

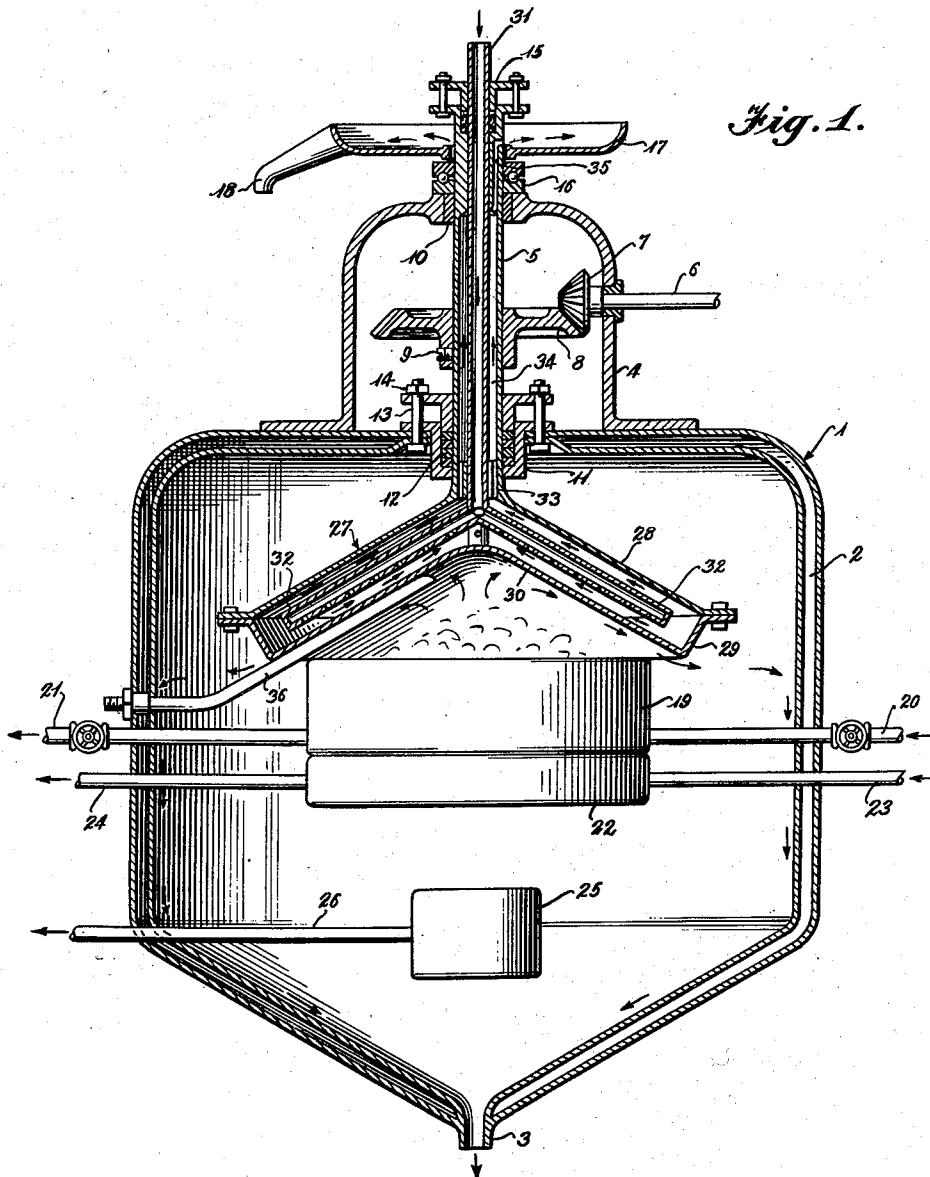
Jan. 16, 1951

B. H. THURMAN
DISTILLATION APPARATUS

2,538,540

Filed June 22, 1944

3 Sheets-Sheet 1



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