Sept. 29, 1931. C. S. PIGGOT 1,824,836

BONNET FOR RECTIFYING COLUMNS

Filed May 25, 1927

Fig. 1.

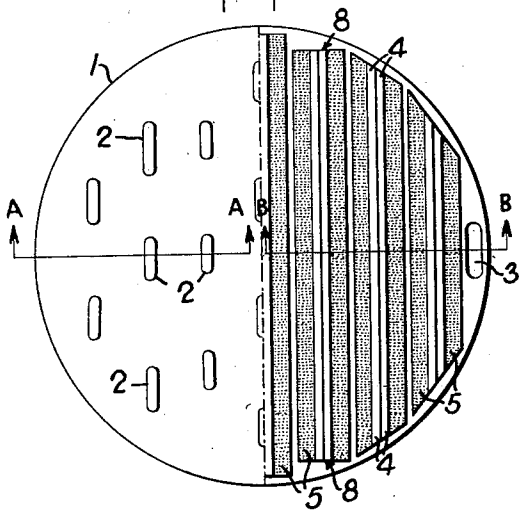


Fig. 2.

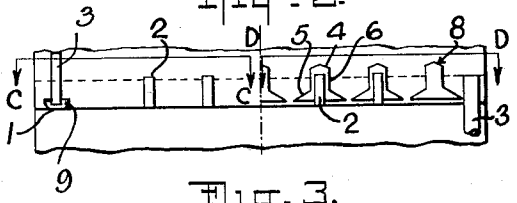


Fig. 3.

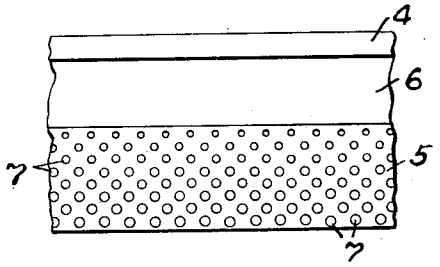
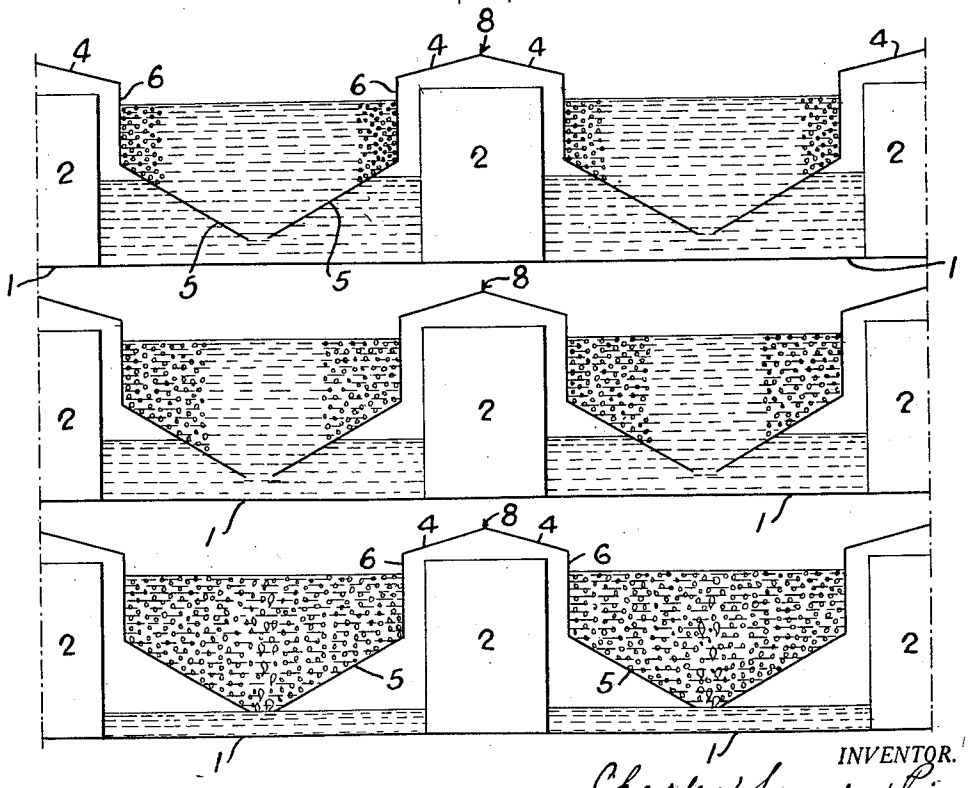


Fig. 4.



