

UNITED STATES PATENT OFFICE.

MILON J. TRUMBLE, OF ALHAMBRA, CALIFORNIA.

REFINERY POWER PLANT.

Application filed December 1, 1922. Serial No. 604,301.

This invention relates to the oil refining industries, and relates particularly to equipment for refining petroleum oils.

Crude petroleum oils, as taken from the wells, are compositions of various hydrocarbon elements which are adapted to a wide variety of uses. These hydrocarbons are separated from the crude oil by distillation, the component hydrocarbons of which the crude oil is formed having different gravities, being drawn off from the distilling operation at the separate temperatures at which the particular elements volatilize. Many forms of equipment and many processes are employed in segregating the constituent parts of crude oil. These processes all agree in one thing; the expenditure of heat for the volatilization of the constituent volatiles which are subsequently liquefied from their gaseous state by the removal of heat therefrom in condensers.

The now extensively employed and efficient systems for refining of the light hydrocarbons from petroleum oils are continuous in operation. In these systems the crude oil is conducted through heating coils at high speed and under pressure, in which heating coils the oil is raised to the volatilization point of the particular hydrocarbon constituent which it is desired to distill off from the crude base. From the heating coils the unvolatilized crude oil and the volatilized hydrocarbon are conducted into separators or vaporizers in which the liquid hydrocarbons are separated from the gaseous hydrocarbons, the heated residuum being thence conducted through a heat interchanger to heat the inflowing new crude oil and the volatilized hydrocarbons being conducted through condensers in which they are reduced to a liquid state by the cooling action of cold water delivered through the condensers for this purpose. The heat employed for the purpose of distillation in these systems is taken up by the cooling water in the condensers and is finally dissipated into the atmosphere at the cooling towers which are employed to reduce the temperature of the water so that it may again be employed for condensing volatilized hydrocarbons at the condensers.

In the large oil refineries many barrels of oil are used as fuel to volatilize the hydrocarbon constituents of the oil being refined. This volatilization of the volatile hydrocarbon does not constitute an actual expendi-

ture of heat because this heat is still present in the volatilized elements up to the time they are condensed, and must be removed therefrom at the condensers in order to liquefy the product into commercial form. Under these conditions it may be rightfully considered that the actual point at which the heat is expended or given off is at the condensers and cooling tower. For the purpose of dissipating this heat into the atmosphere large quantities of water and batteries of cooling towers are employed, and the heat which is dissipated thereby is an actual loss of power in heat, from which no result is obtained other than the volatilization of the hydrocarbons which are being refined out of the crude base.

It is an object of my invention to provide a means whereby the heat elements now wasted in the refining of oil may be converted into useful work by utilizing these heated elements for the generation of electrical or mechanical energy.

It is a further object of the invention to provide a continuous refining system in which steam is employed for the purpose of agitating and heating the crude oil which has been previously raised to the desired volatilizing temperature, this employment of steam having the purpose of maintaining the temperatures and pressures in the system at a constant point and further assisting in freeing the volatile constituents which it is desired to refine from the crude base.

It is a further object of the invention to provide a system of this character which is substantially automatic in its operation and is provided with automatic means for controlling the pressures therein.

It is a further object of the invention to provide a system of this character having an improved form of evaporator and an improved flow controlling device associated therewith.

The particular advantages of the invention and further objects thereof will be made evident hereinafter.

In the accompanying drawing, which is wholly diagrammatic and for illustrative purposes only, 1 represents an oil pump which pumps unrefined crude oil from reservoirs, not shown, through piping 2 and 3 into a heat interchanger 4 in which it is heated before being delivered through piping 5 into the heating coils 6 situated in the furnace 7. In the heating coils 6, the oil is

raised to the temperature at which the constituents desired to be drawn off in this distillation operation volatilize, and from the coils 6 is delivered through a piping 8 into a vaporizing drum 9. The inner end 12 of the pipe 8 is perforated along the lower side thereof as indicated at 14 so that the hot oil and the volatilized hydrocarbon will be delivered into the body of heated oil 15, existing in the bottom of the drum 9, in fine spray streams. The unvaporized oil or residuum collecting in the drum 9 flows through a pipe 17 into the bottom of a flow regulator comprising a chamber 18 while the volatilized elements pass upwardly through a duct 19 into a vaporizer drum 20. In the vaporizer drum the volatilized gases are received in a cup member 22 which fits over the upper end of the duct 19 and are sprayed downwardly and outwardly into the drum 20 through a horizontally extending pipe 24 having holes 25 in the lower side thereof. In the drum 9, due to the agitation of the oil body 15, certain heavy constituents are carried over into the drum 20 wherein they condense and collect, an outlet pipe 27 being provided to conduct these heavy portions into the bottom of the regulator 18. The volatiles pass from the vaporizer drum 20 through a duct 28 into the upper part of the regulator chamber 18 wherein they are downwardly deflected by a circular baffle plate 32 within which they rise as indicated by the arrows 33 and are delivered under the pressure of the system through a piping 34 into a full condensing turbine 35 which is connected by piping 37 to a final cooler or condenser 38 which delivers the final condensates through piping 39 to settling tanks or other separating means, not shown.