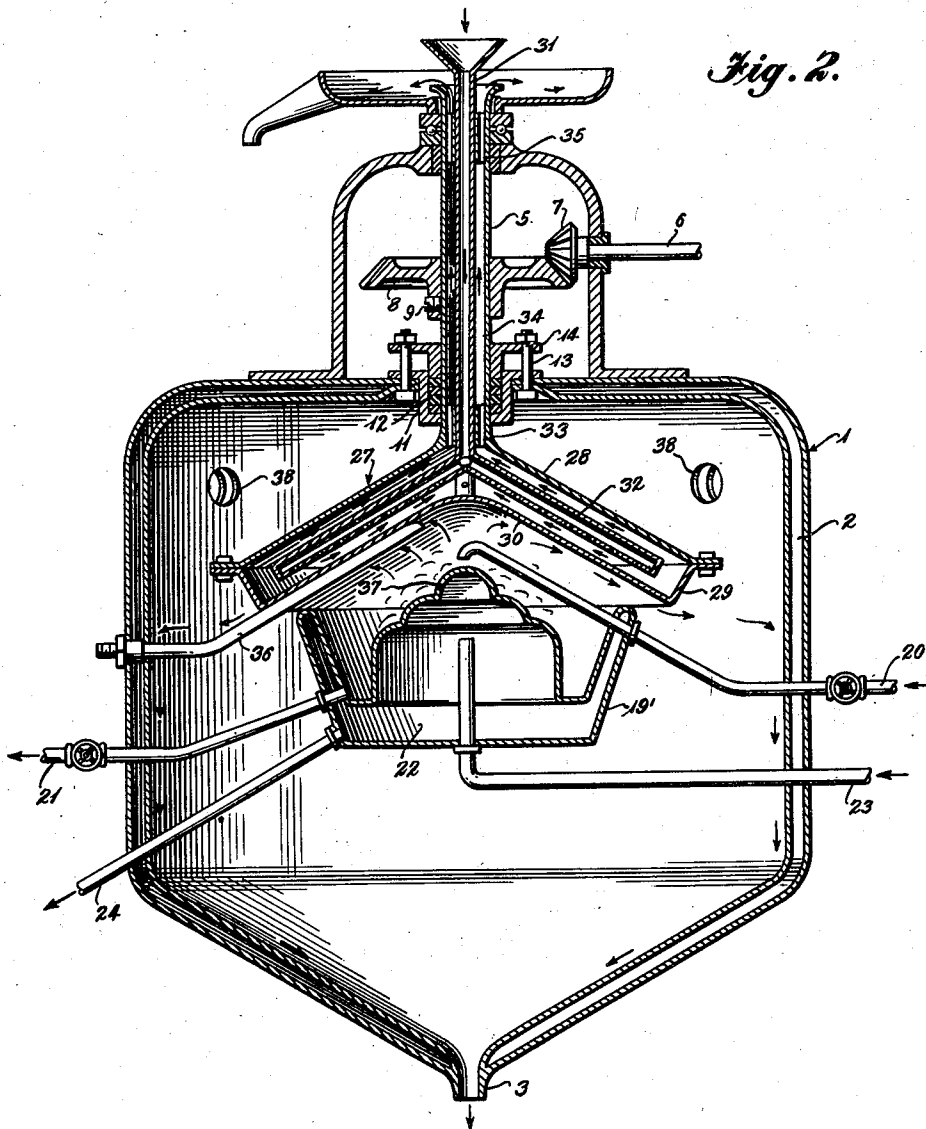
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Fig. 3.

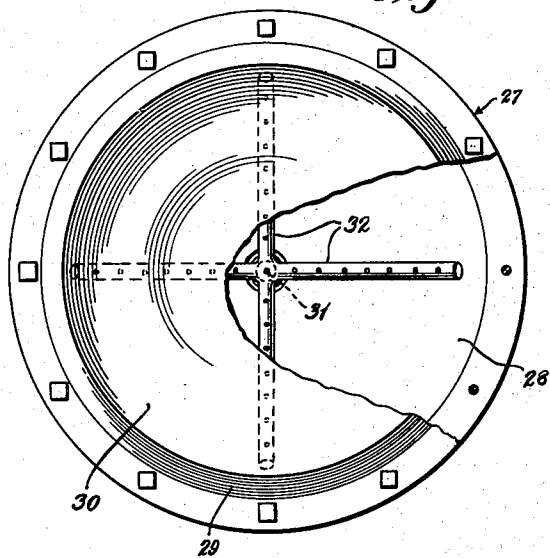


Fig. 4.

