E. F. PRENTISS & R. A. ROBERTSON.

APPARATUS FOR DISTILLING ROCK OIL AND OTHER HYDROCARBONS.

No. 41,858. Patented Mar. 8, 1864.

Fig: 5.

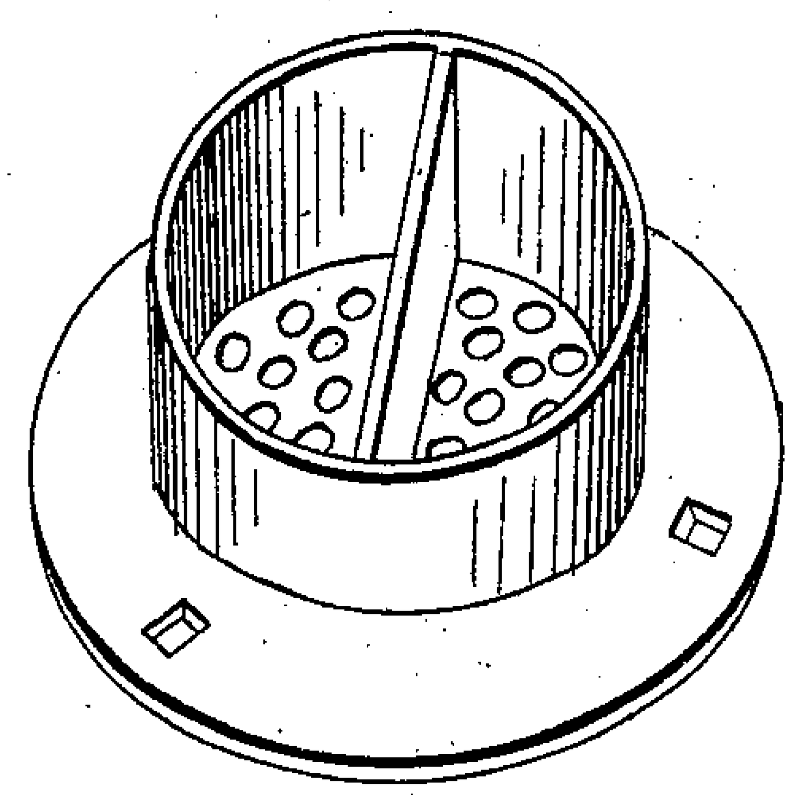
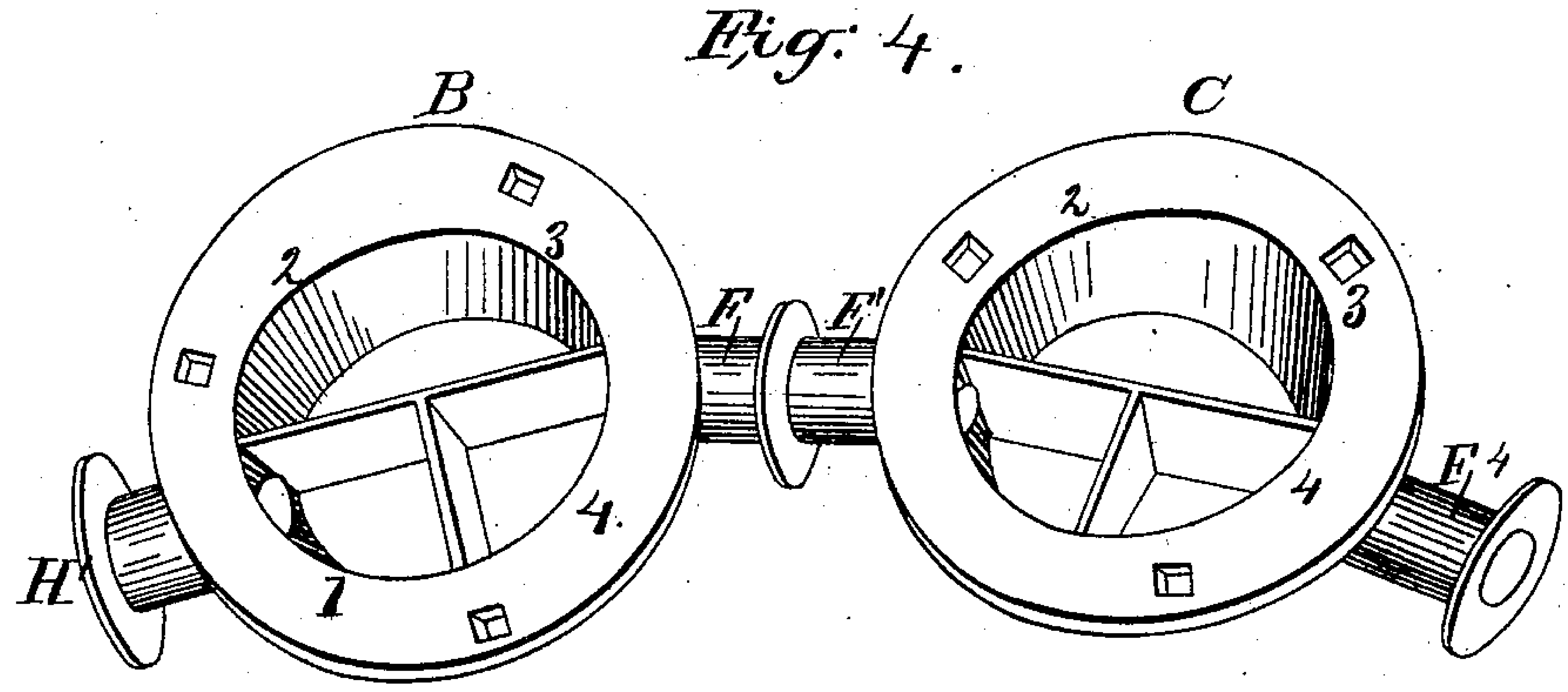