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UNITED STATES PATENT OFFICE

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BONNET FOR RECTIFYING COLUMNS

Application filed May 25, 1927. Serial No. 194,047.

The invention relates to an improved bonnet for use in rectifying columns, and includes correlated improvements and discoveries whereby and wherewith rectification processes are enhanced.

The present design of rectifying columns embodies an arrangement of bonnets which leaves a considerable amount of space unutilized. This is due to the fact that the bonnets are spaced apart at considerable distances, and also because the rate of operation being necessarily slow for the most effective "scrubbing", only that portion of the liquid immediately adjacent to the edge of the bonnet presents an effective "scrubbing" area, thus limiting the capacity of the column. Further the type of opening, usually triangular, of the bonnets makes effective operation dependent upon a low rate. Consequently in the event that the column is "crowded" or "over-loaded" for any reason whatsoever, the bubbles of the rising vapors passing through these openings become larger and larger, which decreases the contact surface, until finally a condition ensues when the vapors "blow through" in a continuous stream with very little "scrubbing" action.

A process of distillation, generally, and of rectification particularly, depends as to efficiency of operation upon the completeness with which the various constituents are separated one from the other. The completeness of separation in turn is dependent upon the amount of "scrubbing" which the vapors receive while in contact with the dephlegmated or reflux liquid. This "scrubbing" action is a function of the surface contact between the vapor and liquid phases and of the pressure under which the vapor is brought into contact with the liquid,—that is, the larger the surface contact and the greater pressure of the vapor, the more effective will be the rectification process.

An object of the invention is to provide an improved type of bonnet for use in rectification columns which will render the operation of rectification processes more efficient, and thus occasion a more complete and ready separation of the constituents.

Another object of the invention is to provide an improved rectifying bonnet which will bring about the utilization of practically the entire liquid area between the bonnets, thus greatly increasing the capacity of the column.

A further object of the invention is to provide an improved bonnet which will tend to prevent, automatically, the rising vapors from "blowing through", thereby rendering the operation of the column much more flexible, while maintaining its effectiveness, whether operating at high or low rates, or capacities.

Still other objects of the invention are to provide an improved rectifying bonnet of, specifically, an inverted trough-like structure, which increases the surface contact between the liquid and vapor phases and the pressure under which the vapor is brought into contact with the liquid by being provided with an apron, which is perforated.

Other objects of the invention will be in part obvious and will in part appear hereinafter.

The invention accordingly comprises the features of construction and arrangement of parts which will be exemplified in the construction hereinafter set forth and the scope of the application of which will be indicated in the claims.

In the practice of the invention there may be provided a rectifying bonnet of, for example, an inverted trough-like type consisting of a deflecting surface and retaining wall, with which there is in combination an apron angularly disposed—that is, which slopes out and away from the side of the trough or retaining wall at preferably a small angle from the horizontal—and which is perforated. The perforations may be placed over the whole area of the apron or over any suitable or desired part thereof. The size of the perforations are to be such (and this will be governed by the character of the material to be treated, as explained later) as will ensure the formation of the vapors passing therethrough into the liquid above as discrete and separate bubbles, and they may be so spaced that these bubbles remain separate

as they rise through the liquid. As will be set forth in detail below the invention contemplates an increase in the size of the perforations in the apron so that the size of the perforations in the lower and outer portion thereof will be somewhat greater than the size of the perforations in the upper and inner portion.

