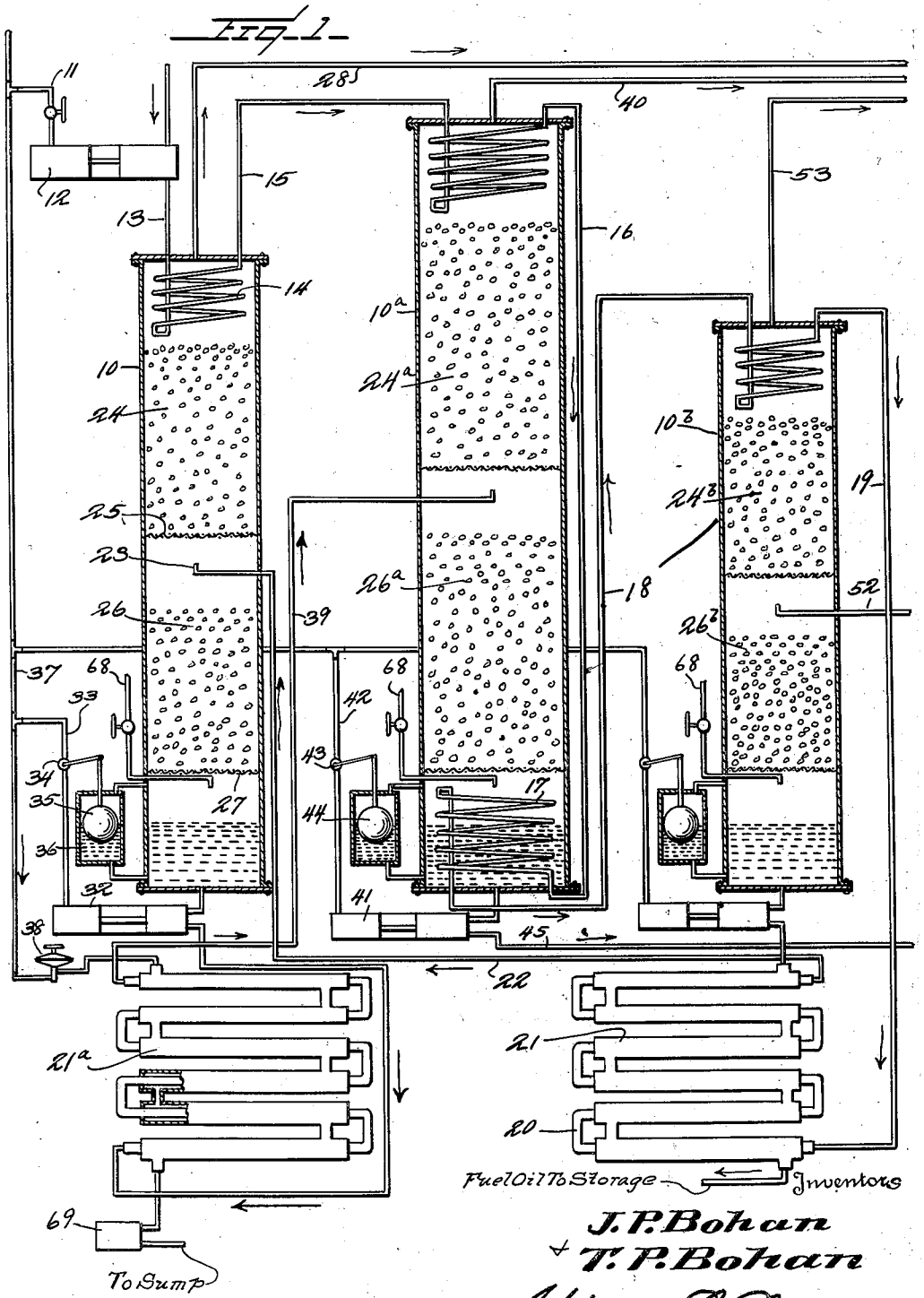
April 30, 1935. J. P. BOHAN ET AL 1,999,954

REFINING APPARATUS FOR CRUDE OIL

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Fig. 1



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REFINING APPARATUS FOR CRUDE OIL

