

Nov. 30, 1948.

K. C. D. HICKMAN

2,455,059

VACUUM UNOBSTRUCTED PATH DISTILLATION APPARATUS

Filed April 5, 1945

FIG. 1.

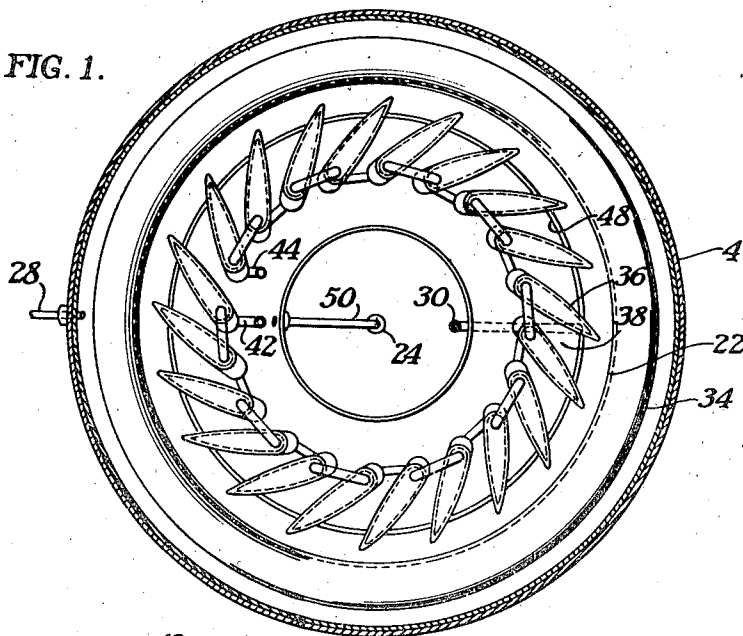


FIG. 2.

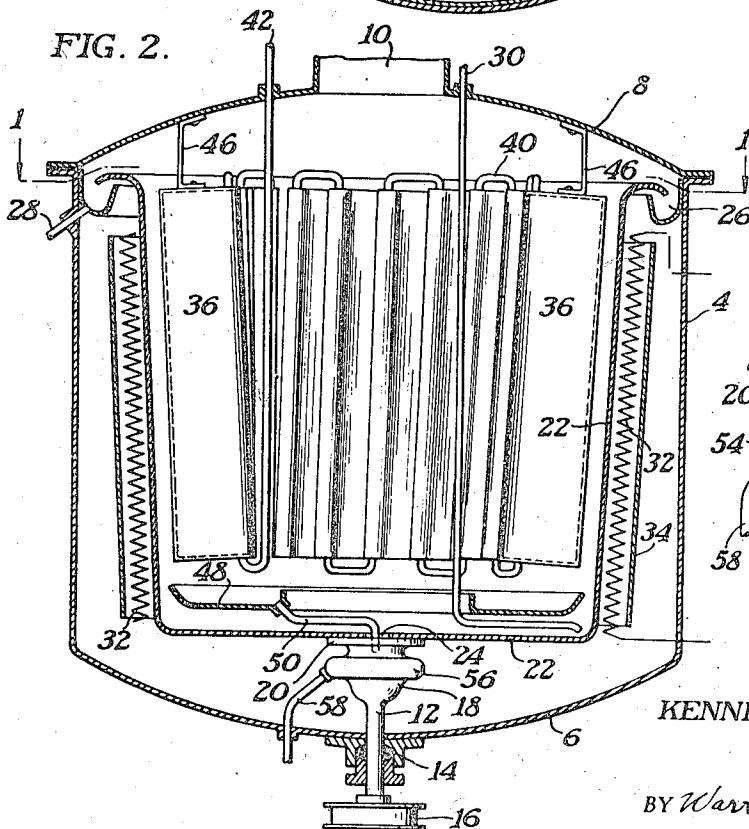
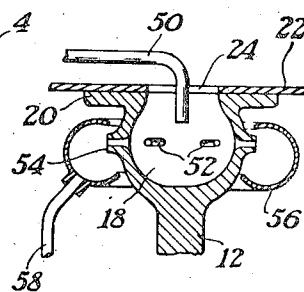


FIG. 3.



KENNETH C. D. HICKMAN
INVENTOR

BY *Warren H. Cannon*
ATTORNEY

UNITED STATES PATENT OFFICE

2,455,059

VACUUM UNOBSTRUCTED PATH
DISTILLATION APPARATUSKenneth C. D. Hickman, Rochester, N. Y., as-
signor to Distillation Products, Inc., Rochester,
N. Y., a corporation of Delaware

Application April 5, 1945, Serial No. 586,810

9 Claims. (Cl. 202—205)

1

This invention relates to improved vacuum distillation apparatus and, in particular, to vacuum unobstructed path distillation apparatus which is at least partially self-evacuating.

