

May 25, 1943.

J. A. GIBB

2,320,073

BUBBLE DECK

Filed July 31, 1941

4 Sheets-Sheet 1

Fig. 1.

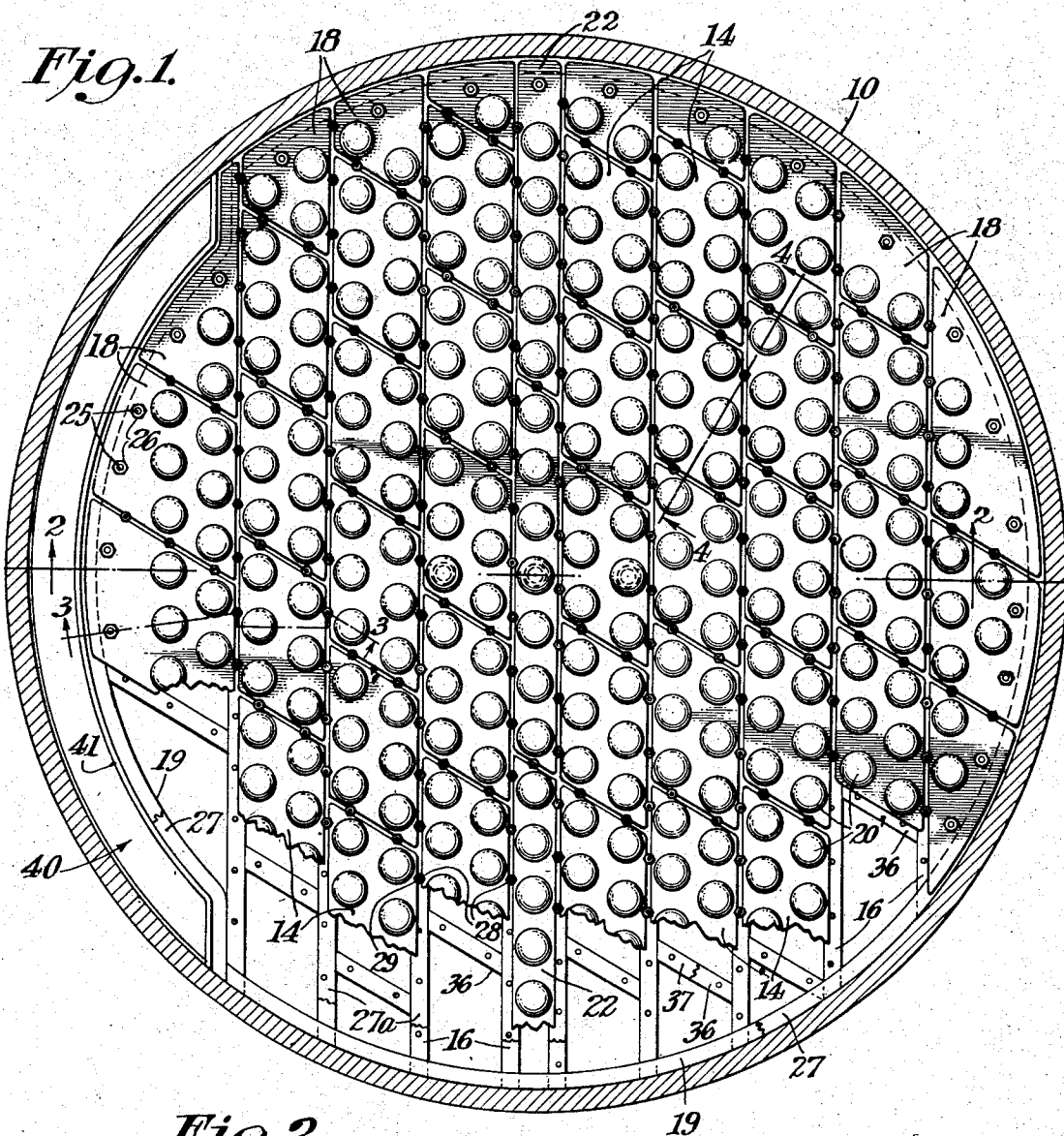
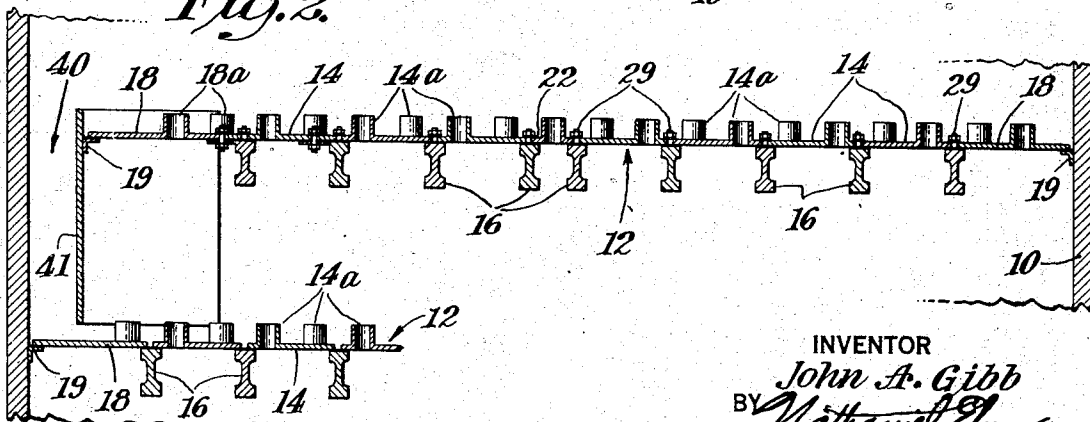


