

Jan. 15, 1952

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2,582,657

BUBBLE TOWER

Filed April 21, 1948

2 SHEETS—SHEET 1

FIG. 1

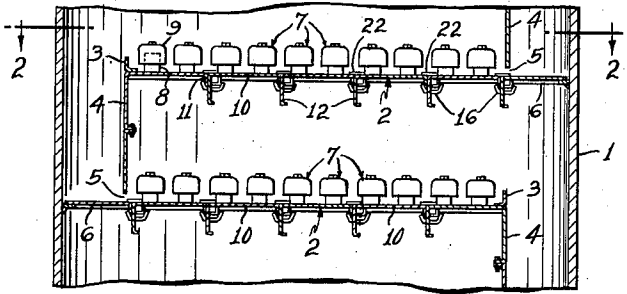


FIG. 2

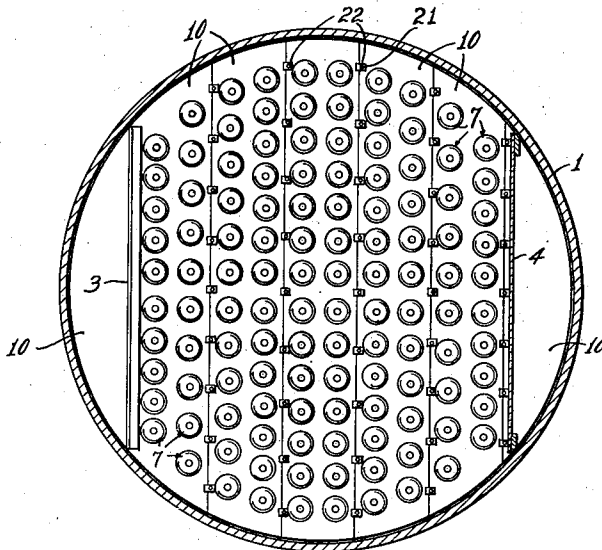


FIG. 3

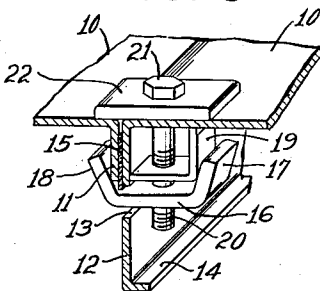
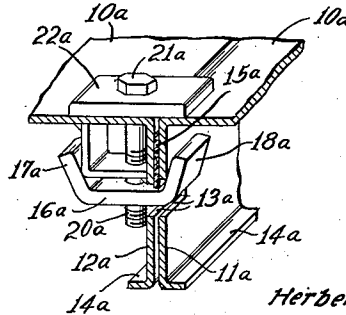