The invention has for its object to provide improved vacuum distillation apparatus, particularly of the unobstructed path distillation type in which the energy contained in the distilling vapors is utilized to assist in the removal of gases from the still. Another object is to provide improved high vacuum unobstructed path distillation apparatus of the centrifugal type. A still further object is to improve the state of the art. Other objects will appear hereinafter.

These and other objects are accomplished by my invention which includes apparatus wherein distilling vapors under vacuum conditions are caused to pass, with gases to be evacuated, into a Venturi-shaped passage where the vapors are condensed and from which passage gases are removed by evacuating pumps.

In the following description I have set forth preferred embodiments of my invention but it is to be understood these are given by way of illustration and not in limitation thereof.

In the accompanying drawings I have illustrated a preferred embodiment of my invention, wherein:

Fig. 1 is a horizontal section of a vacuum still having self-evacuating features and a rotatable vaporizing surface;

Fig. 2 is a vertical section of the apparatus illustrated in Fig. 1; and

Fig. 3 is a fragmentary vertical section of the liquid withdrawal means shown in Fig. 2.

Referring to Figs. 1, 2 and 3, numeral 4 designates a cylindrical still casing provided with an integral gas-tight base 6 and a removable gas-tight cover 8, which cover is provided with an evacuating conduit 10 which, during operation, is connected to the backing pumps (not shown). Numeral 12 designates a shaft which is rigidly housed in a packed gland and bearing 14 and which is provided at its lower end with a drive pulley 16. The upper end of shaft 12 is provided with a hollow portion 18 which terminates in an outwardly spread flange 20 which is integral with a vaporizing surface 22 which is in the form of a truncated cone. The central portion of 22 is provided with an opening 24 corresponding to the hollow portion 18 in shaft 12. The upper periphery of vaporizing surface 22 is flared outwardly and extends into an annular gutter 26 surrounding the outer periphery. Numeral 28 designates a conduit for withdrawing

2

liquid from gutter 26 and numeral 30 designates a conduit for introducing liquid to be distilled onto the inside lower surface of vaporizing surface 22. Numeral 32 indicates a heater for vaporizing plate 22 which is provided with a reflecting baffle 34, which serves to concentrate the heat onto vaporizing surface 22.

Numeral 36 indicates a plurality of hollow condensing lattices which have a streamlined shape and which are positioned inside the vaporizing cone 22 so that there is a converging space 38 between each pair of condensing lattices, the space converging as one passes from the vaporizing surface toward the axis of the apparatus. These condensing lattices are connected together as one integral unit by means of conduits 40 so that cooling liquid flows therethrough in sequence, being introduced into the first lattice of the series through conduit 42 and being withdrawn from the last lattice in the series through conduit 44. The condensing lattices are maintained in the position illustrated by supporting brackets 46. Numeral 48 designates an annular dish, or gutter, positioned below lattices 32 so the liquid draining therefrom falls into the gutter 48. Numeral 50 designates a withdrawal conduit through which liquid flows from gutter 48 and passes into the hollow portion 18 at the top part of shaft 12. Numeral 52 indicates a plurality of holes positioned in the portion of 18 which has the largest diameter, the holes being extended outwardly to form jets 54 which protrude into an annular gutter 56, which surrounds them. Gutter 56 is provided with a withdrawn conduit 58.

In operating the apparatus illustrated in the drawings, conduit 10 is connected to a source of vacuum, preferably high vacuum. Shaft 12 is caused to rotate by force applied to pulley 16. Heating element 32 is put into operation so as to heat vaporizing surface 22 to vaporizing temperature. Distilland, preferably in degassed condition, is introduced through conduit 30 onto the lower part of plate 22 and cooling fluid is introduced through conduit 42 and withdrawn through conduit 44. Liquid flowing from conduit 30 is caused to flow upwardly over the inside surface of 22 in the form of a thin film by centrifugal force. During this passage the thin film of liquid is heated to distillation temperature and vapors pass from the vaporizing surface 22 into the various converging or Venturi shaped passages between the pairs of lattices 36. The vapors have a high velocity and their predominanting directional component is toward the axis of

the still or, at least in the general direction of the condensing lattices. Gases in the space between the lattices and the vaporizing surface 22 are forced by numerous collisions into the converging space 38. The distilling vapors are condensed on the walls of the lattices but, since the vapors are continuously replenished or backed up by fresh vapors, gases forced into the Venturi space are thus prevented from returning. The pressure is, therefore, built up in the center of the apparatus and the gases which are thus pumped into the center of the apparatus are removed through conduit 10.

