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COMPLETE SPECIFICATION

Process for the Conversion of Hydrocarbon Mixtures

(A communication to me from abroad by the Universal Oil Products Company, of 310, South Michigan Avenue, Chicago, Illinois, United States of America, a Corporation organised under the Laws of the State of Delaware, United States of America.)

I, ALBERT LEVY MOND, Doctor of Science of the University of Geneva, Chemical Engineer and Chartered Patent Agent, of 19, Southampton Buildings, Chancery Lane, London, W.C.2, a British Subject, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to the conversion of hydrocarbon mixtures of predominantly paraffinic character to produce substantial yields of olefinic hydrocarbons capable of subsequent polymerization to produce relatively heavy hydrocarbon mixtures of the character of lubricating oil. The process is applicable to the treatment of paraffin wax and hydrocarbon oils containing the same, such as the intermediate highly paraffinic stocks occurring during the separation of solid paraffin from distillates containing high percentages of the solid hydrocarbons and also to synthetically produced paraffinic hydrocarbon mixtures such as those resulting from the interaction of carbon monoxide and hydrogen in the presence of suitable catalysts.

In a more specific sense, the invention is concerned with a process of heat treatment or pyrolysis, which readily permits control of time and temperature at critical points in the conversion process, so that such mixtures of paraffinic hydrocarbons are converted largely into olefins.

It is recognised that modifications of the cracking process as applied to heavy oils for the production of low boiling motor fuel fractions constitute an extensive art at the present time. These have been necessary in view of the widely varying character of the stocks cracked both on the basis of their boiling ranges and their chemical characteristics, as well as the requirements for the motor fuel and other fractions produced.

Knowledge of the independent influences of temperature, pressure and time factor on the course of cracking reactions is in a rather uncertain state due to the difficulties of accurately measuring these factors and determining their separate influences upon the character of cracked products. For example, the influence of temperature upon the velocity of cracking is evidently very pronounced after a temperature of about 850° F. (455° C.) is reached, so that the rate of cracking as measured by gasoline and/or gas production becomes an exponential function of the temperature. In cracking any given stock, it may be a question whether to use a relatively low temperature and a long time factor or a relatively high temperature and a short time factor, both methods having their proponents and being applicable to different stocks under different conditions of operation, and for different purposes. The present invention is concerned with a process for applying relatively high temperature and low time factor cracking to paraffin wax and hydrocarbon distillate mixtures of a paraffinic character so that primary cracking reactions predominate to produce substantial yields of low boiling olefins.

It has been generally recognised that low-boiling olefinic hydrocarbon mixtures, particularly those obtained by cracking hydrocarbon oils constitute a suitable starting material for the production of valuable derivatives therefrom and particularly of their polymerisation into lubricating stocks with the aid of suitable polymerisation agents. The present invention provides a process for producing olefinic starting materials of this character in an efficient and advantageous manner.

Numerous processes are known for the conversion of high-boiling hydrocarbon oils into motor fuels of satisfactory anti-knock value by a vapour phase cracking operation, wherein the high-boiling oil is heated to a vaporising temperature in a heating zone, the heated oil is thereupon freed from non-vaporous components in

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an enlarged vapour separating zone, and the vapours thus obtained are then subjected to vapour phase cracking conditions in a heated tubular reaction zone, if
 5 desired in the presence of steam, whereupon the temperature of the conversion products is abruptly lowered to below cracking temperature by direct admixture of a cooling fluid such as hydrocarbon oil
 10 from within or outside the system.

It has also been proposed in the production of gas for the enrichment of "blue water gas" and of hydrocarbon products including olefins of from 2 to 5
 15 carbon atoms and materials of motor spirit boiling range from gas oil, fuel oil or other petroleum fractions to subject the latter to a preliminary vaporisation with separation of the heavier unvaporised
 20 hydrocarbons in an enlarged vapour separating zone followed either by directly cracking the vaporised material or by first superheating the resulting gaseous products to a predetermined optimum temperature for the concurrent production of
 25 gas and motor spirit with or without the removal of heavier hydrocarbons, such as those susceptible to tar or coke formation at the cracking temperature employed and thereupon effecting the cracking of the
 30 superheated material in a single cracking tube or a plurality of heater units arranged in parallel at a substantially constant temperature during a relatively
 35 prolonged time interval of reaction adapted to develop to substantial completion the desirable products of mutual reaction of the materials undergoing treatment, and to finally discharge the hot
 40 reaction products into the first of a series of separating and condensing towers for the isolation of the desired products.

