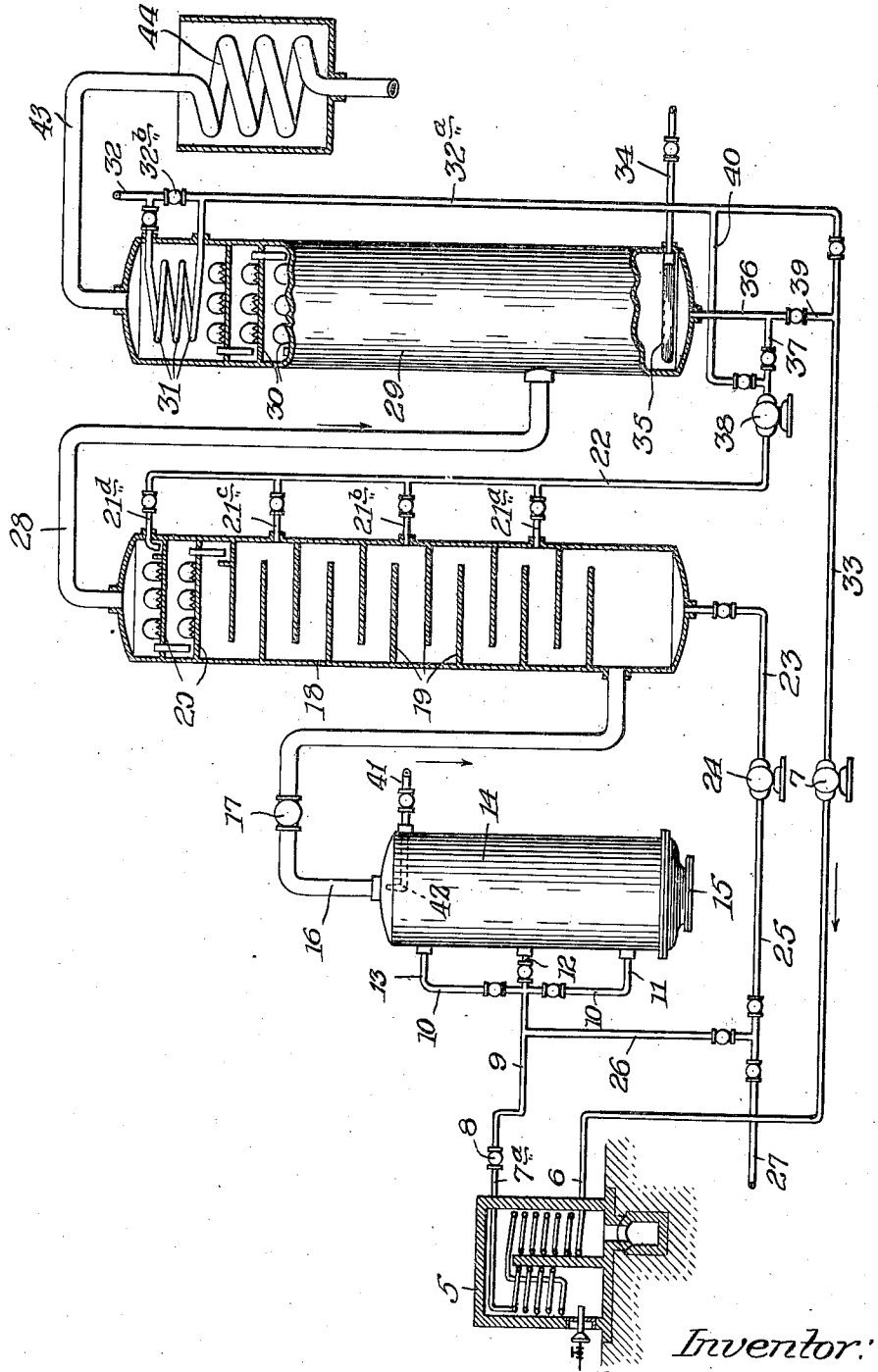
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CONVERSION PROCESS

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CONVERSION PROCESS

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The present invention relates to improvements in the production of lower boiling point hydrocarbon oils such as gasoline or other oil suitable as motor fuel, from heavier or higher boiling point hydrocarbon oils. It will be fully understood from the following description, illustrated by the accompanying drawing, in which the figure shows diagrammatically, and partially in section, apparatus suitable for carrying the invention into effect.