FIG. 4



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2 SHEETS—SHEET 2

FIG. 5

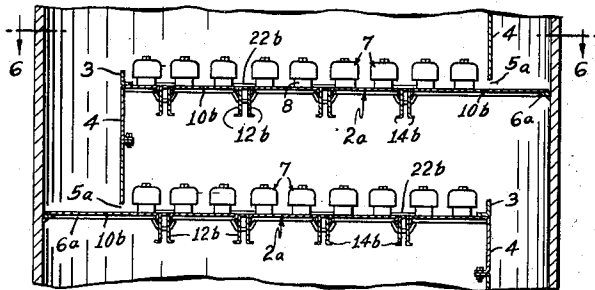


FIG. 6

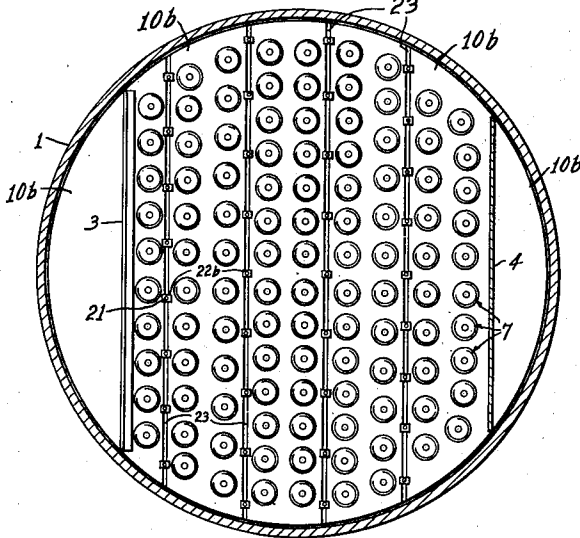


FIG. 11

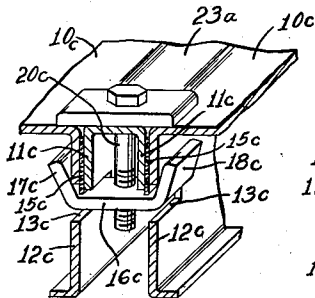


FIG. 12

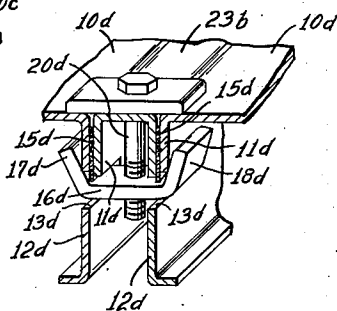
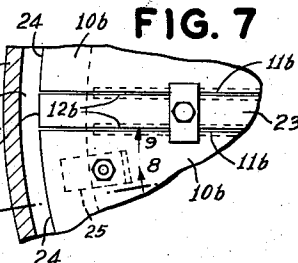


FIG. 9

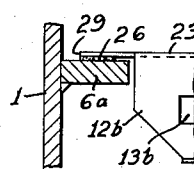


FIG. 8

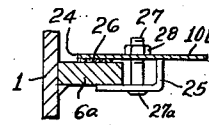
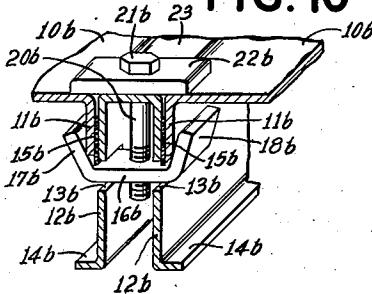


FIG. 10



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2,582,657

BUBBLE TOWER

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7 Claims. (Cl. 261-114)

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This invention relates to bubble towers such as are employed in carrying on fractionating processes, and the aim of the invention is to provide an improved construction of bubble tower.

As usually built, a bubble tower consists of a closed vertical cylindrical tank having horizontal bubble trays mounted within it in spaced relation to one another throughout the height of the tower. The liquid and vapors are introduced into the tower at appropriate points and at suitable temperatures, and, as is well understood, predetermined temperatures are maintained at different elevations within the tower by any appropriate means. Vertical conduits or "downcomers" carry the liquid down from tray to tray. The trays are provided with numerous short tubes or "risers" fitted with bubble caps which allow the vapors to pass upwardly but also bring them into contact with the liquid on each tray.

The present invention relates, more particularly to the construction of these bubble trays. These are made in sections to facilitate mounting and replacement, and for the additional and compelling reason that in most cases the only access to the interior of the bubble tower is through manholes in its side walls, the tower otherwise being a closed tank. This limits the maximum width of the tray sections to about 18 inches so that in a 10-foot diameter tower, and making allowance for the downcomers, each tray comprises about five sections.

In mounting the tray sections within the tower it is convenient and desirable for the workman to first put in the tray section nearest the manhole, and then climb in upon it to assemble the remaining sections. Conversely, in removing a tray from the tower it is desirable for the workman to enter the manhole above the tray and support himself on the tray which is being removed. In other words, it is desirable for him always to operate from the top of the tray rather than the bottom, and each tray section, or at least each two tray sections must have the necessary strength to support the weight of the workman.