It has now been found that the separation of preheated hydrocarbon material
 45 into non-vaporous residue and vapours prior to the cracking proper is disadvantageous when it is desired to obtain from the hereinbefore defined initial paraffinic hydrocarbon material an olefinic product
 50 suitable for subsequent polymerisation into hydrocarbon mixtures of the character of lubricating stocks and that a better yield of the desired olefinic product and an improved efficiency of the process as
 55 a whole can be obtained when the process is conducted so that a short time cracking of the initial hydrocarbon material follows directly the heating for the purpose of vaporisation.

Thus, the present invention comprises heating the liquid or liquified initial hydrocarbon material sufficiently to
 60 vaporise the same entirely or almost entirely without material cracking while
 65 rapidly passing through a primary heat-

ing element of tubular and preferably series tubular construction, immediately thereupon subjecting the heated material to vapour phase cracking conditions in a
 70 plurality of parallel and substantially equal streams in a separate cracking element which directly communicates with, but is controlled independently of, the primary heating element and wherein
 75 said heated material is further heated for a sufficiently short time to limit the conversion reaction of the initial hydrocarbon material essentially to a primary cracking reaction thereby to produce substantial
 80 yields of low boiling olefins, abruptly reducing the temperature of the products issuing from said cracking element by direct contact with a cooling fluid to a
 85 point at which substantially no further cracking takes place, separating the cooled products into vaporous conversion products and non-vaporous residue and recovering the desired olefinic products from the vaporous conversion products by
 90 fractional condensation.

In one specific embodiment of the present invention, the initial hydrocarbon material is subjected to vaporisation without material cracking while rapidly passing through a primary heating element of
 95 series tubular construction and immediately thereupon is subjected to the cracking in a plurality of substantially equal streams passing through parallel tubular heating elements under conditions of
 100 high temperature, low pressure and short times to produce high yields of olefins, water or cooled intermediate hydrocarbon fractions are introduced into the resultant conversion products to quickly reduce the
 105 temperature thereof to below a point where further cracking takes place, heavy residual products are separated from the conversion vapours and the latter are fractionated into fixed gases, gasoline
 110 boiling range products of high olefinic content, refluxes which are recycled for further conversion or used in part for cooling the conversion products, and water which may also be re-used, if so
 115 desired, as the cooling fluid.

The process further comprises certain definite features of operation which are essential to the success of the operation on
 120 a commercial basis, and to indicate some of the details of the preferred operation, the attached drawing has been provided which shows by way of example in general side elevation, an arrangement of inter-
 125 connected elements in which the process may be conducted.

Referring to the accompanying drawing charging oils are introduced to a pump 3 by way of a line 1 containing a control valve 2 and are either discharged into the 130

lower section 49 of a final fractionating column 47 by way of line 4 containing control valve 5 or fed through branch line 6 containing control valves 7 and 7' directly 5 to line 8 containing control valve 9 and leading to vaporizing coil 10. The proportioning of the two streams will depend upon the character of charging stock in respect to its boiling range and the presence of relatively heavy constituents which may be difficult to vaporize without cracking. To further control the character of the material subjected to vaporization and later cracking, line 106 10 containing control valve 107 permits a diversion of the charge to flash chamber 30 so that relatively heavy material may be removed as residuum at the outset of the process, thus avoiding possible coke troubles and contamination of the products with materials of an undesirably high degree of unsaturation. For further control of the process and particularly to assist in controlling the final fractionation of the cracked products, a portion of the combined feed from line 6 may be diverted through line 98 containing control valve 99 and through cooler 93¹ to a tank 100 which acts as a reservoir to compensate for fluctuations in the operation of the process and from which the accumulated material may be withdrawn through line 101 containing control valve 102 by a pump 103 and returned through line 104 30 containing control valve 105 to commingle with cooled fractionator bottoms in line 80 and passed to the lower section 49 of fractionating column 47.

Primary heating element 10, arranged to receive heat from a furnace setting 20 having a construction to be presently described in more detail, is of series tubular construction and employed as a vaporizer and preheater. It has been 45 determined after a long series of experiments that, when it is desired to produce highly olefinic distillates by the cracking of paraffinic hydrocarbon fractions, they must be heated through a certain temperature range very rapidly to avoid secondary reactions involving the polymerization, and consequently a loss, of the desired olefins. Apparently this temperature range which is to be passed over 50 quickly is within approximately 853° to 1022° F. (465° to 550° C.), which includes most of the temperatures commonly employed in cracking heavy distillate and residual charging stock with the primary 60 object of producing gasoline.

It has been further determined that best results in regard to the formation of olefins are obtained when pressures are used which are somewhat lower than 65 those ordinarily employed in cracking for

gasoline production. Thus, in ordinary cracking plants, pressures of from approximately 100 to 500 pounds per square inch (6.7 to 34 atmospheres) are employed, while in the present process 70 pressures of less than 260 pounds per square inch (18 atmospheres) can be used, but it is better to employ pressures below 100 pounds per square inch (6.7 75 atmospheres) and preferably only sufficiently above atmospheric to ensure proper flow through the equipment.