Referring more particularly to the drawing, the numeral 5 indicates a furnace, in which there is provided a suitable heating coil for imparting a desired cracking temperature to the oil under treatment. The oil is supplied to the coil in the furnace through the line 6 by the pump 7, and after being heated, leaves the furnace through the line 7a provided with a pressure release valve 8. The oil or vapors then pass through the line 9 into a manifold 10, from which the oil may be discharged at a selected level through line 11, line 12 or line 13, into the enlarged chamber 14. The latter is preferably of a vertically elongated form and is provided at its bottom with a suitable manhead 15, permitting access to its interior for cleaning and removal of coke.

Vapors pass out of the enlarged chamber 14 through the line 16 provided with valve 17, and enter the lower portion of the tower 18. The interior of this tower is provided with suitable fractionating plates 19, such as baffle plates or screen plates and in the upper portion thereof, a few more efficient fractionating plates 20, such as bubble cap plates, may be arranged. Oil may be discharged into this tower at one or more levels through the pipes 21a, 21b, 21c, 21d, which are supplied from the manifold 22. Oil thus supplied descends the tower in countercurrent to the rising vapors, scrubs the latter, and the resulting liquid is collected in the lower portion of the tower 18. This liquid is removed from the tower 18 through the discharge line 23 by pump 24. It is then forced to the line 25, and a part of or all of it may be caused to pass through the valved line 26 into the line 9 before it enters the manifold 10. Any remainder of oil withdrawn from the base of the column 18 may be discharged from the system through the valved line 27. This line may also be employed for supplying additional oil to the line 26, when desired for purposes of temperature control. For oil so supplied, it is preferred to use residual oils, which could not otherwise be distilled without deposition of coke.

The uncondensed vapors from the tower 18 pass out through the vapor line 28 into an intermediate point in the fractionating tower 29, which is suitably provided internally with fractionating plates 30, illustrated as bubble cap plates. The upper portion of the column may be cooled, for example, by oil fed to the coil 31 in the top of the column from the oil supply line 32. By this means, a suitable reflux is established in the column, and the oil passed through the coil 31 is preheated. This oil is discharged from the coil 31 through the line 32a, by which it is conducted to the line 33 leading to the suction side of pump 7 which feeds line 6 and the heating coil in furnace 5. A by-pass 32b is provided around coil 31.

Condensate formed in the column 29 descends and collects in the lower portion of the column, where it may be stripped, if desired, by steam supplied from line 34 to the distributing pipe 35 in the lower portion of the column. The condensate leaves the column through the line 36. A portion of it may be taken up through valved line 37 by the pump 38 and fed to the manifold 22, from which it may be caused to enter the column 19 through the lines 21a, 21b, 21c and 21d at one or more desired levels. The remainder of the oil or condensate withdrawn from the lower portion of the column 29 passes through the valved pipe 39 to the line 33 leading to the pump 7 which passes it, together with the oil preheated in the coil 31, into the heating coil in the furnace 5.

The following illustrates a process conducted in accordance with the present invention.

A suitable heavy oil, which it is desired to convert into gasoline, and which is preferably a distillate oil heavier than gasoline, is supplied by pump or other suitable device to the line 32 and is passed through the coil 31 in the upper portion of the fractionating column 29, being there preheated by the rising vapors and cooling the latter to provide condensate and reflux. The oil, thus preheated, passes through line 32a and mingles with the condensate which collects in the lower portion of the column 29 and which passes out of the latter through the lines 36 and 39. The mixed oil, which is at a temperature below that at which cracking to form gasoline takes place at an appreciable rate, is forced by pump 7 through line 6 into the heating coil in furnace 5. In the latter, the oil is heated to completely vaporize it and bring the vapors to a rapid cracking temperature.

