

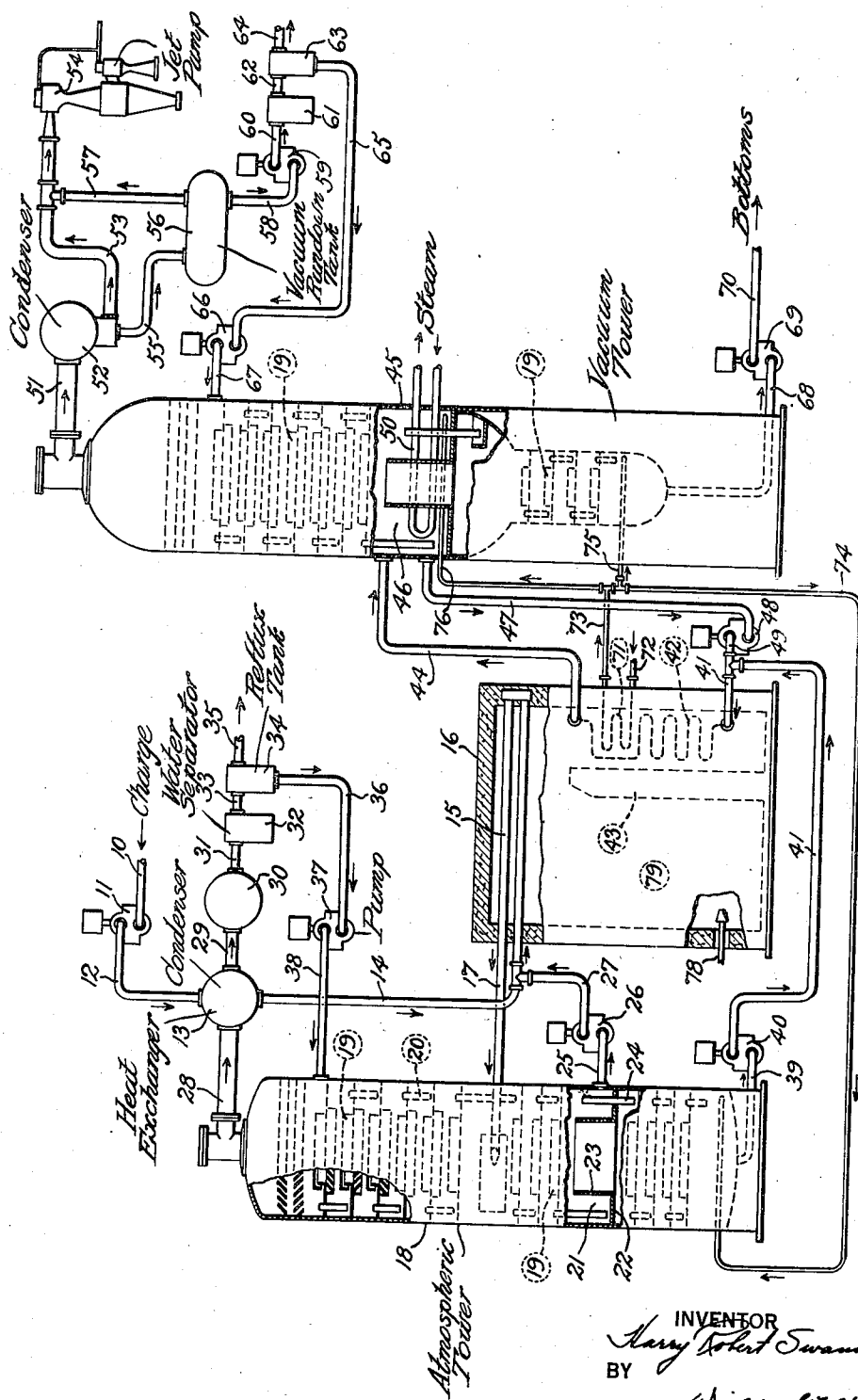
Jan. 18, 1938.

H. R. SWANSON

2,105,935

OIL TREATMENT

Filed Nov. 26, 1930



INVENTOR
Harry Robert Swanson
BY
William E. M. Knight
ATTORNEY

UNITED STATES PATENT OFFICE

2,105,935

OIL TREATMENT

Harry Robert Swanson, White Plains, N. Y., as
signor to Foster Wheeler Corporation, New
York, N. Y., a corporation of New York

Application November 26, 1930, Serial No. 498,218

11 Claims. (Cl. 196—73)

My invention relates to the art of distillation and more particularly to the distillation of hydrocarbons.

