

May 22, 1928.

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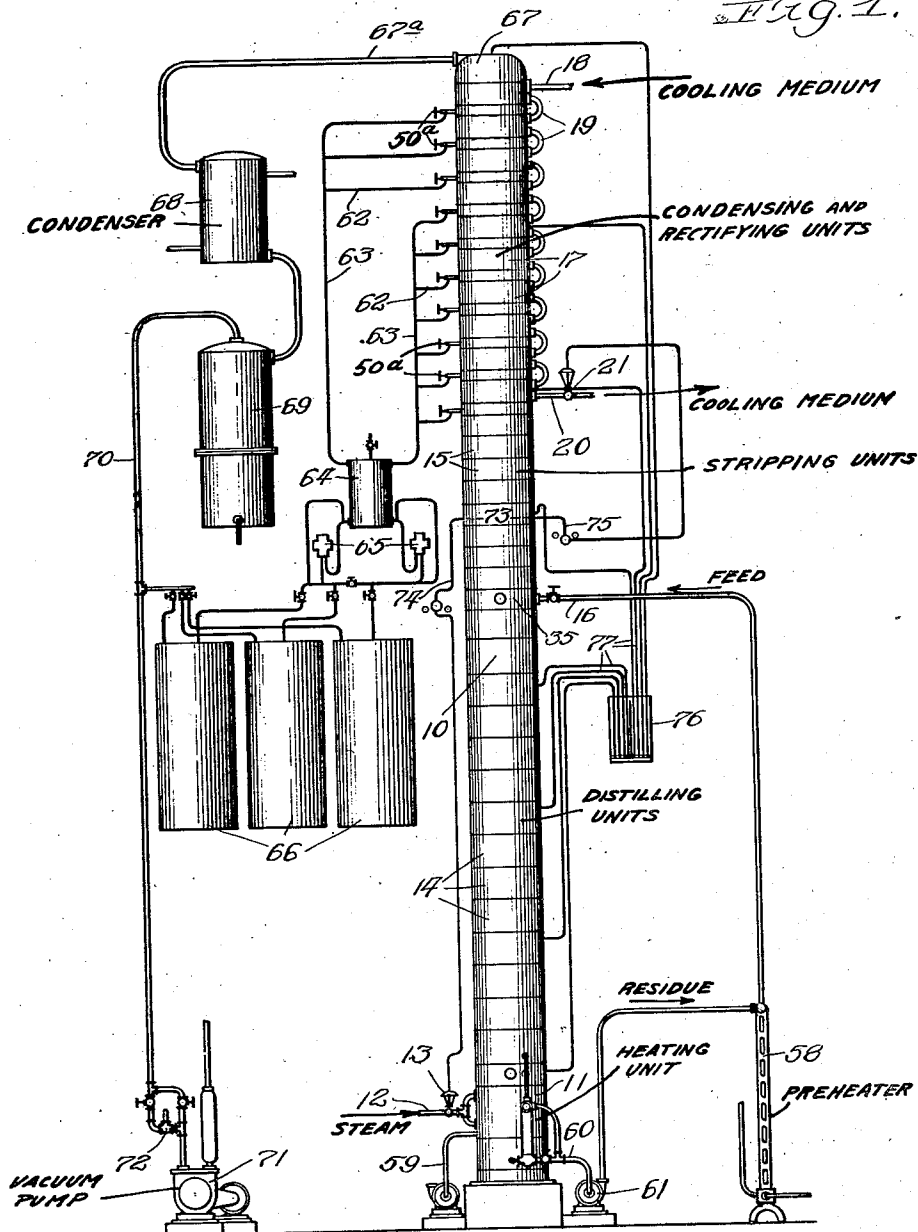
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DISTILLATION APPARATUS

Filed Nov. 12, 1923

4 Sheets-Sheet 1

Fig. 1.



