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OIL STILL

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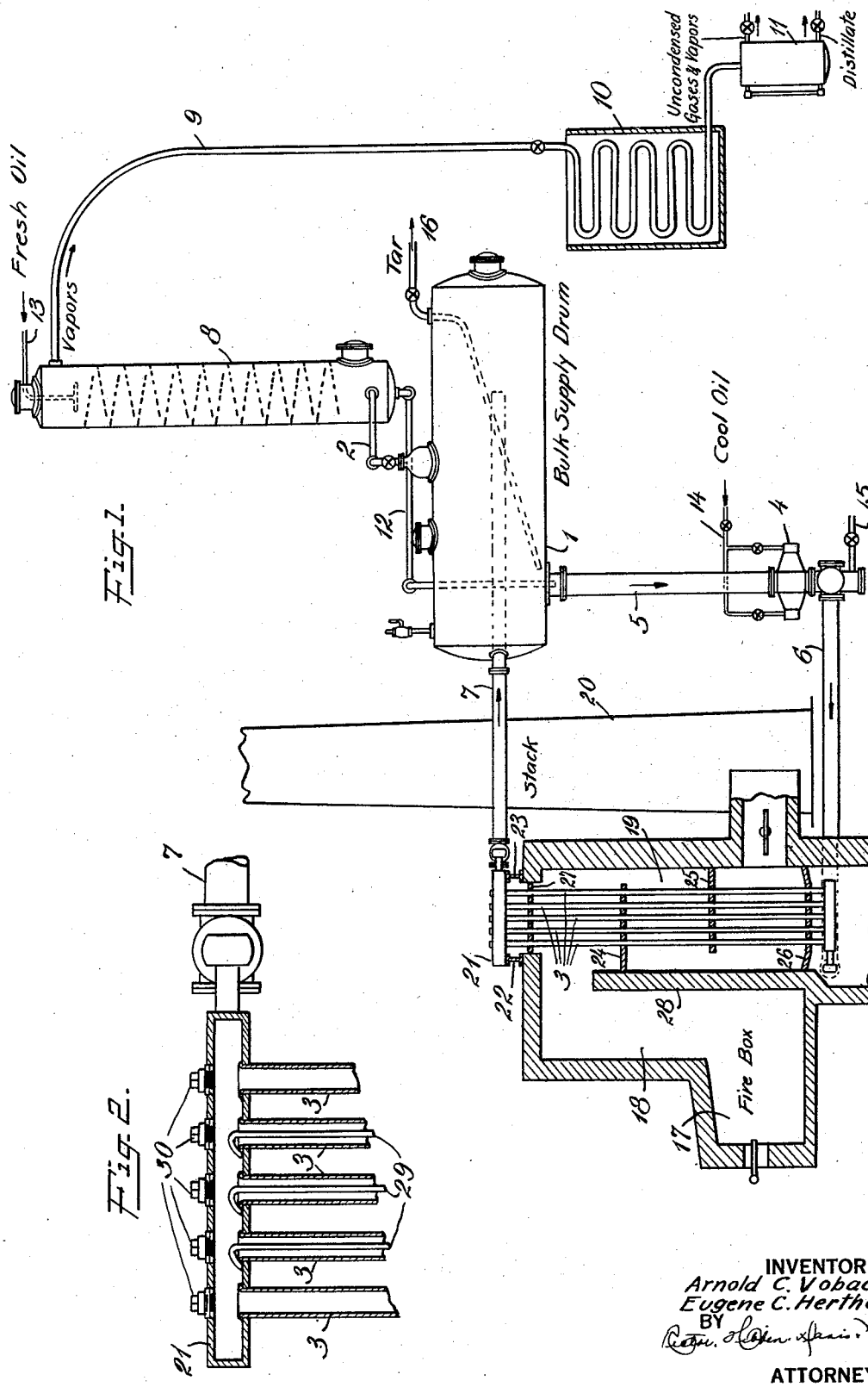


Fig. 1.

Fig. 2.

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OIL STILL

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This invention relates to improvements in apparatus for the distillation of hydrocarbon oils for the production of lighter hydrocarbon oils therefrom. More particularly, the invention relates to improvements in circulatory oil cracking stills in which a body of oil is maintained at the cracking temperature in a bulk supply tank by circulating the oil from and to the bulk supply tank through a battery of heating tubes connected in multiple, located in a suitable furnace.