In order to assist in controlling the time to which the vaporized hydrocarbon materials are subjected to temperatures best suited for their conversion to olefins, steam is introduced into the oil vapours so that there is a diluting effect and the rate of passage of the vapours through the critical range of olefin-producing temperature is subject to more exact control, while at the same time there is a reduction in partial pressure. Provision is made for introducing steam from a source not shown through line 11 containing control valve 12 and its passage through a coil 13 which functions also as a heat economizer since it abstracts heat from the combustion gases which have passed around the vaporizing and cracking elements in a manner to be later described. If desired, the use of coil 13 95 may be dispensed with and the steam brought to a suitable degree of superheat in an exterior system. The steam is preferably introduced at a point near the end of heating element 10 by way of line 16 containing control valve 17 or it may be admitted to the line joining the primary vaporizing and secondary cracking 105 elements by opening valve 18 and closing valve 17. The amount of steam employed may be varied over a wide range depending again upon the character of the charging stock and the results desired. 110

The vapours from element 10 containing controlled amounts of steam now pass through the cracking element 19 which consists of separate coils of pipe in parallel connection so that the 115 pressure drop is reduced and the time the vapours are maintained at a critical cracking temperature is kept at an optimum point usually upwards of 500° C. The preferred temperatures for most of the hydrocarbon fractions suitable for conversion by the present process are included within the approximate range of 1000 to 1060° F. (538—571° C.). Apparently this temperature range is critical for solid 125 paraffins and highly paraffinic distillates containing, for example, over 70% of crystallizable paraffin wax, and also for lighter distillate containing similarly 130

high percentages of normally liquid paraffin hydrocarbons.

In conjunction with the use of the above temperature range, it is necessary to observe a low time factor, which commonly varies from approximately one to six seconds in the cracking element. This method of operation permits limiting the decomposition reactions to those of a primary character and may be used to produce reaction products of an entirely different character from those which would be produced under lower temperature and higher time factors, since in cracking a highly paraffinic stock the primary reactions have been found to involve to a great extent simply dehydrogenation reactions, which gives a large production of olefins corresponding to the dehydrogenation of the original paraffins and some cracking of these to produce lower molecular weight olefins, with practically no secondary decomposition or polymerizing reactions.

The furnace setting 20 preferably houses both the vaporizing and cracking elements in separate sections in such a way that the latter is subjected to combustion gases of relatively high temperature which are circulated to produce a more or less constant temperature differential between the combustion gases and the oil vapour, while the partially cooled gases pass to the section housing the vaporizing coil, which section may receive additional increments of heat to any necessary extent. Thus a burner 21 which may utilise either liquid or gaseous fuel produces combustion gases which first travel upwardly as shown by the arrow and then downwardly in concurrent flow with the oil vapours passing through the parallel sections of element 19. In order to effect a circulation of the combustion gases around the cracking element, a jet 25 which is supplied with steam through line 23 containing control valve 24 is positioned as shown and the amount of circulation of the combustion gases may be controlled by the amount of steam admitted. The waste combustion gases from the cracking section pass upwardly through series vaporizing coil 10 which receives sufficient supplementary heat from the gases from burner 22.

The cracked vapours are now preferably quickly cooled to some temperature at which cracking is substantially stopped, usually below 500° C., and to effect this cooling either water or cooled intermediate hydrocarbon fractions may be employed. In case the overhead liquid distillate from the final fractionator is to have an end boiling point higher than approximately 400° F. (204° C.), the

cooling or "quenching" of the cracked products is conveniently brought about by injecting water (representing condensed steam) into the cracked vapour line. The cracked vapour is passed through line 26 containing control valve 27 and into line 28 containing control valve 29 and leading to flash chamber 30 which acts as a primary fractionator and residuum separator. Water for quenching may be introduced from the bottom of final receiver 56 by way of line 66, control valve 67, pump 68, and line 69 containing control valve 70.

In case it is desired to make light overhead condensates having a final boiling point substantially lower than 400° F. (204° C.) it is better practice to cool the cracked vapours with intermediate refluxes and for this purpose cooled fractionator bottoms are preferably employed which may enter the junction of lines 26 and 28 from line 87 containing control valve 88. The production of these refluxes will be described at a later point in connection with the fractionator operation.