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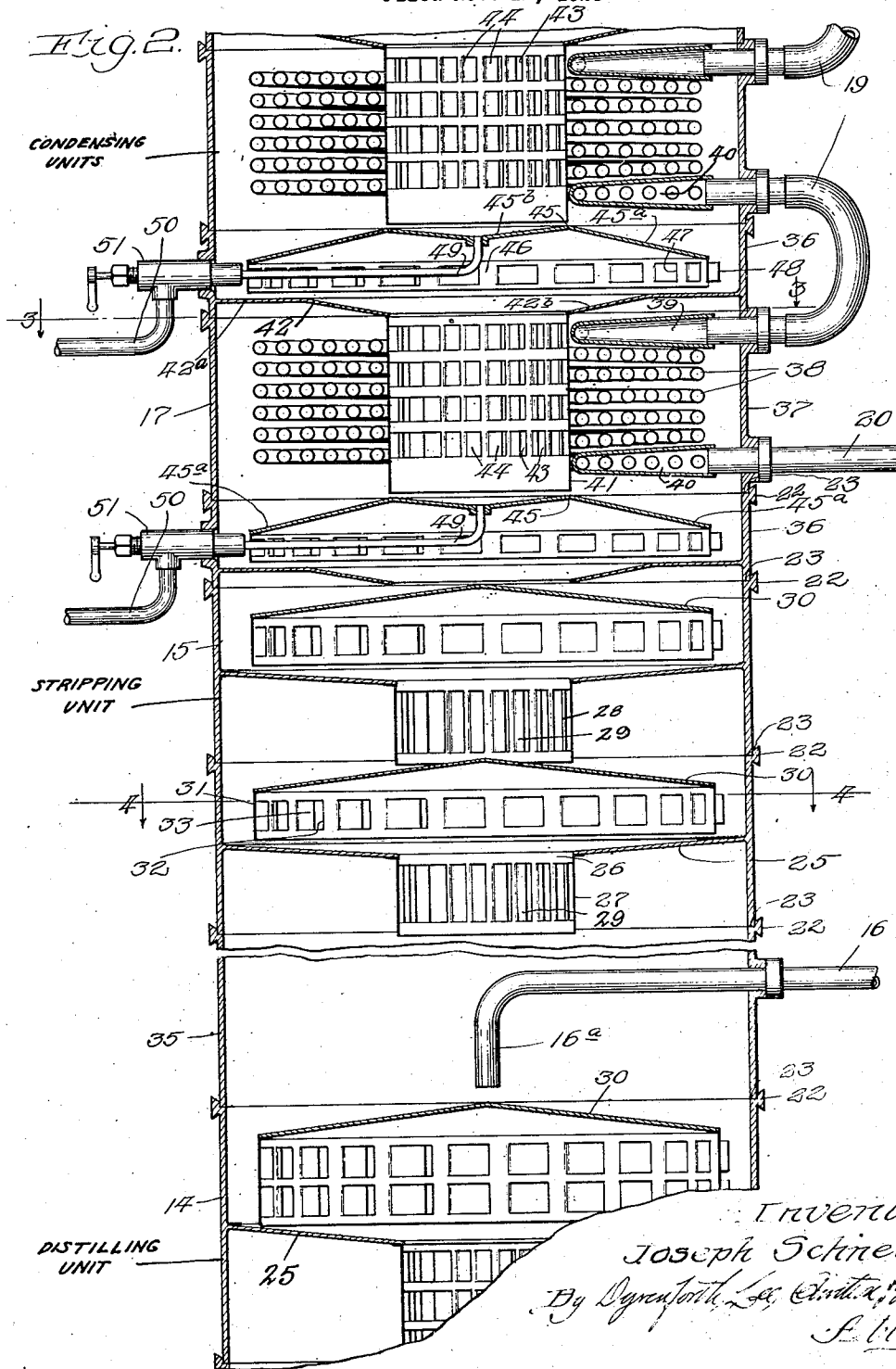
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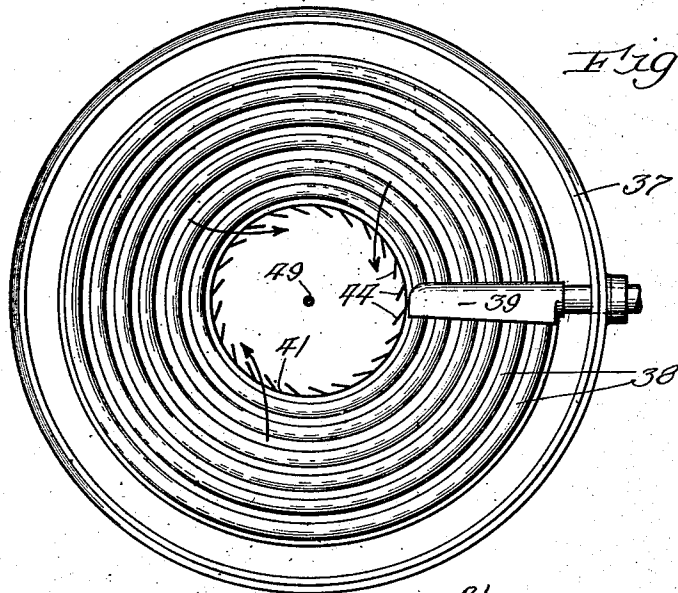