When operating upon a mixture consisting largely of substances of low specific gravity and small surface tension, such as ether, benzene, chloroform, methyl alcohol, acetone, etc., the perforations will be smaller than in cases where the liquid is made up largely of substances of greater specific gravity and higher surface tension, as water, hydrocarbon oils, glycerine, etc. The angular disposition of the apron with reference to the side or retaining wall of the bonnet may be varied also as to the specific gravity and surface tension of the material to be treated, and further to govern the pressure on the vapors within the bonnet; for the greater the angle of slope of the apron from the horizontal, the greater will the difference in pressure of the vapor be between the first and last row of perforations. Accordingly by properly selecting the angle of slope with reference to the specific gravity of the "scrubbing" liquid, and also the size of the perforations, there may be ensured a flow of separate and discrete bubbles from the first row of perforations, even when the pressure is so increased as to cause vapors to flow through the last row of perforations as well.

In the event that the pressure of the vapors within the bonnet is increased beyond that which will cause the vapor to bubble through the last row of perforations, they will then pass or bubble out beyond the edge of the apron, which may be termed an emergency condition. However, even when this emergency condition exists, the whole apron will deliver vapors to the liquid above as separate bubbles, and the efficiency is accordingly not impaired, the bubbles escaping beyond the apron being also subjected to the "scrubbing" action of the liquid.

For a fuller understanding of the nature and objects of the invention, reference should be had to the following detailed description taken in connection with the accompanying drawings, in which:

Figure 1 is a plan view showing a rectifying plate, a half section AA showing the disposition of the vapor risers, and a half section BB showing the disposition of my improved rectifying bonnet above the vapor risers;

Fig. 2 is a sectional view of Fig. 1 on lines AA and BB;

Fig. 3 is an elevation of an inverted trough-like bonnet provided with a perforated apron; and

Fig. 4 illustrates the operation of the improved type of bonnet at various rates or pressures.

In the drawings, Fig. 1, a rectifying plate 1 is provided with vapor risers 2, which may be of suitable area and cross-section, and with a pipe or outlet 3, by means of which the liquid is conducted from a higher to a lower plate, the height of such outlet above the plate as shown in Fig. 2 governs the level or depth of liquid on the plate, and the lower end of such tube is sealed by the liquid on the lower plate. The vapor risers, in the embodiment shown, are surrounded by a rectifying bonnet 8, which may be of any approved type, as the inverted trough-like type, cap type, etc. The rectifying bonnet has a deflecting surface 4 and a retaining or side wall 6, with which side wall there is in combination an apron 5, this apron being angularly disposed and of perforate structure. The perforations 7 may vary in size according to the specific gravity and surface tension of the materials being treated. As indicated in Fig. 2 the size of the perforations 7 increases from the retaining wall outwardly, so that the perforations will be somewhat larger in the outer section of the apron. This feature is of particular importance in connection with liquids of relatively high specific gravity and relatively great surface tension. In certain instances, particularly when difficulty in leveling the bonnets may be experienced, it may be desirable to form the apron with a corrugated surface having the perforations placed at the top of the corrugations. For the general and usual applications of the bonnet, this, however, will not be necessary. Moreover, an angular disposition or slope of the apron with respect to the side wall, it is anticipated, will not exceed 30° from the horizontal but it will be understood of course that the angular disposition of the apron is not so limited.

That the surface area available for utilization in the "scrubbing" action comprises practically the entire liquid area between the bonnets is shown in Fig. 4, in which the operation of an improved bonnet at various pressures is also illustrated showing the change in effective surface area with change in pressure, the plates from the uppermost to the lowest operating at low, intermediate and high pressures, respectively.