Accordingly, one of the objects of the invention is to construct the bubble tray sections in such a way as to provide joints between these sections which serve to stiffen the tray structure to carry the necessary load and which are capable of convenient assembly from the top of the tray structure.

As is well understood, the trays are subjected to the corrosive action of the liquid, and for this

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reason it has been proposed to construct them of corrosion-resistant metal, such for example as stainless steel. In view, however, of the high cost of such material, it is desirable to use as thin gauge sheets as possible. In view of what has been said, it will be understood that the construction of these trays in such a way as to have the necessary strength becomes something of a problem.

Heretofore it has been proposed to introduce a beam, for example, in the form of a truss, or otherwise, to support the tray sections, this beam being anchored at each end on the opposite walls of the tower. In the case of extremely large towers one end was supported on a cross beam. With that construction the tray sections consisted merely of flat metal sheets, the side margins of which rested on adjacent beams, and the end margins of which could be supported on the usual shelf provided on the inner surface of the tower. Such a tray construction is objectionable for a number of reasons.

Another object of the invention is, therefore, to provide a tray structure in which each of the tray sections possesses inherent stiffness or rigidity to an extent which will not only enable it to resist deformation during handling, but will also provide sufficient strength when the tray sections are assembled to sustain the customary loads to which the trays are subjected.

A further object of the invention is to provide a tray structure for a bubble tower which when assembled provides adequate strength for supporting the usual loads without resorting to the employment of beams attached to the walls of the tower to aid in supporting the tray.

The invention will be understood from a consideration of the accompanying drawings, which illustrate several embodiments thereof by way of example, together with the following description. In these drawings:

Fig. 1 is a view in central vertical section of a portion of a bubble tower showing two adjacent bubble trays;

Fig. 2 is a horizontal section taken on line 2-2 of Fig. 1;

Fig. 3 is a projectional or so-called perspective view, partly in section and drawn to an enlarged scale, showing the construction of the joints between the tray sections illustrated in Figs. 1 and 2;

Fig. 4 is a view similar to Fig. 3 showing a modification;

Fig. 5 is a view similar to Fig. 1 to illustrate another modified form of bubble tray;

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Fig. 3 is a horizontal section taken on line 6—6 of Fig. 5;

Fig. 7 is a fragmentary detailed view illustrating the manner of supporting the tray sections shown in Figs. 5 and 6 on the walls of the tower;

Fig. 8 is a vertical section taken on line 8—8 of Fig. 7;

Fig. 9 is a similar section taken on line 9—9 of Fig. 7;

Fig. 10 is a perspective view similar to Figs. 3 and 4, drawn to the same enlarged scale, showing one of the joints between the tray sections of Figs. 5 and 6; and

Figs. 11 and 12 are similar views showing modifications.

Referring now to the accompanying drawings, and first to Figs. 1-2 inclusive, the vertical cylindrical wall of the bubble tower is shown at 1. Two bubble trays are indicated generally by numeral 2. Each is provided with a weir 3 in the form of an angle bar to maintain the level of the liquid at the proper height.

The liquid flowing downwardly from the upper portion of the tower is conducted to upper tray 2 through space formed by a downcomer plate 4 and the curved wall 1 of the tower. The liquid flows out onto the tray through the space 5 at the lower edge of the downcomer, and, overflowing the weir 3 at the opposite side of the tray it is conveyed by a second downcomer 4 to lower tray 2. The liquid flows downwardly in this manner from tray to tray. Trays 2 are supported on shelves or ledges 6 which consist of metal bars, rectangular in cross section and semi-circular in extent, secured to the wall 1 of the tank in any suitable manner as, for example, by welding.