Line 28 containing the cooled cracked products enters the bottom of flash chamber 30 which preferably contains baffles as shown to assist in separating entrained liquid particles and removing substantially all high boiling materials unsuitable for further cracking. The separated liquids are withdrawn through line 31 containing control valve 32 and passed through a cooler 33 and thence through run down line 34 containing control valve 35 to a receiver 36. From this point they are taken by a pump 39 by way of a line 37 containing control valve 38 and may be disposed of finally as waste product by way of discharge line 43 containing control valve 44. To further assist in retaining all heavy liquid residual particles, a portion of the discharge from residuum pump 39 may be passed through line 40 containing control valve 41 and introduced above the baffles in the flash chamber on a cone 42 which acts as a distributor.

The vapours from flash chamber 30 pass through line 45 containing control valve 46 to enter the bottom section 49 of fractionating column 47 which has a dividing plate 50 permitting the accumulation of intermediate refluxes. Although not shown in the drawing, fractionating column 47 may contain any number of any type of plates or baffles in the upper and lower sections to permit proper fractionation of the entering material.

Bottoms from fractionating column 47 pass through line 71 containing control valve 72 and through a cooler 73 from 130

whence run down line 74 containing control valve 75 leads to receiver 76. The portion of the bottoms thus cooled are now made to serve several purposes, passing 5 through line 77 containing control valve 78 to pump 79 which discharges through line 80 containing control valves 81 and 82 and having a branch line 83 containing control valve 84. To further assist in controlling fractionation in column 47 a 10 portion of the cooled fractionator bottoms may pass through valve 82 in line 80 to commingle with the combined feed supply from tank 100 and enter the lower section 15 49 of fractionating column 47 as previously disclosed, thus adding to the flexibility of the process. The cooled reflux from line 88 may be diverted in part through line 85 containing control 20 valve 86 to assist washing and fractionation of the vapours in the upper portion of flash chamber 30 and in part through line 87 containing control valve 88 to cool the cracked products in line 26 as previously 25 described.

That portion of the fractionating column bottom reflux not employed for cooling and fractionation purposes may be diverted while still hot from line 71 to 30 line 93 by way of connecting line 89 containing control valve 90 and pass through control valve 94 in line 93 to reflux pump 95 which discharges through line 96 containing control valve 97 into line 6 to mix 35 therein with the portion of the original charging material not passed to the fractionating column. Depending upon the character of the charging stock and upon the extent of cracking found 40 necessary to produce substantial yields of polymerizable olefins, all or a portion of the intermediate refluxes accumulating on dividing plate 50 of the fractionating column may be passed through line 91 45 and control valve 92 to line 98 and thence to revaporizing and re cracking with the charge.

The vapours from upper section 48 of fractionating column 47 pass through line 50 51 containing control valve 52 and through a final condenser 53, from which the condensed materials pass through a rundown line 54 containing control valve 55 to receiver 56 having a gas release line 55 57 and a control valve 58 and a hydrocarbon distillate draw line 59 containing control valve 60. A portion of the overhead hydrocarbon distillate may be taken by pump 63 by way of line 61 containing 60 control valve 62 and returned by way of line 64 containing valve 65 to the upper section of the fractionating column to assist in controlling the boiling range of the emerging vapours. Receiver 56 also 65 acts as a water separator.

Without the intent of limiting the scope of the invention in exact accordance with the data presented, the following examples are introduced to show the character of the results obtainable by the commercial application of the process essentially as described above.

EXAMPLE I.

The stock cracked was a soft paraffin wax having a melting point of 59.5° C. This was an intermediate product in which the paraffin had been concentrated by sweating a highly paraffinic distillate. The general properties of this stock are shown in the following table:—

PROPERTIES OF CHARGING OIL.
Specific gravity at 70° C. (158° F.) 0.801
Gravity, "A.P.I. at 70° C. (158° F.) 45.4
Initial boiling point 300° C. (572° F.)
Fraction 300—325° C. (572—617° F.) 1%
Fraction 325—340° C. (617—644° F.) 2%
Fraction 340—350° C. (644—662° F.) 4%
Pour point 53° C. (127.4° F.)

The following table shows the temperatures in °C. which were employed during continuous operation conducted in accordance with the general scheme shown in and described in connection with the drawing:

TEMPERATURES.
Exit of primary vaporizer 465° C. (869° F.)
Steam to inlet of secondary heater 620° C. (1148° F.)
Inlet of secondary heater 445° C. (833° F.)
Exit from secondary heater 551° C. (1024° F.)
After quenching by water 472° C. (882° F.)

EXAMPLE II.

The material subjected to cracking was the heavier portion of a product made by catalytically reacting carbon monoxide and hydrogen in the presence of catalysts and known to the trade as "Kogasin". The properties of this material are shown below

Specific gravity 0.766
4% over at 302° F. (150° C.)
23% over at 392° F. (200° C.)
71.5% over at 572° F. (300° C.)
End boiling point 735° F. (390° C.)