Condensed vapors on lattices 36 flow by gravity downward into gutter 48 and flow thence through conduit 50 into hollow 18 at the top of shaft 12. This liquid is then thrown by centrifugal force through openings 52 and nozzles 54 into gutter 56 and is then withdrawn from the still through conduit 58. Undistilled residue, i. e., liquid which is not vaporized during passage over vaporizing surface 22, is thrown by centrifugal force into annular gutter 26 and is removed from the still through withdrawal conduit 28.

The invention has the outstanding advantage that the energy of the distilling vapors, which is ordinarily wasted, is caused to materially assist in the evacuation of the still. In the specific construction shown centripetal force is caused to assist in this evacuation by positioning the lattices as shown and by rotating vaporizing surface 22 in a counter-clockwise direction. The velocity of rotation thus imparted to the vapors is utilized to cause them to pass with even higher velocity into the converging or Venturi spaces 38. While my invention finds its greatest utility in centrifugal distillation apparatus, it is in no way limited thereto and gravity flow distillation equipment can be used if desired. Thus, the apparatus illustrated could be modified to provide a stationary conical vaporizing surface similar to that illustrated, the liquid being introduced as a thin film at the top and undistilled residue being withdrawn from the bottom.

What I claim is:

1. Vacuum unobstructed path distillation apparatus comprising in combination a vaporizing surface over which distilland is caused to flow in a thin film, means for heating the vaporizing surface, means for introducing distilland onto the vaporizing surface, means for removing undistilled residue from the vaporizing surface, a plurality of condensing elements positioned opposite to the vaporizing surface and separated therefrom by substantially unobstructed space, the principal condensing surfaces of said elements converging with respect to each other, as the parts of the element farthest from the vaporizing surface are approached, means for cooling the condensing elements, means for removing condensate from the condensing elements and a conduit for evacuating gases from the space between the vaporizing surface and the condensing elements, which conduit is positioned so that gases passing therethrough must, to a large extent, first pass through the converging spaces between the condensing elements.

2. Vacuum unobstructed path distillation apparatus comprising in combination a vaporizing surface over which distilland is caused to flow in a thin film, means for heating the vaporizing surface, means for introducing distilland onto the vaporizing surface, means for removing undistilled residue from the vaporizing surface, a plurality of condensing elements positioned opposite

to the vaporizing surface and separated therefrom by substantially unobstructed space, which elements converge with respect to each other, as the parts of the element farthest from the vaporizing surface are approached, so as to form a plurality of Venturi jets, means for cooling the condensing elements, means for removing condensate from the condensing elements and a conduit for evacuating gases from the space between the vaporizing surface and the condensing elements, which conduit is positioned so that gases passing therethrough must, to a large extent, first pass through the converging spaces between the condensing elements.

3. Vacuum unobstructed path distillation apparatus comprising in combination a rotatable vaporizing surface over which distilland is caused to flow in a thin film by centrifugal force, means for heating the vaporizing surface, means for introducing distilland onto the vaporizing surface, means for removing undistilled residue from the vaporizing surface, a plurality of condensing elements positioned opposite to the vaporizing surface and separated therefrom by substantially unobstructed space, the principal condensing surfaces of said elements converging with respect to each other as the parts of the element farthest from the vaporizing surface are approached, means for cooling the condensing elements, means for removing condensate from the condensing elements and a conduit for evacuating gases from the space between the vaporizing surface and the condensing elements, which conduit is positioned so that gases passing therethrough must, to a large extent, first pass through the converging spaces between the condensing elements.

4. High vacuum unobstructed path distillation apparatus comprising in combination a rotatable, hollow vaporizing surface over the inside surface of which distilland is caused to flow in a thin film by centrifugal force, means for heating the vaporizing surface, means for introducing distilland onto the vaporizing surface, means for removing undistilled residue from the vaporizing surface, a plurality of condensing elements positioned within the vaporizing surface and separated therefrom by substantially unobstructed space, the principal condensing surfaces of said elements converging with respect to each other as the parts of the element farthest from the vaporizing surface are approached, means for cooling the condensing elements, means for removing condensate from the condensing elements and a conduit for evacuating gases from the space between the vaporizing surface and the condensing elements, which conduit is positioned so that gases passing therethrough must, to a large extent, first pass through the converging spaces between the condensing elements.

