Dec. 29, 1953 H. B. KOHN 2,664,280

SUPPORTING BEAMS FOR BUBBLE TRAYS AND THE LIKE

Filed Feb. 26, 1948 3 Sheets-Sheet 1

Fig. 1.

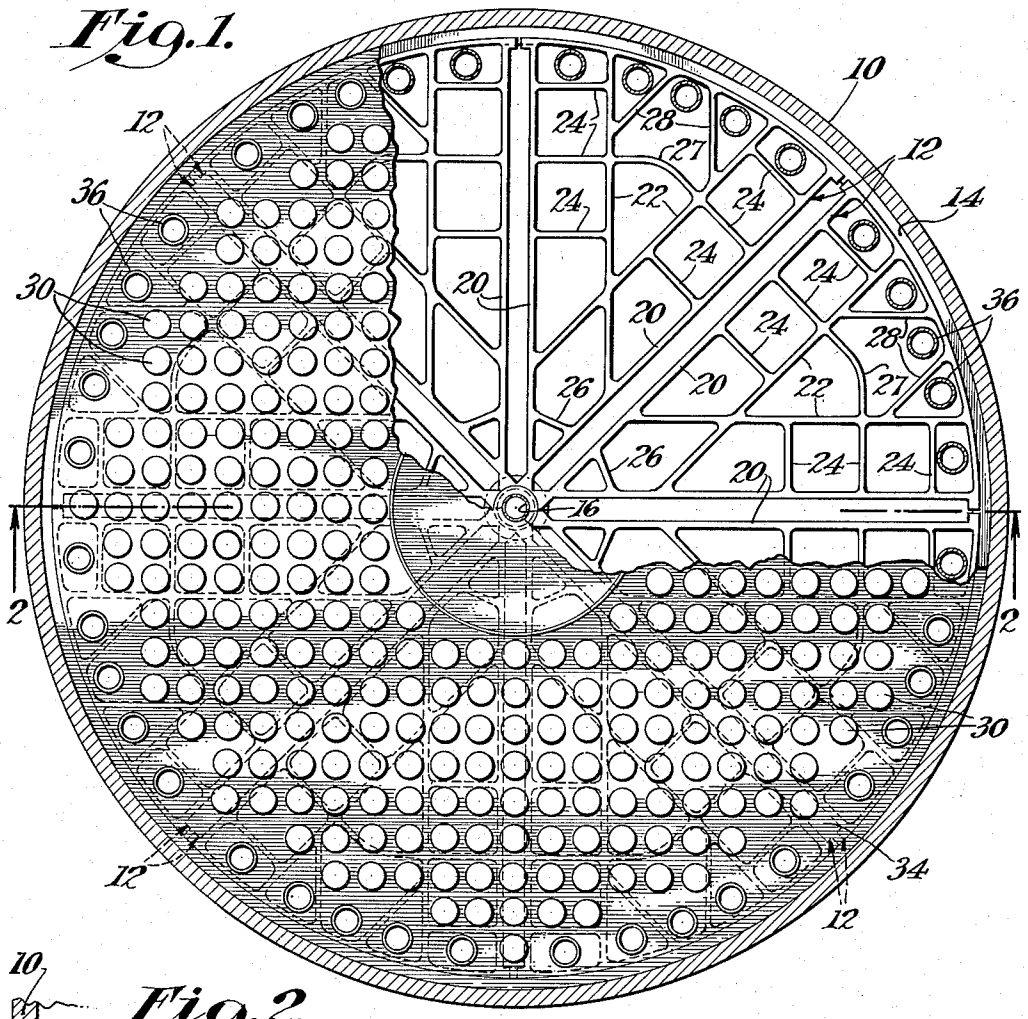
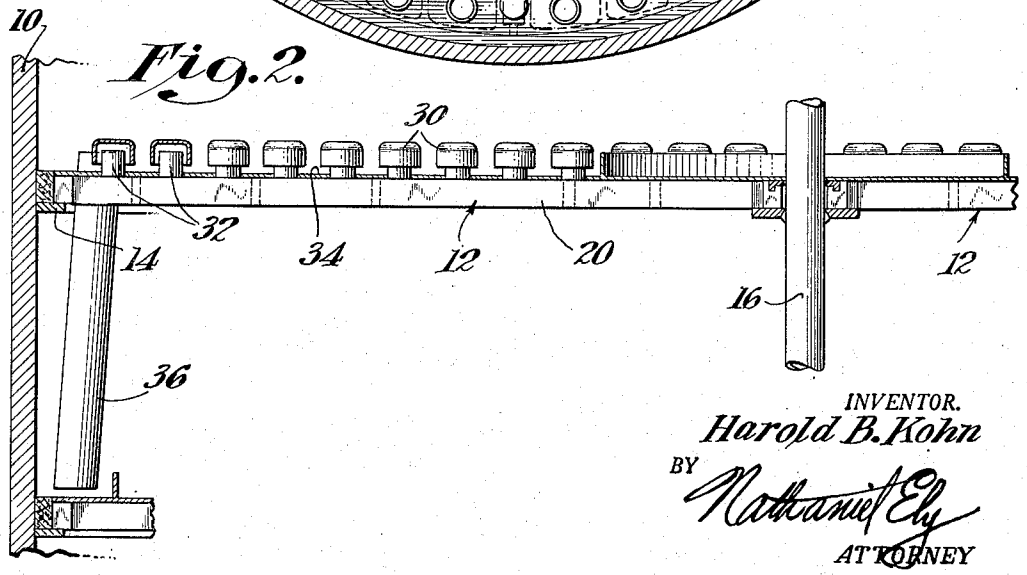


