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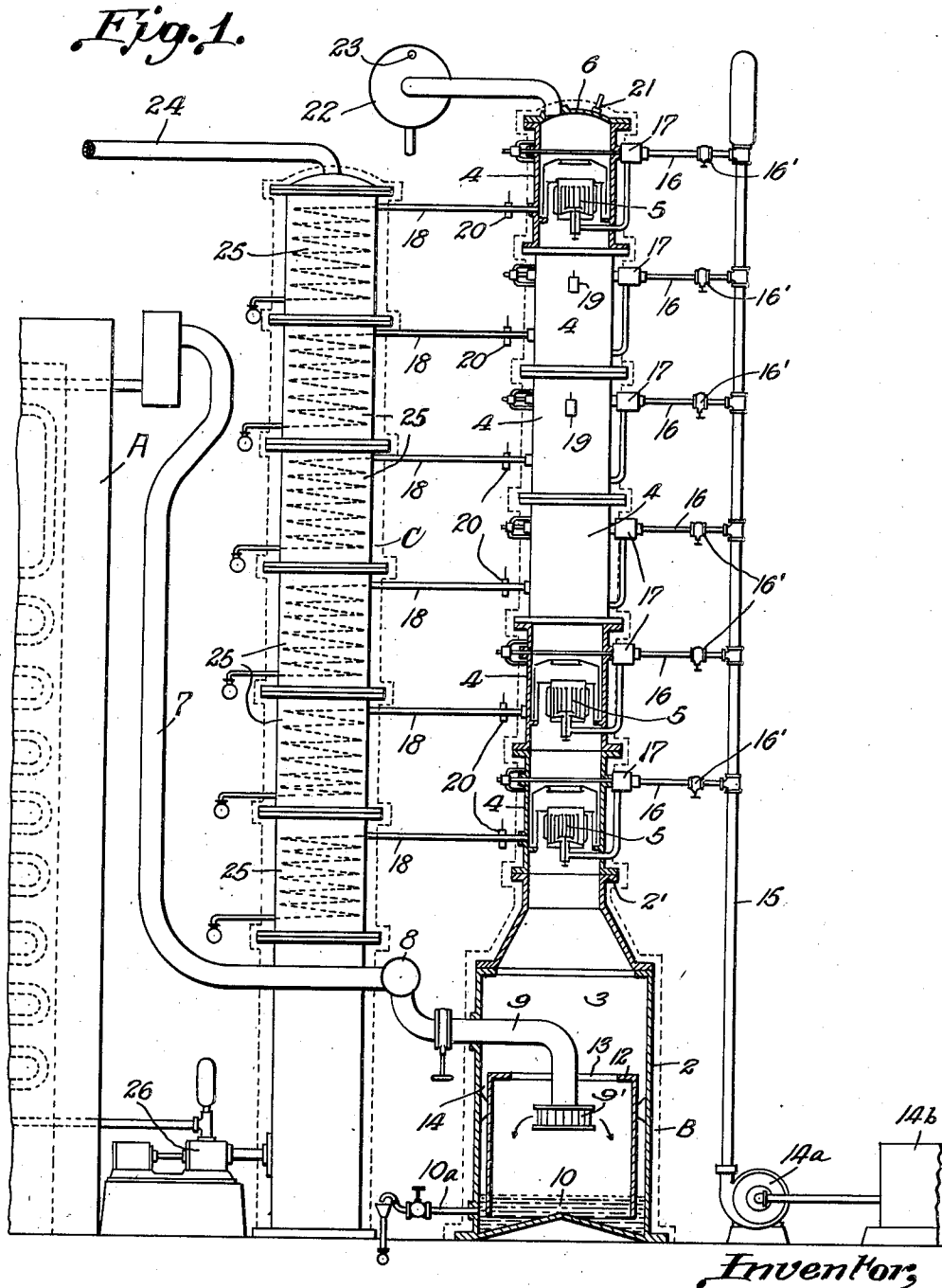
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2,189,491