Fig. 2.



INVENTOR
John A. Gibb
BY *Nathaniel Ely*
ATTORNEY

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Fig. 7.

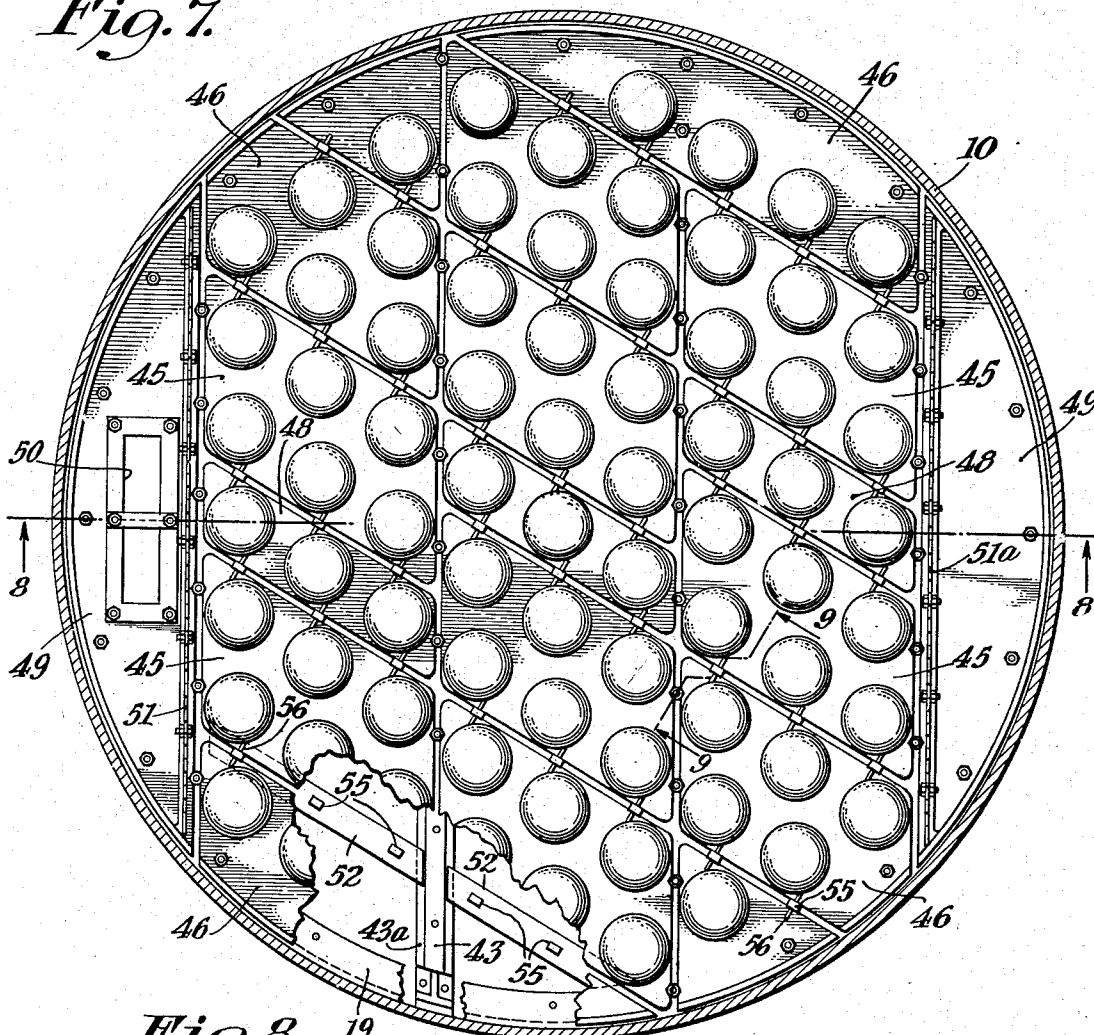


Fig. 8.

