April 20, 1937. C. L. SMITH ET AL 2,077,645

TRAY STRUCTURE FOR BUBBLE TOWERS

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Fig. 1

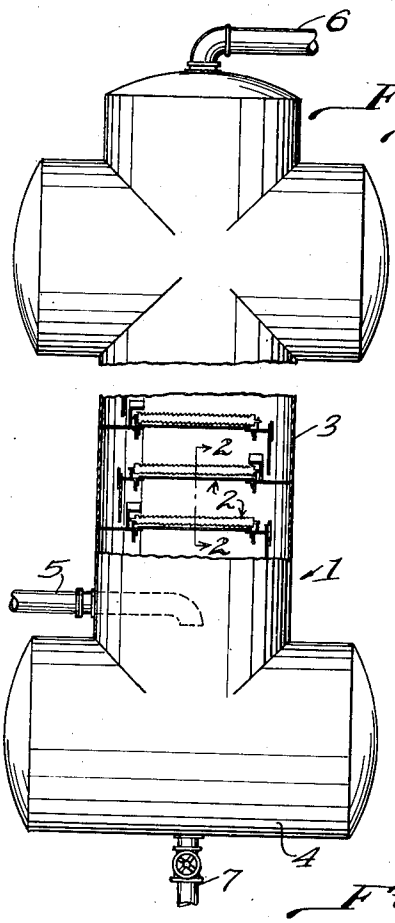


Fig. 5

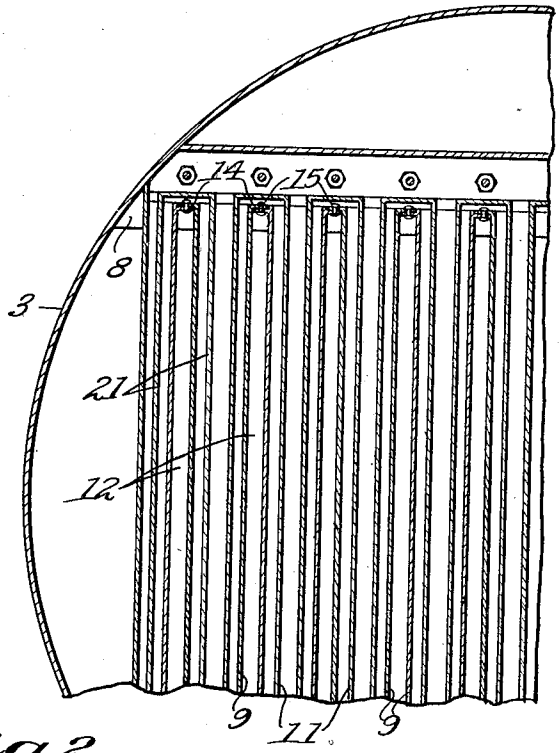
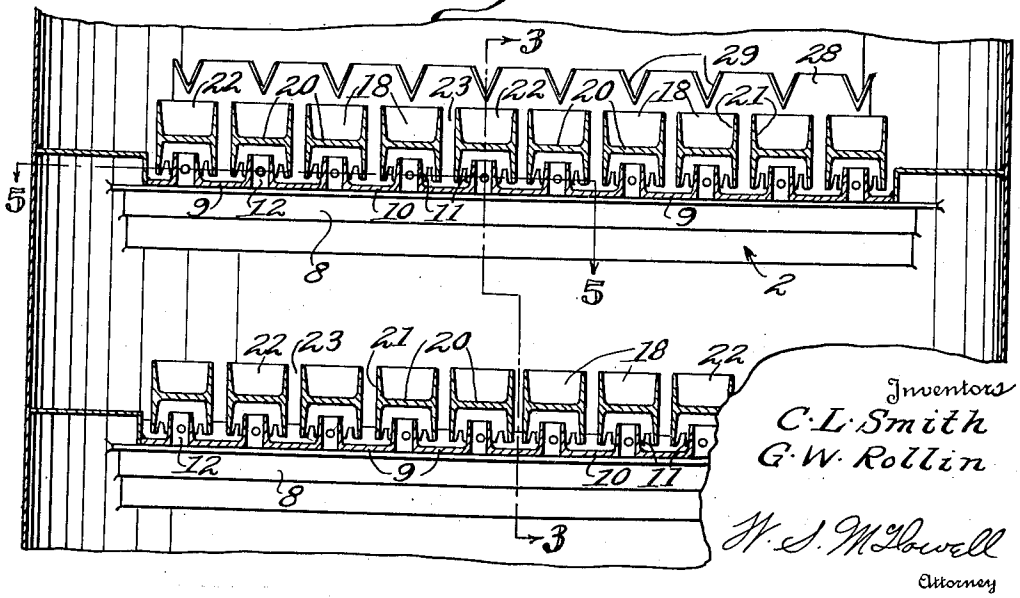


Fig. 2.