Filed April 5, 1932 2 Sheets-Sheet 2

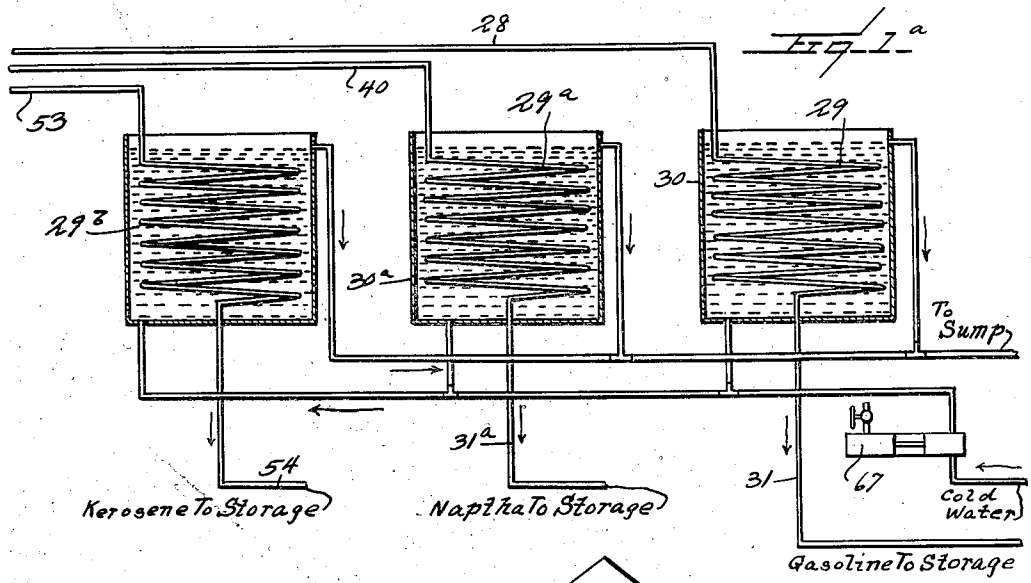


Fig. 1a

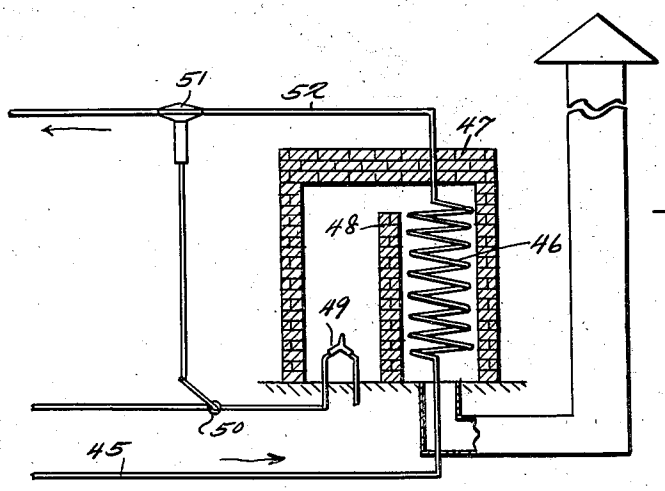


Fig. 1b

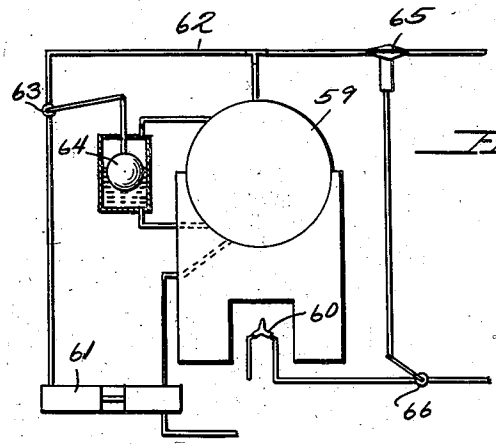


Fig. 2

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UNITED STATES PATENT OFFICE

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REFINING APPARATUS FOR CRUDE OIL

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Louisville, Ky.

