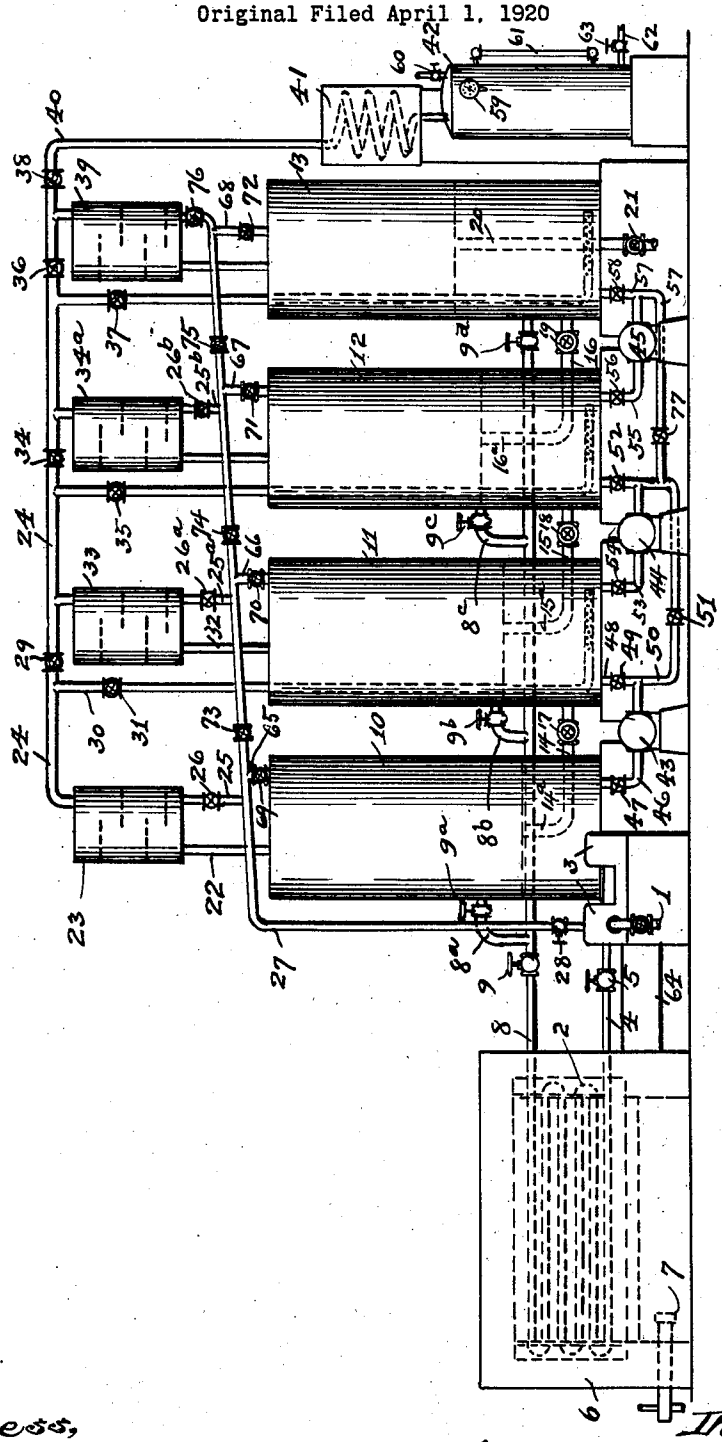
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APPARATUS AND PROCESS FOR TREATING HYDROCARBON OILS

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APPARATUS AND PROCESS FOR TREATING HYDROCARBON OILS

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My invention relates to improvements in an apparatus and process for treating hydrocarbon oils and refers more particularly to a differential pressure process for the converting of heavy hydrocarbon oils into lighter oils of the character of gasoline or the like.