CONTACTING PROCESS AND APPARATUS

Original Filed March 1, 1937

2 Sheets-Sheet 1



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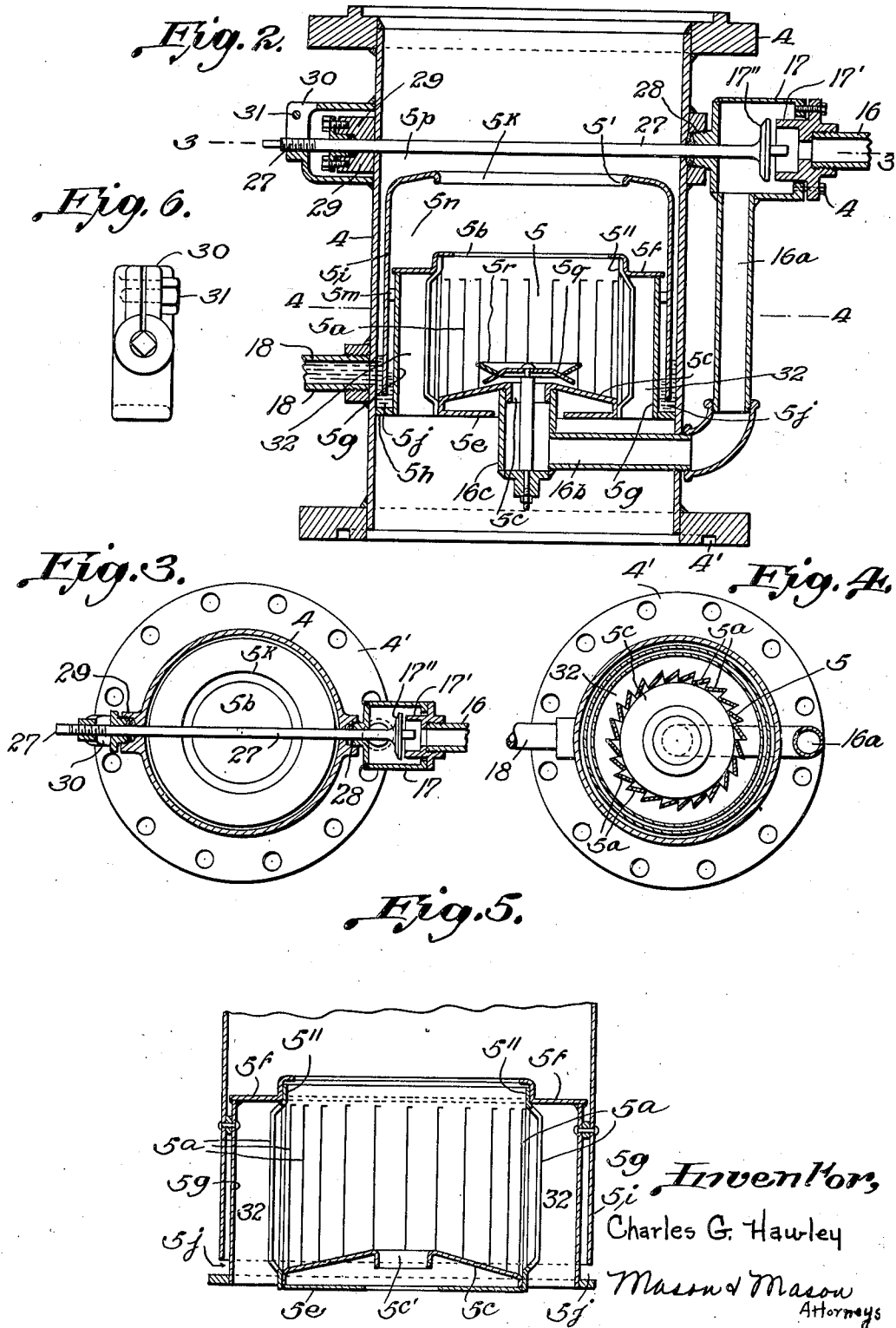
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UNITED STATES PATENT OFFICE

2,189,491

CONTACTING PROCESS AND APPARATUS

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Application March 1, 1937, Serial No. 128,470
Renewed November 6, 1939

12 Claims. (Cl. 196—94)

This application is a continuation-in-part of my earlier application Serial No. 707,803, filed January 22, 1934, and now Patent No. 2,075,344.

The invention relates to and comprises improvements in and applicable to the practice of the art of mixing or contacting matter in a gaseous condition and swift motion or flow with matter in a liquid phase, as required to modify one or both; for example, as in the fractionation of hot petroleum vapor and in the progressive condensation of vapors generally. Concurrently the invention relates to and comprises improvements in the art of and means for progressively and abruptly separating the products of such admixture, to the end that each product thereof shall be discharged in the condition best suiting it to immediate use or further treatment.

This invention is specially concerned with the fractionation of petroleum, and its primary object is to accomplish that operation in a continuous manner, within less space than usual, and with little expenditure of energy; and, in general, to obtain the required results in better degree, with greater certainty, more quickly and more economically than hitherto possible, and, by means of apparatus of simplified form and low cost, capable of accurate and easy control, and readily made automatic.

As well known, petroleum, when heated and vaporized at high temperature, may be divided into a very great number of distinguishably different parts or fractions; which, by condensation, may be presented as liquids having different characteristic temperatures. In practice, the number of such fractions or "cuts" is limited, each commercial fraction comprising a group of possible inter-fractions; i. e., each fraction being capable of refractionation. Thus it is possible to extract from hot petroleum vapor a heavy, high temperature commercial product or condensate, such as lubricating oil; and, then successively lighter products, as and when the temperature of the remaining vapor in the stream is sequentially reduced.