Application April 5, 1932, Serial No. 603,335

6 Claims. (Cl. 196—106)

This invention relates to a system of separating various marketable products such as gasoline, naphtha and kerosene from crude petroleum oil, and particularly to a system which accomplishes this result without employing either extreme high pressure or temperature.

One of the main objects of the invention is to provide an apparatus or still of this character which is small and may be erected in an oil field whose continued production is doubtful so that in the event the field should fail, the apparatus may be easily disassembled, moved and reerected economically in another producing field.

A further object of the invention is to provide a system of this character which is automatic and may be operated by semi-skilled labor, thus securing a greater profit from a given quantity of crude oil than is possible with the stills at present in use.

Another object is to provide an apparatus of this character which since it does not employ extreme temperatures nor extreme pressures shall be considerably cheaper to build than the ordinary apparatus used.

Another object is to secure the result desired without the use of high temperatures and pressures, which act to scorch and cake the oil, thus eliminating frequent shut-downs to clean out the caked and charred heavier semi-solids from the apparatus.

A further object is to provide a system of this character in which the flow of oil through the apparatus is entirely controlled by means of the pump which initially pumps the oil into the first tower of the apparatus.

Other objects will appear in the course of the following description.

Our invention is illustrated in the accompanying drawings, wherein:—

Figure 1 is a vertical sectional view of the main portion of the apparatus, the heaters 2 of the beaters being shown in elevation;

Figure 1*a* is a diagrammatic sectional view of the condensers read in connection with Figure 1;

Figure 1*b* is a diagrammatic sectional view of the indirect heater for the last tower of the series and is to be read in connection with Figure 1;

Figure 2 is a diagrammatic elevation of the steam supplying furnace, boiler and allied parts.

The drawings are largely diagrammatic and in these drawings 10, 10*a* and 10*b* indicate towers. The crude oil is pumped from the supply pipe 11 by means of the pump 12 to the pipe 13 which conducts this oil into the reflux condenser 14 in the top of the tower 10.

It will be understood that hot vapors arising through this tower 10, as will be later stated, and the crude oil being cold will cause a small amount of these hot vapors in the tower 10 to condense and fall back in the tower and assist in the separation of the naphtha from the oil sprayed in the tower. From the reflux condenser 14, the oil is carried by pipe 15 into the reflux condenser 14*a* in the tower 10*a* and, of course, absorbs heat from the vapors arising in this tower 10*a* and causes the condensation of a portion of these vapors. From the reflux condenser 14*a*, the oil flows by pipe 16 to the lower end of the tower 10*a* and into the coil 17 which is immersed in the heavy hot oil accumulated in the bottom of the tower 10*a*. Here the oil in the coil 17 receives heat that would otherwise be wasted. From the coil 17, the oil flows by means of pipe 18 to a reflux condenser 14*b* in the upper end of the tower 10*b* where the condensing and heating operation is again repeated. From the reflux condenser 14*b*, the oil flows by means of pipe 19 into the inner pipe 20 of a heat exchanger designated generally 21. This heat exchanger consists of the convoluted inner pipe 20 and outer connected pipes surrounding the convoluted pipe 20 and connected to a source of hot oil. From the inner pipe 20 of the heat exchanger 29, the oil is carried by pipe 22 to the tower 10 and is sprayed into the middle of this tower by a spray pipe 23. Above this spray pipe is a bed of gravel 24 supported upon a perforated septum 25 and below this spray pipe 23 there is a layer of gravel 26 supported by means of the perforated septum 27. The crude oil flowing from the pipe 20 through the heat exchanger 21 is raised to a temperature of 220° F.

When the oil from the heat exchanger is sprayed into the tower 10 by the sprayer 23, the temperature of the oil is such that the lighter elements immediately turn into vapor and flow upward through the upper bed of gravel 24 while the heavier elements remain in liquid form and flow down through the lower bed of gravel 26. The object of these two beds of gravel 24 and 26 is to assist in separating all the lighter elements possible from the heavier elements in the crude oil. The lighter elements flowing upward as vapor through the upper bed of gravel are washed free of any heavier elements that might be mixed with them. This washing or cleaning effect is obtained by the reflux secured by the reflux condenser 14. From the tower 10, these vapors are

led by pipe 28 to the condensing coil 29 in the condensing tub 30 which is filled with cold water and the vapor is condensed into liquid form as gasoline and is discharged into a gasoline storage tank by the pipe 31.