Among its salient objects are to provide a process in which the oil is subjected in succeeding steps to different pressures and temperatures, the limits of same being controlled to maintain the oil under the most advantageous cracking conditions; to provide a process in which the oil vapors passing through the stages of the process are dephlegmated in each stage by being passed through the residual oil before finally being directed to the condenser, thereby producing a more uniform distillate; to provide a process in which the precipitated carbon is prevented from settling in the bottom of the separate retorts which constitute the stages of the process due to constant agitation; to provide a process in which the heat and pressure involved in the process of cracking the oil are economically employed to separate the lighter from the heavier hydrocarbons and at the same time provide a novel and improved type of apparatus to efficiently carry out the process of the character referred to.

The single figure is a diagrammatic side elevation of the apparatus used to carry out this process.

Referring to this drawing, the raw oil is introduced to the supply pipe 1 from any convenient source and is forced into the cracking tubes 2 through the pump 3 and charging pipe 4, which is controlled by valve 5. The oil in the tubes is subjected to heat in the furnace 6, the heat being supplied by means of an oil burner 7. The cracked oil is directed from the cracking tubes through the lines 8, 8a, 8b and 8c controlled by valves 9, 9d, 9a, 9b and 9c respectively to a series of connected retorts 10, 11, 12 and 13. These retorts are connected by the lines 14, 15 and 16, in which are interposed the valves 17, 18 and 19. The ends of these pipe lines are upturned at 14a, 15a and 16a to form open ended stand-pipes in each of the retorts. An open ended stand pipe 20 extends up into the retort 13 and furnishes a residuum drawoff from this final stage of the apparatus. This drawoff pipe 20 is controlled by a valve 21.

In each of the succeeding retorts, it will be noted that the standpipe extends a little higher into the retort and retains the residual oil at a somewhat higher level. The vapors generated in the retort 10 rise into the vapor line 22 and are dephlegmated in the aerial 23. From this aerial the uncondensed vapors are directed out through the line 24, while the distillate is returned to be retreated in the cracking tubes through the secondary connecting line 25, which is controlled by a valve 26 and the return line 27, controlled by valve 28 and the pump 3. The natural course of the vapors, after passing into the line 24, assuming the valve 29 closed, is down through the injector line 30, controlled by valve 31 into the residual oil of the next succeeding retort 11. The lower part of this injector line is perforated, thereby permitting the vapors to be diffused in small streams through the residual oil.

The passing of these vapors through this liquid subjects them to further dephlegmation and assists in the vaporization of any lighter hydrocarbons which may be contained in the residual oil of this retort. The vapors or gasses bubbling up through the liquid pass out through the top of the retort 11, through the line 32 and are again subjected to the condensing action of the dephlegmator 33 located above the retort 11. As previously explained, the vapors pass off into the line 24 and the distillate is returned to the cracking tube. With the valves 29, 34, 36, in a closed position and valve 38 in an open position, and the vapors taking their normal course, they will be directed as explained through each of the successive retorts, being subjected to a dephlegmatory action both in the aerials 23, 33, 34a and 39 and in the residual oil in retorts 10, 11, 12 and 13 and finally pass over from the final aerial 39 through the gooseneck 40 to the water condenser 41 and receiver 42. The distillate condensed in the aerials is tapped off to be returned through the pipe 27 to the cracking tubes, as explained in the case of the aerial 23 which is located above the first retort 10.

The condensate from the dephlegmators instead of being returned to the cracking tubes through the line 27 may be directed to the retorts through the connecting pipes 65, 66, 67 and 68 which are regulated by the valves 69, 70, 71 and 72. Valves 73, 74, 75 and 76 in the distillate return line 27 and valves 26, 26a and 26b in pipes 25, 25a and 25b furnish additional means for controlling the disposition of the condensate from the dephlegmator.

To maintain the residual oil in the retorts at a proper height, it may be necessary to pump the oil from one stage to another and for this purpose, I mount the pumps 43, 44 and 45 between

the respective retorts and connect them with the retorts in such a manner that pump 43 may draw oil from the retort 10 through the inlet line 46 controlled by valve 47 and supply the same to the retort 11 through the line 48, controlled by valve 49; or by closing the valve 49, the retort 11 may be cut out and the residual oil supplied to the retort 12 through the line 50, which is controlled by valves 51 and 52. The pump 44 in the same way may draw a supply of residual oil through the inlet pipe 53 controlled by valve 54 and supply the same to the retort 12 through the line 50, or if the valve 52 be closed, the retort 12 may be cut out and the residual oil supplied to the retort 13 through line 57 regulated by valves 58 and 77. The pump 45, taking its charge of residual oil from the retort 12 through the line 55, controlled by valve 56, supplies the same to the retort 13 through line 57 controlled by valve 58. The height of the residual oil in each of the retorts may be regulated either by the system of pumps or by the valves 17, 18 and 19 interposed in the standpipe lines.