In combination with the aforementioned apparatus a boiler 40 is provided from which steam is delivered, through piping 41 having a valve 42 therein, into a superheater 45 which delivers superheated steam into the system at various points, for the purpose of maintaining the desired pressure and temperature conditions therein, through a pipe 47 having a regulating valve 48 therein. Superheated steam is delivered from the superheater 45 into the piping 8 at a point just before the delivery of the heated oil and volatilized constituents through the portion 12 of the pipe 8 into the separating drum 9. Superheated steam may also be delivered into the coils 6 through piping 50 and regulating valve 51. Steam spray pipes 55, 56, and 57 are further provided respectively in the drums 9 and 20, and in the bottom of the regulator chamber 18, for the purpose of delivering steam into the bodies of oil contained in these devices, the steam having the purpose of agitating the oil so as to thoroughly free the volatile products therefrom and for the purpose of maintaining the de-

sired heat and pressure conditions therein. The residuum from the drums 9 and 20 being delivered through piping 17 and 27, is delivered into the lower end of the regulator 18 and passes through a sinuous course around baffle plates 60 and 61, forming an oil body indicated at 65, this body of oil lifting the float 66 to a point where the valve 67, situated in the residuum outflow piping 68, will be opened due to the swinging of the operating lever 69 in the valve 67 which is accomplished by the interposition of a link 70 between the lever 69 and the crank 71 which in turn is associated with the supporting arm 72 of the float 66. It will be perceived that as the float raises, the levers 71 and 69 are swung downwardly through corresponding angles, thus making it possible to regulate the opening of the valve 67, and consequently the outflow of oil from the regulator 18, by means of the level of the body of oil 65 contained within this regulating chamber. Through steam piping 75 which connects through a suitable packing gland 76 and interior piping 77 with a steam spray ring 78 situated within the float member 66, a constant inflow of steam may be accomplished which will serve to drive out through the pipe 80 any condensates which may collect within the interior of the float 66 or any oil which may enter therein due to a slight leakage of the float. If so desired, the piping 77 and 75 may be employed as a drain for the float 66, through which the collections may be forced from the float under the pressure existing within the regulator. Through the outflow piping 68, the heated residuum is directed into the heat exchanger 4 wherein the heat thereof is transferred to the cold oil delivered into the exchanger 4 through the piping 3, and is from the heat exchanger delivered through piping 81 to suitable storage tanks, not shown.

Distilling operations under pressure are subject to more complete control than such operations conducted at atmospheric pressures. Therefore, in the operation of my device it is desirable that the crude oil be delivered continuously into the system under pressure by the pump 1, and the pressure maintained throughout the system. In the common methods of refining by distillation, the pressures in the system vary considerably at different points and at different periods. It will be recognized that a change in pressure will naturally effect a change in the gravity of the constituents drawn off in the distilling operation during such periods wherein the pressure varies from the established pressure. In the operation of my device, the heated oil from the heat exchanger is delivered under pressure through the piping 5 into the heating coil 6 wherein it circulates at high velocity and is therein raised to the desired volatilizing point. If

a lowering of pressure should occur within the coil 6, this pressure is immediately made up by the addition of superheated steam from the superheater 45 which is delivered
 5 into the coil 6 through piping 50 and a pressure regulating valve 51, which may be set to operate at the desired pressure. Another point in the system where a drop in pressure and temperature is liable to occur is at
 10 the separator or vaporizer where the volatilized elements are released from the heated residuum; therefore, connection is made between the superheater 45 and the piping 8 through a regulating valve 48 and the piping 47, thus providing a means whereby the
 15 pressure in the portion 12 of the pipe 8 and in the drums 9 and 20, may be maintained substantially constant.

If it is desirable, the various pipes may
 20 be provided with any suitable heat insulation (not shown) so that heat losses due to radiation may be reduced to a minimum, thus making it possible to maintain a substantially constant pressure throughout the
 25 entire system. It has been recognized by refining experts that the spraying of steam through a body of oil accomplishes and expedites the distillation thereof, but the use of steam for this purpose is not widely practiced owing to the great heat losses and the
 30 fact that the heat employed for the generation of the steam does not provide adequate return in increased production to justify its employment; but in my system no limitations need be placed upon the use of superheated steam and its free distribution throughout the system, because of the fact that this steam after functioning in the distilling of the oil is finally delivered from
 40 the regulator chamber 18 through the piping 34 with the volatile hydrocarbons into a turbine 35 where the heat thereof is expansively employed in the driving of the turbine by which such heat, ordinarily
 45 wasted and dissipated into the atmosphere through condensers and cooling towers, is transformed into power. For this purpose it is desirable to employ a full condensing turbine so that when the gaseous products delivered through the pipe 34 from a regulator chamber 18 are finally conducted into the cooler or condenser 38, they will be substantially entirely liquefied and require only
 50 a cooling thereof before being delivered in the form of condensates through the piping 39 to the separating devices in which the hydrocarbons are segregated from the water which results from the condensing of the steam in the turbine and the condenser 38.

