

Nov. 7, 1933.

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DISTILLATION AND THE LIKE

Filed Aug. 21, 1928

2 Sheets-Sheet 1

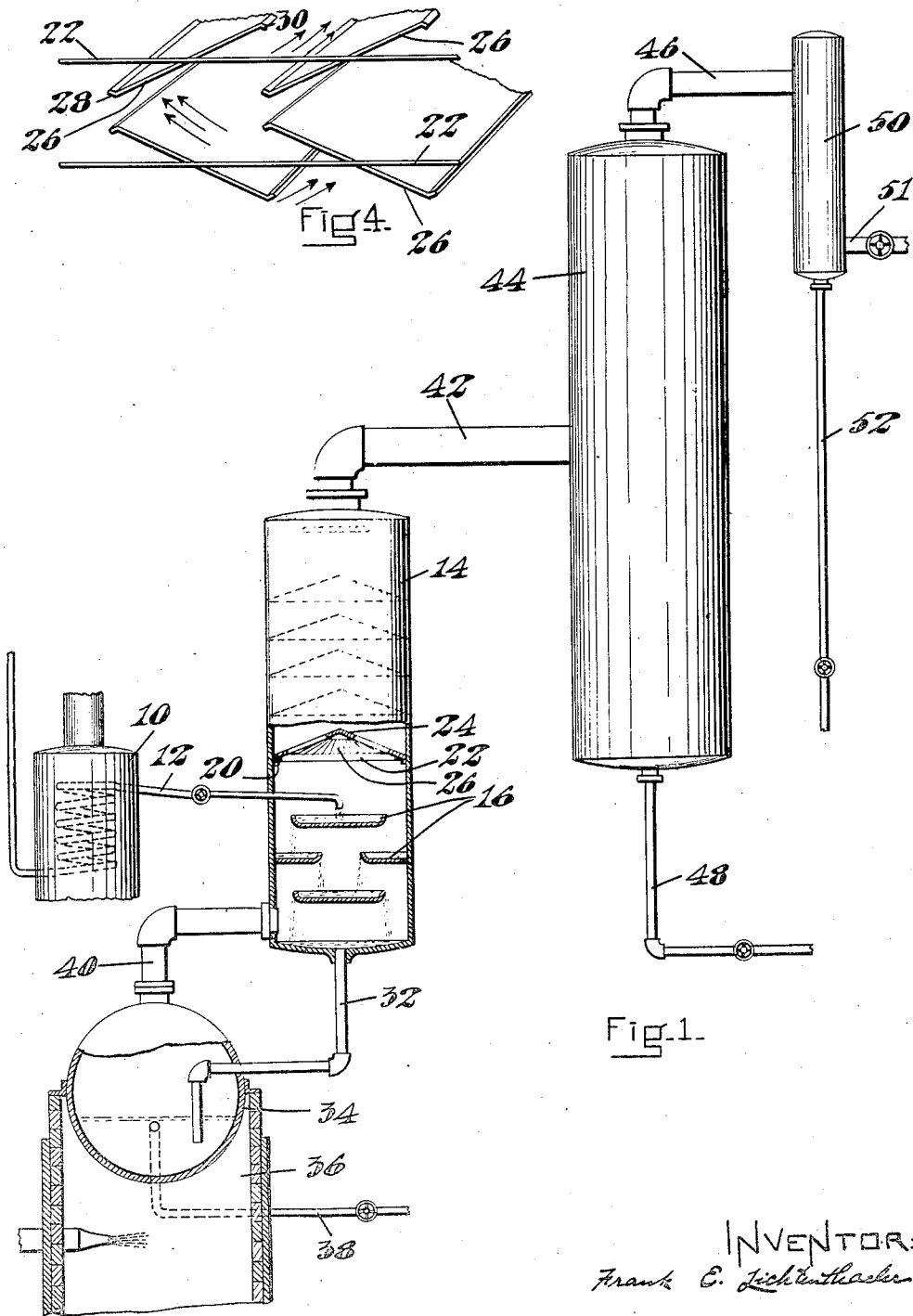


Fig. 1.

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Fig. 2.

