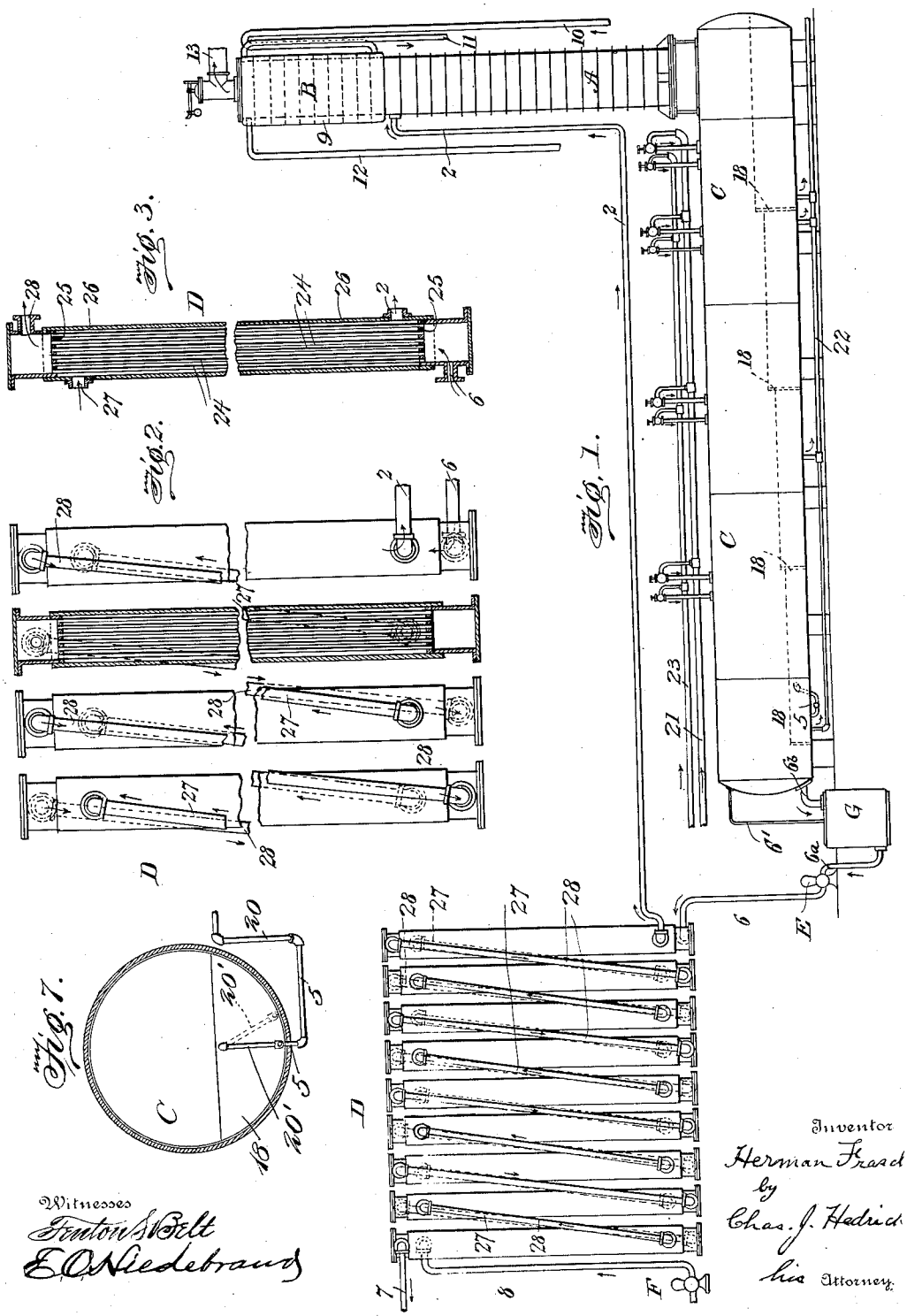
No. 845,735. PATENTED FEB. 26, 1907.

H. FRASCH.

STEAM STILL FOR PETROLEUM.

APPLICATION FILED AUG. 20, 1902. 2 SHEETS—SHEET 1.