The direction of flow of the vapor within the tower is upward, and to allow passage through trays 2 they are provided with a multiplicity of large perforations, each of which is furnished with a bubble cap device 7. These bubble cap devices each comprise a short tubular riser 8 mounted at the edge of a perforation and which extends, as shown by the dotted lines in Fig. 1, above the level of the liquid maintained on the trays by weirs 3. Risers 8 are each furnished with a suitable bubble cap 9, the diameter of which is larger than riser 8 and delivers the vapor into the liquid below its surface.

Each of the bubble trays 2 is composed of a series of horizontal sheet metal sections 10 which preferably are of approximately uniform width, but which may vary somewhat in width, depending on the tower design. The two outside tray sections 10 which are at the bottoms of the downcomer spaces, that is outside of downcomer plates 4, are sector shaped so as to meet the wall of the tank. With the exception of these two sections all of the remaining tray sections 10 are elongate with parallel side edges as shown in Fig. 2, and are supported only at their opposite ends on the ledge or shelf 6.

It will be understood that tray sections 10 are of comparatively thin material, for example 1/8-inch stainless steel sheet, approximately 18 inches wide and some 6 to 10 feet in length. In order to render these tray sections sufficiently stiff to support the weight of the liquid on them, and the more concentrated weight of the workman who assembles the trays, and to provide joints between the tray sections which will prevent leakage of the liquid from one tray section to another, each of tray sections 10 is provided with vertical flanges 11 and 12 along their side edges. See Figs. 1 and 3.

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Flange 11 is a comparatively narrow one whereas the flange 12 along the opposite edge of each tray section is of substantial width, and is provided with a horizontal lip 14 along its lower edge and with a series of horizontally spaced rectangular apertures, one of which is shown at 13 in Fig. 3. When the tray sections 2 are assembled in the tank a narrow flange 11 on one section is placed in abutting relation with a wide or deep flange 12 on the adjacent tray section, and a strip 15 of suitable packing material is placed between them to facilitate the formation of a liquid-tight joint.

The apertures 13 in flanges 12 are spaced below the horizontal surface of tray section 10 a sufficient distance to permit the operation of a clamping member 16 which has a horizontal body portion terminating in two upwardly flaring wing or camming portions 17 and 18. Above each aperture 13 an abutment member 19 in the form of a steel angle is secured permanently in fixed position by welding, or otherwise, as shown in Fig. 3. The lower right hand corner of this member 19 is disposed in engagement with the inner camming surface of wing portion 17, while the clamping member 16 extends through aperture 13 and the inner or camming surface of the opposite wing portion 18 is brought into engagement with the outer surface of the lower edge of the abutting flange 11 on the adjacent tray section 10.

In order to actuate clamping member 16 a rod 20, preferably in the form of a bolt having a head 21, and threaded throughout its lower portion is arranged in threaded engagement with an aperture at the center of the clamping member. Head 21 engages a block 22 which bridges the joint and extends, as shown at the left in Fig. 3, over the upper marginal edge of the adjacent tray section 10. It will be understood that by turning the rod 20, for example by means of head 21, clamping member 16 is forced upwardly thereby bringing its opposite cam or wing portions 17 and 18 into engagement with the parts just described and thereby forcing the two flanges 11 and 12 toward one another and compressing the backing strip 15. The angle of the inner surfaces of camming portions 17 and 18 with respect to the axis of bolt 20 is purposely made small so as to provide a large horizontal component of force tending to urge the two flanges together. The apertures 13 with their clamping devices 16 operated by the bolts 20 are spaced approximately 1 foot apart throughout the length of each of the several joints between the tray sections 10 of each of the trays 2. This spacing is indicated by the blocks 22 and heads 21 of the bolts shown in Fig. 2.

Referring now to Fig. 4 the modified form of joint between the tray sections 10a here shown is similar to the one described in connection with Fig. 3 aside from the fact that both of the flanges 11a and 12a are of the same depth and provided with horizontal lips 14a. Consequently both flanges have registering apertures 13a, and camming portion or wing 18a of the clamping device, instead of engaging the outer marginal edge of flange 11 as in Fig. 3, engages the outer surface of flange 11a along the upper edge of its aperture 13a. Otherwise, the construction of the joint is identical with that previously described.

