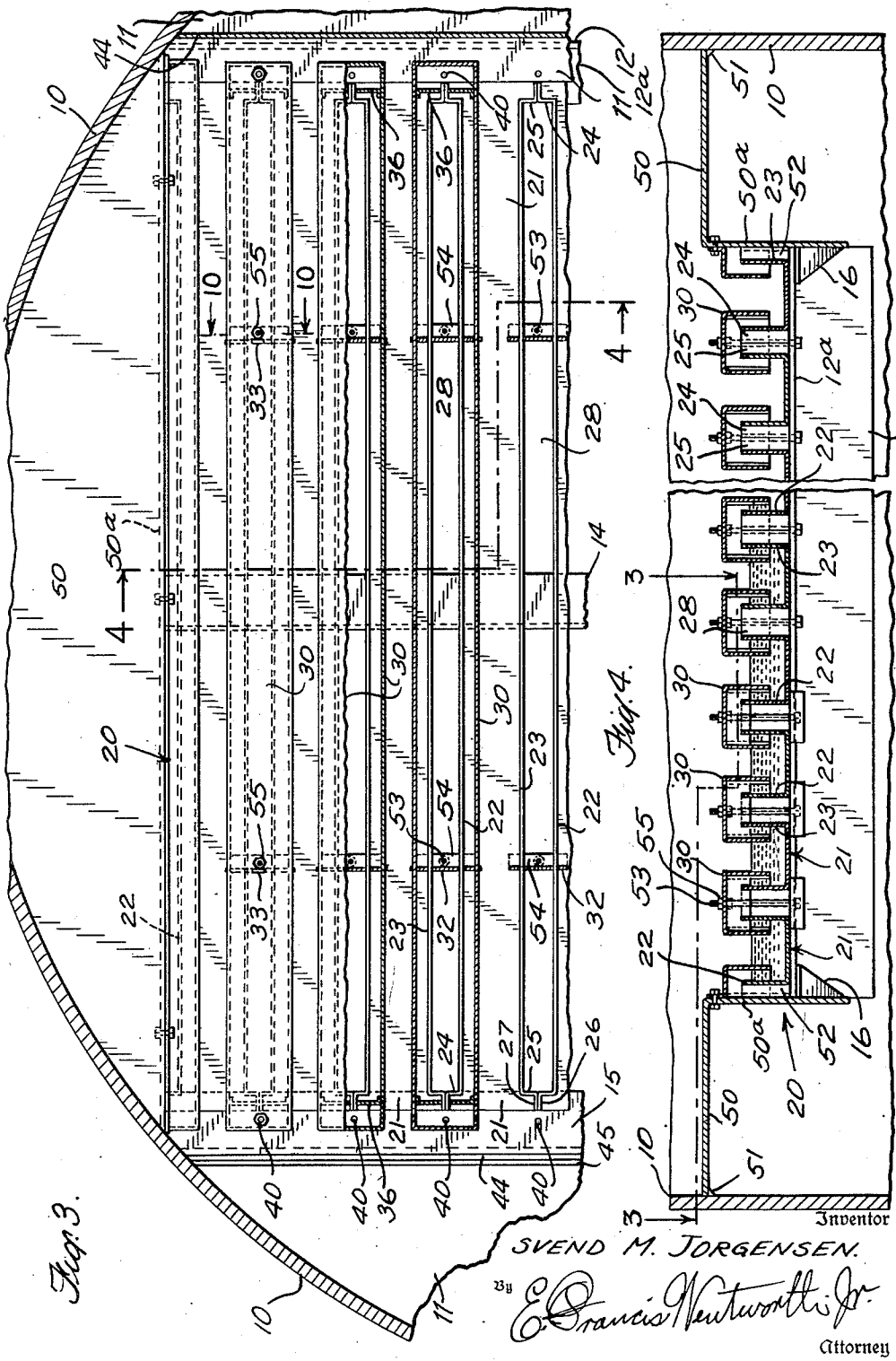


Fig. 3.