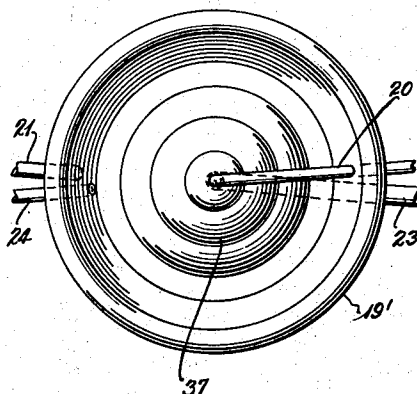
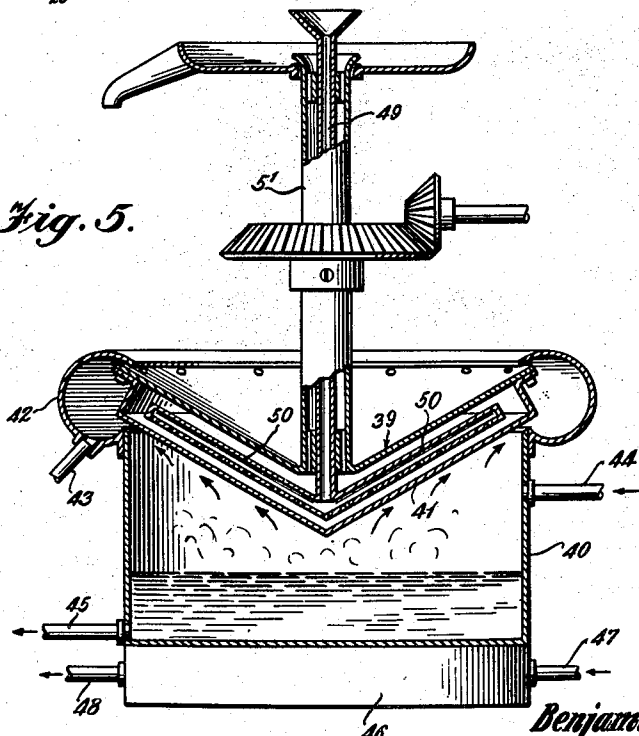


Fig. 5.



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DISTILLATION APPARATUS

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3 Claims. (Cl. 202—187)

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This invention relates to distillation apparatus and more particularly has reference to distillatory systems in which there is provided the shortest possible path for the vapors from the vaporizing surface to the condensing surface.

It is an object of my invention to provide, in close proximity to a vaporizer, an efficient condensing unit affording a large condensing surface from which condensate is continually discharged without appreciable refluxing to the vaporizer, whereby to improve the distilling operation.

A further object of the invention resides in the provision of a rotary internally cooled condensing unit of the character indicated, constructed to confine the cooling medium and prevent admixture of any portion of the latter with the vapors being condensed or the material being distilled.

Other objects and advantages of the invention will appear from the more detailed description thereof in connection with the accompanying drawings wherein:

Figure 1 is a vertical sectional view of one form of distilling apparatus embodying the features of the invention;

Figure 2 is a vertical sectional view of another modification of the distilling apparatus;

Figure 3 is an inverted plan view of the condensing unit of Figures 1 and 2 with a portion of the bottom plate broken away to show the perforated radial pipes for supplying refrigerant;

Figure 4 is a plan view of the vaporizing element of Figure 2; and

Figure 5 is a vertical sectional view of a further modification of the distillation apparatus.

Referring more particularly to Figure 1, the distillation apparatus comprises an outer cylindrical shell or vessel 1 which, in the case illustrated, is jacketed for heating or cooling as indicated at 2, and is provided with a bottom drain or outlet pipe 3 for condensate. Secured to top of shell or casing 1 in any suitable manner is a supporting bracket 4 for the hollow rotary sleeve or shaft 5, the latter being actuated from drive shaft 6 through beveled pinion 7 and beveled gear 8 secured to shaft 5 by set screw 9. The hollow shaft 5 rotates in bushing 10 and a stuffing box 11, having packing material 12, secured to the top of shell 1 by means of bolts 13 and nuts 14. A similar stuffing box 15 is provided at the top of shaft 5 and a thrust bearing 16 is disposed between the top of bracket 4 and a stationary collecting pan 17 having discharge spout 18.

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Mounted within shell 1 in any suitable manner is a cylindrical evaporating pan or vaporizing receptacle 19 open at its top and having a valved inlet pipe 20 for the introduction of distilland or liquid to be distilled and a valved discharge pipe 21 for the removal of the distillation residue. The evaporating pan 19 is heated in any suitable manner such as by means of heating chamber 22 to which steam or other heating medium is supplied through pipe 23 and withdrawn through pipe 24. When the apparatus is employed for vacuum distillation, the vacuum pump 25, having discharge line 26, is preferably placed within shell 1 to provide short path evacuation.