Necessarily, such process, termed "fractionation," is practiced in successive stages and hitherto has suffered from the slowness with which it has been practiced and from the pollution of each product by the seemingly unavoidable entrainment of heavier condensate from the preceding stage or stages.

It is not difficult to heat and vaporize the starting petroleum, but that having been done, it becomes necessary to arbitrarily lower the temperature of the vapor by stages, a matter of real

difficulty. As an aid in that procedure it has been customary to limit the hot vapor to vertical ascent and to introduce into the ascending stream a large volume of oil of lighter character (more readily vaporized) than the next lightest fraction to be taken from the vapor stream.

The cooler oil accepts heat from the ascending vapor, serving to reduce the temperature of the latter while being itself vaporized; a matter of heat exchange. As a rule, the supplied liquid comprises the larger part of the lightest fraction produced by the same or like process; hence the term "reflux" usually applied thereto.

The reflux liquid falls from stage to stage within the ascending stream of hot vapor and is constantly increased in density, each higher stage of admixture supplying a composite condensate to serve as the condensing medium in the next lower stage. Temperature changes are small and usually it is necessary to group the stages and to take the commercial product from the lowest stage of each said group. As should be apparent, under such conditions clean cut fractions are difficult to obtain, much unnecessary work is done, time is consumed, and it is particularly difficult to adjust conditions to changes in the quality or the quantity of the starting petroleum, and, control of the side streams is difficult.

These are the chief objections to present-day fractionating processes, and persist when liquids other than petroleum are thus fractionated. Further, in the effort to make savings, it is customary to cause or allow the hot vapors to ascend as swiftly as possible. In consequence, there results an entrainment of liquid from stage to stage; and such pollution lessens the values of the several side streams, entailing subsequent purifications, which are expensive. Partial cure may be effected by enlarging the fractionating apparatus but so doing entails other difficulties and raises costs. In contrast with former practices, the present invention admits of higher capacities, and, utilizes much higher vapor velocities; while obviating the entrainment complained of.

The apparatus provided by this invention is of a centrifugal nature. Such apparatus though having no rotating parts, serves to set into whirling motion successive portions of the ascending vapor stream.

These whirling motions mark the several stages of this present vapor condensation and in contrast with former practices each said stage is directly supplied with fresh condensing liquid.

Only enough is supplied to lower the temperature of the vapor to the extent required to produce an oil condensate of the temperature characteristics desired. By varying or adjusting the abstraction of heat in this manner it is made possible to fix the temperature at that ideally indexing the particular product sought. This is true as to each stage of the present process and is made practical by an initial fixing of the temperature and quantity of the condensing liquid for each stage, followed by an automatic control thereof, required in each case to ensure the continuous production of a side stream of definite character. Obviously the volumes of such side-stream correspond to the make up of the starting oil.

Under this invention, the condensing liquid enters a whirling or vortical portion of the vapor stream and is finely comminuted or atomized therein. The comminuted condensing liquid is positively held in and across the path of the hot vapor in the form of a foraminous wall or veil and due to the whirling action of the vapor is so held until the liquid is vaporized and, as vapor, is added to and raised to the temperature of the uncondensed residue of original hot vapor. Having imparted heat to vaporize the supplied liquid, the higher-temperature components of the original vapor are condensed, and, as condensate, are whirlingly ejected from the active part of the vaporous vortex. Thus the exchange is completed and a side stream is formed.

Obviously, this invention admits of the use of any liquid oil which vaporizes at a temperature lower than that of the condensate to be produced, but this invention recognizes the great difference between the latent heats of petroleum fractions and that of water vapor; and hereunder large savings are accomplished by employing water as the condensing medium or agent, for admixture with the hot petroleum vapor, in each stage of this process.

As well known, the admixture of oil and water vapors serves to lower the vapor pressures and accelerates the liberation of lighter vapors from hotter condensates; and, it is to be observed that the injection of water, as herein provided, results in the formation of advantageous water vapor and in the very intimate admixture thereof with the ascending oil vapors.

No advantage of any older system is here sacrificed, and very definitely the process of fractionation is virtually freed from all former time limitations and yet every stage of this process may be depended upon to produce a side stream of uniform quality and high purity. In brief, clean cut fractions here become normal and are firmly assured by the before mentioned automatic control of the condensing medium in relation to and governing side stream temperatures.

One special advantage of this improved process is that in each stage all necessary work is accomplished to produce a given condensate or side stream; and each stage is freed from dependence upon other stages. Another advantage is that the present process is very rapid and is accomplished within apparatus of very small extent and cost, as compared with present-day apparatus of like capacity.