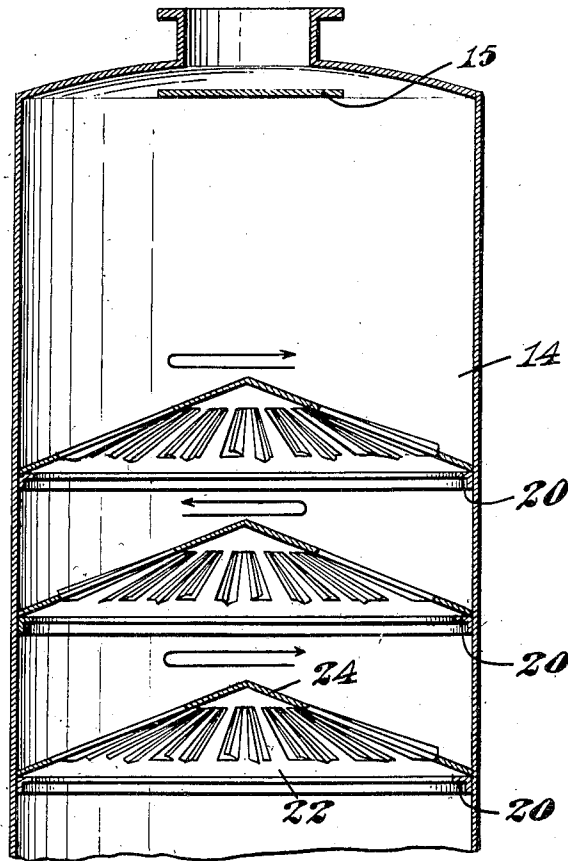


Fig. 3.

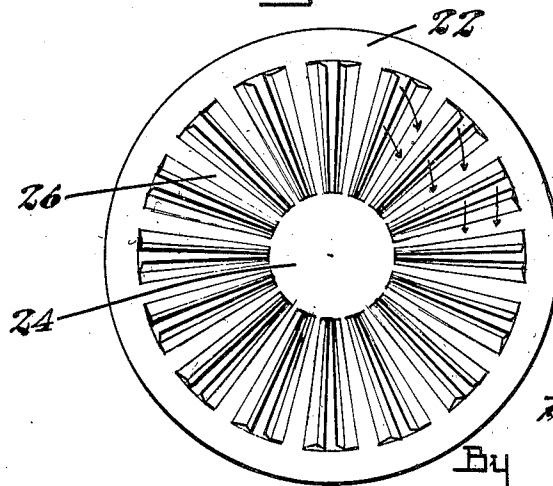
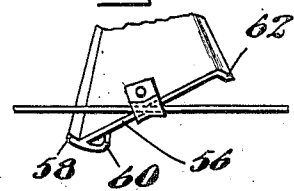


Fig. 5.



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DISTILLATION AND THE LIKE

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8 Claims. (Cl. 183—80)

This invention relates to improvements in distillation and the like, by which I mean to include absorbing, condensing, dissolving or chemically combining any vapor, air or other gas on the one hand with any liquid on the other hand.

In columns used in distillation processes, the efficient interchange of heat between vapors and liquids and the rapidity of reaching equilibrium in this respect at points of contact depend in a large measure on the velocities of the counter flowing streams of vapor and liquid. The rate of flow of the liquid in passing downwardly in a column is dependent on the action of gravity and, accordingly, more or less definitely limited. The velocity of the ascending vapor, however, may be increased indefinitely by increasing the pressure at the point of generation.

It has been the practice in rectifying columns and the like to allow enough space between the plates or decks so that the liquid spattering and splashing from one deck to the next shall not be taken up by entrainment in the ascending vapor column. In the past if the vapor velocity through the tower has become too great, this splashing will reach a point where the liquid is carried almost bodily into the deck above and from the top deck into the condenser. It is this entrainment effect which has heretofore limited the capacity of rectifying and similar columns. The entrainment of liquid by the vapor is especially troublesome under conditions of high vacuum distillation, in that the vapor velocities become greatly increased on account of their increased volume.