One of the objects of my invention is to provide an apparatus for the treatment of crude oils under both atmospheric and sub-atmospheric pressure while utilizing a single heater for heating the oil to be so treated. Heretofore it has been the practice to employ one heater to heat the oil before its introduction into the atmospheric apparatus and to employ a second separate heater to heat the oil before its introduction into the sub-atmospheric or vacuum apparatus. While attempts have been made to incorporate both of these heaters in a single furnace setting, the result has been far from satisfactory due to the inability to regulate the temperatures in the two heaters independently of each other. This may be done to some degree by placing the tubes for one heating operation in the roof of a furnace and the tubes for heating of the subsequent operation in the convection bank of the same furnace. When a furnace of this type operates at maximum efficiency, the ratio of the work done in the radiant or roof section to the work done in the convection bank, remains constant. The charging stock, however, is subject to a varying boiling point range, dictated by plant operation and by various charging stocks. In order to take care of this variation, it is necessary to vary the furnace efficiency by firing with more or less excess air which involves a sacrifice in furnace efficiency and an increase in fuel consumption.

I propose to incorporate both banks of tubes in a single furnace setting and to provide additional means in either of the atmospheric or the vacuum apparatus for varying the relative quantity of heat supplied to the oil in the two apparatuses. Hence, the furnace may be operated with a minimum excess air, thus obtaining high efficiencies.

Further objects and advantages of my invention will be apparent from the following specification considered in connection with the accompanying drawing on which is shown more or less diagrammatically, a preferred form of apparatus for carrying out my invention.

Referring to the drawing, reference character 10 designates a conduit leading from a supply of crude oil. Conduit 10 communicates with a pump 11, the discharge of which is connected by a conduit 12 to a surface type heat exchanger 13 which is in turn connected by means of a conduit 14 with a bank of roof tubes 15 located in the upper part of a furnace setting 16. A conduit 17

connects the outlet of roof tubes 15 with the interior of an atmospheric fractionating tower 18.

The interior of tower 18 is provided with a series of bubble trays 19, both above and below the point where conduit 17 communicates with the tower. Each bubble tray is provided with a down pipe 20 for conducting liquid downwardly from one tray to the next. Below conduit 17 within the tower is provided a pocket 21 formed by a ring-shaped disc or collecting deck 22 provided with a central cylindrical flange 23. A down flow pipe 24 extends from near the top of pocket 21 through plate 22 and discharges onto the next bubble tray below the plate. A conduit 25 communicates with the lower part of pocket 21 and with a pump 26, which discharges through a conduit 27 to conduit 14.

A conduit 28 communicates with the upper part of tower 18 and extends to heat exchanger 13. The heat exchanger 13 is connected by means of conduit 29 with a final cooler 30 which in turn is connected by a conduit 31 with a water separator 32. A conduit 33 connects the separator 32 with a reflux tank 34. A conduit 35 extends from the upper part of reflux tank 34 and leads to storage while a conduit 36 connects the lower part of the reflux tank with a reflux pump 37, which discharges through a conduit 38 into the upper part of tower 18.

A conduit 39 communicates with the bottom of tower 18 and leads to a pump 40 which discharges through conduit 41 to a bank of convection tubes 42 placed in furnace 16 behind the bridge wall 43 thereof so as to be located in the path of the products of combustion leaving the furnace. A conduit 44 connects the outlet of tubes 42 with the interior of a vacuum fractionating tower 45. Vacuum tower 45 is constructed internally similar to atmospheric tower 18 and is provided with a series of bubble trays 19 above and below the point of communication of conduit 44 with the tower. A pocket 46, similar to pocket 21 in tower 18, is formed in tower 45 just below conduit 44. A conduit 47 communicates with the lower part of pocket 46 and leads to a pump 48 which discharges through a conduit 49 to conduit 41. A closed steam coil or heater 50 which may comprise one or more tubes of any desired arrangement and structure is located within pocket 46 so as to be in contact with liquid contained in the pocket.

A conduit 51 communicates with the upper part of tower 45 and leads to a condenser and cooler 52. A conduit 53 connects the hot well of condenser 52 with a steam jet vacuum pump 54. A

conduit 55 connects the bottom of the hot well with a vacuum run down tank 56. The upper part of tank 56 is in communication with conduit 53 by means of a conduit 57. A conduit 58 leads from the bottom of the run down tank to a pump 59 which discharges through a conduit 60 to a water separator 61. Water separator 61 is connected by means of a conduit 62 with a reflux tank 63. A conduit 64 conducts oil from tank 63 to storage while a conduit 65 conducts reflux oil from the tank to a reflux pump 66, which discharges through a conduit 67 into the upper part of tower 45. A conduit 68 communicates with the bottom of tower 45 and with a pump 69 which discharges through conduit 70 to storage.