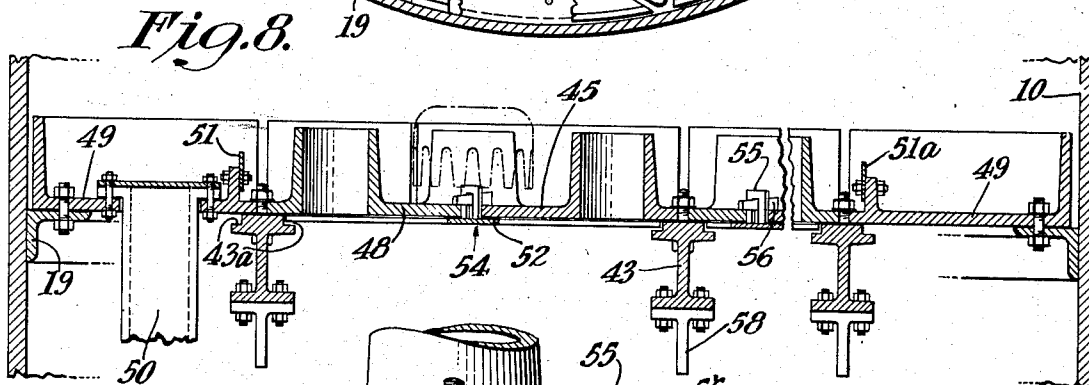
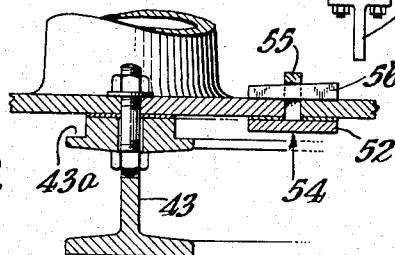


Fig. 9.



INVENTOR
John A. Gibb
BY *Nathaniel Ely*
ATTORNEY

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Fig. 10.