The above charge was cracked in a plant corresponding to the foregoing specification to produce maximum yields of light gasoline having an end point of approximately 335° F. (168° C.) and containing a high percentage of olefinic hydrocarbons. The temperature of the combined feed at the entrance to the vaporizing coil was 470° F. (243° C.) superheated steam was admitted at the

last turn of the vaporizer under 265 lbs. (18 atmospheres) pressure and a temperature of 700° F. (372° C.). A pressure of 60 lbs. gauge (4.1 atmospheres) and a temperature of 1040° F. (560° C.) was maintained at the exit of the cracking element which was immediately reduced to a temperature of 800° F. (426° C.) by the admission of refluxes at a temperature of 175° F. (80° C.). Residuum was withdrawn from the flash chamber at a temperature of 740° F. (393° C.) and cooled to 400° F. (204° C.) before readmission to

assist in washing down the entrained liquids.

The temperature at the top of the flash chamber was maintained at approximately 670° F. (354° C.) under a pressure of 55 lbs. per sq. in. (3.75 atmospheres) and a temperature of 380° F. (196° C.) under a pressure of 50 lbs. per sq. in. 3.4 atmospheres) was maintained at the top of the final fractionator.

The following tabulation indicates the yields by volume and by weight of the various products of the above operation:

Yields.		% by Vol. of Chg.	% by Wt. of Chg.	% Olefins
Unstabilized gasoline 338° F. (170° C.) E.P.		79.6	72	70
30 Residuum, 15° API (S.G.O.996)		6.4	8	—
Gas (Sp.gr.=1.2 air=1.0)		14.0	20	30*
Gas, cu. ft./hbl. charge			585	
Litres/litre charge			104	
*Propylene and butylenes				

A substantial yield of lubricating oil was obtainable by the polymerization of the olefins contained in the light gasoline, these oils having the same general properties as those produced from the olefins obtained by cracking paraffin as in Example I.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. A process for the conversion of normally liquid or solid hydrocarbons comprising essentially a hydrocarbon mixture of predominantly paraffinic character, such as paraffin base stock containing paraffin wax or a hydrocarbon distillate of essentially paraffinic character, to produce olefinic products suitable for polymerisation into lubricating stocks, which comprises heating the liquid or liquified initial hydrocarbon material sufficiently to vaporise the same entirely or almost entirely without material cracking while rapidly passing through a primary heating element of tubular and preferably series tubular construction, immediately thereupon subjecting the heated material to vapour phase cracking conditions in a plurality of parallel and substantially equal streams in a separate cracking element which directly communicates with, but is controlled independently of, the primary heating element and wherein said heated material is further heated for a sufficiently short time to limit the conversion reaction of the initial hydrocarbon material essentially to a primary cracking reaction thereby to produce substantial yields of low boiling olefins; abruptly reducing the temperature of the products issuing from

said cracking element by direct contact with a cooling fluid to a point at which substantially no further cracking takes place, separating the cooled products into vaporous conversion products and non-vaporous residue and recovering the desired olefinic products from the vaporous conversion products by fractional condensation.

2. Process as claimed in claim 1, wherein the initial paraffinic hydrocarbon material upon having been heated rapidly and sufficiently to vaporise the same entirely or almost entirely without material cracking is subjected in the cracking element in the presence of steam to vapour phase cracking conditions of high cracking temperature, low pressure and short time adequate to produce substantial yields of low boiling normally liquid mono-olefins and the temperature of the products issuing from said cracking element is abruptly reduced by direct contact with an aqueous or liquid hydrocarbon cooling fluid to a point at which substantially no further conversion of said mono-olefins takes place.

3. Process as claimed in claim 1 or 2, in which a hydrocarbon distillate of an essentially paraffinic character produced by the interaction of carbon monoxide and hydrogen in the presence of catalysts is subjected to the conversion.

4. Process as claimed in any of the claims 1 to 3, in which the hydrocarbon material to be cracked upon predominating or substantially complete vaporisation is diluted with steam by injecting said steam into a final portion of the primary heating element and/or into the conduit for the passage of the heated material from the primary to the secondary heating element.

5. Process as claimed in any of the claims 1 to 4, in which the hydrocarbon material is subjected to vaporisation in the primary heating element and immediately thereupon while at a temperature approaching the cracking temperature is supplied to the cracking element, the cracking in said cracking element is effected at a temperature of from 500° to 571° C. under a pressure of less than about 18 atmospheres, and the conversion products issuing from the cracking element are cooled to a temperature of less than 500° C.