In the operation of the improved apparatus of the invention a more even heat absorption by the oil in the various portions of the battery of heating tubes is obtained so that danger of local overheating with consequent formation of carbon deposits on the heated surfaces is minimized and the efficiency and capacity of the apparatus likewise increased. Depreciation of the apparatus and fire hazard due to extreme local overheating and burning out of the tubes subjected to the most severe conditions are also reduced in the apparatus of the invention, and, as a longer run may be obtained without shutting down for cleaning, a still further increase in the capacity per still over a long period of time may be obtained.

The invention is of particular application in connection with oil cracking stills of the general character of that described and illustrated in Patent No. 1,285,200 granted to the Sinclair Refining Company, on the application of E. W. Isom, November 19, 1918.

The cracking of heavier hydrocarbon oils by distillation under pressure for the production of lighter hydrocarbon oils therefrom is accompanied by the formation of fixed gas and carbon, pitch, etc., the character and amount of which are functions of the temperature, the amount increasing rapidly as the temperature necessary to effect the desired cracking is exceeded. The carbon and pitch formed tends to adhere to the externally heated surfaces of the still insulating them from the cooling effect of the circulating oil. This action is cumulative and may cause extremely high temperatures to be reached in a comparatively short time, which impairs the strength of the material and sometimes causes rupture of the still or tube walls, but in any event necessitates shutting down the still for cleaning.

In the usual practice of cracking oils, as carried out in stills of the type referred to, it has been found desirable to use oil temperatures of about 700 to 800 degrees F. For high efficiency and economy it is desirable to extract from the products of combustion the largest possible portion of the heat contained therein. To accomplish this, it is essential that a high average temperature differential be maintained between the heating gases and the heat absorbing surfaces with which they contact, thus necessitating a high initial temperature of the heating gases.

Since overheating of any one tube or portion thereof necessitates the termination of the run, the capacity of the still is limited by the conditions prevailing at the point subjected to the most severe conditions. Accordingly when the operation is so regulated that the tubes with which the hot gases are first contacted are not subjected to extreme conditions, the remaining tubes which constitute a considerable portion of the total heating surface, are operating considerably below their maximum capacity.

For maximum efficiency and economy it is therefore desirable, in stills of the character to which the invention relates, to provide for equal distribution of heat absorption through the battery of heating tubes or at least to avoid excessive heating in any region and to provide for effective heat absorption throughout. Usually, however, the heating gases are at their maximum temperature as they first contact with the oil containing tubes, their temperature declining as they circulate over succeeding tubes of the battery, so that the temperature difference between the heating gases and the oil containing tubes with which they later contact, is considerably less than the temperature difference at the initial point of contact.

In certain stills of the general type referred to circulation of the oil through a bank of heating tubes from and to a bulk supply tank is maintained by a pump arranged in the cir-

culating connections, while in others thermosiphonic action is relied upon entirely to produce the desired circulating effect. In either case, however, the velocity of circulation through the individual tubes is effected to a considerable extent by the temperature to which it is subjected. Accordingly, circulation through the heating tubes last exposed to contact with the heating gases tends to become sluggish so that an increased opportunity is afforded for the formation of carbon deposits on the walls of these tubes.

In the apparatus of the present invention cores are arranged in and extend through those tubes in the battery intermediate the front and back rows. By this arrangement the cross sectional area of the battery of heating tubes, and particularly of the intermediate rows of tubes, is appreciably reduced and the velocity of circulation and rate of heat transfer correspondingly increased. The ratio of heating surface to volume in the intermediate tubes of the battery is also increased while a proportionally larger volume of oil is circulated through the heating tubes with which the heating gases first contact and which accordingly absorb the greatest amount of heat. A free and unrestricted passage for the circulation of a relatively large volume of oil through the tubes with which the heating gases last contact is nevertheless provided at the same time that the velocity of circulation through these last tubes is increased so that they may be swept clear of carbonaceous material which might otherwise tend to accumulate therein, due to sluggish circulation, and make or burn onto the walls of the tube as a layer of carbon or coke.