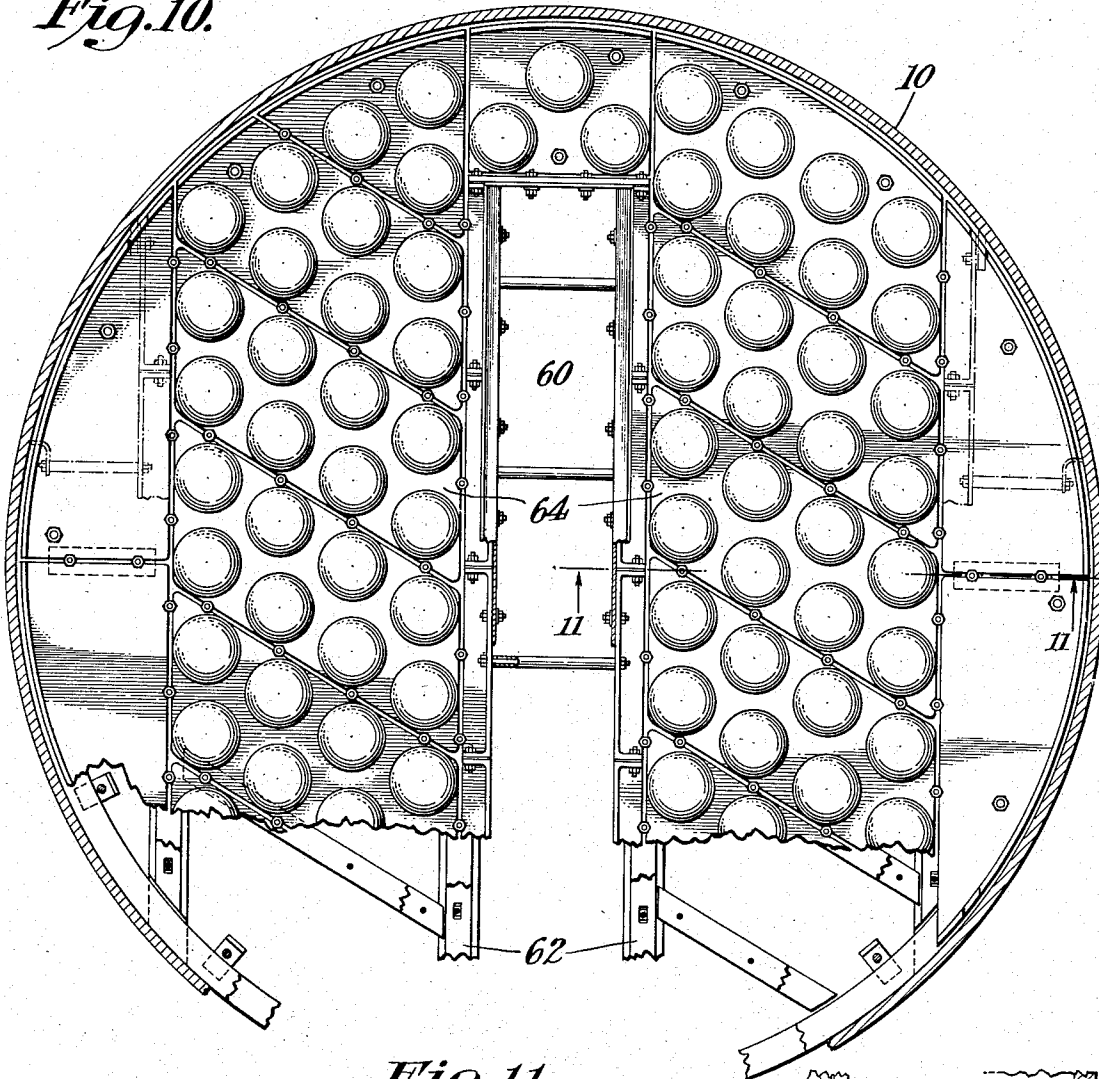
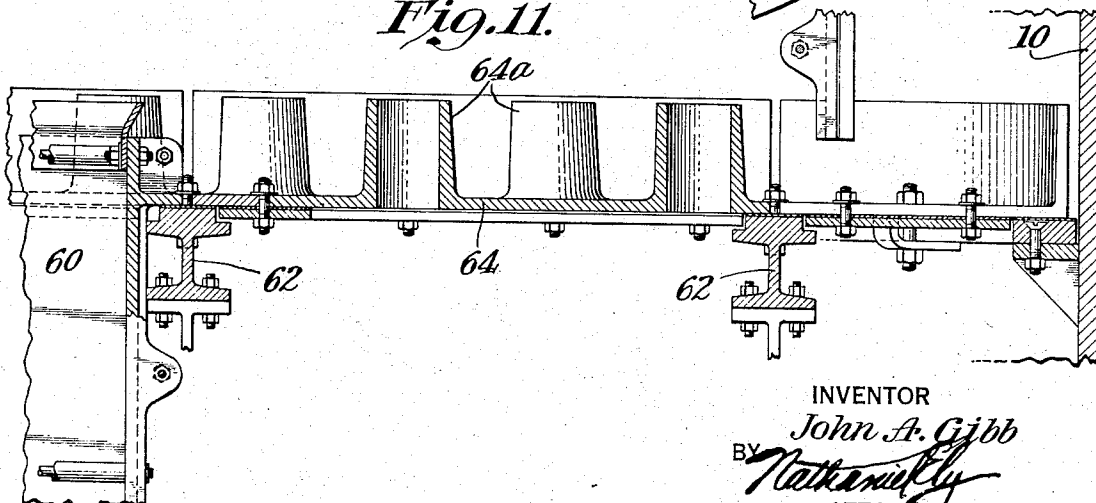


Fig. 11.