The present invention aims first to prevent entrainment in distillation columns, particularly those operating under vacuum, by a new and improved method of handling the ascending vapor stream. I have discovered that by causing the vapor stream to whirl alternately in opposite directions as it reaches successive decks, entrainment of the descending liquid is prevented to a striking degree. By the practice of a method characterized by this step, it is possible, for example, to effect a substantially complete separation of the constituents of crude petroleum bottoms, without danger of carrying over the discoloration of the pitchy residue into the cylinder stock or wax distillate.

It has been well appreciated by those familiar with the art that the entrainment of liquid by vapors or gases can be prevented in some measure; by causing the vapor to impinge against a baffle surface; by suddenly changing the direction of the vapor stream; by suddenly decreasing the

vapor velocity; by scouring or combing the vapor stream over a sharp edge; or by imparting a whirling motion to the vapor stream with the consequent removal of liquid by centrifugal force. In accordance with the method of my invention, full advantage is taken of all of these factors. The decks employed embody in their construction baffle surfaces against which the ascending vapor stream impinges. The direction of the vapor stream is changed as it passes each deck and it is made to whirl in alternately opposite directions. The velocity of the vapor flow is increased in passing the restricted openings of the decks and then suddenly decreased as it arrives at the space between the decks. The edges of the openings in the decks afford sharp edges upon which the vapor stream is scoured or combed, and finally the whirling motion imparted to the vapor stream generates a centrifugal effect tending to throw the liquid particles to the walls of the column. In one of its aspects, accordingly, my invention consists in a novel method of preventing entrainment in distillation columns by causing the ascending vapor stream to whirl in alternately opposite directions and it is within the scope of the invention to modify this method by including or not, as desired, the additional steps suggested in the foregoing discussion.

In another aspect, my invention consists in an improved column for distillation or the like having a series of spaced decks with openings directed alternately in opposite directions. Preferably, the openings will be of a radial character having sharp edges over which the ascending vapor stream may be combed. The best form of deck known to me for carrying out the method of my invention includes in its construction a series of radially disposed vanes, the plane of each vane being inclined to the horizontal and the vanes in one deck being all inclined in an opposite sense to the inclination of the vanes in adjacent decks.

I have found that spattering occurs which tends to introduce entrainment if the liquid is allowed to flow over the edges of the vanes. Accordingly, an important feature of the invention consists in a vane having a longitudinally extending gutter at one or both edges for the purpose of collecting the liquid, which would otherwise flow in a broad stream over its edge, and conducting it to the wall of the column and confining it to a course protected from the course of the vapor current.

As herein shown and in accordance with a further feature of the invention, the decks are of cone shape and the vanes and radial openings are, ac-

cordingly, disposed at an inclination from the center of the column downwardly toward its walls. This design of deck permits the area of the openings therein to be increased as compared to a flat deck, so that the resistance to vapor flow is reduced and also the descending liquid is directed outwardly toward the walls of the tower, where it may flow down substantially away from contact with the ascending vapor stream.

These and other features of the invention will be best understood and appreciated from the following description of a preferred embodiment thereof, selected for purposes of illustration and shown in the accompanying drawings, in which

Fig. 1 is a diagrammatic view of a distillation installation;

Fig. 2 is a sectional view of the rectifying column;

Fig. 3 is a plan view of one of the decks;

Fig. 4 is an edge view, on an enlarged scale, of a portion of two adjacent decks; and

Fig. 5 is an edge view illustrating a modified construction of vane.

I have illustrated my invention and will describe it in its application to the rectification of oil although, as already pointed out, it is in no sense limited to this particular field.

The oil is heated in the heater 10, which indicates any conventional form of furnace in which the oil is raised to the required temperature. The heated oil passes from the heater 10 through the pipe 12 to the fractionating column 14, where it is discharged into a series of pans 16 arranged in staggered relation in the lower part of the column. The temperature of the oil is such that substantially all of it vaporizes as it leaves the pipe 12 and the hot oil vapor ascends in the column, making its way through a series of decks arranged in the upper part of the column. The high boiling constituents of the oil are condensed by the contact with the decks and descend in a liquid stream, being taken out of the bottom of the column by the pipe 32 which conducts them back to the drum 34 of a supplementary heater 36. These liquid components of the oil are again heated in the drum 34 and the vapor thereof passes up through the duct 40 and enters the lower part of the rectifying column 14, again passing upwardly with the hot oil vapor supplied from the pipe 12. Those constituents which are not again vaporized in the drum 34 are drawn off as residue through the pipe 38 which leads from the bottom of the drum.