Inventors
C. L. Smith
G. W. Rollin

W. S. McDowell
Attorney

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Fig. 3

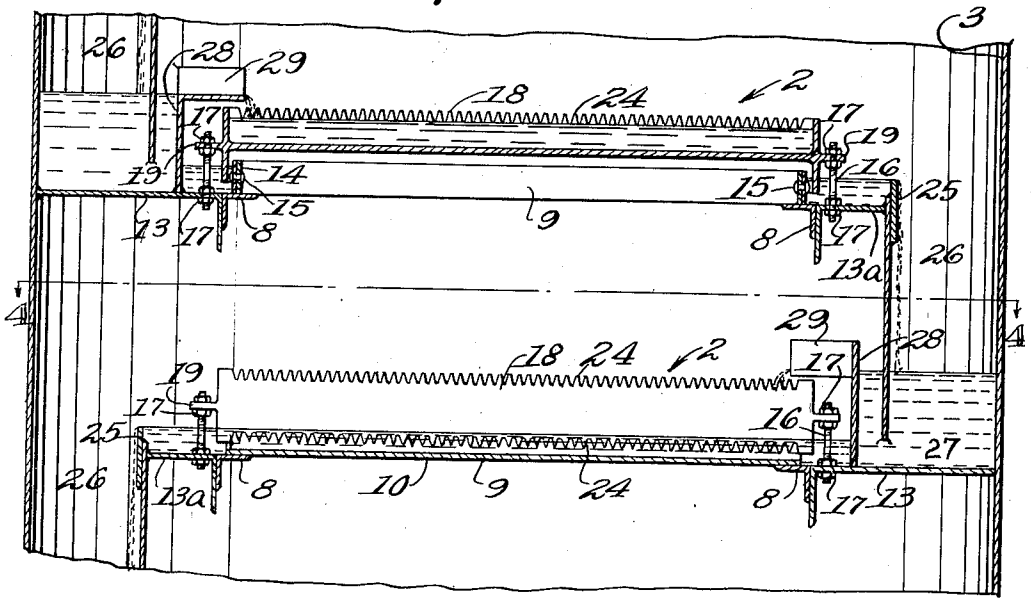
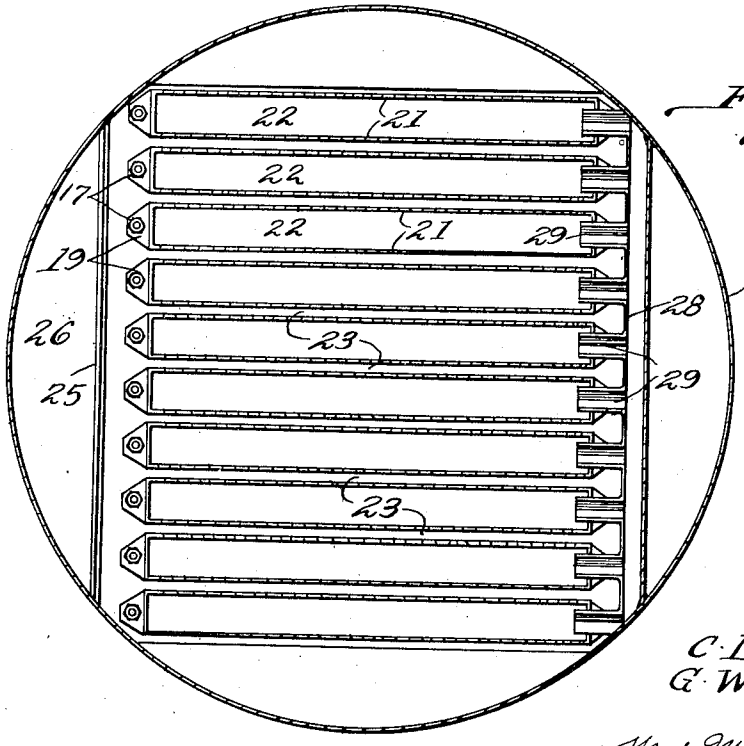


Fig. 4



Inventors
C. L. Smith
G. W. Rollin

By W. S. McDowell

Attorney

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TRAY STRUCTURE FOR BUBBLE TOWERS

Clyde L. Smith and George W. Rollin, Chicago, Ill., assignors to The Pure Oil Company, Chicago, Ill., a corporation of Ohio

Application February 3, 1933, Serial No. 655,116

9 Claims. (Cl. 261—114)

This invention relates broadly to improvements in vapor and liquid contact apparatus, and with reference to its more specific aspects, to fractionating towers of the type particularly used in separating heated hydrocarbon oils and vapors into fractions of different boiling range. Especially the invention is directed to an improved tray structure for bubble towers and has for an object thereof to produce and insure an improved vapor to liquid contact whereby to effect a sharp separation of vapors of predetermined low boiling point from oils of higher boiling point.