INVENTOR
John A. Gibb
BY *Nathan*
ATTORNEY

UNITED STATES PATENT OFFICE

2,320,073

BUBBLE DECK

John A. Gibb, New Rochelle, N. Y., assignor to
The Lummus Company, New York, N. Y., a
corporation of Delaware

Application July 31, 1941, Serial No. 404,796

5 Claims. (Cl. 261-114)

The present invention relates to improvements in bubble decks or trays for bubble columns and the like.

The use of bubble decks or trays in a fractionating column is well known in the art. Generally speaking, they are arranged transversely across the column in spaced relation and in communication with one another so that the liquid undergoing fractionation can flow across each deck and downwardly to the deck below. The downwardly flowing liquid collects on the respective bubble decks in its passage through the column and is contacted counter-currently with ascending vapors.

The general arrangement with respect to the number and location of the bubble trays as well as the number of risers, bubble caps, and downpipes on the respective decks is largely dependent upon the characteristics of the given liquid mixture undergoing fractionation. Ordinarily, the decks are fabricated in one piece although in very large columns it has been customary to use sectional decks to facilitate insertion of the decks in the column. With such sectional decks considerable difficulty arises in arranging the necessary risers, caps, etc., within the confines of the particular segments or sections. Necessarily, large sections varying in size and conforming to the shape of the particular column have to be used, and these are of no use in columns of different diameter.

My invention contemplates overcoming these and other difficulties by the simple expedient of fabricating the bubble tray from key pieces, substantially all of which have a predetermined geometry such that, when assembled, they form a flexible pattern that may be employed as a standard construction for the trays of various size bubble columns.

Another object of my invention is to provide a key piece for a bubble plate or tray, which piece has integral risers and provision for caps and which has such a configuration that a plurality of such pieces can be assembled into a general pattern arrangement that substantially covers the vapor-liquid contact area of the tray regardless of the column size and with the minimum of marginal filler space.

A specific object of my invention is the provision of a key piece for a bubble tray, which piece has a shape in which the configuration of the sides conforms to the pitch of the risers carried by the key piece.

A further object of my invention is the provision of a simplified construction for securing

the segments of bubble trays to their supporting beams so that the segments may be installed and removed with a minimum of effort and so that, at the same time, a liquid-tight seal is formed between the adjoining sections and the supporting beams.

Further objects and advantages of my invention will appear from the following description of preferred forms of embodiment thereof taken in connection with the attached drawings, in which:

Fig. 1 is a horizontal section through a column showing in plan a bubble tray construction contemplated by the present invention;

Fig. 2 is a vertical sectional view through the column, taken on the line 2-2 of Fig. 1, showing several bubble plates and the supporting transverse beam members therefor;

Fig. 3 is an enlarged vertical section, taken on the line 3-3 of Fig. 1, illustrating details of construction of the tray including the bubble cap risers and the supporting and fastening means for the component parts of the tray;

Fig. 4 is an enlarged vertical section, taken on the line 4-4 of Fig. 1, illustrating the sealing strips used for closing the joints between adjacent sections not in contact with the beam members;

Fig. 5 is an enlarged fragmentary view, partly in section and partly in elevation, showing the linkage for fastening the sections to the beam members;

Fig. 6 is a sectional view taken on the line 6-6 of Fig. 5;

Fig. 7 is a horizontal section through a column showing in plan a modified construction of the bubble tray;

Fig. 8 is an enlarged vertical sectional view taken on the line 8-8 of Fig. 7;

Fig. 9 is an enlarged detail view, partly in section and partly in elevation, taken along the line 9-9 of Fig. 7 and showing the supporting and fastening means for the bubble deck sections;

Fig. 10 is a plan view, with parts broken away, of a further modification of the bubble deck shown in Fig. 1; and

Fig. 11 is an enlarged vertical sectional view taken on the line 11-11, of Fig. 10.

In accordance with one preferred form of embodiment of my invention, the bubble tower 10 is provided with a plurality of transversely supported bubble trays generally indicated at 12, which are suitably spaced from one another in the customary manner. Each of these trays 12 is primarily composed of a plurality of key pieces

or segments 14, which may be supported by transverse beam members 16 suitably secured to the wall of the tower. In addition, supplemental pieces 18 are provided to fill out the circular arrangement and to complete the tray; such supplemental pieces rest in part on angular brackets or rings 19, which in turn are secured to the wall of the tower.