When either of these joint constructions is employed the joints between the several tray sections 2, as viewed from above, and shown in Fig. 2, are seen as straight lines interrupted

merely by the presence of the bridging blocks 22 or 22a with the heads 21 or 21a of the bolts on top of them.

The presence of the cooperating flanges 11 and 12, or 11a and 12a, as the case may be, when clamped securely together by means of the clamping member 16 at a plurality of points spaced along each of the joints imparts the necessary rigidity to the tray structure so that it possesses adequate strength to support the loads to which it is subjected. In fact the stiffening flanges clamped together as described form a series of parallel lines of reinforcement, extending across the bubble tower which are substantially equivalent to the placing of a series of parallel beams beneath the tray structure, but without the disadvantages attending the use of separate beams in the structure.

Referring now to Figs. 5-10 inclusive which illustrate a further modification of the bubble tray structure, the general arrangement of the trays is very similar to that shown and described in connection with Figs. 1 and 2 and only the differences will be described. Instead of constructing the trays 2 of sections of substantially equal width, the trays are made up of alternate wide tray sections 10b and narrow tray sections 23. The wide tray sections are provided along their opposite side edges with shallow flanges 11b, and each narrow tray section 23 has a flange 12b of substantial depth along each edge as shown particularly in Fig. 10, and each of these flanges is provided with a horizontal stiffening 14b along its bottom edge. Packing strips 15b are placed between the flanges as shown. The two side or deep flanges 12b on the narrow tray section 23 are flanked on their outer sides by the two narrow or shallow flanges 11b on the neighboring two side tray sections 10b.

The two side flanges 12b of the narrow tray section are provided with spaced apertures 13b arranged in registering pairs as shown in Fig. 10, these pairs of apertures being spaced about one foot apart throughout the length of the tray section. Extending through each pair of registering apertures 13b there is a clamping member 16b having upwardly flared camming portions 17b and 18b which engage the outer marginal edges of the two abutting narrow flanges 11b of the respective side tray sections 10b.

These clamping members are actuated by headed bolts 21b as before, the heads of which bear against blocks 22b which in this instance bridge the width of the narrow tray section 23 so that their end portions engage the upper surfaces of the wide tray sections 10b. The operation of these clamping mechanisms in securing the parts firmly in engagement with one another will be understood from the description preceding. It is to be observed that the spacing of the pairs of apertures 13b along the joints can be observed in Fig. 6 from the locations of the bridging blocks 22b and the bolt heads 21b.

The bubble trays 2a when constructed as just described of the alternate wide and narrow tray sections 10b and 23 are supported in precisely the same way as the tray sections described in connection with Figs. 1-4 inclusive. That is to say, each tray section, whether of the wide type or of the narrow type is supported solely at its opposite ends on the semi-circular shelf 6a which is welded to the interior wall of the tank. This means of support may be understood from Figs. 7, 8 and 9.

Referring first to Fig. 7 the outer peripheral

edges of the wide tray sections 10b are indicated by numeral 24 and the marginal portions of these tray sections rest upon shelf 6a and constitute the sole means of support for these tray sections. Each of the wide tray sections 10b is secured to the shelf 6a by the clamping device shown in Fig. 8 and in dotted lines in Fig. 7. This consists of a right angled clamp 25 which has a short vertical leg slightly longer than the thickness of shelf 6a to accommodate the packing 26 between the margin of the tray section and the top of the shelf, and a horizontal leg which engages the lower edge of shelf 6a. Welded in an aperture in the horizontal leg of clamp 25, as indicated at 27a, there is a bolt 27, threaded at its upper end, which passes through an aperture in the tray section 10b and is fastened in place by means of a nut 28. These clamping devices can be manipulated conveniently from the top of the bubble tray both in setting up and in taking down the tray.