The heavier elements which fall through the bed of gravel 26 and into the lower portion of the tower 10 are retained therein as a relatively deep pool of hot oil and from time to time pumped therefrom by means of the pump 32, this pump being led to a pipe 33 and the passage of steam is controlled by the valve 34. This valve 34 in turn is controlled by a float 35 in a float chamber 36 connected at its upper and lower ends to the upper and lower ends of the space beneath the plate 27 in tower 10. The pump 32 pumps the oil from the lower end of tower 10 into a second heat exchanger designated generally 21*a* and of the same character as the heat exchanger 21. The outer tubes of this heat exchanger are connected by a pipe 36 to the main steam pipe 37 which conducts steam to the pipe 33.

The pipe 37 is connected to the outer pipe of heat exchanger 21*a* by means of an automatic pressure control valve 38. Thus the temperature of the oil leaving the heat exchanger 21*a* is raised to and definitely and accurately controlled at approximately 325° F. by predetermining the pressure of the steam in the outer pipe of the heat exchanger 21*a*. From the inner tube of the heat exchanger 21*a*, the oil at a temperature of 325° F. is carried by means of a pipe 39 into the middle of the tower 10*a* and is sprayed downward in this tower through the lower bed of gravel 26*a*, the vaporized portion of this highly heated oil rising upward through the upper bed of gravel 24*a*. The vapors are discharged through the pipe 40 to the condensing coil 29*a* disposed within the condenser 30*a* and from the coil 29*a*, the liquid such as gasoline, benzine, etc., is carried off to storage by the pipe 31*a*. The unvaporized portion of the oil discharged through the pipe 39 passes down through the bed of gravel 26*a* and into the lower end of the tower 10*a* where it acts to heat the coil 17 as previously described. From the lower end of the tower 10*a*, this oil is pumped away by the pump 41. The steam for this pump is provided by the pipe 42, the passage of the steam being controlled by the valve 43 in turn controlled by a float 44, the float chamber being connected to the upper and lower ends of the space beneath the bed of gravel 26*a*. The pump 41 pumps the liquid accumulated in the lower end of the tower 10*a* into the pipe 45 and into a coil 46 which is disposed in a furnace 47. This is an intermediate heating furnace, the interior of which is divided by a fire wall 48 into two compartments, the compartments opening into each other at their upper ends.

In one of these compartments, the coil 46 is disposed and in the other compartment, there is provided a crude oil burner illustrated diagrammatically and designated 49. By providing a combustion compartment and a tube compartment in this furnace 47, better combustion is obtained, the heat is more evenly distributed and the coil 46 is not exposed to the scouring action of an open flame. The fuel preferably used in the burner 49 is crude oil left after the gasoline, naptha and kerosene have been removed. The burner 49 is of a conventional steam atomizing type, the steam flow remaining constant while the fuel supply to the burner is increased or decreased by means of the controlling valve 50 in turn controlled by a thermostat 51 in the oil line 52, which leads from the oil 46. In this heater, the oil is raised to approximately 450° F. and is then discharged through the pipe 52 and sprayed into the interior of the tower 10*b* where a separating action again takes place as in the towers 10 and 10*a*. The vapors from the tower 10*b* are led by the pipe 53 into the condensing coil 29*b* and the liquid from the condensing coil is carried to a kerosene storage tank by means of the pipe 54. The heavier elements fall in the bottom of the tower 10*b* and through the gravel beds 24*b* and 26*b* and are pumped through the outer coils of the heat exchanger 21 by means of the pump 55, this pump being controlled by the valve 56 in turn controlled by the float 57 whose float chamber is connected to the upper and lower ends of the space below the gravel bed 26*b*. From the outer coils of the heat exchanger, the oil is carried by pipe 58 to a storage tank as fuel oil.