I have determined that a particular geometry of the key pieces will permit the use of a large number of identical pieces to substantially cover the bubble cap or vapor-liquid contact area regardless of the diameter of the tower. This feature is within the limits of tower size in which segmental trays are necessary and, for purposes of example, may be considered particularly applicable to trays having a diameter greater than six to eight feet. Under normal circumstances, the difficulties in casting or otherwise fabricating an integral tray of a size larger than this are such that it is more economical to provide transverse beams and segmental plates.

Each of the segments 14, which I consider key pieces, is provided with integral risers 14a, which in turn support the bubble caps 20 by means of the typical spider arrangement 21. This construction is more particularly shown in Fig. 3. Each of these key pieces, furthermore, preferably contains at least four and customarily six risers in two parallel rows of three each although it may also contain a greater number of risers. It is obvious that the six risers are also arranged in three parallel rows of two each.

Opposite sides of the segments are parallel and straight so that the segments may be placed adjacent one another with a minimum of space between the respective segments. I have found, however, that the most effective assembly of such segments requires an angularity of each segment (the angle formed by the intersection of two of the sides thereof) equal to the pitch of the bubble caps and risers thereon and that the respective sides of each segment be also parallel to the respective rows of bubble caps thereon. As is well known, it is customary to provide a particular pitch of the caps so that the most effective positioning of the caps on the deck and the most effective contact between the vapor and the liquid may be obtained.

The pitch of the caps and risers (which are concentrically positioned beneath the caps) is the angular relationship between a line drawn through the centers of two adjacent caps, one in each of two parallel rows, and a line through the centers of the caps in either of the rows. As shown in the drawings, the angular relationship may be either acute or obtuse; and in this particular case the caps are equidistantly spaced with their centers at the apices of equilateral triangles. The acute angle of the pitch in this case is then 60°. It will be apparent from the drawings that the bubble caps are placed in parallel rows but are also positioned in staggered relation as to each other. As is well known, the spacing of the caps depends on the diameter of the caps and the desired clearance space for vapors therebetween. Square pitch arrangement means an angular relationship of 90°. Other pitches for special conditions are also possible.

As will be more particularly seen by an inspection of Fig. 1, the respective segments or key pieces 14 extend throughout the major area of the tray, and each segment constitutes a com-

plete unit identical to all other units of the same type. When the column is round, the peripheral segmental pieces generally indicated at 18 are used; each of these units 18 is relatively small and may contain one or more complete risers and has the desired configuration on one side to cooperate with the cylindrical surface of the column and has a planar surface on the other sides to cooperate with the adjacent polygonal segments. One further type of segment, the central polygonal unit 22, which has straight edges and which is distinctly a filler piece for the center of the column, is also shown.

The segments of this type are especially suitable for use in columns of different diameters inasmuch as it is possible to employ the typical key segments over the major portion of the area of a tray and then to provide only the small special cast sections for the filler pieces. With such an arrangement, it is possible to standardize to a large extent the parts for a tray, and the special pieces are limited in number as well as in size.

The key pieces 14 and the marginal pieces 18 are conveniently secured to the supporting beams 16 and to the marginal ring or flange 19 to form a liquid-tight construction. As shown in Fig. 3, a marginal piece 18 having the riser 18a is suitably secured to the flange 19 by a clamp member 25 provided with an adjustable nut 26 for securing the marginal piece to the flange. If necessary, a shim or gasket 27 may be used for leveling purposes.

The tray pieces may be secured to the beams 16 by suitable studs 29 as shown in Fig. 3. These project into suitable recesses 29a in the beam and extend upwardly into the space between adjacent segments so that the lock nut and washer assembly 28 will engage the edges of the two segments 14. A nut 28a on the lower end of each stud engages beam 16 as indicated. Apertures 29b in the web of each beam are provided so that nut 28a may be conveniently screwed onto the stud. Shims or gaskets 27a may also be used in this location.

Adjacent edges of the pieces 14, not in contact with the transverse beams or supporting ring, are sealed by plates 36 and accompanying gaskets 37 which extend diagonally of the beams 16 as shown in Fig. 4.