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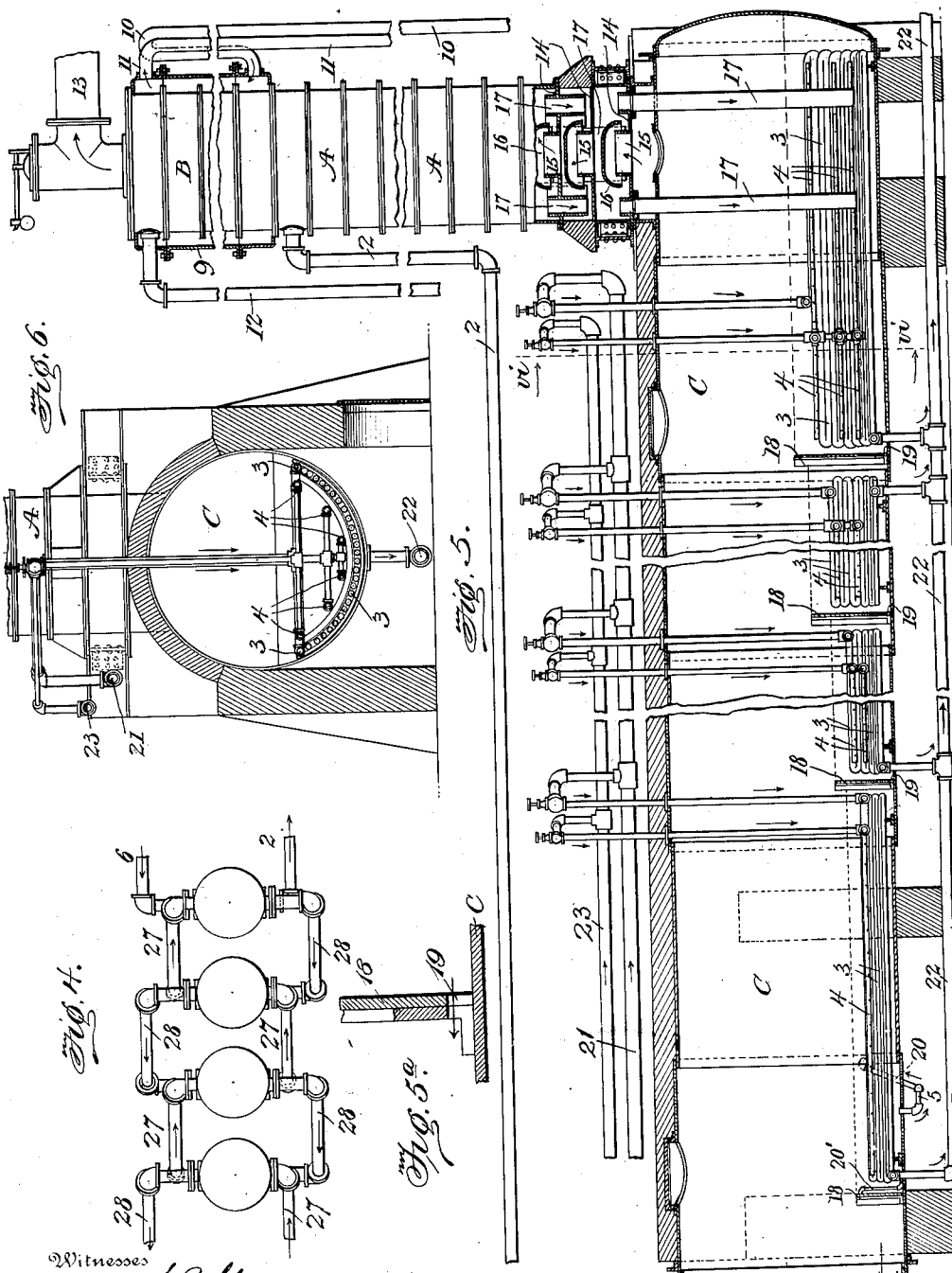

Fig. 6.

Fig. 5.

Fig. 4.

Fig. 5a.

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UNITED STATES PATENT OFFICE.

HERMAN FRASCH, OF NEW YORK, N. Y., ASSIGNOR TO STANDARD OIL COMPANY, OF BAYONNE, NEW JERSEY, A CORPORATION OF NEW JERSEY.

STEAM-STILL FOR PETROLEUM.

No. 845,735. Specification of Letters Patent. Patented Feb. 26, 1907.

Original application filed August 11, 1900, Serial No. 26,648. Divided and this application filed August 20, 1902. Serial No. 120,290.

To all whom it may concern:

Be it known that I, HERMAN FRASCH, a citizen of the United States, residing at New York, borough of Manhattan, county of New York, in the State of New York, have invented certain new and useful Improvements in Steam-Stills for Petroleum; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to distilling and rectifying apparatus designed more particularly to be used for raising the fire test of the burning oil (kerosene) distillate of petroleum by separating from said distillate those portions which on account of their volatility (or low boiling-points) are liable to form explosive mixtures with air at, comparatively speaking, low temperatures; but each of the improvements constituting said invention is intended to be secured for all the uses to which it may be applicable. These improvements consist for the most part of general combinations whose elements may be modified almost indefinitely.

In the accompanying drawings, which form part of this specification, Figure 1 is a diagram in elevation of apparatus in accordance with the invention. Fig. 2 is an elevation, partly broken away and partly in vertical section, of a portion of the heat-exchanger forming part of said apparatus. Fig. 3 is a vertical section, partly broken away, of one of the elements of said exchanger, the section being in a plane transverse to that of Fig. 2. Fig. 4 is a plan of a portion of the heat-exchanger. Fig. 5 is a vertical section, partly in elevation and partly broken away, of the horizontal still, still-column, and rectifier forming part of said apparatus. Fig. 5^a is a detail view illustrating a feature of said horizontal still. Fig. 6 is a transverse section of the horizontal still; and Fig. 7 is a detail view showing two water-discharge pipes for this still, either of which pipes can be used.

The apparatus as a whole consists, as shown, of a distilling and rectifying-column A, having a supply-pipe 2 opening into its upper part; a rectifying-column B, discharging its products of condensation into the upper part of said column A; a horizontal still C, which receives the liquids from said column A and is provided with closed steam-coils 3 and perforated steam-coils 4 and also with a draw-off 5 for the water, and a heat-exchanger D, connected by pipes 6 6^a 6^b with the outlet from still C and by the pipe 2 with the upper part of the column A and provided with an outlet 7 for the cooled high-test distillate and an inlet 8 for the low-test distillate to be heated preliminarily to having its fire test raised in the column A and still C.