It has been observed in the operation of bubble towers operating at a low capacity, that due to the cold oil remaining in the bottom of the tray, proper contact is not secured between the vapors and the liquid in the bottom portion of such trays. As the submergence of the cap in the liquid in a great many trays is only about one-eighth of an inch, at low capacity the vapor to liquid contact in such a construction may be very inefficient.

Therefore it is another object of the present invention to provide an improved tray structure for bubble towers wherein a double cap member is provided which is so designed as to hold a quantity of liquid in the upper portion of the cap member and to provide means for distributing the reflux liquid overflowing the cap member uniformly over its sides. By this construction, several advantages accrue over conventional trays: first, a considerably larger quantity of liquid is held in the tower for contact with the vapor, the quantity being substantially twice that of the conventional tray structure, and therefore the tower is less subjected to sudden temperature changes and more stable operation thereof is obtained. Secondly, by distributing the reflux liquid over the sides of the cap member, instead of allowing it to flow through the trays in the conventional manner, proper and complete liquid to vapor contact is assured.

In accordance with the invention, there is provided a liquid holding tray provided with a plurality of open ended vapor risers extending upwardly from the bottom thereof. Over these vapor risers there is provided a plurality of cap members formed with depending sides which terminate in spaced relation from the bottom of the tray and materially below the open upper ends of the risers, each of said cap members having its upper portion, above said risers, formed with a liquid holding chamber, into which reflux liquid from superposed trays is delivered, whereby the upwardly moving vapors, passing through the risers, is deflected by the cap members and caused to travel downwardly around the sides of the cap member and through the body of liquid held on the tray. After bubbling through this liquid, the vapors pass upwardly through spaces formed between said risers and come into intimate contact with the reflux liquid flowing downwardly over the outer surfaces of the cap member, whereby high boiling compounds present in the vapors are condensed to form the reflux liquid and the lower boiling compounds retained in vaporous form for separation from the liquid.

It is another object of the invention to construct the cap members so that they possess a substantially H shaped cross-sectional configuration, the lower portions of said cap members providing deflecting surfaces while the upper portions thereof form troughs or pockets for the reception of reflux liquid.

Other objects reside in providing the longitudinal edges of the cap members with serrations to insure a uniform distribution of liquid along the full length of the sides of said cap members and in the provision of improved weir means for distributing liquid in uniform quantities to each of said cap members, and in forming the trays to constitute a plurality of spaced channel sections, the sides of which being arranged to form the vapor risers and which are disposed largely between the lower portions of said cap members.

For a further understanding of the invention, reference is to be had to the following description and the accompanying drawings wherein:

Fig. 1 is a view in side elevation of a fractionating tower, portions thereof being broken away to disclose the arrangement of the improved bubble trays comprising the invention;

Fig. 2 is a vertical sectional view taken through the tower and disclosing on enlarged scale the bubble tray structure comprising the present invention;

Fig. 3 is a similar view through the bubble tray structure on a plane perpendicular to that of Fig. 2, as indicated by the line 3—3 of Fig. 2;

Fig. 4 is a horizontal sectional view on the line 4—4 of Fig. 3;

Fig. 5 is a similar view on the line 5—5 of Fig. 2.

Referring more particularly to the drawings, the numeral 1 designates a fractionating tower in which the improved bubble tray structure 2 comprising the present invention is adapted to be arranged. The tower comprises a cylindrical body 3 of desired height and diameter, which terminates at its lower end in an oil reservoir 4. The vapor line 5 enters the lower portion of the body 3 contiguous to the reservoir 4, and vapors

obtained from any suitable source, such as an oil converter or still, are adapted to be admitted into the body 3 by way of said vapor line for purposes of fractionation. The top of the tower may be provided with a chamber for the reception of reflux coils, not shown, and the top of the tower is provided with a vapor outlet 6, which may lead to a condenser or other suitable apparatus. Likewise the reservoir 4 may be provided with a valved draw-off line 7.