Obviously, the heat abstracted to condense a given stream of hot oil vapor is a constant; whatever the agency employed to abstract that heat, and it seems clear that the necessary work may be best done with water as a condensing agent, for, the higher thermal latency of water vaporization makes it to be preferred over the lower

thermal latency of oil vaporization and particularly over that of the lighter fractions ordinarily used for the purpose. Further, the necessary water, being of less volume, can be moved through smaller conduits, which is of distinct advantage in any fractionating column or tower.

Whatever the condensing medium, whether water or oil, the heat imparted thereto is not wasted but is recovered or utilized, generally in heating the crude oil or a re-run oil, before the oil enters the vaporizer or still which is used to prepare it for fractionation.

Both novel process and novel apparatus will be clearly understood upon reference to the following detailed description and the drawings which are part of this specification. In said drawings, Fig. 1 is a vertical elevation of the invention as constructed for the fractionation of petroleum, parts being broken away to disclose internal constructions; Fig. 2 is an enlarged vertical section of one of the heat exchanging, condensing or fractionating units embodying the present invention; Fig. 3 is a sectional view on the line 3—3 of Fig. 2; Fig. 4 is a sectional view on the line 4—4 of Fig. 2; Fig. 5 is an enlarged sectional view of the so-called contact enforcing element of said unit; and, Fig. 6 is an enlarged fragmentary view showing how the negative thermostatic element hereof is locked, after adjustment.

As disclosed by the drawings this invention considered from a mechanical standpoint is of a vortical nature or character, hot vapor and condensing liquid being opposed and mixed in a state of rapid whirling motion. The forces required are derived from the movement of the hot vapor; and aside from control valves, the apparatus includes no moving or rotating parts.

The invention is here presented in the best form thus far devised for the treatment and fractionation of petroleum. That operation being understood, other uses of the invention will become obvious to those skilled in the several arts to which this invention is applicable.

Fig. 1 of the drawings contains a partial showing of a pipe still, marked A, through which the crude or starting petroleum is passed. The still is fired, and furnishes the heat needed to vaporize the petroleum to and at a vapor temperature which is somewhat higher than that required for the production of the heaviest condensate or product to be made. Unvaporized heavy ends or tars are here ignored. Beside the heavy constituents, the hot vapor contains other components which are of lighter grades, having characteristic lower temperatures of condensation. All these are progressively condensed and fractionated when and as the initial vapor temperature is reduced. The required reductions are attained in stages by compelling the hot oil vapor to evaporate a liquid; preferably water, as stated. The evaporated liquid, in the form of vapor, mingles with the original vapor from the still, while the condensed original vapor is drawn off or discharged as a side stream or streams. The latter are then externally cooled, so that they may be delivered in the open air. The work of cooling the vapor from the still is performed in a device called a fractionating column or tower, here represented by the novel column marked B. The work of cooling the hot products of that column is performed in an external crude pre-heater, preferably comprising a separate tower, marked C.

The novel fractionating column or tower of this invention may be employed under pressure or under vacuum as deemed best and most convenient.

Differences of pressure play little part in the present process, other than to ensure the swift ascent of the vapors. That swift ascent is secured by the condensation described and consequent shrinkage in the total vapor volume, toward the top of the column.

By preference, the column B has an enlarged base 2, containing a capacious flash chamber 3 to which further reference will be made. The body of the column comprises a plurality of the before-mentioned fractionating units 4 erected one upon the other and in number corresponding to the number of distinct operations to be performed in the column. Each unit is open at top and bottom, and, each unit contains a contact-enforcing element 5 better depicted in Figs. 2, 3 and 4, to which reference will be made. The lowermost unit 4 rests upon the open top 2' of the base 2, while the uppermost unit is closed by a cap 6.

The hot products from the still, A, pass through a pipe 7, and enter a manifold, 8, it being presumed that several columns, B, will be employed, all served from a single still, A. Leaving the manifold, the products, both liquid and vaporous, enter the flash chamber 3 through a pipe 9 which, turning at the axis of the chamber 3, opens downwardly into the lower part of that chamber. The heavy ends of the oil are not vaporized in the still, nor do they flash into vapor upon reaching the chamber 3. In many cases, these heavy ends are tars which, if clean side streams are to be got from the column, must be separated from the vapor before the latter is permitted to rise into the fractionating units proper.

Meantime, other heavy components may reach the flash chamber 3, in liquid form and must be permitted to vaporize therein, but definitely separated from the tars. To that end, the downward pipe 9 discharges into the lower part of the chamber and is best provided with a tangentially bladed distributing head 9', from which the vapor dominated products emerge in whirling condition, affording ample opportunity for the flashing of oils and projecting the heavier tar particles outward within the base 2. Therein, the collected tars form a liquid pool 10. The collected liquid is discharged through the valved pipe 10a, the depth of the tar pool 10 never being great.