At E and F are pumps for moving the high-test and low-test distillates, respectively.

At G is a drainage-tank which receives the high-test distillate from the still C and from which it is taken by the pipe 6. The small pipe 6′ is for equalizing the pressures in the still C and tank G.

The rectifying-column B is shown provided with a jacket 9, having pipes 10 and 11 for introducing and carrying off a cooling liquid. It may be water or any other cooling liquid—as, for example, the low-test distillate—and this cooling liquid may have its temperature regulated so as to secure the right amount of cooling. It should also be understood that a special jacket is not essential to the rectifying action. It suffices for this that the vapors are repeatedly brought in contact with returning liquid condensed therefrom in higher parts of the rectifying-column. The column A is air-cooled, as shown—that is to say, it is sufficiently exposed externally to the surrounding atmospheric air for the latter to act as a cooling medium with respect to the column.

At 12 is an additional supply-pipe entering the upper part of the rectifying-column B for discharging distillate thereinto when desired. It can be usefully employed, for example, in filling the apparatus with high-test distillate in starting, or it can be used to introduce low-test distillate then or during the operation, the distillate in either case being preliminarily heated or not, as the case may be. The vapor-outlet 13 from this rectifier B carries off the mixed vapors of water and hydrocarbons. It can be connected with an ordinary condenser (not shown) or with other appliance or appliances which, having been heretofore connected with the vapor-outlets of stills, will suggest themselves.

The columns A and B are divided, as

shown, into a number of chambers by horizontal partitions 14, which are perforated and provided each with a pipe 15 and bell 16 and overflow-pipes 17. The vapors arising through the pipes 15 are by the bells 16 brought repeatedly into contact with the liquid, which forms a layer on each partition above the edge of the bell and flows from chamber to chamber through the pipes 17. This is a very common structure of column in arts which employ rectifying, distilling, or absorbing columns. Its specific construction forms no part of the invention, and it can be replaced by any known or suitable arrangement for bringing vapors and liquids repeatedly into contact with each other as they pass through the apparatus. Numerous arrangements of this description are known in various chemical industries.

The still C, as shown, has a horizontally-disposed liquid-space for holding a body of liquid which travels (or flows) at an appropriate speed through the same, being supplied at one end by the stream from the column A through the lowermost pipes 17 (or by any suitable connection if such pipes be not used) and discharging in a stream at the other through the pipe 6^b. At intervals are dams or partitions 18 to divide the traveling body of liquid into a succession of pools which communicate by overflowing one into the other. This separation into pools aids in keeping the different parts of the body of liquid which have been subjected to different degrees of steaming better separated from one another, and this purpose is not dependent upon the relative heights of the dams or partitions; but it is a further advantage to have the pools diminish in depth successively, so that as the liquid nears the outlet it is evaporated in shallower layers, and therefore the dams or partitions 18 are shown as diminishing in height.

At the bottom of each dam, except that next to the outlet end of the still, is an opening 19 for the passage of water, Fig. 5^a; but other arrangements could be provided for its conveyance, if preferred. The water draw-off 5 is provided, as shown, with a rising-pipe section 20, so that the water which has settled out of the oil can pass away separately from the bottom of the still by overflowing at the upper outer end of said pipe-section 20. For it to do this the level of said outer end must be below that of the top of the last dam 18 which is overflowed by the oil, since otherwise the water would accumulate until it should run over the dam with the oil; but it must not be too far below the top of the dam lest the oil should run out of pipes 5 20 with the water. The elbow-couplings, Figs. 5 and 7, allow the section 20 to be turned in order to raise or lower its outer end, and by adjusting its position between the extreme limits allowable the depth of water in still C can be regulated. The greater such depth of water the shallower will be the overlying layer of oil, and, conversely, the less the depth of water the deeper will be the overlying layer of oil.

In each compartment of the still C, except the small compartment at the outlet end thereof, is a closed steam-coil 3 and a perforated coil 4. The closed coil is supplied from the main 21 with exhaust-steam from engines used to supply power at the works or from other sources (or it may be with live steam or both live and exhaust steam) and discharges into the drain-pipe 22. The perforated coil is supplied from the main 23 with live steam, (or it may be with exhaust-steam or with both live and exhaust steam.) By "perforated" coil is to be understood any appropriate device for introducing free steam into the distillate. As shown, these coils consist of a number of straight pipes. They are perforated on the under side with holes which may be an eighth of an inch in diameter and one foot apart, so as finely to divide the entering steam. These holes are sufficiently numerous to give a liberal supply of free steam. As shown, there is not less, but more, than one such hole to each twenty cubic feet of space in the apparatus for holding liquid in process of steaming.

In order to diminish the intensity of the steaming operation toward the oil-outlet of still C, the area of steam-exit (consisting of the aggregate area of the holes by which the steam makes its exit from the pipes into liquid contents of the still) is shown diminishing toward said outlet in proportion both to the cubic contents of the liquid-holding space of the still and to the area of the exposed upper surface of the liquid therein. In the four pools shown the greatest length of perforated pipe (and consequently the greatest area of steam-exit) is found in the first pool (the pool at the right in Fig. 5) and the least length (and consequently the least area of steam-exit) in the last pool. The cubic contents of these pools, and to a less extent the areas of exposed upper surface of liquid therein, also diminish, as shown, toward the oil-outlet of the still, because the pools diminish in depth; but the perforated pipes in the several pools diminish in length still more rapidly, as shown.