Fig: 4.



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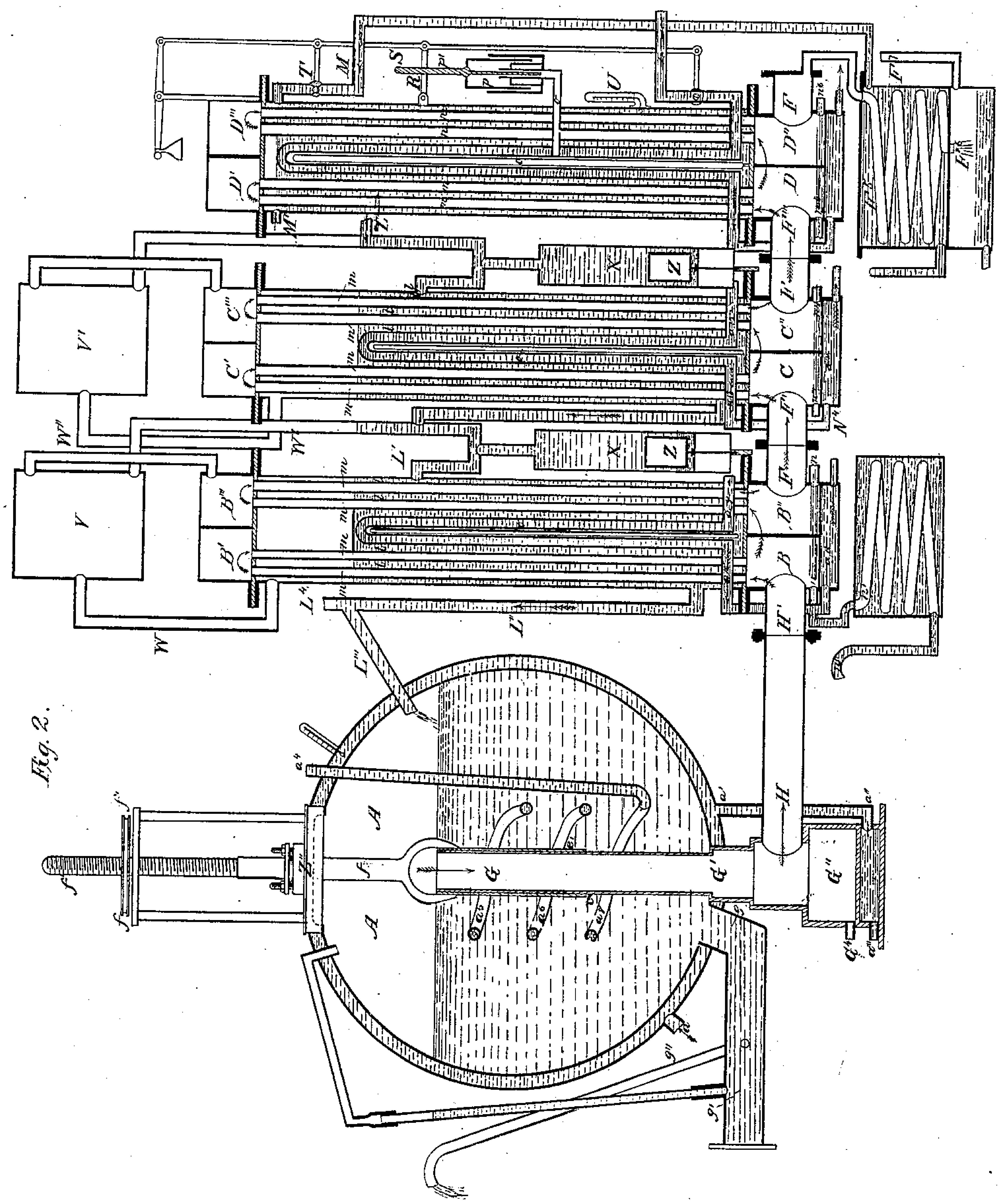