Incorporated in the furnace setting is a superheater 71 which is supplied with steam through a conduit 72 and discharges superheated steam through a conduit 73. Conduit 73 communicates with a conduit 74 which leads to the lower part of atmospheric tower 18 and with conduits 75 and 76 which lead to within vacuum tower 45. A burner 78 supplies oil for combustion in the furnace chamber 79.

The operation of the above described apparatus is as follows:

Crude oil is pumped by means of pump 11 from conduit 10 through conduit 12 to heat exchanger 13, where it is heated somewhat, and thence passes through conduit 14 to the bank of roof tubes 15 located near the roof of the furnace. In passing through the roof tubes 15 the crude oil is heated principally by radiant heat to the desired maximum temperature. In order to obtain color stability and to eliminate thermal decomposition and polymerization of unsaturated products, this maximum temperature, in the case of certain crude oils, is necessarily below the boiling point of the oil at atmospheric pressure. The oil thus heated to this maximum temperature is introduced through conduit 17 into tower 18. Superheated steam is introduced into the tower through conduit 74 and reduces the partial pressure of the oil vapor and thus vaporization of the oil will take place in the tower at a temperature below its normal boiling point. However, the oil introduced into the tower at the maximum allowable temperature will not contain sufficient heat to supply the latent heat of vaporization necessary to vaporize the desired quantity of oil in the tower. Hence, unvaporized oil is collected in pocket 21 and a portion of this oil is recirculated through conduit 25, pump 26 and conduit 27 to conduit 14 where it is blended with the newly supplied oil and passed again through the tubes 15 and thence back to the tower 18. The amount of oil thus recirculated is regulated so that the desired quantity of heat will be carried by the oil into the tower to provide the necessary latent heat of vaporization and so that the oil will be heated in the roof tubes to the desired temperature.

Vapor passes upwardly in tower 18 through the bubble trays 19 therein in the usual manner and is discharged from the top of the tower through conduit 28 to heat exchanger 13 where it gives up some of its heat to the crude oil admitted to the heat exchanger through conduit 12. The vapor passes from the heat exchanger through conduit 29 to condenser 30 where the oil vapor and the steam are condensed and pass through conduit 31 to water separator 32. Liquid oil passes through conduit 33 to reflux tank 34 from which a portion of the oil is led through conduit 35 to storage while the remainder passes through

conduit 36, reflux pump 37 and conduit 38 to the upper part of tower 18. The reflux liquid passes downwardly through tower 18 from one bubble tray to the next through down pipes 20 while the vapor passing upwardly through the tower bubbles through the reflux.

Liquid oil not vaporized in tower 18 passes from the bottom thereof through conduit 39 to pump 40 which forces it through conduit 41 to the tubes 42 where the oil is again heated. In tubes 42 the oil may not be heated above the aforementioned or other predetermined maximum temperature and the oil heated to this temperature is discharged through conduit 44 to within vacuum tower 45. However, inasmuch as the heating by the furnace is determined by the amount of heat necessary to be supplied to roof tubes 15, this amount of heat would heat the oil passing through tubes 42 to too high a temperature if the only oil that passed through these tubes was that supplied from the bottom of tower 18. Therefore, oil is taken from pocket 46 in tower 45 and passed through conduit 47, pump 48 and conduit 49 to be recirculated through the tubes 42. Now, if sufficient oil were to be recirculated in this manner to carry the required amount of heat into tower 45 to provide the necessary latent heat for the vaporization of liquid therein, the temperature of the oil leaving tubes 42 would be below the desired predetermined temperature. In order to remedy this situation I recirculate only a sufficient quantity of oil to maintain the temperature of the oil discharged from tubes 42 at the desired temperature. The remainder of the heat necessary for vaporization of the oil in tower 45 is supplied by the steam coil 50, which heats the oil in pocket 46 in the tower.

Steam jet vacuum pump 54 maintains a vacuum within tower 45 and this, in connection with the reduction of partial pressure due to the introduction of superheated steam, causes the vaporization of oil in the tower at a temperature much below the boiling point of the oil under atmospheric conditions. The oil thus vaporized passes upwardly through the bubble trays 19 and through conduit 51 to the condenser and cooler 52. In the condenser 52 the oil vapors and steam are condensed and pass through conduit 55 to vacuum run down tank 56. The non-condensable gases pass through conduit 53 to steam jet vacuum pump 54, which pump as before stated, maintains the vacuum within tower 45. Liquid passes from vacuum run down tank 56 through conduit 58, pump 59 and conduit 60 to water separator 61. The oil passes from the water separator through conduit 62 to reflux tank 63. A portion of this oil passes through conduit 64 to storage while the remainder passes through conduit 65, pump 66 and conduit 67 to be used as reflux in the tower 45. The bottoms from tower 45 pass through conduit 68, pump 69, which forces them through conduit 70 to storage.