Fig. 2.



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Filed Feb. 26, 1948 3 Sheets-Sheet 2

Fig. 3.

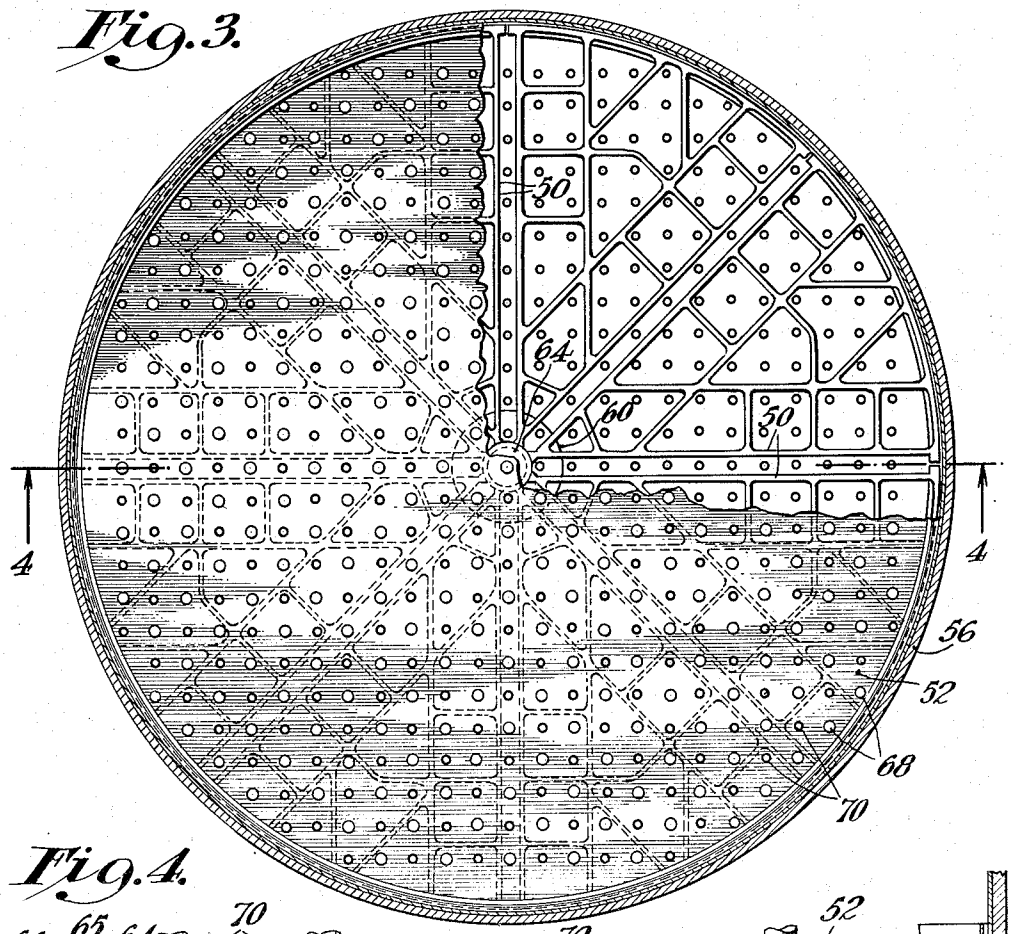


Fig. 4.

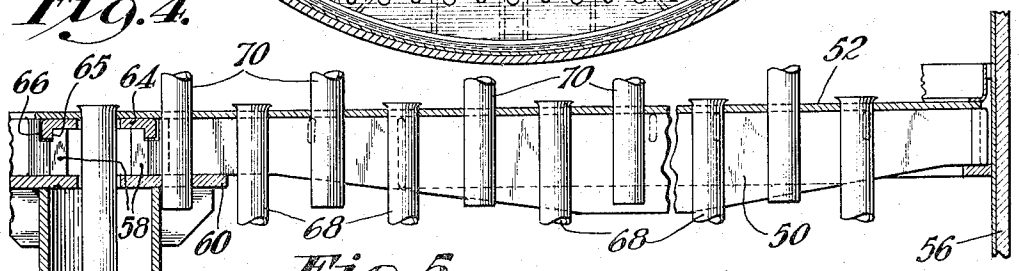
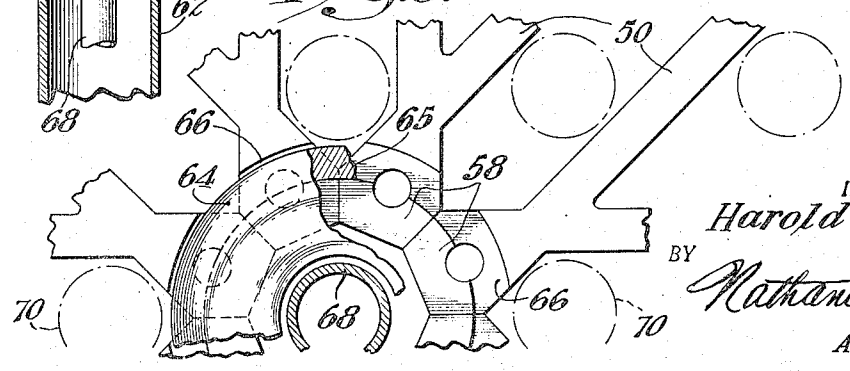


Fig. 5.



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Filed Feb. 26, 1948 3 Sheets-Sheet 3

Fig. 6.