The heat-exchanger D consists, as shown, of a number of connected elements, as many of these being used as may be judged useful to transfer the heat from the outgoing high-test to the entering low-test distillate—say ten, such as shown for the apparatus represented, although for lack of space only nine are indicated. Each element (see Figs. 2 and 3) resembles a tubular boiler or condenser in that it consists of a number of tubes 24 between the partition-plates 25 of a shell 26. The shell is thus divided into two com-

partments or chambers by the partitions and the tubes, and the compartments are connected by the pipes 27 and 28 into two series, so that the high-test distillate starting at one end of one series may pass over one surface of the tubes, (outside or inside, as the case may be, but inside as shown,) while the low-test distillate starting at the other end of the other series passes over the other surface of said tubes, (outside as shown.) Other known or suitable forms of heat-exchangers can be used instead.

In raising the fire test of burning oil distillate with this apparatus the stream of low-test distillate passes over the heat-conducting walls of the heat-exchanger D (to wit, the walls of the tubes 24 in the several elements, as shown) in the opposite direction to the stream of high-test distillate from the still C, so that in cooling the latter distillate the former is heated preliminarily to its introduction into the distilling and rectifying column A—say to 170° Fahrenheit, more or less, according to circumstances, but most advantageously above the fire test to be secured in the distillate. In order to effect the desired heating, there must be a sufficient area of heat-exchanging surface in comparison with the quantity of low-test distillate passing in a given time through the exchanger, and as the liquid-holding capacity of column A and still C is a principal factor in determining the said quantity there should be at least a certain ratio between the said area and said capacity. As shown this ratio is not less, but more, than half a square foot of heat-exchanging surface to each cubic foot of the space in column A and still C for holding liquid in process of steaming.

The preliminarily-heated distillate fed into the upper part of the column A descends through the same and supplies the body of distillate in the still C. This being supplied at one end by a stream and discharging at the other end in a stream, travels after the manner of a river and is subjected to free steam from the perforated coils 4 at intervals in its travel, while at the same time it is heated by the dry heat of the closed coils 3. This dry heat is not so important as the free steam and can be omitted, if preferred. For example, it can be omitted by closing the cocks in the branch pipes leading to coils 3.

The vapors resulting from the action of the free steam (aided by the dry heat of coils 3 if this be used) pass up through the column A and are repeatedly brought in contact with the stream of preliminarily-heated distillate until they pass into and through the rectifying-column B, and so on to the condenser or condensers (not shown) or other apparatus. As the vapors rise the chief part or, in fact, nearly all of the steam from the perforated coils 4 is condensed and, mingling with the stream of preliminarily-heated distillate, forms part of the stream with which the later-rising vapors are continually brought into contact. The oil condensed from the vapors also mingles with the stream and as it descends is reëvaporated, more or less, so that there are repeated condensations and reëvaporations, whereby the oil vapors from the still C are rectified and a naphtha suitably free from products fit for burning oil is obtained. The cooling means for reducing the temperature of the mixed vapors of water and hydrocarbons which pass off by outlet 13 are arranged to cool said vapors sufficiently below the boiling-point of water for the hydrocarbons therein to be at least mainly those of low boiling-points.

The rising vapors which are acted upon by the incoming distillate (as also by the hot water and oil from condensations higher up in the columns) as a condensing agent act in turn thereon to vaporize a portion of said distillate, the vapors thus formed mingling with those from the still C and being rectified along with them. Thus there is in column A both distillation (to wit, of the incoming preliminarily-heated distillate) and rectification, (to wit, of the vapors from the still C and from distillation of the incoming distillate in the column A.) The vapors are subjected to a further rectification in the column B.

The body of oil in the still C is limited relatively to the volume of steam admitted through the perforated coils, so that all the low-boiling products are removed in a short time—it may be in a few minutes, (under fifteen,) and at any rate under two hours. The rectification in the columns A B serves to restore the products fit for burning oil which are evaporated at the same time by this rapid action of the free steam.

Assuming, by way of example, that the dams 18 are respectively twenty, twenty-four, twenty-eight, and thirty-two inches high and are located in a cylinder of five feet internal diameter at such places as to form compartments each nine and a half feet in length, it is recommended to use pipe for coils as follows, namely: in the first compartment, two hundred and thirty-eight feet of one-inch wrought-iron unperforated pipe for the closed coils and fifty-four feet of wrought-iron perforated pipe for the open coils; in the second compartment, two hundred and four feet of one-inch closed pipe and thirty-six feet of one-inch perforated pipe; in the third compartment, one hundred and fifty-three feet of one-inch closed pipe and twenty-seven feet of one-inch perforated pipe, and in the last compartment one hundred and nineteen feet of one-inch closed pipe and eighteen feet of one-inch perforated pipe.