Fig. 3.

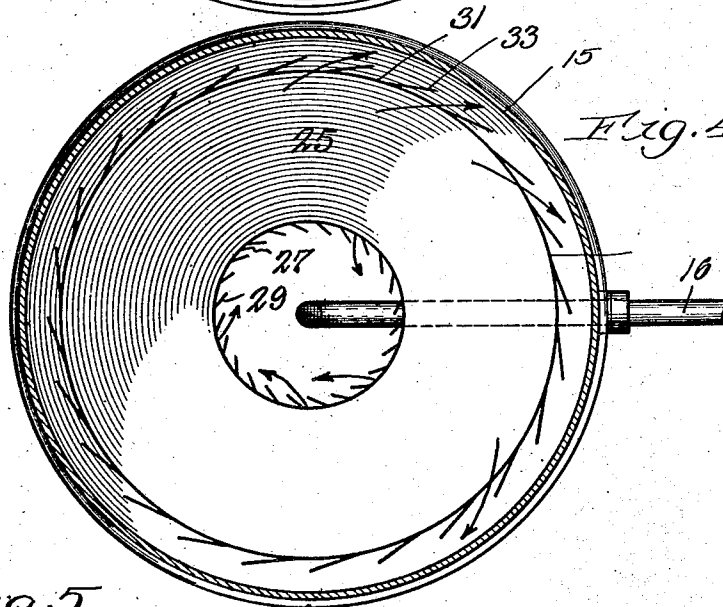


Fig. 4.

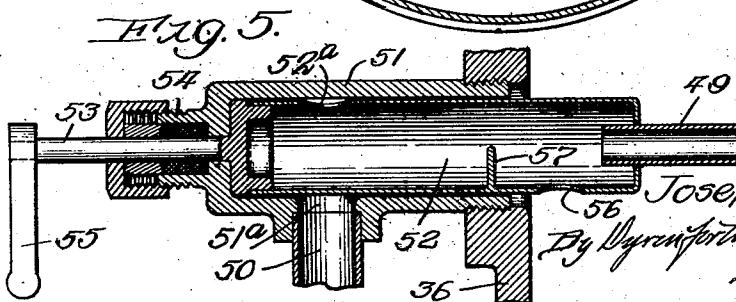


Fig. 5.

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UNITED STATES PATENT OFFICE.

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DISTILLATION APPARATUS.

Application filed November 12, 1923. Serial No. 674,285.