6. Process as claimed in claim 5, in which the hydrocarbon material is subjected to vaporisation in the primary heating element at a temperature up to about 500° C. the cracking of the initial hydrocarbon material is effected within a time period of the order of or less than six seconds at a temperature of the order of 538—560° C. without substantially exceeding 560° C. under a pressure up to 6.7 atmospheres, measured at the outlet from the cracking element and the conversion products are cooled to a temperature of about 425—475° C.

7. Process as claimed in any of the preceding claims, in which the conversion products issuing from the cracking element are admixed with the cooling fluid, the resultant mixture is separated into vapours and non-vaporous residue in a vapour separating zone, wherein the vapours are subjected to a preliminary fractionation or scrubbing with a scrubbing liquid, the vapours remaining uncondensed are supplied from said vapour separating zone to a fractionating zone and separated in the latter on the one hand into a vaporous low boiling product comprising the olefins suitable for polymerisation into lubricating stocks, and on the other hand into reflux condensate fractions of intermediate boiling range and a portion of said reflux condensate fractions is returned for further conversion together with the initial hydrocarbon material to be converted, while, if desired, a second portion of said reflux condensate fraction is supplied as scrubbing liquid to said vapour separating zone.

8. Process as claimed in claim 7, in which a relatively low-boiling and a relatively high-boiling reflux condensate are separated in the fractionating zone, a re-

gulated portion of the high boiling reflux condensate is subjected to substantial cooling and then used as a cooling fluid for quenching the cracked vapours, and the low-boiling reflux condensate is returned in part or all for revaporisation and cracking together with the initial hydrocarbon material to be converted.

9. Process as claimed in claim 7 or 8, in which a portion of the charging stock for the process is supplied to the vaporisation and cracking treatment, another portion of said charging stock however is utilised in admixture with a portion of the reflux condensate fractions as cooling fluid for the quenching of the cracked vapours and/or as scrubbing liquid in the vapour separating zone and/or as cooling and refluxing agent in the fractionating zone.

10. Process as claimed in any of the claims 7—9, in which the liquid residual oil obtained in the vapour separating zone is cooled and a regulated portion of said cooled residual oil is supplied as scrubbing liquid to the vapour separating zone while the remaining portion of said residual oil is withdrawn from the process as liquid residual product thereof.

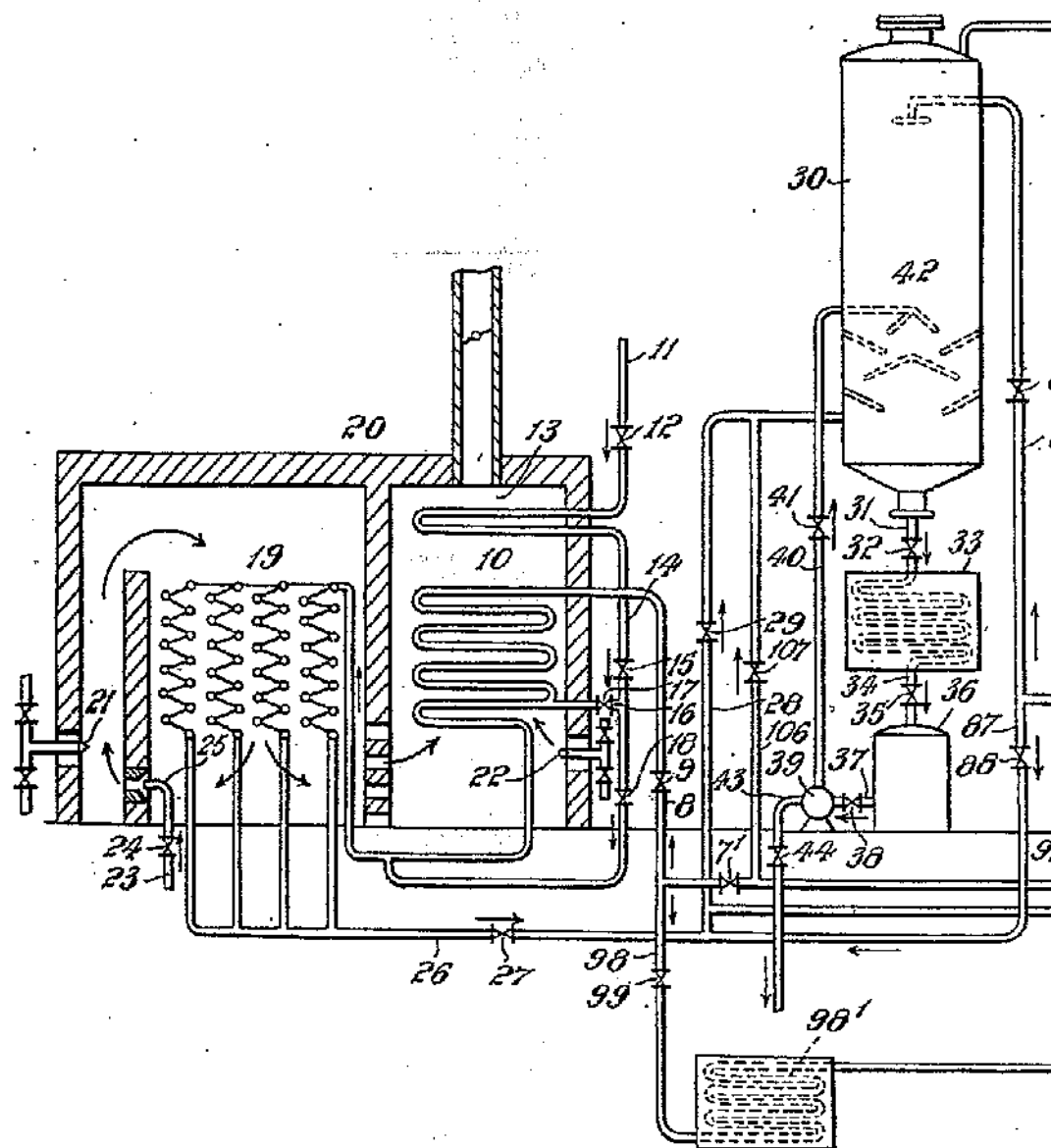
11. Process as claimed in claim 7, in which a high boiling hydrocarbon mixture containing the initial hydrocarbon material to be converted as well as high boiling components unsuitable for conversion into low boiling olefinic hydrocarbons is supplied to the vapour separating zone, said high boiling components are separated and removed in admixture with the non-vaporous residue of the conversion products while the initial hydrocarbon material to be converted is vaporised in said vaporising zone and subsequently condensed in the fractionating zone in admixture with the reflux condensate fractions of intermediate boiling range to be subjected to the revaporisation and cracking.