Thus it will be seen that I have provided a method and apparatus for carrying it into effect which requires but a single furnace for heating the oil supplied to both the atmospheric apparatus and the vacuum apparatus, which furnace may be operated at a maximum efficiency without heating any of the oil above a permissible maximum temperature. Additional heat required in one of the towers is provided by steam coils placed directly in the tower.

While I have shown and described a preferred embodiment of my invention it is to be understood

that it is diagrammatic and that my invention is not to be limited thereby but is to be given the broadest interpretation commensurate with the appended claims.

5 What I claim is:

1. Apparatus for the two-stage distillation of hydrocarbon oils and the like comprising a heater having a first heating coil and a second heating coil, a first fractionating tower and a second
10 fractionating tower, means for introducing charging stock into the tubes in the first heating coil of the heater wherein the oil is heated to a predetermined maximum temperature below the initial boiling point of oil under the total pressure
15 existent in the first fractionating tower, means for introducing oil heated in said last mentioned heating coil into the first tower, means for introducing steam into the first tower, thereby reducing the partial pressure of the oil vapor and
20 causing vaporization to take place, means for separating the vaporized and unvaporized portions of the oil, means for recirculating part of the unvaporized oil introduced into the first tower through the tubes in the first heating coil
25 of the heater, together with charging stock, and reintroducing it into the first tower to supply the latent heat for the desired vaporization, means for introducing bottoms from the first tower into the tubes in the second heating coil of the heater,
30 means for introducing oil from the second heating coil into the second tower, means for maintaining the second tower under a pressure lower than that in the first tower, means for introducing steam into the second tower thereby reducing the partial pressure of the oil vapor and
35 assisting vaporization to take place, means for separating the vaporized and unvaporized portions of the oil, means for collecting unvaporized oil in the second tower, means for recirculating enough of said collected oil through the tubes
40 in the second heating coil of the tower with bottoms from the first tower and reintroducing it into the second tower so that the mixture will be heated only to said predetermined maximum
45 temperature, and means for supplying heat to the oil collected in the second tower to supply the balance of the latent heat needed for the desired vaporization thereof.

2. The process of distilling hydrocarbon oils and the like which comprises passing the oil
50 through a first section of a heating zone to heat the oil to a predetermined maximum temperature below the initial boiling point of the oil under the total pressure existent in a first fractionating zone, introducing the heated oil into said frac-
55 tionating zone, introducing steam into said fractionating zone thereby reducing the partial pressure of the oil and causing vaporization to take place, recirculating unvaporized oil from said
60 fractionating zone through the said section of the heating zone and reintroducing it into said fractionating zone to supply the latent heat for the desired vaporization of the oil in said fractionating zone, withdrawing liquid oil from said frac-
65 tionating zone, passing the withdrawn liquid oil through a second heating section of said heating zone, introducing the last mentioned heated oil into a second fractionating zone maintained at a lower pressure than the first fractionating zone,
70 introducing steam into the second fractionating zone thereby reducing the partial pressure of the oil and assisting vaporization to take place, recirculating through the said second heating section of the heating zone with the oil from the
75 first fractionating zone, sufficient liquid oil from

the second fractionating zone to cause the mixture to be heated only to said predetermined temperature and supplying the balance of the latent heat to the oil in the second fractionating zone to obtain the desired degree of vaporization thereof. 5

3. An apparatus for continuously distilling petroleum oils containing asphalt having in combination, a column having a stripping section, a collecting deck at the top of the stripping section, a heater for heating the oils and asphalt together
10 in the liquid phase, a feed line to the heater, means for discharging oils from the heater onto the collecting deck, a draw-off pipe leading from the collecting deck, a pump for pumping material from the collecting deck to the feed line, 15
a steam admission pipe at the bottom of the column, and an overflow pipe for carrying residue from the collecting deck downwardly in counter-current with the steam.