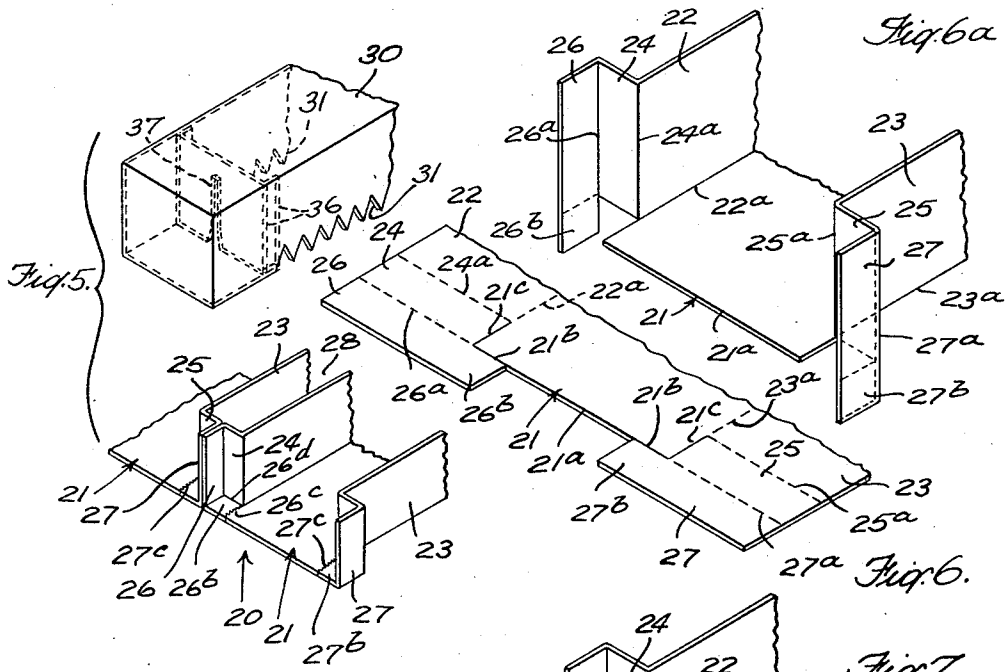
Fig. 4.

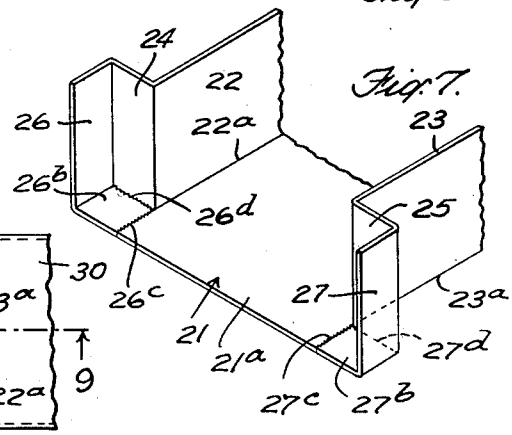
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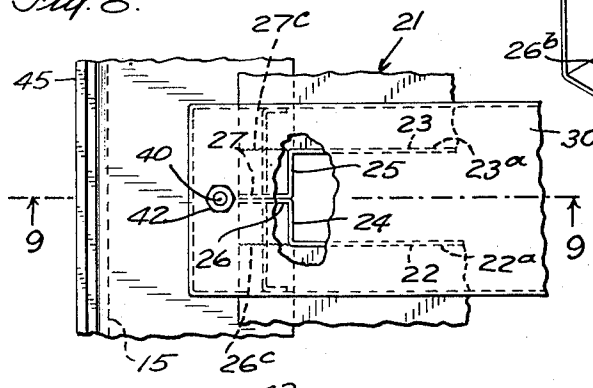
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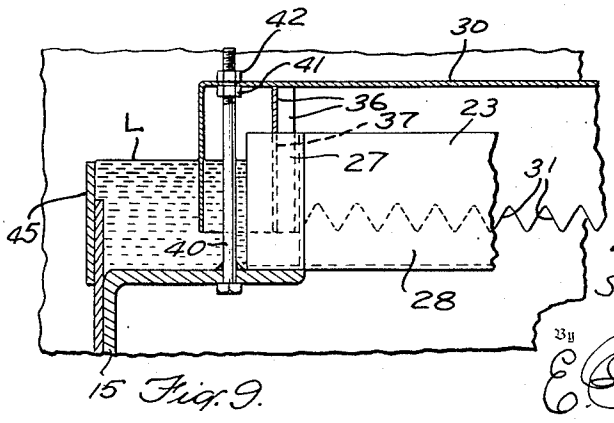
BUBBLE TOWER

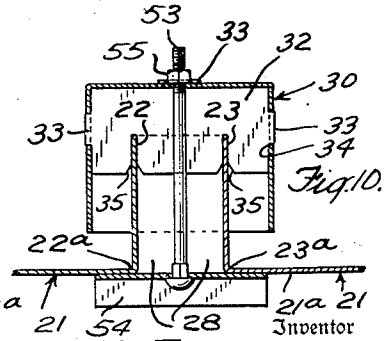
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UNITED STATES PATENT OFFICE

2,690,332

BUBBLE TOWER

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13 Claims. (Cl. 261—114)

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This invention relates to bubble towers and more particularly to tray constructions for bubble towers of the kind in which liquids and vapors are caused to counterflow to obtain intimate contact therebetween.