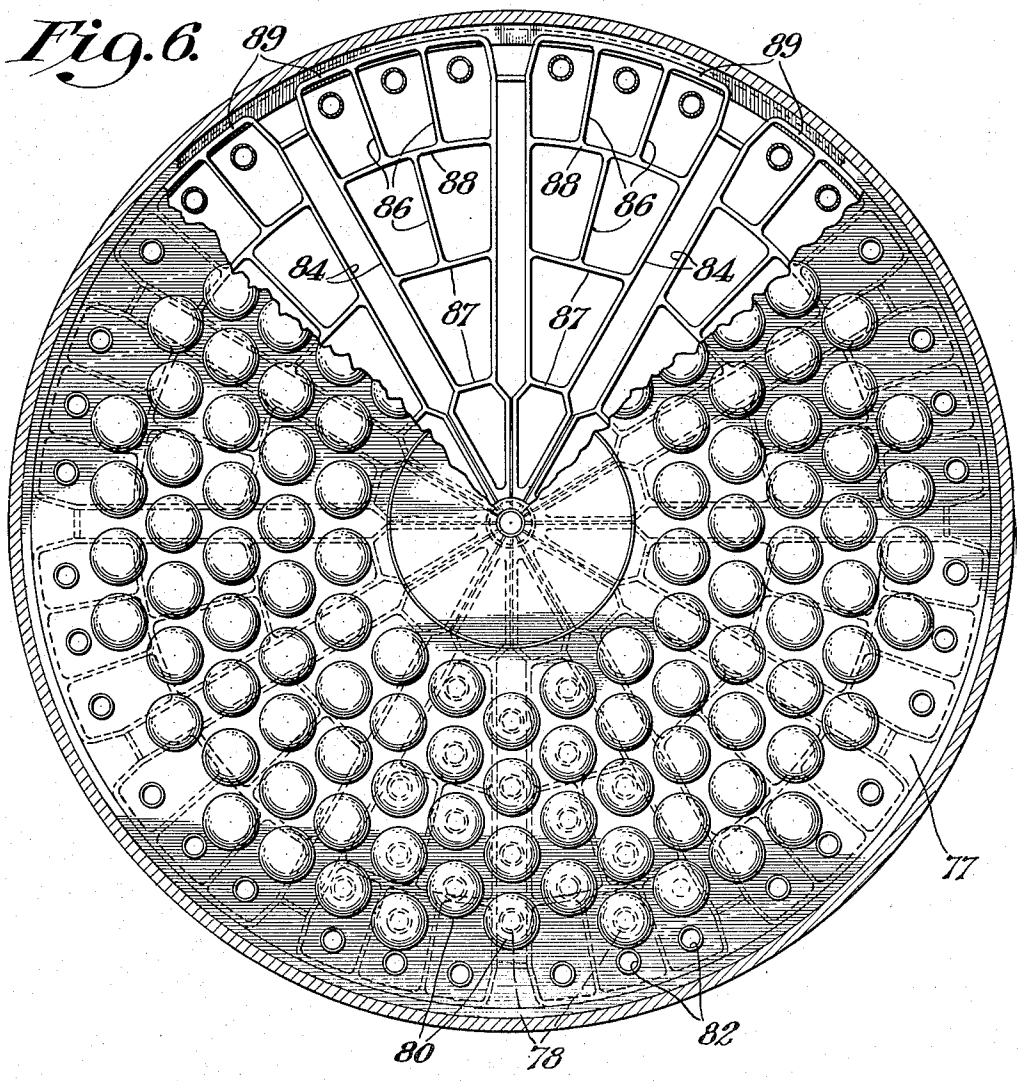
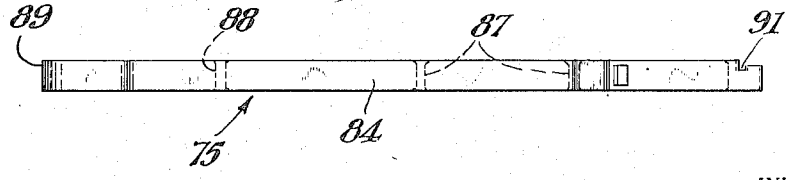


Fig. 7.



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SUPPORTING BEAMS FOR BUBBLE TRAYS AND THE LIKE

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Application February 26, 1948, Serial No. 11,134

8 Claims. (Cl. 261—114)

1

This invention relates to improvements in supporting beams for bubble decks or trays for distillation or reaction columns and the like.

In the prior patent of Gibb No. 2,320,073, reference has been made to the difficulties of economically constructing bubble decks or trays for large columns which may ordinarily be considered as having a diameter of ten feet or more. In such patent, it was pointed out that the sectional construction using a simplified pattern for standard cast sections was most economical as it was possible to use a majority of sections of identical shape thereby reducing the initial cost as well as the cost of maintenance. It also has been suggested that fabricated sheet metal beams and decks be provided especially where corrosive materials are handled. Nevertheless, it is expensive and difficult to assure rigidity with the light weight types of beams and decks except at the cost of loss of riser area and the high fabricating cost usually makes it very expensive construction.

The principal object of my invention is to provide a skeleton or web shaped cast beam construction composed of sectors of standard pattern which may be assembled into an integral beam serving as a tray or deck support, each of the sectors being relatively small thus permitting ready handling and being readily grouped into a highly stable and inexpensive beam of great rigidity.

A further object of my invention is to provide a standardized reinforced wedge or sector shaped frame member for supporting a lightweight bubble cap deck construction in which the webs of the members are so arranged that there is little or no loss or interference with riser area regardless of the location of the frame members.