Fig. 2.

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Fig. 1.

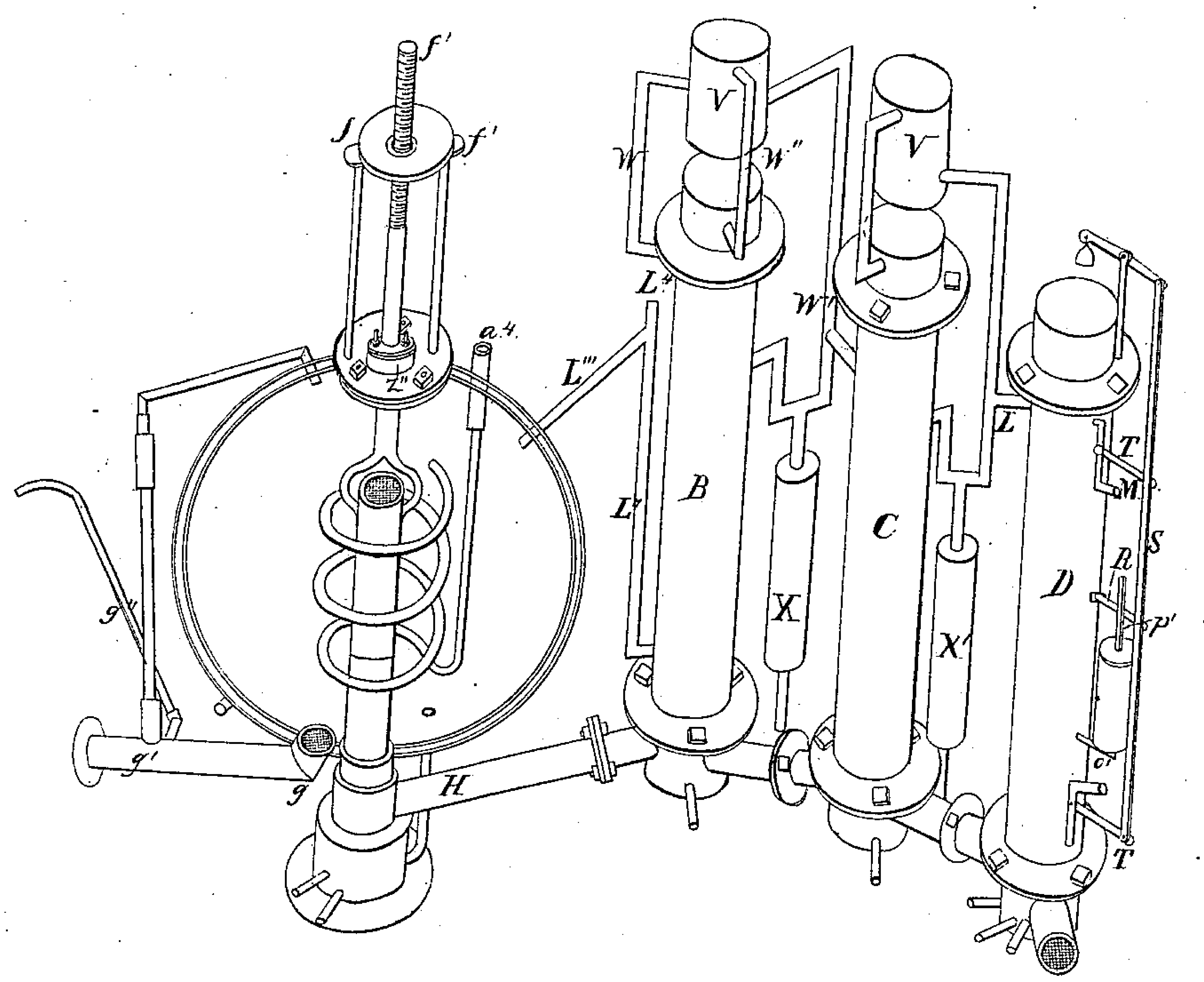
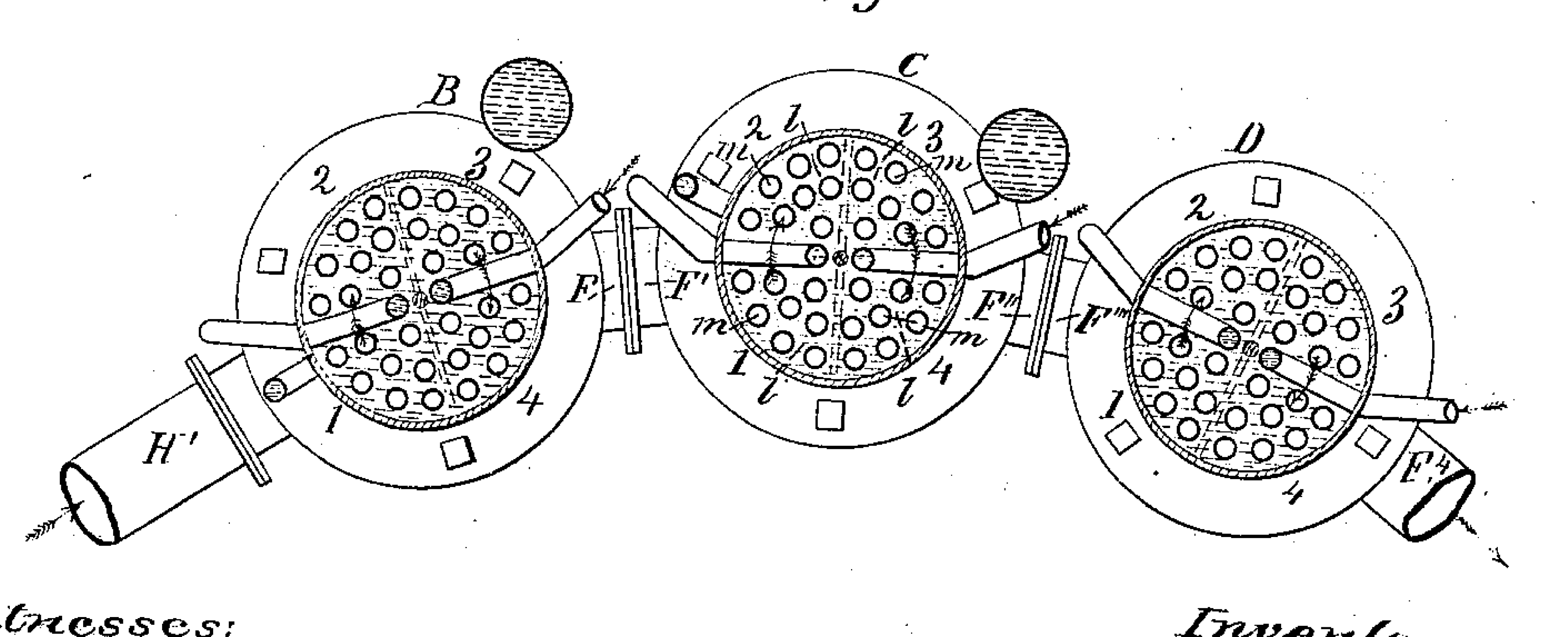