4. An apparatus for continuously distilling 20 petroleum oils containing asphalt having in combination, a heater for heating the oil and asphalt together in the liquid phase, a feed line to the heater, a column having a stripping section with a collecting deck located intermediate the top and
25 bottom plates of the stripping section, means for discharging oils from the heater onto the top plate of the stripping section, a draw-off pipe leading from the collecting deck, a pump for pumping material from the collecting deck to the 30
feed line, a steam admission pipe at the bottom of the column and an overflow pipe for carrying residue from the collecting deck downwardly in countercurrent with the steam.

5. An apparatus for continuously distilling 35 petroleum oils comprising a heater for heating the oil, a feed line to the heater, a column having a stripping section with a collecting deck located intermediate the top and bottom plates
40 of the stripping section, means for discharging oils from the heater onto the top plate of the stripping section, a draw-off pipe leading from the collecting deck, a pump for pumping material from the collecting deck to the feed line, 45
a steam admission pipe at the bottom of the column and an overflow pipe for carrying residue from the collecting deck downwardly in countercurrent with the steam.

6. Apparatus for the distillation of hydrocarbon oils comprising a heater for heating the
50 oil to vaporization temperature, a fractionating column having a stripping section, a collecting deck associated with the stripping section, means for discharging unvaporized oil from the heater onto the collecting deck, means for conducting
55 oil from the collecting deck to the stripping section, and means for recirculating oil from the collecting deck through the heater.

7. Apparatus for the distillation of hydrocarbon oils comprising a heater for heating the oil to
60 vaporization temperature, a fractionating column having a stripping section, a collecting deck at the top of the stripping section, means for discharging unvaporized oil from the heater onto the collecting deck, means for conducting oil
65 from the collecting deck to the stripping section, and means for recirculating oil from the collecting deck through the heater.

8. Apparatus for the distillation of hydrocarbon oils comprising a heater for heating the oil to
70 vaporization temperature, a fractionating column having a stripping section, a collecting deck disposed intermediate the top and bottom plates of the stripping section, means for discharging unvaporized oil from the heater into the upper 75

portion of the stripping section, means for conducting oil from the upper portion of the stripping section to the collecting deck, means for conducting oil from the collecting deck to the lower portion of the stripping section, and means for recirculating oil from the collecting deck through the heater.

9. Apparatus for the distillation of hydrocarbon oils comprising a heater for heating the oil to vaporization temperature, a fractionating column having a stripping section at the bottom of the column, a collecting deck associated with the stripping section, means for discharging unvaporized oil from the heater onto the collecting deck, means for conducting oil from the collecting deck to the stripping section, and means for recirculating oil from the collecting deck through the heater.

10. Apparatus for the two-stage distillation of hydrocarbon oils and the like comprising a heater having a first heating coil and a second heating coil, a first fractionating tower and a second fractionating tower, means for introducing charging stock into the tubes in the first heating coil of the heater wherein the oil is heated to a predetermined maximum vaporization temperature below the initial boiling point of oil under the total pressure existent in the first fractionating tower, means for introducing oil heated in said last mentioned heating coil into the first tower, means for separating the vaporized and unvaporized portions of the oil, means for recirculating part of the unvaporized oil introduced into the first tower through the tubes in the first heating coil of the heater, together with charging stock, and reintroducing it into the first tower to supply the latent heat for the desired vaporization, means for introducing bottoms from the first tower into the tubes in the second heating coil of the heater, means for introducing oil from the second heating

coil into the second tower, means for separating the vaporized and unvaporized portions of the oil, means for collecting unvaporized oil in the second tower, means for recirculating enough of said collected oil through the tubes in the second heating coil of the tower with bottoms from the first tower and reintroducing it into the second tower so that the mixture will be heated only to said predetermined maximum temperature, and means for supplying heat to the oil collected in the second tower to supply the balance of the latent heat needed for the desired vaporization thereof.

11. The process of distilling hydrocarbon oils and the like which comprises passing the oil through a first section of a heating zone to heat the oil to a predetermined maximum vaporization temperature below the initial boiling point of the oil under the total pressure existent in a first fractionating zone, introducing the heated oil into said fractionating zone, recirculating unvaporized oil from said fractionating zone through the said section of the heating zone and reintroducing it into said fractionating zone to supply the latent heat for the desired vaporization of the oil in said fractionating zone, withdrawing liquid oil from said fractionating zone, passing the withdrawn liquid oil through a second heating section of said heating zone, introducing the last mentioned heated oil into a second fractionating zone, recirculating through the said second heating section of the heating zone with the oil from the first fractionating zone, sufficient liquid oil from the second fractionating zone to cause the mixture to be heated only to said predetermined temperature and supplying the balance of the latent heat to the oil in the second fractionating zone to obtain the desired degree of vaporization thereof.

HARRY ROBERT SWANSON.