By increasing the average velocity of circulation through all of the tubes in the battery an increased volume of oil is circulated through the tubes with which the heating gases first contact so that both the increased rate of heat transfer due to the increased velocity of circulation and the increased volume of oil are effective in increasing the capacity of the still as well as in reducing the temperature of that part of the heat transferring surfaces which is subjected to the most severe temperature conditions. The increased rate of heat absorption at the heating surfaces subjected to the most extreme conditions also permits the maintenance of a higher initial temperature of the heating gases.

The oil circulating through the intermediate tubes of the battery which are not contacted with the heating gases at their initially high temperature is conveyed in annular streams in intimate contact with the heating surfaces, and with an increased velocity of flow. The heat absorbed by the oil in these intermediate tubes, which comprise a large portion of the heating surface, is increased in the apparatus of the invention by the greater rate of heat transfer, due to the increased velocity of the circulating oil flowing therethrough, and at the same time greater protection is afforded to the tubes with which the heating gases first contact.

The invention will be further described in connection with the accompanying drawings illustrating in a somewhat conventional and diagrammatic manner one embodiment of the apparatus of the invention, but it is intended and will be understood that the invention is illustrated thereby, but is not limited thereto.

In the drawings:

Fig. 1 is an elevation partly in section of a pressure still embodying the invention;

Fig. 2 is a sectional elevation, to a larger scale, of a portion of the battery of heating tubes and the upper header.

The pressure still illustrated in Fig. 1 is of the general character described and illustrated in Patent No. 1,285,200, previously referred to. It comprises a bulk supply drum 1, adapted to maintain the main body of oil being cracked, a vapor line 2 for the escape of vapors of the cracked oil, a battery of heating tubes 3 arranged in a furnace, a circulating pump 4 and circulating connections 5, 6 and 7 connecting successively the bulk supply drum, the circulating pump, the lower end of the heating tubes, the upper end of the heating tubes and the bulk supply drum. The vapors escaping from the bulk supply drum to the vapor line 2 may be passed through the reflux tower 8 in which they may be subjected to direct contact with fresh oil charged to the still. The vapors from the reflux tower escape through vapor line 9 to a condenser 10, and receiver 11 from which the distillate and uncondensed vapors and gases may be separately withdrawn. Reflux, and admixed fresh oil when fresh oil is introduced into the reflux tower, are returned to the still through connections 12. Fresh oil may be introduced to the upper end of the reflux tower through connection 13. Cool, fresh oil may be supplied to the bearings of the circulating pump through connection 14 to cool and protect the same. A connection 15 is provided for pumping out and initially charging the still. A connection 16 is arranged for withdrawing tar from the still during the operation thereof.

The furnace structure comprises a firebox 17 which may be of any usual or approved construction furnishing the required amount of heat, an uptake 18, a downtake heating flue 19 connecting with the stack 20. The battery of oil heating tubes 3 is suspended vertically in the heating flue 19, the upper header 21 thereof being supported on I-beams 22 and 23 on top of the furnace. The heated products of combustion descending through the heating flue 19 are caused to circulate back and forth over the heating tubes by means of the baffles 24 and 25. The lower end of the heating flue is closed by a partition or floor

26 arranged somewhat above the lower end of the heating tubes and supported thereby. The upper end of the heating flue is closed by partition 27 arranged in the opening in the top of the furnace through which the heating tubes depend, this partition as well as the baffles 24 and 25 being supported by the heating tubes. The heating tubes 3 of the battery are thus suspended from their upper end and may expand or contract freely with changes of temperature. The battery of heating tubes may likewise be removed as a unit through the opening at the top of the furnace for the purpose of inspection and repair.

The distance between the baffle 24 and the top of the heating flue is greater than the distance between the baffles 24 and 25 and this latter distance in turn is greater than the distance between the baffle 25 and the bottom of the heating flue so that the velocity of the heating gases is progressively increased through the successive passes in the heating flue as the temperature of the heating gases falls, thereby compensating to a greater or less extent for the decreased heating effect of the heating gases as their temperature declines. The front tubes in the battery of heating tubes are prevented from receiving an undue amount of heat by direct radiation from the firebox 17 by provision of the bridge wall 28 and the elongated flue or uptake 18, the bridge wall acting as a screen to cut off direct radiation from the firebox to the heating tubes.