Fig. 3.



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UNITED STATES PATENT OFFICE.

ELIJAH FREEMAN PRENTISS, OF PHILADELPHIA, PENNSYLVANIA, AND ROBERT ADAM ROBERTSON, OF LIVERPOOL, ENGLAND.

IMPROVED APPARATUS FOR DISTILLING ROCK-OIL AND OTHER HYDROCARBONS.

Specification forming part of Letters Patent No. **41,858**, dated March 8, 1864.

To all whom it may concern:

Be it known that we, ELIJAH FREEMAN PRENTISS, now of the city of Philadelphia, and State of Pennsylvania, and ROBERT ADAM ROBERTSON, of Liverpool, England, have invented a new and useful Improvement in Apparatus for Distilling Rock-Oil, Well-Oil, or other Hydrocarbon Oils; and we do hereby declare the following to be a full and exact description of the same, reference being had to the annexed drawings, making a part of this specification, in which—

Figure 1 is a side view of our apparatus, (the globular still being cut away to show its internal arrangement;) Fig. 2, a vertical section through the entire apparatus supposed to be filled and in full operation; Fig. 3, a horizontal section corresponding to Fig. 2, and taken on the line 9 10 of Fig. 2, showing also in dotted lines the partitions dividing the chambers at the tops of the columns. Fig. 4 is a perspective view of the castings forming the bases of the different columns, showing the internal partitions for directing the currents of vapor into the proper quadrants; Fig. 5, a similar view of the castings forming the tops of the columns, showing the partition for directing the currents of vapor, said partition being at right angles with the longer partition of the bases.

Our improvement has for its object the obtaining of various classes of products by the distillation of crude well-oil, petroleum-oil, &c. By using the number of columns shown in the drawings, we produce these products—viz., first, lubricating-oil; second, burning-oil; third, a substitute for turpentine; fourth, benzine; and we obtain these results by the combination of a still with a series of condensing chambers or columns through which the vapors from the still are passed, the first column being set and maintained at a temperature proper for condensing the lubricating-oil—say, about 260° Fahrenheit to 400° Fahrenheit—the second being maintained at a temperature proper for condensing burning-oil—say, about 260° Fahrenheit—the third at a temperature proper for condensing the liquids fit to be substituted for turpentine—say, about 160° Fahrenheit—and, finally, the benzine and other condensable products of the vapor are condensed in a cold worm. We pass or feed the crude oil into the still through two of the series of condensing-columns, so that the oil operates as condensing-baths to the vapors. We have also secured a quiet ebullition in our still by roughening the surface of the injecting steam-coil, and we secure a uniformity in the several temperatures of the respective columns above mentioned by attaching to each an automatic expanding air regulator or thermostat, acting directly upon the supply of steam admitted into the heating-pipes of each of the condensing-chambers.

Similar letters of reference indicate corresponding parts in the several figures.