The present invention relates to improvements in the art of distillation, and more particularly to distillations in which the distillation and rectification processes are carried out in a single unitary column device. It will be more fully understood from the following description, illustrated in the accompanying drawings, in which:

Figure 1 is a diagrammatic view of apparatus embodying the present invention;

Fig. 2 is a sectional view showing a preferred form of construction of the units making up the stripping and condenser portions of the column;

Fig. 3 is a transverse sectional view through a condenser unit on the line 3—3 of Fig. 2;

Fig. 4 is a transverse sectional view through a stripping unit on the line 4—4 of Fig. 2;

Fig. 5 is a sectional view through a collecting and discharge cock; and

Fig. 6 is a sectional view showing a modified and somewhat simplified form of condenser section.

Referring more particularly to the drawings, the numeral 10 indicates a column made up of superimposed units, of which the lowermost is a heater unit, designated by the numeral 11, to which steam is supplied through the pipe 12 controlled by valve 13. A preferred construction of the heater unit is shown in my co-pending application Serial No. 674,287 filed of even date herewith. Above the heater unit 11 are superimposed a number of distilling units 14 and stripping units 15 of similar construction, those higher in the column being preferably shorter in height than the lower ones to compensate for the diminution in volume of the vapors. At an intermediate point in the column, the material to be distilled is fed in through a valved pipe 16, the point of admission preferably corresponding approximately to that point in the column at which the reflux has a composition the same as that of the infed material. Above the distilling and stripping units are mounted the condensing and rectifying units 17. A suitable cooling medium, which may be, for example, water or brine, is fed into the uppermost of the condenser units 17 through

pipe 18, passes successively downward through the several units through the connecting pipes 19, and makes its exit through the pipe 20 controlled by the valve 21. In the form of construction illustrated, the flow of the cooling medium is controlled by this valve 21 in the outlet pipe 20.

In the column of the present invention, as in that of my prior application Serial No. 433,376, filed Dec. 27, 1920, the sections of the various units forming the column are so constructed as to permit a substantially free passage of the vapors and reflux there-through, and to impart a positive rotary motion to the vapors and reflux, thereby effecting a very complete heat interchange between them.

In my preferred form of construction, the several units are made up with circular walls terminating in flanges 22 of generally triangular cross section and having shoulders 23 into which the lower end of the wall of the next section above fits. This construction is more fully set forth in my Patent No. 1,366,955 granted Feb. 1, 1921.

Each of the units 14 and 15 making up the distilling and stripping sections is provided internally with an annular shelf or baffle 25 having a slight downward pitch and extending from the wall to a central circular opening 26. From this opening a cylindrical skirt 27 extends downwardly, and this skirt is provided around its entire circumference with large openings 28, the skirt being formed at these openings to provide inwardly directed vanes 29 resembling the vanes of a turbine rotor. Above the ring 25 in each unit is provided a deflector 30, preferably of conical form with a slight downward pitch and having its apex substantially at the center of the unit. The deflector 30 extends outwardly, leaving a vapor passage between it and the interior wall of the unit. From the outer margin of the deflector 30 a cylindrical skirt 31 extends downwardly nearly to the upper surface of the annular ring 25 and is supported on the latter. The skirt 31 is provided with openings 32 and is also provided at these openings with vanes 33 extending outwardly from its circumference. These vanes also resemble the vanes of a turbine rotor. It

will also be noted from a consideration of the drawings that the inner skirts 27 of each unit extend down substantially into engagement with the upper surface of the deflector 30 of the next lower unit leaving only a narrow passage for liquid. It is therefore apparent that substantially all of the vapors must pass through the openings 28 of the inner skirts 27 and through the openings 32 of the outer skirts 31, and in each case are given a positive rotary movement by the vanes 29 and 32. It will be noted from the drawings that some of the units are deeper than others, and that varying numbers of openings and vanes are provided therein. In view of the similarity in structure, these units of varying size have not been separately described, the differences in size being due to the varying volumes of vapors to be acted upon in the different parts of the column.

At a suitable point in the column, a section 35 is interposed, into which the material to be distilled is brought through pipe 16. This pipe is provided approximately centrally within the column with a downwardly directed portion 16^a, through which the material to be distilled is discharged substantially above the center of the deflector 30 of the next lower section.