The receiver for collecting the final distillate is fitted with the usual type of pressure gauge 59, pressure relief valve 60, liquid gauge 61 and draw-off pipe 62 controlled by a valve 63. By causing the gases to pass through a series of aerials, and bubble up through the residual oil in the retorts, the final vapor is thoroughly dephlegmated. This agitating of residual oil in the respective retorts by passing vapors therethrough tends to keep the precipitated carbon caused by the cracking of the oil in suspension in the retorts and obviates, to a great extent, the difficulties of having this precipitated carbon deposited upon the interior of the retorts and vapor lines. The controlling of the amount of residual oil relative to the volume of gases in the respective retorts, together with the absolute control of the pressure commensurate with the temperature provides a combination by means of which the character of the final distillate may be positively controlled.

If desired, the heating gases from the furnace may be directed by means of a duct 64, to the different retorts to offset to a certain degree, the heat lost through radiation in the retorts and vapor lines.

It will be noted that with the arrangement of the valves (as shown) in the inlet, vapor distillate return lines from the dephlegmators and the residuum or condensate control lines to the respective retorts, one or more of the retorts may be cut out of the system at any time to be cleaned or repaired.

In the cracking of hydrocarbon oils, in the process above explained the oil on entering the first retort is at a high temperature and high pressure. In this first expansion or cracking zone, vapors will be released from the body of the oil commensurate with the temperature and pressure maintained in said zone. That portion of the oil which is directed to the succeeding retort will be subjected to a temperature somewhat lower than the temperature in the initial stage and a correspondingly decreasing pressure. Here again, oil vapors which would be released under such conditions are freed from the oil and are subjected to identical conditions of dephlegmation as those released from the initial stage except that after passing through the aerial condenser, they are injected into the body of the oil in a succeeding retort where the temperature of the oil is somewhat lower. So on, in each succeeding stage, the decreasing pressure maintained therein releases oil vapors having a higher end point. From the final stage we have a combination of these vapors injected through the oil body and directed to be condensed and collected as a distillate in the receiving tank.

As an illustrative run, I will heat gas oil from the midcontinent field of from 32° to 34° Baumé to a temperature of about 850° F. in the heating coils and admitting the same to the initial stage, where a pressure of 125 pounds is maintained upon the oil. For efficient operation and for procuring a greater yield of oil, I find that the succeeding temperatures in the stills 11, 12 and 13 are roughly 750°, 700° and 650° F. respectively. The pressure in each stage decreases from 25 to 50 pounds. Under such conditions a yield of 50% distillate may be obtained from which I have been able to procure by redistillation, about 80% of 400° F. end point gasoline.

I claim as my invention:

1. A continuous process for treating hydrocarbon oils, comprising subjecting the oil to heat in a cracking zone to be heated to a cracking temperature, in passing the oil through successive vapor releasing chambers of diminishing temperatures and pressure, in removing reflux condensate from the vapors produced in each vapor releasing chamber, and in passing the vapors produced in one vapor releasing chamber through a body of oil undergoing treatment at a cracking temperature in the succeeding vapor releasing chambers of lower temperature and pressure and in finally discharging the vapors for condensation and collection.

2. A continuous process for treating hydrocarbon oil, consisting in subjecting the oil to heat in a cracking zone, in passing the cracked oil through successive vapor releasing chambers of decreasing temperature and pressure, dephlegmating the oil vapors from one of said vapor releasing chambers by passing the same through a body of unvaporized oil at a cracking temperature in the succeeding chamber, drawing off and condensing the vapors from the final vapor releasing chamber.