The hot oil vapor with leaves the fractionating column 14 passes through the duct 42 to a second rectifying column 44, where the rectifying process is continued, the heavier constituents or cylinder stock being drawn off by the pipe 48 and the hot oil vapor passes out through the duct 46 from the top of the column to a condenser 50. For purposes of illustration, this is shown as a jet condenser but apparatus of any preferred type would serve as well. The final product or wax distillate is drawn from the condenser through the pipe 52, after which it is separated from the water and ready for the market.

It will be understood that the entrainment above discussed and which the present invention aims to eliminate is the picking up, by the vapor current as it makes its way upwardly in the fractionating column of the descending liquid condensed upon the decks and flowing downwardly in the column. As already stated, I have found that this entrainment may be prevented by abruptly changing the course of the vapor current

at each deck. As herein shown, this is effected by the construction of the deck. These are in the shape of an obtuse angle cone comprising a solid center or cap 24, a peripheral ring 22 and radially disposed vanes.

While the decks may be assembled from smaller parts and would be so for columns of large diameter, I have herein shown the decks as made up of an integral piece of sheet metal in which the vanes are formed by cutting radial lines and then bending the material adjacent to the cuts upwardly at one edge and downwardly at the other edge of the vane so formed. In this construction, the center section or zone of the vane is a part of the surface of the cone while the portion of the vane between the center zone and one edge is bent so that it dips downwardly below the inner surface of the cone and is provided with a gutter 28 extending longitudinally along its edge. The other section of the vane is bent upwardly so that it projects above the plane of the cone and its edge is turned at a sharp angle to form a gutter 30. Each deck, therefore, comprises a plurality of vanes all sloping downwardly and outwardly toward the walls of the column and all inclined in the same general direction. As shown in Fig. 4 for example, all the vanes of the uppermost deck of the two therein illustrated are inclined transversely and upwardly toward the right. The space between the vanes, therefore, constitutes an opening directed also toward the right and vapor passing through this deck is given a whirling motion in a clockwise direction.

In order to change the direction of whirling movement abruptly at each deck, the transverse inclination of the vanes in adjacent decks is reversed; that is to say, all the vanes in each deck are inclined in the same direction but the decks are arranged so that the vanes in adjacent decks are all inclined in an opposite sense. For example, in the lower of the two decks shown in Fig. 4, the vanes are inclined upwardly on the left, thus forming openings directed toward the left so that vapor passing through this deck is given a whirling motion in a counterclockwise direction.

While the decks above described constitute one effective construction by which the direction of whirling movement of the vapor is reversed, it should be understood that my invention is not limited to this or to any specific construction but that it contemplates a method wherein the direction of vapor flow is reversed by any means whatsoever.

The abrupt reversal of direction of vapor flow in the manner described is, I believe, the principal factor in preventing entrainment of the liquid passing downwardly through the decks but, as already intimated, there are other factors contributing to this end. The vanes constitute baffle surfaces against which the vapor impinges directly and this tends to separate the liquid particles from the vapor and cause them to coalesce on the deck surfaces. It will be apparent also that the velocity of vapor flow is increased as the vapor passes through the restricted openings between the vanes and is then suddenly decreased as it arrives at the free space between the decks. This sudden decrease in vapor velocity has a tendency to deposit liquid particles as their momentum is dissipated. The edges of the vanes further constitute sharp edges over which the vapor stream is scoured or combed in passing through each deck and this action tends to remove liquid particles from the stream. It

will further be seen that a circular whirling movement is imparted to the vapor stream by the combined action of the inclined vanes and the circular column. On this account, a centrifugal tendency is developed in the liquid particles which tends to throw them to the walls of the column and thus separate them from the vapor.