The steam supplied through the pipe 37 to the pumps 32, 41 and 55 is secured from a high pressure steam boiler designated generally 59 heated by an oil burner 60 of the same general character as the oil burner 49 previously referred to. The boiler feed water is pumped to the boiler by means of the pump 61, the steam from which is taken from the boiler by the pipe 62 controlled by a valve 63 in turn controlled by a float 64, the float chamber of which communicates with the upper and lower portions of the boiler. Pressure in this boiler is maintained by means of the pressure controlling valve 65 which in turn controls the valve 66 which controls the flow of fuel to the burner, thereby controlling the intensity of the fire. Throughout the entire apparatus whenever any heat exchange is made, the counter-flow principle is used, that is to say the element to be heated, enters the apparatus where the heating element is coolest and leaves it where the heating element is hottest.

Each step of this apparatus is kept in time with the step preceding it by means of the float controls 35, 44, 57 and these float controls maintain a constant predetermined level in the bottom of each of the separating towers 10, 10*a* and 10*b* and retain at the lower end of each tower a relatively deep pool of hot oil. The entire apparatus is controlled by means of the master pump 12 and since all of the operations are automatic if the pump 12 is slowed down or speeded up the remainder of the apparatus will automatically adjust itself to increase or decrease within the capacity of the apparatus.

Cold water may be supplied to the condensing tubs for the condensers 24*a*, 24*b*, and 24*c* in any suitable manner as for instance the pump 67.

It will be seen from the figures that pipes 68 are associated with each tower whereby steam may be discharged into the base of each tower below the lower bed of gravel, this steam aiding in heating the condensing liquid as the steam rises through the tower.

The fuel used in the burners 49 and 60 is fuel oil left after the kerosene naptha and gasoline have been removed from the crude oil. In this way after the apparatus has once been started no outside source of fuel is necessary. The steam flow to both of these burners remains constant but the fuel supply to the burner is increased or decreased by means of the controlling valves as set forth, changing the flow of fuel oil to secure any desired variation in heat output of the burners. The water condensate in the outer coils of the heat exchangers 21*a* is carried off by means

of the steam trap 69 or in any other suitable manner.

We claim:—

1. A petroleum distilling apparatus including a series of counter-flow towers, each heated to a different temperature and each having a charge preheating coil in its upper end, means for conducting oil at a relatively low temperature successively through the several coils from the coil in the tower of least temperature to the coil in the tower of highest temperature, means for spraying the petroleum flowing from the last coil of the series in the tower of higher temperature into the first and coolest tower of the series whereby to separate the vapor from the liquid, means for pumping the oil collected in the lower end of each tower of the series except the last tower into the next tower of the series and spraying it thereinto, means for pumping the liquid from the last tower of the series, each of the pumps associated with the towers having controlling means therefor in turn controlled by the level of the liquid in the corresponding tower, means for carrying off and separately condensing the vapors from the several towers, means for heating the liquid in any one tower to a predetermined degree before it is sprayed into the next succeeding tower, means for using liquid taken from the lower end of the last and hottest tower of the series as a heating medium in heating the transfer apparatus for the oil passing into the first and coolest tower of the series, means for using steam at a constant pressure and temperature as a heating medium in the transfer apparatus for the oil passing from the first and coolest tower of the series into the second tower thereof, and means for heating the oil from the next to the last tower to a predetermined temperature.

2. A petroleum distilling apparatus including a series of towers, each heated to a different temperature and each having a charge preheating coil at the upper end thereof, means for conducting relatively cool oil from a source successively through the several coils from the coil in the tower of least temperature to the coil in the tower of highest temperature, heat transferring apparatus through which the oil for the last coil of the series is conducted, a pump connected to the last tower of the series and discharging liquid from the bottom of this tower into the heat transferring apparatus, means for controlling said pump in accordance with the liquid level in the last tower of the series, means for conducting oil from said heat transfer apparatus to the first tower of the series and spraying said oil downward through the tower to thereby separate the lighter fractions from the liquid, a second heat transfer apparatus, means for conducting steam at a predetermined pressure through heat transfer apparatus, a pump taking oil from the lower end of the first tower of the series and forcing the oil through the heat transfer apparatus and into the second tower of the series, a float actuated by the level of liquid in the first tower of the series for controlling said last named pump, means for spraying the oil downward through the second tower of the series whereby to separate the vaporized fraction from the liquid, a pump receiving oil from the lower end of the second named tower, float operated means associated with the second named tower for controlling the operation of said second named pump, a heater, the pump discharging liquid into said heater, the other end of the heater having a pipe discharging into and spraying the liquid down into the third tower of the series.