In the annexed drawings, A A′ represent the still; B B′ B″ B‴, the first condenser; C C′ C″ C‴, the second condenser, and D D′ D″ D‴ the third condenser.

We construct our still A A′ of cast-iron in a spherical form about eight feet in diameter, and surround it by a wrought-iron jacket, leaving a steam-space of about three inches. This spherical still is attached to a vertical tube, *e e′ e″ e‴*, which terminates in a vertical stem or rod, *f f′*, which has a screw cut upon its upper extremity. The vertical tube *e e′ e″ e‴* slides upon a hollow vertical column of cast-iron, G G′ G″, expanded at its base so as to make a hollow pedestal. This hollow column G G′ G″ forms a support for the spherical still and also a tube of escape for the vapors of the boiling crude oil which it contains, the vapors arising from the oil in the still following the directions of the arrows—that is, over the top of, into, and vertically down through G G′, thence through the cross-tubes H H′, thence it ascends through the vertical tubes in column B B′, its course being indicated by the white spaces and also by the arrows, as will be more fully described hereinafter.

By means of the sliding of the tube *e e′ e″ e‴*, to which the still A A′ is immediately attached upon the column G G′ G″, the relative position of the upper extremity of the tube G G′ G″ to the surface of the liquid can be changed through the medium of the nut *f f′* and the screws F F′. Any liquid oil which may accidentally froth over into G G′ G″ falls to the bottom of the column and escapes through the escape-pipe G^IV.

The oil is heated in the still A A′ by means of superheated steam introduced from an ordinary boiler and superheating apparatus into the steam-jacket *a* at a temperature of 700° to 800° Fahrenheit, and after circulating around the exterior of the still A A′ passes out and escapes by the passage *a′ a″ a‴*. The superheated steam is also introduced from the superheater directly into the contents of the still A A′ through the tube a^{IV}, which terminates in a spiral coil, a^{V} a^{VI} a^{VII}, having numerous small apertures. The spiral coil a^{V} a^{VI} a^{VII} is roughened on the exterior so as to form a multitude of small points, each being a point of ebullition, in order to disseminate the heat throughout the mass of the contents, and thus secure a quiet ebullition. There is an aperture or passage of escape for the heavy residuum which would remain in the still A A′. This passage of escape is shown at *g g′*, being a tube leading from the bottom of the still A′.

g″ is a movable tube attached to *g g′* so as to form a tap, shut when vertical, and usually kept open more or less. Through this the heavy greasy or tarry residuum escapes. By moving this tube *g″* to different elevations the grease can be drawn more or less freely. The fresh crude oil is constantly fed into the still through the tube L in the manner presently to be described.

The construction of the three condensing-columns, B B′ C C′ D D′, is as follows: Each column is composed of a cylinder of rolled copper about fifteen inches diameter and about eight feet high. The interior is filled with a series of tubes of copper about one inch in diameter—say about eighty-eight in number or twenty-two in each quadrant-space. These tubes are attached at the head and base to a perforated plate one-half inch thick. Immediately above and below each column there are chambers. (Shown at B′ and B‴, B and B″, C′ and C‴, C and C″, D′ and D‴, D and D″.) These chambers at the bottom serve for cross-passages between the extremities of the tubes. The tubes are so arranged that the vapor from the still A entering through the tube G G′ and the cross-tube H H′ into the chamber B will ascend in the tubes which are white or uncolored on one quarter of the circle, as shown by the arrow, to the top chamber, B‴, where it will pass across and descend through a corresponding set of tubes marked white.