Above the stripping section of the still there are provided a suitable number of condenser units, each of which may be, as shown in Fig. 2, constructed in two parts, a collector unit 36 and a superimposed cooling unit 37. In each of the cooling units 37 there is mounted a plurality of coils 38, opening at one end at the top of the unit into an inlet manifold 39, and at the other end in the lower part of the unit into an outlet manifold 40. These coils 38 are so disposed as to leave an open inner central space, in which is arranged a downwardly depending cylindrical skirt 41, which is secured to and depends from the inner rim of the baffle plate 42 of the collecting section next above. The depending cylindrical skirt 41 is provided with openings 43 and vanes 44 directed inwardly in a manner similar to the depending skirts 27 of the distilling and stripping units 14 and 15, and functioning in a similar manner.

Each of the collecting units 36 is provided near its top with a collecting-deflector plate 45, having an outer ring portion 45^a of conical form with a slight downward pitch and an inner inverted conical portion 45^b. This inverted conical portion is of substantially the same diameter as the skirt 41 depending from the next collector unit above, and is directly thereunder, so as to receive and collect refluxed liquid therefrom. The downwardly pitched conical ring portion 45^a is below the condenser coils 38 of the next higher cooling unit, and receives reflux there-

from. At its outer rim the deflecting collecting ring 45 is provided with a downwardly depending skirt 46 having openings 47 and outwardly directed vanes 48 functioning in a manner similar to the corresponding parts of the skirts 31 depending from the deflectors 30 of the stripping and distilling units. The depending skirt 46 extends substantially to the baffle ring 42, which extends from the wall of the section toward the interior of the still. A marginal ring portion 42^a of this baffle ring is substantially level and without pitch and the inner ring portion 42^b has a downward pitch. To the inner rim of this baffle ring the skirt 41 is secured, as already described, except in the case of the lowermost collector unit, which, as shown in Fig. 2 discharges directly upon the deflector plate 30 of the topmost stripping unit 15.

Reflux collected in the central inverted conical portion 45^b of the deflector-collector plates 45 is conducted through a discharge pipe 49 to a controlled discharge cock 50^a, the structure of which is best shown in Fig. 5 in a detailed sectional view. This cock is formed with an external cylindrical casing 51, suitably secured in the wall of the collector unit 36 and provided with a discharge opening 51^a on its underside. Within the casing 51 is rotatably fitted a cylindrical member 52 provided with a stem 53 which extends out through the stuffing box 54 formed in the end of the casing 51, the stem 53 being provided with a suitable handle 55 for the rotation of the internal cylindrical valve member. The valve member 52 may project inwardly for a short distance and reflux from the conical collector 45^b is supplied to it through the pipe 49. The valve member 52 is provided within the unit 36 with a discharge opening 56, and it is provided with a second discharge opening 52^a angularly displaced with respect to the discharge opening 51^a and arranged so that, on rotation of the valve member 52 it may be brought into alignment with the discharge opening 51^a. A transverse baffle 57 is provided in the valve member 52 beyond the opening 51^a. In its normal operating position, the valve member 52 is so placed that the opening 56 is directed downwardly, the opening 52^a being then sealed by the casing 51 and the transverse baffle 57 impeding the flow of liquid. Under these conditions, liquid entering the valve through the pipe 49 is discharged immediately through the opening 56 upon the flat portion 42^a of the baffle ring 42 below the valve. By rotation of the valve 52 until the opening 52^a comes into alignment with the discharge opening 51^a, the opening 56 is moved to a position on top of the valve, and liquid entering the valve through the pipe 49 is discharged through the valve casing 52, the discharge

opening 51^a and pipe 50. It is thus readily apparent that the valves may be employed to discharge reflux outside of the system, or may be so operated as to discharge it within the system for further action therein.