The present invention is particularly concerned with the construction of the bubble trays indicated at 2. It will be understood that any suitable number of these trays, arranged in superposed relationship, may be provided in the body 3 of the fractionating tower depending upon the capacity and service of the latter. Each tray group includes angle supports 8 to which are fastened the ends of a plurality of horizontally disposed, relatively spaced channel members 9. These members may be of standard structural steel sections, or may be cast or pressed as desired. Each channel member comprises a bottom 10 and upstanding sides 11, the said sides being relatively spaced, with respect to adjoining channel members, to produce vertical open-ended risers 12 adapted for upward passage of vapors. The sides 11 have their ends laterally bent, as shown in Fig. 5, as at 14, to close the ends of the slot-like risers 12. These laterally bent ends may be welded or riveted together as at 15, in order that the ends of the risers may be closed.

Arranged adjacent to the angle supports 8 are horizontal plates 13, which are suitably secured to the inner surfaces of the body 3. Carried by the plates 13 are upstanding screws 16, the ends of which are threaded for the reception of nuts 17. The nuts carried by the upper ends of the screws 16 effect the adjustable support of a plurality of cap members 18. These cap members, as shown in Fig. 2, are preferably of H-shaped formation, and may be formed from standard structural steel members, or may be pressed or cast as practice may dictate. In this instance, the longitudinal ends of said cap members are formed with offset lugs 19, which receive the nuts 17 provided at the upper ends of the screws 16. By this arrangement, the horizontal positions of the cap members, with respect to the risers may be varied and subject to accurate control. Since the cap members are substantially of H-shaped formation, they each include a horizontal web 20 which is arranged immediately over the open upper end of a cooperative riser. Each web terminates in spaced sides 21 projecting substantially equal distances above and below the web 20. By this construction, there is formed in the top of each cap member, a longitudinally extending trough or chamber 22, adapted for the reception of reflux liquid. The cap members are relatively spaced with respect to each other so that restricted slots or longitudinal passages 23 are provided therebetween for the upward passage of vapor and the descent of liquid. The lower edges of the sides 21 terminate materially below the top of the risers and immediately above the upper surfaces of the webs or the bottoms 10 of the trays formed by the channel members 9. By this arrangement, vapors, passing upwardly through the tower, upon encountering a set of trays, travel through the risers 12 formed between the sides 11 of the channel members 9. The vapors then contact with the lower surfaces of the webs 20 of the cap members 18, heating the cap members to some degree whereby to release vapor from the liquid oil contained in the troughs or chambers 22. After contacting with the webs 20, the vapors are deflected downwardly and bubble through a relatively shallow body of oil contained in the trays as represented by the channel members 9. The vapors then pass upwardly through the elongated passages 23, coming into contact with descending streams of oil which overflow the longitudinal upper edges of the troughs or chambers 22.

As shown in Fig. 3, the longitudinal upper and lower edges of the sides 21 of the cap members 18 are toothed or serrated as at 24 in order to provide for uniform vapor and liquid flow along the full length of the sides 21. Following their release from the upper ends of the passages 23, the vapors then continue to the next upper set of trays, where the action is repeated. The liquid which collects on the trays represented by the channel members flows outwardly over the plate 13*a*, and the level of this liquid is determined by a weir plate 25, arranged adjacent to the outer edge of the plate 13*a*. The liquid then passes downwardly between the weir 25 and the side of the tower through the passage indicated at 26 and collects in a reservoir 27 formed by the plate 13 in the next lower tray section, a second weir 28 and the side of the tower 1. The upper edge of each weir 28 is provided with a multiplicity of V-shaped troughs 29 which deliver liquid uniformly to each of the troughs or chambers 22 formed in the upper portions of the cap members 18. The liquid which does not flow over in the weir 25 passes downwardly through the risers 12 in countercurrent contact with vapor to the next lower set of trays, coming into contact with vapors of progressively increasing temperature, whereby to insure the removal of all low boiling compounds which should be removed from the liquids as vapors.

In view of the foregoing, it will be seen that the present invention provides an improved tray structure for vapor and liquid contact apparatus wherein effective, thorough and complete contact takes place between ascending vapors of progressively decreasing temperature with descending liquid of progressively increasing temperature. One of the outstanding features is the provision of the cap members with the oil holding reservoir in the upper portions thereof which not only serve to provide for the desired vapor to liquid contact but, in addition, serve to retain larger bodies of oil in the successive tray structures than is customary in apparatus of this character, thus stabilizing the operation of such equipment by producing reliable and uniform results and this is especially true when the tower is being operated at low capacity. By serrating the edges of the cap members, uniform films of liquid pass downwardly along the full length of the sides thereof and likewise there is a similar uniformity in the upward travel of the vapors along or adjacent to said sides through the passages 23. The construction has the additional advantage of being economical to produce, since it is formed largely from readily available standardized materials which are so arranged as to avoid high constructional or replacement costs.