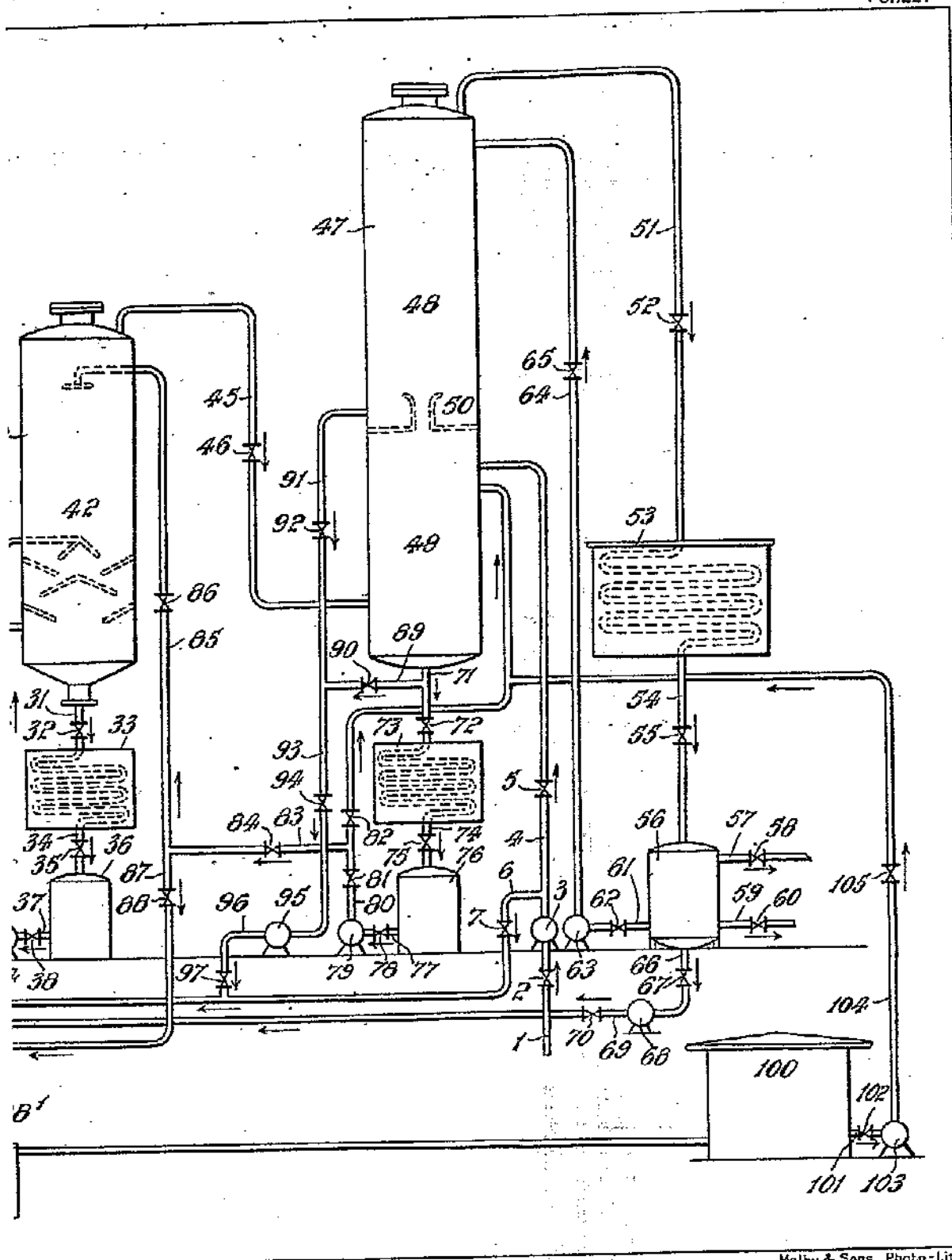
12. Process for the production of olefinic hydrocarbons capable of polymerisation into heavy hydrocarbon mixtures of the character of lubricating oil from hydrocarbon mixtures of predominantly paraffinic character substantially as described.