3. A continuous process for treating hydrocarbon oil, consisting in subjecting the oil to heat in a cracking zone, in passing the heated oil through successive vapor releasing chambers of decreasing temperature and pressure, dephlegmating the oil vapors from one of said vapor releasing chambers by passing the same through a body of unvaporized oil at a cracking temperature in the succeeding vapor releasing chamber, in subjecting the vapors to a further dephlegmating action and in returning the reflux condensate obtained thereby to the cracking zone for retreatment and in drawing off and condensing the vapors from the final chamber.

4. A continuous process for cracking hydrocarbon oils, consisting in subjecting the oil to a cracking temperature in a heating zone, in passing the highly heated oil through zones wherein successively decreasing temperatures and pressures are maintained, in dephlegmating the oil vapors generated in the respective zones by injecting the same into the bodies of the unvaporized oil in the succeeding zones and by passing them through successive dephlegmating towers, at least one of said bodies being at a cracking temperature, in returning selected portions of the resulting reflux condensate through the heating zone, and in collecting and subjecting the vapors from a predetermined zone to condensation.

5. A continuous process for treating hydrocarbon oils, consisting in subjecting the oil to a cracking temperature in a heating zone, in directing the heated oil constituents through zones of decreasing temperature and pressure, in dephlegmating the oil vapors generated in the respective zones by passing them into the bodies of the unvaporized oil in the succeeding zones, at least one of said bodies being at a cracking temperature, in maintaining the carbon in suspension by agitating the oil in each zone with such vapors from the preceding zone, in further dephlegmating the vapors by passing them through successive dephlegmating towers, in returning selected portions of the reflux condensate resulting from such dephlegmation for re-treatment in the heating zone, and in subjecting the vapors from the final zone to condensation, and in collecting the resulting distillate.

6. A continuous process for treating hydrocarbon oil comprising subjecting the oil to heat in a cracking zone, passing the oil through successive vapor releasing chambers, collecting successively greater quantities of liquid oil in said successive vapor releasing chambers, passing oil vapors from a preceding vapor releasing chamber through the body of oil in a succeeding chamber and drawing off and condensing the vapors issuing from the final releasing chamber.

7. A continuous process for treating hydrocarbon oil comprising subjecting the oil to heat in a cracking zone, passing the oil through successive vapor releasing chambers, collecting successively greater quantities of liquid oil in said successive vapor releasing chambers, passing oil vapors from a preceding vapor releasing chamber through the body of oil in a succeeding chamber, thereafter subjecting the vapors to a dephlegmating action and returning reflux condensate obtained thereby to the cracking zone for retreatment.

8. Apparatus for cracking hydrocarbon oils comprising a heating coil, a battery of stills, means for selectively charging oil from the coil to the several stills, means for condensing a portion of the vapors from the stills, and means for selectively admitting condensate to the several stills.

9. Apparatus for cracking hydrocarbon oils comprising a heating coil, a battery of stills, means for selectively charging oil from the coil to the several stills, condensing means in connection with the stills, means for conducting condensate from said condensing means and selectively admitting same to the stills severally, and means for selectively drawing off liquid from the lower portion of the stills.

10. Apparatus for cracking hydrocarbon oils comprising a plurality of stills, vapor equalizing and liquid level lines interconnecting the stills in series, means for introducing oil to the stills comprising a manifold line with valved branches to the several stills adapted to selectively admit the oil to the stills severally, a reflux condenser adapted to receive vapors from the stills and means for returning condensate from said reflux condenser to the several stills comprising a manifold line with valved branches to the several stills.

11. An apparatus for cracking hydrocarbon oils comprising a heating means, a plurality of serially arranged vapor releasing chambers, means for introducing oil from said heating means to any one of said chambers, means for maintaining successively greater quantities of oil in the succeeding chambers of the series, means for taking off vapors from each of said chambers, means for passing vapors taken from a preceding chamber through a succeeding chamber, means for subjecting vapors issuing from the last of said series of chambers to condensation, and means for maintaining a superatmospheric pressure on the oil undergoing treatment in the apparatus.