The expanding vapors rise within the chamber 3. To prevent the lifting of tars from the lower part of that chamber 3, a concentric cylinder 11 is provided. That container is open at the bottom, below the liquid level, but is only partially closed at the top, as by the deflecting ring 12. The freed vapors whirl upward and outward through the central opening 13 in the top of the cylinder 11, and thus stray quantities of tar are centrifugally projected against the upper, inner wall of the chamber 3, thence to fall to the bottom of that chamber through the quiet annular space 14 surrounding the chamber 11. Very definite cleansing of the hot vapors is thus accomplished.

From the flash chamber 3, the clean hot vapors ascend through the several fractionating units 4 sequentially. In each said unit the hot vapor is set into rotation and is subjected to the cooling effect of liquid which is injected thereinto, the quantity of cooling liquid being controlled for reasons and in manner about to be described. The cooling liquid, preferably water, as before explained, is best prepared in a tank 14b or other source assuring substantial uniformity of temperature. If necessary it is taken from that source by a pump 14a.

The liquid may be elevated in a standpipe 15 rising at the side of the column B, and is taken to the several units 4 through respective valved supply pipes 16. The valves 16' are for emergency uses. The actual flow of water to each unit is separately regulated within a valve box 17 provided on each unit 4, the construction of which will be explained.

As to each unit, the only requisite is that the volume of the cooling water supplied thereto shall be adequate to cool the passing vapor and condense a definite part thereof, and thus produce a side stream of desired quality. That side stream leaves the unit through a pipe 18 as hereinafter detailed. The controlling valve, here provided in the box 17, is manually adjustable and its position in the box 17 governs the volume of the cooling water allowed to enter the unit in each case. That valve is also automatic in its action, as hereinafter explained, and has sufficient range to automatically care for variations in the volume and temperature of the rising oil vapor, and also variations in the temperature of the cooling liquid.

As an aid to a proper manual adjustment of the cooling water valve, each unit is provided with a thermometer. The latter may be positioned in or upon any upper part of the unit, as shown by points 19 in Fig. 1, but is best positioned in a thermometer well 20 provided in the side stream or pipe 18. Thus the temperature of the vapors leaving the unit, or the temperature of the condensate leaving the unit, is used as a guide in fixing and controlling the in-flow of cooling liquid. Obviously, in each case, the temperature of the departing vapor and that of the side stream are substantially the same, a temperature which fixes the character of the side stream taken from the unit.

It is clear that the total vapor temperature reduction accomplished in each unit fixes the amount and extent of the condensation likewise accomplished in that unit. The further condensation is carried, the greater the number of different oil components found in the resulting side stream and the temperature of that condensate is obviously an index to the dominating quality thereof. Reversely, a small reduction of vapor temperature produces a lesser quantity of condensate, made up of fewer segregable or fractionable components. As these units may be used in any number there is here provided the means for taking from any single stream of hot vapor, any desired number of different side streams or fractions, each of a clean-cut character.

Many starting oils are of different constitutions, and, as will be understood, the quantities or volumes of the side streams should be accurately proportioned to the corresponding components present in the oil under treatment. Further, admixture with unwanted components should be minimized; hence, the desirability of this process whereby it is made possible to practically prevent contamination; and generally, it is of great advantage that when starting oils are changed, all needed adjustments may be quickly made and thereafter automatically maintained in and by the novel apparatus here provided.

Fig. 1 is largely diagrammatic and is made to show very plainly the various valved pipes belonging to the column. If actually made as here shown, the column should be supplemented by stagings from which the various valves may be reached by the operator; otherwise the several inflow and outflow pipes, valves and thermom-

eters should be carried to ground level, or to a control board, where they may be easily reached.

While under this invention the condensate from an upper unit may be used as cooling medium in a lower unit, this invention definitely prefers and proposes a closely governed fresh attack upon each definite part of the vapor column considered as a whole. It also proposes and accomplishes the substantially complete vaporization of the supplied liquid in each stage, and the common contaminations of side streams are thereby avoided.

At the top of the column a safety valve 21 may be used; and a final condenser 22 may be there provided, and also means 23 for exhausting non-condensable gases.

The column C here shown at the side of the fractionating column B receives the crude oil through the pipe 24 and contains a plurality of coils 25 connected with respective side stream pipes 18, whereby the heat of the side streams is imparted to the crude oil as the latter moves toward the still A. The cooled side streams are taken out through coil connections 25, while the heated crude is taken from the base of the column, as by a pump 26 which is used to feed the still A.

The relations and general construction, use and operation of the fractionating column B being now understood, attention is directed to Figs. 2 to 6 inclusive, which better illustrate the pertinent details of one of the so-called units 4. All said units are of the same construction and mode of operation.