While there has been described one of the preferred embodiments of the present invention, nevertheless it will be understood that the invention is not limited in scope to the specific

details of construction illustrated and described but that the same is subject to considerable variation without departing from the underlying features of the invention as expressed in the following claims.

What is claimed is:

1. A bubble tray structure for fractionating towers comprising a tray composed of a plurality of parallel channel members, said members having their side walls spaced to produce a plurality of open-ended vapor passages therebetween, and a plurality of bubble cap members arranged over said vapor passages with the lower edges of said members spaced from the bottoms of said channels and adapted to be submerged in liquid contained thereby, the upper portions of said members being formed to provide troughs for the reception of liquid and means separate from said vapor passages for transferring liquid from said tray.

2. A bubble tray structure for fractionating towers comprising a tray composed of a plurality of parallel channel members, said members having their side walls spaced to produce a plurality of open-ended vapor passages therebetween, a plurality of cap members arranged over said vapor passages with the lower edges of said members spaced from the bottoms of said channels and adapted to be submerged in liquid contained thereby, the upper portions of said members being formed to provide troughs for the reception of liquid, weir means for maintaining a predetermined liquid level in said channel members and means for uniformly distributing liquid to said troughs.

3. A bubble tray structure for fractionating towers comprising a tray composed of a plurality of parallel channel members, said members having their side walls spaced to produce a plurality of open-ended vapor passages therebetween, a plurality of cap members arranged over said vapor passages with the lower edges of said members spaced from the bottoms of said channels and adapted to be submerged in liquid contained thereby, the upper portions of said members, being formed to provide troughs for the reception of liquid, and weir means for distributing liquid uniformly to each of said troughs.

4. A bubble tray structure for fractionating towers comprising a tray composed of a plurality of parallel channel members, said members having their side walls spaced to produce a plurality of open-ended vapor passages therebetween, a plurality of substantially H-shaped cap members arranged over said vapor passages with the lower edges of said H members spaced from the bottoms of said channels and adapted to be submerged in liquid contained thereby, the upper portions of said H members being formed to provide troughs for the reception of liquid, means for adjusting said H members to maintain a desired spaced relationship between the same and said channel members and weir means to distribute liquid uniformly to said troughs.

5. A fractionating tower comprising a casing, an inlet and outlet connected thereto, a plurality of superimposed horizontally disposed trays in said casing, said trays containing a plurality of substantially parallel channels with vapor uptakes therebetween, bubble cap members for said uptakes, said cap members being formed with troughs on the upper portions thereof, and said trays being spaced so that an upper tray is independent of the tray and associated cap members immediately below and means for distributing liquid from an upper tray to the troughs below.

6. A fractionating tower comprising a casing, an inlet and outlet connected thereto, a plurality of horizontally disposed trays in said casing, said trays containing a plurality of substantially parallel channels with vapor uptakes therebetween, bubble cap members for said uptakes, said cap members being formed with imperforate troughs on the upper portions thereof, and said trays being spaced so that an upper tray is independent of the tray and associated cap members immediately below, and separate means for flowing liquid from an upper tray to the troughs below.

7. A fractionating tower comprising a casing, an inlet and outlet connected thereto, a plurality of horizontally disposed trays in said casing, said trays containing a plurality of substantially parallel channels with vapor uptakes therebetween, bubble cap members for said uptakes, said cap members being formed with troughs on the upper portions thereof, said trays being spaced so that an upper tray is independent of the tray and associated cap members immediately below, and means for uniformly distributing liquid to said troughs.

8. A fractionating tower comprising a casing, an inlet and outlet connected thereto, a plurality of horizontally disposed trays in said casing, said trays containing a plurality of substantially parallel channels with vapor uptakes therebetween, bubble cap members for said uptakes, said cap members being formed with troughs on the upper portions thereof, said trays being spaced so that an upper tray is independent of the tray and associated cap members immediately below, means for maintaining a predetermined liquid level on said trays, and means for uniformly distributing liquid to said troughs.

9. A fractionating tower comprising a plurality of superposed bubble trays, said trays containing a plurality of elongated channels with vapor uptakes therebetween, bubble cap members for said uptakes, troughs on the upper portions of said cap members, said trays being independent of each other and spaced so as to provide a continuous uninterrupted vapor space between adjacent trays, and means for feeding liquid from an upper tray to the troughs below.

CLYDE L. SMITH.
GEORGE W. ROLLIN.