Secured to hollow shaft or sleeve 5, for rotation therewith, is a circular cooling chamber indicated generally by the numeral 27. In the case illustrated, this rotary cooling chamber comprises a conical or inverted funnel-shaped top plate 28 integral with sleeve 5 and to which is attached, as shown, the upturned edge 29 of the conical bottom plate 30 constituting the condensing surface. As shown in the drawing, the marginal edge of conical cooling chamber 27 preferably extends beyond the vertical cylindrical wall of evaporator 19 to insure the discharge of condensate from condensing surface 30 beyond the confines of the evaporator and thereby minimizes refluxing of condensate to the latter. Also, the rotary cooling element is preferably spaced from the top of the evaporator only a sufficient distance as will permit such discharge of condensate. It will also be apparent that the conical shape of the plate 30 provides a vapor collecting dome above the evaporating pan 19.

For cooling bottom plate or condensing surface 30, an inlet pipe 31 for refrigerant extends through packing gland 15 and hollow shaft 5 into the cooling chamber where it communicates with perforated radial extension pipes 32. Pipe 31 and extensions 32 may be either stationary or rotatable with shaft 5 and chamber 27. The cooling medium introduced through pipe 31 and its perforated extensions 32 circulates over the top of condensing plate 30 and through chamber 27, discharging from the latter through ports 33 into space 34 between shaft 5 and pipe 31 and then through ports 35 into collecting pan 17. The cooling medium is withdrawn from pan 17 through spout 18 and may be again cooled and recirculated to pipe 31 by means not shown. The refrigerant may be any suitable cooling fluid but the closed chamber 27 is particularly advantageous for the use of low boiling liquids, such as water, inasmuch as it prevents admixture of va-

ports of the cooling medium with vapors evolved from the material being distilled. In the case of cooling liquids which do not vaporize under the prevailing conditions, the closed cooling chamber prevents commingling of refrigerant with the condensate and distillation residue.

For the removal from condensing surface 30 of solids or liquids too viscous to flow or be thrown therefrom by centrifugal force, there is provided a stationary scraper element 36 in close proximity to the condensing surface and secured to shell 1 as shown.

The operation of the apparatus is apparent from the foregoing description. The vapors evolved in the vaporizer 19 immediately contact the cooled condensing surface 30 where they are condensed and the condensate thrown outwardly of the evaporator into shell 1 by the centrifugal force of the rotating cooling element, the condensate being withdrawn from the shell through bottom outlet 3. The discharge of condensate from the condensing unit is facilitated by the conical shape of the condensing surface 30. The condensation is thus effected at or near the surface of the liquid being distilled and since the condensate is continuously discharged from the revolving condenser, there is at all times provided a fresh clean condensing surface, thereby eliminating the condensate film usually present on the ordinary stationary condenser. The distillation is further aided by reason of the fact that there is no appreciable refluxing of the condensate from the condensing surface into the vaporizer. A particularly advantageous feature of the invention is the closed cooling chamber 27 which prevents admixture of cooling medium with the vapors or material undergoing distillation. Since the condensate is thrown against the walls of vessel 1 and further cooling and condensation effected by jacket 2, it is possible to place vacuum pump 25 inside the outer shell, thus affording short path evacuation. It is well known that friction on vapors to an evacuator varies directly as the length of the conduit to the evacuator and inversely as the cross-section of the conduit. By the arrangement shown, this frictional resistance is greatly minimized and molecular distillation thus made possible.

The apparatus of Figures 2 and 4 is especially designed for molecular distillation inasmuch as it provides for filming of the liquid to be distilled. In this modification, the vaporizing element 19' has a cascade surface 37 over which the distilland is filmed; the vapor path between this vaporizing surface and the condensing surface being so short that difficultly distillable substances can be successfully treated in the apparatus. Ports 38, leading to suitable vacuum apparatus, are provided in the outer shell near the revolving cooling element to allow a short path of evacuation above the condenser. The remaining elements of Figure 2 are similar to the corresponding parts in Figure 1 and are indicated by like reference numerals.