The supply of low-test distillate is so regulated that enough to fill the oil-spaces of column A and still C will be introduced by

pipe 2 every fifteen minutes, more or less. The supply of free steam is regulated to give oil of the desired fire test, and the temperature of the liquid in the jacket 9 is sufficiently below the boiling-point of water to prevent the passage of burning oil hydrocarbons through the column B. In raising the fire test of the oil, about twenty per cent. of the low-test distillate ordinarily may, according to my experience, be separated as low-boiling products; but of course the percentage removed may vary. The temperatures in columns A and B are such as to effect the condensation therein of the chief part of the steam let into the perforated coils of still C. The temperature in the still C is about that of water-vapor under the barometric pressure inside of the still—to wit, about 212° Fahrenheit when the pressure in the still is not reduced below that of the outside atmosphere. The body of oil in the still C being divided into a succession of communicating pools by the dams 18, the different parts are kept separate, and the dams being of diminishing height the pools are of diminishing depth, so that at the end the steam has less oil to pass through, which is believed to conduce to the efficiency of its action. The water which enters the still C with fresh distillate and with the oil from the condensations in the columns A B settles out and is decanted by the draw-off 5. It could of course be withdrawn with the oil by allowing it to pass the last dam, for which purpose the pipe 20′, having its lower end near the bottom of the still and its open upper end inserted through the dam near the top, may be provided. By swinging the pipe so that its lower end shall be brought nearer to or farther from the bottom of the still the depth of the water therein can be regulated.

It will of course be understood that the low-test distillate could be heated preliminarily to its introduction into the distilling-column A otherwise than by means of the high-test distillate; but in this case the economical advantage of the mutual interchange of heat between the incoming low-test distillate and the outgoing high-test distillate would be lost, and the ability most perfectly to secure this economy is an important result attending the substitution of the continuous distillation of the present invention for the periodical working of current practice. Further, the distillate is subjected to free steam in the column A, and such subjection is not necessarily dependent upon the use of the still C; but the capacity of the apparatus for separating low-boiling products is increased by embodying therein a special apparatus (like the still C) for subjecting the distillate to the free steam. The subjection of the vapors rising in column A to the returning stream of condensed oil, mingled with the hot water from the chief portion of said free steam, is not dependent upon the said stream containing also the low-test distillate; but it is advantageous to have it contain the same, and, if it is desired to secure such advantage, the low-test distillate should, as shown, be introduced at so high a point on the column A as in its descent to have a material influence on the rising vapors.

The skill of the calling, in the light of the preceding description, will enable the apparatus described to be used for liquids other than burning oil distillate, to which it may be applicable.

The liquid to be distilled of any suitable kind can be introduced at the place or places described for the low-test distillate, the steam (in closed or perforated coils, or both) can be used at the temperatures and of the volume considered most suitable, and the outgoing residual liquid and the incoming liquid to be distilled can be passed through a heat-exchanger in opposite directions, as described above for the outgoing high-test distillate and the incoming low-test distillate, the former being the residual liquid from the special distillation to which the latter is subjected.

The present application is a division and continuation of my application filed August 11, 1900, and officially serially numbered 26,648. The division has been made in compliance with official requirement.

In the hereinafter written claims the expression "liquid to be distilled" means primarily low-test burning oil distillate whose fire test is to be raised by the removal of the low-boiling products; but it also includes by extension other petroleum of hydrocarbon oil, especially, but not exclusively, an oil containing hydrocarbons with boiling-points below that of water, while consisting mainly of higher-boiling products, and also any other appropriate liquid, especially, but not exclusively, such a liquid as contains substances with boiling-points below that of water. The "boiling-point of water" in the hereinafter written claims refers to its boiling-point under the barometric pressure in the still. This is intended to be practically that of the outside atmosphere; but it is not essential that it should be so.

I claim as my invention or discovery—

1. A steam stilling apparatus for separating hydrocarbons with boiling-points too low for burning oil from higher-boiling hydrocarbons, said apparatus consisting of a column which is provided internally with a succession of appliances for bringing the body of vapors rising in said column into repeated contact with descending liquid, an oil-supply pipe which opens into the upper part of said column for delivering thereinto petroleum or hydrocarbon oil containing the low-boiling hydrocarbons first mentioned but composed mainly of higher-boiling products, oil-heating

means for raising the oil-supply to a temperature lower than the boiling-point of water and not more than about 60° Fahrenheit below the same, which means are connected with said oil-supply pipe, a vapor-outlet which carries off the vapors from said column, vapor-cooling means for reducing the temperature of the vapors to such extent below the boiling-point of water that the hydrocarbons passing off are mainly of the low-boiling kind first mentioned, which means include provisions for allowing the condensate to descend with the oil from said supply-pipe over said appliances for bringing the rising vapors into repeated contact with descending liquid, open steam-pipes for supplying steam in such excess of what passes off with the low-boiling hydrocarbons that the chief part of said steam is condensed and so retained in said apparatus, which pipes deliver steam into the apparatus at such points that the steam passes up through said column, a settling vessel which receives the oil and water from said column, and means whereby the separated oil and water from said settling vessel are delivered in different directions, substantially as described.