The peripheral edge, that is one end, of one of the narrow tray sections 23 is indicated in Fig. 7 by numeral 29. As is shown in Fig. 9 the marginal portion, or end region of this narrow tray section rests upon shelf 6a. From this figure also it is clear that the wide or deep flanges 12b on this member terminate short of the inner edge of shelf 6a and are not in any way supported upon it, the narrow section 23 being supported in exactly the same way that the wide sections 10b are supported, and not contributing in any way to the support of these wide tray sections, except through the cooperation of flanges 12b with the narrow flanges 11b as described above to provide a stiffening region extending from end to end of the wide and narrow tray sections. In other words, the narrow tray sections 23 do not constitute in any sense a beam structure which is supported at its ends on the shelf 6a and, in turn, support the side tray sections 10b.

Referring now to Fig. 11 there is here illustrated a modification of the joint structure shown in Fig. 10. Fig. 12 shows a still further modification of this structure. All three of these joint structures comprise two narrow and two wide or deep flanges, the wide flanges having registering pairs of apertures appropriately spaced throughout the length of the flanges. Also the parts are clamped together in the same way as described in connection with Fig. 10. The differences between these three modifications are in the locations of the wide and narrow flanges and in the parts which are engaged by the camming portions of the clamping devices.

In Fig. 11 the arrangement is just the reverse of Fig. 10, that is to say, the narrow flanges 11c are on the narrow tray section 23a and the wide or deep flanges 12c are on the wide tray sections 10c. Accordingly the registering pairs of apertures 13c are in these flanges 12c, and the camming portions 17c and 18c of the clamping members 16c engage the outer margins of the upper edges of these apertures.

In Fig. 12 the narrow tray section 23b has one narrow flange 11d along one edge and one wide or deep flange 12d along its opposite edge. Consequently each of the wide tray sections 10d is also provided with a narrow flange 11d along one side edge and a wide flange 12d along its opposite edge. In this case the camming portion 17d of the clamping device 16d engages the outer margin of the upper edge of the aperture 13d which is in the flange 10d, the left hand section as shown in Fig. 12, and the opposite cam-

ming portion 18d engages the outer marginal edge of the narrow flange 11d on the right hand wide tray section 10d.

It will be understood that all of the wide tray sections are secured to the supporting shelves 6 or 6a by the clamping device illustrated and described in connection with Fig. 8, whether the sections are of the form shown in Figs. 3 and 4 or of the form shown in Figs. 10, 11 and 12.

While the invention has been described in connection with several modifications, it will be understood that various other changes may be resorted to within the scope and spirit of the invention as defined by the appended claims.

I claim:

1. In a bubble tower, a tray structure comprising a plurality of horizontal sheet metal sections each having vertical flanges along their side edges with the inner faces of the flanges of adjacent sections contacting one another to form joints between the sections, one of said flanges of each joint being of substantial depth and containing a series of horizontally spaced apertures, an abutment member on the outer face of said flange adjacent each of said apertures, a series of clamping members, one disposed in each of said apertures, having each a body portion and two opposed camming portions, one of said camming portions engaging said abutment member and the opposite camming portion engaging the outer surface of the contacting flange, and headed bolts extending from the upper surface of said tray structure having their lower end portions in threaded engagement with said respective clamping members to actuate them to urge said flanges towards one another.

2. In a bubble tower, a tray structure comprising a plurality of horizontal sheet metal sections each having vertical flanges along their side edges with the flanges of adjacent sections abutting one another to form joints between the sections, said flanges being coextensive in depth and containing a series of spaced apertures arranged in registering pairs, a clamping member projecting through each of said pairs of apertures and terminating in upwardly flaring wing portions having inner cam surfaces engaging parts on said adjacent flanges and operative to urge said flanges toward one another thereby tightening the joint between said flanges and uniting them to stiffen the tray sections in the vertical direction, and headed bolts extending from the upper surface of said tray structure having their lower end portions in threaded engagement with said respective clamping members to actuate them.