Referring to Fig. 3, part B, which is the base of B B′, the course of vapor will be more distinctly shown. The vapor ascends through the tubes in quadrant marked 1 to the top chamber, where it passes across and descends through the quadrant marked 2 to the bottom chamber, where it descends through quadrant marked 3 to the top, and descends through quadrant marked 4, whence it passes on to the next column, C, passing through the tube F F′ into the chamber C, where it ascends and descends successively through the tubes marked white in the quadants of C, respectively marked 1, 2, 3, and 4, in the same manner in which it ascended and descended through the four quadrants of B. Thence it passes out of quadrant 4 of column C, through F″ F‴ into D, and here it ascends and descends successively through the tubes marked white in the quadrants marked 1, 2, 3, and 4, respectively, the same as described in reference to columns B and C; thence it passes out through F‴ into a common condensing-worm, F^{V}, and a tank, F^{VI}, whence the incondensable gases are led off through a safety-pipe, F^{VII}, to the top of the building.

The crude oil is brought into the still in the following manner: The pipe L is connected with a reservoir of crude oil. This pipe leads into the side of column C C′, and the oil fills the space *l l l* between the tubes *m* to the height shown, which space is colored green to indicate it being filled by the oil. The oil introduced into this space obviously surrounds and makes a bath for the vapor-tubes *m* (not colored) before described. After filling the space around the vapor-tubes in C C′ the crude oil passes across through L′ into the space around the vapor-tubes in B B′, and after surrounding and forming a bath for the vapor-tubes *m* in B B′, it passes thence through L″ L‴ into the still A. An auxillary mode of filling the still A at starting can be had through an auxillary attachment at L^{IV} direct with the reservoir of crude oil.

In the column D D′, instead of introducing crude oil into the space around the vapor-tubes, cold water is introduced from the tub inclosing the worm F^{V} to form a bath for the vapor-tubes (colored yellow in the drawings.) The water escapes through the waste-pipe M′.

The operation of the apparatus is as follows, viz: The still and first two columns being filled with crude oil to the levels shown in Fig. 2, and the third column being filled with water, superheated steam is admitted within the outside jacket of the still A at *a*, and also through the steam-tubes of the different columns, until they attain the different degrees of heat at which the columns are to be set when the regulating apparatus attached to each column is put in gear. Then superheated steam is injected into the still through a^{IV} a^{VII} a^{VI} a^{V}. The vapor driven off by the heat so obtained rises above and passes through G G′ and H H′ into and through the vapor-tubes *m* of the column B B‴. The vapor, in passing through these vapor-tubes of B B‴, is partially condensed by the crude-oil bath (marked green) which surrounds them. This crude oil in B B‴ is maintained at any desired temperature—say 400° Fahrenheit—and the liquid condensed at that temperature falls down the tubes into the chambers at the bottom of the column, and may be separately drawn off through three separate worms, one worm for each compartment of said chamber, or, as shown by the drawings, through one worm at *n*, and finally is received into a tank at *n″* in the form of a marketable lubricating-oil. The worm n'' is formed as shown, having its delivery end raised outside of the worm-tub a little above the surface of the cold water, to prevent anything but oil from passing. The vapor, which is not condensable at the heat that the column is fixed at, passes on through F F′ to and through the vapor-tubes in column C C′, where it encounters the bath of crude oil in the green spaces at a temperature of 300° Fahrenheit, or such other degree of heat as may be desired, and the liquid condensed at this temperature descends through the vapor-tubes into the bottom of C C‴, whence it passes off through N‴ into a worm or worms similar to that under the column B B‴, and is drawn off in the form of burning-oil at N^{IV}, fit for market. The vapor, which is not condensed at the last-named temperature—viz., 260°—passes on through F″ F‴ to the vapor-tubes in column D D‴, which are surrounded with water, (shown yellow,) maintained at any desired temperature—say 160°. The liquid condensed at that temperature descends into the chambers at the bottom of column D D‴, when it passes off through n^{V} and n^{VI} into a cooling-worm or worms similar to that under the column B B‴, and is then drawn off in the form that we call "turps" or a substitute for turpentine. The vapor which is not condensable at 160° passes out at F^{VI} into another worm, F, in which it is surrounded with cold water, and thus condensed and drawn off at F^{VI} in the form of benzine. Any remaining incondensable vapor passes off through a waste-pipe, F^{VII}.