2. A steam stilling apparatus for separating hydrocarbons with boiling-points too low for burning oil from higher-boiling hydrocarbons, said apparatus consisting of a column which is provided internally with a succession of appliances for bringing the body of vapors rising in said column into repeated contact with descending liquid, an oil-supply pipe which opens into said apparatus for delivering thereinto petroleum or hydrocarbon oil containing the low-boiling hydrocarbons first mentioned but composed mainly of higher-boiling products, a vapor-outlet which carries off the vapors from said column, vapor-cooling means for reducing the temperature of the vapors to such extent below the boiling-point of water that the hydrocarbons passing off are mainly of the low-boiling kind first mentioned, which means include provisions for allowing the condensate to descend over said appliances for bringing the rising vapors into repeated contact with descending liquid, open steam-pipes for supplying steam in such excess of what passes off with the low-boiling hydrocarbons that the chief part of said steam is condensed and so retained in said apparatus, which pipes deliver steam into the apparatus at such points that the steam passes up through said column, a settling vessel which receives the oil and water from said column, and means whereby the separated oil and water from said settling vessel are delivered in different directions, substantially as described.

3. A steam stilling apparatus for separating hydrocarbons with boiling-points too low for burning oil from higher-boiling hydrocarbons, said apparatus consisting of a column which is provided internally with a succession of appliances for bringing the body of vapors rising in said column into repeated contact with descending liquid, an oil-supply pipe which opens into the upper part of said column for delivering thereinto petroleum or hydrocarbon oil containing the low-boiling hydrocarbons first mentioned but composed mainly of higher-boiling products, a vapor-outlet which carries off the vapors from said column, vapor-cooling means for reducing the temperature of the vapors to such extent below the boiling-point of water that the hydrocarbons passing off are mainly of the low-boiling kind first mentioned, which means include provisions for allowing the condensate to descend with the oil from said supply-pipe over said appliances for bringing the rising vapors into repeated contact with descending liquid, open steam-pipes for supplying steam in such excess of what passes off with the low-boiling hydrocarbons that the chief part of said steam is condensed and so retained in said apparatus, which pipes deliver steam into the apparatus at such points that the steam passes up through said column and have a liberal area of steam-outlet as compared with the liquid-holding space in said apparatus for effecting the removal of the low-boiling hydrocarbons in a short time, to wit, under two hours, a settling vessel which receives the oil and water from said column, and means whereby the separated oil and water from said settling vessel are delivered in different directions, substantially as described.

4. A steam stilling apparatus for separating hydrocarbons with boiling-points too low for burning oil from higher-boiling hydrocarbons, said apparatus consisting of a column which is provided internally with a succession of appliances for bringing the body of vapors rising in said column into repeated contact with descending liquid, an oil-supply pipe which opens into said apparatus for delivering thereinto petroleum or hydrocarbon oil containing the low-boiling hydrocarbons first mentioned but composed mainly of higher-boiling products, a vapor-outlet which carries off the vapors from said column, vapor-cooling means for reducing the temperature of the vapors to such extent below the boiling-point of water that the hydrocarbons passing off are mainly of the low-boiling kind first mentioned, which means include provisions for allowing the condensate to descend over said appliances for bringing the rising vapors into repeated contact with descending liquid, open steam-pipes for supplying steam in such excess of what passes off with the low-boiling hydrocarbons that the chief part of said steam is condensed and so retained in said apparatus, which pipes de-

liver steam into the apparatus at such points that the steam passes up through said column and have a liberal area of steam-outlet as compared with the liquid-holding space in said apparatus for effecting the removal of the low-boiling hydrocarbons in a short time, to wit, under two hours, a settling vessel which receives the oil and water from said column, and means whereby the separated oil and water from said settling vessel are delivered in different directions, substantially as described.

5. A steam stilling apparatus for separating hydrocarbons with boiling-points too low for burning oil from higher-boiling hydrocarbons, said apparatus consisting of an elongated horizontal still with oil-inlet at one end and oil-outlet at the other, a vapor-outlet which carries off the vapors from said still, vapor-cooling means for reducing the temperature of the vapors to such extent below the boiling-point of water that the hydrocarbons passing off are mainly of the low-boiling kind first mentioned, which means include provisions for allowing the condensate to return to said still, open steam-pipes for supplying steam in such excess of what passes off with the low-boiling hydrocarbons that the chief part of said steam is condensed and so retained in said apparatus, which pipes deliver steam into said still below the liquid-level therein, and means whereby the oil and water from said still after being permitted to separate can be delivered in different directions, substantially as described.

6. A steam stilling apparatus for separating hydrocarbons with boiling-points too low for burning oil from higher-boiling hydrocarbons, said apparatus consisting of an elongated horizontal still with oil-inlet at one end and oil-outlet at the other, a vapor-outlet which carries off the vapors from said still, vapor-cooling means for reducing the temperature of the vapors to such extent below the boiling-point of water that the hydrocarbons passing off are mainly of the low-boiling kind first mentioned, which means include provisions for allowing the condensate to return to said still, open steam-pipes for supplying steam in such excess of what passes off with the low-boiling hydrocarbons that the chief part of said steam is condensed and so retained in said apparatus, which pipes deliver steam into said still below the liquid-level therein and have a liberal area of steam-outlet as compared with the liquid-holding space in said apparatus for effecting the removal of the low-boiling hydrocarbons in a short time, to wit, under two hours, and means whereby the oil and water from said still after being permitted to separate can be delivered in different directions, substantially as described.

7. A still having an inlet and an outlet for the liquid to be distilled and an intervening horizontally-disposed liquid-holding space and also having open steam-pipes which are arranged in said space and whose area of steam-exit lessens toward the outlet, substantially as described.