3. In a bubble tower, a tray structure comprising a plurality of horizontal sheet-metal sections each having vertical flanges along its side edges with the flanges of adjacent sections abutting one another to form joints between the sections, at least one of said flanges of each joint being of substantial depth and having a series of horizontally-spaced apertures, a clamping member projecting through each of said apertures into engagement with the outer surface of one of the abutting flanges, rods operable from the upper surface of said tray structure having their lower end portions in threaded engagement with the respective clamping members to actuate them, said outer surface of said one of the abutting flanges and the clamping members having cooperating surface portions which, when the clamping members are actuated, cause said one of the abutting flanges to

move towards the other of the abutting flanges, and means at the side of said other of the abutting flanges remote from the cooperating surface portions of the clamping members resisting movement of said other of the abutting flanges in a direction away from said cooperating surfaces of the clamping members, whereby when the clamping members are actuated said flanges will be forced toward one another to form a tight joint and the flanges united to stiffen the tray sections in the vertical direction.

4. In a bubble tower, a tray structure comprising a plurality of horizontal sheet-metal sections each having vertical flanges along their side edges with the flanges of adjacent sections abutting one another to form joints between the sections, one of said flanges being deeper than the other and containing a series of horizontally spaced apertures, a clamping member projecting through each of said apertures and extending below the edge of the adjacent flange to engage the outer margin thereof, rods operable from the upper surface of said tray structure having their lower end portions in threaded engagement with said respective clamping members to actuate the same, the outer marginal portion of the shorter flange and the clamping members having cooperating surfaces which, when the clamping members are actuated, cause the shorter flange to move towards the deeper flange, and means at the side of the deeper flange remote from the shorter flange resisting movement of the deeper flange away from the shorter flange, whereby when the clamping members are actuated said flanges will be forced toward one another to form a tight joint and the flanges united to stiffen the tray sections in the vertical direction.

5. In a bubble tower, a tray structure including two wide and one narrow horizontal sheet metal sections with the narrow section disposed between the wide sections, each having vertical flanges along their side edges abutting the flanges of the adjacent section to form joints between the sections, two of said flanges being deeper than the other two and containing each a series of spaced apertures arranged in registering pairs, a clamping member projecting through each of said pairs of apertures, headed bolts extending from the upper surface of said tray structure having their lower end portions in threaded engagement with said respective clamping members to actuate them, the outer surfaces of the two outermost flanges and the clamping members having cooperating surface portions which, when the clamping members are actuated, cause each of the outermost flanges to be forced towards their respective inner abutting flanges to form tight joints therewith which stiffen the tray sections in the vertical direction.

6. In a bubble tower, a tray structure including two wide and one narrow horizontal sheet metal sections with the narrow section disposed between the wide sections, each having along their side edges vertical flanges abutting the flanges of the adjacent section to form two joints between the three sections, the flanges of the narrower section being deeper than the outer abutting flanges of the adjacent wider sections and containing each a series of spaced apertures arranged in registering pairs, a clamping member projecting through each of said pairs of apertures and extending below the distal edges of the adjacent outer flanges of the wider sections, said clamping members being operative to urge

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said flanges toward one another, and headed bolts extending from the upper surface of said tray structure having their lower end portions in threaded engagement with said respective clamping members to actuate the same, the outer surface of the abutting flanges of the two wide sections and the clamping members having cooperating surface portions which, when the clamping members are actuated, cause each of the flanges of the wide sections to be forced towards the respective inner abutting flanges of the narrow section to form tight joints therewith which stiffen the tray sections in the vertical direction.

7. In a bubble tower as set forth in claim 3, blocks clamped against the upper surface of the

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tray structure and bridging said joints and extending over the marginal edges of the adjacent tray sections.

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