The regulation of the temperature in the respective columns is effected by means of a sealed air-tube, O, (colored red,) which connects by a cross-tube, O′, with a small inverted cup, P, resting on a mercury bath and attached by a stem, P′, to the lever R, which lever raises and lowers the rod S, which rod S works the throttle T, which admits the cold water, and the throttle T′, which admits steam to the column D D‴. When the heat in the column D D‴ rises above 160°, the air in O, expanding, is forced into the interior of the inverted cup P and elevates it, carrying up the lever R and the rod S, thereby throttling the steam at T′ and opening the cold-water supply at T, and the cap P descends and reverses the action at T′ and T, respectively, whenever the air in O falls to a temperature lower than 160°. The degree of heat is ascertained in the first instance from a thermometer inserted into the column, as at U, Fig. 2, a separate thermometer being inserted in each of the oil-columns for a similar purpose. The temperature of 360° in B B‴ and of 260° in C C‴ is maintained by a similar apparatus operating on the crude oil to be admitted on the one hand and upon the steam on the other hand in like manner, as is above described for D D‴.

We have attached to the top of the two columns B B‴ and C C‴ auxiliary chambers V V′, the use of which is to separate any oil which may be carried up by the vapor from the boiling-spaces, (shown colorless) at the top of the columns. Thus if the vapors and oil together ascend through W into the chamber V, the oil falls to the bottom of V and finds its way back into the crude oil through the tube W′. The vapors ascend to the top of V and pass off through W″ into the head of the column B B‴, and mix with the vapors passing into the column C C‴. A similar arrangement is attached to the top of C C‴ for a similar purpose. There is a portion of condensed steam or water which finds its way along with the vapor into B B‴ and into C C‴. A small portion of this steam is condensed in the chambers V and V′, and the water forms and collects in the water-legs X and X′, and escapes from the bottom of these water-legs through taps Y and Y′. These taps are opened and closed by floats Z and Z′, which rise in water and fall in oil; hence, when there is any water there, they float and open the tap, and when it is gone the floats fall and shut the taps. The bottom of the main hollow stand, in which the still A rests, is heated by means of steam introduced through the passage a' a'' into a'''. A similar arrangement of steam-passage a^{IX} a^{X} a^{XI} maintains the temperature in B B‴, and in the chamber at the bottom of B B‴, and so of the column C C‴ by the steam-passage a^{XII}, a^{XIII}, and a^{XIV}.

The number of columns B B‴, C C‴, and D D‴ may be increased to any extent, each column being set and maintained at a different temperature, and separating a distinct product, effecting, in fact, a continuous fractional distillation.

Having thus described our improvement, what we claim as our invention, and desire to secure by Letters Patent, is—

1. The combination of the still A, the injecting-worm a^{IV} a^{V} a^{VI} a^{VII} and the central tube, G G′ G″.

2. Roughening the surface of the injecting-worm or tube a^{V} a^{VI} a^{VII} to render the ebullition regular and quiet.

3. The combination of the still A with the series of columns, three or more, each column being set and maintained at the temperature necessary to separate the product condensable at such temperature, whereby at one continuous operation the crude oil is separated into the various products due to condensation at the different temperatures fixed upon.

4. The arrangement of the vapor-tubes and oil-spaces in columns B B‴ or C C‴, whereby the crude oil on its way to supply the still A is made to act as a condensing-bath to the vapors in these columns coming from the still A.

5. The arrangement of the columns B B‴ and C C‴ in combination with the still A and the movable exit-tube g'', whereby the operation of the still is rendered continuous.

6. The air-regulator or its equivalent, for regulating the temperature of the respective columns, or either of them, in combination with the pipes of supply of the heating and cooling media.

7. The water-legs X, and the floats Z, for regulating the escape of water from the columns.

8. The auxiliary heads V V', for enabling the oil bath in each column to act as a still.

9. The warming of the bottoms of the chambers, which are at the bases of the columns, by means of steam-chambers arranged and operating as shown above.

10. The warming of the bottom of the column on which the still A is supported, substantially as above described.

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