Having to deal with highly inflammable vapors, the unit 4 as a whole should be dependable in every respect. For this reason it is preferred to avoid the use of castings; and each unit is best made of wrought metal, autogenous welding being employed where necessary.

Convenient flanges 4' are provided at top and bottom of the unit body for easy attachment to abutting units. Instead of bolting the units together, the completed units may be welded end to end, no unit containing any part likely to require repair. All critical joints are visible from the exterior for ready inspection or repair.

The whirl-promoting or centrifugal element 5, called a "tuyère", is preferably composed of thin sheet metal. In other words, it is of small mass and cylindrical, presenting a circumferential series of closely spaced tangential blade portions 5a, all having the same direction.

The top of said tuyère is open, as shown at 5b, while the bottom is closed by a conical disc 5c having a central liquid inlet 5c'. The part 5e is a disc below the bottom part 5c and protecting the latter from the direct blast of the hot vapor.

The part 5 is supported by a flange 5f together with a cylindrical wall 5g, the latter narrowly spaced from the inner wall of the body portion and widely spaced from the exterior of the bladed part 5. The wall 5g is fixed to the wall of the body portion, by a ring portion 5h.

An optional part comprises the inverted dish-like element 5i, reaching nearly to the bottom of the space 5f. Said element 5i has an opening 5k in its top, preferably defined by a down-turned, pressure-effecting lip 5'. The part 5i is supported from the part 5g, as by cross studs 5m.

The space 5n within the element 5i forms a separating race and the space above the element 5i forms another separating race 5p. The skirt or vertical part of the element 5i divides the annular space 5j into two parts, one serving to re-

ceive the condensate from the race 5n and the other serving the race 5p. It is also required to provide a liquid seal, which balances the slight pressure difference between the inner and outer drain spaces. The side stream pipe 18 leads outward from condensate-collecting space 5j.

The inflow liquid pipe 16 and the valve box 17, before mentioned, are clearly marked in Fig. 1. The valve box 17 is of relatively large diameter and contains a valve seat 17', also of large diameter and past which the liquid from the pipe 16 flows into the box 17.

The liquid which enters the box 17, flows into the element 5, through the pipes 16a, 16b and a vertical section 16c, attached to the bottom 5c at the opening 5c'. The part 5q is a spreader, spaced from the floor portion 5c, and supported as by the central post shown. The part 5r is a vortex-defeating cone supported therewith.

Coacting with the seat 17' is a similarly large valve disc 17'' which is mounted upon a valve stem 27 that extends through the closed end of the box and across the upper part of the unit. That stem is adjustable from its end 27'' which is exposed upon the opposite side of the unit. The valve stem is composed of a metal having a very low co-efficient of expansion, preferably Invar, an iron and nickel alloy. The body of the unit expands under heat and the relatively non-expandible valve stem coacts therewith to move the valve 17'', with respect to the valve seat 17'. That valve is always open during operation; and because of the large diameters of seat and valve disc a very slight thermostatic movement serves to adequately change the flow of cooling liquid from the pipe 16.

A packing box 28 is preferably interposed between the box 17 and the interior of the unit, and in the opposite side of the unit is another packing box 29. Beyond the latter, the stem 27 is threaded and the outer end of the stem is squared for operation by a suitable wrench or hand wheel (not shown). The stem is to be adjusted after vapor is admitted to the column and that work is done while the operator looks at the adjacent thermometer, before mentioned.

By manual adjustment in this manner the quantity of liquid going to the unit is fixed to yield a side stream of desired temperature and quality. After such adjustment, the thermostatic valve works automatically to maintain the side stream at a fixed constant.

The stem is held in the fixed complementary, threaded, part 30, and after adjustment is locked therein. As shown in Fig. 6 the part 30 is split and may be tightened upon the threaded stem by a clamping bolt, 31.

During operation, the hot vapor ascends through the annular passage 32 (surrounding the element or tuyère 5) and passes into the element 5, through the numerous tangential tuyère openings formed by the many blades 5a. Being thereby directed, the vapor whirls vigorously within the element 5, forming the vapor vortex, before mentioned. At the same time liquid from the pipe 16, passes out beneath the spreader 5q and, in sheet-like form, moves outward across the floor portion 5c.

As well known, the surface tension of a liquid forming a thin sheet, particularly when disturbed, tends to separate it into many drop-like parts. That is what takes place on the floor part 5c, and the broken liquid is caught by the whirling vapor and almost instantaneously broken up into many finer droplets or particles. The thus comminuted

liquid continuously takes on the whirling motion of the vapor and due to that whirling motion and the centrifugal forces developed, the liquid particles remain in the outer part of the tuyère portion, spiralling upward with the vapor. In that manner a comparatively thick, foraminous wall of whirling liquid particles is constantly maintained, through which the vapor must pass in order to reach the central portion of the element

5. Continued and very intimate contact between vapor and liquid is thus ensured and, as a result, the supplied liquid is continuously or progressively vaporized by heat accepted from the hot vapor; and reversely, the evaporation of that liquid lowers the temperature of the hot vapor and thus forms an oil condensate having substantially the same temperature as the cooled, residual (departing) vapor.