Each of the tubes intermediate the front and back rows of the battery is provided with a core 29 suitably suspended therein and extending centrally therethrough to the lower header. The upper headers 21 are provided with removable plugs 30 arranged to register with the end of the heating tubes 3 so that the cores may be readily removed and the tubes cleaned.

In the operation of the apparatus of the invention oil is circulated from the bulk supply drum 1 by means of the circulating pump 4 to the lower end of the heating tubes 3 and thence upwardly therethrough and back to the bulk supply drum from the upper end of the heating tubes. Circulation is assisted by the progressive heating of the oil as it flows upwardly through the heating tubes. The hot products of combustion arising from the firebox are first contacted with the upper end of the heating tubes through which a large volume of oil is being circulated at increased velocity and which are accordingly capable of the greatest heat absorption without objectionable overheating, the gases then circulating back and forth over the heating tubes downwardly to the connection with the stack. A free and unobstructed flow is nevertheless maintained through the heating tubes with which the coolest heating gases are contacted and through which the circulation might otherwise tend to become sluggish.

The heat in the hot products of combustion is thus effectively utilized, the bridge wall 28 cutting off direct radiation from the firebox and assisting to prevent overheating of the front tubes of the battery from that cause while further distribution of heat absorption is provided by the increase in velocity of the products of combustion as they pass downwardly through the heating flue and as their temperature decreases due to the absorption of heat by the circulating oil, by the progressively decreasing area of the passage through which they are required to circulate.

We claim:

1. In tubular oil cracking stills, a heating flue, a firebox connected to one end of the heating flue and a stack flue connected to the other end thereof, a battery of oil heating tubes connected in multiple arranged in and extending through the heating flue whereby heating gases passing from the firebox to the stack flue pass thereover in the heating flue, means for circulating oil through the oil heating tubes in multiple and in a direction generally countercurrent to the flow of heating gases thereover, and cores arranged in and extending through the oil heating tubes in the said heating flue except those tubes immediately adjacent the firebox and the stack flue.

2. In tubular oil cracking stills, a heating flue, a firebox connected to one end of the heating flue and a stack flue connected to the other end thereof, a battery of oil heating tubes connected in multiple arranged in and extending through the heating flue whereby heating gases passing from the firebox to the stack flue pass thereover in the heating flue, means for circulating oil through the oil heating tubes in multiple and in a direction generally countercurrent to the flow of heating gases thereover, the intermediate oil heating tubes in the said heating flue having cores located centrally therein and extending longitudinally therethrough whereby the cross sectional area of the intermediate tubes is decreased and the velocity of circulation therethrough increased.

3. In tubular oil cracking stills, a heating flue, a firebox connected to one end of the heating flue and a stack flue connected to the other end thereof, a battery of oil heating tubes connected in multiple arranged in and extending through the heating flue whereby heating gases passing from the firebox to the stack flue pass thereover in the heating flue, the oil heating tubes first exposed to the heating gases from the firebox in the heating flue having a free, unobstructed passage therethrough and the intermediate heating tubes of the battery having cores centrally located therein and extending therethrough.

4. In an oil cracking still a furnace having a heating flue connected at one end to a fire-

box and at the other end to a stack flue, a battery of heating tubes connected in multiple arranged in and extending through the heating flue in the furnace, a still drum and connections including a pump for circulating oil therefrom through the heating tubes of the battery in multiple and back to the still drum, and cores located and extending through the heating tubes in the said heating flue except those first exposed to the heating gases from the firebox and those last exposed to the heating gases passing from the heating flue to the stack flue.

5. In an oil cracking still a furnace having a heating flue connected at one end to a firebox and at the other end to a stack flue, a battery of heating tubes connected in multiple arranged in and extending through the heating flue in the furnace, a still drum and connections including a pump for circulating oil therefrom through the heating tubes of the battery in multiple and back to the still drum, baffles in the heating flue for causing gases from the firebox to flow over the heating tubes in a series of passes, and cores located and extending through the heating tubes in the said heating flue except those first exposed to the heating gases from the firebox and those last exposed to the heating gases passing from the heating flue to the stack flue.

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