8. A still having an inlet and an outlet for the liquid to be distilled and an intervening horizontally-disposed liquid-holding space diminishing in depth toward the outlet and also having open steam-pipes which are arranged in said space and whose area of steam-exit lessens toward said outlet, substantially as described.

9. A still having an inlet and an outlet for the liquid to be distilled and an intervening horizontally-disposed liquid-holding space diminishing in depth toward the outlet and also having open steam-pipes which are arranged in said space and whose area of steam-exit per square foot of exposed upper surface of liquid lessens toward said outlet, substantially as described.

10. A still having an inlet and an outlet for the liquid to be distilled and an intervening horizontally-disposed liquid-holding space and also having open steam-pipes which are arranged in said space and whose area of steam-exit lessens toward the outlet, in combination with vapor-cooling means arranged for condensing a portion of the vapors from said still while allowing another portion to pass over, substantially as described.

11. A still having an inlet and an outlet for the liquid to be distilled and an intervening horizontally-disposed liquid-holding space diminishing in depth toward the outlet and also having open steam-pipes which are arranged in said space and whose area of steam-exit lessens toward said outlet, in combination with vapor-cooling means arranged for condensing a portion of the vapors from said still while allowing another portion to pass over, substantially as described.

12. A still having an inlet and an outlet for the liquid to be distilled and an intervening horizontally-disposed liquid-holding space diminishing in depth toward the outlet and also having open steam-pipes which are arranged in said space and whose area of steam-exit per square foot of exposed upper surface of liquid lessens toward said outlet, in combination with vapor-cooling means arranged for condensing a portion of the vapors from said still while allowing another portion to pass over, substantially as described.

13. A steam stilling apparatus for separating hydrocarbons with boiling-points too low for burning oil from higher-boiling hydrocarbons, said apparatus consisting of a column which is provided internally with a suc-

cession of appliances for bringing the body of vapors rising in said column into repeated contact with descending liquid, an oil-supply pipe which opens into the upper part of said column for delivering thereinto petroleum or hydrocarbon oil containing the low-boiling hydrocarbons first mentioned but composed mainly of higher-boiling products, a vapor-outlet which carries off the vapors from said column, vapor-cooling means for reducing the temperature of the vapors to such extent below the boiling-point of water that the hydrocarbons passing off are mainly of the low-boiling kind first mentioned, which means include provisions for allowing the condensate to descend with the oil from said supply-pipe over said appliances for bringing the rising vapors into repeated contact with descending liquid, open steam-pipes for supplying steam in such excess of what passes off with the low-boiling hydrocarbons that the chief part of said steam is condensed and so retained in said apparatus, which pipes deliver steam into the apparatus at such points that the steam passes up through said column, a settling vessel which receives the oil and water from said column, and means whereby the separated oil and water from said settling vessel are delivered in different directions, substantially as described.

14. A steam stilling apparatus for separating hydrocarbons with boiling-points too low for burning oil from higher-boiling hydrocarbons, said apparatus consisting of a column which is provided internally with a succession of appliances for bringing the body of vapors rising in said column into repeated contact with descending liquid, an oil-supply pipe which opens into the upper part of said column for delivering thereinto petroleum or hydrocarbon oil containing the low-boiling hydrocarbons first mentioned but composed mainly of higher-boiling products, a vapor-outlet which carries off the vapors from said column, vapor-cooling means for reducing the temperature of the vapors to such extent below the boiling-point of water that the hydrocarbons passing off are mainly of the low-boiling kind first mentioned, which means include provisions for allowing the condensate to descend with the oil from said supply-pipe over said appliances for bringing the rising vapors into repeated contact with descending liquid, open steam-pipes for supplying steam in excess of what passes off with the low-boiling hydrocarbons, which pipes deliver steam into the apparatus at such points that the steam passes up through said column, a settling vessel which receives the oil and water from said column, and means whereby the separated oil and water from said settling vessel are delivered in different directions, substantially as described.

15. A steam stilling apparatus for separating hydrocarbons with boiling-points too low for burning oil from higher-boiling hydrocarbons, said apparatus consisting of a column which is provided internally with a succession of appliances for bringing the body of vapors rising in said column into repeated contact with descending liquid, an oil-supply pipe which opens into said apparatus for delivering thereinto petroleum or hydrocarbon oil containing the low-boiling hydrocarbons first mentioned but composed mainly of higher-boiling products, a vapor-outlet which carries off the vapors from said column, vapor-cooling means for reducing the temperature of the vapors to such extent below the boiling-point of water that the hydrocarbons passing off are mainly of the low-boiling kind first mentioned, which means include provisions for allowing the condensate to descend over said appliances for bringing the rising vapors into repeated contact with descending liquid, open steam-pipes for supplying steam in excess of what passes off with the low-boiling hydrocarbons, which pipes deliver steam into the apparatus at such points that the steam passes up through said column, a settling vessel which receives the oil and water from said column, and means whereby the separated oil and water from said settling vessel are delivered in different directions, substantially as described.