A further object of my invention is to provide a supporting framework of key pieces for trays or perforated decks in large diameter vessels in which the webs of the pieces are so arranged as to permit the use of standard pitch openings with substantially no interference with or loss of open area and without requiring adjustment of the pitch of the openings.

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

Figure 1 is a horizontal section through a reactor or vessel showing a bubble cap tray and beam support with parts broken away to show the detailed construction thereof.

Figure 2 is a vertical cross-section taken substantially along line 2—2 of Figure 1.

Figure 3 is a horizontal section similar to Figure 1 showing a modified form of webbed beam construction for a tube sheet.

2

Figure 4 is a vertical section taken substantially along the line 4—4 of Figure 3.

Figure 5 is a plan view with parts broken away of a detail of the center securing member.

Figure 6 is a view similar to Figure 3 showing a horizontal cross section of a modified construction.

Figure 7 is an elevation of a web sector of the type shown in Figure 6.

Large diameter reaction vessels, such as bubble columns and catalytic reactors require internal supporting structure which becomes more and more difficult to construct as diameters and loads increase. For example, a bubble tray for a ten foot column which will have several hundred or more bubble caps and support a relatively deep mass of liquid may have a dead weight of fifteen hundred to seventy-five hundred pounds. This must be supported without undue or appreciable stress on the column and with the customary multiple decks, the supporting problem is very substantial. With a reactor full of catalyst, the loads may be as much as ten times as great.

The beam construction for such loads must not only support the weight with the desired rigidity and also be adaptable for assembly into the reaction vessel, but it must also have the important characteristic of not reducing the operating efficiency of the unit. In accordance with my invention, I meet these conditions as well as reduce the ultimate construction and maintenance cost of the beam.

As more specifically shown in Figure 1, the column 10 may be a bubble column or equivalent reactor having a plurality of bubble trays as hereinafter described. The support for each tray consists of a series of sector members 12, each of which is of such length as to overhang the peripheral reinforcing and supporting ring 14 on the outer edge and the central column 16. Preferably there are eight of these pieces or sectors although a greater number may be found desirable on larger diameter vessels. While the members 12 are referred to as sectors their shape deviates somewhat from that of a true sector, as shown.

These sectors or supporting members 12 are each provided with side edge webs 20 and parallel internal webs 22. In addition, they are provided with transverse reinforcing webs 24 and secondary webs 26, 27 and 28 which fill in the irregular remaining space.

As shown, all side edge webs 20 are spaced at least one diameter of riser apart from the equivalent webs in the adjacent sector and the thickness of the webs is such that it is less than the spacing between risers. The bubble caps generally indicated at 30, mounted on typical risers

32, are mounted on a relatively thin sheet metal plate 34, which overlies the web members 12. The risers are placed on a square pitch without any substantial loss of the total riser area. Downcomers are shown at 36.

It will be noted by inspection that the internal reinforcing webs 22, 24, 26, 27 and 28 are arranged in a symmetrical and mirror image spacing with respect to a central line through the sector. It is thus possible to move the sectors to varied positions without disturbing any riser on a square pitch pattern. Thus a single pattern is adequate for production of all beam sectors.

The sector shaped beam obviously may be used in towers of less than ten feet in diameter with advantage but the construction has greater value in the larger vessels. Ordinarily an even multiple of sectors is used and, as in this case, the sectors have their radial center lines on a forty-five degree spacing. Each sector is symmetrical about its radial central plane. In some cases, other arrangements may be used as, for example, if one entire sector is used for downcomers rather than as shown. Some modifications may also be made for structural reasons if necessary.

As a modified form of construction, identical shaped supporting sectors 50 may be utilized to carry a tube supporting plate 52 used for the control of flow of granular material through and removal of vapors from a reactor which may generally be designated 56. This construction is more particularly shown in Figure 3, and while the sector members are of the same general construction as shown in Figure 1, the size of the openings in plate 52 is such that a larger number of units or tubes may be provided. In a construction of this type, down-flow of granular material may be accomplished by suitable tubular members 68 carried by the tube sheet 52 and vapor may be removed from the risers 70 which extend below the beams as shown in Figure 4.