The oil condensate formed by the cooling of the oil vapor is presented in the form of particles within the element 5 and which take on the same whirling and spiral motion above described with reference to the action of the comminuted cooling liquid. Presently and progressively, the condensate particles are consolidated against the imperforate rim 5' of the element 5, and are whirlingly ejected from the top of that tuyère portion, to be caught in the described collecting races 5n and 5p. Concurrently, the uncondensed vapor (that of lowered temperature) passes upward and onward to the next condensing and separating unit. As explained, the condensates drain into the annular collecting space 5j and are discharged through the side stream pipe 18. Thus the operation of interchange is completed.

During all of this time the uncondensed or residual hot vapors pass through and correspondingly heat the upper part of the unit body, and the latter responds to changes of temperature in those vapors; that is, the size of the unit body changes with every change of vapor temperature. Such changes may be caused by variations in the quantity or the temperature of the vapor entering the element 5, and by variations in the quantity of cooling water admitted from the pipe 16; and as explained, very slight expansion or contraction of the body portion of the unit results in respectively opening or closing the automatic valve described, as required to maintain the temperature of the side stream as a constant. That operation here described as to one column unit takes place in each unit of the column, differing only in temperature. In this manner any desired condensate or "side-stream" may be taken from the vapor of any composite or fractionable liquid, petroleum being a familiar representative of such liquids.

Most safely and conveniently the body of this unit 4 is of cylindrical form and, preferably, all units are of the same cross-sectional area. Capacity is computed by multiplying internal cross section, preferably one square foot, by the travel, in feet, of the rising vapor, in a unit of time. For example, each unit 4 herein shown is presumed to have an internal diameter of approximately fourteen inches and a height of two feet, from which all other parts may be readily proportioned. Vapor movement may safely range from 1,000 to 3,000 cubic feet per minute, giving this column very high capacity. To be contrasted therewith are the velocities ruling in present-day fractionating towers, the latter rarely attaining 300 feet per minute, which indeed endangers the products by inducing entrainment. Here, swift movement of the vapors is

definitely beneficial; and, by reason of the small number of units required, high velocity becomes possible without entrainment and without objectionable pressure drop or loss between the still and the top of this new column. As will be apparent, this column, for a like number of side-streams, is many times smaller than present fractionating towers of equal capacity; further, these columns may be used in multiple; and, very few thereof are needed to do the same and better work; and, they demand less attention than the common towers.

Herein, preference is expressed for certain dimensions but it is to be understood that such expressions are not limitations of the invention, for, the apparatus may be made in various sizes.

Because of the small size of this column and the definite control of temperature in each of its stages, the column may be operated without insulation. Nevertheless, such insulation is represented by dotted lines in Fig. 1.

Finally, attention is called to the fact that the perfection of the operation herein described is such that the oil vapor may be entirely condensed and disposed of in various side streams, leaving only water vapor to be finally condensed or otherwise disposed of in and from the top of the described column. This being true, the present invention first affords the means for condensing such water vapor within the column and then as an alternative proposes and claims the working of the still and the fractionating column at pressures higher than ordinary and the use of the terminal water vapor in any of the ways in which steam is used from a steam boiler, for example in a steam engine or turbine. Various uses of such steam will be readily apparent to oil refiners and others, and while not specially illustrated herein, will be recognized as of merit from the standpoint of a proper "heat balance." Where water vapor is thus generated and used under pressure, the exhaust steam may be most conveniently used to heat the crude oil for the still. Obviously, under this steam process, the still and the column together take the place of a furnace under a common boiler and the heat is more advantageously imparted to the feed water, resulting in its high efficiency as a steam generator and at the same time yielding special and superior oil condensates or side streams. Whether temperatures and pressures can be raised to the point of cracking petroleum is still a question for proper proof.

I claim:

1. The herein described improvement in the art of fractionating liquid such as petroleum, which consists in organizing a stream of hot vapor of such liquid, directing different parts of said stream into vortical motion, feeding water into each vapor vortex so formed and thereby comminuting and vaporizing the supplied water and concurrently condensing a portion of the first mentioned vapor, controlling the volume of the supplied water and thus governing the character of respective condensates, removing the condensates, and, condensing the terminal vapors.