12. An apparatus for cracking hydrocarbon oils comprising a heating means, a plurality of serially connected vapor releasing chambers, means for maintaining successively greater quantities of liquid oil in the succeeding vapor releasing chambers, means for introducing oil from said heating means to said serially connected vapor releasing chambers, means for introducing vapors from a preceding chamber into the lower portion of a succeeding chamber, means for subjecting vapors issuing from said serially connected chambers to final condensation, and means for maintaining controlled pressure conditions on the oil in each of said serially connected vapor releasing chambers.

13. A process of distilling oil comprising heating a heavy hydrocarbon oil under pressure to a cracking temperature while it is being circulated in a stream, discharging the heated oil into an enlarged chamber while maintaining the pressure therein to separate vapors from the oil, continuously leading the vapors and the oil in separate streams from the chamber into a body of oil maintained at a cracking temperature and pressure, bringing the vapors into direct contact with the oil of the body and leading off vapors from the body and condensing them.

14. A conversion process which comprises heating heavy hydrocarbon oil to cracking temperature under pressure while flowing in a restricted stream, discharging the heated oil into an enlarged chamber maintained under superatmospheric pressure and separating vapors from unvaporized oil therein, continuously removing unvaporized oil from said chamber and maintaining a body thereof at a cracking temperature in a second chamber, continuously removing vapors from the first-named chamber and introducing the same into said body in the second chamber, and removing vapors from the second chamber and condensing the same.

15. A conversion process which comprises heating heavy hydrocarbon oil to cracking temperature under pressure while flowing in a restricted stream, discharging the heated oil into an enlarged chamber maintained at cracking temperature and under superatmospheric pressure and therein separating vapors from unvaporized oil, continuously removing separate streams of vapors and unvaporized oil from said chamber and introducing the same to a second chamber maintained under lower pressure than the first-named chamber, a body of unvaporized oil being maintained at a cracking temperature in the second chamber and the stream of vapors being introduced into said body, and removing vapors from the second chamber and condensing the same.

16. A conversion process which comprises heating heavy hydrocarbon oil to cracking temperature under pressure while flowing in a restricted stream, discharging the heated oil into an enlarged chamber maintained at cracking temperature and under superatmospheric pressure, simultaneously distilling a body of oil at a cracking temperature in a second chamber maintained under lower pressure than the first-mentioned chamber, separately removing vapors and unva-

porized oil from the first-mentioned chamber and introducing the same into said body of oil in the second chamber, and removing vapors from the second chamber and condensing the same.

17. A conversion process which comprises heating heavy hydrocarbon oil to cracking temperature under pressure in a heating zone and separating the same into vapors and unvaporized oil in an enlarged chamber maintained under pressure, removing unvaporized oil from the chamber and distilling a body thereof at cracking temperature in a second chamber, separately removing vapors from the first-mentioned chamber and dephlegmating the same to condense heavier fractions thereof, returning resultant reflux condensate to the heating zone, introducing lighter fractions of the vapors uncondensed by said dephlegmation into said body of unvaporized oil in the second chamber, and removing and condensing the vapors from the second chamber.

18. A conversion process which comprises heating hydrocarbon oil to cracking temperature under pressure in a heating zone and separating the same into vapors and unvaporized oil in an enlarged chamber maintained under cracking conditions of temperature and pressure, removing unvaporized oil from the chamber and maintaining a body thereof in a second chamber maintained at lower cracking temperature and pressure than the first-mentioned chamber, separately removing vapors from the first-mentioned chamber and dephlegmating the same to condense heavier fractions thereof, returning resultant reflux condensate to the heating zone, introducing vapors uncondensed by the dephlegmation into said body of unvaporized oil in the second chamber, and removing and condensing the vapors from the second chamber.

19. A conversion process which comprises heating heavy hydrocarbon oil to cracking temperature under pressure while flowing in a restricted stream, discharging the heated oil into an enlarged chamber maintained under cracking conditions of temperature and superatmospheric pressure, continuously removing unvaporized oil from the chamber and maintaining a body thereof at a cracking temperature in a second chamber under lower pressure than the first-mentioned chamber, continuously removing vapors from the first-mentioned chamber and introducing the same into said body of oil in the second chamber, and removing vapors from the second chamber and condensing the same.

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