Having once condensed and separated the liquid from the vapor, it is important to return it by a path protected as much as possible from the direct action of the vapor current. This is nicely effected as herein shown by the inclination of the deck and vane surfaces, which tends to direct the liquid outwardly toward the walls of the column where the velocity of the ascending vapor is at a minimum. The liquid is prevented from flowing over the edges of the vanes by the longitudinal gutters 28 and 30 and in this way a protected path is afforded to the liquid by which it may flow to the outer ends of the vanes.

If desired, a gutter may be provided at both surfaces of the lower edge of the vane. Such a construction is suggested in Fig. 5, where the vane 56 is constructed of a separate flat sheet of metal which may be riveted or otherwise assembled in a fabricated deck and in which a gutter 58 is provided at the upper surface of its lower edge. A gutter 60 extends along the lower surface of its lower edge and a gutter 62 along the lower surface of its upper edge, so that at all points the liquid is guarded from the vapor current and prevented from running over either edge of the vane.

It will be understood that the jet condenser 50 is connected through the pipe 51 to a vacuum pump in the usual manner, and that it is effective to maintain a high degree of vacuum in both columns 14 and 44.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is,—

1. In a column for distillation or the like, a series of transversely-extending spaced decks each having oblique radial openings therein and a plurality of vanes adjacent to the openings, all inclined in the same transverse direction and each provided with a longitudinally-extending gutter.

2. In a column for distillation or the like, a series of transversely-extending spaced decks each having a plurality of radial outwardly-inclined slots with the material at one edge of each slot bent downwardly and the material at the other edge bent upwardly forming an inclined vapor-deflecting vane between each pair of slots and each vane having its upper and lower longitudinal edges disposed at an angle to the face of the vane.

3. In a column for distillation or the like, a series of spaced and transversely-extending cone-shaped decks, each having openings therethrough and a plurality of radial vanes adjacent to the openings and sloping downwardly from the center of the deck toward the wall of the column and having a longitudinally-extending gutter formed therein, the vanes in each deck being transversely inclined in the same direction and the vanes in adjacent decks being inclined in opposite directions.

4. The method of preventing entrainment in distillation columns, or the like, wherein a heated liquid is supplied and substantially vaporized at an intermediate point, which consists in causing the ascending vapor stream above such point of supply to whirl alternately and abruptly in opposite directions as it reaches each of a series of closely spaced points in its travel, thereby causing the entrained moisture to leave the vapor stream by reason of its momentum at the points of reversal.

5. The method of preventing entrainment in distillation columns, or the like, wherein a heated liquid is supplied and substantially vaporized at an intermediate point in the column, which consists in breaking the vapor stream into a series of radially disposed currents, and causing each current above such point of vaporization to whirl alternately and abruptly in opposite directions in passing spaced predetermined points in a relative short distance of its upward travel, thereby causing the entrained moisture to leave the vapor stream by reason of its momentum at the points of reversal.

6. The method of preventing entrainment in distillation columns, or the like, wherein a heated liquid is supplied and substantially vaporized at an intermediate point, which consists in breaking the ascending vapor streams into a series of substantially equal currents, interrupting the flow of each current above such point of supply and vaporization at a series of relatively closely spaced points in its path, and simultaneously combining said component currents and directing each of said currents abruptly in alternately opposite whirling directions as it reaches the successive points of interruption, thereby causing the entrained liquid to leave the vapor stream by reason of its momentum at each point of interruption.

7. The method of preventing entrainment of liquid residue in the fractionation of liquids, which consists in substantially reducing the pressure of the vapor of the liquid, causing the vapor to pass upwardly in a spiral path from its point of vaporization, and abruptly alternating the direction of the lateral component of its movement at a series of spaced predetermined points above such point of vaporization and in a relatively short distance of its upward travel, thereby causing the entrained liquid to leave the vapor stream by reason of its momentum at the points of reversal.

8. In a column for distillation or the like, having an inlet for a heated liquid at an intermediate point in its height, a series of transversely-extending decks, uniformly spaced and located above said inlet in closely spaced relation and having oblique radial openings therein directed alternately in opposite directions in consecutive decks and adapted to cause vapor ascending above said inlet to whirl abruptly in a different direction in a portion of its travel as it passes through each successive deck, thereby causing the entrained moisture to leave the vapor stream by reason of its momentum at each point of reversal.

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