The bubble tower and tray construction while useful in many fields requiring such apparatus is particularly useful in the oil industry for providing intimate contact between vapors and liquids to procure fractionation and heat exchange between the vapor and the liquid.

Features and objects of the invention are to provide novel bubble tray constructions of sectionalized elements or units that are light, individually capable, for example, of being carried or handled by one man, that are readily assembled or can be put together quickly or removed individually for cleaning, repair or replacement, that for assembly utilize a minimum of small pieces such as nuts, bolts or clips or other fastening devices thereby minimizing labor of assembly or disassembly and which are dimensioned so that individual sections apart from light weight can be removed or replaced through relatively small openings in the tower, for example, manways sixteen inches in diameter.

Further objects and novel features will become apparent from the following description and the drawings forming a part hereof wherein:

Fig. 1 is a fragmentary vertical section of a bubble tower equipped with trays of the invention;

Fig. 2 is a vertical section on an enlarged scale of a single half of one of the tray troughs and its cap as well as the manner of supporting the troughs;

Fig. 3 is a transverse horizontal section of a bubble tower viewed from above the level of a horizontal row of trays;

Fig. 4 is a transverse vertical section taken along line 4—4 of Fig. 3 and viewed in the direction of the arrows;

Fig. 5 is an exploded fragmentary perspective view illustrating assembly details of the tray and cap construction;

Fig. 6 is a fragmentary perspective view of one of the tray sections in the initial stage of its preparation;

Fig. 6*a* is a fragmentary perspective view of one of the tray sections in an intermediate state of its preparation;

Fig. 7 is a similar fragmentary perspective of the tray element of Fig. 6 in its completed form;

Fig. 8 is a fragmentary plan view illustrating details of the cap supporting elements;

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Fig. 9 is a vertical section taken along line 9—9 of Fig. 8 and viewed in the direction of the arrows; and

Fig. 10 is a vertical section taken substantially along line 10—10 of Fig. 2 and illustrating details of the cap stiffener construction.

Referring to the drawings, 10 denotes a bubble tower. A plurality of segmented metal plates 11 are welded, bolted or fixed in other ways to the interior of the tower 10, these plates 11 being arranged in staggered relation and being positioned on opposite sides of the tower 10 at different levels. The segmented plates 11 each extend for only a short distance into the tower 10 and are supported at their inner edges on flanges 12*a* of transversely extending angle bars or beams 12 to which the said edges are secured as by welding at 13. At substantially the level of each of the segmented plates 11 and extending in parallelism with and spaced apart from the bars or beams 12, a plurality or intermediate similar angle bars or beams 14 and 15 are provided. The bars or beams 12, 14 and 15 are all supported at their opposite ends by suitable hangers 16 which are supported from the inner wall of the tower 10. The bars or beams are either welded to the hangers or else wedges (not shown) may be used to clamp the bars or beams to the hangers in well known manner.

The beams 12, 14 and 15 at each level act as supports for the trays 20 (Fig. 5) which are made up of sectional elements or units each constructed as is hereinafter described. In the embodiment shown and particularly as seen in Figs. 5, 6 and 7, the tray 20 at each level in the bubble tower is constructed of individual sections 21 and and assembled together to form the tray. Each tray section 21 is formed from a single substantially rectangular sheet of metal, for example, stainless steel alloy. In forming each sheet into a tray section 21, the sheet at its opposite transverse ends is cut away to provide the rectangular recesses 21*a*. Ninety degree cuts 21*b*, 21*c* are then made at each inner corner of the recess 21*a*. The opposite longitudinal edge portions of equal width of the sheet are bent upwardly along the fold lines 22*a* and 23*a* to define vertical side walls 22, 23 of equal height. At opposite ends of each sheet each of the walls 22 and 23 is bent laterally at fold lines 24*a* and 25*a* to define portions 24 and 25 and at right angles to portions 24 and 25 along fold lines 26*a*, 27*a* to define portions 26 and 27 offset from walls 22 and 23 but parallel therewith. The width of the respective portions 26 and 27 is substantially equal