Although any desired vapor phase cracking conditions may be employed in heating the oil

in the heating coil, it is preferred to cause it to be rapidly vaporized and brought to a temperature of at least 850° F. with a relatively small amount of cracking to gasoline; preferably not more than 15% of the total amount of cracking to gasoline during the entire pass. In its continued travel through the heating coil, the oil vapors are maintained at a temperature above 850° F., and preferably brought to a temperature of 900 to 1000° F. with a pressure on the coil outlet of 100 to 400 lbs., maintained by the valve 8. Although such conditions are preferred, as they produce a desirable type of fuel product of the vapor phase type with relatively low loss, as pointed out in the Snow and Sullivan Patent 1,918,991, and other desired conditions for the production of vapor phase or liquid phase cracking, as preferred, may be employed. As will be apparent hereinafter, the temperature employed must be sufficiently high to effect the desired cracking and coking of the heavy tarry products introduced through the line 26, and must be substantially above the minimum (say by 50° to 100° F.) required to secure the desired type of cracking.

In passing through the valve 8, the pressure on the hot oil vapors or oil products from the heating coil is reduced, say to 10 to 60 lbs. gauge, or even to substantially atmospheric. The oil then passes through the line 9 to the manifold 10 and before reaching the latter is intermingled with tarry products derived from the column 18, as hereinafter more fully set forth. The mingled oil products enter the manifold 10 and are discharged into to enlarged chamber 14, preferably tangentially, and the tarry products of cracking and unvaporized products accumulate therein and are allowed to continue to crack and form coke by their contained heat. In beginning operations, the chamber 14 may be preheated, for example, by the procedure described in the Thiele Patent 1,947,319. The oil products may be initially introduced from the manifold 10 through the lower pipe 11. As the coke deposit in the chamber 14 builds up, the line 11 may be closed and the oil products then introduced through the higher line 12. On further building up of the coke deposit in the chamber 14, the line 12 may be closed off also, and the oil products allowed to enter through the line 13. It is preferred to employ a plurality of chambers such as chamber 14, which may be used alternately or in rotation as each is filled with coke. For simplicity of illustration, only one is shown.

The vapors from the chamber 14 pass out through the line 16. Coking or clogging of the outlet of the chamber may be avoided by supplying thereto a small amount of fresh oil, as through line 41 and nozzle 42 directed towards the opening of vapor line 16. The chamber 14 will ordinarily be at a temperature of 850° F. or higher, and may be so maintained by lagging or by the application of a mild heat. A suitable temperature therein is about 900° F. The vapors coming off may be at a temperature of 800° F. or higher, say 800 to 850° F. These vapors pass into the scrubbing tower 18, wherein they are scrubbed with a small proportion of oil introduced into one or more of the pipes 21^a, 21^b, 21^c, 21^d at different levels to remove entrained heavy or tarry matter. The heavy products thus entrained, together with the feed stock supplied into the tower 18, collect in the bottom of the latter and pass out through the line 23 to the pump 24, which forces them to the line 25 and the line 26 into the line 9, conveying the hot vapors and oil products from the heating coil to the enlarged chamber 14. If the proportion of heavy products thus supplied to the line 9 is excessive, so that satisfactory reduction and conversion to coke does not take place in the enlarged chamber 14, a portion of such heavy products may be diverted through the line 27 to storage or used as fuel oil. The proportion of heavy products which may be then added to the hot vapors passing through the line 9 will not ordinarily exceed about 10%.

The vapors from the scrubbing tower 18 pass out through the vapor line 28 into the fractionating column 29, in which the heavier portions thereof, heavier than the desired gasoline product, are condensed, suitable cooling being effected by the passage of suitably controlled proportions or all of the fresh oil through the coil 31 in the top of the column. The lighter constituents of the vapors, including the hydrocarbons in the gasoline point range, pass out through the line 43 to the condenser 44.

The reflux condensate formed in the column 29, which may be completely stripped of its lighter constituents by steam supplied to the distributing pipe 35 from the line 34, passes out through the line 36, and a portion thereof is withdrawn through the line 37 by the pump 38 to be forced into the manifold 22, from which it passes into the scrubbing tower 19. The remainder of the condensate formed in the column 29 mixes with the preheated fresh oil. If desired, instead of condensate from tower 29, fresh oil may be drawn by pump 38 from line 32^a through line 40 and fed to the scrubbing tower 19.