The turbine 35 delivers mechanical energy representative of the heat contained in the volatilized products, and owing to the fact that there is substantially no heat loss throughout the system, and owing to the
 65 fact that a considerable portion of the heat

contained in the residuum is employed to primarily heat the cold incoming crude oil, the power generated by the turbine will represent a very large portion of the heat expended in the volatilization of the hydrocarbons which are being distilled out of the crude base. It is desirable to employ the turbine for driving electro-generators from which electric energy may be distributed to industries throughout the surrounding
 70 area. It will be perceived that by so employing the ordinarily wasted heat for the purpose of power generation, returns from this conservation of power will cover, and in some cases more than cover, the entire cost of the distilling operation, thus leaving the distilled hydrocarbons in the form of a very valuable by-product to a power generating system. There are quite
 75 a number of refineries operating throughout the country having capacities of 300,000 barrels, and it will be easily understood, when it is considered that one of these plants employs three sixteen inch high pressure water systems merely for the purpose of delivering water through the condensers to remove the heat from the volatilized hydrocarbons, that the horsepower wasted in such a plant due to the throwing away of the heat contained in the volatilized constituents
 80 would supply the power requirements of quite a large area and that electrical power thus generated could be delivered at a very low cost.

I claim as my invention:

1. In an apparatus of the class described the combination of: a heater for raising the temperature of oil to the required volatilization temperature; means for delivering oil to said heater; means for removing and separating the distillation products from said heater comprising a vaporizer in which the volatilized hydrocarbons of said oil are separated from the nonvolatilized residuum, and a regulating chamber into which said
 100 volatilized hydrocarbons and said residuum are separately conducted from said vaporizer and which includes regulating means for governing the discharge flow of residuum in a manner maintaining a liquid sealed residuum outlet from said chamber; a motive device for transforming the expansive heat energy of said volatilized hydrocarbons into mechanical energy and means for conducting said volatilized hydrocarbons from said
 105 regulating chamber to said motive device.

2. An apparatus, as defined in claim 1, in combination with means for generating steam at a higher pressure than is employed in said volatilizing apparatus, and pressure
 110 reducing valves through which said steam is delivered into said apparatus at various points whenever the pressure in said apparatus drops below the required operating pressure.
 130

3. An apparatus, as defined in claim 1, in combination with means for generating steam at a higher pressure than is employed in said volatilizing apparatus, and means
5 for introducing steam from said steam generating means into said volatilizing apparatus at different points, for the purpose of agitating non-volatilized oil contained therein and for maintaining the required
10 heat and pressure in said volatilizing apparatus.

4. An apparatus, as defined in claim 1, in which said regulating means comprises: a shell having a residuum outlet and a gas outlet;
15 a float in said shell; a valve for controlling the outflow of residuum through said outlet; and means so connecting between said float and said valve that the flow through said valve will be governed by the
20 level of residuum in said shell.

5. In an apparatus of the class described, the combination of: regulating means; means for introducing into said regulating
25 means oil heated to the volatilization point of certain of its constituents; motive means for converting expansive energy of vapors to mechanical energy, said motive means being arranged to receive vapors from said
30 regulating means; and means for adding vapor to the hydrocarbon vapors from said oil so as to maintain a substantially constant pressure in the volume of vapors delivered to said motive means.

6. In an apparatus of the class described, the combination of: regulating means; means for introducing into said regulating
means oil heated to the volatilization point of certain of its constituents; motive means

for converting expansive energy of vapors to mechanical energy, said motive means
40 being arranged to receive vapors from said regulating means; and pressure regulated means for adding vapor to the hydrocarbon vapors from said oil so as to maintain a substantially constant pressure in the volume
45 of vapors delivered to said motive means.

7. In an apparatus of the class described, the combination of: regulating means; means for introducing into said regulating
50 means oil heated to the volatilization point of certain of its constituents; motive means for converting expansive energy of vapors to mechanical energy, said motive means being arranged to receive vapors from said
55 regulating means; and means for adding steam to the hydrocarbon vapors from said oil so as to maintain a substantially constant pressure in the volume of vapors delivered to said motive means.

8. In an apparatus of the class described,
60 the combination of: regulating means; means for introducing into said regulating means oil heated to the volatilization point of certain of its constituents; motive means for converting expansive energy of vapors
65 to mechanical energy, said motive means being arranged to receive vapors from said regulating means; and pressure regulated means for adding steam to the hydrocarbon vapors from said oil so as to maintain a
70 substantially constant pressure in the volume of vapors delivered to said motive means.

In testimony whereof, I have hereunto set my hand at Los Angeles, California, this 25th day of November, 1922.

MILON J. TRUMBLE.