As a modification of the fastening means just described, a simplified form, shown in Figures 5 and 6, comprises a linkage composed of a link 30 having upper and lower longitudinally arranged rectangular slots 31. One end of the link 30 is adapted to be inserted in the opening between the adjacent edges of the pieces 14, and the other end extends into a recess or well 32 formed in the beam 16, which is also provided with aperture 32a in its web in communication with recess 32. With the use of tapered pins or wedges 34, generally rectangular in cross-section, the link 30 can be locked tightly to the beam 16 in a manner similar to that of the stud bolt 29; also, the adjacent edges of the pieces 14 are forced against the supporting upper surface of the beam 16 thereby. This construction provides a very simple expedient for securing the segmental pieces to the beams and greatly facilitates the initial installation of the trays as well as their ready removal for cleaning purposes.

The liquid passes from one tray to another through apron-type downpipes 40 preferably disposed diametrically opposite the point of introduction of the liquid onto the tray. This arrange-

ment causes the liquid to flow across the respective trays in a zigzag fashion in its descent through the tower. The downpipes 40 are formed by the adjacent shell wall and the aprons 41 depending from the marginal section of the tray and supported thereby. The upper end of the aprons 41 extends somewhat above the tray floor and constitutes a weir for controlling the liquid level on the tray. The aprons also extend below the liquid level on the next lower tray to prevent blowthrough of the rising vapors.

Modified arrangements of the key pieces to form variations in the general design of the tray construction contemplated by the present invention are shown in Figs. 7 and 10. With reference to these figures, it will be noted that the beams are spaced further apart and that the placement of the pieces thereon is such that they are supported along their short sides or edges. This rearrangement of the key pieces does not depart substantially from the characteristics of the general pattern of the tray assembly but, nevertheless, does permit variations in the spacing of the supporting beams and the location of the downpipes and a change in the shape and/or form of the marginal pieces.

With reference more particularly to Fig. 7, it will be noted that the tray construction shown therein contemplates the location of the beams 43 so that the segmental pieces 45 are supported lengthwise therebetween. Special marginal pieces 46 have one of their sides formed on substantially the same curvature as that of the wall of the column 10 so as to fit closely thereagainst. Although the size of the risers in this case is slightly greater than that of the risers contained on key pieces 14, the pitch of the risers on the key pieces 45 is the same as that of the risers on the key pieces 14. Additional filler pieces such as 48 may be required in this arrangement. In addition, relatively flat arcuate sections 49 without risers and caps may be used to provide for the downflow of the liquid; it should be noted that one of these sections on each deck is provided with the downpipe 50.

It will be apparent to those skilled in the art that the bubble deck shown in Fig. 7 is of the cross-flow type. As is customary, weir 51 (see Fig. 8) is provided to maintain a predetermined depth of liquid on the tray, and weir 51a is provided to produce an even distribution of the liquid thereonto.

In the present modification, as well as the one shown in Fig. 10, the supporting beams 43 are somewhat different in cross-section from the beams 16 shown in Figs. 2 to 6. It will be noted that each of the beams 43 is provided with a pair of longitudinally disposed ledges 43a along its top or supporting surface, which ledges are designed to accommodate the ends of the plates 52 that join the unsupported sides of the key pieces 45. The ledges 43a do not give any support to the plates 52, but they prevent the displacement or dropping of the plates 52 to the deck below when the fastening means generally indicated at 54 is removed.

This fastening means preferably comprises a linkage composed of a rectangular link piece 55 adapted to accommodate a wedge 56 as shown in Fig. 9. The beams 43 are bolted to brackets 58 secured to the wall of the column 10. It will be appreciated that very little, if any, of the weight of the bubble tray is carried by the angle ring 19 and that the principal function of the ring 19 is

to afford a sealing contact with the perimeter or marginal pieces of the tray.

In Figs. 10 and 11 the invention is shown as embodied in a bubble deck of the double cross-flow type. As illustrated, the downpipe 60 is located centrally of the column on one deck between two of the beams 62 and extends substantially across the column. In the present installation the column may be of smaller diameter than those previously described, and the number of risers 64a contained on each key piece 64 may be increased to four instead of three per row. This construction permits the use of longer key pieces, wider spacing of the beams 62, and the use of large risers and bubble caps.