2. The herein described improvement in the art of fractionating liquids such as petroleum, which consists in organizing a stream of hot vapor of such liquid, converting said stream into a vortex having a central discharge, feeding a cooling liquid into said vortex and thereby abstracting heat from the whirling vapor stream and condensing those constituents thereof which

liquify at the temperature of the vapor leaving said vortex, centrifugally ejecting the condensate and forming a side stream of substantially that temperature, manually adjusting the inflow of condensing liquid and thus determining the temperature of said side stream, thereafter thermostatically controlling the inflow of liquid in relation to the adjusted temperature of said side stream and thereby holding said temperature substantially constant notwithstanding variations of the initial hot vapor.

3. The herein described improvement in the art of fractionating liquid such as petroleum, which consists in organizing a stream of hot vapor of such liquid, directing said stream into a vortex having a central discharge, feeding water into said vortex and thereby abstracting heat from the vapor stream and condensing those constituents thereof which liquify at the temperature of the vapor leaving said vortex, centrifugally ejecting the condensate and forming a side stream of substantially that temperature, first manually adjusting the inflow of water and thus fixing the temperature of said side stream and thereafter thermostatically varying the inflow of water and thereby holding the side stream temperature substantially constant.

4. The herein described fractionating or condensing unit, comprising a body portion which is the vapor conduit, in combination with a whirl-promoting tuyère fixed in such conduit and providing a tangentially bladed passage through which the vapor must pass in moving from end to end of the unit, means adapted to feed condensing liquid into said tuyère to at least partially condense the passing vapor, means adapted to collect and discharge condensate from said unit, an adjustable valve adapted to control the feed of liquid into said tuyère and thus define the condensing action of the unit, and, means of an automatic nature adapted to vary the opening of said valve in response to variations in the heat of the residual vapors leaving said tuyère and any variations in the temperature of the condensing liquid entering said tuyère.

5. The herein described fractionating or condensing unit, comprising a body portion which is the vapor conduit, in combination with a whirl-promoting tuyère fixed in such conduit and providing a tangentially bladed passage through which the vapor must pass in moving from end to end of the unit, means adapted to feed condensing liquid into said tuyère to at least partially condense the passing vapor, means adapted to collect and discharge condensate from said unit, a manual valve adapted to control the feed of liquid into said tuyère and thus define the condensing capacity of the unit, and, thermostatic means incorporated with said body portion and adapted to vary the opening of said valve in response to variations in the size of said body portion.

6. The herein described fractionating or condensing unit, comprising a body portion which is the vapor conduit, in combination with a whirl-promoting tuyère closed at one end and open at the other end and fixed in such conduit and pro-

viding a tangentially bladed passage through which the vapor must pass in moving from end to end of the unit, a pipe entering said body and adapted to feed condensing liquid into the closed end of said tuyère, an annular race formed at the open end of said tuyère, means adapted to drain and discharge condensate from said race and unit, a valve in said pipe adapted to control the feed of liquid into said tuyère and thus define the condensing capacity of the unit, manual means for adjusting said valve, and, other means adapted to automatically vary the opening of the adjusted valve in response to variations in the heat of the vapor departing from such tuyère.

7. The herein described fractionating or condensing column, comprising a body portion which is the vapor conduit, in combination with a whirl-promoting tuyère fixed in such conduit and providing a tangentially bladed passage through which the vapor must pass in moving from bottom to top of the unit, the lower end of said tuyère being closed, means for feeding condensing liquid into the lower part of said tuyère, means for collecting and discharging condensate from said tuyère and a protective bottom provided in said tuyère below its closed end.

8. The herein described fractionating or condensing column, comprising a thermally expandible body portion which is the vapor conduit, in combination with means for feeding condensing liquid into said column and admixing same with passing vapor, means for discharging condensate from said column, said column being free to expand and contract in response to internal variations of temperature, a valve stem of non-expandible character crossing said column, one end of said stem being equipped with a valve member adapted to control the flow of condensing liquid into said column, and said stem being normally fixed but manually adjustable from the exterior of the column.

9. The combination as claimed in claim 8, and having in addition means for locking said stem after adjustment, leaving said valve subject to the expansion and contraction of the column.

10. The combination as claimed in claim 8 and in which said valve and its complementary seat are made of large diameter, so that slight relative movement shall produce a marked variation in the flow of the condensing liquid.

11. The combination as claimed in claim 8 and having, in addition, a temperature indicator for the condensate discharged from said unit.

12. The herein described improvement in the art of fractionating liquids such as petroleum, which consists in highly heating such liquid and organizing a stream of its hot vapor, subjecting successively different parts of that stream to vortical admixture with cool water, vaporizing the latter and producing a quantity of vapor condensate, in each case controlling the supply of water to ensure the condensation of a given portion of the hot vapor, concurrently removing the vapor condensates as side streams, and, finally condensing the terminal mixed vapors.

CHARLES GILBERT HAWLEY.