to the projecting end portion 21*a* of the sheet. The lengths of the portions 26 and 27, however, are greater than the height of the respective walls 22 and 23 by an amount defining lower flap portions 26*b* and 27*b* and the lengths of the said flap portions or tabs 26*b*, 27*b* are equal respectively to the widths of the wall portions 24 and 25. The tab portions 26*b*, 27*b* are folded substantially at right angles to the wall portions 26, 27 to lie alined with end portion 21*a* of the sheet and so that their outermost free ends respectively abut the opposite free side edges of the portion 21*a* to which they are permanently secured by welds at 26*c*, 27*c*. The flaps 26*b*, 27*b* are also welded at 26*d*, 27*d* to the lower edges of wall portions 24, 25. Each tray section when constructed as just described has substantially the appearance of an I when seen in plan. (See Fig. 3.) In the alternative each tray when constructed as described can be said to have a longitudinal channel with a T-head enlargement at each end. In other words, each tray section 21 is formed from a unitary sheet folded to provide a bottom and side walls 22, 23, the side walls having laterally offset portions 24, 26 and 25, 27 also provided by folding and wherein abutting free edges 26*c*, 26*d* and 27*c*, 27*d* of folded portions are permanently secured together as by welding.

When a plurality of these troughs or tray sections 21 are positioned side by side to span each group of support bars or beams 12, 14 and 15, at each level it will be apparent as seen in Fig. 5 that the laterally offset side walls 26 and 27 of an adjacent pair of the tray sections abut each other and the adjacent pair of the walls 22, 23 of adjacent pairs of the tray sections 21 are spaced apart from each other respectively a width equal to the sum of the widths of a wall portion 24 and a wall portion 25 defining between them a vapor or gas riser space 28 which is completely open along both its bottom and top, while each of the tray sections 21 itself has a completely closed bottom including the main body of the sheet of which each tray section is formed and the bent underflap portions 26*b* and 27*b*. The tray sections 21 at each level are adapted to be held down removably on their supporting beams 12, 14 and 15 in any conventional manner, for example, by appropriate wedges, (not shown) or in other ways.

A cap 30 is provided to overlie each of the spaces 28. Each cap 30 is substantially of inverted U-shaped cross section being preferably closed at its outer ends and having substantially greater length than the length of the respective tray sections 21. The lowermost side edges 31 of the caps 30 are serrated for purposes presently to be described. Cap stiffener plates 32 extending transversely between side walls of the cap 30 at spaced apart points are provided for each cap. These stiffeners are appropriately fixed to walls of the cap 30, for example, by providing peen projections 33 along side edges of the stiffener plates 32 which are projected through appropriate openings 34 in the top and side walls of cap 30 and which are peened over to lock them in place. Each of the stiffener plates 32 is provided with a pair of spaced apart vertically extending slots 35 whose center to center distance is that of the distance between the adjoining walls 22, 23 defining the space 28 so that when the cap is fitted over the space 28 the walls 22, 23 defining it fit in the respective spaced apart slots 35. The height of the slots 35 is less than the walls 22 and 23 over which they fit so that the top wall of cap 30 is retained in an elevated position relative to the upper edges of the walls 22 and 23. In addition the stiffener plates 32 by reason of their slotted engagement with the adjoining walls 22 and 23 act also as stiffeners for these walls. Adjacent the opposite ends of caps 30, stiffener plates 36 are provided. These plates are fastened to the walls of the cap 30 in the same way as plates 32, but differ from the latter in having only a single vertical slot 37 instead of a pair of slots 35. This single slot 37 is slightly wider than the thickness of the pair of abutting walls 26 and 27 of adjacent tray sections. If a gasket (not shown) is interposed between the abutting walls 26, 27 and slot 37 of plate 36 forced over these walls, the plate 36 acts to press the two abutting walls 26, 27 against the interposed gasket and acts then to seal the end joints of gas space 28 made by these walls 26, 27 as well as to hold the adjoining sections 21 firmly together. Caps 30 and tray sections 21 are tied together in a composite unit in their described assembled relationship by tieing means. As shown more particularly in Figs. 3, 4, 9 and 10, adjacent tray sections 21 are maintained in their assembled relationship and the caps 30 are held in position by a plurality of bolts 53 and angle clips 54 which bolts and clips are located adjacent stiffener plates 32. Clips 54 are of sufficient length to bridge spaces 28 and are disposed with one leg thereof in contact with the under surface of adjacent trays. Bolts 53 extend through the clips 54, the heads of the bolts engaging said one leg of the clips. Bolts 53 also extend through spaces 28 and caps 30. A nut 55 threadedly engages each of bolts 53 and is tightened against the upper surface of the caps thereby maintaining the clips and caps in position. The caps 30 are held down adjacent opposite ends thereof by tie down bolts 40 welded to and upstanding from the beams 12 and 15 and on which the respective nuts 41 and 42 threadedly engage, nut 41 acting as a limit stop and nut 42 as a clamp for the cap. Other ways of securing caps 30 in place may be provided.