The general operation of the column will be apparent from a consideration of Fig. 1. The material to be distilled, after passing through a preheater 58, in which it is heated by heat exchange with the residue issuing from the column, passes through valved pipe 16 into the unit 35 of the column, which is arranged at an intermediate point thereof, preferably approximately where the descending reflux in the balanced column has the composition of the infed material as regards volatile constituents. The infed material descends through the distilling units 14 to the heater 11 in countercurrent to the rising vapors. Steam is fed into the heater through the pipe 12 and condensed water and used steam are drawn off through the pipe 59. Residue is drawn off through pipe 60 and forced by pump 61 to the preheater 58. The vapors rising in the column pass upwardly through the distilling units 14, the stripping units 15 and the condenser units 17, in which both condensation and rectification takes place. In these various units the baffles form a circuitous vapor and reflux passage, through which they travel without substantial obstruction. There is a collection of reflux in each of the condenser units, and reflux of the desired composition may be drawn off through any one of the valve discharge cocks 50^a, passing through the selected discharge pipes 62 and 63 to receiving boxes 64, test boxes 65 and into the receiving tank 66. Vapors uncondensed in the column pass out from the dome 67 through the vapor line 67^a to a condenser 68, from which vapors and condensed liquids pass into receiving tank 69. From the latter a vapor line 70 leads to the vacuum pump 71, which is provided with a suitable control valve 72 for control of the vacuum produced. The cooling medium for the condenser, which may be water or brine or any other suitable material, enters the uppermost condenser unit through pipe 18, passes from one unit to another in succession through the pipes 19 after traveling through the coils in each unit, and makes its exit through the pipe 20 provided with control valve 21. Temperature conditions within the column are controlled from an intermediate point 73 (the thermal center), the temperature of which, when the column is in operation, is substantially intermediate the temperature at the heater unit and that at the vapor exit of the column. Thus, with a column operating upon a beer or fermented wort for the removal of a high grade alcohol of about 198 proof at a vapor pressure of about 75 mm., the temperature just above the heater may be about 60° C.,

that at the condenser unit from which the alcohol is removed about 37° C., and that at the point from which the still is controlled about 48.5° C. From this point in the column, one control line 74 is brought for the control of the valve 13 on the pipe 12 supplying steam to the heater and another control line 75 is brought for the control of the valve 21 on the exit pipe 20 for the cooling medium from the condensers.

The column is preferably operated under vacuum, which enables the production, in the case of materials such as alcohol which form constant boiling-point mixtures with water, of products of higher concentration than those normally procurable at atmospheric pressure. For example, in the case of alcohol by operating under pressures of 75 millimeters absolute or lower, alcohol of 198 to 199 proof may be readily secured. Pressure conditions at various points of the column are observed by means of a number of barometric indicators 76 supplied from a common mercury reservoir and controlled by lines 77 leading to various points in the column. The column is preferably operated with a maximum pressure difference from the heater to the top of the column of approximately one-half inch of mercury, although this may be varied, according to the condition and nature of the material being handled, and may in some cases reach as high as one inch.

Within the column in the distilling and stripping sections, the vapors are forced to travel a circuitous course by means of the baffle rings 25 and deflectors 30. The vapors are thereby forced to pass through the peripheral openings in the depending skirts 27 and 31, the descending reflux being in part guided downward by the skirts. The vanes formed in these skirts give the rising vapors a positive and vigorous rotary movement, acting in a manner analogous to the vanes of a turbine rotor. The vapors, whirled about in this manner, break up the particles of reflux into an exceedingly fine mist, thereby providing a very large surface for heat interchange. As a result of this action, a substantial heat equilibrium is maintained at all points in the column between reflux and rising vapors.