A preferred method of supporting the central part of the web 50 is shown in greater detail in Figures 4 and 5 in which the sectors are provided with substantially hexagonal or key shaped internal ends 58 which are supported on a plate 60 carried by the central column 62. A supplemental ring 64, having a projecting portion or tongue 65 extends into a recess 66 in the key shape portion 58 in the top of each beam and serves as a keeper.

Due to the small web area, there can be even weight distribution, and this in turn permits the use of a lighter column and relatively very thin gauge trays. As an example, with a plate diameter of 11 feet 9 inches, the thickness of tube sheets 52 in Figure 4 is only $\frac{1}{16}$ of an inch. The maximum height of the web of the beam 50 was approximately 7 inches. In this case, the load on the tube sheet was approximately 150,000 lbs. at a temperature of about 950° F. With the bubble decks shown in Figure 1, the web depth of the beam was of the order of two to two and one-half inches and the tray 34 would only be about 16 ga.

A still further modified form of construction is shown in Figures 6 and 7 which show a beam construction for triangular pitch bubble caps or openings. In this case, the beam sectors are indicated generally at 75 and are adapted to support a bubble deck 77 having risers 78 and caps 80. Downcomers are shown at 82.

With triangular pitch, the sectors preferably have their radial center lines on a thirty degree spacing and each sector is symmetrical with reference to its radial central plane. The marginal webs 84 are radial as are the short central webs 86. Transverse webs 87 are perpendicular to the radial members 86 but web 88 may be arcuate due to its distance from the center. The peripheral web 89 is also arcuate and overlies the internal reenforcing ring as in the first form of embodiment. The center of the respective sectors is provided with the locking recess 91 and is mitred and closely fits the adjacent sectors on a central support.

It will be appreciated that the web construction of the various sectors will require some adjustment depending on the number of caps, area of risers and pitch but that extraordinary strength can be obtained by the reenforced web construction. The arrangement of the webs is such that the required thickness of tube sheet over all openings will be substantially the same. This takes into account the shape and spans of the net open areas. As a result, it is possible to use a minimum thickness of bubble tray, deck or plate.

With the relatively thin webs which are spaced as hereinbefore described, it is possible to provide 140 caps of 3" diameter on 4½" risers in a 12 foot deck using triangular pitch. If the square pitch of Fig. 1 is used, I can effectively locate 360 caps of 3½" diameter on risers of approximately 2½" on the same size deck. In each case, the loss of riser area is substantially less than 5%.

While I have shown and described a preferred form of embodiment of my invention, I am aware that modifications may be made thereto and I therefore desire to include such modifications as may come within the scope and spirit of the description herein and of the claims appended hereinafter.

I claim:

1. A skeleton beam as a support for a substantially flat plate or tray member containing a plurality of perforations therein, said perforations being located on the intersection points of three groups of equally-spaced parallel axes, each of said groups being oriented at a 60° angle to each of the other two groups, whereby said perforations are arranged in a triangular array, said beam comprising straight edges having an included angle of 30°, outer webs substantially parallel to each of said straight edges, inner webs substantially parallel to said straight edges, and a plurality of transverse reinforcing webs between said outer and inner webs, said web pattern being symmetrical about a vertical plane through a line bisecting said angle, whereby said perforations are maintained free of obstruction by said supporting beams.

2. A sector-like skeleton beam, for the purpose set forth, formed mainly of an arrangement of relatively narrow interconnected ribs, two of which converge on lines intersecting at a point short of the adjacent end portion of the beam and a third connects the opposite ends of said two webs to define therewith a sector-like contour, the remainder of said webs forming an open grille within the enclosure defined by said contour-defining webs, the pattern formed by said web arrangement being symmetrical with respect to a line bisecting the included angle of said converging lines, and said end portion of the beam adjacent said intersection point being transversely enlarged to support the beam, and space it from a similar beam when associated therewith.

3. The beam of claim 2 formed of a single casting.

4. The beam of claim 2, wherein the opposite sides of said end portion diverge from said intersection point and converge toward the outer extremity of said end portion.