Each of the beams 15 has a downwardly extending baffle plate 44 secured to its vertical flange, for example, by welding, and extending from the flange to a distance slightly above the level of the segmented plate 11 directly below. In addition, an upwardly directed dam member or plate 45 extends upwardly of the vertical flange of beam 15 and its upper edge defines the overflow level of liquid in the tray sections 21 so that the liquid will overflow the upper edge of the dam member 45 to fall to the segmented plate 11 on the tray level directly below.

The lengths of the tray sections 21 utilized, as shown in Figs. 3 and 4, is such that they do not extend the complete distance between the opposite sides of the tower 10. The unfilled sectioned spaces remaining at each side of each level of trays are each filled by a segmented plate member 50 welded at 51 to the inner wall of tower 10 and provided along its chord with a downwardly depending vertical flange 50*a* which with the side wall 22 or 23 of the tray section 21 next adjacent it defines a space 52 substantially half the width of the space 28 hereinbefore described.

The operation of the tower with the tray sections 21 at each level supported as described is as follows: Liquid L is directed to the segmented plate 11 of the uppermost level, see for example Fig. 1, where it flows under the lower edge of baf-

fle 44, under the lower serrated edges of the cap 30 and distributes itself in the various channels of the tray sections 21 and flows rightward as seen in Fig. 1, filling these channels to the overflow level of the dam 45 at the extreme right whence it falls to the segmented plate 11 on the next lower level of tray sections 21 where after flowing under the lower edge of baffle 44 of the said next level it distributes itself in the channels of the trays on this level flowing leftwardly to overflow the dam 45 at the left. This zig-zag flow alternately from right to left at each succeeding level of tray section in the bubble tower continues until the lowest level is reached. At the same time while the oppositely directed or zig-zag flow of liquid from level to level is occurring the gas to be bubbled through the liquid is admitted at the lowermost level entering the lowermost spaces 28 and moving upwardly through these spaces and the caps 30 and under the serrated edges thereof at each level and bubbling through the liquids in the tray sections at each level until ultimately the gas has risen to the top of the bubble tower.

With the construction described a minimum number of joints have been utilized and the tray sections 21 of each row are readily removable individually for cleaning or for repair. It is a comparatively simple matter for removal purposes to unscrew the clamping nuts 42 and nuts 55 of the caps 30 and to remove the tray sections spanned by such caps. The weight of each tray section 21 is at a minimum because bolting or other fastening arrangements are replaced by the simple welds described. Each individual tray section 21 as well as each individual cap 30 may be of such dimensions that its weight individually will not exceed what can be conveniently carried by one man. Moreover, since the tray sections and caps are pre-assembled the erection of a bubble tower designed to include such parts may be completed in a much shorter period of time than that which would be necessary in structures for like purposes utilizing bolting arrangements for the fastening of parts. The entire structure, because of the minimum number of fastenings, itself is lighter than comparative structures using bolted parts and can be made of lighter structural material.

While a specific embodiment of the invention has been described, variations in structural detail within the scope of the claims are possible and are contemplated. There is no intention therefore of limitation to the exact structure shown and described.