Although it is preferred to maintain vapor phase cracking conditions in the heating coil, suitable temperatures and pressures may be employed, as is well known in the art, to retain a part or all of the oil in the liquid phase at the outlet thereof. The pressure conditions in the coil, which may be at 100 to 1000 lbs. pressure or higher, and the supply of heavy oil products to the products from the heating coil as they enter the enlarged chamber are so controlled as to secure an elevated cracking temperature in the latter, say 775° F. or higher. Under these conditions, the heavy residual products deposited in the enlarged chamber 14 are permitted to pass completely to coke or to a non-liquid residuum. In the event that any liquid residuum collects therein, it may be kept at a high temperature so as to be substantially completely converted into a solid residuum or coke by causing a part or all of the highly heated products from the heating coil to enter the enlarged chamber through a lower inlet.

The proportion of tarry liquid scrubbed out of the vapors from the chamber 14 in the tower 18 is relatively small, and the products so removed are of a tarry nature unsuitable of itself as a cracking stock. Atmospheric pressure or pressure only slightly higher, say not more than 25 to 30 lbs. is preferably maintained in the scrubbing tower 18. The fractionating plates or baffle plates employed in the lower portion thereof are preferably of a character such as baffle plates, which may be readily cleaned of accumulations of coke or carbonaceous material.

I claim:

1. The method of converting relatively high boiling hydrocarbon oils into lower boiling products such as gasoline which comprises heating in a confined stream a substantially comlpetely vaporizable hydrocarbon oil charging stock con-

sisting substantially entirely of a petroleum distillate to substantially completely vaporize the oil and bring the vapors to a high cracking temperature of at least 900° F., passing the stream of heated oil vapors into an enlarged chamber wherein they undergo substantial cracking in the vapor phase by their contained heat, removing in a stream the cracked vapors from said chamber and passing the stream of vapors directly to and through a scrubbing tower, continuously introducing into said tower a small proportion of the said vaporizable charging distillate stock supplied to the cracking operation and intimately contacting the said vapors flowing through said tower only with said completely vaporizable distillate charging stock which is added in a volume just sufficient to scrub from the said cracked vapors substantially only entrained heavy and tarry products of cracking, passing only liquid products comprising said heavy tarry products from said tower into said enlarged chamber while excluding from said chamber heavy residual stocks from external sources, and intimately contacting them with the aforesaid stream of highly heated oil vapors entering the said enlarged chamber, retaining the said heavy products in said chamber at a cracking temperature until they are substantially completely converted to solid residuum, separately withdrawing the scrubbed vapors from said scrubbing tower and passing them directly to a fractionating operation wherein undesired higher boiling constituents thereof are separated in the form of reflux condensate, and separately removing and collecting the fractionated vapors.

2. The method of converting relatively high boiling hydrocarbon oils into lower boiling products such as gasoline which comprises heating in a confined stream a substantially completely vaporizable hydrocarbon oil charging stock consisting substantially entirely of a petroleum distillate to substantially completely vaporize the oil and bring the vapors to a high cracking temperature, passing the stream of heated oil vapors into an enlarged chamber wherein they undergo substantial cracking in the vapor phase by their contained heat, removing in a stream the cracked vapors from said chamber and passing the stream of vapors directly to and through a scrubbing tower, continuously introducing into said tower a small proportion of the said vaporizable charging distillate stock supplied to the cracking operation and intimately contacting the said vapors flowing through said tower only with said completely vaporizable distillate charging stock which is added in volume just sufficient to scrub from the said cracked vapors substantially only entrained heavy and tarry products of cracking, passing only liquid products comprising said heavy tarry products from said tower into said enlarged chamber while excluding from said chamber heavy residual stocks from external sources, and intimately contacting them with the aforesaid stream of highly heated oil vapors entering the said enlarged chamber, the proportion of the returned heavy products being not above 10% relative to the total material charged to said enlarged chamber, retaining the said heavy products in said chamber at a cracking temperature until they are substantially completely converted to solid residuum separately withdrawing the scrubbed vapors from said scrubbing tower and passing them directly to a fractionating operation wherein undesired higher boiling constituents thereof are separated in the form of reflux condensate, and separately removing and collecting the fractionated vapors.