16. A steam stilling apparatus for separating hydrocarbons with boiling-points too low for burning oil from higher-boiling hydrocarbons, said apparatus consisting of a column which is provided internally with a succession of appliances for bringing the body of vapors rising in said column into repeated contact with descending liquid, an oil-supply pipe which opens into the upper part of said column for delivering thereinto petroleum or hydrocarbon oil containing the low-boiling hydrocarbons first mentioned but composed mainly of higher-boiling products, a heat-exchanger which has not less than about half a square foot of heat-exchanging surface to each cubic foot of the space in said apparatus for holding liquid in process of steaming and which on one side is connected with said oil-supply pipe and on the other with the oil-outlet of said apparatus, a vapor-outlet which carries off the vapors from said column, vapor-cooling means for reducing the temperature of the vapors to such extent below the boiling-point of water that the hydrocarbons passing off are mainly of the low-boiling kind first mentioned, which means include provisions for allowing the condensate to descend with the oil from said supply-pipe over said appliances for bringing the rising vapors into repeated contact with descending liquid, open steam-pipes for supplying steam in such excess of what passes

off with the low-boiling hydrocarbons that the chief part of said steam is condensed and so retained in said apparatus, which pipes deliver steam into the apparatus at such points that the steam passes up through said column, a settling vessel which receives the oil and water from said column, and means whereby the separated oil and water from said settling vessel are delivered in different directions, substantially as described.

17. A steam stilling apparatus for separating hydrocarbons with boiling-points too low for burning oil from higher-boiling hydrocarbons, said apparatus consisting of a distilling vessel, an oil-supply pipe which opens into said vessel for delivering thereinto petroleum or hydrocarbon oil containing hydrocarbons of the kind first mentioned but composed mainly of higher-boiling products, a vapor-outlet which carries off the vapors from said vessel, vapor-cooling means whereby the mixed vapors before passing off are cooled below the boiling-point of water, open steam-pipes which supply free steam in excess of what passes off in admixture with hydrocarbon vapors and which deliver the steam into the apparatus at such points that the steam passes through said vessel, and a settling vessel which receives the water condensed in said apparatus from the free steam and the oil accompanying such water and which is provided with overflows from its top and bottom respectively, the former for discharge of oil, the latter for discharge of water, substantially as described.

18. A steam stilling apparatus for separating hydrocarbons with boiling-points too low for burning oil from higher-boiling hydrocarbons, said apparatus consisting of a distilling vessel, an oil-supply pipe which opens into said vessel for delivering thereinto petroleum or hydrocarbon oil containing the low-boiling hydrocarbons first mentioned but composed mainly of higher-boiling products, a vapor-outlet which carries off the vapors from said column, vapor-cooling means for reducing the temperature of the vapors to such extent below the boiling-point of water that the hydrocarbons passing off are mainly of the low-boiling kind first mentioned, which means include provisions for allowing the condensate to return to said distilling vessel, open steam-pipes for supplying steam in such excess of what passes off with the low-boiling hydrocarbons that the chief part of said steam is condensed and so retained in said apparatus, which pipes deliver steam into the apparatus at such points that the steam passes through said distilling vessel, and a settling vessel which receives the water condensed in said apparatus from the free steam and the oil accompanying such water and which is provided with overflows from its top and bottom respectively, the former for discharge of oil, the latter for discharge of water, substantially as described.

19. A horizontal still having open steam-pipes delivering steam into the liquid-space of said still and also having dams which divide said liquid-space into pools while permitting the flow of liquid from pool to pool at both top and bottom of the pools, substantially as described.

20. A still provided with open steam-pipes which deliver free steam thereinto and also with overflows from the top and bottom respectively of its liquid-space, the former for discharge of oil, the latter for discharge of water, substantially as described.

21. A steam stilling apparatus composed of a still which is provided with open steam-pipes for delivering free steam thereinto, and a column which receives the vapors from said still and is provided internally with a succession of appliances for bringing the body of vapors rising in said column into repeated contact with descending liquid, said column having provisions for cooling the vapors below the boiling-point of water and for delivering condensate into said still, and said still having its open steam-pipes for delivering free steam in excess of what passes off in admixture with hydrocarbon vapors and being provided with overflows from the top and bottom respectively of its liquid-space, the former for discharge of oil, the latter for discharge of water, substantially as described.

22. A steam stilling apparatus composed of a still which is provided with open steam-pipes for delivering free steam thereinto, a column which receives the vapors from said still and is provided internally with a succession of appliances for bringing the body of vapors rising in said column into repeated contact with descending liquid, and a heat-exchanger, said column having provisions for cooling the vapors below the boiling-point of water and for delivering condensate into said still, said still having its open steam-pipes for delivering free steam in excess of what passes off in admixture with hydrocarbon vapors and being provided with overflows from the top and bottom respectively of its liquid-space, the former for discharge of oil, the latter for discharge of water, and said heat-exchanger receiving the liquid from one of said overflows and delivering heated oil therefrom into the distillatory part of said apparatus, substantially as described.

23. A steam stilling apparatus, composed of an elongated horizontal still provided with means for heating it uniformly to about the boiling-point of water and also with open steam-pipes which deliver steam at intervals

into the liquid-space of said still, an air-cooled column which delivers its condensate into said still at one end, the outlet for the residual liquid being at the other end, and means which include a cooling-jacket for further cooling the vapors from said air-cooled column, substantially as described.

In testimony whereof I affix my signature in presence of two witnesses.

HERMAN FRASCH.

Witnesses:
F. W. LOTHMAN,
J. C. UPDEGROVE.