A still further modification of the invention is shown in Figure 5. This simplified apparatus is suitable for distillation under atmospheric pressure. In the modification of Figure 5, the revolving cooling chamber 39, rotated from hollow shaft 5', is funnel-shaped and is disposed in the upper portion of cylindrical open kettle or vaporizing vessel 40. Condensing surface 41 of cooler 39 terminates in a collecting compartment or trough 42 around the upper periphery of vaporizer 40, the condensate being discharged by centrifugal force from the condensing surface into

compartment 42 from which the condensate is withdrawn through pipe 43. The distilland is supplied through pipe 44 and the distillation residue removed through pipe 45. The distillation heat is supplied by heating chamber 46 to which steam or other heating medium is introduced by pipe 47 and withdrawn through pipe 48. The cooling medium for revolving condensing chamber 39 and condensing surface 41 is supplied through pipe 49 and its perforated radial extensions 50.

The apparatus of this invention can be applied to the treatment of any vaporizable substance, including the sublimation of solids. In addition to molecular distillation, it can be employed in the evaporation of soap lyes in the glycerine industry and in distillations and sublimations not requiring vacuum enclosure, such as in the manufacture of varnishes and paints where volatile substances are removed during the heat bodying of oils and gums. In such heat bodying treatment, the revolving condenser prevents refluxing and raising the acidity of the heat-bodied oils, keeping the latter lighter in color and lower in acidity. Other uses of my invention will be apparent to those skilled in the art.

I claim:

1. Distillation apparatus, comprising: an evaporating pan for vaporizing a material to be distilled; an imperforate hollow rotatable condensing element having a concave conical vapor condensing surface overlying said evaporating pan and forming a vapor collecting dome over said evaporating pan, said condensing surface having a region thereof positioned in close proximity to the rim of said evaporating pan to provide a short path for the vapor to said condensing surface, said condensing surface also extending radially beyond the rim of said evaporating pan to throw off condensate from the interior of said dome into a region disposed outwardly of said evaporating pan; means for introducing a cooling medium into said hollow condensing element from a zone out of contact with said vapor for circulation through said condensing element to cool said condensing surface and for discharging the spent cooling medium from said hollow condensing element in a similar zone, whereby to avoid admixture of the cooling medium with either the vapor being condensed or the material being distilled; means for rotating said hollow condensing element; and means for scraping condensed solid material from said condensing surface as it is being rotated.

2. Distillation apparatus, comprising: a casing providing a distillation chamber; an evaporating pan in said casing for vaporizing a material to be distilled; a hollow rotatable condensing element positioned in said casing and having an inverted funnel-shaped vapor condensing surface forming a vapor collecting dome over said evaporating pan, said condensing surface having a region thereof positioned in close proximity to the rim of said evaporating pan to provide a short path for the vapor to said condensing surface, said condensing surface also extending radially beyond the rim of said evaporating pan to throw off condensate from the interior of said dome into a region disposed outwardly of said rim of said evaporating pan; means for introducing a cooling medium into said hollow condensing element from exteriorly of said casing for circulation through said condensing element to cool said condensing surface and for discharging the spent cooling medium from said hollow condensing ele-

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ment exteriorly of said casing, whereby to prevent admixture of the cooling medium with either the vapor being condensed or the material being distilled; and means for rotating said hollow condensing element to remove condensed material from said condensing surface by centrifugal force.

3. Distillation apparatus, comprising: a casing providing a distillation chamber; means in said casing for vaporizing a material to be distilled; a hollow rotatable condensing element positioned in said casing and including vertically spaced top and bottom conical walls with a marginal side wall therebetween, the outer surface of said bottom wall providing a condensing surface for contact with said vapor; a hollow rotatable, vertical shaft connected with said condensing element and having an end extending to the exterior of said casing through a wall of said casing; sealing means between said wall and said shaft to seal said casing from the atmosphere; a pipe in said shaft having its upper end outside said casing and having its lower end extending into said condensing element and providing an inlet passage for a cooling medium; a plurality of perforated extensions extending from said pipe into the space between said conical walls and serving to distribute the cooling medium in said condensing

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element, said shaft having a discharge passage for the cooling medium surrounding said pipe and communicating at its lower end with the interior of said condensing element and having its upper end arranged externally of said casing, said condensing surface being concentric with said shaft; and means for rotating said shaft to rotate said condensing element to remove condensed material from said condensing surface by centrifugal force.

BENJAMIN H. THURMAN.

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