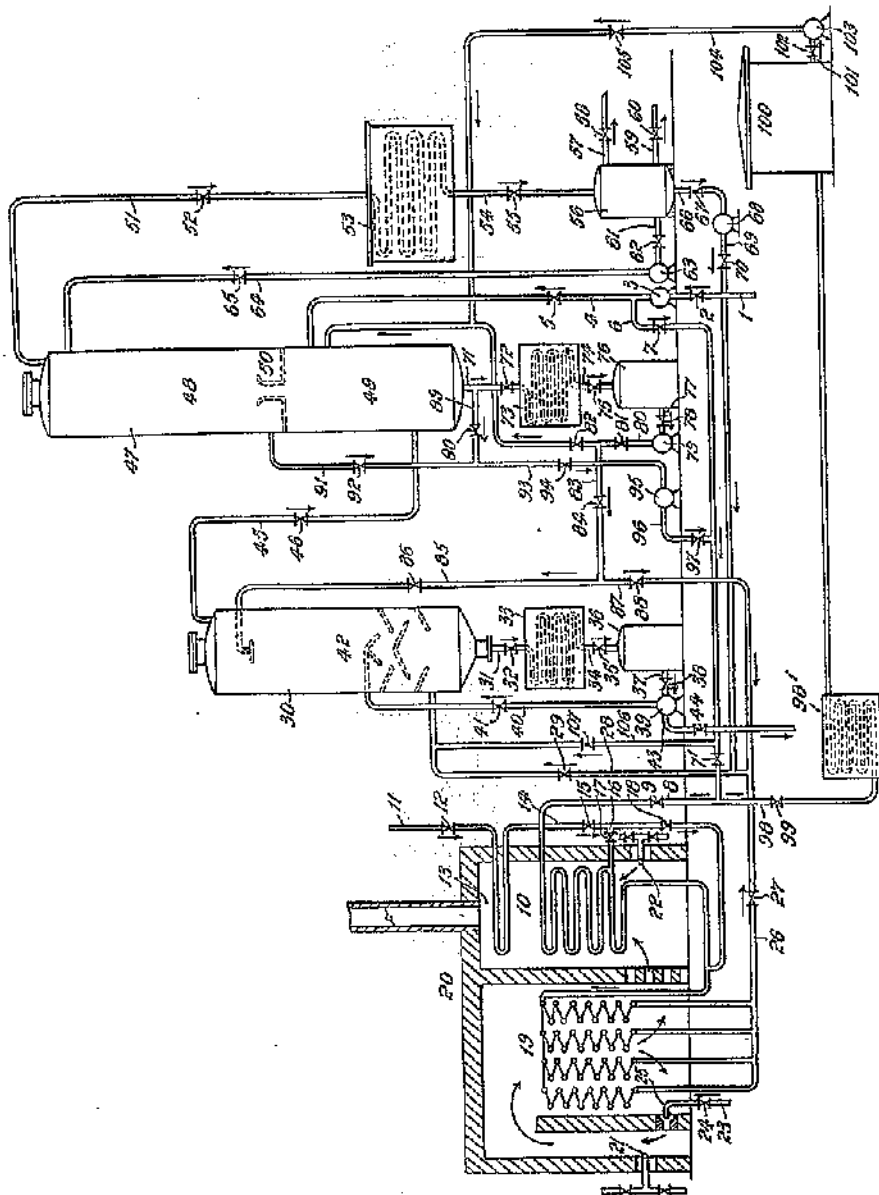
Dated this 9th day of April, 1937.

ALBERT L. MOND,
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