What is claimed is:

1. In a bubble tower, a bubble tray construction comprising individual tray sections assembled together to provide the tray construction, each tray section having bottom and side walls defining troughs and laterally offset portions in the side walls adjacent its ends, the laterally offset portions of the side walls of one tray section extending away from said side walls and toward the laterally offset portions of the laterally adjacent side wall of the next laterally adjacent tray section, each of the offset portions having a member projecting away therefrom in the same general direction as the side walls of said trays extend, said member being of a height substantially the same as the height of said side walls and having the adjacent surfaces of said members of adjacent sections abutting one another, said offset portions spacing adjoining side walls from each other to define vapor riser spaces between pairs of adjacent tray sections, the bottom of the tray sections being coextensive with said offset portions and said members and in fluid-tight relationship therewith, and securing means removably associated with said members and comprising a plate having a slot therein said slot having opposite walls engaging the surfaces of said members opposite said abutting surfaces, the distance between the opposite walls of the slot being such as to maintain the adjacent surfaces of said members in fluid-tight longitudinally slidable relationship and prevent lateral movement apart only of said adjacent members.

2. In a bubble tower, a bubble tray construction comprising individual tray sections assembled together to provide the tray construction, each tray section of a single sheet of flat metallic material and having bottom and side walls defining troughs and laterally offset portions in the side walls adjacent its ends, the laterally offset portions of the side walls of one tray section extending away from said side walls and toward the laterally offset portions of the laterally adjacent side wall of the next laterally adjacent tray section, each of the offset portions having a member projecting away therefrom in the same general direction as the side walls of said trays extend, said member being of a height substantially the same as the height of said side walls and having the adjacent flat surfaces of said members of adjacent sections abutting one another, said offset portions spacing adjoining side walls from each other to define vapor riser spaces between pairs of adjacent tray sections, the bottom of the tray sections being coextensive with said offset portions and said members and in fluid-tight relationship therewith, and securing means removably associated with said members and comprising a plate having a slot therein said slot having opposite walls engaging the surfaces of said members opposite said abutting surfaces, the distance between the opposite walls of the slot being such as to maintain the adjacent flat surfaces of said members in fluid-tight longitudinally slidable relationship and prevent lateral movement apart only of said adjacent members.

3. In a bubble tower, a bubble tray construction comprising individual tray sections assembled together at different levels in the tower to provide bubble trays at each of said levels, each tray section having bottom and side walls defining troughs and laterally offset portions in the side walls adjacent its ends, the laterally offset portions of the side walls of one tray section extending away from said side walls and toward the laterally offset portions of the laterally adjacent side wall of the next laterally adjacent tray section, each of the offset portions having a member projecting away therefrom in the same general direction as the side walls of said trays extend, said member being of a height substantially the same as the height of said side walls and having the adjacent surfaces of said members of adjacent sections abutting one another, said offset portions spacing adjoining side walls from each other to define vapor riser spaces between pairs of adjacent tray sections, the bottom of the tray sections being coextensive with said offset portions and said members and in fluid-tight relationship therewith, and securing means removably associated with said members and comprising a plate having a slot therein said slot having opposite walls engaging the surfaces of said members opposite said abutting surfaces, the distance between the opposite walls of the slot

being such as to maintain the adjacent surfaces of said members in fluid-tight longitudinally slidable relationship and prevent lateral movement apart only of said adjacent members.

4. The bubble tower tray construction of claim 3 wherein each tray section consists of a single sheet of metallic material with portions thereof folded to define the bottom side walls, the offset portions and said members.

5. In a bubble tower, a bubble tray construction comprising individual tray sections assembled together to provide the tray construction, each tray section having bottom and side walls defining troughs and laterally offset portions in the side walls adjacent its ends, the laterally offset portions of the side walls of one tray section extending away from said side walls and toward the laterally offset portions of the laterally adjacent side wall of the next laterally adjacent tray section, each of the offset portions having a member projecting away therefrom in the same general direction as the side walls of said trays extend, said member being of a height substantially the same as the height of said side walls and having the adjacent surfaces of said members of adjacent sections abutting one another, said offset portions spacing adjoining side walls from each other to define vapor riser spaces between pairs of adjacent tray sections, the bottom of the tray sections being coextensive with said offset portions and said members and in fluid-tight relationship therewith, a cap supported over each vapor riser space, stiffening means for each cap, said stiffening means also engaging the adjacent side walls of the pair of tray sections defining each riser space to maintain side by side assembled relationship of the tray sections, and securing means removably associated with said members and comprising a plate having a slot therein said slot having opposite walls engaging the surfaces of said members opposite said abutting surfaces, the distance between the opposite walls of the slot being such as to maintain the adjacent surfaces of said members in fluid-tight longitudinally slidable relationship and prevent lateral movement apart only of said adjacent members.