It is thus obvious that the assembly of the decks may be in accordance with any process arrangement and that little variation is required in the geometry of the sections or segments composing the different sizes and/or types of bubble decks. By using key pieces having substantially the same geometry, I am able to manufacture bubble decks closer to a standardized pattern than heretofore obtainable. It is also obvious that, by making the key pieces of relatively small dimensions, I may hold them to closer tolerances and thereby avoid the necessity of machining operations to bring the parts within the permitted manufacturing tolerances. Furthermore, by the expedient use of the shims and sealing plates wherever required, I may easily preserve the level of the decks. There is also provided very simple means for compensating for the degree of out-of-roundness of the tower by adjustment of the space between the pieces constituting a given deck. Although no means have been shown to retain the bubble caps in position, it will be understood that any usual type may be used.

It will be appreciated that the standard key pieces, segments, plates, or units comprising each bubble deck or tray may be made in any convenient polygonal shape as desired. Triangular pieces may be used if they are found suitable; in such case each piece preferably will contain at least three bubble cap or vapor risers, and one side of each piece will rest on a supporting beam with the opposite apex resting on the adjoining supporting beam. In practice, a piece having the shape of an equilateral triangle will be most satisfactory. Other larger polygonal pieces such as hexagonal units may also be used.

The shape of the standard key pieces may be any that is desired and is not to be limited to equiangular polygons. Particularly in the case of quadrangular or quadrilateral pieces, it is convenient to utilize one shaped in the form of a parallelogram, the angularity between the opposite pairs of parallel sides of which is preferably 60°. In such case, when two or more rows of vapor risers are contained on each piece, they may be conveniently arranged on equilateral triangular centers, the arrangement which is generally employed because of its space-saving and other advantageous features. It will be found that each piece, of whatever shape, should contain at least two and more preferably three vapor risers; in the case of a quadrangularly shaped piece, these risers will also preferably be arranged in one row. It will also be found, however, that, in practice, the bubble cap risers are more preferably arranged in at least two rows on each quadrangular piece.

Various modifications of the invention will suggest themselves to those skilled in the art, but it

is my desire to cover all such modifications as come within the scope of the appended claims.

I claim:

1. A bubble deck construction comprising a bubble tray, the major part of the area of which consists of key pieces having a standardized configuration, beams for supporting the key pieces, and means for locking adjacent key pieces to the supporting beams, each of said beams being provided with a recess in its upper surface and an aperture in its web in communication with said recess, said locking means comprising a linkage that includes a link provided with two spaced longitudinal apertures, said link extending downwardly into said recess and upwardly into the space between the adjacent key pieces, a wedge member engaging the upper aperture of said link and forcing the key pieces into engagement with the beam, and a second wedge member engaging the aperture in the web of said beam and the lower aperture of said link and forcing the beam into engagement with the key pieces.

2. A bubble deck construction comprising a bubble tray, the major part of the area of which consists of key pieces having a standardized configuration, beams for supporting the key pieces, and means for locking adjacent key pieces to the supporting beams, each of said beams being provided with a recess in its upper surface and an aperture in its web in communication with said recess, said locking means comprising a linkage that includes a stud extending downwardly into said recess and upwardly into the space between the adjacent key pieces, said stud being threaded at both of its ends, a nut engaging the upper end

of said stud and forcing the key pieces into engagement with the beam, and a second nut engaging the lower end of said stud and positioned in the aperture in the web of said beam and forcing the beam into engagement with the key pieces.

3. A standard bubble tray segment comprising a quadrangular plate member having parallel rows of bubble cap risers thereon in staggered relation, opposite sides of said member being respectively parallel to each other and to the respective rows of risers thereon, one of the angles formed by the intersection of two of the sides being acute, the angularity of the member and the pitch of the risers being equal.

4. The standard bubble tray segment as claimed in claim 3, in which the acute angle is 60°.

5. A circular sectional bubble tray comprising primarily a plurality of standard key pieces, each piece being a quadrangular plate member having parallel rows of bubble cap risers thereon in staggered relation, opposite sides of said member being respectively parallel to each other and to the respective rows of risers thereon, one of the angles formed by the intersection of two of the sides being acute, the angularity of the member and the pitch of the risers being equal, and a plurality of peripheral pieces, each shaped at its outer edge to fit the circumference of the tray and shaped along its other edges to fit the standard key pieces, certain of said peripheral pieces having at least one bubble cap riser thereon.

JOHN A. GIBB.