The separation of two or more substances by the passage of their vapors through a rectifying column, in which they are subjected to the "scrubbing" action of a refluxing liquid, depends upon the differences in their respective boiling points, and this in turn is proportional to their vapor pressures, to the solubility of the vapors in the refluxing liquid, to the area of contacting surfaces of the liquid and vapor phases, and to the pressure under which the liquid and vapor are brought into contact. Accordingly the

smaller the bubbles of vapor passing through the "scrubbing" liquid, the greater is the area of surface contact, and the greater is the pressure of the vapor within the bubbles, which pressure is a function of the surface tension of the liquid, and in the case of small bubbles it may amount to several hundred pounds per square inch. The efficiency of a rectifying column, therefore, with a given amount of reflux and a given number of plates, depends upon the number and smallness of the bubbles of vapor passing through the reflux, and in order to be most effective these bubbles must remain discrete and separate—that is, they must be of a size and so distanced as to prevent their combination with ensuing formation of larger bubbles.

The foregoing considerations are fulfilled in the construction and arrangement of my improved rectifying bonnets which, when placed in a rectifying column, will impart to such column the following advantages over a column of the same size and number of plates, but otherwise equipped: The "scrubbing" action will be more efficient because a great number of small bubbles of vapor pass through the reflux, thereby increasing the area of surface contact, and the smallness of the bubbles also causes within them a considerable pressure. The plate surface is more completely utilized by making use of all the plate surface between the bonnets, giving thereby greater capacity. The control of the size of the bubbles and the change of the area used with changes in pressure of the vapor increases the flexibility of the column and makes it just as efficient when operated at high rates as when operated at low rates or capacities. The "blowing through" of the vapors is largely, if not entirely, prevented, which makes the operation of the column easier and increases the capacity of a column of given size.

Since certain changes may be made in the above construction and different embodiments of the invention could be made without departing from the scope thereof, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

It is also to be understood that the following claims are intended to cover all of the generic and specific features of the invention herein described, and all statements of the scope of the invention which, as a matter of language, might be said to fall therebetween.

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

1. Apparatus of the character described, comprising a cap for the delivery of gases, and an apron extending downwardly and outwardly therefrom at an angle of between approximately 30° and approximately 60° to the horizontal, said apron being perforated throughout its extent, the perforations in said apron increasing in size from its upper and inner portion to its lower and outer portion.

2. Apparatus of the character described, comprising a cap portion having a substantially vertical side wall and an apron extending downwardly and outwardly of said side wall at an angle thereto, said apron being perforated throughout its extent, the size of the perforations in the lower and outer portion of the apron being greater than the size of the perforations in upper and inner portion, said apron being arranged to permit the free flow of gas around its lower and outer edge when the pressure becomes sufficient to press the liquid entirely from beneath said apron.

3. A rectifying bonnet, comprising an inverted structure with top and side wall, and means to introduce vapors into said inverted structure, the inverted structure being arranged to direct vapors over the lower edge of said side wall, in combination with a perforate apron extending downwardly and outwardly from the lower edge of said side wall and at an angle thereto, said apron having perforations increasing in size from the side wall outwardly.

4. A rectifying bonnet comprising an inverted structure with top and side wall, in combination with a perforate apron extending outwardly and downwardly from the lower edge of said side wall and at an angle thereto and being perforated throughout its extent, the perforations in said apron increasing in size from said side wall outwardly.

5. A rectifying bonnet comprising an inverted trough-like structure with top and side wall, in combination with a perforate apron extending downwardly and outwardly from said side wall, said apron having perforations of varying size, the perforations in said apron increasing in size from said side wall outwardly.

6. A rectifying bonnet comprising an inverted trough-like structure with top and side wall, in combination with a perforate apron extending downwardly and outwardly from the lower edge of said side wall, the openings in said apron increasing in size from the side wall outwardly.

7. A rectifying bonnet, comprising, in combination, vapor-delivery means and a perforate apron, said perforate apron extending downwardly and outwardly from said vapor-delivery means and having openings which increase in size from the inner to the outer portion of the apron.

In testimony whereof I affix my signature.

CHARLES SNOWDEN PIGGOT.