3. A method of separating fractions from petroleum consisting in conducting the charge of petroleum at a constant speed successively through reflux coils in the upper ends of a series of counter-flow towers, each tower of the series being heated to a higher degree than the tower immediately preceding it, carrying the oil through the reflux coil of an intermediate tower of the series into a coil disposed in the base of the said intermediate tower, then conducting the oil to a reflux coil in the upper end of a final tower, heating the oil flowing from this final coil to a temperature of approximately 220° F., spraying it into the first tower of the series to permit the separation in said tower of the lightest fractions from the petroleum, pumping off the liquid from the lower end of this first tower at a constant rate and simultaneously heating the liquid to a temperature of 325° F., spraying this liquid at this temperature into an intermediate counter-flow tower to separate the gasoline fractions, pumping off the liquid in the lower end of the last named tower and forcing it at a constant speed through a furnace and raising it in this furnace to a temperature of 450° F., discharging the oil so heated into and spraying it downward through a third counter-flow tower to separate the kerosene fractions from the remainder of the oil, carrying off and separately condensing the vapors from the several towers, and controlling the temperature of the said furnace to maintain said temperature constant.

4. A petroleum distilling apparatus including a series of towers each heated to a different temperature, each having a charge preheating reflux condensing coil therein, the condensing coils being connected in series with a steam operated master pump and being disposed successively in towers of increasing temperature, means for heating the petroleum before it passes into the condensing coil of the last tower of the series, means for heating the petroleum after it passes through the coil in the last tower and spraying it into the first tower of the series, a steam operated pump for each tower of the series except the last and taking liquid from the bottom of one tower and spraying it into the next tower of the series, means for highly heating the petroleum immediately before its discharge into the last tower of the series, a pump for the last tower discharging liquid from the bottom of the tower, all of said pumps having a common source of steam, and means controlled by the level of liquid in each tower for controlling the passage of steam to the corresponding pump.

5. A petroleum distilling apparatus including a series of counter-flow towers each having a charge preheating reflux condensing coil therein, the condensing coils being connected in series with a source of relatively cold crude petroleum and a master steam pump, means for heating the petroleum before it passes into the condensing coil of the last tower of the series, means for heating the petroleum after it passes through the coil of the last tower and spraying it into the first tower of the series, a pump for each tower except the last, each pump taking liquid from the bottom of the corresponding tower and spraying it into the next tower of the series, means for heating the liquid prior to its discharge into the last tower of the series, a pump for the last tower of the series taking liquid from the bottom of this tower and discharging it for storage,

all of said pumps having a common source of steam supply, a steam controlling valve for each pump, and means controlled by the height of liquid in the lower end of each tower controlling the admission of steam to the corresponding pump.

6. A method of refining crude petroleum oil which consists in pumping the crude petroleum at a constant rate successively through a series of reflux condensing coils in the upper ends of a series of counter-flow towers to thereby preheat the oil, spraying the oil from the last tower of the series downward through the first tower of the series at a temperature of approximately 220° F., pumping off the liquid from the bottom of the first tower, heating the liquid so pumped off to approximately 325° F. and discharging it into the second tower, pumping off the liquid from the bottom of the second tower, raising its temperature to approximately 450° F. and discharging it into a third tower separately carrying off and condensing the vapors from all these towers, pumping off the liquid from the third tower of the series, controlling the several pumps associated with the several towers in accordance with the level of the liquid in the bottoms of the several towers to thus maintain pools of constant depth in the bottom of the towers and utilizing the hot liquid at the bottom of the second named tower to heat the oil passing to the reflux condenser of the third named tower and utilizing the liquid from the bottom of the third named tower to heat the oil sprayed into the first named tower.

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