6. The bubble tray construction of claim 5 wherein the securing means is secured to the cap.

7. The bubble tray construction of claim 5 wherein the stiffening means comprise transversely extending vertically slotted plates secured to the cap, the slots of the plates in each cap receiving the adjacent side walls of the adjacent pair of tray sections.

8. The bubble tray construction of claim 5 wherein the securing means comprise transversely extending vertically slotted plates secured to the caps adjacent the opposite ends thereof and the stiffening means comprise a plurality of said plates secured to the caps intermediate said adjacent ends.

9. In a bubble tower, a bubble tray construction comprising individual tray sections assembled together to provide the tray construction, each tray section having bottom and side walls defining troughs and laterally offset portions in the side walls adjacent its ends, the laterally offset portions of the side walls of one tray section extending away from said side walls and toward the laterally offset portions of the laterally adjacent side wall of the next laterally adjacent tray section, each of the offset portions having a member projecting away therefrom in the same general direction as the side walls of said trays extend, said member being of a height substantially the same as the height of said side walls and having the adjacent surfaces of said members of adjacent sections abutting one another, said offset portions spacing adjoining side walls from each other to define vapor riser spaces between pairs of adjacent tray sections, the bottom of the tray sections being coextensive with said offset portions and said members and in fluid-tight relationship therewith, a cap supported over each vapor riser space, tying means for removably maintaining adjacent trays and the cap in position in relationship to one another, and securing means removably associated with said members and comprising a plate having a slot therein said slot having opposite walls engaging the surfaces of said members opposite said abutting surfaces, the distance between the opposite walls of the slot being such as to maintain the adjacent surfaces of said members in fluid-tight longitudinally slidable relationship and prevent lateral movement apart only of said adjacent members.

10. The bubble tray construction of claim 9 wherein the tying means comprises a clip extending transversely of said vapor riser space and adapted to bear against the under surface of adjacent trays, a bolt extending through said clip and said cap, said bolt having a head at one end thereof bearing against the clip and a threaded end opposite said one end projecting through said cap, and a nut on said threaded end adapted to be tightened against said cap to maintain the clip in tightened relationship with said adjacent trays and maintain said cap in position over each vapor riser space.

11. In a bubble tower, a bubble tray construction comprising individual tray sections assembled together side by side at a plurality of levels in the tower to provide the bubble tray construction at each level, means in the tower for supporting assembled tray sections at each level, each tray section having bottom and side walls defining troughs and laterally offset portions in the side walls adjacent its ends, the laterally offset portions of the side walls of one tray section extending away from said side walls and toward the laterally offset portions of the laterally adjacent side wall of the next laterally adjacent tray section, each of the offset portions having a member projecting away therefrom in the same general direction as the side walls of said trays extend, said member being of a height substantially the same as the height of said side walls and having the adjacent surfaces of said members of adjacent sections abutting one another, said offset portions spacing adjoining side walls from each other to define vapor riser spaces between pairs of adjacent tray sections, the bottom of the tray sections being coextensive with said offset portions and said members and in fluid-tight relationship therewith, securing means removably associated with said members and comprising a plate having a slot therein said slot having opposite walls engaging the surfaces of said members opposite said abutting surfaces, the distance between the opposite walls of the slot being such as to maintain the adjacent surfaces of said members in fluid-tight longitudinally slidable relationship and prevent lateral movement apart only of said adjacent members, a dam at each level located adjacent all correspondingly located outlet ends of the troughs of the tray sections in that level and a baffle at each level adjacent all correspondingly located inlet ends of the troughs of the tray sections in that level, each baffle ex-

tending downwardly between a pair of levels and depending from the uppermost level of the pair, whereby liquid flows in all troughs at each level and successively downwardly from level to level.

12. The bubble tray construction of claim 11 including a cap positioned over each vapor riser space, tying means for removably maintaining adjacent trays and a cap in position in relationship to one another.

13. The bubble tray construction of claim 11 including a cap positioned over each vapor riser space, tying means for removably maintaining adjacent trays and a cap in position in relationship to one another, which tying means comprises a clip extending transversely of said vapor riser space and adapted to bear against the under surface of adjacent trays, a bolt extending through said clip and said cap, said bolt having a head at one end thereof bearing against the clip and a threaded end opposite said one end projecting through said cap, a nut on said threaded end adapted to be tightened against said cap to maintain the clip in tightened relationship with said adjacent trays and maintain said cap in position over each vapor riser space.

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