In the condenser units, the rising vapors are guided and positively rotated or whirled in a similar manner by the baffle rings 42, the collecting-deflector plates 45 and the vanes provided in the perforated skirts 41 and 46 depending respectively therefrom. In the condenser units it will be noted, that the rising whirling vapors first contact intimately with the surfaces of the cooling coils 38 surrounding the cylindrical skirt 41 depending from the baffle rings 42. Reflux given up by the vapors on contact with the condenser coils drop to the downwardly

pitched portion 45^a of the collecting deflector ring 45 and are guided by them in such a manner as to be broken up and intimately contacted with the rising vapors, and vaporized portions of this reflux pass upwardly with the vapors. Unvaporized portions pass downwardly and are guided by the baffle rings 42 into the inner portion of the skirt 41 depending therefrom. Here the reflux is broken up and intimately contacted with the vapors entering through the openings 43 after having been contacted with the condenser coils 38. In the cylindrical space within the skirt 41, unvaporized reflux is collected by the central collecting area 45^b of the collecting-deflector plate 45. The reflux passes through pipes 49 to the discharge valve 50^a, by which, in operation without draw-off, it is discharged directly upon the horizontal portion 42^a of the baffle ring 42, by which it is spread out, and together with reflux descending from the condensing coils of the condenser unit above, again acted upon by vapors in the manner already described. Where the reflux has the composition desired in the final product, the valve 50^a is so operated that the reflux is discharged through one of the pipes 62 and collected outside of the column. It will be clear from the above description that the reflux so drawn off from any given section is the reflux from the next higher section which has been subjected to the action of the cooled vapors of the sections from which the reflux is withdrawn, but is not intermixed with reflux resulting from the cooling action in the latter section.

In Fig. 6 there is shown in section a modified construction of the condenser units, in which the cooling and collecting portions are combined into a single unit. The units are designated by numeral 17^a. In each unit is a cooling coil 75^a connected with an inlet manifold 76^a and an outlet manifold 77^a, the coil being arranged to leave a central space, in which is disposed the skirt 78 depending from the inner rim of a baffle ring 79 secured to the wall of the unit. The skirt 78 is provided with openings 80 and inwardly directed vanes 81, as in the first form of construction described. Above the baffle ring 79 is mounted a collecting-deflector plate 82 having a central collecting portion 82^a and an outer downwardly pitched deflecting portion 82^b disposed below the coils of the next higher unit. The collecting-deflector plate 82 is supported by a skirt 83 which extends downwardly from its outer rim to the baffle plate 79 below and rests thereupon. The skirt 83 is provided with openings 84 and outwardly directed vanes 85 at the openings, as in the first described construction. The cooling medium passes from one coil 75^a to the next by pipes 19^a.

From the center of the collecting portion 82^a of the collecting-deflector plate 82 a pipe 86 is carried to and through the wall of the unit, terminating in a discharge cock 87. The reflux from the next higher section, after contact with vapors cooled by the cooling coils, collect in the collecting portion 82^a of plate 82, and, if discharged cock 87 is closed, overflows the plate and is broken up and whirled about by the vapors rising through the openings in the skirt 83. While on the plate 82 the reflux is subjected to the heating action of the vapors rising from below. When the discharge cock 87 is open the reflux collected passes to the exterior of the column.

I claim:

1. In combination, a distilling system including superimposed heating, distilling and condensing sections, providing a vapor passage therethrough, said sections constituting a column, means for feeding liquid into the column at an intermediate point in the distilling section, means for supplying a heating medium to the heating section, means for supplying a cooling medium for the condensing section, and means adapted to be actuated by the temperature at an intermediate point in the distilling section above the point of feed of fresh material, for controlling the supply of heating medium and the supply of cooling medium.

2. In combination, a distilling system including superimposed heating, distilling and condensing sections providing a vapor passage therethrough, said sections constituting a column, means for feeding liquid into the column at an intermediate point in the distilling section, means for supplying a heating medium to the heating section, means for supplying a cooling medium to the condensing section, and means adapted to be actuated by the temperature at an intermediate point in the distilling section for controlling the supply of heating medium and the supply of cooling medium.

3. A unitary column construction having superimposed heating, distilling, stripping and condensing sections, the condensing sections being made up of superimposed units, means in each condenser unit for collecting reflux from the next higher unit substantially free from reflux formed in the unit in which collection is made, means for supplying the collected reflux to the next lower condenser unit, and controllable means in connection with each condenser unit, for withdrawing the collected reflux therefrom.