5. In a hollow column whose inner wall has a substantially circular horizontal section and in which material is passed between different levels, the combination of a deck within said column, substantially identical sector-like supporting beams for said deck underlying same and arranged in succession around the center of said cross section, each of said beams extending radially from a point adjacent the center of the column to a point adjacent said shell wall and comprising an open skeleton structure of relatively narrow contour-defining webs forming the converging sides and the outer end of the beam and relatively narrow reinforcing webs within the enclosure defined by said contour-defining webs and connected thereto, each beam being symmetrical with respect to the radial central plane thereof and the deck having numerous perforations distributed over the area thereof and located over the spaces defined by said beam webs for said passage of material through the deck and the beams, means supporting the beams at their outer ends; and means supporting the beams at their inner ends including a post at the center of the column, supporting ledge means borne by said post and underlying the inner end portions of the beams, a key ring surrounding the axis of the post and overlying the inner end portions of the beams and interlocking connections between said ring and said inner end portions preventing radial displacement of the beams.

6. In a hollow column whose inner wall has a substantially circular horizontal section and in which material is passed between different levels, the combination of a deck within said column, sector-like supporting beams for said deck underlying same and arranged in succession around the center of said cross section, each of said beams extending radially from a point adjacent the center of the column to a point adjacent said shell wall and comprising an open skeleton structure of relatively narrow contour-defining webs forming the converging sides and the outer end of the beam and relatively narrow reinforcing webs within the enclosure defined by said contour-defining webs and connected thereto, the converging sides of each beam converging on lines which intersect at a point radially spaced from the inner end of the beam and being substantially parallel to and substantially spaced from the adjacent sides of the beams at opposite sides thereof, the inner end portion of the beams being laterally enlarged and the outer end portions of the beams having lateral spacing projections, to hold the sides of the beams in said spaced relation, and the deck having numerous perforations distributed over the area thereof and located over the spaces defined by said beam webs and over the spaces between the beams for said passage of material through the deck, the beams and the spaces between the beams, means supporting the beams at their outer ends, and means supporting the beams at their inner ends.

7. In a hollow column whose inner wall has a substantially circular horizontal section and in which material is passed between different levels, the combination of a deck within said column, sector-like supporting beams for said deck underlying same and arranged in succession around the center of said cross section, each of said beams extending radially from a point adjacent the center of the column to a point adjacent said shell wall and comprising an open skeleton structure of relatively narrow contour-defining webs forming the converging sides and the outer end of the beam and relatively narrow reinforcing webs within the enclosure defined by said contour-defining webs and connected thereto, the converging sides of each beam being substantially parallel to and substantially spaced from the adjacent sides of the beams at opposite sides thereof, said beams being substantially identical and some of said reinforcing webs of each beam being straight and parallel, respectively, to the webs forming the converging sides of the beam, others of the said webs being arranged transversely of the beam and all of said webs of the beam defining a pattern which is symmetrical about the radial center line of the beam, the deck having numerous perforations distributed over the area thereof and located over the spaces defined by said beam webs and over the spaces between the beams for said passage of material through the deck, the beams and the spaces between the beams, means supporting the beams at their outer ends, and means supporting the beams at their inner ends.

8. In a hollow column whose inner wall has a substantially circular horizontal section and in which material is passed between different levels, the combination of a deck within said column, sector-like supporting beams for said deck underlying same and arranged in succession around the center of said cross section, each of said beams extending radially from a point adjacent the center of the column to a point adjacent said shell wall and comprising an open skeleton structure of relatively narrow contour-defining webs forming the converging sides and the outer end of the beam and relatively narrow reinforcing webs within the enclosure defined by said contour-defining webs and connected thereto, the converging sides of each beam being substantially parallel to and substantially spaced from the adjacent sides of the beams at opposite sides thereof, said beams being substantially identical and having their radial center lines arranged on a 45° spacing and the deck having numerous perforations distributed over the area thereof and located over the spaces defined by said beam webs and over the spaces between the beams for said passage of material through the deck, the beams and the spaces between the beams, said perforations being arranged on a square pitch with reference to lines parallel to one diameter of said column cross section and all of said webs of the beams being clear of said perforations, means supporting the beams at their outer ends, and means supporting the beams at their inner ends.

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