3. The method of converting relatively high boiling hydrocarbon oils into lower boiling products such as gasoline which comprises heating in a confined stream a substantially completely vaporizable hydrocarbon oil charging stock consisting substantially entirely of a petroleum distillate to substantially completely vaporize the oil and bring the vapors to a high cracking temperature, passing the stream of heated oil vapors into an enlarged chamber wherein they undergo substantial cracking in the vapor phase by their contained heat, removing in a stream the cracked vapors from said chamber and passing the stream of vapors directly to and through a scrubbing tower, continuously introducing into said tower a small proportion of the said vaporizable charging distillate stock supplied to the cracking operation and intimately contacting the said vapors flowing through said tower only with said completely vaporizable distillate charging stock which is added in volume just sufficient to scrub from the said cracked vapors substantially only entrained heavy and tarry products of cracking, passing only liquid products comprising said heavy tarry products from said tower into said enlarged chamber while excluding from said chamber heavy residual stocks from external sources, and introducing them into and intimately contacting them with the aforesaid stream of highly heated oil vapors entering the said enlarged chamber, retaining the said heavy products in said chamber at a cracking temperature until they are substantially completely converted to solid residuum, separately withdrawing the scrubbed vapors from said scrubbing tower and passing them directly to a fractionating operation wherein undesired higher boiling constituents thereof are separated in the form of reflux condensate, withdrawing said condensate and passing it to the said heating and vaporizing operation as charging stock therefor, and separately removing and collecting the fractionated vapors.

4. The method of converting relatively high boiling hydrocarbon oils into lower boiling products such as gasoline which comprises heating in a confined stream a substantially completely vaporizable hydrocarbon oil charging stock consisting substantially entirely of a petroleum distillate to substantially completely vaporize the oil and bring the vapors to a high cracking temperature of at least 900° F., passing the stream of heated oil vapors into an enlarged chamber wherein they undergo substantial cracking in the vapor phase by their contained heat, removing in a stream the cracked vapors from said chamber and passing the stream of vapors directly to and through a scrubbing tower, continuously introducing into said tower a small proportion of the said vaporizable charging distillate stock supplied to the cracking operation and intimately contacting the said vapors flowing through said tower only with said completely vaporizable distillate charging stock which is added in volume just sufficient to scrub from the said cracked vapors substantially only entrained heavy and tarry products of cracking, passing only liquid products comprising said heavy tarry products from said tower into said enlarged chamber while excluding from said chamber heavy residual stocks from external sources, and introducing them into and intimately contacting them with the aforesaid stream of highly heated oil vapors entering the said enlarged chamber, the proportion of the re-

turned heavy products being not above 10% relative to the total material charged to said enlarged chamber, retaining the said heavy products in said chamber at a cracking temperature until they are substantially completely converted to solid residuum, separately withdrawing the scrubbed vapors from said scrubbing tower and passing them directly to a fractionating operation wherein undesired higher boiling constituents thereof are separated in the form of reflux condensate, withdrawing said condensate and passing it to the said heating and vaporizing operation as charging stock therefor, and separately removing and collecting the fractionated vapors.

5. The method of converting relatively high boiling hydrocarbon oils into lower boiling products such as gasoline which comprises heating in a confined stream a substantially completely vaporizable hydrocarbon oil charging stock consisting substantially entirely of a petroleum distillate to substantially completely vaporize the oil and bring the vapors to a high cracking temperature, passing the stream of heated oil vapors into an enlarged chamber wherein they undergo substantial cracking in the vapor phase by their contained heat, removing the cracked vapors from said chamber and passing them directly to and through a scrubbing tower, continuously introducing into said tower only a small proportion of the said vaporizable charging distillate stock supplied to the cracking operation and intimately contacting the said vapors flowing through said tower only with said completely vaporizable distillate charging stock to scrub from the said cracked vapors substantially only entrained heavy and tarry products of cracking, separately withdrawing the said scrubbed heavy tarry products and introducing them into the stream of highly heated vapors at a point intermediate the said heating operation and the said enlarged chamber, retaining the said heavy products in said chamber at a cracking temperature until they are substantially completely converted to solid residuum, separately withdrawing the scrubbed vapors from said scrubbing tower and passing them directly to a fractionating operation wherein undesired higher boiling constituents thereof are separated in the form of reflux condensate, and separately removing and collecting the fractionated vapors.

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