5. High vacuum unobstructed path distillation apparatus comprising in combination a rotatable vaporizing surface having the form of a truncated cone over the inside surface of which distilland is caused to flow in a thin film by centrifugal force, means for heating the vaporizing surface, means for introducing distilland onto the vaporizing surface, means for removing undistilled residue from the vaporizing surface, a plurality of condensing elements positioned inside and opposite to the vaporizing surface and separated therefrom by substantially unobstructed space, the principal condensing surfaces of said elements converging with respect to each other as the parts of the element farthest from the vaporizing surface are approached and thus cooperate to form a plurality

5

of Venturi jets, means for cooling the condensing elements, means for removing condensate from the condensing elements and a conduit for evacuating gases from the space between the vaporizing surface and the condensing elements, which conduit is positioned so that gases passing therethrough must, to a large extent, first pass through the converging spaces between the condensing elements.

6. High vacuum unobstructed path distillation apparatus comprising in combination a rotatable vaporizing surface having the form of a vertically positioned truncated cone, up the inclined inside walls of which distilland is caused to flow in a thin film by centrifugal force, means for heating the vaporizing surface, means for introducing distilland onto the inside of the vaporizing surface, means for removing undistilled residues from the vaporizing surface, a plurality of vertical, stream-lined condensing elements positioned inside the vaporizing surface and separated therefrom by substantially unobstructed space, which elements converge with respect to each other as the axis of the vaporizing surface is approached and thus cooperate to form a plurality of elongated Venturi jets, means for cooling the condensing elements, means for removing condensate from the condensing elements and a conduit for evacuating gases from the space between the vaporizing surface and the condensing elements, which conduit is positioned so that gases passing therethrough must, to a large extent, first pass through the converging spaces between the condensing elements.

7. Vacuum distillation apparatus comprising a closed vessel having therein an inwardly facing distilling surface over which distilland is caused to flow in a film, said distilling surface being disposed about a central space, a plurality of condensing elements also disposed about said central space in generally opposed relation to said distilling surface and being separated therefrom by substantially unobstructed space, the principal condensing surfaces of said condensing elements converging with respect to one another at the side remote from said distilling surface and forming therebetween passages of progressively decreasing size leading from the space between said distilling surface and said condensing elements to said central space, and exhaust means including an outlet port disposed adjacent said central space so that gases passing from the space between said distilling surface and said condensing elements to said outlet port must largely pass through said converging passages.

8. Vacuum distillation apparatus comprising a closed vessel having therein a rotatable vaporizing member comprising upstanding annular walls

6

providing an inwardly facing distilling surface over which distilland is caused to flow in a film, an annular condenser disposed inside said vaporizing member in opposed relation to said distilling surface and being separated therefrom by substantially unobstructed space, said condenser having therein a series of openings extending in a direction generally parallel to the principal axis of the annulus, said openings leading from the space between said distilling surface and said condenser to a central space within said annular condenser and having decreasing cross-sectional areas from the outside inward providing a series of Venturi-like passageways connecting said spaces, and exhaust means including an exhaust conduit arranged contiguous to said central space so that gases passing to said exhaust from the space between said distilling surface and said condenser must largely pass through said Venturi-like passageways with concomitant pumping effects.

9. Vacuum distillation apparatus comprising a closed vessel having therein a rotatable vaporizing member comprising upstanding annular walls providing an inwardly facing distilling surface over which distilland is caused to flow in a film, an annular condenser disposed inside said vaporizing member in opposed relation to said distilling surface and being separated therefrom by substantially unobstructed space, said condenser having therein a series of vertically-extending, slot-like openings leading from the space between said distilling surface and said condenser to a central space within said annular condenser, said openings having walls converging toward said central space and being directed at a substantial angle to the radii of the annulus whereby the velocity of rotation causes gases and vapors to tend to travel through said openings from the space between said distilling surface and said condenser to said central space with concomitant pumping effect, and exhaust means arranged to withdraw gases and vapors from said central space.

KENNETH C. D. HICKMAN.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
721,310	Junkers	Feb. 24, 1903
2,113,607	Upton	Apr. 12, 1938
2,234,166	Hickman	Mar. 11, 1941
2,343,668	Hickman	Mar. 7, 1944
2,421,371	Budlane	June 3, 1947

Certificate of Correction

Patent No. 2,455,059.

November 30, 1948.

KENNETH C. D. HICKMAN

It is hereby certified that errors appear in the printed specification of the above numbered patent requiring correction as follows:

Column 2, line 34, for the word "withdrawn" read *withdrawal*; column 3, line 15, for "butter" read *gutter*; column 5, line 18, for "residues" read *residue*; column 5, line 27, for "eyements" read *elements*;

and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 5th day of April, A. D. 1949.

[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.