4. A unitary column construction having superimposed heating, distilling, stripping and condensing sections providing a vapor passage therethrough, the condensing section being made up of superimposed units, each provided with means for collecting reflux from the next higher unit substantially

free from reflux formed in the unit in which collection is made, and means for supplying the collected reflux to the next lower condenser unit, controllable means in connection with each condenser unit for withdrawing collected reflux therefrom, means for feeding liquid into the column at an intermediate point in the distilling section, means for supplying a cooling medium to the condensing section, means for supplying a heating medium to the heating unit, and means adapted to be actuated by the temperature at an intermediate point in the distilling column for controlling the supply of heating medium to the heating section and of cooling medium to the condenser section.

5. In a condenser, a plurality of superimposed condenser units forming a unitary construction, means in each unit for collecting reflux delivered by the next unit above substantially free from reflux formed in the unit in which collection is made and for discharging reflux into the next unit below, said means being controllable to discharge said reflux outside of the condenser.

6. A vertical condenser having a plurality of substantially horizontal reflux collecting planes and vapor cooling means between said planes, means for delivering reflux from each of said planes to the next lower plane and means for segregating the reflux so delivered at each plane from reflux delivered thereto from the cooling means above it.

7. In a condenser, a plurality of superimposed condenser units forming a unitary construction, means in each unit for collecting reflux delivered by the next section above substantially free from reflux formed in the unit in which collection is made and for contacting said reflux with vapor before its collection, and means for discharging the collected reflux into the next section below.

8. In a condenser, superimposed condenser units forming a unitary construction, means in each unit for collecting reflux delivered by the next section above substantially free from reflux formed in the unit itself, and means for discharging the collected reflux into the next section below.

9. In a condenser construction, superimposed units forming a unitary construction, means in each unit for collecting reflux delivered by the next section above substantially free from reflux formed in the unit itself and means for discharging the collected reflux into the next section below, said means being controllable to discharge said reflux outside of the condenser.

10. In a condenser, superimposed units

forming a unitary construction having a substantially free vapor passage there-through, cooling means in each unit, means for delivering reflux condensed by said cooling means in each unit to the next lower unit and collecting it therein substantially free from reflux formed in said next lower unit, said means providing for exerting the heating effect of vapors rising from below upon the collected reflux, and means for delivering the collected reflux to the next lower unit.

11. In a vertical condenser unit, a baffle ring extending from the wall of the unit inwardly through an open central space, a cylindrical skirt depending from the inner rim of said ring, peripheral openings in said skirt, vanes at each of said openings for imparting rotary movement to vapors passing therethrough, and cooling coils surrounding the cylindrical skirt and below the baffle ring.

12. In a vertical condenser unit, coils disposed to leave a central space, a baffle ring above the coils extending from the wall of the unit over the condenser coils, a centrally disposed plate below the coils and having a central collecting portion, and means for guiding reflux from the baffle rings to the central collecting portion of the central plate and preventing condensate formed below said baffle rings from passing into said collecting portion and for intimately contacting vapor therewith.

13. In a vertical condenser construction, a unit having a central deflector plate providing an open space between its outer rim and the wall of the unit, a cylindrical skirt depending from the outer rim of said deflector plate, said cylindrical skirt being provided with peripheral openings and vanes at each of said openings for imparting rotary movement to vapors passing therethrough, and cooling coils positioned above said deflector plate.

14. In a vertical condenser construction, a unit having a central deflector plate, an open space between its outer rim and the wall of the unit, said deflector plate having a central collecting portion, a cylindrical skirt depending from the outer rim of said deflector plate, said cylindrical skirt being provided with peripheral openings and vanes at each of said openings for imparting rotary movement to vapors passing therethrough, a cooling coil above the deflector plate, and means for guiding reflux from above to the central collecting portion of the deflector plate.

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